# MODEL CITY ORDINANCE RELATING TO ELECTRIC VEHICLE (EV) CHARGING INFRASTRUCTURE

This document provides lawmakers, city planners and other stakeholders with a guide for updating building codes to address the growing need for electric vehicle charging infrastructure.

This guide discusses two scenarios for cities to consider: 1) a conservative requirement designed simply to meet bare minimum needs, and 2) a more progressive requirement designed to support growth in EV adoption with minimal need for future, costly retrofits. The codes are structured to address new parking construction and major renovations in residential and commercial buildings, with an emphasis on multi-unit dwellings (MUDs).

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# INTRODUCTION

## Electrical Vehicle Outlook

The global electric car stock surpassed 2 million vehicles in 2016[1] and is set to increase to 3 million by 2021[2]. Bloomberg New Energy Finance predicts that "EVs will account for 54% of all new light-duty vehicle sales globally by 2040…and we see a momentous inflection point for the global auto industry in the second half of the 2020s"

Throughout 2017, global automakers made numerous announcements regarding their efforts to electrify their product lineups. Volvo announced that every model it sells will have an electric motor by 2019. Hyundai and Kia made similar statements, sharing plans to launch eight new EV models by 2020. Volkswagen announced that it will have fifty electric models by 2030, and Daimler and BMW shared their electrification plans for 2022 and 2025, respectively. As of September 2017, Tesla received more than 450,000 reservations for its mass-market Model 3 electric vehicle. The future is electric, and hundreds of thousands of EVs will be delivered in the US over the next few years. It is critical that cities, states, building developers and workplaces take steps to ensure that EV charging is available and convenient for the coming wave of owners embracing this sustainable technology.

## Global push for GHG reduction using EV technology

The transportation sector accounts for 23% of global energy-related greenhouse gas emissions[1]. Several nations are making a push to end Internal Combustion Engine (ICE) vehicle sales and production in an effort to reduce GHGs and push transportation into the future through electrification, and to tackle air quality issues that are affecting the entire world. A study from MIT's laboratory for Aviation and the Environment found that transportation combustion emissions account for nearly 53,000 early deaths each year in the US alone[3]. In 2013, the International Agency for Research on Cancer (IARC) classified 'outdoor air pollution' as a cancer-causing agent (carcinogen), and includes emissions exhausts[4]. The most recent data from the Global Burden of Disease Project indicate that in 2010, 3.2 million deaths worldwide resulted from air pollution, including 223,000 from lung cancer.

In July 2017, both Britain and France announced they would end sales of gas and diesel cars by 2040, with India setting a date of 2030. Norway, with the highest EV penetration in the world (24% of cars are electric[5]) has announced an ICE car ban by 2025. China, the world's largest car market, also recently announced that they plan to end production and sales of traditional gasoline cars in the near future and Germany is considering similar goals. Closer to home, California has a goal to have 1.5 million Zero-Emission Vehicles (ZEVs) on the road by 2025 and enough charging infrastructure to support 1 million ZEVs by 2020. These international and national goals emphasize a clear focus to reduce of GHG emissions through increased global EV adoption.

[1] IEA Global EV Outlook 2017
[2] Bloomberg New Energy Finance
[3] http://www.sciencedirect.com/science/article/pii/S1352231013004548?via%3Dihub
[4] https://www.cancer.org/latest-news/world-health-organization-outdoor-air-pollution-causes-cancer.html
[5] http://www.hybridcars.com/top-10-plug-in-vehicle-adopting-countries-of-2016/

## The role of charging infrastructure in mass EV adoption

While automakers and governments around the world continue to push for greater EV adoption, EV charging infrastructure is quickly becoming the most significant barrier to growth in this segment. The International Energy Agency has found that:

> ***"The availability of chargers emerged as one of the key factors for contributing to the market penetration of EVs. Ensuring the availability of chargers is also essential for enabling the diversification of the transport fuel mix and catalyzing its transition towards clean energy"*** [6]

Unlike gasoline car owners, charging behavior for EV owners indicate that more than 80% of EV drivers charge their cars at home or at work. In addition, housing trends show that a larger share of the general US population is moving out of single-family homes and into cities with high density, multi-unit dwellings (MUDs). In 2015, 40% of all new construction in the US was multi-unit dwellings.[7]

## EV infrastructure capacity & construction cost savings

The accessibility of EV chargers in MUDs, and the ability to connect future Electric Vehicle Supply Equipment (EVSE) in parking structures, is critical to the adoption of EVs. Earlier this year, a federal working group for Natural Resources Canada examining EV infrastructure readiness found that:

> *"**The most significant barrier presented by MUDs is the common lack of electrical [power] capacity and distributed subpanels to support broad EVSE deployment.** We have seen that a lack of access to home charging is a significant barrier to EV adoption that must be addressed… Among existing dwellings, multi-unit dwellings deserve priority attention. EV charging in MUDs often have two key issues associated with them: first, insufficient power capacity; and second, restrictive decision making processes that limit a resident's ability to install a charging station."*

The issues referenced above can be mitigated for new MUDs if appropriate <u>building codes</u> are established to provide for both current and future power capacity needs.

For the most part, developers are not including EV charging in new condominium and apartment construction today. As a result, condominium owners and apartment landlords are facing costly electrical upgrades as the transition to electric mobility accelerates. **Retrofit costs for customer-side EV infrastructure can range from $3,600 to over $10,200 excluding the EVSE,** depending on the configuration and complexity of the parking structure.

A study conducted by Energy Solutions and Pacific Gas and Electric Company[8] prior to building standard changes in San Francisco, in addition to data from Southern California Edison's EV infrastructure retrofitting program demonstrate that 1) installing EV infrastructure at the time of construction can be 91% less expensive than post construction retrofits and 2) per stall installation costs can be reduced through economies of scale deploying more stations at time of construction. See Exhibit 1.

[6] https://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf
[7] http://www.nmhc.org/Apartment-Industry-Quick-Facts/
[8] Energy Solutions & Pacific Gas and Electric (November 2016), "Plug-in Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco."

***Exhibit 1:*** *Cost of installing charging station infrastructure before and after construction.*

| **Scenario** | **Cost Per EV Parking Space With 40A Circuit (excl. EVSE)** | |
|---|---|---|
| | **New Build** | **Retrofit**[9] |
| 5-10 EV spaces | $920 | $10,273 |
| 26+ EV spaces | $860 | $3,634 |
| *Source: Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco" and "SCE Charge Ready Advisory Board 5th Meeting – Slide 11) All costs in $USD.* | | |

*Note: These values only represent the customer-side make-ready infrastructure costs, and do not include the cost of EVSE, which range from $400 to over $6500 for a single-port Level-2 unit*[10]

## Electrical Capacity requirements

The time it takes to charge an EV is a key consideration for consumers. It can take up to 50+ hours for a typical 50kWh, 200+ mile range EV to fully charge using the standard Level 1 (110V) outlet found in most homes. Level-2 (240V) power reduces charging times to under 8 hours, which represents a reasonable overnight or workday charge time. Level-2 charging adds ~25 miles of range per hour, and is the preferred charging solution in MUDs, workplaces and commercial locations. Level-3 chargers are high-power chargers typically located along major freeway routes between cities, and are capable of returning a battery to nearly full capacity in under one hour.

Since the majority of charging occurs at home or at work (80%[11]), ensuring that Level-2 charging is available in residential and workplace parking structures provides an additional sense of reliability and convenience for current and future EV drivers. Thus, designing new MUDs for this type of charging equipment is vital. Exhibit 2 demonstrates the different charging times associated with each class of charging equipment:

***Exhibit 2:*** *EV charging levels explained*

| Level of Service | Type of Charge | Typical Power Rating* | Time to charge a new generation battery EV | Driving distance added per hour |
|---|---|---|---|---|
| **Level 1** | Trickle charge | 1 - 1.4 kW | 50(+) hours | 3.3 miles |
| **Level 2** | Standard charge | 7.7 kW | 8 hours | 30 miles |
| **Level 3** | Fast charge (DC) | 50-150+ kW | ½ to 1 hour. | 125 - 400 miles |

[9] Southern California Edison 'Charge Ready' Program Advisory Meeting #5 (August 2017) – Slide 11
[10] https://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf
[11] https://www.inl.gov/article/charging-behavior-revealed-large-national-studies-analyze-ev-infrastructure-needs/

## Building codes as a pathway to EV Readiness

State and local governments can take steps to address the shortage of EV charging infrastructure by including EV readiness requirements in new building codes. California's CalGreen code outlines basic elements for EV-readiness, however, cities such as San Francisco and Palo Alto have recognized that the CalGreen code is not adequate to meet current or future EV demand, and have taken steps to increase EV readiness requirements.

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# DEFINITIONS

For the purposes of this section, the following definitions shall apply:

*EVSE mounted alongside a connected meter*

**EVSE (electric vehicle supply equipment) –** EVSE consists of all the equipment needed to deliver electrical energy from an electricity source to charge a PEV's battery. It communicates with the PEV to ensure that an appropriate and safe flow of electricity is supplied.

**Level 2 EVSE** - "Level 2 EVSE" shall mean an EVSE capable of charging at 40 amperes or greater at 208 or 240V AC.

**Panel –** The electrical panel (also known as breaker panel, service panel, or load center) is a box containing the circuit breakers that are wired to circuits that distribute power to the EVSE. The circuit breakers turn the power to the EVSE on and off to protect equipment from damage in the event of an electrical short or overcurrent. The circuit breaker is also used to turn off power to the EVSE when it is being serviced.

**Conduit -** The electrical conduit is a tube or piping system for enclosing electric wiring. If the conduit needs to be placed underground for EVSE installation, then the installation will require trenching or boring

*Electrical Panel (NYSERDA)*

**"EV Ready"** or **"EV Make-Ready"** - Refers to a parking space that includes the following components; listed raceway (conduit), sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable termination points such as a junction box with a service loop or directly landed within an EVSE (i.e. Full Circuit)

**"EV Capable"** - Refers to parking spaces that have electrical capacity (breaker space) allocated in a local subpanel to accommodate future EVSE installations

**Major Alterations** - "Major Alterations" and "additions" are where interior finishes are removed and significant upgrades to structural and mechanical, electrical, and/or plumbing systems are proposed, where areas of such construction are 25,000 gross square feet or more.

*   *   *

# SUMMARY OF ‘CORE’ EV INFRASTRUCTURE REQUIREMENTS

There are several core building requirements that would make a building ready to accommodate EV charging and fulfil the inevitable future electrical demand of EV drivers within the building:

1. **Specify that pre-installed charging spaces in multi-unit buildings operate at a minimum service “Level 2” at 208V/40A or 240V/40A**

    - **Justification:** Modern EVs have greater battery capacity and require longer charge times (See Exhibit 2). As such, charging service “Level-2” should be the standard for MUDs. While Level-1 equipment may be sufficient for plug-in hybrids of the past, this is not the case for current and future vehicle offerings with 200+ miles of range. Level 2 charging capacity allows cars to charge fully in 4-7 hours which is reasonable for overnight charging.

    - **Cities that have adopted this requirement:** San Francisco, Oakland, Fremont, Palo Alto

2. **Require that main electrical switchgear be installed with sufficient space and capacity to support 20% of EV spaces at 208/240V and 40A per space, with a dedicated branch circuit and overcurrent protection device, per space.**

    - **Justification:** Retrofitting parking structures can be 91%+ more expensive than outfitting garages during the initial construction phase. With the useful life of new buildings estimated at around 50 years[12], parking structures built today will ultimately transition to 100% electric vehicles. With this in mind, it is crucial to build EV capacity at the pre-construction stage so as to take advantage of the opportunity to avoid future retrofit costs. The 20% capacity requirement proposed in this document provides a balance between up-front spending and long-term avoidance of retrofit costs. Under this scenario, buildings would be outfitted to support additional EV drivers beyond the 20% figure, with minimal additional cost. Specifically, a 20% minimum allows for an *entire parking garage of EVs* to charge at once, within a reasonable timeframe, using basic load management software (~3 hours to fill the national daily commute of 30 miles[13] and up to 10 hours for a 100 to 200 mile charge, depending on the number of cars). Any lower capacity than 20% will result in sub-optimal charging times and may prevent future EV-owning residents from undertaking the additional retrofits required to add additional charging capacity (Point #3 below).

    - **Cities that have adopted this requirement:** Atlanta (20%)**,** Palo Alto (25%), San Francisco (20%), Oakland (20%)

3. **Require that all parking spaces in a parking structure be made “EV-Capable” i.e. conduit be installed throughout the structure and subpanels sized to accommodate 60A or 40A breakers for each. In deeded structures, require that no stall be more than 100ft from any subpanel**

    - **Justification:** By requiring that at least 20% of stalls are “EV-Ready” (Point #2 above), the total electrical capacity is able to be shared among the remaining 80% of EV parking stalls using *load sharing technology*. However, this is only possible if the electrical conduit (trunk line) and subpanels are pre-installed throughout the parking garage to allow Level-2 Charging Equipment to be connected in the future.
    - **Cities that have adopted this requirement:** San Francisco, Oakland, Palo Alto

[12]http://www.ey.com/Publication/vwLUAssets/Depreciation_on_buildings/%24FILE/1022184%20Depreciation%20on%20Buildings%20September%202010%20FINAL.pdf
[13]http://newsroom.aaa.com/2015/04/new-study-reveals-much-motorists-drive/

# EV-READINESS - CHARGING CAPACITY PROJECTIONS

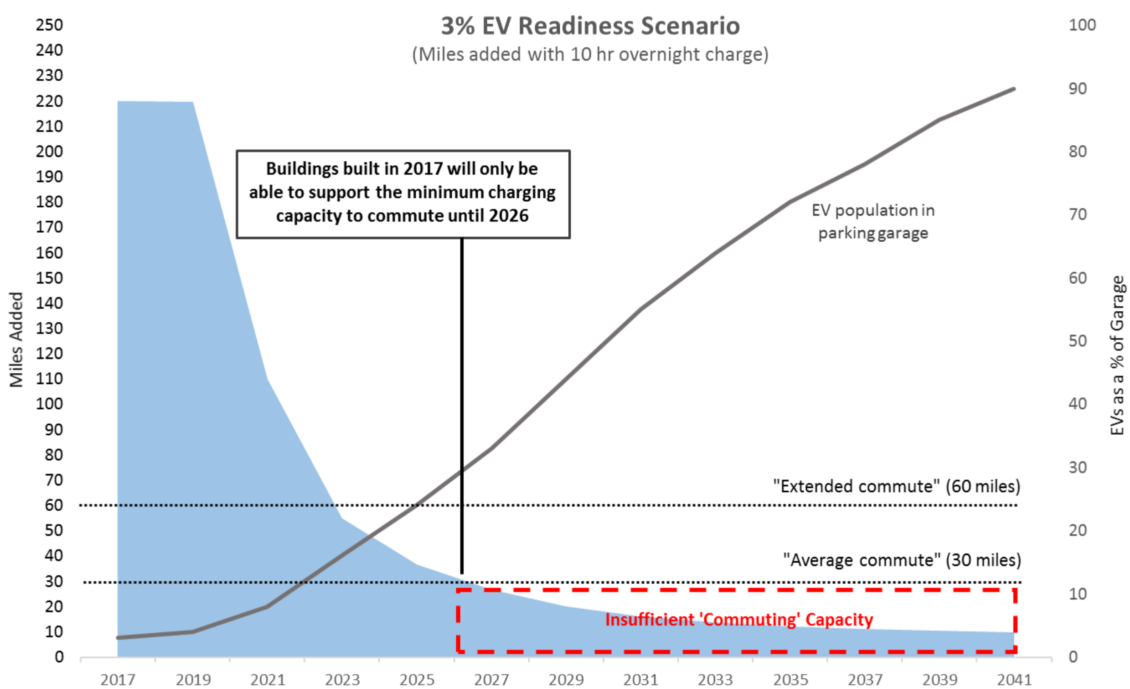
## SCENARIO:

This section describes three EV-readiness scenarios (3%, 20% and 50%) in a 100-space parking garage with 100% EV capability (i.e. wiring exists for all spaces) wherein drivers are charging overnight (10 hours) using Level-2 charging. These scenarios assume a best case with respect to *connectivity*, wherein **all parking spaces have the ability to charge an EV**. They also assume a worst-case scenario with respect to the *state of charge* of EVs, wherein **all EVs have an almost depleted battery** at the start of the charge session. The latter situation occurs when drivers return home from long trips.

## PROJECTIONS AND OUTCOMES:

By 2025, EV drivers will be unable to recharge their daily commute in parking structures that only comply with California's state-wide 3% EV readiness minimum (see Exhibit 3). In a parking structure with 20% EV readiness capacity, the power available is sufficient to fulfil the daily commute for all drivers beyond 2041 (Exhibit 4). At 50% EV readiness, almost all 100 EVs can be supplied with a full 200+ mile range overnight charge by 2041, and all EVs will have extended commuting range charging capacity (Exhibit 5). The 50% scenario will become necessary as automated vehicle technology advances, allowing for vehicles to provide ride-sharing services throughout the day and dramatically increasing the number of miles needed to recharge overnight.

***Exhibit 3:*** *Charging Capacity projection of a 100-space parking garage under a 3% EV Readiness (3% Electrical Capacity) requirement scenario, with all EV's charging simultaneously*[14]




[14] Assumptions:

- Parking garage is 100% EV Capable (i.e. all new EVs coming into the garage can connect and charge immediately)
- Level 2 charging capacity of 32Amps continuous (40A breaker) at 240V. Maximum output of connector is 7.7kW
- 50kW battery EVs (200-220 mile range)
- Average national daily commute = 30 miles (http://newsroom.aaa.com/2015/04/new-study-reveals-much-motorists-drive/)
- EV growth numbers mirror the EV sales percentages projected in the Bloomberg New Energy Finance 'Electric Vehicle Outlook 2017

***Exhibit 4:*** *Charging Capacity projection of a 100-space parking garage under a 20% EV Readiness (20% Electrical Capacity) requirement scenario, with all EV's charging simultaneously*

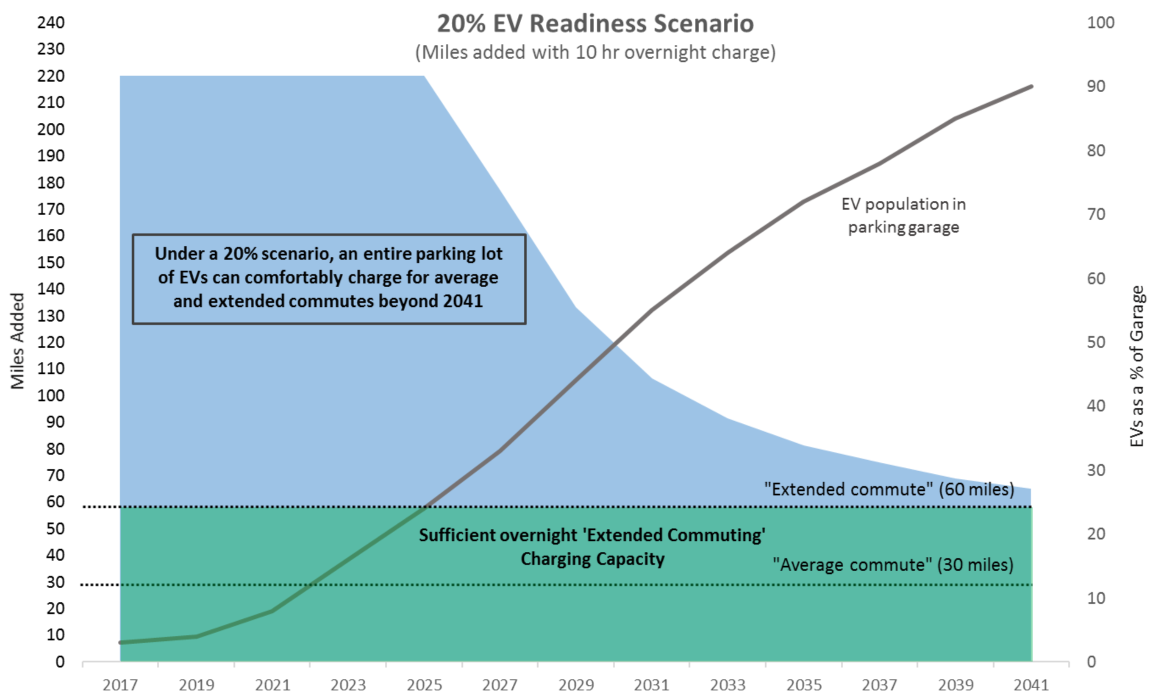



***Exhibit 5:*** *Charging Capacity projection of a 100-space parking garage under a 50% EV Readiness (50% Electrical Capacity) requirement scenario, with all EV's charging simultaneously*

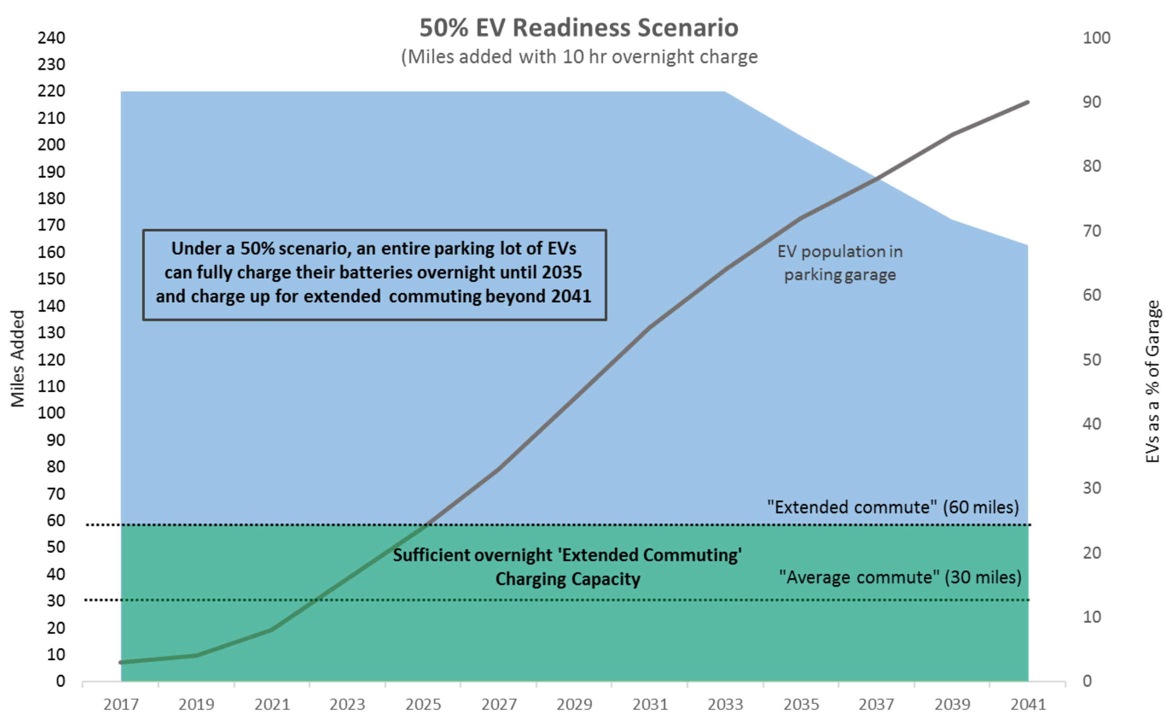
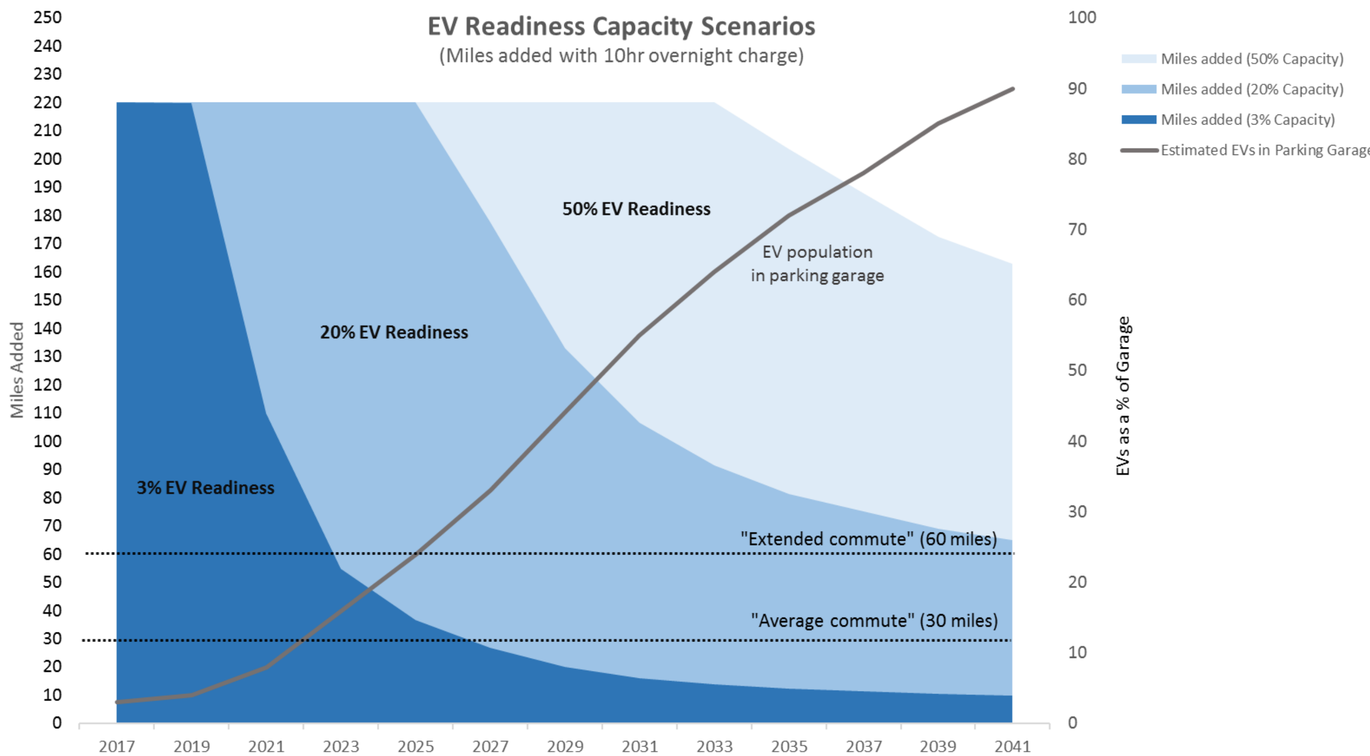


***Exhibit 6:*** *Charging Capacity projections of a 100-space parking garage under 3%, 20% and 50% EV Readiness requirement scenarios, with all EV's charging simultaneously*

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# PROGRESSIVE ORDINANCE IDEAS (2017)

The first part of this document outlined a baseline, conservative ordinance proposal of 20% EV readiness. If a jurisdiction is targeting higher EV adoption, it should consider incorporating the language provided in this *"Progressive"* ordinance section. Progressive ordinances have expanded criteria for the following metrics, however, these are no means the only parameters that can be targeted:

Summary of Progressive Ordinances:

- Higher Amperage (60A+)
- Electrical Capacity Requirements to support 50%+ of spaces
- Conduit/Raceway throughout entire parking structure (100% EV Capability)
- Residential MUD 'Common Space' EV space requirements etc.

## Additional Progressive Ordinances Ideas:

1. Require that 50% of Parking Spaces be made "EV-Ready" [Vancouver]
2. Circuits and Overprotective devices shall remain reserved exclusively for EV charging [San Francisco]
3. Where parking spaces are provided for public use or for common use, at least one EV space shall be located in common use areas and available for use by all residents. [San Francisco]

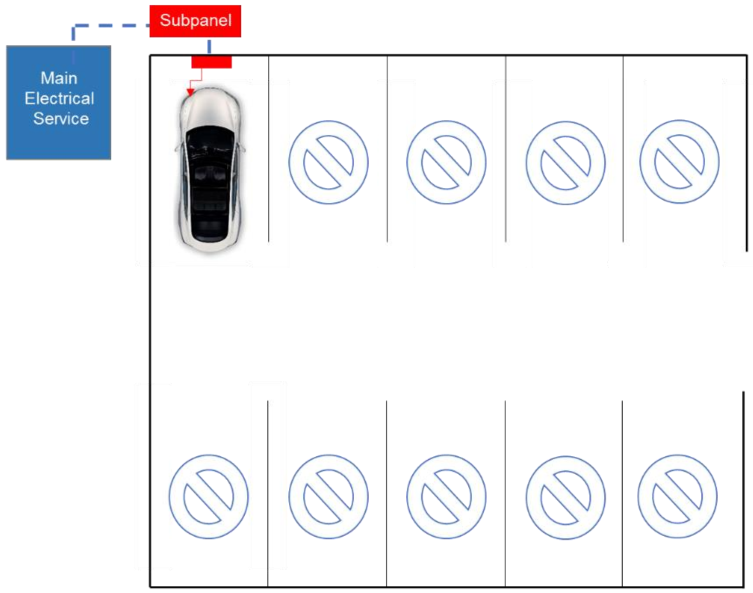
## Multi-Unit Residential/Commercial - EV Infrastructure Summary Table

| | Core | Progressive |
|---|---|---|
| ***Electrical Capacity*** | 208/240V capacity, 40A breaker per space | 208/240V capacity, 60A breaker per space |
| ***Panels*** | Space to accommodate one 40A breaker, per EV space, for 20% of spaces | Space to accommodate one 60A breaker, per EV space, for 50% of spaces |
| ***Parking Spaces & EV Capability (Deeded)*** | EV-ready Infrastructure for 20% of total spaces. Subpanels within 100ft of each EV stall. | EV-ready Infrastructure for 50% of total spaces. Subpanels within 100ft of each EV stall. |
| ***Parking Spaces & EV Capability (Non-Deeded)*** | EV-ready Infrastructure for 20% of total spaces | EV-ready Infrastructure for 50% of total spaces |
| ***Automatic Load Management*** | No difference | No difference |
| ***Major Alterations*** | 50% of the total number of off-street parking spaces shall be made EV-ready | 100% of the total number of off-street parking spaces shall be made EV-ready |
| ***Common Space*** | N/A | Where parking spaces are provided for common-use by 3 residents, at least 1 EV space shall be allocated |

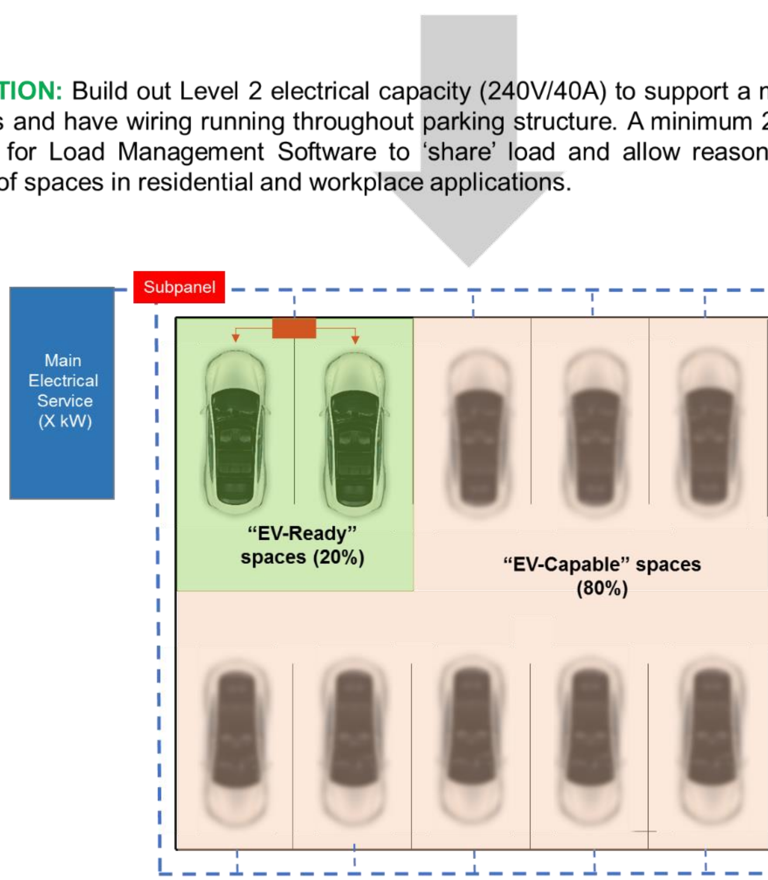
# ELECTRICAL CAPACITY & LOAD MANAGEMENT

**Objective (Non-Deeded Parking):** Concentrating charging stalls near new or existing electrical service and having sufficient electrical capacity for 20% (minimum) of parking stalls and sufficient connectivity for 100% of stalls

**PROBLEM (Non-Deeded Parking):** A typical Multi-Unit building parking structure has little to no electrical capacity available for Electric Vehicles. The first EV owner(s) face high installation costs and will not be incentivized to aid expansion of capacity to additional EV owners. This results in charging capacity (breaker space) being available to the initial EV owners only.




**SOLUTION:** Build out Level 2 electrical capacity (240V/40A) to support a minimum of 20% of EV spaces and have wiring running throughout parking structure. A minimum 20% electrical capacity allows for Load Management Software to 'share' load and allow reasonable charge times for 100% of spaces in residential and workplace applications.




Using Load Management Software, the main service is now sufficient to serve:

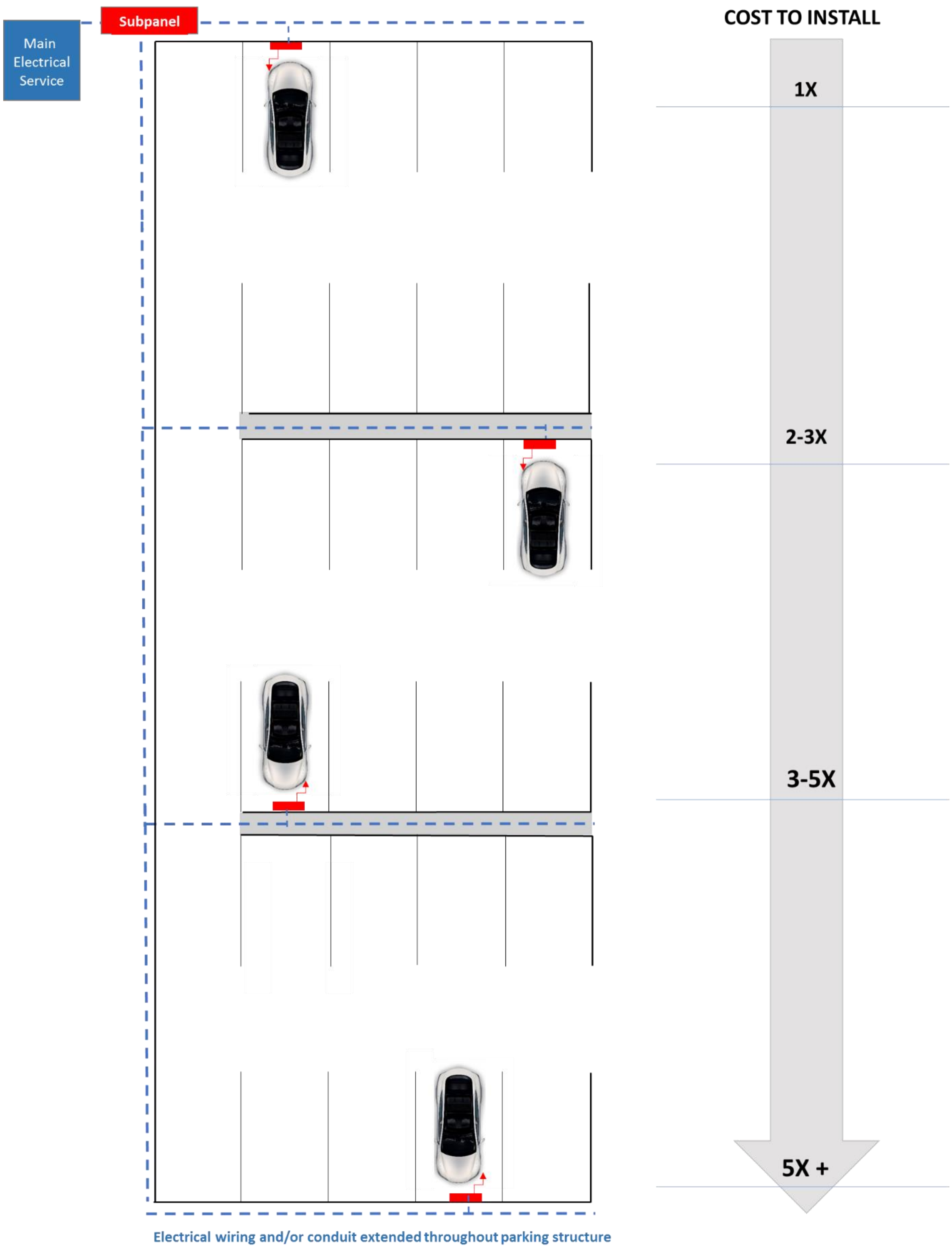
- 20% of cars @ 240V/40A = X kW
- 100% of cars @ 240V/40A = X/5 kW

This means that in the event that 100% of cars need to charge at once, they would all be able to add enough range for a daily commute in 5 hours or less.

Electrical wiring and/or conduit can be extended throughout parking structure at for remaining 80% of cars as long as panel breaker space exists (EV-Capability)

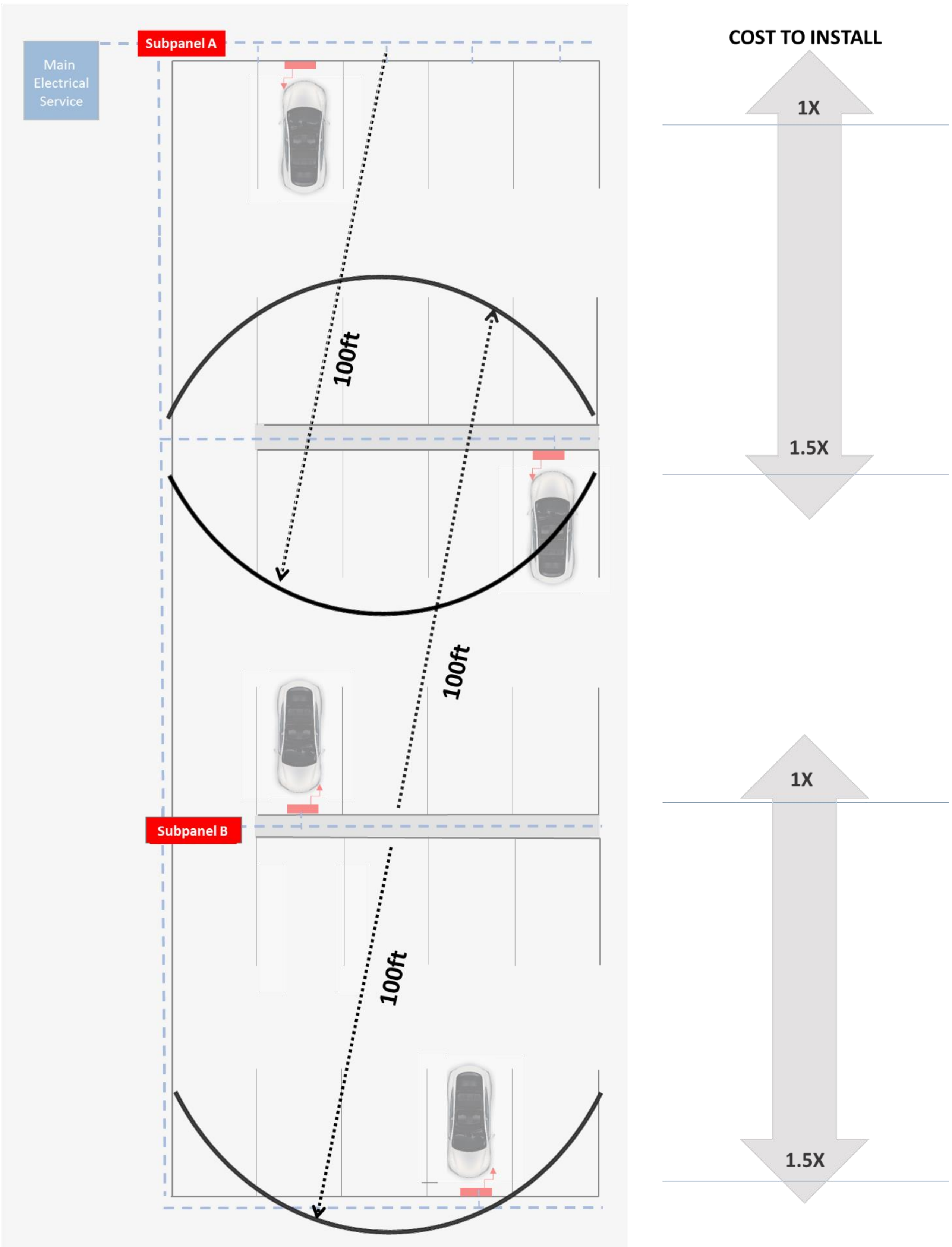
**Objective (Deeded parking):** Ensure sufficient electrical capacity for 20% of parking stalls, connectivity and breaker space for 100% of stalls, and equitable access to power, for all stalls

**PROBLEM (Deeded Parking)** – In addition to lack of electrical capacity (as in deeded parking before) there is an issue with EV charging station access to subpanels. If only one subpanel exists, the cost of connection/wiring increases the further away you are from the panel. Therefore the furthest parking space from the panel pays the most to connect (i.e. Inequitable installation costs)



**Objective (Deeded parking):** Ensure sufficient electrical capacity for 20% of parking stalls, connectivity and breaker space for 100% of stalls, and equitable access to power, for all stalls

**SOLUTION (Deeded Parking)** – Multiple subpanels within 100ft of each parking space normalizes the cost of connection/wiring across every parking space (i.e. Equitable installation costs)



# EV INFRASTRUCTURE MODEL ORDINANCE LANGUAGE

## *CORE REQUIREMENTS*

### PREFACE

Newly constructed single family, multifamily residential, non-residential/commercial 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 aforementioned structures undergoing major alterations and/or additions, where "major alterations" and "additions" are where interior finishes are removed and significant upgrades to structural and mechanical, electrical, and/or plumbing systems are proposed, shall also comply with the following requirements for EVSE.

All parking space calculations under this section shall be rounded up to the next full space.

### SINGLE FAMILY & SMALL MULTI-UNIT (<3 UNIT) RESIDENCES

This section applies to new, one to three family dwellings and town-houses with attached or adjacent private garages or carports.

**Electrical Capacity and Panel Requirements:**

(a) Branch circuit panelboard(s) shall be installed with capacity to support one, 2 pole, 40-Amp 208/240-Volt circuit *for each parking space* as specified. Construction documents shall verify that the main electrical service, including any on-site or utility distribution transformer(s), switchgear and raceway, have sufficient capacity to simultaneously provide 32-Amp continuous current per required EV space (i.e. a 40A breaker at 80% rating)

(b) The panelboard(s) shall have sufficient space to install a minimum of one 40-Amp dedicated branch circuit and overcurrent protective device *per EV Space*. The circuits and overcurrent protective devices shall remain reserved exclusively for EV charging.

**EV Parking Space Requirements:**

(a) Each parking space shall include the following 'make-ready' infrastructure shall include the following components with a minimum of 40-Amp 208 or 240 Volt capacity per EV Space (i.e. EV Ready); listed raceway, sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable termination points such as a junction box with a service loop or directly landed within an EVSE. The termination points shall be in close proximity to the proposed EV charger locations.

(b) Where parking spaces are deeded, no parking space shall be located more than 100 feet from a supporting electrical supply panel.

## RESIDENTIAL MULTI UNIT DWELLINGS (3+), NON-RESIDENTIAL/COMMERCIAL BUILDINGS AND MAJOR ALTERATIONS

This chapter shall apply to all new construction and major alterations of a building with three or more multifamily dwellings and shall be required install at least the following levels of Electric Vehicle (EV) infrastructure:

**Electrical Capacity and Panel Requirements:**

(a) Branch circuit panelboard(s) shall be installed with capacity to support one, 2 pole, 40-Amp 208/240-Volt circuit *for each parking space* as specified. Construction documents shall verify that the main electrical service, including any on-site or utility distribution transformer(s), switchgear and raceway, have sufficient capacity to simultaneously provide 32-Amp continuous current per required EV space (i.e. a 40A breaker at 80% rating)

(b) The panelboard(s) shall have sufficient space to install a minimum of one 40-Amp 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 "Panelboards" 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.

**EV Parking Space Requirements [NON-DEEDED PARKING]:**

(a) For a minimum of 20% of EV Spaces, install 'Make-Ready' infrastructure with a minimum of 40-Amp 208 or 240 Volt capacity per EV Space (i.e. EV Ready).

Make-Ready infrastructure shall include the following components; listed raceway, sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable termination points such as a junction box with a service loop or directly landed within an EVSE. The termination point shall be in close proximity to the proposed EV charger location.

(b) Calculations for the number of EV Spaces shall be rounded up to the nearest whole number as per the table X below:

Table X**:**

| NUMBER OF SPACES | EV MAKE-READY INFRASTRUCTURE AND OPTIONAL EVSE INSTALLED IN: | ELECTRICAL PANEL CAPACITY (240V/40A) FOR: |
|---|---|---|
| 20+ | 20% of parking spaces | 20% of Parking spaces |
| 16-20 | 4 parking spaces | 20% of Parking spaces |
| 11-15 | 3 parking spaces | 20% of Parking spaces |
| 2-10 | 2 parking spaces | 20% of Parking spaces |
| 1 | 1 parking space | N/A |

**EV Parking Space Requirements [DEEDED PARKING]:**

(a) Electrical raceway to the electrical supply panel serving the garage shall be capable of providing a minimum 40-Amp 208/240-Volts of electrical capacity to at least 20% of the parking space of the garage.

The Electrical Room supplying the garage must have the electrical capacity and physical space for an electrical supply panel sufficient to provide 2-pole, 40-Amp 208/240-Volts electrical capacity to at least 20% of the parking spaces of the garage.

Where parking spaces are deeded to residential or commercial occupants, no parking space shall be located more than 100 feet from a supporting electrical supply panel.

The relevant supply panel should be on the same parking level or easily accessible. Each panel shall have electrical capacity to support the total garage supply allocated to electric vehicles or 40A per parking space supported by that panel, whichever is lower, and physical breaker space to support all parking spaces supported by that panel[15]

**Automatic Load Management:**

(a) The intent of sizing EVSE electrical service to provide 40-Amp at 208 or 240 Volts to at least 20% of spaces simultaneously is to provide the option to utilize Automatic Load-Management Systems to provide Level 2 EV charging to 100% of parking spaces in the future, as described in NEC 625.41 (2014).

A listed Automatic Load Management system manages the available capacity in a safe manner, such as allocating 40-Amp at 208 or 240 volts to vehicles to 20% of the total number of EV Charging Stations simultaneously, or allocating 8-Amperes to vehicles to 100% of parking spaces at once, or similar. Given the capacity required by this Section,

[15] This language important for a parking structure with multiple subpanels (that may be on multiple floors). The 'whichever is lower' language allows for subpanels that may only need to support less than 20% electrical capacity

individual EV chargers may be installed in up to 20% of parking spaces before an EV load management system is necessary.

**Major Alterations:**

(a) Where three or more (i.e. 3+) multifamily dwelling units are constructed on a building site, or undergo major alteration, 50% of the total number of off-street parking spaces shall be 'make-ready' for electric vehicle charging spaces (EV Spaces) capable of supporting EVSEs and shall conform to the electrical capacity and panel specifications defined in *Electrical Capacity and Panel Requirements*

* * *

# EV INFRASTRUCTURE MODEL ORDINANCE LANGUAGE

## *PROGRESSIVE REQUIREMENTS*

### PREFACE

Newly constructed single family, multifamily residential, non-residential/commercial 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 aforementioned structures undergoing major alterations and/or additions, where “major alterations” and “additions” are where interior finishes are removed and significant upgrades to structural and mechanical, electrical, and/or plumbing systems are proposed, shall also comply with the following requirements for EVSE.

All parking space calculations under this section shall be rounded up to the next full space.

### SINGLE FAMILY & SMALL MULTI-UNIT (<3) RESIDENCES

This section applies to new, one to three family dwellings and town-houses with attached or adjacent private garages or carports.

**Electrical Capacity and Panel Requirements:**

(c) Branch circuit panelboard(s) shall be installed with capacity to support one, 2 pole, 60-Amp 208/240-Volt circuit *for each parking space* as specified. Construction documents shall verify that the main electrical service, including any on-site or utility distribution transformer(s), switchgear and raceway, have sufficient capacity to simultaneously provide 48-Amp continuous current per required EV space (i.e. a 60A breaker at 80% rating)

(d) The panelboard(s) shall have sufficient space to install a minimum of one 60-Amp dedicated branch circuit and overcurrent protective device per EV Space. The circuits and overcurrent protective devices shall remain reserved exclusively for EV charging.

**EV Parking Space Requirements:**

(c) Each parking space shall include the following EV ‘make-ready’ infrastructure with a minimum of 60-Amp 208 or 240 Volt capacity per EV Space (i.e. EV Ready); listed raceway, sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable termination points such as a junction box with a service loop or directly landed within an EVSE. The termination point shall be in close proximity to the proposed EV charger location.

Where parking spaces are deeded, no parking space shall be located more than 100 feet from a supporting electrical supply panel.

## RESIDENTIAL MULTI UNIT DWELLINGS (3+), NON-RESIDENTIAL/COMMERCIAL BUILDINGS AND MAJOR ALTERATIONS

This chapter shall apply to all new construction and major alterations of a building with three or more multifamily dwellings and shall be required install at least the following levels of Electric Vehicle (EV) infrastructure:

**Electrical Capacity and Panel Requirements:**

(a) Branch circuit panelboard(s) shall be installed with capacity to support one, 2 pole, 60-Amp 208/240-Volt circuit *for each parking space* as specified. Construction documents shall verify that the main electrical service, including any on-site or utility distribution transformer(s), switchgear and raceway, have sufficient capacity to simultaneously provide 48-Amp continuous current per required EV space (i.e. a 60-Amp breaker at 80% rating)

(b) The panelboard(s) shall have sufficient space to install a minimum of one 60-Amp dedicated branch circuit and overcurrent protective device per EV Space up to a minimum of 50% 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 above 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.

**EV Parking Space Requirements [NON-DEEDED PARKING]:**

(a) For a minimum of 50% of EV Spaces, install ‘Make-Ready’ infrastructure with a minimum of 60-Amp 208 or 240 Volt capacity per EV Space (i.e. EV make-ready).

Make-Ready infrastructure shall include the following components; listed raceway, sufficient electrical panel service capacity, overcurrent protection devices, wire, and suitable termination points such as a junction box with a service loop or directly landed within an EVSE. The termination point shall be in close proximity to the proposed EV charger location.

(b) For the remaining parking spaces, install subpanels and supporting infrastructure throughout the parking facility to enable future growth. Subpanels shall be sized appropriately to accommodate 60-Amp breakers for each stall that the panel would service if 100% of stalls were connected in the future, at Level-2 standards (i.e. EV-Capable). Subpanels shall be connected to an appropriate mounting location for future EV charging equipment using trade-size 1 conduit.

(c) Calculations for the number of EV Spaces shall be rounded up to the nearest whole number as per the table X below:

Table X:

| NUMBER OF SPACES | MAKE-READY INFRASTRUCTURE AND OPTIONAL EVSE INSTALLED IN: | ELECTRICAL PANEL CAPACITY (240V/40A) FOR: |
|---|---|---|
| 20+ | 50% of parking spaces | 50% of Parking spaces |
| 16-20 | 10 parking spaces | 50% of Parking spaces |
| 11-15 | 7 parking spaces | 50% of Parking spaces |
| 2-10 | 5 parking spaces | 50% of Parking spaces |
| 1 | 1 parking space | N/A |

**EV Parking Space Requirements [DEEDED PARKING]:**

(a) Electrical raceway to the electrical supply panel serving the garage shall be capable of providing a minimum 40-Amp 208/240-Volts of electrical capacity to at least 50% of the parking space of the garage.

The Electrical Room supplying the garage must have the electrical capacity and physical space for an electrical supply panel sufficient to provide 2 pole, 40-Amp 208/240-Volts electrical capacity to at least 50% of the parking spaces of the garage.

Where parking spaces are deeded to residential or commercial occupants, no parking space shall be located more than 100 feet from a supporting electrical supply panel. The relevant supply panel should be on the same parking level or easily accessible.

Each panel shall have electrical capacity to support the total garage supply allocated to electric vehicles or 60A per parking space supported by that panel, whichever is lower, and physical breaker space to support all parking spaces supported by that panel[16]

**Automatic Load Management:**

(a) The intent of sizing EVSE electrical service to provide 60 amperes at 208 or 240 Volts to at least 50% of spaces simultaneously is to provide the option to utilize Automatic Load-Management Systems to provide Level 2 EV charging to 100% of parking spaces in the future, as described in NEC 625.41 (2014).

A listed Automatic Load Management system manages the available capacity in a safe manner, such as allocating 60-Amp at 208 or 240 volts to vehicles to 50% of the total number of EV Charging Stations simultaneously, or allocating 14-Amp to vehicles to 100% of parking spaces at once, or similar. Given the capacity required by this Section,

[16] This language important for a parking structure with multiple subpanels (that may be on multiple floors). The 'whichever is lower' language allows for subpanels that may only need to support less than 20% electrical capacity

individual EV chargers may be installed in up to 50% of parking spaces before an EV load management system is necessary.

**Major Alterations:**

(a) Where three or more (i.e. 3+) multifamily dwelling units are constructed on a building site, or undergo major alteration, 100% of the total number of off-street parking spaces shall be electric vehicle charging spaces (EV Spaces) capable of supporting EVSEs and shall conform to the electrical capacity and panel specifications defined in *Electrical Capacity and Panel Requirements*

**Common Areas:**

(a) Where parking spaces are provided for public use or for common use by three residents, at least one EV space shall be located in common use areas and available for use by all residents.

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