Pacific Northwest NATIONAL LABORATORY

PNNL-31576-1

Electric Vehicle Charging for Residential and Commercial Energy Codes

Technical Brief

December 2024

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M Young

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Pacific Northwest National Laboratory
Richland, Washington 99354

Preamble

The U.S. Department of Energy (DOE) and Pacific Northwest National Laboratory (PNNL) developed a series of technical briefs supporting national, state and local initiatives to update and advance building energy codes. These technical briefs represent specific technologies, measures or practices that can be incorporated as module-based “plug-ins” via the national model energy codes, such as the International Energy Conservation Code (IECC) or ASHRAE Standard 90.1 or adopted directly by state and local governments pursuing advanced energy savings. The collection of technical briefs is part of a larger effort to provide technical assistance supporting states and local governments working to update their building codes.

This technical brief presents a compilation of information on electric vehicles (EVs), examining market trends, benefits to consumers and adoption jurisdiction, and means of enabling the EV charging infrastructure by way of energy codes for new construction. A description of the concept is provided along with supporting justification and examples of similar concepts which have been adopted by states and local jurisdictions, as well as technical information on expected costs and benefits. In addition, the brief provides sample energy code language that can be overlaid directly onto model energy codes for EV charging infrastructure (Section 3). A technical brief is intended to be a resource for interested stakeholders, particularly those charged with considering the impacts of proposed code updates.

Additional assistance may be available from DOE and PNNL to support states and local governments who are interested in adding EVs and other “stretch” provisions to their building codes, such as technical guidance, customized analysis of expected impacts (e.g., based on state-specific building stock, energy reduction goals, or utility rates), and further tailored code language to overlay state building codes or other standards. DOE provides this assistance in response to the Energy Conservation and Production Act (ECPA), which directs the Secretary of Energy to provide technical assistance “to support implementation of state residential and commercial building energy efficiency codes.” (42 USC 6833) PNNL supports this mission by evaluating concepts for future code updates, conducting technical reviews and analysis of potential code changes, and providing assistance to states and local jurisdictions who strive to adopt, comply with and enforce energy codes. This helps to ensure successful implementation of building energy codes, as well as a range of advanced technologies and construction practices, and encourages building standards which are proven practical, affordable and efficient.

DOE Building Energy Codes Program

The U.S. Department of Energy provides technical assistance to states, municipalities and the design and construction industry supporting building energy codes. Modern building codes offer the latest technologies and cost-effective solutions, contributing to lower energy bills for homes and businesses and ensuring safe, efficient and affordable buildings. Learn more at energycodes.gov.

Executive Summary

Numerous studies show that sales of electric vehicles (EVs) have grown consistently over recent years in the U.S. The U.S. Energy Information Administration (EIA) estimated 3 million EVs were on the road in 2022, and the Edison Electric Institute (EEI) forecasts a total of 26.4 million EVs on the road by 2030. Based on this forecast, EEI projects the need for an additional 12.9 million EV charge ports by 2030. If EV charging infrastructure fails to keep pace with sales of EVs it could result in consumers stranded without options to power their vehicles.

EVs are capable of providing substantial benefits to the consumers. EVs are less expensive to operate than conventional internal combustion engine vehicles, have lower maintenance costs, and have the convenience of fueling (charging) at home or work. Studies conducted in California show that costs associated with installing EV charging infrastructure can be substantially more expensive for retrofit scenarios compared to new construction, making inclusion of EV infrastructure in new construction codes a cost-effective policy option to increase infrastructure to meet growing demands.

PNNL tracks adoption of mandatory EV provisions across the U.S. As of December 20, 2024, 12 states (California, Oregon, Washington, Colorado, New Mexico, Illinois, Maryland, Delaware, New Jersey, Rhode Island, Massachusetts and Vermont) and 53 local governments have added EV provisions to their building codes, local ordinances and zoning requirements.[1]

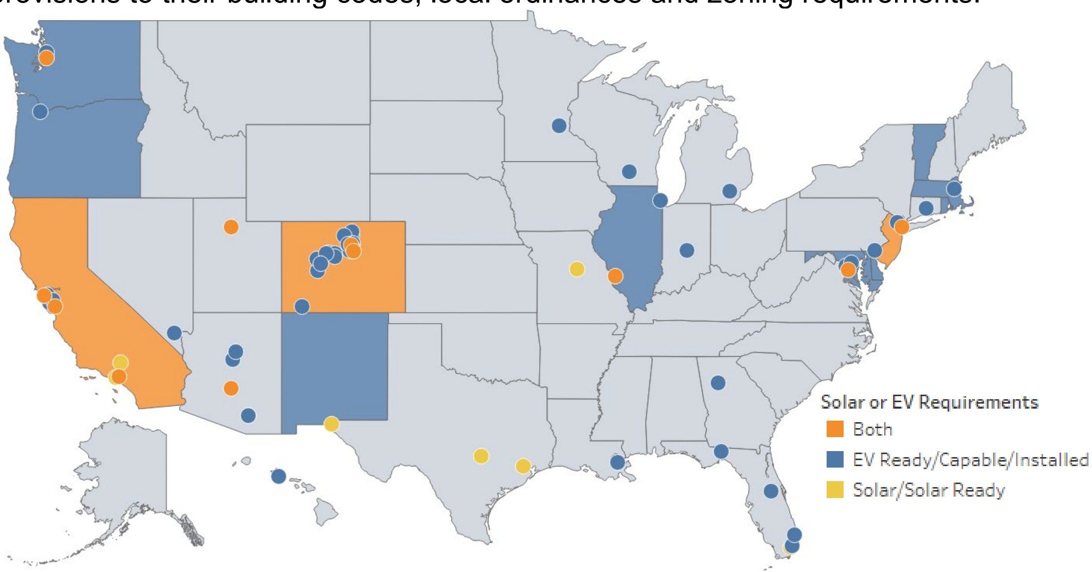

Figure 1. State and Local Electric Vehicle and Solar Building Requirements

Originally published in 2022, this tech brief has been revised to align with recent model energy code committee discussions and published EV infrastructure code language. This technical brief summarizes market trends, costs and benefits, and provides sample code language for EV charging infrastructure for consideration to be included in model codes, such as the International Energy Conservation Code (IECC) and ANSI/ASHRAE/IES Standard 90.1, as well

[1] An interactive version of this map is available at https://public.tableau.com/app/profile/doebecp/viz/Top100MetroDatabase-PrimaryCityCode-V4/MetroResidentialCode

as directly by states and local governments in their building codes. The technical brief summarizes related efforts undertaken by states and local governments, and builds upon language considered during the 2021 and 2024 IECC development cycles. [2,3]

[2] Code language was developed and approved for inclusion in the 2021 and 2024 versions of the IECC but both were removed upon appeal.

[3] The International Code Council (ICC) previously published model code language for the 2021 IECC, titled *Electric Vehicle and Building Codes: A Strategy for Greenhouse Gas Reductions.* https://www.iccsafe.org/wp-content/uploads/21-20604_COMM_EV_Strategy_RPT_v5.pdf

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1.0 Electric Vehicle Charging in Residential and Commercial Energy Codes

The electric vehicle market is growing substantially. In the U.S. sales of all electric vehicle (EV) types (hybrid, plug-in hybrid, and battery) increased 47% from 2020 to 2021 (Bureau of Transportation Statistics). EV sales in the U.S. reached a new milestone in 2023, representing 18.8% of all new light-duty vehicle sales during the fourth quarter (EIA 2024). The data indicated that EV sales grew consistently since the second quarter of 2020, until seeing a slight decline to 18.0% in the first quarter of 2024. While EVs represent less than 1.2% of vehicles on the road in the U.S., that percentage is expected to reach 10% by 2030 and it will be necessary to expand EV charging infrastructure to ensure consumers have reliable sources to fuel their vehicles (EIA 2024; EEI 2022).

Approximately 74% of all vehicles in the U.S. belong to residents of single-family or duplex homes that have access to an electrical outlet within 20 feet of a parking space, which can typically be used for overnight EV charging. New homes are built to last for decades, thus they represent a unique opportunity to be equipped to handle future technologies, including the ability to charge EVs. As 33% of vehicles in the U.S. (including apartments and mobile homes) do not have reliable access to dedicated off-street parking, the EV market must move beyond single-family detached homes and expand EV charging access in other feasible locations, such as multifamily unit dwellings (MUD), workplaces, and commercial properties. EV-Ready building codes support this expansion and can save consumers thousands of dollars in installation costs when included in initial construction (SWEEP 2018).

Incorporating EV requirements into building codes is a relatively low-cost strategy that can support local and state efforts to support consumers and achieve a cleaner and more resilient grid. Doing so also may support future efforts to use battery storage to manage utility peak demand. This includes using EVs as a distributed energy resource and realizing vehicle-to-grid integration (VGI), where bidirectional chargers allow electricity to flow from the EV back to the grid. Thus in the near future, EVs will provide added value to the grid and to car owners without the outlay of new capital. According to E3, the expected additional revenue to the consumer is $345/year for managed unidirectional charging that ramps up and down. The additional benefits of VGI resulting from other grid services, such as frequency regulation, increase the value by about $500 per year (Gridworks 2019).

The concept of incorporating EV charging infrastructure into the model codes was considered, and initially approved, for the 2021 International Energy Conservation Code (IECC), but later removed in response to appeals (ICC 2019). Following the 2021 appeals period, DOE, ICC, and other interested stakeholders coordinated to update the concept such that it could be considered directly by states and local governments interested in adopting EV provisions into their codes, as well as for future model code development via the IECC. The proposed language was presented for consideration again for the 2024 IECC, where it was negotiated and again voted for approval in the body of the code; however, the provisions were once again removed as a result of an appeals process. Unlike the 2021 IECC, the provisions were moved to optional appendices in the 2024 IECC – Appendix CG in the commercial code and Appendix RE in the residential code – which can be voluntarily adopted by states and jurisdictions.

The EV charging infrastructure requirements included in this technical brief build upon the language considered for both the 2021 and 2024 editions of the IECC, and adds further information, analysis and suggested code language as developed by PNNL. These model requirements are intended to support consistency in approach and provide a degree of certainty for building owners, designers, contractors, manufacturers and building and fire safety professionals. As each state and municipality is different the recommended number of required spaces designed with EV charging infrastructure included in the model code language should be adjusted to reflect the local needs of your jurisdiction. There are other resources that provide some guidance on integrating EV charging infrastructure with building codes, including: New Building Institute's *Electric Vehicle Supply Equipment (EVSE) Permitting & Inspection Guidelines*; Plug In America's *EV Building Codes Toolkit;* and Southwest Energy Efficient Project's (SWEEP) *Guide to EV Infrastructure Building Codes*.

1.1 Consumer Benefits

EVs benefit the consumer through lower operational and maintenance costs. It is cheaper to fuel an EV; its fuel efficiency is equivalent to up to 130 miles per gallon for a gasoline-powered vehicle (DOE 2024). This translates to an annual average cost savings of over $800. In addition, EVs have no internal combustion engine, oil, spark plugs, or timing belts that require annual maintenance, and electric motors require little to no maintenance, which translates into additional average annual savings on repair and maintenance costs of around 40% (Atlas Public Policy 2024). EVs also provide convenience by fueling at home or work rather than driving to a gas station.

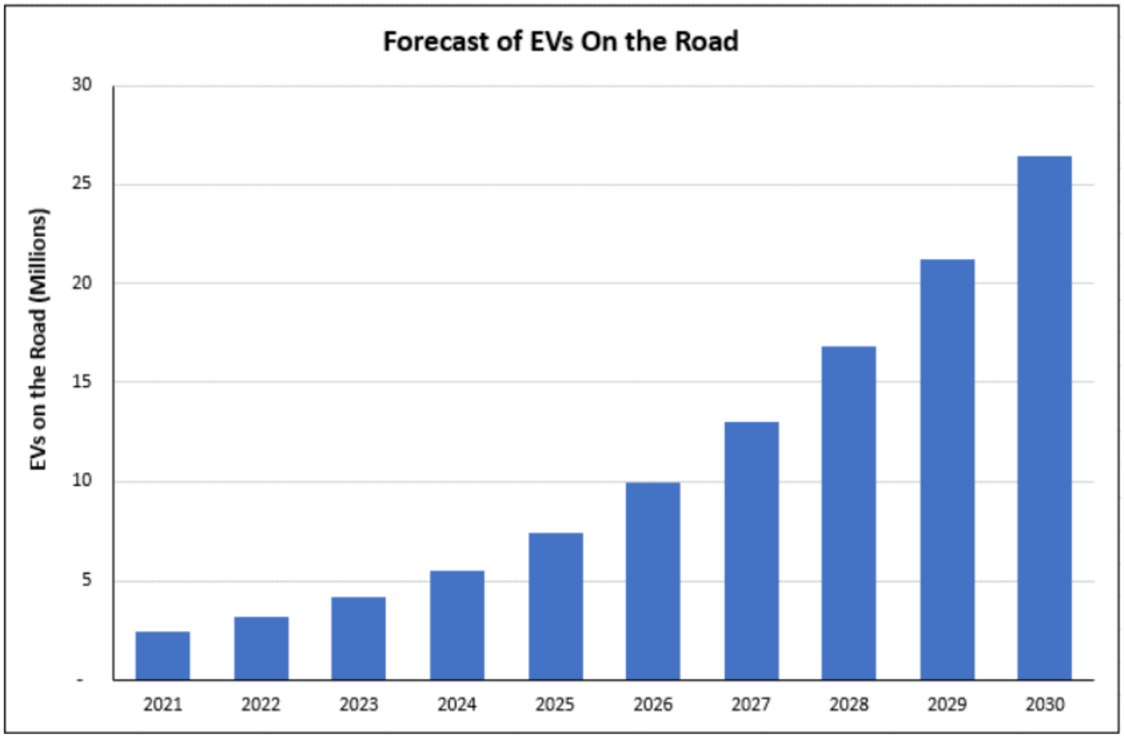
Finding the nearest charging station is becoming easier with new EV charging applications. As of 2024, there are over 176,000 charging ports across the U.S. representing a 27% increase since 2021 (DOE 2024). In addition to numerous online resources, the DOE Alternative Fuels Data Center maintains a comprehensive station locator for the United States and Canada. Each station location includes information about the business where the station is found, charging speeds, and port types.

1.2 EV Market Trends

Reports of EV purchases show record sales and a growing market suggesting that EVs will factor prominently in the future of transportation. Over 3 million EVs were on U.S. roads in 2022, more than triple the 1 million on the road in 2018, and 30 times the 100,000 on the road in 2012 (EIA 2023). By 2030, EEI forecasts the number of EVs on the road to reach 26.4 million. This would represent approximately 10% of the 259 million light-duty vehicles on the road in the U.S. **Error! Reference source not found.** Figure 2 and Figure 3**Error! Reference source not found.** show the EV stock forecast and EV sales forecast as a percentage of all vehicle sales, respectively.

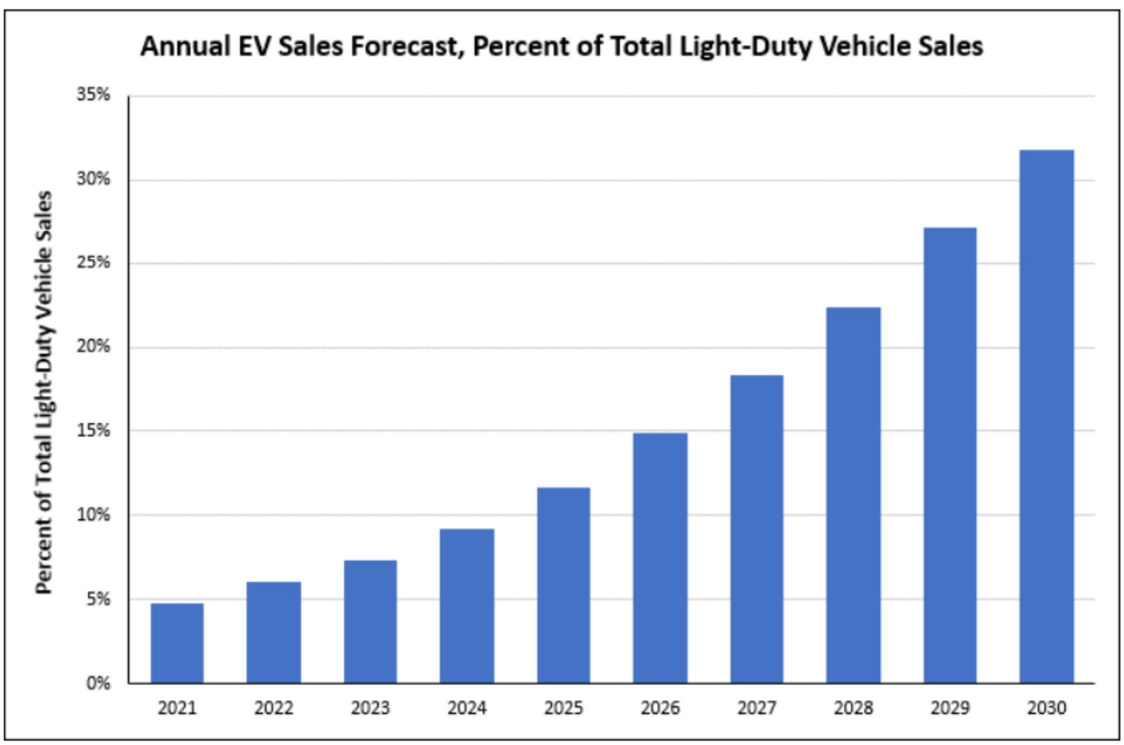
Most major auto manufacturers have announced plans to electrify a significant portion of their vehicle fleets over the next three 3 decades (Yang 2022).[4] The interest in EVs has grown together with greater model availability, increased vehicle range and favorable financing opportunities. The success of the EV market is directly related to the availability of the EV charging infrastructure in private and public settings. Increasing the availability of EV charging infrastructure will help both consumers and the grid adapt to this change.

[4] Some auto manufacturers have started scaling back their EV plans, despite predictions for increasing sales of EVs (Wayland 2024).



Source: Edison Electric Institute 2022

Figure 2. EV Stock Forecast to 2030



Source: Edison Electric Institute 2022

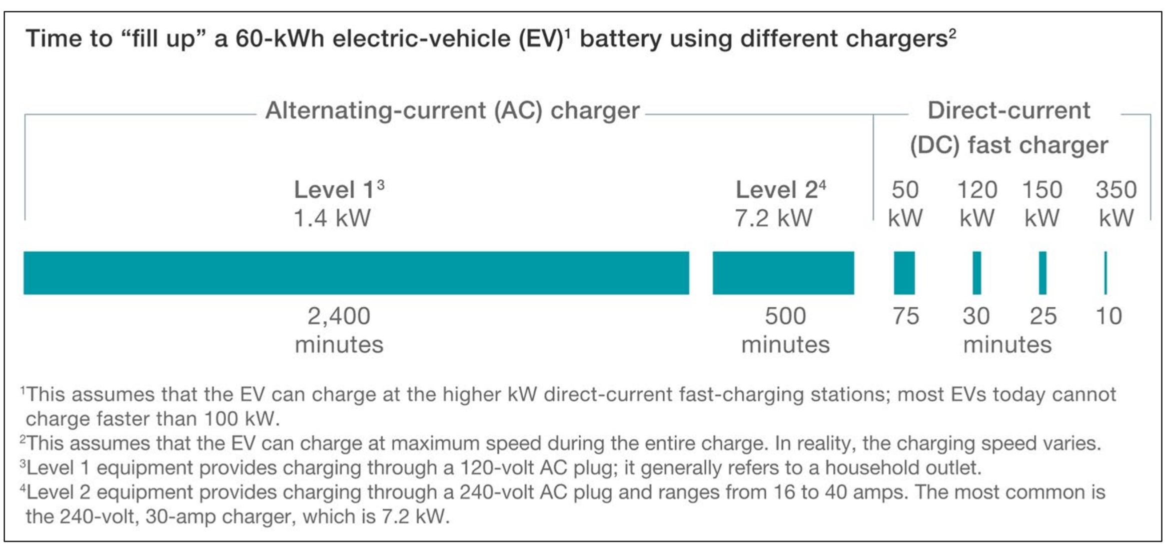
Figure 3. EV Sales Forecast

1.3 EV Charging

In order to fuel an EV, a connection to the grid or power source is required in the form of a charging station also known as electric vehicle supply equipment (EVSE). EVSEs come in a variety of configurations but are typically separated by power level. There are three levels of ESVE: Level 1, Level 2, and DC Fast Charging (DCFC).

- **Level 1**: Level 1 charging uses a common 120-volt household outlet. Every EV or plug-in hybrid can be charged on Level 1 by plugging the charging equipment into a regular wall outlet. Level 1 is the slowest way to charge an EV. It adds between 3 and 5 miles of range per hour. Level 1 EV chargers are located typically at home, workplace or public parking, but only make up less than 1% of U.S. public EV charging ports (DOE 2024).
- **Level 2**: Level 2 charging is the most widely used level for daily EV charging, making up 80% of all U.S. public EV charging ports. Level 2 ESVE can be installed at home, at the workplace, as well as in public locations like shopping plazas, train stations, and other destinations. Level 2 charging can replenish between 12 and 80 miles of range per hour, depending on the power output of the Level 2 charger, and the vehicle's maximum charge rate (DOE 2024).
- **DC Fast Charging (DCFC)**: DCFC (sometimes referred to as Level 3) is the fastest type of charging available and can recharge an EV at a rate of 3 to 20 miles of range per minute (or 180 to 1,200 miles of range per hour). Unlike Level 1 and Level 2 charging that uses alternating current (AC), DCFC receives a 3-phase 480 volt AC, but delivers direct current (DC) to the vehicle. The voltage is also much higher than Level 1 and 2 charging, which is one reason why you don't see DCFC chargers installed at home. Very few residential locations have the high-voltage supply that is required for DCFC charging and it is costly to achieve the required voltage supply.

According to the Joint Office of Energy and Transportation study on community charging, 80% of EV-owners elect to charge their vehicle at home where charging can take place overnight. Installment of Level 2 or DCFC EVSE at workplaces or in public settings allows EV-owners to drive more miles on electricity and enables longer trips while reducing range anxiety. **Error! Reference source not found.** compares EV charge time based on EV charging level.

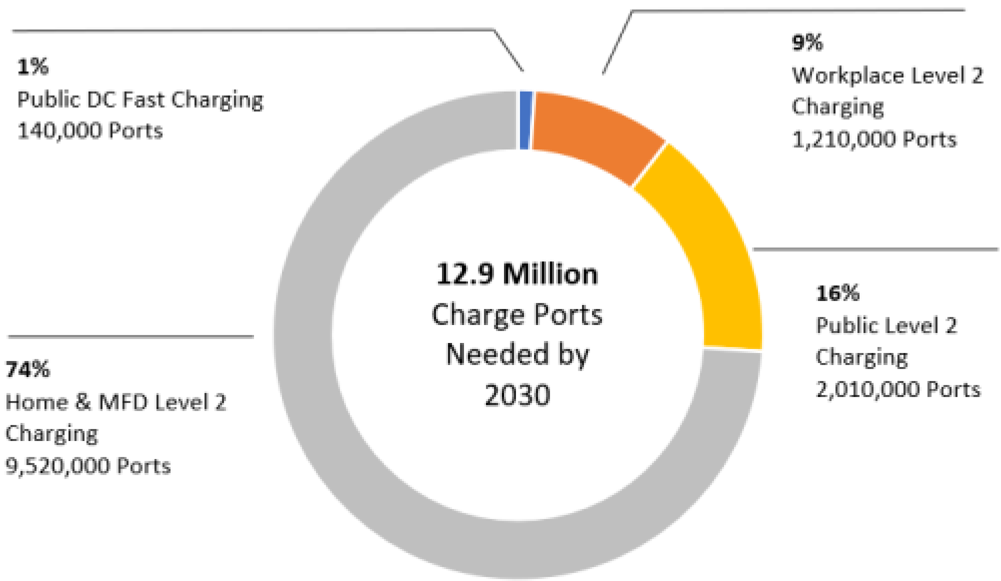


Source: Mckinsey Sustainability 2018

Figure 4. EV Charge Time Based on EV Charging Power

1.4 EV Charging Infrastructure

As mentioned earlier, EEI forecasts the number of EVs on U.S. roads to reach 26.4 million by 2030. To support this growth, an additional 12.9 million EV charging stations will be required by 2030. This includes 10.7 million Level 2 public and private charging stations and 140,000 DC fast charging stations. Given the extensive charging time of a Level 1 charger, Level 2 chargers are currently prioritized as the solution until newer and more advanced residential charging methods are available. Figure 5 shows the projected mix of EV charging stations needed by location. The majority of the charge ports needed wilt be Level 2 charger for homes and multifamily dwellings (MFDs)[5].



Source: Edison Electric Institute 2022

Figure 5. EV Charging Infrastructure by Location in 2030 based on the EEI Forecast

State and local governments around the country have led the way on EV-Ready building codes, with requirements that have been adapted to best fit the needs of each community. Three basic options for EV infrastructure requirements are shown in Figure 6. For one- and two-family dwellings with dedicated off-street parking, Level 2 EV-Capable or EVSE-Ready outlet provisions are required for at least one parking space per residence. For multifamily dwellings and commercial properties, EV charging infrastructure requirements are applied as a percentage of total parking spaces (e.g., 5% of total parking spaces are to be EV-Capable for parking lots with over 10 parking spaces).

[5] Also referred to as Multifamily Unit Dwellings (MUDs).

EV-Capable Parking Space: Electrical Panel Capacity & Conduit

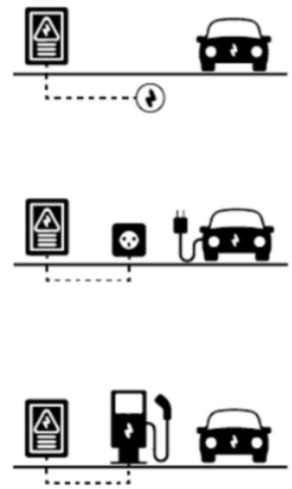
- Install panel capacity and conduit (raceway) to accommodate the future build-out of EV charging with 208/240 V, 40-amp circuits.
- Rational: Provide hard-to-retrofit elements during new construction while minimizing up-front cost.

EV-Ready Parking Space: Install full circuit

- Full circuit installations include 208/240V, 40-amp panel capacity, raceway, wiring, receptable, and overprotection devices similar to a dryer circuit.
- Rational: Full circuits are plug-and-play ready and minimize total costs and additional barriers to installing Electric Vehicle Supply Equipment (EVSE).

EV-Installed: Install EV Charging Station (also known as Electric Vehicle Supply Equipment or EVSE).

- Install charging stations during new construction.
- Rational: Provide a visible signal that building supports EV charging and reduce future EV charger installation costs to zero.



Source: DOE 2024

Figure 6. Options for EV Infrastructure Requirements

The availability and ease of access to Level 2 and DCFC EVSE is a critical barrier to EV adoption. A lack of pre-existing EV charging infrastructure, such as electrical panel capacity, raceways, and pre-wiring, can make the installation of a new charging station cost-prohibitive for a potential EV-owner (Francort 2015). The DOE Alternative Fuel Data Center provides additional resources to support the development of EV charging infrastructure. Resources include procurement and installation checklists, operation and maintenance costs, and access to the EVI-Pro Lite Tool, which can help jurisdictions identify the number and type of EV charging stations required for their area.

1.5 Existing EV Charging Requirements in Energy Codes

This section highlights some of the various approaches to EV-integrated building codes that are harnessed by different local governments in more depth. Table 1 highlights sample EV infrastructure code provisions that are currently implemented across North America. These approaches can influence future code adoption for local jurisdictions seeking to meet GHG reduction targets.

Table 1. States or Cities with EV Charging Infrastructure Requirements

State or Municipality	Year	Type	One- or Two-family Dwellings	Multifamily Unit Dwellings	Commercial
Washington	2024	State Building Code	1 EV-Ready Space per dwelling Unit	10% EV-Installed, 25% EV-Ready, 10% EV-Capable	10% EV-Installed, 10% EV-Ready, 10% EV-Capable
Portland, OR	2023	Zoning Code	-	If there are between 1 and 6 spaces 100% EV-Ready, If there are 7 or more spaces then the greater of 50% or 6 EV-Ready spaces	20% EV-Ready
Mountlake Terrace, WA	2023	Ordinance	-	10% EV-Installed	EV-Installed ranging from 1% to 3% of parking spaces
Fremont, CA	2023	Ordinance	1 EV-Ready Space per dwelling unit	Ranges from 1 EV-Ready space to 10% of spaces, based on total parking spaces	-
Clark County, NV	2023	Development Code	1 Level 2 outlet (240 volt)	25% EV-Capable, 3% EV-Installed (25+ spaces)	5 to 25% EV-Capable (Retail: 10%; Warehouse: 5%; Other Commercial Buildings: 25%) 3% EV-Installed depending on number of spaces
Boca Raton, FL	2023	Ordinance	-	New parking facilities with 20 or more spaces must provide: 5% EV installed spaces; 10% EV-Ready spaces; and 20% EV-Capable spaces	-
Wayne Township, NJ	2022	Ordinance	-	EVSE in at least 33% of required off-street parking; additional EVSE required in subsequent years	Parking garages need 1 - 5 EV-Capable parking spaces depending on number of parking spaces
Orlando, FL	2022	Ordinance	-	20% EV-Capable; 2% EV Installed	10% EV-Capable; 2% EV Installed
Longmont, CO	2022	IRC	1 EV-Ready Space per dwelling unit	-	-
Leon County, FL	2022	Ordinance	-	1 EV-Ready space per unit for Townhouse or Condominium (with 3+ units), 1 EV-Installed Space per 25 parking spaces, 10% EV-Installed (100+ spaces)	1 EV-Installed Space per 25 parking spaces, 10% EV-Installed (100+ spaces) that count toward overall parking requirement (EVSE)
Larimer County, CO	2022	Ordinance	1 EV-Ready Space per dwelling unit	5% EV-Installed, 15% EV-Ready, 30% EV-Capable	5% EV-Installed, 10% EV-Ready, 10% EV-Capable

State or Municipality	Year	Type	One- or Two-family Dwellings	Multifamily Unit Dwellings	Commercial
California (CALGreen)	2022	IBC / IRC	1 EV-Capable Space per dwelling Unit	35% EV-Capable	Up to 30% EV-Capable based on number of spots
Oregon	2022	IBC / IRC	-	20% EV-Ready	
Tucson, AZ	2021	IRC	1 EV-Ready space per dwelling unit	10% EV-Ready, 20% EV-Capable	Retail - 5% EV-Installed, 10% EV-Capable
New Castle County, DE	2021	IECC	1 EV-Capable Space per dwelling Unit	R-2 occupancies 10% EV-Capable	-
Louisville, CO	2021	IRC/ Zoning Ordinance	1 EVSE-Installed and 1 EV-Capable space per dwelling unit	10% EV-Installed, 10% EV-Ready, 15% EV-Capable	5-10% EV-Installed, 10% EV-Ready, 10-15% EV-Capable (depending on sector)
Ann Arbor, MI	2021	Ordinance	1 EV-Ready Space per dwelling Unit	Mix of EV-Capable, EV-Ready and EV-Installed	Mix of EV-Capable, EV-Ready and EV-Installed by building type
Avon, CO	2021	Ordinance	1 EV-Ready Space per dwelling Unit	5% EV-Installed, 10% EV-Ready, 15% EV-Capable (7+ spaces)	5% EV-Installed, 10% EV-Ready, 15% EV-Capable (10+ spaces)
St. Louis, MO	2021	Ordinance	1 EV-Ready Space per dwelling Unit	2% EV-Installed, 5% EV-Ready (increases to 10% in 2025)	2% EV-Installed, 5% EV-Ready
Madison, WI	2021	Ordinance	-	2% EV-Installed, 10% EV-Ready (increases by 10% every 5 years)	1% EV-Installed (increases by 1% every 5 years), 10% EV-Ready (increases by 10% every 5 years)
Washington D.C.	2021	Legislation	-	20% EV-Ready (3+ spaces)	20% EV-Ready (3+ spaces)
Aspen, CO	2021	IBC / IRC	1 EV-Capable Space per dwelling Unit	100% EV-Ready for Group R-2	Up to 15% EV-Installed, up to 30% EV-Capable
Summit County, CO	2020	IBC / IRC	1 EV-Ready Space per dwelling Unit	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (10+ spaces)	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (25+ spaces)
Dillon, CO	2020	IBC / IRC	2 EV-Ready Space per dwelling Unit	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (10+ spaces)	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (25+ spaces)
Breckenridge, CO	2020	IBC / IRC	3 EV-Ready Space per dwelling Unit	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (10+ spaces)	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (25+ spaces)
Frisco, CO	2020	IBC / IRC	4 EV-Ready Space per dwelling Unit	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (10+ spaces)	5% EV-Installed, 10% EV-Ready, 40% EV-Capable (25+ spaces)
Salt Lake City, UT	2020	Ordinance	-	20% EV-Ready (5+ spaces)	-
City of Boulder, CO	2020	IBC / IRC	1 EV-Ready Space per dwelling Unit	5% EV-Installed, 15% EV-Ready, 40% EV-Capable (25+ spaces)	5% EV-Installed, 10% EV-Ready, 10% EV-Capable
Denver, CO	2022	IBC / IRC	1 EV-Ready Space per dwelling Unit	5% EV-Installed, 15% EV-Ready, 80% EV-Capable	5% EV-Installed, 10% EV-Ready, 10% EV-Capable

State or Municipality	Year	Type	One- or Two-family Dwellings	Multifamily Unit Dwellings	Commercial
Honolulu, HI	2020	Ordinance	1 EV-Capable Space per dwelling unit	25% EV-Ready (8+ spaces)	25% EV-Ready (12+ spaces)
Chicago, IL	2020	Ordinance		20% EV-Ready (5+ spaces)	20% EV-Ready (30+ spaces)
Boulder County, CO	2020	IBC / IRC	1 EV-Ready Space per dwelling Unit	5% EV-Installed, 10% EV-Ready, 40% remaining spaces EV-Capable (25+ spaces)	5% EV-Installed, 10% EV-Ready, 10% remaining spaces EV-Capable (25+ spaces)
Palo Alto, CA	2020	Ordinance	1 EV-Ready Space per dwelling Unit	1 EV-Ready Space per Unit, 10% L2 EV-Ready remaining L1 EV-Ready (<25)	6-10% L2 EVCS, 5-10% EV-Ready, up to 30% EV-Capable
Lakewood, CO	2019	Zoning Ordinance	1 EV-Capable Space per dwelling unit	2% EV-Installed, 18% EV-Capable (10+ spaces)	2% EV-Installed, 13% - 18% EV-Capable (10+ spaces)
Flagstaff, AZ	2019	IBC / IRC	1 EV-Ready Space per dwelling Unit	3% EV-Ready	3% EV-Ready
Massachusetts	2019	-	-	-	1 EV-Ready space (15+ spaces)
Seattle, WA	2019	Ordinance	1 EV-Ready Space per dwelling Unit	100% EV-Ready up to 6 space, 20% for parking lots with 7+ spaces	10% EV-Ready
Sedona, AZ	2019	Appendix	1 EV-Capable Space per dwelling Unit	-	5% EV-Capable
Golden, CO	2019	Ordinance	-	1 EV-Installed Space per 15 parking space, 15% EV-Capable	1 EV-Installed Space per 15 parking space, 15% EV-Capable
San Jose, CA	2019	Ordinance	1 EV-Ready Space per dwelling Unit	10% EV-Installed, 20% EV-Ready, 70% EV-Capable	10% EV-Installed, 40% EV-Capable
Fort Collins, CO	2019	IBC / IRC	1 EV-Capable Space per dwelling Unit	10% EV-Installed, 20% EV-Ready, 40% EV-Capable	5% EV-Installed, 15% EV-Ready, 20% EV-Capable
Vancouver, BC	2019	IBC / IRC	1 EV-Ready Space per dwelling Unit	100% EV-Ready	10% EV-Ready
Oakland, CA	2018	IBC / IRC	-	10% EV-Ready, 90% “Raceway Installed”, 20% total panel capacity	10% EV-Ready, 10% “Raceway Installed”, 20% total panel capacity
San Francisco, CA	2018	IBC / IRC	1 EV-Ready Space per dwelling Unit	10% EV-Ready, 10% EV-Capable, remaining 80% with space for future electric panel	10% EV-Ready, 10% EV-Capable, remaining 80% with space for future electric panel
Atlanta, GA	2017	Code of Ordinances	1 EV-Capable Space per dwelling Unit	20% EV-Capable	20% EV-Capable
New York City, NY	2013	IBC / IRC	-	20% EV-Capable	-

International Green Construction Code – Model Code

The 2021 International Green Construction Code (IgCC) includes the following requirements for the installation of EVSE:

501.3.7.3 Electric vehicle charging facilities. Where 20 or more on-site vehicle parking spaces are provided for International Building Code (IBC) Occupancy Group A, B, E, F, I, M, and S buildings, not less than 4% of the total number of parking spaces or not less than 8% of designated employee only parking spaces shall be EV-Ready spaces. Where 10 or more on-site vehicle parking spaces are provided for IBC Occupancy Group R-1, R-2, and R-4 buildings, not less than 20% of the total number of parking spaces shall be EV-Ready spaces. The required number of EV-Ready spaces shall be rounded up to the next highest whole number.

California – State Level

California set ambitious targets for ZEV charging infrastructure to support their mission of having 5 million ZEVs by 2030. The state plans to install 250,000 shared plug-in EV chargers, including 10,000 DCFCs and 200 hydrogen stations by 2050. The 2022 California Green Building Codes (CALGreen) includes provisions for EV infrastructure requirements in new multifamily, residential and non-residential buildings, as well as stretch code requirements. Local governments can adopt or surpass the CALGreen stretch codes for EV-Capable or EV-Ready spaces, although it is not required.

CALGreen requires new construction of multi-unit dwellings to include EV-Capable infrastructure in at least 35 percent of parking spaces. CALgreen includes two-tiered reach codes that enable cities to adopt requirements for EV-Capable infrastructure in 35% or 40% of multi-unit development (MUD) parking spaces. CALGreen has also established requirements for new construction single-family residences, duplexes and townhouses with private garages. The residential provisions require EV-Capable capacity to support Level-2 charging station installations. CALGreen now requires new construction non-residential buildings to have up to 30%of parking spaces EV-Capable, as shown in Table 2.

Table 2 2022 CALGreen EV Parking Space Requirements

TOTAL NUMBER OF ACTUAL PARKING SPACES	TIER 1 NUMBER OF REQUIRED EV CAPABLE SPACES	TIER 1 NUMBER OF EVCS (EV CAPABLE SPACES PROVIDED WITH EVSE)[2, 3]
0–9	2	0
10–25	5	2
26–50	11	4
51–75	19	5
76–100	26	9
101–150	38	13
151–200	53	18
201 and over	30 percent of actual parking spaces[1]	33 percent of EV capable spaces[1]

Local governments have shown support of the CALGreen EV infrastructure building code requirements, with 20 jurisdictions exceeding the minimum code requirements in their local code adoptions. Some municipalities are also implementing parking ordinances to encourage the installation of EV charging stations, specifically for new construction. Some jurisdictions have gone even farther to explore adoption of EV infrastructure codes that address existing buildings including the City of Marin, City of Menlo Park, and the City and County of San Francisco. Such stretch codes target alterations and additions to provide opportunities for EV infrastructure installation in existing buildings.

Denver, Colorado – City Level

Denver, Colorado amended the 2021 IECC and IRC to include the following EV charging infrastructure requirements to meet its goal of electrifying 30% of all vehicles by 2030:

One- and two-family dwellings: At least one EV-Ready parking space per dwelling unit.

Multi-family dwellings (3+ dwellings) with 10+ spaces: 15% of parking spaces to be EV-Installed, 5% EV-Ready Parking Spaces, and 40% EV-Capable Parking Spaces.

Commercial buildings (Groups A, B, E, M) with 10+ spaces: 10% of parking spaces to be EV-Installed, 5% EV-Ready Parking Spaces, and 10% EV-Capable Parking Spaces.

Table 3. EV Parking Space Requirements (Denver)

Table C405.13.1: Required EV Charging Infrastructure			
OCCUPANCY	EVSE INSTALLED SPACES	EV READY SPACES	EV CAPABLE SPACES
GROUP A, B, E, M	10%	5%	10%
GROUP I	5%	0%	5%
GROUP R-1 AND R-2a	15%	5%	40%
GROUP R-3 AND R-4	2%	0%	5%
GROUP S-2 parking garages	10%	5%	0%

Winter Park, Florida – City Level

The City of Winter Park adopted an EV-Readiness Ordinance that amends both its Land Development Code and Building Code. Winter Park amended Section 58-86 "Off-street Parking and Loading Regulations" of its Land Development Code to include EV charging station infrastructure and parking space requirements. Under this amendment, non-residential properties with surface parking or parking structures are required to have a minimum of 10 percent of total parking spaces to be Level-2 EV-Ready. The EV charging infrastructure is required to be installed in accordance with the technical amendment made to the Florida Building Code (Chapter 22, Section 2703 of the City of Winter Park Code of Ordinances). The Land Development Code amendment also requires non-residential properties to provide, at minimum, 1 parking space equipped with a Level-2 EV charging station per every 20 required off-street parking spaces.

Vancouver, BC – International/City Level

The City of Vancouver adopted Building Code Bylaw 10908, which requires EV charging infrastructure installation in new construction residential and commercial buildings. Single-family dwellings with garages are required to have at least one EV-Ready parking space per dwelling unit. Multifamily unit dwellings (MUDs) are required to have 100 percent of parking spaces be EV-Ready, while commercial buildings must have 10% of parking spaces be EV-Ready (City of Vancouver 2021). Although the code requires EV-Ready for 100%of parking spaces in MUDs, there is no requirement to install the electrical capacity to charge all spaces at full power. Vancouver's code requirements encourage the use of charging management technology to achieve a high level of plug-in electric vehicle readiness without the need for larger capacity upgrades.

2.0 Economic Analysis

The costs associated with installing EV charging infrastructure during new construction are substantially lower than during a retrofit. A cost-effectiveness study for the City and County of San Francisco conducted by Pacific Gas & Electric showed costs for installing Level 2 EV charging stations as a retrofit are several times more expensive than installing them during new construction (Pike and Steuben 2016). Installing infrastructure during new construction avoids the retrofit costs of breaking and repairing existing materials (e.g., walls, slabs, sidewalks, etc.), installing longer raceways, and using more expensive methods of upgrading service panels. A study conducted by Rocky Mountain Institute determined the installed costs of a single port ESVE unit in a major U.S. metropolitan area typically ranges from $0-$900 for Level 1, $380-$4,900 for Level 2 and $20,000-$35,800 for DC fast charging (50 kW). Various elements lead to the high variability of costs due to the type of unit, applications, location, commercial or residential, required upgrades and cost factors to determine if a ESVE unit will be on the low or high end of the range (Nelder and Rogers 2020).

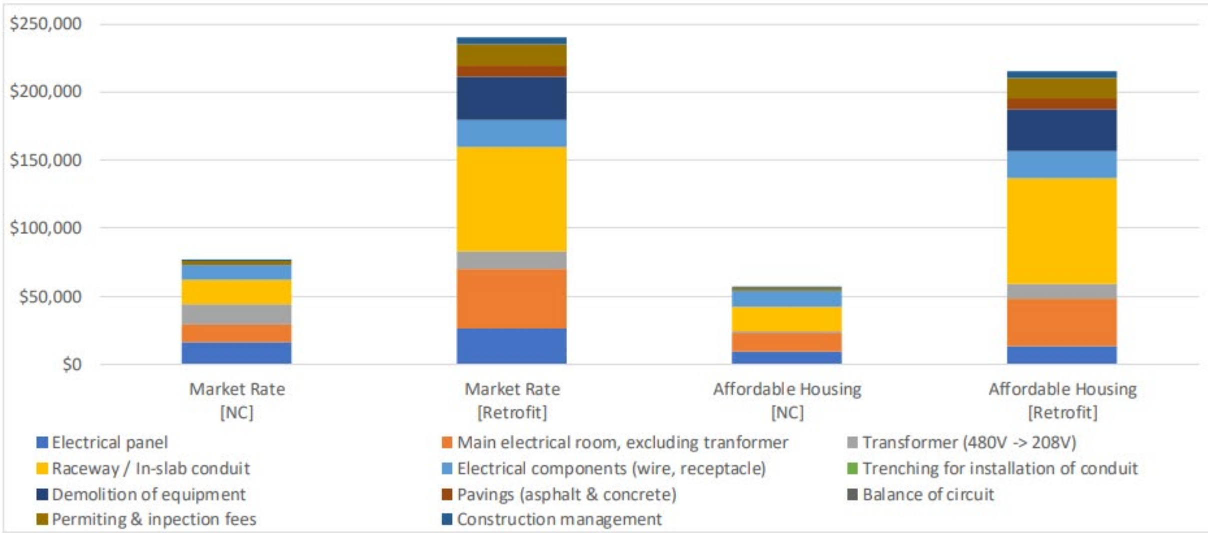
Table 4 shows the results of an Energy Solutions analysis conducted for Peninsula Clean Energy and Silicon Valley Clean Energy that compares the incremental cost of installing the necessary electrical infrastructure to support Level 1 (L1) and Level 2 (L2) EV-Ready spaces (complete circuit) at the time of new construction versus at the time of a building retrofit. The analysis considers both a 60-unit MUD (three or more units) and 60-space office. The number of additional L1 and L2 ports assumes CALGreen 2019 EV requirements as the baseline. The 60-unit MUD assumed the total number of ports distributed were 75% L1 spaces and 25% L2 spaces. The 60-space office building assumed the total number of ports distributed were 30% EV Capable spaces, 10% L1 spaces and 10% L2 spaces.

Table 4. Incremental Cost of EV Charging Infrastructure

	Per EV Parking Space with Electric Circuit		**Total Incremental Cost of Building**	
	New	Retrofit	New	Retrofit
Scenario A – 60-Unit Multi-Unit Dwelling; 9 L2 Ports, 45 L1 Ports	$1,410	$4,443	$76,142	$239,909
Scenario B – 60-Space Office Building; 2 L2 Ports, 24 L1 Ports	$1,166	$3,232	$34,971	$96,970

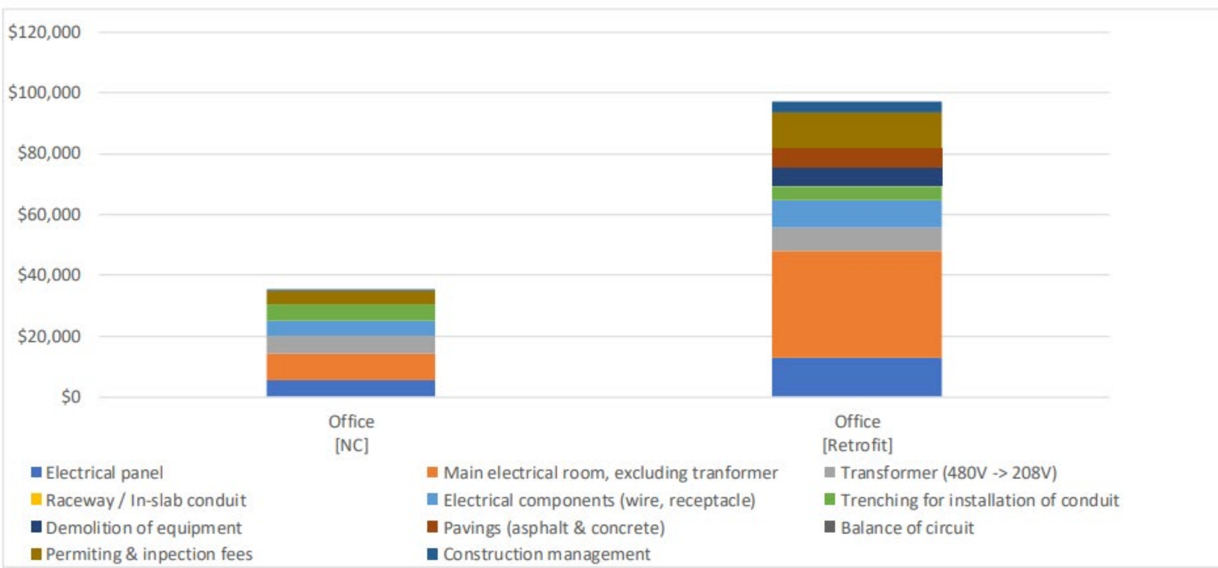
Source: Energy Solutions 2019

In one example, the incremental cost estimate to retrofit an existing building with two additional L2, EV-Ready spaces is $3,232 per space, while new construction cost for the same L2, EV-Ready spaces is $1,166 per space. Thus $2,066 (64%) of the retrofit cost would be avoided if EV-Ready infrastructure was included during the initial construction of the parking lot. These additional retrofit costs typically include labor expenses for demolition, trenching and boring, balancing the circuits, and new permitting costs. Figure 7 and Figure 8 show the cost breakdown of the charging infrastructure installation for each building type.



Source: Energy Solutions 2019

Figure 7. Incremental Cost of EV Charging for New Construction and Retrofit for 60-unit MUD



Source: Energy Solutions 2019

Figure 8. Incremental Cost of EV Charging for New Construction and Retrofit for Office

A similar cost analysis conducted by the California Air Resources Board (CARB) demonstrated significant avoided retrofit costs for installing EV charging stations during new construction. CARB staff reviewed multiple sources to obtain the average retrofit costs of installing EV charging infrastructure to support Level 2 charging stations in existing buildings. An estimated $7,000 per parking space can be avoided with multiple installations of Level 2 charging stations. An estimated $8,000 per parking space can be avoided when an individual Level 2 charging station is installed. These retrofit costs do not include the cost of the EVSE. Retrofit costs are focused on parking lot trenching, adding electrical service, and/or panel upgrades. CARB staff estimates avoided retrofit costs for installing Level 2 EV charging stations during new construction range from $272 million to $386 million between 2020 and 2025 (CARB 2019).

For one- and two-family dwellings, costs for Level 2 charging stations include the price and labor associated with the installation of one 40-ampere, 208/240-volt dedicated branch circuit and a circuit terminating in a receptacle, junction box, or EVSE. The International Council on Clean Transportation found the average cost to install a Level 2 EVSE in an existing home was $1,400 across the 100 most populous metropolitan areas in the U.S. (Nicholas 2019). A separate study by NREL analyzed multiple sources of pricing data and found the average high-cost installation for Level 2 EVSE was approximately $2,900. The key factors affecting the cost of installing EVSE in an existing home included insufficient electrical panel capacity for a dedicated 40-ampere charging circuit, location of the electric panel relative to the garage, and permit costs. The capacity limitation was found to be more prevalent in less-affluent areas (Francfort 2015). The proposed residential charging code language would reduce the cost impact for a home-owner to make the switch to EV by requiring EVSE infrastructure to be included in new homes.

Table 5. Cost of EV Charging Infrastructure

		Unit Cost per Port	Install Cost per Port
L1 residential	Low	$0	$100
	High	$0	$1,000
L2 residential	Low	$400	$500
	High	$1,200	$1,700
L2 commercial	Low	$2,200	$2,200
	High	$4,600	$6,000

Adapted from NREL 2023, *The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure*

Other studies draw similar conclusions that Level 2 EV-Ready charging infrastructure is significantly less expensive to install during new construction than during a building retrofit. New Buildings Institute found that making the necessary upgrade from a 100-ampere to a 200-ampere panel can cost $1,500 to $4,000 in addition to the cost of adding new electrical circuits for EV charging infrastructure (NBI 2022). Additional efforts are needed on a national, state and local scale to support the growing EV market and expand EV charging access for single-family, multifamily, workplace, and commercial land uses. EV-Ready building codes support this expansion and can save consumers thousands in installation costs (SWEEP 2018). New residential and commercial buildings are constructed to last for decades, so it is critical that EV charging infrastructure be incorporated at the pre-construction stage to ensure that new buildings can accommodate the charging needs of future EV-owners.

3.0 Sample Code Language

Jurisdictions seeking to adopt provisions requiring EV infrastructure must first decide if the intended effected buildings are residential, commercial, or both. The sample code language presented here is based on the existing series of DOE technical briefs on stretch codes and the language included in the residential appendix (Appendix RE) and the commercial appendix (Appendix CG) of the 2024 IECC with additional revisions to reflect market best practices from state and local adoptions across the country. While the sample code language is structured for compatibility with the IECC, modifications can be made to allow compatibility with ASHRAE Standard 90.1. For jurisdictions amending Standard 90.1, it is recommended that the bulk of the sample code language for Commercial Option 1 be inserted as a new section under the mandatory provisions in Section 8: Power (i.e:,.: requirements added into 90.1-2022 would be added into a new Section 8.4.5). Commercial Option 2 could also be adapted for inclusion with an adoption of ASHRAE 90.1 but should be done so carefully to avoid confusion around implementation.

Applicability and effectiveness of the sample code language depends on the authority of the adopting jurisdiction to ensure adoption of the appendix, and its code language is mandatory and covers the building types intended. Authorities having jurisdiction (AHJs) can adopt appendices as mandatory for all new construction in one of two ways:

1. Add new language based on the optional appendix (or appendices) into the body of the code in the appropriate location; or

2. Add charging language to the mandatory requirements for buildings that compliance with the appendix (or appendices) is mandatory.

Each option has benefits and drawbacks. Option 1, adding new language to the body of the code, will make the change clearer and more understood that enforcement is required, but it will make the code appear to be more heavily amended which many jurisdictions seek to avoid. For jurisdictions considering adjusting the required number of spaces or adopting versions of the IECC that predate the 2024, Option 1 is preferred. Option 2, adding a mandatory requirement of charging language, is a simpler amendment to the code, but may go overlooked by design teams and AHJs enforcing the code. This can easily be overcome through specific training on the new requirements. This option may also be less flexible in changing the number or percentage of required spaces. This option is not recommended for jurisdictions adopting versions of the IECC that predate the 2024. Both adoption strategies will make the EV provisions mandatory for new construction.

Language presented here is derived from both appendices, with incorporating best practices of current adopting jurisdictions as well as additional modifications that add and remove language to make it more suitable to local adoption. In addition to Section 3.1, a jurisdiction can elect to utilize Section 3.2 or Section 3.3 of this brief for the adoption of EV provisions into the residential energy code, and Section 3.4 or 3.5 for the adoption of EV provisions into the commercial energy code.

3.1 Definitions

The following definitions shall be added to Section R202 and Section C202 of the of the current adopted version of the IECC Residential and Commercial provisions.

AUTOMOBILE PARKING SPACE. A space within a *building* or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, electric vehicle supply equipment (EVSE), a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). A designated automobile parking space that is provided with electrical infrastructure such as, but not limited to, raceways, cables, electrical capacity, a panelboard or other electrical distribution equipment space necessary for the future installation of an EVSE.

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An automobile parking space that is provided with a branch circuit and an outlet, junction box or receptacle that will support an installed EVSE.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, electric vehicle connectors, attached plugs, any personal 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.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE SPACE). An automobile parking space that is provided with a dedicated EVSE connection.

3.2 Residential Option 1: Adding New Language (All IECC Versions)

The following requirements for construction document review shall be added to Section R105 of the current adopted version of the IECC Residential provisions.

> **R105.2.3 Electric vehicle charging infrastructure.** Construction documents shall indicate the raceway termination point and proposed location of future *EV* spaces and *EV* chargers. Construction documents shall also provide information about the amperage of future *EVSE*, raceway methods, wiring schematics, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all *EV*s at all required *EV* spaces at the full rated amperage of the *EVSE*.

The following EV charging infrastructure requirements shall be placed in Section R404 of the 2021 or 2024 IECC residential provisions. If included in an adoption of the 2021 IECC, the code section numbering will begin with R404.4. If included in an adoption of an older version of the IECC, the section numbering should be reviewed and changed to be sequential with the current adoption.

R404.5 Electric vehicle power transfer infrastructure. New residential automobile parking spaces for residential buildings shall be provided with EV power transfer infrastructure in accordance with **Sections R404.5.1** through **R404.5.5**."

R404.5.1 Quantity. New residential buildings shall be provided with *EV capable*, *EV ready* or *EVSE* spaces in accordance with Table R404.5.1.

Table R404.5.1 EVSE Installed, EV-Ready and EV-Capable Space Requirements for New Residential Buildings

Dwelling Type	Minimum Number of Spaces with *EVSE* Installed[a]	Minimum Number of *EV Ready Spaces*[b]	Minimum Number of *EV Capable Spaces*
One- and Two-Family	0	0	1/unit
Multifamily	40%	0%	60%

a. Installed electric vehicle supply equipment installed spaces *(EVSE spaces)* that exceed the minimum requirements of this section may be used to meet the minimum requirements for *EV ready spaces* and *EV capable spaces*.

b. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet the minimum requirements for *EV capable spaces*.

R404.5.2 EV capable spaces. Each *EV capable space* used to meet the requirements of **Section R404.5.1** shall comply with the following:

1. A continuous raceway or cable assembly shall be installed between a suitable panelboard or other on-site electrical distribution equipment and an enclosure or outlet located within 6 feet (1828 mm) of the *EV capable space*.
2. The installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with **Section R404.5.5**.
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a two-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."

R404.5.3 EV ready spaces. Each branch circuit serving *EV ready spaces* used to meet the requirements of **Section R404.5.1** shall comply with the following:

1. Termination at an outlet or enclosure, located within 6 feet (1828 mm) of each *EV ready space* it serves and marked "For electric vehicle supply equipment (EVSE)."
2. Service by an electrical distribution system and circuit capacity in accordance with **Section R404.5.5.**
3. Designation on the panelboard or other electrical distribution equipment directory as "For electric vehicle supply equipment (EVSE)."

R404.5.4 EVSE spaces. An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* serving either a single *EVSE space* or multiple *EVSE spaces* used to meet the requirements of **Section R404.5.1** shall comply with the following:

1. Be served by an electrical distribution system in accordance with **Section R404.5.5**.

2. Have a nameplate charging capacity of not less than 6.2 kVA (or 30A at 208/240V) per *EVSE space* served. Where an *EVSE* serves three or more *EVSE spaces* and is controlled by an energy management system in accordance with **Section R404.5.5**, the nameplate charging capacity shall be not less than 2.1 kVA per *EVSE space* served.

3. Be located within 6 feet (1828 mm) of each *EVSE space* it serves.

4. Be installed in accordance with **NFPA 70** and be listed and labeled in accordance with **UL 2202** or **UL 2594**.

R404.5.5 Electrical distribution system capacity. The branch circuits and electrical distribution system serving each *EV capable space, EV ready space and EVSE space* used to comply with **Section R404.5.1** shall comply with one of the following:

1. Sized for a calculated *EV* charging load of not less than 6.2 kVA per *EVSE*, *EV ready* or *EV capable space*. Where a circuit is shared or managed, it shall be in accordance with **NFPA 70**.
2. The capacity of the electrical distribution system and each branch circuit serving multiple *EVSE spaces*, *EV ready spaces* or *EV capable spaces* designed to be controlled by an energy management system in accordance with **NFPA 70** shall be sized for a calculated *EV* charging load of not less than 2.1 kVA per space. Where an energy management system is used to control *EV* charging loads for the purposes of this section, it shall not be configured to turn off electrical power to *EVSE* or *EV* ready spaces used to comply with **Section R404.5.1**.

The following text shall be added to Section R405 of the 2021 IECC or 2024 IECC residential provisions, revising Table R405.2.[6,7]

TABLE R405.2 REQUIREMENTS FOR ENERGY RATING INDEX

SECTION	TITLE
Electrical Power and Lighting Systems	
R404.1	Lighting Equipment
R404.2	Interior Lighting Controls
R404.5	Electric Vehicle Power Transfer Infrastructure

[6] Portions of the table not revised are omitted from this brief and are not intended to be deleted by adoption of this language.

[7] Previous editions of the IECC use a different method of notating mandatory measures. For adoption of language with previous editions, review how that edition indicates mandatory measures and incorporate that notation to ensure all EV measures are mandatory for all compliance paths.

The following text shall be added to Section R406 of the 2021 IECC or 2024 IECC residential provisions, revising Table R406.2.[7,8]

TABLE R406.2 REQUIREMENTS FOR ENERGY RATING INDEX

SECTION	TITLE
Electrical Power and Lighting Systems	
R404.1	Lighting Equipment
R404.2	Interior Lighting Controls
R404.5	Electric Vehicle Power Transfer Infrastructure

The following reference standards shall be placed in Chapter 6 of the current adopted version of the IECC Residential provisions.

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

2202– 2009: Electric Vehicle (EV) Charging System Equipment—with revisions through February 2018

R404.5.5

2594–-2016: Standard for Electric Vehicle Supply Equipment

R404.5.5

Notes for jurisdictions adopting residential language:

Recommended minimum EV parking space requirements in Table R404.5.1 may be adjusted based on the needs of each jurisdiction. Additional categories may be added for buildings served by garages vs. parking lots or other distinguishing features of the buildings as would be needed to accommodate local practices and needs.

The addition of the EV charging section to Table R405.2 and Table R406.2 make the requirements mandatory across all compliance paths (prescriptive, performance, and ERI). If only a select number of paths will require installation of EV infrastructure, those amendments can be adjusted to meet the needs of the jurisdiction.

Notes for jurisdictions adopting residential language continued:

There are other important code references to examine in parallel to IECC/IRC Chapter 11 requirements. If not consistent with the latest editions, update:

- Section 625 of the National Electrical Code (NFPA 70)
- Section E3702.14 of the 2024 International Residential Code or Section E3702.13 of the 2021 International Residential Code

See Section R330.10 of the 2024 International Residential Code or Section R328.10 of the 2021 International Residential Code and Section 1207.11.9 of the 2024 International Fire Code or Section 1207.11.10 of the 2021 International Fire Code for provisions on the use of electric vehicles as energy storage systems.

3.3 Residential Option 2: Refer to Appendix RE (2024 IECC Only)

The following text shall be added in Section R101.2 of the 2024 IECC:

R101.2 Scope. This code applies to the design and construction of detached one- and two-family dwellings and multiple single-family dwellings (townhouses) and Group R-2, R-3 and R-4 buildings three stories or less in height above *grade plane*.

> **R101.2.1 Appendices.** Provisions in ~~the appendices shall not apply unless specifically adopted~~ Appendix RE are adopted as mandatory.

The following text shall be added in Section R401.2:

R401.2 Application. Residential buildings shall comply with Section R401.2.1, R401.2.2, R401.2.3 or R401.2.4. All new residential buildings shall comply with provisions of Appendix RE.

3.4 Commercial Option 1: Add New Language (All IECC Versions)

The following requirements for construction document review shall be added to Section C105 of the current adopted version of the IECC Commercial provisions.

C105.2.2 Electric vehicle charging infrastructure. Construction documents shall indicate the raceway termination point and proposed location of *EV capable spaces*. Construction documents shall also provide information about the amperage of future *EVSE spaces*, raceway methods, wiring schematics, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all *EV*s at all required *EVSE spaces* at the full rated amperage of the *EVSE*.

The following EV charging infrastructure requirements shall be placed in Section C405 of the 2024 IECC commercial energy code or existing code. In the 2021 IECC, the code section numbering will begin with C405.13. If included in an adoption of an older version of the IECC, *the section numbering should be reviewed and changed to be sequential with the current adoption.*

C405.17 Electric Vehicle power transfer infrastructure. Parking facilities shall be provided with electric vehicle (EV) power transfer infrastructure in accordance with **Sections C405.17.1** through **C405.17.7**

C405.17.1 Quantity. The number of required *EV* spaces, *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this section and **Table C405.17.1** based on the total number of automobile parking spaces and shall be rounded up to the nearest whole number. For R-2 buildings, the **Table C405.17.1** requirements shall be based on the total number of *dwelling units* or the total number of *automobile parking spaces*, whichever is less.

1. Where more than one parking facility is provided on a *building site*, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.
2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
3. Installed electric vehicle supply equipment installed spaces *(EVSE spaces)* that exceed the minimum requirements of this section may be used to meet the minimum requirements for *EV ready spaces* and *EV capable spaces*.
4. Installed *EV ready spaces* that exceed the minimum requirements of this section may be used to meet the minimum requirements for *EV capable spaces*.
5. Where the number of *EV ready spaces* allocated for R-2 occupancies is equal to the number of *dwelling units* or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for *EVSE spaces* for R-2 occupancies shall not apply.
6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in **Table C405.17.1** shall be used.

Exception: Parking facilities serving occupancies other than R2 with fewer than 10 *automobile parking spaces* shall be provided with no fewer than one *EVSE space*.

Table C405.17.1
Required EV Power Transfer Infrastructure

OCCUPANCY	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
Group A	10%	0%	10%
Group B	15%	0%	35%
Group E	15%	0%	35%
Group F	15%	0%	30%
Group H	1%	0%	0%
Group I	15%	0%	30%
Group M	15%	0%	30%

Group R-1	25%	25%	50%
Group R-2	25%	25%	50%
Groups R-3 and R-4	2%	0%	5%
Group S exclusive of parking garages	1%	0%	0%
Group S-2 parking garages	15%	0%	30%

C405.17.2 EV capable spaces. Each *EV capable space* used to meet the requirements of **Section C405.17.1** shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capable space* and electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply a minimum circuit capacity in accordance with **Section C405.17.5**.
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have dedicated overcurrent protection device space and electrical capacity to supply a calculated load in accordance with **Section C405.17.5**.
4. The enclosure or outlet and the electrical distribution equipment directory shall be marked: “For future electric vehicle supply equipment (EVSE).”

C405.17.3 EV ready spaces. Each branch circuit serving *EV ready spaces* used to meet the requirements of **Section C405.17.1** shall comply with the following:

1. Termination at an outlet or enclosure, located within 3 feet (914 mm) of each *EV ready space* it serves.
2. Have a minimum system and circuit capacity in accordance with **Section C405.17.5.**
3. The electrical distribution equipment directory shall designate the branch circuit as “For electric vehicle supply equipment (EVSE)” and the outlet or enclosure shall be marked “For electric vehicle supply equipment (EVSE).”

C405.17.4 EVSE spaces. An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of **Section C405.17.1**, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with the following:

1. Have a minimum system and circuit capacity in accordance with **Section C405.17.5**.
2. Have a nameplate charging capacity of not less than 6.2 kW.
3. Be located within 6 feet (1828 mm) of each *EVSE space* it serves.
4. Be installed in accordance with **Section C405.17.6.**

C405.17.5 System and circuit capacity. The system and circuit capacity shall comply with **Section C405.17.5.1** and **C405.17.5.2.**

C405.17.5.1 System capacity. The electrical distribution equipment supplying the branch circuit(s) serving each *EV capable space*. *EV ready space* and *EVSE space* shall comply with one of the following:

1. Have a calculated load of 7.2 kVA or the nameplate rating of the equipment, whichever is larger, for each *EV capable space*, *EV ready space* and *EVSE space*.
2. Meets the requirements of Section **C405.17.5.3.1**.

C405.17.5.2 Circuit capacity. The branch circuit serving each *EV capable space*, *EV ready space* and *EVSE space* shall comply with one of the following:

1. Have a rated capacity not less than 50 amperes or the nameplate rating of the equipment, whichever is larger.
2. Meets the requirements of **Section C405.17.5.3.2**.

C405.17.5.3 System and circuit capacity management. Where system and circuit capacity management is selected in **Section C405.17.5.1** or **C405.17.5.2**, the installation shall comply with Sections **C405.17.5.3.1** and **C405.17.5.3.2**.

C405.17.5.3.1 System capacity management. The maximum equipment load on the electrical distribution equipment supplying the branch circuits(s) serving *EV capable spaces*, *EV ready spaces* and *EVSE spaces* controlled by an energy management system shall be the maximum load permitted by the energy management system, but not less than 3.3 kVA per space.

C405.17.5.3.2 Circuit capacity management. Each branch circuit serving multiple *EVSE spaces*, *EV ready spaces* or *EV capable spaces* controlled by an energy management system shall comply with one of the following:

1. Have a minimum capacity of 25 amperes per space.
2. Have a minimum capacity of 20 amperes per space for R-2 occupancies where all automobile parking spaces are *EV ready spaces* or *EVSE spaces*.

C405.17.6 EVSE installation. *EVSE* shall be installed in accordance with **NFPA 70** and shall be listed and labeled in accordance with **UL 2202** or **UL 2594**. *EVSE* shall be accessible in accordance with **Section 1107** of the International Building Code.

The following reference standards shall be placed in Chapter 6 of the current adopted version of the IECC Commercial provisions.

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

2202– 2009: Electric Vehicle (EV) Charging System Equipment—with revisions through February 2018

C405.17.6

2594–-2016: Standard for Electric Vehicle Supply Equipment

C405.17.6

Notes for jurisdictions adopting commercial language:
Recommended minimum EV parking space requirements in Table **C405.17.1** may be adjusted based on the needs of each jurisdiction. Jurisdictions may elect to vary requirements based on total number of parking spaces, type of parking facility (garage or lot), or other local considerations and practices.

There are other important code references to examine in parallel to IECC/IBC Chapter 11 requirements. If not consistent with the latest editions, update:

- Section 625 of the National Electrical Code (NFPA 70)
- Section 406.2.7 of the IBC

Jurisdictions adopting EV provisions that have not adopted the 2021 IBC must also amend earlier versions of the International Building Code to renumber Section 1109.14 Fuel-dispensing Systems and add the following language into Chapter 11:

SECTION 1107
MOTOR-VEHICLE-RELATED FACILITIES

1107.1 General. Electrical vehicle charging stations shall comply with **Section 1107.2**. Fuel-dispensing systems shall comply with **Section 1107.3**.

1107.2 Electrical vehicle charging stations. Electrical vehicle charging stations shall comply with **Sections 1107.2.1** and **1107.2.2**.

Exceptions:

1. Electrical vehicle charging stations provided to serve Group R-2, R-3 and R-4 occupancies are not required to comply with this section.
2. Electric vehicle charging stations used exclusively by buses, trucks, other delivery vehicles, law enforcement vehicles and motor pools are not required to comply with this section.

1107.2.1 Number of accessible vehicle spaces. Not less than 5 percent of vehicle spaces on the *site* served by electrical vehicle charging systems, but not fewer than one for each type of electric vehicle charging system, shall be accessible.

1107.2.2 Vehicle space size. Accessible vehicle spaces shall comply with the requirements for a van accessible parking space that is 132 inches (3350 mm) minimum in width with an adjoining access aisle that is 60 inches (1525 mm) minimum in width.

1107.3 Fuel-dispensing systems. Fuel-*dispensing* systems shall be *accessible*.

3.5 Commercial Option 2: Refer to Appendix CG (2024 IECC Only)

The following text shall be added in Section C101.2 of the 2024 IECC:

C101.2 Scope. This code applies to the design and construction of buildings not covered by the scope of the IECC-Residential provisions.

> **C101.2.1 Appendices.** Provisions in ~~the appendices shall not apply unless specifically adopted~~ <u>Appendix CG are adopted as mandatory</u>.

The following text shall be added in Section C401.2 of the 2021 or 2024 IECC:

C401.2 Application. *Commercial buildings* shall comply with Section C401.2.1 or C401.2.2. <u>All new *commercial buildings* shall comply with provisions of Appendix CG.</u>

4.0 References

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