ELECTRIC VEHICLE (EV) CHARGING INFRASTRUCTURE: MULTIFAMILY BUILDING STANDARDS

ABSTRACT: Building standards for multifamily housing help to ensure EV charging infrastructure is accessible to all income levels. California's Green Building Standards (CALGreen) Code requires new multifamily housing developments with 17 units or more to install EV charging infrastructure in at least 3 percent of total parking spaces. California Air Resources Board (CARB) staff completed a technical and cost analysis, which indicates that the 17 unit size threshold should be eliminated and a higher 10 percent requirement is needed beginning in 2020 to meet the demand for Level 2 charging stations between 2025 and 2030.

CALIFORNIA AIR RESOURCES BOARD

CARB TECHNICAL AND COST ANALYSIS: 2019 CODE CYCLE

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California Air Resources Board (CARB)

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Technical and Fiscal Analysis Pursuant to AB 341

Health and Safety Code, § 18930.5 (b) as amended by Assembly Bill 341 in October 2013 allows the Building Standards Commission (BSC) and other state agencies that propose building standards to allow for input by state agencies with expertise in green building subject areas. California Air Resources Board (CARB) staff has expertise in air quality and climate change, which is related to multiple building standards in the Green Building Standards (CALGreen) Code. Since 2008, CARB staff has provided suggested changes to the CALGreen Code to ensure it is updated to support CARB programs and regulations including, but not limited to, California Global Warming Solutions Act of 2006 (AB 32, Nunez, Statutes of 2006, Chapter 488), Zero Emission Vehicles (ZEV), and The Sustainable Communities and Climate Protection Act of 2008 (SB 375, Steinberg, Statutes of 2006, Chapter 728). Beginning with the 2016 triennial Code Cycle, CARB staff provides technical and fiscal analyses along with suggested code changes as required by Health and Safety Code, § 18930.5 (b). Additionally, CARB staff may identify which proposed changes may be considered for adoption as mandatory within the next two code adoption cycles. This document provides the technical analysis to support the suggested code changes under AB 341. As part of the complete submittal package, CARB is providing Draft Express Terms with the suggested code language, draft Initial Statement of Reasons, and an economic and fiscal analysis with a Form 399 Economic and Fiscal Impact Statement.

Disclaimer

This document has been prepared by the staff of the California Air Resources Board. CARB's Executive Officer certifies, by this submittal, to the Department of Housing and Community Development that the information provided in the document is true and accurate based upon the information currently known to CARB staff and the staff's expertise. Formal submittal and publication do not indicate that the contents have been reviewed and/or approved by the Board members of the California Air Resources Board.

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Executive Summary

Transportation is the largest source of greenhouse gas (GHG) emissions and criteria pollutants in California (California Air Resources Board, 2017). Zero emission vehicles (ZEVs) can help to improve air quality. Projections for ZEVs on California's roadways are expected to rise over the years; an estimated 1.5 million by 2025, 5 million targeted by 2030, and 100 percent of new car sales will be ZEVs by 2050 (Governor Brown, 2018). Installing adequate infrastructure statewide is essential to assist with charging and refueling clean air vehicles.

Current Standards

California's Green Building Standards (CALGreen) Code includes mandatory provisions for electric vehicle (EV) charging infrastructure to support future installation of charging stations. New multifamily buildings with 17 or more units must install EV charging infrastructure in 3 percent of parking spaces. California Air Resources Board (CARB) staff completed a technical and cost analysis to determine whether these current building standards are adequate to meet the EV charging demand in multifamily housing in 2025 and beyond.

Gap Analysis for Multifamily Housing

The California Energy Commission (CEC) establishes the statewide need for EV charging infrastructure. Using the Electric Vehicle Infrastructure Projections (EVI-Pro) model, CEC determined that 120,000 plug-in electric vehicles (PEVs) will reside in multifamily housing by 2025; each vehicle will need one charging station. (Bedir et al., 2018). CARB staff completed a gap analysis to determine what is being done to meet this need. CARB staff reviewed multiple sources of investments to identify the total number of existing, funded, planned, and proposed Level 2 charging stations that will be installed in multifamily housing by 2025. CARB staff also evaluated investments for DC fast charging plazas under development to serve multifamily housing. Lastly, CARB staff estimated the number of EV Capable Spaces that may be installed due to the current code requirements and local government reach standards.

A gap of between 66,000 and 79,500 charging stations are still needed to meet the demand for charging stations in multifamily housing by 2025.

Proposed Code Changes

CARB staff recommends deleting the 17 unit building size threshold, which limits the EV charging infrastructure requirements to about 30 percent of new construction. Raceway and panel capacity are still the appropriate EV charging infrastructure to install in new buildings; it allows for flexibility of the building owner to select the specific type of charging station. However, CARB staff recommends increasing the current 3 percent requirement. A minimum 10 percent requirement is needed to fill the gap in EV charging infrastructure needed in multifamily housing by the year 2025. A 10 percent requirement would also put California on track to support 2030 EV charging needs and 2030 climate goals.

Additional code changes are proposed to improve implementation of the building standards. CARB staff recommends adopting definitions for EV Capable and EV Ready building standards. EV Capable building standards require the installation of raceway and panel capacity. EV Ready building standards would include wiring as well to allow

for even easier installation of charging stations. Lastly, CARB staff recommends increasing the EV Capable percentages in the voluntary provisions from 5 to 15 percent for Tier 1 and 20 percent for Tier 2. CARB staff recommends that the Tier 2 provision also include the installation of at least one charging station. These higher percentages are more in line with the percent requirements that many cities are adopting as mandatory at the local level. CARB staff recommends transitioning these voluntary provisions to mandatory within the next two code cycles.

Cost Estimates

Upfront costs for raceway and panel capacity in new construction average about $280 per space for parking garages and up to $760 per space for surface lots. An additional $2,175 to $3,450 per space may be added for smaller buildings with 9 units or less when single phase power is selected and a dedicated transformer is installed to serve the EV charging load. When transformer costs are added to raceway and panel capacity costs, the total additional cost of EV charging infrastructure represents between 0.1 to 0.5 percent of the average cost of a new multifamily housing unit.

Statewide Cost Benefit

Significant retrofit costs between $7,000 and $8,000 per space can be avoided by installing EV charging infrastructure in new construction. Overall, there is a significant statewide cost benefit with the code changes proposed by CARB. Based on new construction projections between 2020 and 2025, CARB staff estimates statewide costs between $43 million and $76 million for the suggested code changes. Statewide retrofit costs between $272 million and $386 million could be avoided, which results in an estimated statewide benefit (avoided costs) of $229 to $310 million between 2020 and 2025.

1) Introduction

Mobile sources are the largest contributor to ozone, particulate matter, and GHG emissions in California. CARB leads the state's efforts to reduce transportation related smog-forming pollutants and GHG emissions in California. Transportation electrification is one strategy to reduce emissions from cars. California's ZEV regulation will result in an increasing number of plug-in electric vehicles by 2025 and beyond.

Annual on-road sales of ZEVs are expected to reach 8 percent of total new car sales by 2020 and ramp up to 15 percent in 2025. Approximately 1.5 million ZEVs are projected to be on California's roadways by 2025. The CALGreen Code supports California's ZEV program; it includes mandatory requirements for EV charging infrastructure in new residential buildings and commercial buildings. However, CARB staff evaluated the current building standards for EV charging infrastructure to determine if the provisions would meet the needs for multifamily housing by 2025 and beyond.

In new multifamily housing where 17 or more units are constructed, the CALGreen Code requires multifamily dwelling units to install EV charging infrastructure. The main requirements for infrastructure include raceway and panel capacity, which must be installed in at least 3 percent of total parking spaces. These building standards are intended to support future installation of Level 2 EV charging stations. Based on the findings in this technical and cost analysis, CARB staff determined that the current building standards for new construction are not adequate to support the need for charging stations to serve multifamily housing residents in California by 2025 or 2030.

CARB staff developed this technical and cost analysis in consultation with several state agencies including the CEC, California Government Operations Agency (GovOps), California Public Utilities Commission (CPUC), Department of General Services (DGS), the Governor's Office of Business and Economic Development (GO-Biz), and the Department of Housing and Community Development (HCD). The main purpose of completing the technical and cost analysis was to determine if any changes are needed to the CALGreen Code to help meet the demand for EV charging in multifamily housing. This document provides the justification to support CARB's suggested code changes for multifamily housing during the 2019 Code Cycle.

EV sales continue to grow rapidly. One of the main barriers to EV adoption is limited access to EV charging stations. As more ZEVs are on California roadways, it is essential for EV charging stations to be abundantly available to provide adequate fueling. A variety of charging stations including Level 1, Level 2 and DC fast charging stations in homes, workplaces, public, corridors, and destinations are needed to meet the demand. It is essential for new buildings to install raceway and panel capacity to support future installation of charging stations. By providing this basic EV charging infrastructure in new buildings, it provides flexibility to building owners to install the charging station of their choice. It also prevents significant retrofit costs in the future.

2) Gap Analysis

A. What infrastructure is needed for 2025 and beyond?

CEC assesses the need for EV charging infrastructure in California. The CEC worked with the National Renewable Energy Laboratory to develop the EVI-Pro model, which takes into consideration the statewide projections for the number and type of ZEVs that will be on California roads by 2025. When just evaluating

the multifamily housing needs, EVI-Pro estimates that approximately 120,000 charge points are needed by 2025 to serve multifamily housing. (Bedir et al., 2018) CEC staff considers this to be a conservative estimate due to limitations in the availability of representative data quantifying parking at residential buildings.

B. What is being done to meet the need?

Number of Level 2 Charging Stations in Multifamily Housing

Several efforts are underway to fund the installation of Level 2 EV charging infrastructure to meet the demand for ZEVs statewide. CARB staff evaluated the existing, funded, planned, and proposed investments for EV charging infrastructure in California (Table 1). CARB staff estimate that EV charging infrastructure in multifamily housing totals between 20,200 and 33,000 Level 2 charging stations.

Table 1. Estimated Number of Level 2 EV Charging Stations in Multifamily Housing in California

Type	Source	Low	High
Existing	AFDC	80	100
Funded	IOU Infrastructure Pilot Programs	2,940	5,910
	ARFVTP	228	243
	Settlements	2,640	3,308
Planned	POU Programs	8,990	13,300
Proposed	SB 350	5,300	10,080
Total		20,178	32,941

Number of Vehicles Served by DCFC Charging Plazas

In addition to Level 2 charging stations, several efforts are underway to install DCFC stations to serve multifamily housing. CARB staff reviewed the utilities' proposals for fast charge programs pursuant to SB 350 as well as the NRG and VW settlements to estimate the number of multifamily vehicles that could be served by DCFC infrastructure (Table 2). An estimated total between 360 to 540 DCFC charging stations may be installed at DCFC plazas. CARB staff assumed that two-thirds of the DCFC stations would be operating at 150 kW and one-third of the stations would be operating at 50 kW. CARB staff also assumed that the DCFC refueling profile would be consistent with a gasoline refueling profile. For the chargers operating at 150 kW, CARB staff estimated a refueling time of 15-20 minutes per event and 32-43 events total per day. For the chargers operating at 50 kW, CARB staff estimated a refueling time of 25-30 minutes per event and 22-27 events per day.

An estimated 10,250 to 18,100 total vehicles could be served by DCFC stations. However, not all of the vehicles registered to multifamily residents can be served by DCFC. Half of the ZEVs registered to multifamily residents are plug-in hybrid electric vehicles (PHEVs), which CARB staff assumes cannot be served by DCFC. The other half of ZEVs registered to multifamily residents are BEVs. CARB staff assumes that three-quarters of those BEVs can be served by DCFC. As a result, just about 37.5 percent of the total number of vehicles served per day by future installations of DCFC plazas may serve multifamily residents in

California. Therefore, the total number of multifamily vehicles served by DCFC plazas is between 3,800 and 7,000. In a conservative scenario, each Level 2 charging station would serve 1 vehicle per day. CARB staff estimates that DCFC plazas may offset the need for an estimated 3,800 to 7,000 Level 2 charging stations. For a more detailed summary of these estimates, see Tables A9-A13 in Appendix A.

Table 2. Summary of Vehicles Served by DCFC Infrastructure Investments

Program	SB 350		Settlements		Total	
	Low	High	Low	High	Low	High
Total DCFC	120	140	240	400	360	540
Total Vehicles Served per Day	3,350	5,300	6,900	12,800	10,250	18,100
Multifamily Vehicles Served per Day	1,200	2,000	2,600	5,000	3,800	7,000

A detailed summary of the estimates for "What's Being Done to Meet the Need" can be found in Appendix A (Table 3).

Table 3. Summary of What's Being Done to Meet the Need

Investments Serving Multifamily Housing	Low	High
Level 2 Charging Stations	20,200	33,000
Vehicles Served by DCFC Investments	3,800	7,000
Total	24,000	40,000

EV Capable Spaces Due to Building Standards

CARB staff estimated the number of EV Capable charging spaces that may be able to help fill the gap based on current building standards and local government reach standards (Table 4). CARB staff estimated that between 4,000 and 4,500 EV Capable spaces have been installed due to the building standards that have been in effect since July 1, 2015. CARB staff also estimated that approximately 10,000 and 12,000 EV Capable spaces may be installed statewide due to local government reach standards. While the number of EV Capable spaces will not necessarily result in the installation of Level 2 charging stations in all the spaces, it is a useful gauge to estimate the gap in charging stations needed to serve multifamily housing. Appendix C provides more details on EV charging infrastructure building standards adopted at the local level.

Table 4. Summary of EV Capable Spaces from State and Local Building Standards (Years 2015-2025)

EV Capable Building Standards	Low	High
CALGreen Code – 7/1/15 Supplement (Between Years Mid-2015 to 2020)	4,000	4,500
Local Government Reach Standards (Between Years 2018-2025)	10,000	12,000
Total	14,000	16,500

C. What is the gap in EV charging infrastructure for multifamily housing?

A gap of between 66,000 and 79,500 Level 2 EV charging stations is projected by 2025 (Table 5). The estimated gap is based on CEC's EVI-Pro model projection for the number of charging stations needed in 2025 and CARB staff review of what's being done to meet the need for both Level 2 and DCFC investments to serve multifamily housing. CARB staff also reviewed state standards and local government reach standards to estimate the number of EV Capable Spaces that may be installed by 2025.

Table 5. CARB Staff Estimated Gap in Level 2 EV Charging Stations Needed to Serve Multifamily Housing by 2025

Projections	Low	High
Needed EVSE	120,000	120,000
What's being done to meet the need?	40,000	24,000
EV Capable Spaces[1]	14,000	16,500
Gap	66,000	79,500

3) Technical Review of Multifamily Building Standards

A. What percent of ZEVs are registered to multifamily residents?

As of October 2016, just over 250,000 total ZEVs were registered in California. The total number of ZEVs represents nearly 1 percent of the state's 28 million privately owned light duty vehicles (LDV). Since 2013, the estimated fraction of ZEVs in multifamily housing has fluctuated between 11% and 14%. The percent of ZEVs owned by multifamily residents is consistent with the percent distribution of the total light duty vehicle fleet. In 2017, DMV data indicates that approximately 14% of all privately owned light duty vehicles were registered to multifamily housing residents (Figure 1).

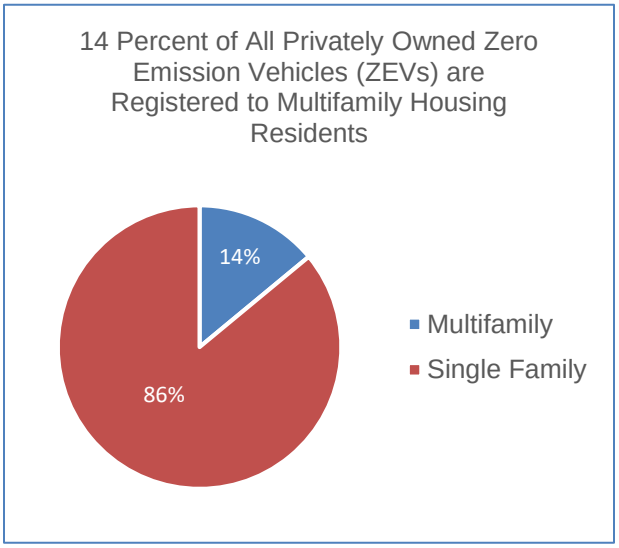

Figure 1. 2017 DMV Data Details Summarizing Privately Owned ZEV Registrations in California

B. What types of ZEVs do multifamily residents own or lease?

ZEVs are divided into two main categories: plug-in electric vehicles (PEVs) and fuel cell electric vehicles (FCEV). Plug-in electric vehicles include two subcategories: battery electric vehicles (BEVs) and PHEVs. PHEVs include both an on-board battery as well as a gasoline-fueled engine. BEVs rely solely on an on-board battery and grid electricity for fueling. A very small fraction of the total

[1] Data on conversion of EV Capable spaces to EV chargers is inconsistent and has not been exhaustively compiled due to the challenges associated with collecting permit or other information from each local government.

ZEVs registered to multifamily households were FCEVs in 2016 (Table 6). The majority of ZEVs in multifamily households were either PHEVs or BEVs.

Table 6. Percent Distribution of ZEV Types Registered to Multifamily Residents in 2016

ZEV Type	Percent
PHEV	50%
BEV	49%
FCEV	1%
Total	100%

C. What is the current percent distribution of ZEVs in multifamily housing?

CARB staff estimated the percent of ZEVs currently in multifamily housing. The percent was calculated using the ZEVs in multifamily housing divided by total ZEVs registered statewide. Figure 2 displays the results by climate zone in California. This information indicates that the current population of ZEVs in multifamily housing are distributed fairly evenly throughout California.

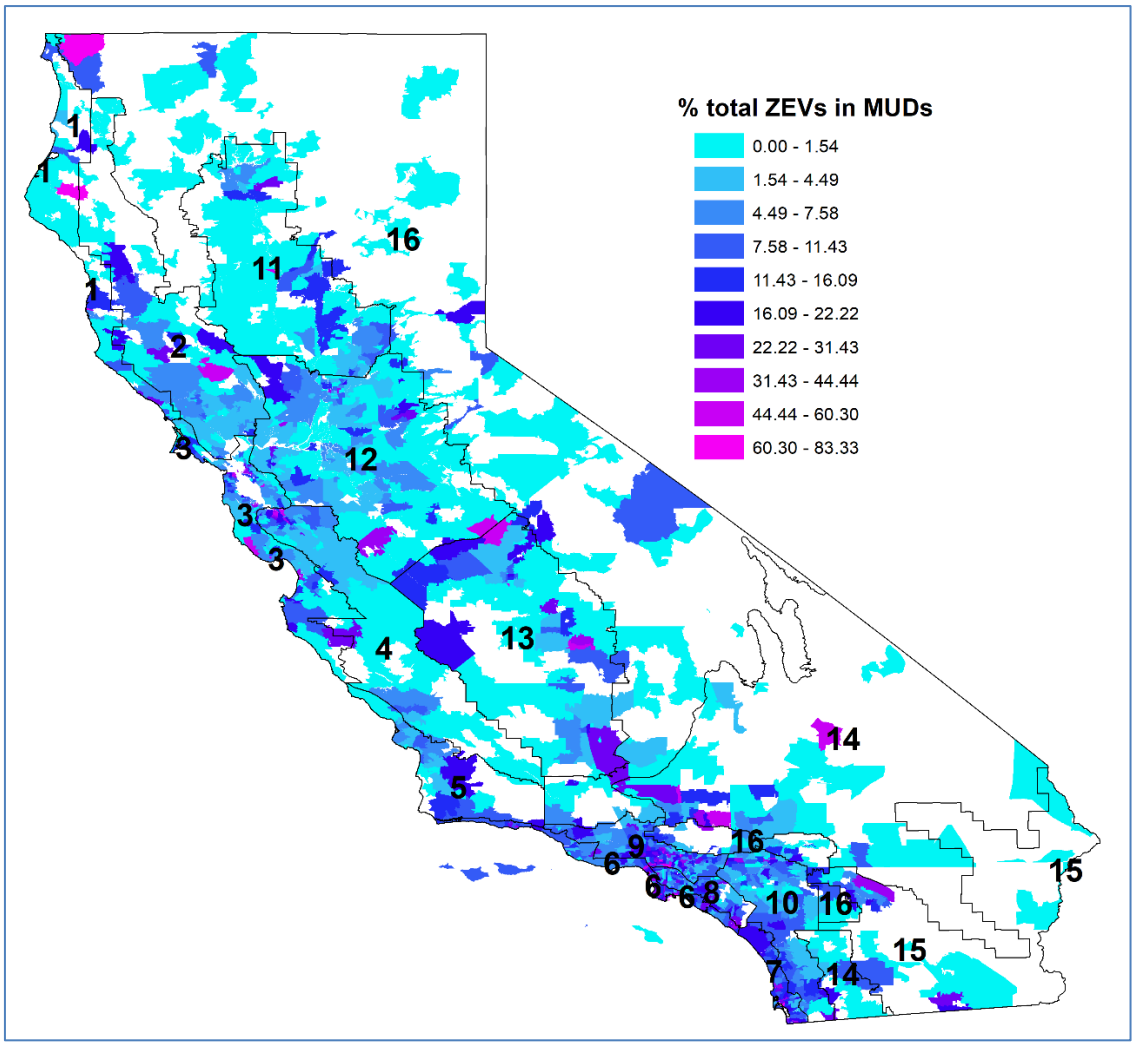

Figure 2. Percent Distribution of ZEVs Residing in Multifamily Housing in 2016

D. What are the barriers to EV charging in multifamily housing?

Most PEV owners refuel overnight when they are home. Multifamily housing residents face a number of barriers to installing EV charging stations. In older

multifamily buildings that are not EV Capable, there is a high cost to installing EV charging stations. Renters are unlikely to invest in equipment that they may move away from in the future. Most owners currently do not see EV charging stations as an amenity that would increase property value and attract tenants. Overcoming these barriers is essential to advance the market for PEVs. (DeShazo, Wong, & Karpman, 2017) One key strategy to help overcome these barriers is to install EV charging infrastructure in new multifamily housing to lower the future costs of installing EV charging stations.

E. What are the current code requirements for multifamily housing?

- Where 17 or more multifamily dwelling units are constructed on a building site
- 3 percent of total parking spaces shall be EV Capable to support future installation of EVSE
- Construction documents shall indicate location of proposed EV spaces
- At least one EV space shall be in common area available for use by all residents
- Parking dimensions - 18 feet long and 9 feet wide
    - One in 25 EV spaces shall also have an 8-foot wide minimum aisle.

Single EV Space Required

- Raceway capable of accommodating a 208/240-volt dedicated branch circuit
- Raceway shall not be less than trade size 1
- Raceway shall originate at the main service or subpanel and terminate in listed cabinet, box or enclosure close to the proposed location of the EV spaces
- Panel capacity to install a 40-amp dedicated branch circuit and space(s) reserved to permit installation of branch circuit overcurrent protective device

Multiple EV Spaces Required

- Construction documents shall indicate the raceway termination point and location of future EV spaces and EV chargers
- Provide information on amperage of future EVSE, raceway methods, wiring schematics, and electrical load calculations to verify panel capacity, including on-site distribution transformer(s)
- Design shall be based upon a 40-amp minimum branch circuit
- Raceway and related components that are planned to be installed underground, enclosed, inaccessible or in concealed areas shall be installed at construction

Identification

- Service panel or subpanel shall identify overcurrent protective device space(s) "EV CAPABLE"

F. Should the building standards include a building size threshold?

A national summary of construction characteristics indicates that the current building size threshold of 17 units may only impact about 30 percent of projected new multifamily units. CARB staff recommends deleting the 17 unit size threshold to allow for 100 percent of new multifamily housing to install EV charging infrastructure. Table 7 provides a summary of the percent distribution

of new multifamily housing by building size as reported to the U.S. Census Bureau in 2016.

Table 7. 2016 Percent Distribution of Multifamily Units by Building Size[2]

Building Size	Total	2 units	3 to 4 units	5 to 9 units	10 to 19 units	20 to 29 units	30 to 49 units	50 units or more
Percent Distribution	100%	18%	11%	13%	28%	15%	5%	10%

G. What is the right percent of EV Capable charging spaces?

CARB staff recommend that at least 10 percent of parking spaces installed in new multifamily housing must be EV Capable. When raceway and panel capacity are provided, the added cost of installing an EV charging station is minimal. CARB staff reviewed new construction estimates and over 200 municipal ordinances to determine average off-street parking requirements statewide. Based on the number of projected new parking spaces in multifamily housing and the gap in Level 2 EV charging infrastructure, a 10 percent requirement would close the gap in the year 2025, assuming uniform ZEV adoption. However, we know that adoption is seldom uniform and that at least a 10 percent requirement is needed to put California on track to meeting EV charging needs for 2030. In other words, a 10 percent requirement will help prepare California for 2030 and create necessary opportunities for deeper near term adoption in a given building – especially in communities that may not adopt more aggressive voluntary standards.[3] Since buildings typically have a 30 year life or longer, CARB staff recommends that HCD adopt a 10 percent requirement for the multifamily provisions in the 2019 CALGreen Code.

Estimates for New Construction of Multifamily Housing

CARB staff collected data on residential new construction forecasts from CEC staff developing the 2017 Integrated Energy Policy Report (California Energy Commission, 2017) and the Construction Industry Research Board CIRB). An estimated 310,000 to 385,000 new multifamily housing units are projected for construction between 2020 and 2025. However, HCD staff indicated that 2 unit buildings and half of 3-4 unit buildings may be covered under the duplex and townhome requirements for EV charging infrastructure.[4] CARB staff adjusted the projections for new multifamily housing to account for this conclusion. Totals for the number of EV Capable duplexes and townhomes were not included in the estimate for "what's being done to meet the need" for Level 2 chargers because the infrastructure would be installed in private garages. By excluding these units, CARB staff estimated an adjusted 237,000 to

[2] U.S. Census Bureau, Characteristics of New Multifamily Buildings Completed in 2016, Units per Building, Website: https://www.census.gov/construction/chars/mfb.html. Accessed on September 26, 2017.

[3] Dynamic power management for EVSEs is becoming more readily available today. Power management enables the installation of more charging equipment without requiring more electrical capacity. In the context of the discussion for future requirements for meeting the 2030 EV charging needs it will be relevant to consider power management opportunities.

[4] Mandatory building standards for EV charging infrastructure in new one- and two-family dwellings and townhouses with attached private garages can be found in the 2016 California Green Building Standards Code, Part 11, Mandatory Residential Measures, Code Section 4.106.4.2 on the following website: https://codes.iccsafe.org/public/chapter/content/2079/.

295,000 multifamily housing units may be constructed between 2020 and 2025. Table 8 provides a summary of these adjusted estimates. More details on the projections for new construction of multifamily housing can be found in Appendix B.

Table 8. Adjusted Projections for Multifamily Housing Between 2020 and 2025

Year	Low	High
	CEC Projections Using DOF Data	CARB Staff Projections Using CIRB Data
2020	40,185	51,627
2021	39,440	50,594
2022	39,628	49,582
2023	39,194	48,591
2024	39,167	47,619
2025	39,683	46,667
Total	237,296	294,680

New Parking Projections

CARB staff reviewed over 200 local jurisdiction municipal codes to determine the statewide average parking requirements for new multifamily housing. On average, about 1.8 parking spaces must be installed per new multifamily unit. Table 9 provides a summary of these local parking requirements. By including the low range and high range estimate of adjusted new multifamily housing starts summarized in Table 8, an estimated 427,133 to 530,424 new parking spaces may be subject to the proposed code.

Table 9. Summary of CARB Staff Review of Municipal Codes and Statewide Average Parking Requirements

Population Size	Total Number of Jurisdictions	Sample Size	Average Parking Requirement by Population Size
Over 200,001	18	8	1.6
100,001-200,000	48	21	1.8
50,001-100,000	103	46	2.0
25,001-50,000	94	42	2.0
10,001-25,000	109	49	1.9
5,001-10,000	51	23	1.8
5,000 and Under	57	25	1.8
Total	**480**	**214**	**1.8**

As cities strive to implement climate goals, one of the key priorities will include support for California's SB 375 regional targets to reduce GHG emissions associated with vehicle miles travelled. Parking minimums in new development may no longer be desired in the future as cities encourage alternative forms of transportation and increase prevalence of multifamily housing near public transit. CARB staff estimates may overestimate the amount of new parking if cities begin to eliminate or reduce parking requirements for new multifamily housing. As a

result, an even greater percent of new parking spaces would need EV charging infrastructure to meet future charging needs and climate goals.

i. 10 Percent Requirement Needed Based on Gap Analysis

Table 10 indicates that the current 3 percent requirement, which only applies to multifamily buildings with 17 units or more, would result in the installation of EV charging infrastructure in nearly 4,000 to 5,000 parking spaces. An estimated gap of 66,000 to 79,500 charging stations to serve multifamily housing is projected by the year 2025. A 10 percent requirement would result in the installation of approximately 43,000 to 53,000 EV Capable Spaces; this would begin to fill the gap in EV charging infrastructure for 2025. Since buildings will be around for 30 or more years, CARB staff recommends at least a 10 percent requirement for multifamily new construction to put California on track to meet 2030 charging and GHG goals.

Table 10. Estimated Number of Parking Spaces with EV Charging Infrastructure in Multifamily Housing Starts in All Climate Zones

Climate Zone	Adjusted Total Parking Spaces	Mandatory[5] per Section 4.106.4.2	Options for Revised Percentages					
		3%	4%	5%	6%	7%	8%	10%
1	2,766	25	111	138	166	194	221	277
2	11,876	107	475	594	713	831	950	1,188
3	15,786	142	631	789	947	1,105	1,263	1,579
4	69,940	629	2,798	3,497	4,196	4,896	5,595	6,994
5	71,091	640	2,844	3,555	4,265	4,976	5,687	7,109
6	15,948	144	638	797	957	1,116	1,276	1,595
7	4,640	42	186	232	278	325	371	464
8	55,344	498	2,214	2,767	3,321	3,874	4,428	5,534
9	30,792	277	1,232	1,540	1,848	2,155	2,463	3,079
10	28,653	258	1,146	1,433	1,719	2,006	2,292	2,865
11	14,219	128	569	711	853	995	1,138	1,422
12	46,078	415	1,843	2,304	2,765	3,225	3,686	4,608
13	49,057	442	1,962	2,453	2,943	3,434	3,925	4,906
14	6,470	58	259	323	388	453	518	647
15	1,427	13	57	71	86	100	114	143
16	3,047	27	122	152	183	213	244	305
CEC Total	427,134	3,844	17,085	21,357	25,628	29,899	34,171	42,713
CIRB Total	530,423	4,774	21,217	26,521	31,825	37,130	42,434	53,042

[5] Current building standards only apply to about 30% of new construction; the estimated number of EV Capable parking spaces were applied to only 30% of total parking spaces based on this assumption.

ii. Ramping Up to Meet 2030 Goals

EV charging infrastructure provisions in the CALGreen Code will need to ramp up very quickly over the next two code cycles to meet 2030 climate goals. For the 2019 Code Cycle, CARB staff recommends a 10 percent requirement as a reasonable baseline for all new construction statewide to put California on track to meeting 2030 charging needs. However, it is essential that the proposed voluntary Tier 1 and Tier 2 provisions for 15 percent and 20 percent progress to mandatory provisions in the next two code cycles to further transition to 2030 targets. Updating the building standards at this rate would account for the exponential increase in vehicle adoption rates, which will more than triple in the five-year timeframe between 2025 and 2030.

Governor Brown enacted Executive Order B-48-18, which calls for 5 million ZEVs by 2030 and the installation of 250,000 charging stations. An estimated 5 million ZEVs represents about 20 percent of the projected light duty vehicle fleet in 2030. To implement this goal, the Executive Order specifically calls for all state entities to "support and recommend policies and actions that make it easier for people to install electric vehicle chargers in their homes and businesses." This order points to high penetration of EVs and the need to plan for accompanying infrastructure that must be completed within a decade of buildings constructed under the 2019 Code Cycle.

California's 2017 Climate Change Scoping Plan calls for "strategies to move toward a goal of achieving 100 percent ZEV sales in the light-duty vehicle sector." Achievement of this policy would necessitate that demand for EV charging to grow dramatically and even surpass a 20 percent requirement for EV charging infrastructure in parking spots over the lifetime of the buildings constructed under the next few code cycles. As shown in Table 11, ZEVs are expected to represent over 40 percent of the projected light duty vehicle fleet by 2050 (California Air Resources Board, 2016)

Table 11. CARB Staff Summary of Percent Requirement Options Based on Projections for the Future Mix of Light Duty Fleet Vehicles

Year	Total Light Duty Vehicle Population (Millions)	Total ZEVs (Millions)	Percent Requirement Options
2030	28.9	5	20%
2050	35.2	15	43%

California state agencies must enact policies and regulations to achieve the mandates provided by the legislature and through executive orders. SB 32 call for greenhouse gas (GHG) emission reductions below 1990 levels of 40 percent by 2030. California is also committed to reducing GHG emissions by 80 percent below 1990 levels by 2050. The buildings constructed under the 2019 CALGreen Code will very likely exist during both time periods and well beyond. Historical building turnover rates per the American Community Survey suggest that roughly half of the building stock in 2050 will be constructed under this and subsequent implementation of the CALGreen Code. This means these buildings will either need to start with the infrastructure necessary to meet these targets, or be retrofitted to do so.

H. Where is new construction planned in relation to ZEVs?

CARB staff reviewed the Construction Industry Research Board's report on "New Development in California 2018: Principal Projects Across the State." This report provides information on where new development is planned statewide in the next 5 to 7 years. CARB staff used this information and the CEC's EVI Pro model estimates for where a total of 121,000 PEVs are expected to reside in multifamily housing by the year 2025. Figure 3 provides an overview of the amount of new multifamily housing construction planned and the estimated total number of PEVs in multifamily housing units by county by 2025. Approximately 30 counties are not planning development of new multifamily housing per the CIRB report on projected new development. However, many of those counties are still expecting some PEV growth in MUDs. Additionally, counties with higher projections for new construction are also expected to realize significant growth in PEVs. Based on this information, CARB staff concludes that the majority of new development of multifamily housing planned statewide will occur in counties with associated PEV growth in multifamily residences.

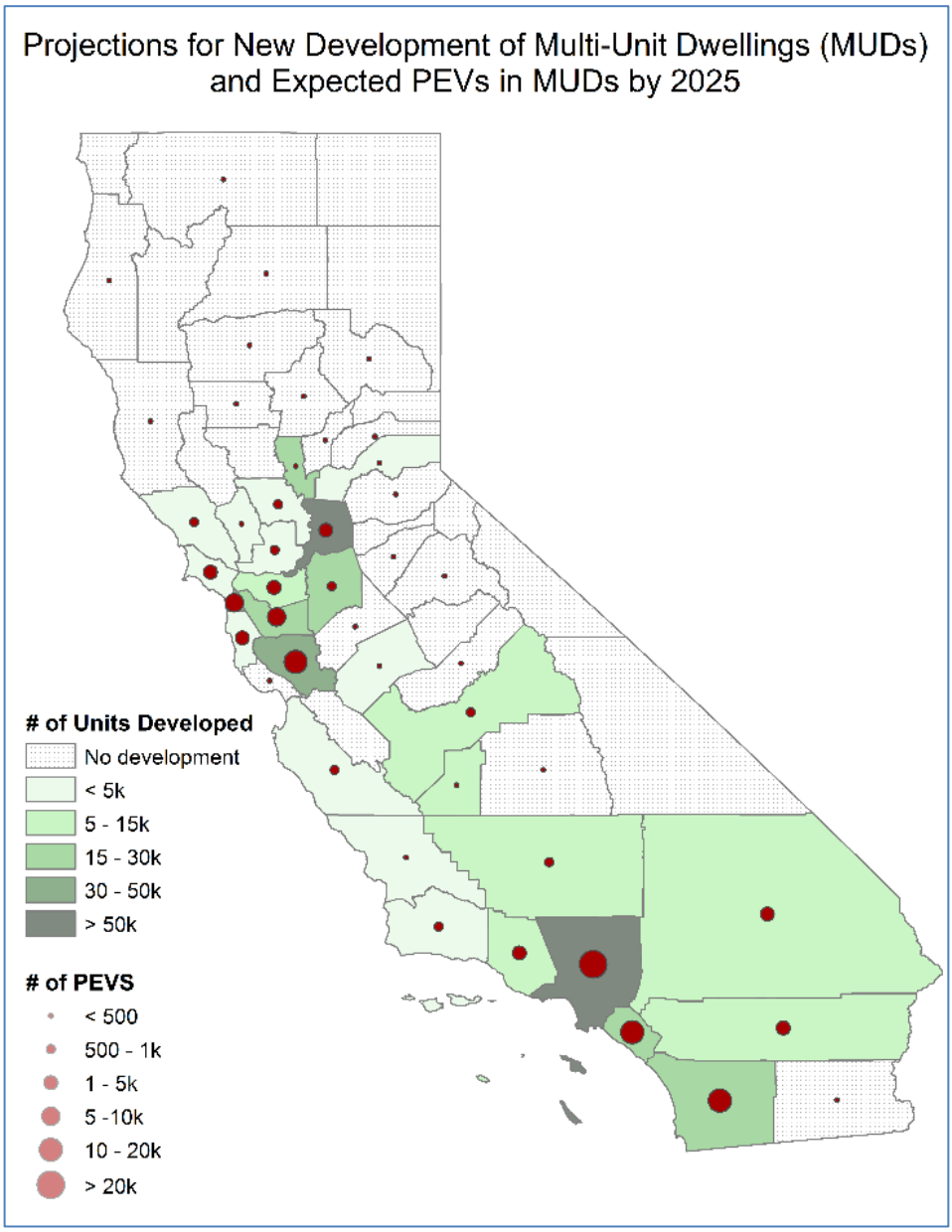

Figure 3. Projections for New Development of MUDs and Expected PEVs in MUDs by 2025

I. What are the recommended voluntary reach standards?

In addition to the mandatory provisions required by the CALGreen Code, the green building standards also include voluntary reach standards that can be adopted by local governments. CARB staff proposes a Tier 1 threshold for 15 percent of parking spaces and a Tier 2 threshold for 20 percent of parking spaces. Tier 2 should also include a provision that requires installation of at least one charging station. These thresholds are consistent with what many jurisdictions are adopting as mandatory at the local level. CARB staff encourages cities and counties to adopt either of these tiers as a measure to achieve additional GHG emission reductions. These GHG emission reductions could count towards achieving "beyond code" goals in Climate Action Plans. Table 12 summarizes the estimated number of additional EV Capable parking spaces installed statewide if all local governments adopted the Tiers. CARB staff recommends advancing Tier 1 and Tier 2 provisions to mandatory building standards within the next two code cycles.

Tenants in multifamily dwellings face uniquely challenging barriers to EV ownership. The simple fact is that EV charging profiles include significant amount of home charging, because that is where vehicles spend the vast majority of their parked time. The lack of EV infrastructure with multifamily parking space will surely deter purchases of EVs and shrink market demand. An $8000 infrastructure improvement cost concurrent with the purchase of a brand-new vehicle adds significant barrier to EV adoption in multifamily homes.

Even with the measures installed to make a spot "EV Capable," these barriers persist with running conductor wiring and using panel capacity as a tenant. Because a single charger is so likely to be needed over the life of the building, installing at least one Level 2 charger for parking capacities of 10 or more spaces would start the state down the path of infrastructure it will need to be successful. While a large part of the work is done by running raceway and creating service panel capacity, there is an imperfect conversion rate of these EV Capable spots to effective EV chargers. Installing at least one charger as a Tier 2 measure will visually normalize their existence, enhance the success of market transformation, and still result in an overall cost-effective update to CALGreen.

Table 12. Estimated Number of Additional EV Capable Charging Spaces Installed Statewide if All Local Governments Adopted the Tiers

Estimate	15% - Tier 1	Additional EV Capable Spaces	20% - Tier 2	Additional EV Capable Spaces
Low	64,070	21,357	85,427	42,713
High	79,563	26,521	106,085	53,042

J. What other code changes are recommended?

Definitions for EV Capable and EV Ready
While the term “EV Capable” is used in the CALGreen Code, there is no specific definition adopted as part of the building standards. Electric Vehicle Charging Space (EV Space) is defined in the CALGreen Code as "a space intended for future installation of EV charging equipment and charging of electric vehicles." Electric Vehicle Charging Station (EVCS) is also defined in the CALGreen Code as "one or more electric vehicle charging spaces served by electric vehicle charger(s) or other charging equipment allowing charging of electric vehicles. Electric vehicle charging stations are not considered parking spaces.” CARB staff recommends that HCD adopt definitions for both EV Capable and EV Ready to clarify the difference between the two terms as a subset of the EV Space definition.

- EV Capable: Installation of “raceway” (the enclosed conduit that forms the physical pathway for electrical wiring to protect it from damage) and adequate panel capacity to accommodate future installation of a dedicated branch circuit and charging station(s).

- EV Ready: Installation of dedicated branch circuit(s), circuit breakers, and other electrical components, including a receptacle or blank cover needed to support future installation of one or more charging stations.

4) Cost Analysis

Infrastructure Costs
New construction requirements can be installed at a very low cost to enable cost effective installation of charging stations. As shown in Table 13, CARB staff estimate an upfront first cost between $280 and $760 to install EV charging infrastructure in multifamily housing (RS Means Data, 2017). The low range cost estimate is comparable to estimates published in the EV Readiness Study in 2013 (Department of Housing and Community Development, 2013). The low range estimate is most applicable to installing surface mounted raceway on an exposed wall in a parking garage. The high range estimate assumes that the raceway would be installed in a slab underground.

Table 13. Upfront Cost Estimates for New Construction

Parking Type	Raceway, box connectors, j-box, box cover, screws, panel board, circuit breakers, and labor
Covered Garage	$280
Surface Lots	$760

Electrical Service and Transformer Costs
CARB staff consulted with utilities to investigate concerns about the potential of added upfront costs for electrical service and transformers when installing EV charging infrastructure in new multifamily housing. CARB staff discovered that electrical service fees can be avoided. Developers have the option to designate a blank space for a meter to serve EV charging energy demand. When EV Capable spaces convert to EV Charging Spaces in the future, allowance costs (including rebates) should cover service upgrade fees to install the EV Meter.

Dedicated transformers to serve EV charging load may be needed for new construction projects if developers select single phase power; developers of smaller buildings with 9 units or smaller typically opt for single phase power. A dedicated transformer may not be needed if the existing service is adequate. A study prepared by the City of Oakland states that transformer upgrades for EV charging infrastructure are typically not common; less than 0.2% of PEVs on California roads have required transformer upgrades (City of Oakland, 2018). For larger buildings, developers typically require three phase power, and in that case, one transformer can be installed to meet building and EV charging energy demand. Therefore, there should not be any added transformer costs associated with installation of EV charging infrastructure in most new multifamily housing. (SoCal Edison, 2018) However, CARB staff did estimate the upfront added cost of dedicated transformers in smaller buildings with 9 units or less. Upfront costs can vary depending on the location of the transformer and EV Capable spaces. However, typical costs associated with dedicated transformers would add about $2,175 to $3,450 for one to two EV Capable spaces respectively (RS Means Data, 2017). Appendix E provides more details on these cost estimates.

Real Estate Costs
While the CALGreen Code requirements for EV charging infrastructure clearly state that the percent of EV Capable spaces shall be based on a portion of the total number of parking spaces, some cities interpret these requirements as additional parking needed. As a result, some building code officials are requiring additional parking spaces, which results in an added cost for developers. According to HCD, there is a real estate cost of $30,000 per parking space. To avoid these additional real estate costs, CARB staff recommends that HCD add clarifying language to the EV charging infrastructure provisions in the CALGreen Code to ensure that building code officials do not require added parking beyond the minimum local parking requirements.

Accessibility Costs
When EVSE is installed, EV Capable Spaces are no longer considered parking spaces and are designated as electric vehicle charging stations (EVCS). Accessibility requirements must be followed when installing EVCS. These provisions are located in Part 2 of the California Building Code, Volume 1, Chapter 11B. For buildings that install 1 to 4 EVCS, the first space must be van accessible. For buildings that install 5 to 25 EVCS, the first space must be van accessible and the second space must be standard accessible. For buildings that install 26 to 50 EVCS, the first space must be van accessible, the second space must be standard accessible and the third space must be ambulatory.

Smaller multifamily buildings in the 3 to 19 unit size range would only need to install from 1 to 3 EV Capable spaces total. When EVSE are installed to convert these EV Capable parking spaces to EVCS, it would require that one space is van accessible. Multifamily buildings in the 20-100 unit size range would install between 5 to 14 EV Capable spaces total. New multifamily buildings in this size range would need to install 1 van accessible space and 1 standard accessible space. Larger multifamily buildings in the 101 to 250 unit size range would install 32 EV Capable spaces with a 10 percent requirement. These buildings would need to install one van accessible, one standard accessible, and one ambulatory space when charging stations are installed. According to HCD, accessibility requirements add about $15,000 per parking space. However, these costs should not be accounted for until parking spaces are converted to EVCS.

a) Annual Statewide Costs

The current building standards require installation of EV Capable infrastructure in 3 percent of parking spaces in new multifamily buildings with 17 units or more. CARB staff recommends deleting the 17 unit threshold and requiring at least 10 percent of new parking spaces to install EV charging infrastructure. The statewide cost estimate for this proposal is based on the difference between the current building standards and CARB's suggested changes. The current requirement may result in the installation of an estimated 4,000 to 5,000 EV spaces statewide between 2020 and 2025. An updated threshold of 10 percent may result in the installation of an estimated 43,000 to 53,000 EV charging spaces. The annual statewide cost estimate is based on the difference in added infrastructure. CARB staff estimate the statewide costs to install EV charging infrastructure in new multifamily buildings may be between $43 million to $76 million if the HCD adopts a revised 10 percent requirement. Initial construction costs would add an estimated $180-258 per multifamily unit. This added upfront costs represents between 0.1 to 0.6% to the average cost per new multifamily housing unit.

b) Avoided Retrofit Costs

Significant retrofit costs can be avoided by installing EV charging infrastructure in new construction. CARB staff reviewed multiple sources to obtain average retrofit costs of installing 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 electrical vehicle supply equipment (EVSE). Retrofit costs are focused on parking lot trenching, adding electrical service and/or panel upgrades. The 10 percent requirement would result in the installation of an additional 38,000 to 47,000 parking spaces with EV charging infrastructure beyond the current 3 percent requirement. If the proposed 10% requirement is not adopted, CARB staff assumed that every one of these parking spaces would need the basic EV charging infrastructure (raceway and panel capacity) to become EV Capable and support future installation of Level 2 charging stations. CARB staff estimates that the avoided retrofit costs range from $272 million to $386 million between 2020 and 2025.

c) Statewide Benefit

There is a significant statewide cost benefit with CARB's proposed code changes. Based on new construction projections between 2020 and 2025, the proposed code changes would result in an estimated statewide benefit (avoided costs) of $229 to $310 million between 2020 and 2025 (Table 14).

Table 14. Estimated Statewide Benefit (Avoided Costs) for 10% Requirement between Years 2020 and 2025

Range	Initial Construction Costs (Millions)	Avoided Retrofit Costs (Millions)	Statewide Benefit (Avoided Costs)
Low	$43	$272	$229
High	$76	$386	$310

5) Incentives for Charging Stations

True success of the EV charging infrastructure provisions in the CALGreen Code will occur when EV Capable spaces are converted to actual charging stations.

a) Utility Rebate Programs

Depending on where new development of multifamily housing is located, there are multiple incentive programs available through investor owned utilities as well as publicly owned utilities. Below is a summary of the various utility program incentives available for the installation of Level 2 charging stations in multifamily housing.

Table 15. Summary of Utility Program Incentives for Level 2 Charging Stations in Multifamily Housing

Utility	Program	Incentives Available
PG&E	EV Charge Network	Installation of EVSE
SCE	Charge Ready	Installation of EVSE
SDG&E	Power Your Drive	Installation of EVSE
SMUD	Charging Forward	$1500 Rebate/EVSE
LADWP	Charge Up LA	$500 Rebate/EVSE

Additional information on rebates and incentives to install EV charging stations in multifamily housing can be found on California's Drive Clean website[6].

b) Low Carbon Fuel Standard Credits

In addition to the utility EV charging infrastructure rebate programs, CARB incentivizes installation of charging stations through the Low Carbon Fuel Standard. There are two key options for developers that plan to install EV charging stations in new construction.

1) Developers can work with a service provider on a partnership agreement to capture some of the costs of installing EV charging stations using LCFS credits. Developers could enter into a contract with a service provider to get a percent of the LCFS credit value based on the service provider tracking the throughput of kWh to the EV charging stations, claiming credits based on that throughput, and selling the credits to high carbon fuel providers like oil companies.

[6] DriveClean.ca.gov is a buying guide for clean and efficient vehicles brought to you by the California Air Resources Board.

2) Developers can participate in the LCFS directly as electric vehicle service providers if they own, operate, maintain, and track vehicle usage of kWh through the charging equipment. However, in order to sell credits, CARB staff estimate they would need to aggregate several thousand credits (2,000-5,000 is a best guess), in order for a large buyer to consider the purchase worthwhile. One vehicle generates about 2-3 credits per year. Therefore, service to about 1,000 cars would be needed to generate enough credits to bundle for sale. Credits are typically purchased for more than $100 per credit.

6) Greenhouse Gas (GHG) Savings

CARB staff estimated the GHG emission reduction potential for the proposed 10 percent requirement for EV Charging Infrastructure provisions for multifamily housing in the 2019 CALGreen Code. An estimated 546,000 to 643,000 metric tons of CO_2e could be avoided annually if all of the EV Capable spaces projected for installation between the years 2020 and 2025 (43,000-53,000) were converted to EV charging spaces. The lower estimate for GHG emission reduction potential is based on the low range estimate of EV Capable spaces and a grid average electricity emission factor and the higher estimate is based on the high range estimate of EV Capable spaces with a marginal electricity emission factor. Appendix H provides more details on these GHG savings estimates.

7) Summary and Conclusions

CARB staff strongly recommends HCD strengthen the current provisions for EV charging infrastructure in multifamily housing. By eliminating the 17 unit size threshold, all new construction of multifamily housing will have the ability to accommodate future installation of Level 2 charging stations; this will ensure that infrastructure is accessible to all income levels, including low-income and disadvantaged communities. CARB staff also recommends that HCD adopt a requirement for at least 10 percent of total parking spaces to install EV charging infrastructure in all new multifamily housing. By adopting these code changes, HCD will help to fill the gap of EV charging stations needed to serve multifamily housing in 2025 and put California on track to meeting EV charging needs in 2030. HCD adoption of these requirements for multifamily housing during the 2019 Code Cycle will help to improve air quality and demonstrate they are doing their part to support the statewide goals to reduce GHG emissions in California.

Appendix A: Details on "What's Being Done to Meet the Need?"

Existing

CARB staff reviewed data on the Alternative Fuels Data Center website to determine the total number of Level 2 charging stations in California. Over 4,000 Level 2 charging stations with over 12,000 charge points exist in public and private locations in California. However, there is no clear distinction for multifamily housing locations. (U.S. Department of Energy, 2017) CARB staff made a conservative estimate and assumed that between 80 and 100 Level 2 charging stations exist in MUD across California.

Funded

Both CPUC and CEC provide funding for the installation of charging stations throughout California. CPUC provides the source of funds for investor-owned utility (IOU) pilot programs (California Public Utility Commission, 2017). CEC funds are dedicated through the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) Investment Plan. (California Energy Commission, 2018) Tables A1 and A2 summarize the number of charging stations funded through both programs.

Table A1. CARB Staff Estimate of the Number of EV Charging Stations Funded for Installation in Multifamily Housing Due to IOU Infrastructure Pilot Programs

Utility	Total EV Charging Stations	Locations	Percent Installed in Multifamily	Range of EV Charging Stations Installed in Multifamily Housing	
				Low	High
SDG&E	3,500	Multifamily and workplace	40-60%	1,400	2,100
SoCal Edison	1,000	Multifamily, workplace, and public	4-6%	40	60
PG&E	7,500	Multifamily and workplace	20-50%	1,500	3,750
Total	12,500			2,940	5,910

Table A2. CEC's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) Investment Plan Update (2018/2019)

Status	Private			Public			Total
	Residential	Fleet	Workplace	Multiunit Dwelling	Public/ Commercial	Corridor/ DC Fast Chargers	
Installed	3,936	104	246	228	2,289	116	6,919
Planned	-	-	57	15	352	352	776
Total	3,936	104	303	243	2,641	468	7,695

a. CPUC/NRG Settlement

The original NRG settlement required installation of make-ready stubs to support 10,000 privately-owned chargers at a total of 1,000 multifamily, workplace, and public interest sites. The first 60 percent of installations were required to be allocated in specific percentages between multifamily, workplace, and public interest sites. The remaining 40 percent of installations could be allocated at NRG discretion.

Table A3. CARB Staff Estimate of Number of Make-Ready Stubs Based on the Original NRG Settlement

Target Location	First 60 Percent		Remaining 40 Percent				Total 100 Percent	
	Mandatory Percent Allocation	Estimated Number of Charging Stations	Estimated Percent Allocation		Estimated Number of Charging Stations		Estimated Number of Charging Stations	
			Low	High	Low	High	Low	High
Multi-family	35%	3,500	2%	5%	200	500	3,700	4,000
Workplace	15%	1,500	15%	20%	1,500	2,000	3,000	3,500
Public Interest	10%	1,000	23%	15%	2,300	1,500	3,300	2,500
Totals	60%	6,000	40%	40%	4,000	4,000	10,000	10,000

The second Settlement Amendment allows NRG to allocate up to $12.5M of the $40M set aside for make readies to install, own, and operate at least 10 DCFC Charging Plazas to support multifamily housing. Each Charging Plaza must have at least three DCFCs. The second Settlement Amendment removes the minimum requirement on the number of make-ready stubs at multifamily sites. As of October 2017, NRG had 5,320 make ready stubs under contract and installed, 2,580 of which were in multifamily housing.

Table A4. Revised CARB Staff Estimate of Make-Ready Stubs Based on Amendment to the NRG Settlement

Target Location	Estimated Number of Charging Stations	
	Low	High
Multi-family	2,580	3,200
DCFC Plazas	30	60
Workplace	3,000	3,500
Public Interest	3,300	2,500
Totals	8,910	9,260

b. Volkswagen (VW) Settlement

Due to the VW settlement, a ZEV investment of $800 million total is committed to California. Electrify America will invest $200 million in four installments over the next 10 years. According to the Investment Plan, a total of $120 million will fund approximately 400 charging stations with 2,000-3,000 charge points during the first cycle. A portion of those funds ($45 million) will be for community charging in 5 metro areas (Los Angeles, San Francisco, San Jose, San Diego, and Sacramento). In each area, Electrify America will install 350+ charging stations across five major use cases. A majority of the spending is devoted to public use cases (commercial/retail centers, community depots, and municipal parking lots/garages), one third of the investment will support workplace charging, and the remainder will be spent in multifamily dwellings.

Table A5. CARB Staff Estimate of VW Settlement Plans for Charging Infrastructure (2,000–3,000 Charging Stations Total)

Range	Cycle	Charging Infrastructure				Green City Initiative	Subtotal Level 2 Charging Stations	Subtotal DCFC	Total Charging Stations
		Community Charging Program			Highway Fast Charging				
		Level 2	DCFC	Total	DCFC	Level 2			
Low	1	117	233	350	50	75	192	283	475
	2	117	233	350	50	75	192	283	475
	3	117	233	350	50	75	192	283	475
	4	117	233	350	50	75	192	283	475
	Total	467	933	1,400	200	300	767	1,133	1,900
High	1	183	367	550	80	75	258	447	705
	2	183	367	550	80	75	258	447	705
	3	183	367	550	80	75	258	447	705
	4	183	367	550	80	75	258	447	705
	Total	733	1,467	2,200	320	300	1,033	1,787	2,820
Average		600	1,200	1,800	260	300	900	1,460	2,360

Table A6. VW Settlement: CARB Staff Summary of Investment Allocations by Cycle ($ Millions)

VW Settlement	Charging Infrastructure		Green City Initiative	Public Education	Electrify America Operation Costs	Total Investment
	Community Charging	Highway Fast Charging				
Cycle 1	$45	$75	$44	$20	$16	$200
Cycle 2	$45	$75	$44	$20	$16	$200
Cycle 3	$45	$75	$44	$20	$16	$200
Cycle 4	$45	$75	$44	$20	$16	$200
Total	$180	$300	$176	$80	$64	$800

Table A7. VW Settlement: CARB Staff Estimates for Number of Charging Stations Installed

Community Charging Program		Percent of Allocation		Level 2		DCFC	
		Low	High	Low	High	Low	High
Commercial/Retail Centers	Majority	60%	55%	360	330	720	660
Community Depots							
Municipal Lots/Garages							
Workplace	One-Third	30%	27%	180	162	360	324
Multifamily	Remaining	10%	18%	60	108	120	216
Total		100%	100%	600	600	1200	1200

Planned
CARB staff reviewed residential electric vehicle incentives from two publicly owned utilities: Sacramento Municipal Utility District (SMUD, 2017) and Los Angeles Department of Water and Power (LADWP, 2018). Both of these POUs offer rebates for installation of Level 2 charging stations in multifamily housing. Table A8 summarizes CARB staff estimates of the range in total number of Level 2 charging stations planned by POU.

Table A8. Summary of Publicly Owned Utility (POU) Installations of Level 2 Chargers in Multifamily Housing

Utility		SMUD	LADWP	Total
Level 2 Chargers	Low	390	8,600	8,990
	High	400	12,900	13,300

Proposed
The CPUC is currently reviewing additional proposals pursuant to SB 350 from the six electric IOUs. CARB staff reviewed the latest proposals to the CPUC. Liberty Utilities is the only small IOU that has a program targeted for residential EV charging infrastructure. Table A9 summarizes the estimated number of make-ready spaces that would be installed in multifamily housing due to the Liberty Utilities program. SDG&E has a pending proposal for residential charging infrastructure, which could include multi-unit dwelling of four units or fewer. SCE also proposed a program that would target smaller multi-unit dwellings with four units or fewer. Table A10 summarizes CARB staff estimates of the large IOU proposals pursuant to SB 350 that would target multifamily housing. Although CARB staff determined that the large IOU proposals are targeted for smaller multifamily housing with attached private garages, they are still counted towards the total estimate of "What's Being Done to Meet the Need" for Level 2 charging stations in multifamily housing.

Table A9. CARB Staff Estimate of Small IOU SB 350 Proposal for Residential EV Charging Infrastructure

Utility	Program	Total Customers	Percent Distribution				Estimate of EVSE Installed			
			Single Family		Multifamily		Single Family		Multifamily	
			Low	High	Low	High	Low	High	Low	High
Liberty Utilities	Make-Ready Rebate	1,000	92%	95%	5%	8%	920	950	50	80

Table A10. CARB Staff Estimate of Large IOU SB 350 EV Charging Infrastructure in Multifamily Dwelling Units

Utility	Charging Infrastructure	Low	High
SDG&E	Level 2 Chargers	4,500	9,000
SCE	Make-Ready Stubs	750	1,000
Total	Mix	5,250	10,000

DCFC Investments

Table A11. Settlements: CARB Staff Estimate of Total DCFC Installed from Plazas and Depots

Settlement	NRG		VW		Total	
	Low	High	Low	High	Low	High
Subtotal - 150 kW	20	40	140	190	160	230
Subtotal - 50 kW	10	20	70	90	80	110
Total DCFC	30	60	210	280	240	340

Table A12. Settlements: CARB Staff Estimate of the Number of Vehicles Served by DCFC Plazas

Settlement	NRG				VW				Total	
Charger Output	150 kW		50 kW		150 kW		50 kW			
Range	Low	High	Low	High	Low	High	Low	High	Low	High
Number of DCFC	20	40	10	20	140	190	70	90	240	340
Vehicles Served per Day	640	1,700	220	500	4,500	8,200	1,540	2,400	6,900	12,800

Assumptions:

1) Charging profile is the same as fueling profile
2) 150 kW Chargers: 15 Minutes per Event - 4 Events per Hour - 54 Events per Day - Reduced to 80% of Time Fueling = 43 Events per Day
3) 150 kW Chargers: 20 Minutes per Event - 3 Events per Hour - 40 Events per Day - Reduced to 80% Time Fueling = 32 Events per Day
4) 50 kW Chargers: 25 Minutes per Event - 2.5 Events per Hour - 34 Events per Day - Reduced to 80% Time Fueling = 27 Events per Day
5) 50 kW Chargers: 30 Minutes per Event - 2 Events per Hour - 27 Events per Day - Reduced to 80% Time Fueling = 22 Events per Day

Table A13. SB 350: CARB Staff Estimate of DCFC Infrastructure Investments

DCFC Program	PG&E Fast Charge Program		SCE Urban DCFC Pilot		Totals	
CPUC Decision	Pending		Approved			
Investment	$22.4 Million		$3.98 Million		$26.38 Million	
Number of Sites	52		5		57	
Stations per Site	2		5		2.28	
Range	Low	High	Low	High	Low	High
DCFC – Subtotal – 150 kW	67	73	13	20	80	93
DCFC – Subtotal – 50 kW	33	37	7	10	40	47
DCFC - Total	100	110	20	30	120	140

Assumptions: While every DCFC has at least 2 ports, each DCFC can only charge 1 vehicle at a time. Each port has a different charger; either CHADEMO or other combined charger standard such as SAE.

NOTE: The SDGE Electrify Local Highways Project estimate was not included because it applies to public highway corridors.

Table A14. SB 350: CARB Staff Estimate of the Number of Vehicles Served by DCFC Plazas

Settlement	PG&E				SCE				Total	
Charger Output	150 kW		50 kW		150 kW		50 kW			
Range	Low	High	Low	High	Low	High	Low	High	Low	High
Number of DCFC	67	73	33	37	13	20	7	10	120	140
Vehicles Served per Day	2,100	3,100	700	1,000	400	900	150	300	3,350	5,300

Assumptions:

6) Charging profile is the same as fueling profile
7) 150 kW Chargers: 15 Minutes per Event - 4 Events per Hour - 54 Events per Day - Reduced to 80% of Time Fueling = 43 Events per Day
8) 150 kW Chargers: 20 Minutes per Event - 3 Events per Hour - 40 Events per Day - Reduced to 80% Time Fueling = 32 Events per Day
9) 50 kW Chargers: 25 Minutes per Event - 2.5 Events per Hour - 34 Events per Day - Reduced to 80% Time Fueling = 27 Events per Day
10) 50 kW Chargers: 30 Minutes per Event - 2 Events per Hour - 27 Events per Day - Reduced to 80% Time Fueling = 22 Events per Day

Table A15. Summary of Vehicles Served by DCFC Infrastructure Investments

Program	SB 350		Settlements		Total	
Range	Low	High	Low	High	Low	High
Total DCFC	120	140	240	340	360	480
Total Vehicles Served per Day	3,350	5,300	6,900	12,800	10,250	18,100
Multifamily Resident Vehicles Served per Day	1,200	2,000	2,600	5,000	3,800	7,000

Appendix B: Projections for New Multifamily Housing

Summary of CEC's New Construction Estimates

CARB staff obtained projections for residential new construction from CEC staff developing the 2017 Integrated Energy Policy Report (California Energy Commission, 2017). An estimated 310,000 new multifamily housing units will be constructed between 2020 and 2025. CEC's data is based on historical population and housing estimates from the California Department of Finance. The estimates of single family dwelling units include single family detached units (units which are detached from any other structure and have open space on all four sides) and single family attached dwellings (units which are attached to other units with adjoining walls extending from ground to roof that separate them from other adjoining structures and forms a property line). Multiple family dwelling units include structures with 2 or more housing units. Table B1 provides a summary of the CEC annual forecast for new multifamily housing units by climate zone. Table B2 displays the projected total number of new multifamily housing units broken out by building size; CARB staff estimated this distribution based on the U.S. Census Bureau characteristics summarized in Table 7 of the main report.

Table B1. CEC Staff Projections for New Multifamily Housing Starts By Year and Climate Zone

Climate Zone	Year						Total
	2020	2021	2022	2023	2024	2025	
1	329	331	342	333	331	343	2,009
2	1,543	1,521	1,455	1,375	1,339	1,393	8,625
3	1,793	1,858	1,916	1,928	1,985	1,984	11,464
4	8,359	8,395	8,452	8,491	8,546	8,549	50,791
5	8,677	8,517	8,622	8,567	8,575	8,670	51,627
6	1,856	1,921	1,985	1,934	1,930	1,957	11,582
7	524	540	560	562	588	596	3,370
8	6,512	6,643	6,745	6,729	6,682	6,881	40,192
9	3,451	3,949	3,853	3,733	3,651	3,724	22,362
10	3,420	3,453	3,521	3,434	3,490	3,490	20,808
11	2,021	1,784	1,712	1,632	1,569	1,608	10,326
12	7,012	5,479	5,366	5,231	5,132	5,243	33,463
13	5,662	5,819	5,939	5,982	6,097	6,128	35,626
14	860	789	776	760	749	764	4,698
15	179	175	178	169	168	167	1,036
16	331	384	379	373	369	377	2,213
Total	52,529	51,556	51,801	51,234	51,199	51,874	310,191

Table B2. CARB Staff Estimate of the Distribution of New Multifamily Housing Starts by Climate Zone and Building Size

Climate Zone	Total MF Housing Starts (2020-2025)	2 units	3 to 4 units	5 to 9 units	10 to 19 units	20 to 29 units	30 to 49 units	50 units or more
1	2,009	362	221	261	562	301	100	201
2	8,625	1,552	949	1,121	2,415	1,294	431	862
3	11,464	2,064	1,261	1,490	3,210	1,720	573	1,146
4	50,791	9,142	5,587	6,603	14,222	7,619	2,540	5,079
5	51,627	9,293	5,679	6,712	14,456	7,744	2,581	5,163
6	11,582	2,085	1,274	1,506	3,243	1,737	579	1,158
7	3,370	607	371	438	943	505	168	337
8	40,192	7,235	4,421	5,225	11,254	6,029	2,010	4,019
9	22,362	4,025	2,460	2,907	6,261	3,354	1,118	2,236
10	20,808	3,745	2,289	2,705	5,826	3,121	1,040	2,081
11	10,326	1,859	1,136	1,342	2,891	1,549	516	1,033
12	33,463	6,023	3,681	4,350	9,370	5,019	1,673	3,346
13	35,626	6,413	3,919	4,631	9,975	5,344	1,781	3,563
14	4,698	846	517	611	1,316	705	235	470
15	1,036	187	114	135	290	155	52	104
16	2,213	398	243	288	620	332	111	221
Total	310,191	55,834	34,121	40,325	86,854	46,529	15,510	31,019

Comparison of CEC and Building Industry Estimates

Since CARB staff relies on new construction estimates to develop projections for future parking spaces, it was necessary to evaluate another source of projections. CARB staff obtained estimates from the Construction Industry Research Board (CIRB) for multifamily housing units between years 2009 and 2020. Historical data between years 2009 and 2016 are based on building permits from the California Homebuilding Foundation. Building projections between years 2017 and 2020 are provided by the California Economic Forecast (Construction Industry Research Board, 2017). CARB staff totaled the estimates for multifamily housing between the two sources; there was a five percent difference between the estimates of total multifamily housing units between 2009 and 2020. Table B3 provides a summary of this five percent difference.

Table B3. CARB Staff Comparison of CEC and CIRB Estimates for New Multifamily Residential Housing Starts

Year	CEC	CIRB	Percent Change from Previous Year		Percent Difference Between CEC and CIRB
			CEC	CIRB	
2009	31,373	10,967	-33%	23%	96%
2010	24,997	19,236	-20%	75%	26%
2011	22,306	25,702	-11%	34%	-14%
2012	29,735	31,665	33%	23%	-6%
2013	28,791	48,481	-3%	53%	-51%
2014	41,584	48,755	44%	1%	-16%
2015	60,200	53,337	45%	9%	12%
2016	77,554	51,753	29%	-3%	40%
2017	51,234	58,384	-34%	13%	-13%
2018	53,399	68,573	4%	17%	-25%
2019	52,740	69,112	-1%	1%	-27%
2020	52,529	67,486	-0.4%	-2%	-25%
Total	526,443	553,451	N/A	N/A	-5%

CIRB estimates for multifamily housing were higher than CEC estimates in several of the years. CARB staff requested CIRB projections through 2025, but they were not available. Therefore, CARB staff projected new construction estimates using CIRB data. CARB staff determined that approximately 385,000 multifamily units may be constructed between 2020 and 2025 using the CIRB data. Table B4 provides a summary of the low range estimates for new construction using CEC data and the high range projection for new multifamily housing using CIRB data.

Table B4. Projections for Multifamily Housing between 2020 and 2025

Year	Low	High
	CEC Projections Using DOF Data	CARB Staff Projections Using CIRB Data
2020	52,529	67,486
2021	51,556	66,136
2022	51,801	64,814
2023	51,234	63,517
2024	51,199	62,247
2025	51,874	61,002
Total	310,191	385,202

HCD staff indicated that 2-unit buildings and half of 3-4 unit buildings would be covered under the duplex and townhome requirements for EV charging infrastructure.[7] CARB staff adjusted the projections for new multifamily housing to account for this conclusion. Totals for the number of EV Capable duplexes and townhomes were not included in the estimate for "what's being done to meet the need" for Level 2 chargers because the infrastructure would be installed in private garages. By excluding these units, CARB staff estimated an adjusted 237,000 to 295,000 multifamily housing units may be constructed between 2020 and 2025. Table B5 provides a summary of these adjusted estimates.

Table B5. Adjusted Projections for Multifamily Housing between 2020 and 2025

Year	Low	High
	CEC Projections Using DOF Data	CARB Staff Projections Using CIRB Data
2020	40,185	51,627
2021	39,440	50,594
2022	39,628	49,582
2023	39,194	48,591
2024	39,167	47,619
2025	39,683	46,667
Total	237,296	294,680

[7] Mandatory building standards for EV charging infrastructure in new one- and two-family dwellings and townhouses with attached private garages can be found in the 2016 California Green Building Standards Code, Part 11, Mandatory Residential Measures, Code Section 4.106.4.2 on the following website: https://codes.iccsafe.org/public/chapter/content/2079/.

Appendix C: EV Spaces Due to Local Government Reach Standards

Table C1: Estimated Number of EV Capable Spaces from New Multifamily Dwellings and Parking Spaces (2018-2025) (California Economic Forecast, 2017)

Region	Jurisdiction	Total new multifamily units 2018-2025	Average Parking Installed Per Unit	New parking from 2017-2025	EV Charging Percent Requirement	Percent Above Code	EV Capable Spaces
East Bay (Association of Bay Area Governments, 2013)	Berkeley	1,923	1.0	1,923	10% Pre-wired	7%	135
	Fremont	3,546	1.8	6,383	10%	7%	447
	Oakland	19,906	0.75	14,930	10% Full Circuit and additional 10% Panel Capacity for parking lots with more than 20 spaces	7%	1,045
	Contra Costa County	889	1.8	1,600	5% - EVSE Installed	2%	32
San Francisco County	San Francisco	18,800	0.75	33,691	20% - EV Capable & 100% - Conduit Only	17%	5,727
North Bay	San Rafael	182	1.8	328	5% EV Capable (Tier 1)	2%	7
	Santa Rosa	143	1.8	257	5% EV Capable (Tier 1)	2%	5
Silicon Valley	Palo Alto (Association of Bay Area Governments, 2013)	1,292	1.8	2,326	Resident Parking: 100% EV Ready; Guest Parking: 25% EV Ready with at least 5% EV Chargers	22%	227
	Santa Clara County	1,930	1.5	2,895	3% - EV Capable & Multifamily Bldgs with more than 100 parking spaces - 1% Additional Shall Install EVSE	1%	29
	Sunnyvale	2,586	1.8	4,655	12.5% - EV Capable	9.5%	442
	San Mateo	750	1.6	1,200	At least one EV Space for 3-16 Units; & 10% - EV Capable for Bldgs with 17 or More Units	7%	84

Continued Table C1: Estimated Number of EV Capable Spaces from New Multifamily Dwellings and Parking Spaces (2018-2025) (California Economic Forecast, 2017)

Region	Jurisdiction	Total new multifamily units 2018-2025	Average Parking Installed Per Unit	New parking from 2017-2025	EV Charging Percent Requirement	Percent Above Code	EV Capable Spaces
Silicon Valley	Cupertino	2,050	1.8	3,690	5% - EV Capable	2%	74
	Menlo Park	1,861	1.3	2,326	5% Pre-Wire for Residential Buildings 10,000 sq.ft. and larger	2%	47
North LA	Lancaster (Southern California Association of Governments, 2012)	1,631	1.8	2,936	20% - EV Capable for 10 Dwelling Units or Less & 10% - EV Capable for More than 10 Dwelling Units with Half Installed EV Chargers	7%	206
Central LA	Los Angeles	57,163	1.8	102,893	5%	2%	2,058
South LA	Long Beach	2,825	1.1	3,108	25% EV Capable & 5% EV Chargers	27%	839
West LA	Santa Monica	942	1.8	1,696	5% - EV Capable	2%	34
East LA	Pasadena	601	1.8	1,082	5% EV Capable (Tier 1) & At least 2 EV Chargers (one conductive and one inductive) shall be provided in developments with 250 parking spaces or more	2%	22
Central Coast	Santa Cruz	486	1.8	875	12% - EV Capable for 5 or more units	9%	79
Totals		119,506	Varies	186,869	Varies	Varies	**11,537**

Appendix D: Copy of Local Government Reach Standards

Local Government Amendments to Multifamily Housing
Electric Vehicle Charging Infrastructure Provisions in the 2016 CALGreen Code

Nearly twenty local governments in California have adopted reach standards related to EV charging infrastructure. This appendix provides an excerpt of EV charging infrastructure requirements specific to multifamily housing. Code language compiled below does not include EV charging infrastructure requirements related to single family residential or commercial buildings.

Northern California

- Berkeley
- Contra Costa County
- Cupertino
- Fremont
- Menlo Park
- Oakland
- Palo Alto
- San Francisco City and County
- San Mateo
- San Rafael
- Santa Clara County
- Santa Cruz
- Santa Rosa
- Sunnyvale

Southern California

- Lancaster
- Long Beach
- Los Angeles
- Pasadena
- Santa Monica

Northern California

Berkeley

Specifications for Electrical Vehicle Charging Readiness

At least 10 percent of parking spaces for new residential parking, or at least 1 parking space if less than 10 residential parking spaces will be provided, shall be pre-wired to allow for future Level 2 PEV charging system installation. Each of the subject parking spaces must be served by a 208/240 volt, 40 amp, grounded AC outlet, or there must be electric panel capacity and conduit to support future 208/240 volt, 40 amp outlets at each subject parking space. If a car lift is used to provide parking spaces, the pre-wiring may be part of the car lift or can be installed on the walls adjacent to the car lift, provided that future PEV charging systems could be used by vehicles on the car lift and the minimum 10 percent of parking spaces threshold is maintained. In multifamily projects at least one of the pre-wired parking spaces must be an accessible parking space, as defined by the California Building Code, or a standard parking space that can provide a 5' wide, 18' long access aisle and a path of travel to the building.

Contra Costa County

74-4.006 - Amendments to CGBSC.
Section 4.106.4.2 New multifamily dwellings. For any new multifamily dwelling other than a dwelling type specified in Section 4.106.4.1, at least five percent of the total number of parking spaces provided for all types of parking facilities, but in no case no less than one parking space, shall be electric vehicle charging spaces (EV spaces). Each EV space shall be equipped with fully operational electric vehicle supply equipment (EVSE). The location of each EV space shall be identified on construction documents. Calculations to determine the number of EV spaces shall be rounded up to the nearest whole number.

Cupertino

16.58.400 Section A4.106.8–Amended.
Add and amend Section A4.106.8 to read as follows:

A4.106.8 Electric vehicle (EV) charging. Dwellings shall comply with the following requirements for the future installation of Electric Vehicle Supply Equipment (EVSE).

A4.106.8.2 New Multifamily dwellings. At least 5 percent of the total parking spaces, but not less than one, shall be capable of supporting future electric vehicle supply equipment (EVSE).

A4.106.8.2.1 Single charging space required. When only a single charging space is required, install a dedicated branch circuit sufficient to provide adequate electrical capacity to serve a Level 2 EVSE. Also, install a listed raceway or pre-wiring from the dedicated branch circuit to the designated electric vehicle parking stall. The raceway shall not be less than trade size 1 (nominal 1-inch inside diameter). The raceway shall be securely fastened at the main service or subpanel and shall terminate in close proximity to the proposed location of the charging system into a listed cabinet, box or enclosure. Pre-wiring shall include the installation of appropriately sized conductors and adequate electrical capacity to serve a Level 2 EVSE.

> **Exception:** Other pre-installation methods approved by the local enforcing agency that provide sufficient conductor sizing and service capacity to install Level 2 Electric Vehicle Supply Equipment (EVSE).

A4.106.8.2.2 Multiple charging spaces required. When multiple charging spaces are required, install a dedicated branch circuit sufficient to provide adequate electrical capacity to serve a Level 2 EVSE. Also, install a listed raceway or pre-wiring from the dedicated branch circuit to all designated EVSE spaces. Plans shall be provided to include the location(s) and type of the EVSE, raceway method(s), wiring schematics and electrical calculations to verify that the electrical system has sufficient capacity to simultaneously charge all the electrical vehicles (EV) at all designated EV charging spaces at their full rated amperage. Plan design shall be based upon Level 2 EVSE at its maximum operating ampacity. Only underground raceways and related underground equipment are required to be installed at the time of construction. Pre-wiring shall

include the installation of appropriately sized conductors and adequate electrical capacity to serve a Level 2 EVSE.

> **Note:** Utilities and local enforcing agencies may have additional requirements for metering and EVSE installation, and should be consulted during the project design and installation.

A4.106.8.2.3 Labeling requirement. A label stating "EV CAPABLE" shall be posted in a conspicuous place at the service panel or subpanel and next to the dedicated EV charging spaces.

A.4.106.8.3 Alternative Means for Electric Vehicle (EV) Charging for Residential buildings. The provisions of Section A4.106.8.1 and A4.106.8.2 are not intended to prevent the use of any alternative means of achieving the standards for electric vehicle charging, provided that any such alternative is approved by the Building Official based on findings that the proposed alternative is satisfactory and complies with the intent of the provisions and is at least as equivalent as the prescribed requirements.

(Ord. 14-2117, § 1, 2014)

Fremont

15.48.030 Amendment to 2016 CGBSC Section 202 (Definitions).

Section 202 of the 2016 California Green Building Standards Code is amended by modifying the following definition. The remaining definitions are not modified:

EV READY PARKING SPACE: A parking space served by a complete 208/240 V 40 ampere electrical circuit.

(Ord. 21-2016 § 12, 11-1-16.)

15.48.040 Amendment to 2016 CGBSC Section 301 (General).

Section 301 of the 2016 California Green Building Standards Code is amended as follows:

301.1 – 301.3.2 {CGBSC text not modified}

301.3.3 Additions to Parking Facilities: The requirements related to electric vehicle charging also apply to additions to increase the number of parking spaces at any facility. The requirements will apply only to the number of new parking spaces.

301.4 – 301.5 {CGBSC text not modified}

(Ord. 21-2016 § 12, 11-1-16.)

15.48.050 Amendment to 2016 CGBSC Section 4.106 (Site Development).

Section 4.106 of the 2016 California Green Building Standards Code is amended as follows:

4.106.1 – 4.106.3 {CGBSC text not modified}

4.106.4 Electric vehicle (EV) charging for new construction and additions. New construction and additions as described in Section 301.3.3 shall comply with this section. Electric vehicle supply equipment (EVSE) shall be in accordance with the California Electrical Code, Article 625.

Exceptions:
On a case-by-case basis, where the local enforcing agency has determined EV charging and infrastructure are not feasible based upon one or more of the following conditions:

1. Where there is no commercial power supply.
2. Where there is evidence substantiating that meeting the requirements will alter the local utility infrastructure design requirements on the utility side of the meter so as to increase the utility side cost to the homeowner or the developer by more than $400.00 per dwelling unit or $400.00 per parking space, whichever is greater. In such cases, buildings subject to Section 4.106.4 shall meet the requirements by maximizing the number of EV Ready Parking Spaces, without exceeding the limit above. Cost per parking space shall be determined by dividing total cost by total number of EV and non-EV parking spaces.

4.106.4.2 New multifamily dwellings and additions.
The following number of EV Ready Parking Spaces are required at the time of original construction:

Total Number of Actual Parking Spaces	Number of Required EV Ready Parking Spaces
0-9	1
10-25	2
26-50	4
51-75	6
76-100	9
101-150	12
151-200	17
201 and over	10 percent of total[1]

1 Calculation of number of spaces shall be rounded up to the nearest whole number.

4.106.4.2.1 {CGBSC text not modified}
4.106.4.2.2 {CGBSC text not modified}

4.106.4.2.3 EV Ready parking spaces. Construction documents shall verify that the electrical panel service capacity and electrical system, including any on-site distribution transformer(s), have sufficient capacity

to simultaneously charge all EVs at all required EV spaces at the full rated amperage of the EV Ready Parking Space.

A raceway, electrical panel capacity, wire and termination point supporting a 208/240 volt 40 ampere circuit, are required to be installed at the time of construction for each EV Ready Parking Space required under 4.106.4.2. Where a single EV Ready Parking Space is required, the raceway shall not be less than trade size 1 (nominal 1-inch inside diameter). All electrical circuit components and EVSE related to this section shall be installed in accordance with the California Electrical Code.

Note: Termination point should be a receptacle suitable for EVSE and located near the proposed EVSE location.
4.106.4.2.4 – 4.106.4.2.5 {CGBSC text not modified}

(Ord. 21-2016 § 12, 11-1-16.)

Menlo Park

12.18.030 Section 4.106.4.2 of Chapter 4 amended.
Section 4.106.4.2 of Chapter 4 is amended to read as follows:
4.106.4.2 New multifamily dwellings. New multifamily dwelling construction located in the City of Menlo Park's R-MU zoning districts shall comply with the R-MU Zoning District's requirement for the installation and pre-wire of EV chargers. In all other new multifamily dwelling construction, where 17 or more multifamily dwelling units are constructed on a building site, 3 percent of the total number of parking spaces provided for all types of parking facilities, but in no case less than one, shall be electric vehicle charging spaces (EV spaces) capable of supporting future EVSE. Calculations for the required number of EV spaces shall be rounded up to the nearest whole number.

Note: Construction documents are intended to demonstrate the project's capability and capacity for facilitating future EV charging. There is no requirement for EV spaces to be constructed or available until EV chargers are installed for use.

(Ord. 1033 § 2 (part), 2017)

TABLE 16.45.130(1)(B): RESIDENTIAL GREEN BUILDING REQUIREMENTS

	NEW CONSTRUCTION		
Green Building Requirement	**10,000 sq. ft.—25,000 sq. ft.**	**25,001 sq. ft.—100,000 sq. ft.**	**100,001 sq. ft. and above**
Electric Vehicle (EV) Chargers[6]	Pre-Wire[2] • Minimum of 5% of total required number of parking stalls AND Install EV Chargers[3] • Minimum of 2 in the pre-wire locations	Pre-Wire[2] • Minimum of 5% of total required number of parking stalls AND Install EV Chargers[3] • Minimum total of 2 plus 1% of the total parking stalls in the pre-wire locations	Pre-Wire[2] • Minimum of 5% of total required number of parking stalls AND Install EV Chargers[3] • Minimum total of 6 plus 1% of the total parking stalls in the pre-wire locations

[2] "Pre-wire" is defined as conduit and wire installed from electrical panel board to junction box at parking stall, with sufficient electrical service to power chargers at all pre-wire locations.

[3] "Charger" is defined as follows: one (1) electric vehicle (EV) charger or charger head reaching each designated EV parking stall and delivering a minimum of forty (40) amps and two hundred forty (240) volts such that it can be used by all electric vehicles.

[4] Building owners may choose to have additions and/or alterations follow the LEED ID+C path, or alternatively,

[6] At minimum, a forty (40) amp, two hundred forty (240) volt receptacle shall be installed at each structural column of residential carports for electrical vehicle charging. This requirement is in addition to pre-wire and installation of EV charger regulations.

Oakland

15.04.3.11105 - CGBSC Section 4.106.4 amended.

In Section 4.106.4 of the California Green Building Standards Code, delete paragraph 2 under "Exemptions" in its entirety and replace with the following:

Exemptions

Where there is evidence substantiating that meeting the requirements will alter the local utility infrastructure design requirements on the utility side of the meter so as to increase the utility side cost to the homeowner or the developer by more than $400.00 per dwelling unit and $400.00 per parking space. In such cases, buildings subject to Section 4.106 shall maximize the quantity of EV charging infrastructure, without exceeding the limit above. Cost per parking space shall be determined by dividing total cost by total number of EV and non-EV parking spaces.

(Ord. No. 13419, § 4, 2-21-2017)

15.04.3.11110 - CGBSC Section 4.106.4.2 amended.

In Section 4.106.4.2 of the California Green Building Standards Code, delete subparagraph 4.106.4.2 in its entirety and replace with the following:

4.106.4.2 New multifamily dwellings.
Where 3 or more multifamily dwellings are constructed on a site, install at least the following levels of PEV infrastructure. All EV charging electric infrastructure and EVSE (when installed) shall be in accordance with the California Electrical Code.

	Full Circuit	Inaccessible Raceway Installed	Electrical Panel Capacity
Greater than 20 parking spaces	10 percent of parking spaces (rounded up)	Remaining 90 percent of parking spaces	Sufficient to supply 20 percent of spaces
16—20 or more parking spaces	2 parking spaces	2 parking spaces	Sufficient to supply 4 parking spaces
11—15 parking spaces	2 parking spaces	1 parking spaces	Sufficient to supply 3 parking spaces
2—10 parking spaces	2 parking spaces	-	Sufficient to supply 2 parking spaces
1 parking space	1 parking space	-	Sufficient to supply 1 parking space

(Ord. No. 13419, § 4, 2-21-2017)

- **15.04.3.11115 - Reserved.**
- **15.04.3.11120 - CGBSC Sections 4.106.4.2.3—4.106.4.2.6 amended.**

In Section 4.106.4.2 of the California Green Building Standards Code, delete subparagraphs numbered 4.106.4.2.3, 4.106.4.2.4, 4.106.4.2.5 and 4.106.5.2.6 in their entirety and replace with the following:

4.106.4.2.3 Full circuit.
Required full circuits shall be installed with 40-Amp 208/240-Volt capacity including raceway, electrical panel capacity, overprotection devices, wire and termination point such as a receptacle at the time of construction. The termination point shall be in close proximity to the proposed EV charger location. Where a single EV parking space is required, the raceway shall not be less than trade size 1 (nominal 1-inch inside diameter).

4.106.4.2.4 Inaccessible raceway.
Construction documents shall indicate wiring schematics, raceway methods, the raceway termination point and proposed location of future EV spaces and EV chargers. Raceways and related components that are planned to be installed underground, enclosed, inaccessible or in concealed areas and spaces shall be installed at the time of original construction.

4.106.4.2.5 Electrical Panel Capacity.
Electrical panels shall be installed with capacity to support one 40-Amp 208/240-Volt circuit for each parking space specified in 4.106.4.2 under “Electrical Panel Capacity". Construction documents shall verify that the electrical panel service capacity and electrical system, including any on-site distribution transformer(s), have sufficient capacity to simultaneously charge all EVs at all required EV spaces at 40-Amps.

Note: Panel capacity to install full circuits at the time of original construction as well as capacity to support future addition of additional circuits shall count towards satisfying this requirement. This requirement does not preclude building owners from allocating the required capacity to increase the number of EVCS and provide less than 40-Amp per vehicle.

4.106.4.2.6 Identification.
The service panel or subpanel circuit directory shall identify the overcurrent protective device space(s) reserved for future EV charging as "EV READY" for full circuits and otherwise "EV CAPABLE". The raceway termination location shall be permanently and visibly marked as "EV READY" for full circuits and otherwise "EV CAPABLE".

Notes:
1. The California Department of Transportation adopts and publishes the "California Manual on Uniform Traffic Control Devices (California MUTCD)" to provide uniform standards and specifications for all official traffic control devices in California. Zero Emission Vehicle Signs and Pavement Markings can be found in the New Policies & Directives Number 13-01. Website: http://www.dot.ca.gov/trafficops/policy/13-01.pdf.

2. See Vehicle Code Section 22511 for EV charging space signage in off-street parking facilities and for use of EV charging spaces.

3. The Governor's Office of Planning and Research (OPR) published a "Zero-Emission Vehicle Community Readiness Guidebook" which provides helpful information for local government, residents and businesses. Website: https://www.opr.ca.gov/docs/ZEV Guidebook.pdf.

(Ord. No. 13419, § 4, 2-21-2017)

15.04.3.11125 - CGBSC Section 4.106.4.2.7 added.

In Section 4.106.4.2 of the California Green Building Standards Code, add new subsection 4.106.4.2.7:

4.106.4.2.7 Chapter 11B Accessible EVCS requirements.
Construction documents shall indicate how many accessible EVCS would be required under Title 24 Chapter 11B Table 11B-228.3.2.1, if applicable, in order to convert all EV Capable and EV Ready spaces required under 4.106 to EVCS. Construction documents shall also demonstrate that the facility is designed so that compliance with accessibility standards including 11B-812.5 accessible routes will be feasible for the required accessible EVCS at the time of EVCS installation. Surface slope for any area designated for accessible EVCS shall meet slope

requirements in section 11B-812.3 at the time of original building construction and vertical clearance requirements in Section 11B-812-4.

Note: Section 11B-812 of the 2016 California Building Code requires that a facility providing EVCS for public and common use also provide one or more accessible EVCS as specified in Table 11B-228.3.2.1. Chapter 11B applies to certain facilities including but not limited to public accommodations and publicly funded housing (see section 1.9 of Part 2 of the California Building Code).
Section 11B-812.4 requires that "Parking spaces, access aisles and vehicular routes serving them shall provide a vertical clearance of 98 inches (2489 mm) minimum." Section 11B-812.3 requires that parking spaces and access aisles meet maximum slope requirements of 1 unit vertical in 48 units horizontal (2.083 percent slope) in any direction at the time of new building construction or renovation. Section 11B-812.5 contains accessible route requirements. Section 4.106.4.2.7 requires that developers meet certain aspects of accessibility requirements at the time of new construction.

(Ord. No. 13419, § 4, 2-21-2017)

Palo Alto

16.14.420 Section A4.106.8 Electric vehicle (EV) charging.
Section A4.106.8 of the California Green Building Standards Code is added as mandatory and amended to read:

A4.106.8 Electric Vehicle (EV) Charging for Residential Structures. Newly constructed single family and multifamily residential structures, including residential structures constructed as part of a mixed use development, shall comply with the following requirements for electric vehicle supply equipment (EVSE). All parking space calculations under this section shall be rounded up to the next full space. The requirements stated in this section are in addition to those contained in Section 4.106.4 of the California Green Building Standards Code. In the event of a conflict between this section and Section 4.106.4 of the California Green Building Standards Code, the more robust EV Charging requirements shall prevail.

A4.106.8.1 Definitions. For the purposes of this section, the following definitions shall apply:
(a) Level 2 EVSE. "Level 2 EVSE" shall mean an EVSE capable of charging at 30 amperes or higher at 208 or 240 VAC. An EVSE capable of simultaneously charging at 30 amperes for each of two vehicles shall be counted as two Level 2 EVSE.
(b) Conduit Only. "Conduit Only" shall mean, at minimum: (1) a panel capable to accommodate a dedicated branch circuit and service capacity to install a 208/240V, 50 amperes grounded AC outlet; and (2) raceway or wiring with capacity to accommodate a 100 ampere circuit; terminating in (3) a listed cabinet, box, enclosure, or NEMA receptacle. The raceway shall be installed so that minimal removal of materials is necessary to complete the final installation.
(c) EVSE-Ready Outlet. "EVSE-Ready Outlet" shall mean, at minimum: (1) a panel capable to accommodate a dedicated branch circuit and service capacity to install a 208/240V, 50 amperes grounded AC outlet; (2) a two-pole circuit breaker; (3) raceway

with capacity to accommodate 100-ampere circuit; (4) 50 ampere wiring; terminating in (5) a 50 ampere NEMA receptacle in a covered outlet box.

(d) EVSE Installed. "EVSE Installed" shall mean an installed Level 2 EVSE.

A4.106.8.3 Multi-Family Residential Structures. The following standards apply to newly constructed residences in a multi-family residential structure, except as provided in section A4.106.8.4.

(a) Resident parking. The property owner shall provide at least one EVSE-Ready Outlet or EVSE Installed for each residential unit in the structure.

(b) Guest parking. The property owner shall provide Conduit Only, EVSE-Ready Outlet, or EVSE Installed, for at least 25% of guest parking spaces, among which at least 5% (and no fewer than one) shall be EVSE Installed.

(c) Accessible spaces. Projects shall comply with the 2016 California Building Code requirements for accessible electric vehicle parking.

(d) Minimum total circuit capacity. The property owner shall ensure sufficient circuit capacity, as determined by the Chief Building Official, to support a Level 2 EVSE in every location where Circuit Only, EVSE-Ready Outlet or EVSE Installed is required.

(e) Location. The EVSE, receptacles, and/or raceway required by this section shall be placed in locations allowing convenient installation of and access to EVSE. In addition, if parking is deed-restricted to individual residential units, the EVSE or receptacles required by subsection (a) shall be located such that each unit has access to its own EVSE or receptacle. Location of EVSE or receptacles shall be consistent with all City guidelines, rules, and regulations.

A4.106.8.4 Exception - Multi-Family Residential Structures with Individual, Attached Parking. The property owner shall provide Conduit Only, EVSE-Ready Outlet, or EVSE Installed for each newly constructed residence in a multi-family residential structure featuring: (1) a parking space attached to the residence; and (2) a shared electrical panel between the residence and parking space (e.g., a multi-family structure with tuck-under garages).

(Ord. 5393 § 1 (part), 2016)

San Francisco City and County

4.106.4.2 New Multifamily Dwellings and Major Alterations. Where three or more multifamily dwelling units are constructed on a building site, or undergo major alteration, 100% of the total number of off-street parking spaces provided for passenger vehicles and trucks shall be electric vehicle charging spaces (EV Spaces) capable of supporting future EVSE.

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

4.106.4.2.1 Electric Vehicle Charging Space Locations. Construction documents shall indicate the location of proposed EV spaces. Where parking spaces are provided for public use or for common use by residents, at least one EV space shall be located in common use areas and available for use by all residents.

When EV chargers are installed, accessible EV spaces required by Section 4.106.2.2, Item 3, shall comply with at least one of the following options:

1. The EV space shall be located adjacent to an accessible parking space meeting the requirements of the California Building Code, Chapter 11A, to allow use of the EV charger from the accessible parking space.

2. The EV space shall be located on an accessible route, as defined in the California Building Code, Chapter 2, to the building.

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

4.106.4.2.2 Electric Vehicle Charging Space (EV Spaces) Dimensions. EV spaces shall be designed to comply with the following:

1. The minimum length of each EV space shall be 18 feet (5486 mm).
2. The minimum width of each EV space shall be 9 feet (2743 mm).
3. One in every 25 EV spaces, but not less than one, shall also have an 8-foot (2438 mm) wide minimum aisle. A 5-foot (1524 mm) wide minimum aisle shall be permitted provided the minimum width of the EV space is 12 feet (3658 mm).

a. Surface slope for this EV space and the aisle shall not exceed 1 unit vertical in 48 units horizontal (2.083% slope) in any direction.

b. Notwithstanding any other applicable requirements, when an EV charger is installed serving an accessible parking space, the space may be considered a parking space if the duration of stay is not subject to any limitations different from those generally applied to other publicly accessible parking spaces in the same parking area. If the duration of stay in an accessible space equipped with an EV charger is subject to limitations different from those generally applied to other publicly accessible parking spaces in the same parking area, the space is not a parking space.

4. Accessible spaces must meet the dimensions specified above, Planning Code Section 154, or other applicable accessibility requirements, whichever would result in the largest space size.

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

4.106.4.2.3 Single EV Space Required. Where a single EV space is required, install a full circuit with a minimum of 40-Amp 208 or 240 Volt capacity, including listed raceway, sufficient electrical panel capacity, overcurrent protection devices, wire, and termination point such as a receptacle. The termination point shall be in close proximity to the proposed EV charger location. The raceway shall not be less than trade size 1 (nominal 1-inch inside diameter).

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

4.106.4.2.4 Multiple EV Spaces Required.

(a) For a minimum of 10% of EV Spaces and in no case less than two EV Spaces when the total number of EV Spaces is two or more, install a full circuit with minimum of 40-Amp 208 or 240 Volt capacity per EV Space, including listed raceway, sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable listed termination point such as a receptacle. The termination point shall be in close proximity to the proposed EV charger location. Calculations for the number of EV Spaces shall be rounded up to the nearest whole number.

(b) Branch circuit panelboard(s) shall be installed at each parking level with service capacity to deliver a minimum 40 amperes at 208 or 240 volts multiplied by 20% of the total number of EV Spaces. The panelboard(s) shall have sufficient space to install a minimum of one 40-ampere dedicated branch circuit and overcurrent protective device

per EV Space up to a minimum of 20% of the total number of EV Spaces. The circuits and overcurrent protective devices shall remain reserved exclusively for EV charging.

Exception: Circuits and overcurrent protective devices in panelboards not located on the same level may contribute to the requirements of 4.106.4.2.4(b), provided the circuits are reserved exclusively for EV charging. For example, the circuit serving an EV Space dedicated to a condominium owner may connect to the electrical panelboard of the corresponding condominium.

(c) For all EV Spaces not required to install full circuits or raceway per Section 4.106.4.2.4(a):

(1) Either:

(A) Provide sufficient space for future installation of additional electrical panelboard(s) to support a 40 ampere 208 or 240 Volt capacity branch circuit and overcurrent protection device per EV Space, or equivalent consistent with Section 4.106.4.2.4.1; or

(B) Provide space in installed electrical panelboard(s) to support installation of a 40 ampere 208 or 240 Volt capacity branch circuit and overcurrent protection device per EV Space, or equivalent consistent with Section 4.106.4.2.4.1.

(2) Install raceway or sleeves where penetrations to walls, floors, or other partitions will be necessary to install panels, raceways, or related electrical components necessary per site conditions for future installation of branch circuits. All such penetrations must comply with applicable codes, including but not limited to the San Francisco Electrical Code and the San Francisco Fire Code.

(d) Construction documents, including electrical engineering and design related documents, shall demonstrate that the electrical service capacity and electrical system, including any on-site distribution transformer(s), can charge EVSE at a minimum of 20% of the total number of EV Spaces simultaneously, at the full rated amperage of the EVSE or a minimum of 40 amperes per branch circuit, as modified by Section 4.106.4.2.4.1 Electric Vehicle Fast Charging Spaces. As appropriate, construction documents shall provide information on raceway method(s), wiring schematics, anticipated EV load management system design(s), and electrical load calculations.

NOTES:

1. Electric vehicle charging infrastructure and housing are critical priorities for the City and County of San Francisco. Where provisions of this Section 4.106.4.2.4 require the installation of an electrical transformer, and such transformer cannot be accommodated on the project site due to the combination of project site dimensions, San Francisco Building Code, San Francisco Electrical Code, and applicable utility regulations, the Director of Public Works is encouraged to issue a Sidewalk Vault Encroachment Permit, provided that the fronting property owner complies with all requirements governing street occupancy, including but not limited to the San Francisco Public Works Code and Department of Public Works Order 165,553.
2. An EV load management system may be necessary in order to provide EV charging at more than 20% of EV Spaces.
3. This section does not require EV chargers to be installed.

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

4.106.4.2.4.1 Electric Vehicle (EV) Fast Charging Spaces.

(a) Installation of one EV Fast Charger may reduce the number of EV Spaces required under Section 4.106.4.2.4(a) by up to five EV Spaces, provided that the project

includes at least one EV Space equipped with a full circuit able to deliver 40-Amp 208 or 240 Volt capacity to the EV Space, including listed raceway, sufficient electrical panel capacity, overcurrent protection devices, wire, and suitable listed termination point such as a receptacle.

The electrical panel board(s) provided at each parking level served by EV Fast Chargers shall have sufficient capacity to supply each EV Fast Charger with a minimum of 30 kW AC in addition to the capacity to serve any remaining EV Spaces required under Section 4.106.4.2.4(a) with a minimum of 40 amperes per circuit at 208 or 240 volts per EV Space.

(b) After the requirements of 4.106.4.2.4(a) are met, each planned EV Fast Charger may reduce the number of planned EV Spaces required under 4.106.4.2.4(c) by up to five spaces. Electrical engineering design and construction documents shall indicate the raceway termination point and proposed location of future EV fast charger spaces and EV fast chargers. Electrical engineering design and construction documents shall also provide information on amperage of EV fast chargers, raceway method(s), wiring schematics, and electrical load calculations to verify that the electrical panel service capacity and electrical system has sufficient capacity to simultaneously operate all installed EV fast chargers at the full rated amperage of the EV fast charger(s) and simultaneously serve any remaining spaces required by 4.106.4.2.4(a). Raceways and related components that are planned to be installed underground, enclosed, inaccessible, or in concealed areas and spaces shall be installed at the time of original construction.

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

4.106.4.2.5 Identification. The service panel or subpanel circuit directory shall identify the overcurrent protective device space(s) reserved for future EV charging purposes as “EVSE READY” for full circuits and otherwise “EVSE CAPABLE” in accordance with the California Electrical Code. The raceway termination location or receptacle shall be permanently and visibly marked as “EVSE READY” for full circuits and otherwise “EVSE CAPABLE,” until such time as EVSE are installed.

Notes:

1. The California Department of Transportation adopts and publishes the “California Manual on Uniform Traffic Control Devices (California MUTCD)” to provide uniform standards and specifications for all official traffic control devices in California. Zero Emission Vehicle Signs and Pavement Markings can be found in the New Policies & Directives Number 13-01. Website: http://www.dot.ca.gov/hq/traffops/policy/13-01.pdf.
2. See Vehicle Code Section 22511 for EV charging space signage in off-street parking facilities and for use of EV charging spaces.
3. The Governor’s Office of Planning and Research (OPR) published a “Zero-Emission Vehicle Community Readiness Guidebook” which provides helpful information for local governments, residents and businesses.
Website: http://opr.ca.gov/docs/ZEV_Guidebook.pdf.

(Added by Ord. 92-17, File No. 170202, App. 4/27/2017, Eff. 5/27/2017, Oper. 1/1/2018)

San Mateo

23.70.030 Local Amendment for Electric Vehicle Charging for New Multifamily Residential Construction.

The California Green Building Standards Code, 2016 Edition, Section 4.106.4.2, Electric vehicle (EV) charging space requirements for new multifamily dwellings is amended to include: (a) standards for new multifamily dwellings containing three to 16 units, and (b) increased standards for new multifamily dwellings containing 17 or more units as follows:

(a) New multifamily dwellings containing three to 16 units: Where between three to 16 multifamily dwelling units are constructed on a building site, at least one space shall be an electric vehicle charging space (EV space) capable of supporting future electric vehicle supply equipment (EVSE).

(b) New multifamily dwellings containing 17 or more units: Where 17 or more multifamily dwelling units are constructed on a building site, 10 percent of the total number of parking spaces provided for all types of parking facilities, but in no case less than one, shall be electric vehicle charging spaces (EV spaces) capable of supporting future EVSE. Calculations for the required number of EV spaces shall be rounded up to the nearest whole number.

Note: Projects shall reference the California Green Building Code Section 4.106.4 and California Electrical Code, 2016 Edition, Article 625 for definitions and requirements for electric vehicle charging spaces. (Ord. 2016-11 § 1)

San Rafael

12.23.020 - Amendments to the California Green Building Standards Code.

The 2016 California Green Building Standards Code is amended or modified as follows:

In addition to complying with the base provisions of the 2016 California Green Building Standards Code, new buildings for which an application for a building permit is submitted on or after January 2, 2017, shall additionally comply with Appendix A4 of such code, with respect to the Tier 1 measures, but excluding Division A4.2; or with Appendix A5 of such code, with respect to the Tier 1 measures, but excluding Division A5.2, depending on occupancy type.
(Ord. No. 1943 , div. 8, 11-21-2016)

Santa Clara County

Sec. C3-32. - Amendments to Chapter 4.

Chapter 4 is amended as follows:

Section 4.106.4.2 (New multifamily dwellings) is amended to read as follows:

4.106.4.2 New multifamily dwellings. For new buildings, at least 3 percent of the total number of parking spaces provided for all types of parking facilities, but in no case less than one, shall be electric vehicle charging spaces (EV spaces) capable of supporting future EVSE and shall be identified on the construction documents. Calculations for the number of EVCS shall be rounded up to the nearest whole number.

Note: Construction documents are intended to demonstrate the project's capability and capacity for facilitating future EV charging. There is no requirement for EVCS to be constructed or available until EV chargers are installed for use.

Section 4.106.4.3 (Multifamily dwellings with more than 100 new parking spaces) is added to read as follows:

4.106.4.3 Multifamily dwellings with more than 100 new parking spaces. In addition to requirements in 4.106.4.2, install Level 2 EVSE to service one (1) percent of the total number of parking spaces. The percentage calculated shall be rounded up to the next whole number. The EVSE shall be located within the parking area.

Section 4.106.4.4 (Shared Parking) is added to read as follows:

4.106.4.4 Shared Parking. When parking is provided to new buildings from shared parking lots, including existing and new parking lots, the requirements of this section may be met through the installation of pre-wiring and/or EVSE among both the existing and new parking lots. Pre-wiring or EVSE previously installed in shared parking lots servicing new buildings may also meet the requirements of this section. If a new building does not require the installation of new parking spaces, as approved by the County, the requirements to install pre-wiring or EVSE in parking areas does not apply.

(Ord. No. NS-1100.125, § 2, 12-13-16)

Santa Cruz

24.12.241 ELECTRIC VEHICLE CHARGING STATION REQUIREMENTS.

1. Definitions.
   a. "Electric vehicle" means a vehicle that operates, either partially or exclusively, on electrical energy from the electrical grid, or an off-grid source, that is stored on board for motive purposes.
   b. Electric Vehicle Supply Equipment (EVSE) Installed. "EVSE installed" shall mean an installed Level 2 EVSE, as defined by the California Green Building Standards Code (CAL Green) of California Building Standards regulations, et seq.
2. Required Spaces Are Rounded. When determination of the number of required electric vehicle parking stalls by this title results in a requirement of a fractional space, any fraction of less than one-half may be disregarded, while a fraction of one-half or more shall be counted as one parking space.

3. Electric Vehicle Charging Stations.
   a. Electric Vehicle (EV) Charging for Multifamily Residential Structures. New multifamily dwellings on a single site with five or more units shall provide twelve percent of total parking, but no fewer than one, as electric vehicle parking space with EVSE installed. Multifamily projects requiring an EV van accessible parking space shall receive a credit of one parking space.

(Ord. 2017-02 § 2, 2017).

Santa Rosa

18-42.010 Citation of California Green Building Standards Code.
For purposes of citation, all sections of the California Green Building Standards Code, Part 11 of Title 24, 2016 Edition, published by the California Building Standards Commission, including its Appendix Chapter A4, Sections A4.1; A4.3, A4.4; A4.5 and A4.6, Residential Voluntary Measures at Tier I level for new structures; and Appendix Chapter A5, Sections A5.1; A5.3; A5.4; A5.5 and A5.6, Nonresidential Voluntary Measures at Tier I level for new structures only, as adopted by reference in this Title 18, are renumbered by adding “18-42.” before each section number. (Ord. 4080 § 12, 2016)

Sunnyvale

16.43.040. Pre-wiring for electric car chargers.
2016 California Green Building Code Section 4.106.4.2 is hereby added:

4.106.4.2 New multifamily dwellings. Where new multi-family dwelling units are constructed on a building site, twelve and one-half percent of the total number of parking spaces provided for all types of parking facilities, but in no case less than one, shall be electric vehicle charging spaces (EV spaces) capable of supporting future EVSE. Calculations for the required number of EV spaces shall be rounded up to the nearest whole number.

Note: Construction documents are intended to demonstrate the project’s capability and capacity for facilitating future EV charging. There is no requirement for EV spaces to be constructed or available until EV chargers are installed for use.

(Ord. 3100-16 § 37; Ord. 3015-13 § 2).

Southern California

Lancaster

17.08.330 - Electric Vehicle Charging Stations.

Electric Vehicle Charging Stations (EVCS). New residential development shall provide for EVCS in the manner prescribed as follows:

A. Garages serving each new single-family residence and each unit of a duplex shall be constructed with a gang box (four inches by four inches) connected to a conduit linking the garage to the electrical service, with available "Level 2" plug-in voltage of two hundred forty (240) volt, in a manner approved by the building and safety official, to allow for the future installation of electric vehicle supply equipment to provide an EVCS for use by the resident.

B. In new multiple-family projects of ten (10) dwelling units or less, twenty (20) percent of the total parking spaces required (all of the twenty (20) percent shall be located within the required covered parking) shall be provided with

a gang box (four inches by four inches) connected to a conduit linking the covered parking spaces or garages with the electrical service, in a manner approved by the building and safety official, to allow for the future installation of electric vehicle supply equipment to provide EVCSs at such time as it is needed for use by residents. EVCSs shall be provided in disabled person parking spaces in accordance with state requirements.

C. In new multiple-family projects of more than ten (10) dwelling units, 10% of the total parking spaces required (all of the 10% shall be located within the required covered parking) shall be provided with a gang box (four inches by four inches) connected to a conduit linking the covered parking spaces or garages with the electrical service, in a manner approved by the building and safety official. Of the total gang boxes provided, fifty (50) percent shall have the necessary electric vehicle supply equipment installed to provide active EVCSs ready for use by residents. The remainder shall be installed at such time as they are needed for use by residents. EVCSs shall be provided in disabled person parking spaces in accordance with state requirements.

(Ord. No. 989, § 1, 4-9-2013)

Long Beach

18.47.030 - Amend CALGreen Section 4.106.4.2—New multifamily dwelling.

Section 4.106.4.2 of the 2016 Edition of the California Green Building Standards Code is amended to read as follows:

4.106.4.2 New multifamily dwellings. Where a building contains three (3) or more dwelling units is constructed on a building site, at least one (1) electric vehicle charging spaces (EV spaces) capable of supporting future EVSE shall be provide for each dwelling unit. Where guest parking spaces are provided on a building site, twenty-five percent (25%) of the total number of guest parking spaces, but in no case less than one, shall be EV spaces capable of supporting future EVSE and five percent (5%) of the total number of guest parking spaces, but in no case less than one, shall have EV chargers installed. Calculations for the required number of EV spaces shall be rounded up to the nearest whole number.

Exception: On a case-by-case basis, where the Building Official has determined EV charging and infrastructure are not feasible based upon the installation of an alternative and innovative parking system, the following required number of EV spaces and EV chargers may be permitted in lieu of providing one (1) EV space for each dwelling unit:

1. One hundred percent (100%) of the total number of guest parking spaces shall be EV spaces capable of supporting future EVSE; and
2. Ten percent (10%) of the total number of guest parking spaces shall have EV chargers installed.

Note: Construction documents are intended to demonstrate the project's capability and capacity for facilitating future EV charging. There is no requirement for EV spaces to be constructed or available until EV chargers are installed for use.

(ORD-16-0026 § 1(Exh. A), 2016)

Los Angeles

99.04.106.4.2. New Multi-family Dwellings and "R" Occupancies Other Than One- and Two-family Dwellings and Townhouses. Where multi-family dwelling units and other "R" occupancies not covered under LAMC Paragraph 99.04.106.4.2.1 are constructed on a building site, 5% of the total number of parking spaces provided for all types of parking facilities, but in no case less than one, shall be electric vehicle charging spaces (EV spaces) capable of supporting future EVSE. Calculations for the required number of EV spaces shall be rounded up to the nearest whole number.

99.04.106.4.2.1. Electric Vehicle Charging Spaces (EV spaces) [N]. Construction documents shall indicate the locations of proposed EV spaces and EV charging stations. For buildings with 17 or more dwelling units, at least one of the required EV spaces shall be located in a common use area, equipped with an EV charging station and available for use by all residents.

When EV chargers are installed, EV spaces required by LAMC Paragraph 99.04.106.4.2.2, Item 3, shall comply with at least one of the following options:

1. The EV space shall be located adjacent to an accessible parking space meeting the requirements of the Los Angeles Building Code, to allow use of the EV charger from the accessible parking space.

2. The EV space shall be located on an accessible route to the building, as defined in the Los Angeles Building Code.

99.04.106.4.2.2. Electric Vehicle Charging Space (EV space) Dimensions [N]. The EV spaces shall be designed to comply with the following:

1. The minimum length of each EV space shall be 18 feet (5486 mm).

2. The minimum width of each EV space shall be 9 feet (2743 mm).

3. For buildings with 17 or more dwelling units, one in every 25 EV spaces, but not less than one, shall also have a minimum 8 foot (2438 mm) wide aisle. A 5 foot (1524 mm) wide aisle shall be permitted provided the minimum width of the EV space is 12 feet (3658 mm).

    a. Surface slope for the EV space and the aisle shall not exceed 1 unit vertical in 48 units horizontal (2.083 percent slope) in any direction.

99.04.106.4.2.4. Multiple EV Spaces Required. Construction documents shall indicate the raceway termination point and proposed location of future EV spaces and EV charging stations. Construction documents shall also provide information on amperage of future EVSE, raceway method(s), wiring schematics and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformer(s), have sufficient capacity to simultaneously charge all EVs at all required EV spaces at the full rated amperage of the EVSE, unless otherwise permitted by the Los Angeles Electrical Code. Plan design

shall be based upon a 40-ampere minimum branch circuit. Raceways and related components that are planned to be installed underground, enclosed, inaccessible or in concealed areas and spaces shall be installed at the time of original construction.

Pasadena

14.04.504 - Section 307 is added to the 2016 California Green Building Standards Code is to read as follows.

307.1 Buildings required to comply with Tier 1 include the following:

1. Municipal buildings of 5,000 square feet or more of new construction.
2. Non-residential buildings with 25,000 square feet or more of new construction.
3. Tenant improvements of 25,000 square feet or more.
4. Mixed use and multi-family residential buildings four stories in height or more.

17.46.310 - Electric Recharge Stations

A. **Applicability.** Electric recharge stations shall be provided:

1. In new development projects required to provide at least 250 motor vehicle parking spaces; and
2. For remodeling and expansion of existing development projects that would result in at least 250 additional motor vehicle parking spaces.

B. **Number of spaces required.**

1. At least one conductive and one inductive charger shall be provided in each project required to provide between 250 and 500 parking spaces.
2. An additional conductive and inductive charger shall be provided for each 250 required parking spaces over 500, with a maximum of six.
3. The Zoning Administrator may reduce the number of parking spaces in an existing parking facility for projects that are not required to install charging equipment, but agree to do so voluntarily.
4. The maximum reduction allowed by Subparagraph 3 above, shall be one parking space for each space provided with both a conductive and inductive charger.

Santa Monica

8.106.100 Electric vehicle charging.

(a) **Multi-Family Dwellings.** For new electrical services in multi-family dwellings, the following shall apply:

(1) The total load calculations shall include a load for future electrical vehicle charging. This load shall be calculated at ten kilowatts per five percent of the parking spaces provided.

(2) The minimum rating of the main service panel and the ampacity of the service entrance conductors shall be based on the total calculated load and the requirements of Chapter 2 of the California Electrical Code.

(3) A separate multi-meter distribution section shall be provided for electrical vehicle charging only. The minimum number of meters in this multi-meter section shall be based on five percent of the parking spaces provided. The minimum rating of this multi-meter distribution section shall be calculated at ten kilowatts per five percent of the parking spaces provided.

Each meter shall have a space for a two-pole 208/240 volt circuit breaker where the space is identified as “Electric Vehicle Charging” or “Future Electric Vehicle Charging,” as applicable. This distribution panel section shall be permanently and conspicuously marked “Electric Vehicle Charging Only.”

(4) If the continuous rating of Level 2 and/or Level 3 electric vehicle service equipment is known at the time of installation then these ratings shall be applied to the load calculations in subsection (a), but in no case shall less than ten kilowatts per five percent of the parking spaces be provided.

(5) Where the calculated number of parking spaces results in a fraction of one-half or greater, the calculated number shall be rounded to the next higher whole number.

Exceptions. The requirements of this Section shall not apply under the following conditions:

(1) New electrical service is installed in a building where there is no attached or dedicated parking facility;

(2) New electrical service is not associated with a building or structure;

(3) Compliance is technically infeasible due to the distance between a dedicated parking facility and the structure containing residential occupancies, or similar conditions. (Added by Ord. No. 2445CCS § 55, adopted 11/12/13; amended by Ord. No. 2527CCS § 11, adopted 11/22/16)

Appendix E: Overview of Electrical Service and Transformer Costs

Installation of EV charging infrastructure in new construction of multifamily housing should not add to electrical service costs associated with the development. In most cases, there should also not be any transformer costs added to EV charging infrastructure costs in new multifamily housing. This appendix provides details on the issues related to electrical service and transformers with installing EV charging infrastructure in new multifamily housing. Below is a summary of the key points.

1) Electrical service fees can be avoided. Developers have the option to designate a blank space for a meter to serve EV charging energy demand. When EV Capable spaces convert to EV Charging Spaces in the future, allowance costs should cover service upgrade fees to install the EV Meter.
2) Dedicated transformers to serve EV charging load are needed if existing service is not adequate and developers select single phase power; developers of smaller buildings with 9 units or smaller typically opt for single phase power. For larger buildings, developers typically require three phase power. In this case, one transformer can be installed to meet building and EV charging energy demand.
3) Future energy demand to serve EV charging may not require larger transformers. The 2019 Energy Code will use 10-15 percent less energy in comparison to the 2016 Energy Code. Future energy demand for EV Capable spaces represents between 3-13 percent of the typical energy demand for multifamily housing. Developers should not have to install larger transformers to accommodate EV charging load.

Introduction

Nearly all new multifamily housing requires dedicated service and cannot be accommodated by existing transformers near a project site. When a developer brings a request for power for a new multifamily housing project, they are required to identify the size of the panel. Utilities need to know how much power the development will use right away as well as the ultimate capacity of the panel. Utilities size underground structures to accommodate future power needs. They size the transformers to account for current power needs. Once the additional load is added later, utilities upgrade the transformer with no additional costs to the customer.

Meter Services for Power on the Utility Side

Electric vehicle charging is seen as another point in service, which would add one meter to a project. In most cases, the allowance under Tariff Rules 15 and 16 would cover the additional expense. By having a dedicated meter for EV charging, it allows for the EV meter and EV load to be on an EV Rate in the future.

There are generally three variations for developers requesting meter services for power.

1) If the request for power includes the additional spaces in the panel and the developer wants the EV power metered separately, but, they don't install a separate meter in the beginning, there is a service upgrade fee. In most cases, the Tariff Rules 15 and 16 allowance would cover the cost of the service upgrade.
2) The allowance for new services under Tariff Rules 15 and 16 cover the costs of adding one more meter. The EV Meter can be included in the package of overall service requests. In this case, if the developer takes the allowance at the time of new construction and nobody installs an EV charging station in the first year, the

developer would be billed for deficit charges. However, the deficit billing would only be the amount of allowance that was applied to the EV service meter.

3) If the developer designs the meter with blank space at the time of new construction, there is no electrical service upgrade fee. However, there would be a charge in the future at the time of the request for service. When a customer requests the meter only order, the utility would turn on the dedicated EV Meter and it would be ready for use. The allowance under Tariff Rules 15 and 16 typically cover the cost of this electrical service upgrade fee. There are situations when taxes and service fees may not be covered by the allowances. In these cases, the costs are nominal. This is the preferred option for requesting meter services that would not require any out-of-pocket expenses for a developer.

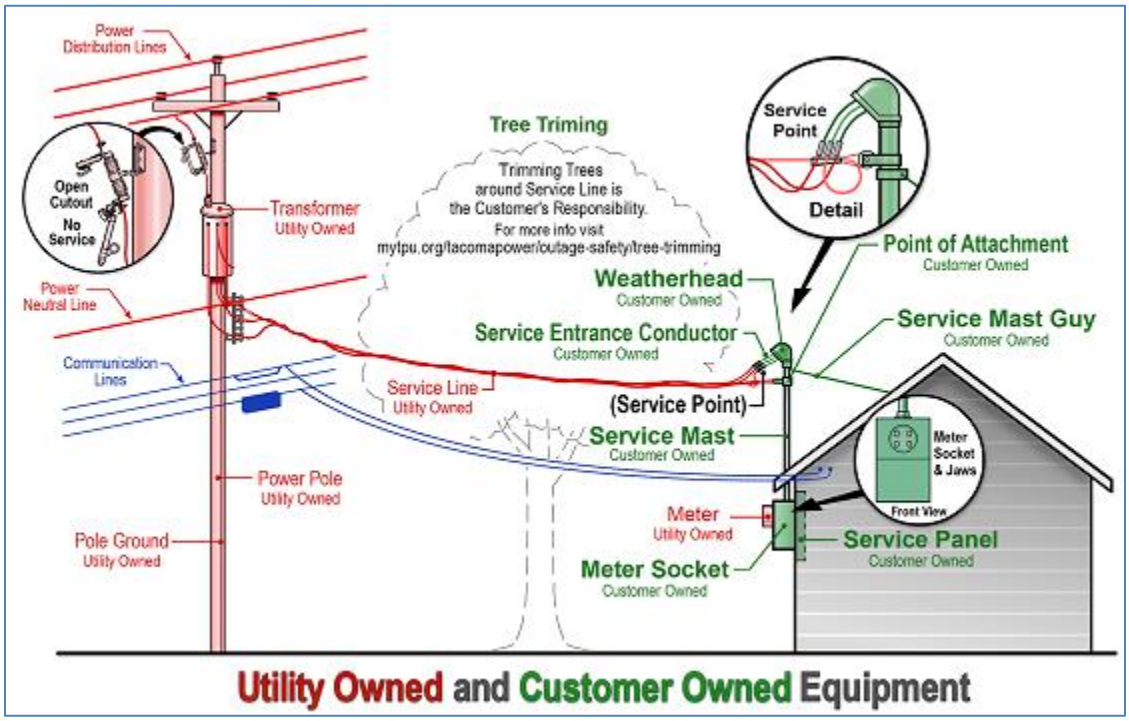

Figure D1. Power Distribution to Residential Buildings[8]

Beyond the Meter on the Customer Side

Single phase power can accommodate Level 2 charging stations. However, projects with single phase power need a dedicated transformer for the EV load that is separate from the building load. DC fast charging stations must have three phase power to operate. Typically, multifamily complexes with multiple small buildings (ex. 4-8 units per building) will request single phase power while larger projects will request and/or require three phase power. If developers select three phase power at the time of new construction, it can be accommodated by one transformer to serve all loads. Three phase power may be more expensive than single phase power because it requires additional cables and splices. However three phase power can serve many more units/buildings per transformer and the transformers are typically designed to be upgraded as needed. Therefore, CARB staff did not account for any additional transformer costs for buildings with 10 units or more.

[8] Tacoma Public Utilities Power Out at Home

Transformer Power for Each EV Capable Space
Transformer power needs are measured in kilovolt-amps.

$$S_{(kVA)} = \frac{I_{(A)} \times V_{(V)}}{1{,}000}$$

Where:
S = apparent power in kilovolt-amps
I = phase current in amps
V = RMS voltage in volts

Each EV Capable space installed to meet the EV charging infrastructure provisions in the CALGreen Code must provide adequate panel capacity to install a 40-amp, 240 volt dedicated branch circuit. A multifamily building that must install one EV Capable space would need approximately 10 kVA of power. Below is a copy of the calculation used to estimate the transformer power needs for a building with one EV Capable space.

Transformer power equation (1 EV Capable Space): $S_{kVA} = \frac{40\ amps \times 240\ volts}{1{,}000} = 9.6\ kVA$

Typical Size of Transformers for Multifamily Housing Projects
Transformer sizes vary based on the size of the project and whether or not it's going to be all electric or include gas infrastructure. A building that is usually 20 units or less requires a transformer sized about 150-300 kVA. For the proposed 10% requirement, multifamily buildings with 5-9 units must install 2 EV Capable spaces, which would require 80 amps or 20 kVA of power. For a smaller transformer, this may represent about 7-13% of the total power demand. A building with 40, 50, or 100 units typically requires a 2,000-2,500 kVA transformer. Buildings in this size range would require 6-9 EV Capable spaces to be compliant with the proposed code. A dedicated transformer in the 60-90 kVA size range would be sufficient. For a larger building, this size of transformer would represent about 3-4% of the total power demand.

Transformer Costs
CARB staff determined that only smaller multifamily buildings with 9 units or less would likely opt for single phase power and therefore would require a dedicated transformer to serve EV charging loads. However, developers of larger multifamily buildings with 10 units or more typically require 3 phase power where one transformer would serve all the power needs of the buildings as well as EV charging.

Since smaller buildings with 9 units or less typically request single phase power, CARB staff estimated the transformer power needs and added cost for these smaller buildings to install a dedicated transformer. A 3-4 unit building with one EV Capable space may select to install single phase power and a dedicated 10 kVA transformer to serve power needs. The cost for a single phase transformer of this size is approximately $2,175. A multifamily building with 5-9 units and 2 EV Capable spaces that selects single phase power would need a dedicated transformer in the 20 kVA size range. Based on electrical cost data in RS Means, transformers do not come in a 20 kVA size range. The cost for a 25 kVA transformer is approximately $3,450. CARB staff used this transformer cost estimate for buildings in the 5-9 unit size range.

Appendix F: Details on the Cost Analysis

Summary of Statewide Cost Estimate

A statewide cost of $43 million to $76 million is estimated due to implementation of the proposed building standard over a 6 year time period from the proposed 2020 effective date and a 2025 target date for EV charging infrastructure needed in multifamily housing. The information in Table F1 is a summary of the more detailed cost estimates provided in Table F2.

Table F1. Overview of Estimated Statewide Construction Costs

EV Charging Infrastructure		Cost per EV Capable Space	Number of EV Capable Spaces	Statewide Cost Estimate (Millions)
Raceway and Panel Capacity		$280 - 760	39,000 – 48,000	$10.9 – 36.5
Dedicated Transformers in Smaller Buildings	3-4 Unit Buildings	$2,175	3,000 – 3,800	$6.5 – 8.3
	5-9 Unit Buildings	$3,450	7,300 – 9,000	$25.2 – 31.0
Total Cost				**$43 – 76**

Estimated Statewide Construction Costs

CARB staff estimated that every new EV Capable Space would install raceway and panel capacity. CARB staff determined that only smaller buildings with 9 units or less would be required to install dedicated transformers to serve the EV charging load. Dedicated transformer costs were added to raceway and panel capacity costs to estimate the total statewide construction costs.

Raceway and panel capacity costs were calculated by multiplying the average cost per space of $280-760 by the total number of EV Capable spaces. Details for raceway and panel capacity costs can be found in Table F3. Transformer costs were estimated by multiplying the average cost for transformers in 3-4 unit buildings and 5-9 unit buildings by the number of spaces expected to be installed in those buildings. Buildings in the 3-4 unit size range would require installation of 1 EV Capable space, which could be accommodated by a 10 kVA sized transformer. Buildings in the 5-9 unit size range would require installation of 2 EV Capable spaces, which could be accommodated by a 20 kVA sized transformer. According to RS Means Cost Data, 10 kVA transformers cost $2,175. Costs for 20 kVA transformers were not available; CARB staff used the 25 kVA transformer cost estimate of $3,450. Table F4 and Appendix E provides more information on transformer costs.

Basic Equations:

<u>Statewide Construction Costs:</u>

1. $Raceway\ and\ Panel\ Capacity\ Costs + Dedicated\ Transformer\ Costs = Statewide\ Construction\ Costs$

   A. *<u>Where Raceway and Panel Capacity Costs are calculated as follows:</u>*

$$\frac{Cost}{Space} \times Total\ Spaces = Raceway\ and\ Panel\ Capacity\ Costs$$

B. Where Dedicated Transformer Costs are calculated as follows:

$$\frac{Cost}{Space} \times Spaces\ in\ Smaller\ Buildings = Dedicated\ Transformer\ Costs$$

Simplified Calculations for Statewide Construction Cost Estimate

Below are simplified estimates to demonstrate basic equations and calculations for projected statewide construction costs. Refer to Table F2 for a summary of the more detailed calculations.

1a. Low Range Estimate:

$$(\$280 \times 39{,}000) + (\$2{,}175 \times 3{,}000) + (\$3{,}450 \times 7{,}300) \therefore$$
$$\$10{,}920{,}000 + \$6{,}525{,}000 + \$25{,}185{,}000 = \$42{,}630{,}000\ or\ \$43\ million\ (rounded)$$

1b. High Range Estimate:

$$(\$760 \times 48{,}000) + (\$2{,}175 \times 3{,}800) + (\$3{,}450 \times 9{,}000) \therefore$$
$$\$36{,}480{,}000 + \$8{,}265{,}000 + \$31{,}050{,}000 = \$75{,}795{,}000\ or\ \$76\ million\ (rounded)$$

Table F2. Incremental Cost to Install EV Charging Infrastructure in 10% of Parking Spaces

Year	Incremental Difference in EV Capable Parking Spaces Installed		Initial Construction Costs			
			Covered Garage	Surface Lots	Transformer Costs	Total Costs
			$280/Space	$760/Space		
2020	Low	6,582	$1,843,024	$5,002,495	$5,371,652	$7,214,677
	High	8,456	$2,367,811	$6,426,916	$6,903,220	$13,330,136
2021	Low	6,460	$1,808,876	$4,909,806	$5,271,329	$7,080,205
	High	8,287	$2,320,455	$6,298,378	$6,763,807	$13,062,184
2022	Low	6,491	$1,817,482	$4,933,165	$5,297,656	$7,115,137
	High	8,122	$2,274,046	$6,172,410	$6,628,748	$12,801,158
2023	Low	6,420	$1,797,591	$4,879,175	$5,238,838	$7,036,429
	High	7,959	$2,228,565	$6,048,962	$6,495,825	$12,544,787
2024	Low	6,416	$1,796,350	$4,875,808	$5,235,984	$7,032,334
	High	7,800	$2,183,994	$5,927,983	$6,367,170	$12,295,153
2025	Low	6,500	$1,820,040	$4,940,108	$5,305,716	$7,125,756
	High	7,644	$2,140,314	$5,809,423	$6,238,391	$12,047,814
Total	Low	38,869	$10,883,362	$29,540,555	$31,719,525	$42,602,887
	High	48,269	$13,515,184	$36,684,070	$39,393,750	$76,077,820

Table F3. Estimated Cost to Install Raceway and Panel Capacity in New Construction of Multifamily Housing[9] (RS Means, 2017)

Low Range Cost Estimate			
Item	**Cost**	**Quantity**	**Total**
Surface Mounted 1" Diameter Conduit, 10' Length - PVC, Schedule 40[10]	$7.70	2	$15.40
Coupling, 1" Diameter	$58.50	1	$58.50
Box Connectors, insulated compression, steel, 1" Diameter	$12.95	1	$12.95
Box for Electrical System, 2-1/8" deep, 4-11/16" Square Box	$39.50	1	$39.50
Square Box Cover, Blank	$14.85	1	$14.85
1" Set Screw, Pack of 10; Pack of 10; $12.19 per box	$1.22	4	$4.88
Panelboard and load center circuit breakers, 240 volt, 2 pole, 15-50 amp	$113.00	1	$113.00
Labor to mount junction box and run conduit (1/4 hour @ $82.62/hour) (ProMatcher, 2017)	$20.66	1	$20.66
			$279.23
High Range Cost Estimate			
Item	**Cost**	**Quantity**	**Total**
1" Diameter Conduit - Rigid Galvanized Steel Conduit in Slab (Per Linear Foot)[11]	$12.55	20	$251.00
Coupling for Rigid Galvanized Steel - 1" Diameter	$154.00	1	$154.00
Box Connector for Rigid Galvanized Steel - 1" Diameter	$19.35	1	$19.35
Steel Pull Box - 6" L X 6" W X 6" D	$86.50	1	$86.50
Square Box Cover, Blank	$14.85	1	$14.85
1" Set Screw, Pack of 10; Pack of 10; $12.19 per box	$1.22	4	$4.88
Panelboard and load center circuit breakers, 240 volt, 3 pole, 15-60 amp	$208.00	1	$208.00
Labor to mount junction box and run conduit (1/4 hour @ $82.62/hour) (ProMatcher, 2017)	$20.66	1	$20.66
			$759.23

Table F4. Summary of Transformer (Dry Type) Costs (RS Means, 2017)

Single Phase, 240/480 volt primary, 120/240 volt secondary	
Size	**Cost**
5 kVA	$1,275
7.5 kVA	$1,625
10 kVA	$2,175
15 kVA	$2,650
25 kVA	$3,450

[9] Cost estimates are based on lowest and highest possible range of costs for surface mounted conduit compared to conduit in concrete slab.
[10] Surface mounted 1" diameter conduit electrical metal tubing is estimated to cost $4.73 per linear foot.
[11] PVC schedule 40, 1" diameter conduit in concrete slab is estimated to cost $4.23 per linear foot.

Additional Background on CARB Staff Estimates
Statewide cost estimates are supported by a number of additional variables. The total number of EV Capable spaces were derived from the number of multifamily housing starts and associated parking projected for construction between 2020 and 2025. Data was gathered from multiple sources including the California Energy Commission (CEC), Construction Industry Research Board (CIRB), the US Census, and local jurisdictions.

Table F5. Summary of Variables Included in Statewide Cost Estimate

Unit		Low Range Estimate	High Range Estimate
Total Parking Spaces		427,000	530,000
Total EV Capable Spaces	Proposed 10% Requirement	43,000	53,000
	Current 3% Requirement	4,000	5,000
	Incremental Difference	39,000	48,000
Spaces in Smaller Buildings	3-4 Unit Buildings	3,000	3,800
	5-9 Unit Buildings	7,300	9,000

Total Parking Spaces
Based on CEC and CIRB data as well as guidance from HCD, an estimated 237,000 to 295,000 multifamily housing starts projected for construction would be subject to the proposed code between 2020 and 2025. CARB staff reviewed over 200 municipal codes to determine that local jurisdictions require on average about 1.8 parking spaces for every new multifamily housing unit. An estimated 427,000 to 530,000 parking spaces are expected to be constructed in new multifamily housing starts between 2020 and 2025. For additional details on these estimates, see Tables 7-9, Appendix B, and Table F6.

Basic Equation:

2. $$Multifamily\ Housing\ Starts\ \times \frac{Average\ Parking\ Required}{New\ Multifamily\ Unit} = Total\ Parking\ Spaces$$

Simplified Calculations for Total Parking Estimates
Below are simplified estimates to demonstrate basic equations and calculations for projected total parking spaces. Refer to Table F5 for a summary of the more detailed calculations.

2a. Low Range Estimate: $237{,}000 \times 1.8 = 426{,}600\ or\ 427{,}000\ (rounded)$

2b. High Range Estimate: $295{,}000 \times 1.8 = 531{,}000\ or\ 530{,}000\ (rounded)$

Table F6. Statewide Estimates for New Multifamily Housing Starts and Parking Spaces

Year	CEC Residential Model Based on DOF Data		CARB Staff Projections Based on CIRB Data	
	Multifamily Housing Starts	New Parking Spaces	Multifamily Housing Starts	New Parking Spaces
2020	40,185	72,332	51,627	92,928
2021	39,440	70,992	50,594	91,070
2022	39,628	71,330	49,582	89,248
2023	39,194	70,549	48,591	87,463
2024	39,167	70,500	47,619	85,714
2025	39,683	71,430	46,667	84,000
Total	237,296	427,134	294,680	530,423

Total EV Capable Spaces

An estimate for the total number of EV Capable spaces subject to the proposed regulation was a key variable to calculate statewide construction costs. CARB staff estimated total spaces as the incremental difference between the current 3% requirement and the proposed 10% requirement. CARB staff estimated that between 39,000 and 48,000 total spaces would be subject to costs of the proposed regulation.

Spaces for Proposed 10 Percent Requirement

CARB staff proposes that the current building standards are revised to eliminate the 17-unit threshold and increase the requirement to install EV charging infrastructure in 10% of parking spaces. CARB staff multiplied the total number of parking spaces by 10 percent to estimate the number of EV Capable Spaces that may be installed due to the proposed 10% requirement. CARB staff estimate that the proposed building standards would result in approximately 43,000 to 53,000 EV Capable Spaces in multifamily housing between 2020 and 2025.

Spaces for Current 3 Percent Requirement

Currently, the CALGreen Code requires that EV charging infrastructure is installed in 3% of parking spaces in new multifamily housing where 17 or more units are constructed. According to US Census data, this size range of buildings represents about 30 percent of new construction starts. Therefore, CARB staff multiplied the total number of parking spaces by 30 percent first and then multiplied that amount by 3 percent to estimate the number of EV Capable spaces subject to the current regulation. CARB staff estimate that the current building standards will result in approximately 4,000 to 5,000 EV Capable spaces.

Basic Equations:

Total Spaces:

3. $Spaces\ for\ 10\%\ Requirement - Spaces\ for\ 3\%\ Requirement = Total\ Spaces$

   A. Where Spaces for 10% Requirement are calculated as follows:
   $Total\ Parking\ Spaces\ \times 0.1 = Spaces\ for\ 10\%\ Requirement$

   B. Where Spaces for 3% Requirement are calculated as follows:
   $(Total\ Parking\ Spaces\ \times 0.30\ ) \times 0.03\ =\ Spaces\ for\ 3\%\ Requirement$

Simplified Calculations for Total EV Capable Spaces
Below are simplified estimates to demonstrate basic equations and calculations for projected total spaces. Refer to Tables F7 and F8 for a summary of the more detailed calculations.

3a. Low Range Estimate:
$(427{,}000 \times 0.1) - ((427{,}000 \times 0.30) \times 0.03) \therefore$
$42{,}700\ -\ 3{,}843 = 38{,}857\ or\ 39{,}000\ (rounded)$

3b. High Range Estimate:
$(530{,}000 * 0.1) - \big((530{,}000 \times 0.30) \times 0.03\big) \therefore$
$53{,}000\ - 4{,}770 = 48{,}230\ or\ 48{,}000\ (rounded)$

Table F7. Statewide Estimate of EV Capable Spaces in 3 Percent of Parking Spaces in New Multifamily Buildings with 17 Units or More

Year	Range	Total Parking Spaces	Current Building Standards	
			17 Units or More	
			30 Percent Allocation	3% of Spaces
2020	Low	72,332	21,700	651
	High	92,928	27,878	836
2021	Low	70,992	21,298	639
	High	91,070	27,321	820
2022	Low	71,330	21,399	642
	High	89,248	26,774	803
2023	Low	70,549	21,165	635
	High	87,463	26,239	787
2024	Low	70,500	21,150	635
	High	85,714	25,714	771
2025	Low	71,430	21,429	643
	High	84,000	25,200	756
Total	Low	427,134	128,140	3,844
	High	530,423	159,127	4,774

Table F8. Incremental Difference in Number of EV Capable Spaces Between Current 3% Requirement and Proposed 10% Requirement

Year	Range	3%	10%	Incremental Difference in EV Capable Parking Spaces Installed
2020	Low	651	7,233	6,582
	High	836	9,293	8,456
2021	Low	639	7,099	6,460
	High	820	9,107	8,287
2022	Low	642	7,133	6,491
	High	803	8,925	8,122
2023	Low	635	7,055	6,420
	High	787	8,746	7,959
2024	Low	635	7,050	6,416
	High	771	8,571	7,800
2025	Low	643	7,143	6,500
	High	756	8,400	7,644
Total	Low	3,844	42,713	38,869
	High	4,774	53,042	48,269

EV Capable Spaces in Smaller Buildings

CARB staff determined that only smaller buildings with 9 units or less would be required to install dedicated transformers to serve the EV charging load. According to the US Census, approximately 11 percent of new multifamily housing starts are buildings in the 3-4 unit size range and 13 percent of buildings are in the 5-9 unit size range. Table 7 provides an overview of the percent distribution of multifamily units by building size.

Based on CEC and CIRB projections for new multifamily housing starts, CARB staff originally estimated that 34,000 to 42,000 multifamily housing starts were in the 3-4 unit size range. However, HCD staff indicated that 2 unit buildings and half of 3-4 unit buildings may be covered under the duplex and townhome requirements for EV charging infrastructure.[12] Therefore, a revised estimated total of 17,061 to 21,186 multifamily housing starts constructed in the 3-4 unit building size range would be subject to the proposed regulation. Assuming that an average of 1.8 parking spaces would be installed for each of those housing units, an associated 30,709 to 38,135 parking spaces are expected to be installed in these buildings. A ten percent requirement would require the installation of approximately 3,000 to 3,800 EV capable spaces in new multifamily buildings in the 3-4 unit size range.

CARB staff estimated a total of 40,325 to 50,076 multifamily housing starts would be constructed in the 5-9 unit building size range. An associated 72,585 to 90,137 parking spaces are expected to be installed in these buildings. A ten percent requirement would require the installation of approximately 7,300 to 9,000 EV capable spaces in these new multifamily buildings. Since transformer costs have never been accounted for in EV charging infrastructure building standards, CARB staff estimates for transformer costs

[12] Mandatory building standards for EV charging infrastructure in new one- and two-family dwellings and townhouses with attached private garages can be found in the 2016 California Green Building Standards Code, Part 11, Mandatory Residential Measures, Code Section 4.106.4.2 on the following website: https://codes.iccsafe.org/public/chapter/content/2079/.

account for all the EV Capable spaces that would be installed in smaller multifamily buildings.

Basic Equations:

<u>Spaces in 3-4 Unit Buildings:</u>

4. $[((Initial\ Multifamily\ Starts\ \times 0.11) \times 0.5) \times \frac{Average\ Parking}{New\ Multifamily\ Unit}] \times 0.10 = Spaces\ in\ 3\ to\ 4\ Unit\ Buildings$

<u>Spaces in 5-9 Unit Buildings:</u>

5. $[(Initial\ Multifamily\ Housing\ Starts\ \times 0.13) \times \frac{Average\ Parking}{New\ Multifamily\ Unit}] \times 0.10 = Spaces\ in\ 5\ to\ 9\ Unit\ Buildings$

Simplified Calculations for Spaces in Smaller Buildings
Below are simplified estimates to demonstrate basic equations and calculations for the number of EV Capable spaces projected for installation in smaller buildings. Refer to Tables F9-F13 for a summary of the more detailed calculations.

4a. Low Range Estimate:
$\left[\left((310{,}000 \times 0.11) \times 0.5\right) \times 1.8\right] \times 0.10 \therefore$
$30{,}690 \times 0.10 = 3{,}069\ or\ 3{,}000\ (rounded)$

4b. High Range Estimate:
$\left[\left((385{,}000 \times 0.11) \times 0.5\right) \times 1.8\right] \times 0.10 \therefore$
$38{,}115 \times 0.10 = 3{,}812\ or\ 3{,}800\ (rounded)$

5a. Low Range Estimate:
$[(310{,}000 \times 0.13) \times 1.8] \times 0.10 \therefore$
$72{,}540 \times 0.10 = 7{,}254\ or\ 7{,}300\ (rounded)$

5b. High Range Estimate:
$[(385{,}000 \times 0.13) \times 1.8] \times 0.10 \therefore$
$90{,}090 \times 0.10 = 9{,}009\ or\ 9{,}000\ (rounded)$

F9. Initial CARB Staff Estimate of the Distribution of Multifamily Housing Units by Building Size Between 2020 and 2025

Year		2020	2021	2022	2023	2024	2025	Total
2 Units	Low	9,455	9,280	9,324	9,222	9,216	9,337	55,834
	High	12,147	11,905	11,666	11,433	11,204	10,980	69,336
3 to 4 Units	Low	5,778	5,671	5,698	5,636	5,632	5,706	34,121
	High	7,423	7,275	7,129	6,987	6,847	6,710	42,372
5 to 9 Units	Low	6,829	6,702	6,734	6,660	6,656	6,744	40,325
	High	8,773	8,598	8,426	8,257	8,092	7,930	50,076
10 to 19 Units	Low	14,708	14,436	14,504	14,345	14,336	14,525	86,854
	High	18,896	18,518	18,148	17,785	17,429	17,081	107,857
20 to 29 Units	Low	7,879	7,733	7,770	7,685	7,680	7,781	46,529
	High	10,123	9,920	9,722	9,528	9,337	9,150	57,780
30 to 49 Units	Low	2,626	2,578	2,590	2,562	2,560	2,594	15,510
	High	3,374	3,307	3,241	3,176	3,112	3,050	19,260
50 Units	Low	5,253	5,156	5,180	5,123	5,120	5,187	31,019
	High	6,749	6,614	6,481	6,352	6,225	6,100	38,520
Total	Low	52,529	51,556	51,801	51,234	51,199	51,874	310,191
	High	67,486	66,136	64,814	63,517	62,247	61,002	385,202

F10. Adjusted CARB Staff Estimate of the Distribution of Multifamily Housing Units by Building Size Between 2020 and 2025 (Excluding Duplexes and Half of 3 to 4 Unit Buildings)

Year		2020	2021	2022	2023	2024	2025	Total
3 to 4 Units	Low	2,889	2,836	2,849	2,818	2,816	2,853	17,061
	High	3,712	3,637	3,565	3,493	3,424	3,355	21,186
5 to 9 Units	Low	6,829	6,702	6,734	6,660	6,656	6,744	40,325
	High	8,773	8,598	8,426	8,257	8,092	7,930	50,076
10 to 19 Units	Low	14,708	14,436	14,504	14,345	14,336	14,525	86,854
	High	18,896	18,518	18,148	17,785	17,429	17,081	107,857
20 to 29 Units	Low	7,879	7,733	7,770	7,685	7,680	7,781	46,529
	High	10,123	9,920	9,722	9,528	9,337	9,150	57,780
30 to 49 Units	Low	2,626	2,578	2,590	2,562	2,560	2,594	15,510
	High	3,374	3,307	3,241	3,176	3,112	3,050	19,260
50 Units	Low	5,253	5,156	5,180	5,123	5,120	5,187	31,019
	High	6,749	6,614	6,481	6,352	6,225	6,100	38,520
Total	Low	52,529	51,556	51,801	51,234	51,199	51,874	237,296
	High	67,486	66,136	64,814	63,517	62,247	61,002	294,680

Assumption: Duplexes and Half of 3 to 4 unit buildings are covered under single family housing provisions.

F11. CARB Staff Estimate of Smaller New Multifamily Housing Starts Constructed Between Years 2020 and 2025

Year	3 to 4 Units		5 to 9 Units		Total	
	Low	High	Low	High	Low	High
2020	2,889	3,712	6,829	8,773	9,718	12,485
2021	2,836	3,637	6,702	8,598	9,538	12,235
2022	2,849	3,565	6,734	8,426	9,583	11,991
2023	2,818	3,493	6,660	8,257	9,478	11,751
2024	2,816	3,424	6,656	8,092	9,472	11,516
2025	2,853	3,355	6,744	7,930	9,597	11,285
Total	17,061	21,186	40,325	50,076	57,385	71,262

F12. CARB Staff Estimate of Parking Spaces Installed in Smaller Multifamily Housing Starts

Year	3 to 4 Units		5 to 9 Units		Total	
	Low	High	Low	High	Low	High
2020	5,200	6,681	12,292	15,792	17,492	22,473
2021	5,104	6,547	12,064	15,476	17,168	22,023
2022	5,128	6,417	12,121	15,166	17,250	21,583
2023	5,072	6,288	11,989	14,863	17,061	21,151
2024	5,069	6,162	11,980	14,566	17,049	20,728
2025	5,135	6,039	12,138	14,274	17,274	20,314
Total	30,709	38,135	72,585	90,137	103,294	128,272

F13. CARB Staff Estimate of the Number of EV Capable Spaces in Smaller Multifamily Housing Starts Based on 10% Requirement

Year	3 to 4 Units		5 to 9 Units		Total	
	Low	High	Low	High	Low	High
2020	520	669	1,229	1,579	1,749	2,248
2021	510	655	1,206	1,548	1,716	2,203
2022	513	642	1,212	1,517	1,725	2,159
2023	507	629	1,199	1,486	1,706	2,115
2024	507	617	1,198	1,457	1,705	2,074
2025	514	604	1,214	1,427	1,728	2,031
Total	3,071	3,814	7,258	9,014	10,329	12,828

Summary of Statewide Benefit
Installing EV charging infrastructure during new construction can help to avoid significant retrofit costs in the future. CARB staff estimate a statewide benefit (avoided costs) of $229-310 million. The estimate is based on subtracting the statewide cost of $43 million to $76 million from the avoided retrofit costs of $272-386 million over a 6 year time period from the proposed 2020 effective date and a 2025 target date for EV charging infrastructure needed in multifamily housing. The information in Table F14 below is a summary of the more detailed statewide benefit outlined in Table F17.

Table F14. Overview of Estimated Statewide Benefit

Economic Impact Assessment	Cost per Space	Number of EV Capable Spaces	Estimate (Millions)
Avoided Retrofit Costs	$7,000-8,000	39,000 – 48,000	$272-386
Statewide Construction Costs	Varies	Varies	$43-76
Statewide Benefit (Avoided Costs)			**$229 – 310**

Basic Equation:

<u>Statewide Benefit:</u>

6. $Avoided\ Retrofit\ Costs - Statewide\ Construction\ Costs = Statewide\ Benefit$

   A. *<u>Where Avoided Retrofit Costs are calculated as follows:</u>*

$$\frac{Cost}{Space} \times Total\ Spaces = Avoided\ Retrofit\ Costs$$

Simplified Calculations for Statewide Benefit
Below are simplified estimates to demonstrate basic equations and calculations for the projected statewide benefit. Due to rounding error, please refer to Tables F16-F17 for a summary of the more detailed calculations. For more background on assumptions made for avoided retrofit costs, please refer to page 22 of this report.

6a. Low Range Estimate:

$$(\$7{,}000\ \times 38{,}869) - (\$43{,}000{,}000)\ \therefore$$
$$\$272{,}083{,}000 - \$43{,}000{,}000 = \$229{,}043{,}000\ or\ \$229\ million\ (rounded)$$

6b. High Range Estimate:

$$(\$8{,}000\ \times 48{,}269) - (\$76{,}000{,}000)\ \therefore$$
$$\$386{,}152{,}000 - \$76{,}000{,}000 = \$310{,}152{,}000\ or\ \$310\ million\ (rounded)$$

Table F15. Retrofit Costs to Install Level 2 Charging Stations

Level 2 - Single Station				
Type of Charger	**Installation Cost**	**Average Cost**	**Year**	**Source**
Public L2	60-80% of capital cost		May-14	Rocky Mountain Institute
L2 Parking garages	$6,000	$6,000	May-14	Rocky Mountain Institute
L2 Parking garages	$5,500	$5,500	Apr-14	Rocky Mountain Institute
Curbside L2	$9,100	$9,100	Apr-14	Rocky Mountain Institute
Public L2	$15,000-$18,000	$16,500	Apr-12	Clean Cities, U.S. Dept. of Energy
Public L2	$3,000-$15,000	$9,000	Oct-12	CNN article "Public Charging Stations Fuel Desire For Electric Cars"
Public L2	$2,000-$10,000	$6,000	Aug-12	UCLA Luskin Center for Innovation
Garage/street L2	$3,000-$8,000	$5,500	Aug-12	UCLA Luskin Center for Innovation
Public L2	$2,000-$8,000	$5,000	Dec-14	POWER Post "Furthering EV Adoption in Colorado Through EVSE Infrastructure Initiatives"
	Average Cost=	**$8,000**		
Level 2 - Multi Station				
Five L2 parking garage station	$4,200	$4,200	Apr-14	Rocky Mountain Institute
Dual L2 Curbside stations	$5,900	$5,900	Apr-14	Rocky Mountain Institute
General L2	(for 1st charger) $12,000; Plus $4000-$8000 per additional unit	$8,000	Aug-12	Clean Cities, U.S. Dept. of Energy
L2 Surface Lots	$7,461-$14,001	$10,731	Aug-17	Southern California Edison
	Average Cost=	**$7,000**		

Table F16. Avoided Retrofit Costs by Installing EV Charging Infrastructure in New Construction

Year	Incremental Difference in EV Capable Parking Spaces Installed		Avoided Retrofit Costs	
			Multiple Level 2 Installations	Single Level 2 Installation
			$7,000/Space	$8,000/Space
2020	Low	6,582	$46,075,610	$52,657,840
	High	8,456	$59,195,277	$67,651,746
2021	Low	6,460	$45,221,895	$51,682,166
	High	8,287	$58,011,372	$66,298,711
2022	Low	6,491	$45,437,042	$51,928,048
	High	8,122	$56,851,144	$64,972,736
2023	Low	6,420	$44,939,766	$51,359,733
	High	7,959	$55,714,122	$63,673,282
2024	Low	6,416	$44,908,756	$51,324,292
	High	7,800	$54,599,839	$62,399,816
2025	Low	6,500	$45,500,991	$52,001,133
	High	7,644	$53,507,842	$61,151,820
Total	Low	38,869	$272,084,061	$310,953,212
	High	48,269	$337,879,597	$386,148,110

Table F17. Statewide Benefit to Install Raceway and Panel Capacity in 10% of Parking Spaces in New Multifamily Housing

Year	Range	Statewide Construction Costs	Avoided Retrofit Costs	Benefit
2020	Low	$7,214,677	$46,075,610	$38,860,933
	High	$13,330,136	$67,651,746	$54,321,610
2021	Low	$7,080,205	$45,221,895	$38,141,690
	High	$13,062,184	$66,298,711	$53,236,526
2022	Low	$7,115,137	$45,437,042	$38,321,905
	High	$12,801,158	$64,972,736	$52,171,578
2023	Low	$7,036,429	$44,939,766	$37,903,338
	High	$12,544,787	$63,673,282	$51,128,495
2024	Low	$7,032,334	$44,908,756	$37,876,422
	High	$12,295,153	$62,399,816	$50,104,663
2025	Low	$7,125,756	$45,500,991	$38,375,235
	High	$12,047,814	$61,151,820	$49,104,006
Total	Low	$42,602,887	$272,084,061	$229,481,173
	High	$76,077,820	$386,148,110	$310,070,290

Summary of Additional Cost Estimates
Based on the statewide construction costs and projected number of multifamily housing starts subject to the proposed legislation, CARB staff estimated that the EV charging infrastructure provisions would add approximately $180-258 per new multifamily housing start. According to average costs per square foot, this would add between 0.1-0.6 percent to upfront costs per unit. CARB staff also calculated a cost effectiveness ratio of $13-20 per metric ton of carbon dioxide equivalent (CO2e).

Basic Equation:

<u>Additional Cost per Housing Unit:</u>

7. $$\frac{Statewide\ Construction\ Costs}{Multifamily\ Housing\ Starts} = Additional\ Cost\ per\ Unit$$

Simplified Calculations for Estimated Cost per Housing Unit
Below is a copy of the basic calculations for the estimated cost per housing unit. Table F18 provides a summary of these calculations.

7a. Low Range Estimate:

$$\frac{\$42{,}602{,}887}{237{,}296} = \$179.54\ or\ \$180\ (rounded)$$

7b. High Range Estimate:

$$\frac{\$76{,}077{,}820}{294{,}680} = \$258.17\ or\ \$258\ (rounded)$$

Table F18. Estimated Cost per Unit for All New Multifamily Housing Constructed Between 2020 and 2025

Range	Statewide Construction Costs	Multifamily Housing Starts	Additional Cost Per Unit
Low	$42,602,887	237,296	$ 180
High	$76,077,820	294,680	$ 258

Basic Equation:

<u>Percent of Average Cost per Unit:</u>

8. $$\frac{Additional\ Cost\ per\ Unit}{Average\ Cost\ per\ Unit} \times 100 = Percent\ of\ Average\ Cost\ per\ Unit$$

Simplified Calculations for Percent of Average Cost per Housing Unit
Below is a copy of the basic calculations for the estimated percent of average cost per new multifamily housing unit. Table F19 provides a summary of these calculations.

8a. Low Range Estimate:

$$\frac{\$258}{\$400{,}000} \times 100 = 0.0645\ or\ 0.1\ percent\ (rounded)$$

8b. High Range Estimate:

$$\frac{\$180}{\$30{,}000} \times 100 = 0.6\ percent$$

Table F19. Percent EV Charging Infrastructure Adds to the Cost of New Construction

Unit Size (Square Feet)	Average Cost (Per Square Foot)		Additional Cost of EV Charging Infrastructure as Percent of Average Cost Per Unit	
	Low	High	Low	High
	$60.00	$200.00		
500	$30,000.00	$100,000.00	0.6	0.3
1,000	$60,000.00	$200,000.00	0.3	0.1
1,500	$90,000.00	$300,000.00	0.2	0.1
2,000	$120,000.00	$400,000.00	0.1	0.1

Basic Equation:

<u>Cost Effectiveness Ratio:</u>

9. $$\frac{Statewide\ Construction\ Costs}{GHG\ Reductions} = Cost\ Effectiveness\ Ratio\ (\$/_{metric\ tons\ CO_2e})$$

Simplified Calculations for Cost Effectiveness Ratio

Below is a copy of the basic calculations for the cost effectiveness ratio. CARB staff divided the statewide construction costs over a 6 year period from 2020 to 2025 by the estimated GHG emission reductions over that same time frame. Table F20 provides a summary of these calculations.

9a. Low Range Estimate:

$$\frac{\$42{,}602{,}887}{3{,}276{,}000} = \$13.00/_{metric\ ton\ CO_2e}$$

9b. High Range Estimate:

$$\frac{\$76{,}077{,}820}{3{,}858{,}000} = \$19.72/_{metric\ ton\ CO_2e}\ or\ \$20/_{metric\ ton\ CO_2e\ (rounded)}$$

Table F20. Cost Effectiveness Ratio

Range	Cost	GHG Savings (Annual)	GHG Savings (2020-2025)	$/Metric Ton CO_2e
Low	$42,602,887	546,000	3,276,000	$13
High	$76,077,820	643,000	3,858,000	$20

Appendix G: Excerpt of Accessibility Provisions for Electric Vehicle Charging Stations (EVCS)

2016 California Building Code, Part 2, Chapter 11B

11B-208 Parking spaces

11B-208.1 General. Where parking spaces are provided, parking spaces shall be provided in accordance with Section 11B-208. *For the purposes of this section, electric vehicle charging stations are not parking spaces; see Section 11B-228.*

11B-228 Depositories, vending machines, change machines, mail boxes, fuel dispensers, *and electric vehicle charging stations.*

11B-228.3 Electric vehicle charging stations

11B-228.3.1 General. *Where electric vehicle charging stations (EVCS) are provided, EVCS shall be provided in accordance with Section 11B-228.3.*

> ***11B-228.3.1.1 Existing facilities.*** *Where new EVCS are added to a facility with existing EVCS, the requirements of Section 11B-812 shall apply only to the new EVCS installed. Alterations to existing EVCS shall comply with Section 11B-228.3.*
>
> ***11B-228.3.1.2 Operable parts.*** *Where EV chargers are provided, operable parts on all EV chargers shall comply with Section 11B-309.4.*

11B-228.3.2 Minimum number. *EVCS complying with Section 11B-812 shall be provided in accordance with Section 11B-228.3.2. Where EVCS are provided in more than one facility on a site, the number of EVCS complying with Section 11B-228.3.2 provided on the site shall be calculated according to the number required for each facility. Where an EV charger can simultaneously charge more than one vehicle, the number of EV chargers provided shall be considered equivalent to the number of electric vehicles that can be simultaneously charged.*

Exceptions:

1. *EVCS not available to the general public and intended for use by a designated vehicle or driver shall not be required to comply with Section 11B-228.3.2. Examples include, but are not limited to, EVCS serving public or private fleet vehicles and EVCS assigned to an employee.*

2. *In public housing facilities, EVCS intended for use by an EV owner or operator at their residence shall not be required to comply with Section 11B-228.3.2.*

11B-228.3.2.1 Public use or common use EVCS.
Where EVCS are provided for public use or common use, EVCS complying with Section 11B-812 shall be provided in accordance with Table 11B-228.3.2.1. Where new EVCS are installed in facilities with existing EVCS, the "Total Number of EVCS at a Facility" in Table 11B-228.3.2.1 shall include both existing and new EVCS.

> ***Exception:*** *All drive-up EVCS shall comply with Section 11B-812.*

TABLE 11B-228.3.2.1
ELECTRIC VEHICLE CHARGING STATIONS FOR PUBLIC USE AND COMMON USE

TOTAL NUMBER OF EVCS AT A FACILITY[1]	***MINIMUM NUMBER (by type) OF EVCS REQUIRED TO COMPLY WITH SECTION 11B-812[1]***		
	Van Accessible	***Standard Accessible***	***Ambulatory***
1 to 4	*1*	*0*	*0*
5 to 25	*1*	*1*	*0*
26 to 50	*1*	*1*	*1*
51 to 75	*1*	*2*	*2*
76 to 100	*1*	*3*	*3*
101 and over	*1, plus 1 for each 300, or fraction thereof, over 100*	*3, plus 1 for each 60, or fraction thereof, over 100*	*3, plus 1 for each 50, or fraction thereof, over 100*

1. *Where an EV charger can simultaneously charge more than one vehicle, the number of EVCS provided shall be considered equivalent to the number of electric vehicles that can be simultaneously charged.*

Appendix H: Greenhouse Gas (GHG) Emission Reduction Estimates

Table H1. GHG Reduction Potential for Installation of Level 2 Electric Vehicle Supply Equipment (EVSE) at EV Capable Spaces in Multifamily Housing by 2025

Variable	Units	Low Range Estimate of EV Spaces (43,000) & Grid Average Electricity Emission Factor[a]		High Range Estimate of EV Spaces (53,000) & Marginal Electricity Emission Factor[b]	
PEV Type		**PHEV**	**BEV**	**PHEV**	**BEV**
Electricity Emission Factor[1]	($MTCO_2e$/ MWh)	0.252	0.252	0.293	0.293
Fuel Economy of Electric Vehicle[2]	(kWh/mile)	0.25	0.25	0.25	0.25
Gasoline CO_2 Emission while Running[3]	(CO_2 gms/ mile)	295	295	295	295
Annual VMT Reduction per Parking Spot[4]	(miles/ charging station/year)	36,500	73,000	36,500	73,000
Number of EVCS		21,500	21,500	26,500	26,500
Annual VMT Reduction of All EVCS	(miles/year)	784,750,000	1,569,500,000	967,250,000	1,934,500,000
GHG Emissions of Gasoline Vehicles[5]	($MTCO_2e$)	231,266	462,532	285,049	570,097
GHG Emissions of Electric Vehicles[6]	($MTCO_2e$)	49,439	98,879	70,851	141,702
GHG Emissions Reduction[7]	($MTCO_2e$)	181,827	363,653	214,198	428,395
GHG Reductions per Charging Station Per Year	($MTCO_2e$)	8	17	8	16
TOTAL	**Annual VMT Reduction of All EVCS (miles/year)**	**2,354,250,000**		**2,901,750,000**	
	GHG Emissions of Gasoline Vehicles[5] ($MTCO_2e$)	**694,000**		**856,000**	
	GHG Emissions of Electric Vehicles[6] ($MTCO_2e$)	**149,000**		**213,000**	
	Total GHG Emissions Reduction[7] ($MTCO_2e$)	**546,000**		**643,000**	

Notes for Table H1:

[1] Carbon Dioxide Equivalent ($CO2_e$) Emission Factors

[a] 2020 Grid Average Electricity Emissions Factor with 33% RPS, Larry Hunsaker, CARB

[b] 2020 Marginal Electricity Emissions Factor, Dave Mehl, CARB

[2] U.S. Department of Energy, 2016, Benefits and Considerations of Electricity as a Vehicle Fuel. Available at: http://www.afdc.energy.gov/fuels/electricity_benefits.html. Accessed: February, 2017

[3] Using EMFAC 2014 Web Database, running exhaust emission rate for CO_2 for all light duty gasoline models and speeds, averaged over all seasons for 2020. Available at: http://www.arb.ca.gov/emfac/2014. Accessed: February, 2017

[4] Annual VMT reduction estimated based on an estimate for annual hours/year of charge time per charging station that charges at a rate of 20 mi/hour for BEV at Level 2, and 10 mi/hour for PHEV at Level 2

[5] GHG emissions calculated using annual VMT reductions at all stations and CO_2 emission rate. Methane and nitrous oxide are conservatively not included.

[6] GHG emissions calculated using annual VMT reductions at all stations, fuel economy of electric vehicle, along with electricity CO_2e emission factors. Nitrous oxide is conservatively not included.

[7] GHG emissions reduction is a difference of GHG emissions of gasoline vehicles and GHG emissions of electric vehicles. Nitrous oxide is conservatively not included.

Abbreviations:

CO_2e - carbon dioxide equivalent

EV - electric vehicle, including both plug-in hybrid electric vehicles (PHEVs) and battery electric vehicle (BEV)

EVCS – electric vehicle charging station(s)

GHG - greenhouse gas

gms - grams

kWh - kilowatt hour

MWh - megawatt hour

MT - metric ton

VMT - vehicle miles traveled

Table H2. Estimated Annual Energy Demand for Electric Vehicle Supply Equipment (EVSE) Installed in MUD EV Capable Spaces

Scenario	EVSE		Power (kW)[c]	Annual Hours	Annual (kWh)	Total Annual (MWh)
	Charger Type	Number of Spaces				
Low	L2 (PHEV)	21,500	3.3	5110	362,554,500	1,087,700
	L2 (BEV)	21,500	6.6	5110	725,109,000	
High	L2 (PHEV)	26,500	3.3	5110	446,869,500	1,340,700
	L2 (BEV)	26,500	6.6	5110	893,739,000	
Total						2,428,400

[c] https://www.fleetcarma.com/electric-vehicle-charging-guide/ 3.3 kW for PHEVs and 6.6 kW for BEVs

Table H3. Estimated Annual VMT Reduction EVSE Installed at MUD EV Capable Spaces

Scenario	EVSE		Annual Hours	Vehicle Onboard Charger Speed (Miles per Hour)	Annual VMT Reduction Per Parking Spot	Annual VMT Reduction for All Stations (miles/year)	Annual VMT Reduction per scenario (miles/year)
	Charger Type	Number of Spaces					
Low	L2 (PHEV)	21,500	3650	10	36,500	627,800,000	1,883,400,000
	L2 (BEV)	21,500	3650	20	73,000	1,255,600,000	
High	L2 (PHEV)	26,500	3650	10	36,500	773,800,000	2,321,400,000
	L2 (BEV)	26,500	3650	20	73,000	1,547,600,000	

Assumptions:

1) Annual hours are based on 10 hours per day.
2) Space occupancy is 80%.

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