



STATE OF WASHINGTON
STATE BUILDING CODE COUNCIL

May 2018
Log No. _____

1. State Building Code to be Amended:

- | | |
|--|---|
| <input type="checkbox"/> International Building Code | <input type="checkbox"/> International Mechanical Code |
| <input type="checkbox"/> ICC ANSI A117.1 Accessibility Code | <input type="checkbox"/> International Fuel Gas Code |
| <input type="checkbox"/> International Existing Building Code | <input type="checkbox"/> NFPA 54 National Fuel Gas Code |
| <input checked="" type="checkbox"/> International Residential Code | <input type="checkbox"/> NFPA 58 Liquefied Petroleum Gas Code |
| <input type="checkbox"/> International Fire Code | <input type="checkbox"/> Wildland Urban Interface Code |
| <input type="checkbox"/> Uniform Plumbing Code | |

For the Washington State Energy Code, please see specialized [energy code forms](#)

Section(s): Amending R202 and adding a new section - R335

Title: Electric Vehicle Charging Infrastructure

2. Proponent Name (Specific local government, organization or individual):

Proponent: Thad Curtz

Title: Individual

Date: March 25, 2022 (Modified May 31, 2022)

3. Designated Contact Person:

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4. Proposed Code Amendment.

Code(s) - IRC Section(s) R202; R335 (a new section)

Add the following definitions to Section R202:

AUTOMATIC LOAD MANAGEMENT SYSTEM (ALMS). A system designed to manage electrical load across one or more EV Ready parking spaces.

ELECTRIC VEHICLE (EV) CAPABLE PARKING SPACE. A parking space provided with a conduit, electrical panel and load capacity to support future installation of EV charging equipment.

ELECTRIC VEHICLE. A battery electric vehicle or plug-in hybrid electric vehicle suitable for highway use and operating partially or exclusively on electrical energy stored from the grid, or an off-board source, for motive purpose. "Electric vehicle" does not include electric motorcycles.

ELECTRIC VEHICLE (EV) CHARGER. Off-board charging equipment used to charge electric vehicles.

ELECTRIC VEHICLE (EV) CHARGING STATION. A parking space provided with an installed electric vehicle charger.

ELECTRIC VEHICLE (EV) READY PARKING SPACE. A parking space provided with an EV charger or a receptacle outlet allowing charging of electric vehicles.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the electric vehicle connectors, attachment plugs, personnel protection system, 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.

Add the following new section:

335.1 Electric vehicle (EV) charging for new construction. The provisions of this section shall apply to the construction of new ~~buildings and accessory structures~~ one- and two-family dwellings; townhouses not more than three stories above grade plane in height with a separate means of egress; and ADUs with required parking and their own electrical meters.

~~Electric vehicle supply equipment (EVSE) shall be installed in accordance with applicable requirements of RCW 19.28 and the National Electrical Code, Article 625.~~

EXCEPTION: Electric vehicle charging infrastructure is not required if any of the following conditions are met:

1. There is no public utility or commercial power supply for the premises.
2. Dwelling units do not have ~~garages or other~~ on-site parking.

335.2 New one- and two-family dwellings with private garages or attached carports, new ADUs with required parking and their own electrical meters, and new townhouses with private garages. A minimum of one 40- ampere dedicated 208/240-volt branch circuit to support EV charging shall be installed for each dwelling unit. The branch circuit shall terminate at an installed EV charger, or at a receptacle outlet or junction box in close proximity to the proposed location of EV charging equipment.

EXCEPTION: Electric vehicle charging infrastructure is not required if any of the following conditions are met:

1. Detached garages do not have other electrical requirements.
2. Vehicles will not be able to park within 12 feet of the ADU using the required parking.

335.3 Buildings and accessory structures Townhouses with on-site parking in surface spaces. ~~Buildings and accessory structures with on-site parking shall be provided with~~ When required parking for residents at townhouses covered by this section is provided through surface parking areas they shall include a minimum of EV Charging Stations, EV-Ready parking spaces, and EV-Capable parking spaces in accordance with Table 335.3. Calculations shall be rounded up to the nearest whole number.

TABLE 335.3
ELECTRIC VEHICLE CHARGING INFRASTRUCTURE

<u>Number of EV Charging Stations</u>	<u>Number of additional EV-Ready Parking Spaces</u>	<u>Number of additional EV-Capable Parking Spaces</u>
<u>10% of total required parking spaces for residents</u>	<u>25% of total required parking spaces for residents</u>	<u>10% of total required parking spaces for residents</u>

EXCEPTION: Townhouses with fewer than six required spaces for residents provided through surface parking areas shall include a minimum of two EV-Ready parking spaces. Townhouses with seven to ten required spaces for residents provided through surface parking areas shall include a minimum of one EV Charging Station and three EV-Ready parking spaces.

335.3.1 EV charging stations and EV-Ready parking spaces. A minimum of one 40-ampere dedicated 208/240-volt branch circuit shall be installed for each EV-Ready parking space and each EV Charging Station. The branch circuits shall terminate ~~at a receptacle outlet~~ in close proximity to the proposed location of the EV-Ready parking space or at the EV Charging Station.

335.3.2 EV-Capable parking spaces. A listed raceway capable of accommodating a minimum of one 40-ampere dedicated 208/240-volt branch circuit shall be installed for EV-Capable parking space. The raceway shall terminate into a cabinet, box or other enclosure in close proximity to the proposed location of the EV-Capable parking space. Raceways and related components that are planned to be installed underground, or in enclosed, inaccessible or concealed areas and spaces, shall be installed at the time of original construction.

~~**335.4 Electrical room(s) and equipment.** Electrical room(s) and/or dedicated electrical equipment shall be sized to accommodate the requirements of Section 335.~~

The electrical service and the electrical system, including any on-site distribution transformer(s), shall have sufficient capacity to simultaneously charge all EVs at all required EV Charging Stations, EV-Ready parking spaces, and EV-Capable parking spaces at a minimum of 40-amperes each.

EXCEPTION: Automatic Load Management System (ALMS) may be used to adjust the maximum electrical capacity required for the EV-Ready and EV-Capable parking spaces. The ALMS must be designed to allocate simultaneous charging capacity among multiple future EV Charging Stations at a minimum of 16 amperes per EV charger. (For example, a circuit with a 60 amp breaker capable of delivering 48 amps of continuous load may be used to provide for three of these spaces.)

~~**335.5 Electric vehicle charging infrastructure for accessible parking spaces.** Accessible EV Charging Stations and EV-Ready parking spaces shall be provided in accordance with Section 429.4 of the International Building Code.~~

5. Brief explanation of the proposed amendment:

The Department of Commerce's *Washington 2021 State Energy Strategy* concludes that staying within the State's greenhouse gas emissions limits requires dramatically reducing the 45% of our current emissions which come from transportation by “electrifying as many passenger, truck and freight vehicles as possible [and] investing immediately in the infrastructure required to support massive vehicle electrification.”¹ In recognition of this need, the State adopted HB1287, specifying that the rules for electric vehicle infrastructure that RCW 19.27.540 requires the Council to adopt “must exceed the specific minimum requirements ... [of that] section for all types of residential and commercial buildings to the extent necessary to support the anticipated levels of zero emissions vehicle use that result from the zero emissions vehicle program requirements in chapter 70A.30 RCW and that result in emissions reductions consistent with RCW 70A.45.020 [the State's greenhouse gas emissions limits].

This proposed change in the IRC will support those anticipated levels of vehicle use, which are discussed in Section 7a below. Charging at home is the most convenient and cheapest option for EV owners, and making that less expensive and simpler by providing for it during new construction rather than through more

complicated and expensive later retrofits is probably the most important change in the building code that the Council can make to support “the anticipated levels of zero emissions vehicle use” in the state and to promote the reductions in transportation emissions consistent with the State's limits. The Council has already responded to this legislation by significantly increasing the requirements for electric vehicle charging infrastructure in Section 429 of the commercial code, which is now being moved forward for public comment. However, those changes will only support charging in the relatively small percentage of residential occupancies constructed under the IBC. This proposal will provide for future charging in most new residences. (This is, in fact, what the Legislature intended to do through the provision in HB1287 removing the exemption of “residential R3” from the EV infrastructure requirements, as the Senate floor debate on the bill shows.)

Electrifying transportation will also contribute to other important State policy goals by improving air quality and reducing the pollutants in stormwater entering Puget Sound.

The proposal would result in a small increase in the initial cost of residential construction, a small increase in the sales of electrical supplies, and a more significant increase in the long term sales of plug-in vehicles and chargers for them. It would not involve special reporting requirements, additional inspections, or have other foreseeable impacts on enforcement.

6. Specify what criteria this proposal meets. You may select more than one.

- The amendment is needed to address a critical life/safety need.
- The amendment clarifies the intent or application of the code.
- The amendment is needed to address a specific state policy or statute.
- The amendment is needed for consistency with state or federal regulations.
- The amendment is needed to address a unique character of the state.
- The amendment corrects errors and omissions.

7. Is there an economic impact: Yes No

8. Life Cycle Cost. You may submit an alternate life cycle cost analysis.

I estimate the typical cost of running an additional 40 Amp, 240 Volt circuit in the process of new residential construction at \$335, using current retail prices for materials at Home Depot. (40 Amp breaker @\$20; 50 ft #8 NM-B @ \$150; receptacle and box @\$15; 1.5 hours licensed electrician's labor @\$150.)

I estimate the typical cost of adding an additional 40 Amp, 240 Volt circuit in existing residential construction at \$1,000. (I had a Level 2 charger installed at my home in Olympia in September last year; the contractor quoted me their standard flat rate for an installation as \$995, not including the EVSE, though I eventually

negotiated a \$150 discount, reducing the final price to \$845. I am in the process of installing a single split heat pump; that contractor's standard flat rate for the electrical is \$1,500. (This includes somewhat more than adding the 20 Amp 240V circuit, since it covers a fusible disconnect and surge protector for the outdoor unit, and a three wire connection in flexible conduit from that to the indoor unit.) I got a bid from another electrician last October for running a 30 Amp 240V circuit for a future heat pump water heater from my panel to the half basement; that was \$1,290 plus permit and tax.

A cost-effectiveness study of installations in multi-family buildings conducted by Pacific Gas & Electric for the City and County of San Francisco in 2016 arrived at a similar estimate of the relative costs of providing complete circuitry for Level 2 chargers in larger new construction versus retrofitting it.¹The retrofits were roughly three times as expensive. Providing circuitry for two EV parking spaces in a building with ten spaces was estimated to cost \$920/circuit, while retrofitting them was estimated to cost \$3,710/circuit. Providing circuitry for twelve EV parking spaces in a building with 60 spaces was estimated to cost \$860/circuit, while retrofitting them was estimated to cost \$2,370/circuit.

On the basis of my estimates, adding a charger in new construction now typically costs around \$665 less than retrofitting the circuit. However, we're considering a current expense at the time of construction versus a delayed cost savings, so our estimated savings need to be adjusted to account for that. If we use a discount rate of 4.55%, Bankrate.com's current estimate for 30 year fixed rate mortgages in Washington, it turns out that it's worth paying \$335 in the present in order to save \$665 in the future for up to 16 years. At that rate, as long as one household out of three in the new units built each year going forward under the proposal got a plug-in vehicle and needed a charger within the first 16 years after construction, and the other two never got one but bore the additional expense of having the circuit installed in their units, there would be no additional overall cost from the requirement. (If the costs of labor and material increased in the future, we'd be paying more for the retrofit than the current cost I'm using here...)

In fact, considerably more than a third of the households in new units constructed with this code change after 2024 would be shifting to plug-in vehicles within 16 years of the unit's construction. Washington is currently committed to a complete phaseout of new fossil fuel light vehicles by 2035 as part of our adoption of California's zero emission vehicle standards, and the Legislature just adopted a 2030 phaseout goal for the state. Sales of plug-ins are growing rapidly. In 2017, 2.5 percent of new light-duty vehicle purchases in the state were

¹ “Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco”; Energy Solutions on behalf of the PG&E Codes and Standards program. Accessed at: <http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-PEV-Infrastructure-Cost-Effectiveness-Report-2016.pdf>

battery electrics or plug-in hybrids ²; in 2019 they were 4.2% of purchases ³; and in 2020 they were 7%.⁴ That's a 68% increase in their market share over the two years between 2017 and 2019, and a further 66% increase in their market share from 2019 to 2020. Reaching 100% plug-in purchases by 2035 would only require about an 18% increase in their market share each year.

At this point, 4.7% of the light vehicles in Washington are plug-ins. Since the average age of those vehicles in the US is now 12.1 years, about 8.3% of them are being replaced each year. An 18% increase in annual market share implies that in 2025, when this proposal began to affect new construction, about 1.58% of the State's households would be acquiring a new plug-in vehicle, and that the accumulated additions to the fleet through increasing annual purchases between now and then would mean that just under 13% of the cars on the road were plug-ins by 2025. After 2035, every one of the 8.3% of vehicles replaced each year will be a zero-emission vehicle, but on this analysis, over a third of the vehicles on the road will already need chargers by 2033, nine years after this code proposal's requirements would become effective. (I'm attaching a spreadsheet with the estimates.)

I also think that for many people the complications and worries involved in choosing and hiring a contractor are a more significant barrier to adding a charger for a plug-in than the cost, and that already having a charger installed or a suitable receptacle allowing you to simply buy an electric vehicle and plug it will increase their adoption. If that's right, the proposal would produce a number of additional economic and social benefits.

I did some comparisons of the lifetime costs and greenhouse gas emissions of plugin passenger vehicles and comparable gasoline vehicles in 2020, using the manufacturer's suggested retail prices and the available Federal and State incentives, the average price of regular conventional retail gasoline in Seattle between 2010 and 2019, which was \$3.26/gallon, and the local price of electricity in Thurston County, where I live - \$.1035/kWh. The emissions estimates include the upstream emissions from the production of gasoline and from the production of the coal and natural gas used to generate PSE's electricity in 2017. (I used this figure for five years, until 2025, when the Clean Energy Transformation Act is supposed to eliminate power from coal; for the five year transition period from then until 2030, I've used half of that; and I've treated the "greenhouse-gas neutral" power required after 2030 as emission free, on the somewhat dubious assumption that the 20% of power from

² 2017 market share from "Pacific Northwest Pathways to 2050: Achieving an 80% reduction in economy-wide greenhouse gases by 2050" Accessed at:

https://www.cascadia.edu/discover/about/sustainability/E3_Pacific_Northwest_Pathways_to_2050.pdf. (Data from the Alliance of Auto Manufacturers 2018 Advanced Technology Vehicle Sales Dashboard.)

³ 2019 market share from <https://evadoption.com/ev-market-share/ev-market-share-state/>

⁴2020 market share from "Electrification Assessment of Public Vehicles in Washington"; Atlas Public Policy, WSU Energy Program & National Renewable Energy Laboratory

Accessed at

https://leg.wa.gov/JTC/Meetings/Documents/Agendas/2020%20Agendas/Nov%2017%20Meeting/Electrification_draftfinalreport.pdf (Data from Atlas EV Hub, "Automakers' Dashboard," September 2020)

natural gas that's still allowed will actually be effectively offset by the measures in the Act.) I've used the default national mileage and driving assumptions from the Alternative Fuels Data Center's Vehicle Cost Calculator – 11,926 miles/year, with 56% of that on the highway - and their discount rate of 2.3%. I compared four very closely related crossover or sub-compact SUVs – the conventional 2019 Hyundai Kona, the 2019 Kia Niro regular hybrid, the 2019 Niro plug-in hybrid, the 2019 all electric Niro, and the somewhat larger all electric Nissan LEAF. (I'm attaching the associated spreadsheet.)

Overall costs per metric ton of reductions

Models	Total Purchase Cost	12 Year Fuel Costs	NPV of 12 Year Fuel Costs Discounted @ 2.3%	Total 12 Year Costs in Current Dollars	2021-2025 Annual Emissions	12 Year Emissions
Kona	\$21,771	\$15,492	\$13,409	\$35,180	4.23 tonnes	50.76 tonnes
Niro Hybrid	\$26,147	\$9,702	\$8,389	\$34,536	2.65 tonnes	31.79 tonnes
Niro Plugin	\$26,636	\$7,008	\$6,063	\$32,699	2.27 tonnes	22.25 tonnes
Niro BEV	\$32,919	\$4,536	\$3,924	\$36,843	1.83 tonnes	13.70 tonnes
Nissan LEAF	\$23,609	\$4,576	\$3,956	\$27,565	1.84 tonnes	13.82 tonnes

Over the life of the car, the standard hybrid saves \$644 compared to the conventional car and reduces CO2 emissions by 18.97 tonnes. The plugin saves \$2,481 and reduces emissions by 28.51 tonnes. The all-electric costs \$1,663 more, and reduces emissions by 37.06 tonnes, at a cost of \$44.87/tonne. (This is about a 73% reduction in total emissions over the period, compared to business as usual.) The Nissan LEAF reduces emissions by 36.94 metric tonnes, a hair less than the the Niro all-electric, but it costs significantly less, saving \$7,615 over 12 years compared to the conventional car. (It's slightly bigger than the Niro, so it's officially a compact rather than a crossover SUV; it's primarily cheaper because it has a smaller battery. The EPA estimates its range at 150 miles, compared to the Niro all-electric's 239.)

These were conservative estimates, for several reasons.

A. According to the 2019 AAA edition of “Your Driving Costs: How Much Are You Really Paying to Drive”, average maintenance, repair and tires for five typical small SUVs ran 9.09 cents/mile; those for hybrids like the Niro were 7.7 cents/mile and those for electric cars like the BMW i3 and the Nissan LEAF were 6.60

cents/mile. ⁵ Those annual costs for the small SUVs are \$1,084/year; they're \$918 for the hybrids; and they're \$787 for the electrics. Over 12 years that would make the hybrid another \$1,989 less expensive than the conventional car; it would make the all-electrics another \$1,575 less expensive than the hybrid, and another \$3,564 cheaper than the conventional car.

B. Puget Sound's power is more expensive than most Washington utilities' and its greenhouse gas emissions are higher. If we did the comparisons using the current prices of gasoline and electricity, the saving from driving an electric vehicle would be much larger.

C. The manufacturing costs of electric vehicles are expected to continue to fall, as batteries become cheaper, but the manufacturing costs of conventional vehicles are expected to stay constant or increase, since 100 years of experience has already gone into refining their production.

D. I didn't include any estimate of the social cost of carbon in the benefits of driving an electric vehicle.

b. Construction Cost. Provide your best estimate of the construction cost (or cost savings) of your code change proposal.

Cost does not vary significantly by square footage. Estimated cost is \$335/dwelling unit.

See estimates in Section 7a above for calculations and sources for estimates of costs/savings.

c. Code Enforcement -

No additional code enforcement is involved.

d. Small Business Impact -

The proposal would produce a very small increase in the sales of electrical supplies, and contribute to a more significant increase in the long term sales of plug-in vehicles and chargers. Electrification of transportation will significantly reduce demand for vehicle repairs, parts and service, which are currently the main source of car dealership's profits, and will reduce gas stations' business over time. Replacing imported fuel with electricity generated in the state will leave more money circulating in our economy.

e. Housing Affordability -

The small increase in construction costs will be passed on to the purchasers and renters of new residential construction, but will have an imperceptible effect on annual mortgage payments. Having a suitable charger receptacle or an actual charger available will simplify the process of shifting to an EV, by eliminating the complications of choosing and dealing with a contractor, which can be at least as large a barrier to EV adoption for most homeowners as the actual additional expense of adding a charger to the price of a car. Driving electric

⁵ "Your Driving Costs: How Much Are You Really Paying to Drive," 2019 edition, AAA. Accessed at: <https://exchange.aaa.com/wp-content/uploads/2019/09/AAA-Your-Driving-Costs-2019.pdf>

can already provide significant savings for drivers in Washington, since we have relatively cheap electricity and relatively expensive gas, and those will continue to increase over time, as the batteries that are a principal component of the costs of EVs keep becoming cheaper. Growing numbers of EVs in the used car market will make the option of switching to an electric vehicle and the associated savings on operating costs and maintenance increasingly available to low income drivers. (Since the costs of an EV are mostly associated with its initial purchase and the financial benefits are associated with its ongoing operating costs, driving a second hand EV is a particular bargain.)

The research about the effects on potential purchasers of adding \$1,000 to the cost of building a house that was mentioned in our first discussion was done by the National Association of Home Builders. (It's at <https://www.nahb.org/news-and-economics/housing-economics/housings-economic-impact/households-priced-out-by-higher-house-prices-and-interest-rates>).

They say it's hard to answer some questions about the effects of cost increases because the data's not available, or because they depend on the dynamics of local markets that are difficult to estimate. Instead, they do a "priced-out" estimate of the number of households that would no longer be able to qualify for a mortgage if there were a \$1,000 increase in the cost of a new home priced at the median in a given market. In the Olympia-Tumwater Metro area in 2018, they figure that home cost \$476,377. They estimated that if all 108,038 of the households in the area had actually been shopping for a house at that price there would have been 122 of them that could just qualify for the mortgage on it, and that wouldn't have been able to qualify for a house at \$477,377.

These people could simply buy a slightly less expensive house if additional efficiency measures added a thousand dollars to the cost of the most expensive one they could afford. The research doesn't tell us how many people who are actually shopping for a new house can't buy a slightly less expensive one if regulations raise prices because there aren't any less expensive houses that will meet their needs. (They may be just able to get a mortgage on the cheapest new houses on the market, or have to have three bedrooms and be just able to get a mortgage for the cheapest new three bedroom houses.) However, if they were "priced out" by the \$1,000 increase on the price of those new houses, they could shop for a slightly less expensive older house. Being "priced out" would not mean that they couldn't buy a house.

By way of comparison, the NAHB estimated that a \$1,000 increase in the U.S. median new home price of \$346,757 would push 153,967 households out of the market (if they were all actually shopping for a house) and that in 2021 lumber price increases over the past 10 months had "priced out" 3.7 million households. (<https://www.nahb.org/news-and-economics/industry-news/press-releases/2021/03/New-Priced-Out-Study-Highlights-the-Housing-Affordability-Crisis>)

f. Other. Describe other qualitative cost and benefits to owners, to occupants, to the public, to the environment, and to other stakeholders that have not yet been discussed:

No additional comments.