

AE DESIGN

EV Charging 101

Installation of electric vehicle (EV) charging stations and infrastructure is becoming a standard requirement by energy codes and AHJs for most new construction projects. It's typically included to receive credit for green building certifications, such as LEED. As part of the code study process for each project, the applicable energy code and local code ordinances need to be reviewed to verify what EV charging infrastructure may be necessary for the project. In some cases, we may find a local ordinance that exceeds the standard energy code requirements, such as the *City of Denver*. The Denver Building and Fire Code establish different EV charging and infrastructure requirements, based on different occupancies and building usage. Let's walk through an example of how to determine the number of EV charges required for a project and *before we begin, it's important to understand the various definitions laid forth in the code. There are several different terms related to EV charging, and EV charging infrastructure. Section C202 defines each of these:*

ELECTRIC VEHICLE CHARGER EQUIPMENT LEVELS

“Equipment used for the purpose of transferring electric energy to a battery or other energy storage device in an electric vehicle.” This is the actual EV charger itself. There are several different types of EV chargers, these are defined by their charging level.

LEVEL 1 (slow charging) - Capable of charging at 20 Amps on a 120V, single-phase branch circuit. Level 1 chargers are typically used for residential applications.

LEVEL 2 (accelerated charging) - Charges of this level are capable of charging at 40 Amps or higher on a 208V or 240V, single-phase branch circuit. Level 2 chargers are often used on commercial projects, and can also be used for residential applications.

LEVEL 3 (fast/rapid charging) - Chargers at this level are capable of fast charging on 100 Amp or higher, 480V, three-phase branch circuits. Level 3 chargers are typically used at designated charging stations, such as Tesla Supercharging stations.

ELECTRIC VEHICLE (EV) CAPABLE SPACE

“Electric Vehicle (EV) Capable Spaces are designated parking spaces where a basic level of infrastructure is installed to accommodate future electric vehicles.”

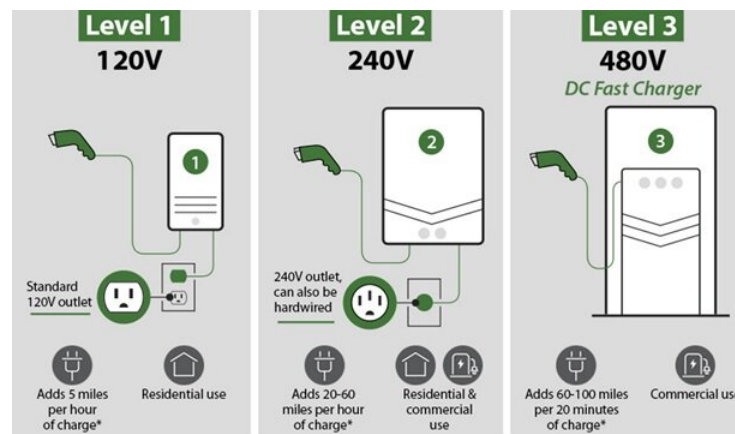


Figure 1

- Installation of no less than 1" conduit
- Installation of pull rope for future conductors
- The conduit shall be sealed at a capped junction box
- Dedicated space for electrical distribution equipment to serve future EVSE

ELECTRIC VEHICLE (EV) READY SPACE

“Electric Vehicle (EV) Ready Spaces are designated parking spaces where the ESVE infrastructure has been installed and is made ready for electric vehicle charging.” EV ready spaces are similar to EV-capable spaces but have more installation requirements.

These requirements include (section C405.10.5.1):

- Installation of no less than 1" conduit
- Conductors installed and
 - *Terminated in a 40 Amp NEMA receptacle*
 - *OR to capped junction box*
 - *OR to an EV charger*

Now that we're familiar with Denver's EV charging definitions, let's move into Section C405.10. This section tells us the quantity of EV-ready spaces, EV capable spaces, and EVSE installed spaces. The code

requires us to determine the quantity based upon the total provided new and existing parking spaces for the building. It is also important to note that a minimum of 70% of the required EV parking spaces shall be amongst the 50% of parking spaces located closest to the intended occupant entrance to the building.

There are two tables shown in this section.

These tables require a minimum of Level 2 charging:

Table C405.10.1 EV spaces in Group R occupancies is added as follows:

TABLE C405.10.1

EV SPACES IN GROUP R OCCUPANCIES

	NUMBER OF LEVEL 2 EV READY SPACES	NUMBER OF LEVEL 2 EV CAPABLE SPACES	NUMBER OF LEVEL 2 EVSE INSTALLED SPACES
1 Space	1	None	None
2 to 9 spaces	1	20% of spaces	None
10 or more spaces	15% of spaces	Remainder of spaces	5% of spaces

Figure 2: R Occupancies

Table C405.10.2 EV spaces in Group A, B, E, I, M and S-2 occupancies is added as follows:

TABLE C405.10.2

EV SPACES IN GROUP A, B, E, I, M and S-2 OCCUPANCIES

	NUMBER OF LEVEL 2 EV READY SPACES	NUMBER OF LEVEL 2 EV CAPABLE SPACES	NUMBER OF LEVEL 2 EVSE INSTALLED SPACES
1 Space	1	None	None
2 to 9 spaces	1	1	None
10 or more spaces	10% of spaces	10% of spaces	5% of spaces

Figure 3: A,B,E,I,M,S-2 Occupancies

For this example, let's say we have a Group B occupancy with 100 parking spots - according to Table C405.10.2, we will need 10% of spaces to be EV ready spaces, another 10% of spaces to be EV capable, and only 5% of spaces to have an installed EV charger.

Level 2 Chargers Only:

EV Ready 10 Spots

EV Capable 10 Spots

EV Charger 5 Spots

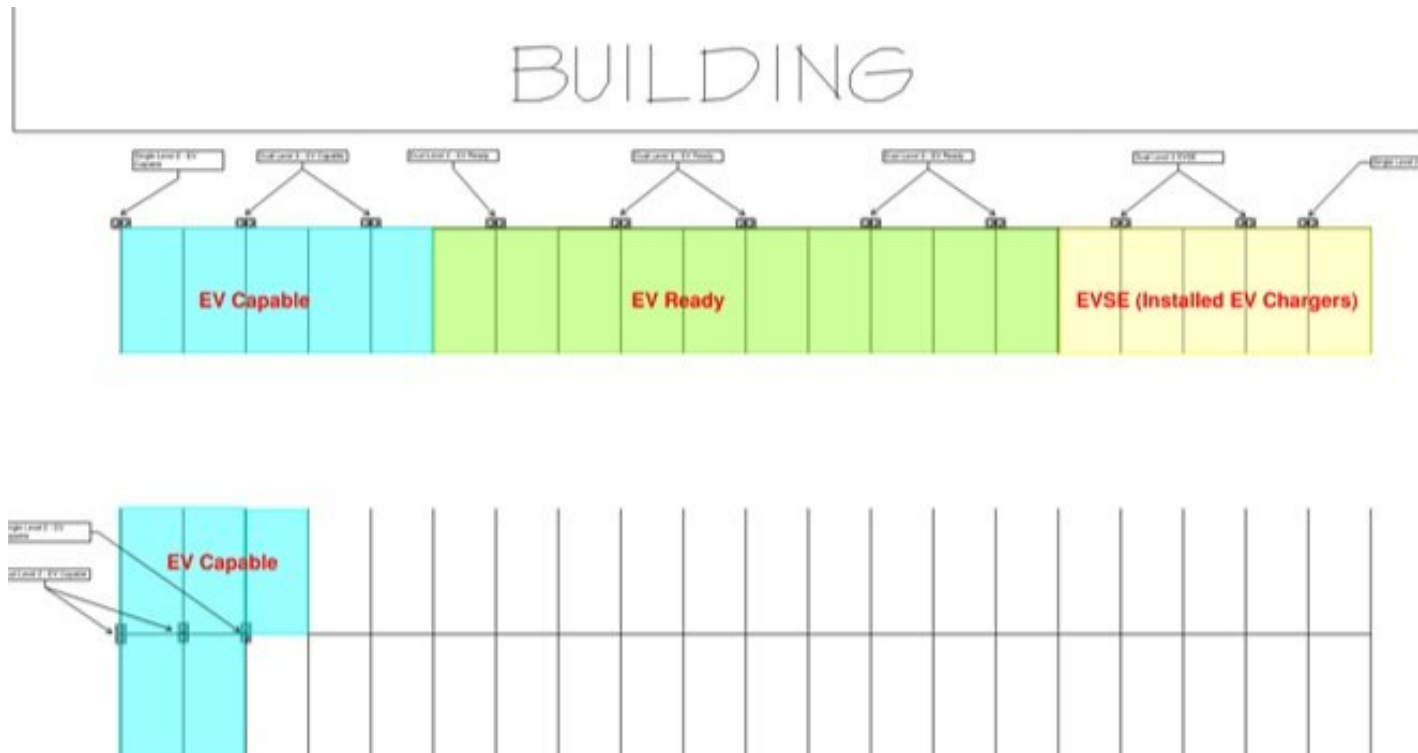


Figure 4

NEC 601.10.2 allows an exception for A, B, E, I, M, and S-2 occupancies if a Level 3 charger is installed. The exception allows a maximum of 5 spaces to be reduced from the number of installed EV chargers if a Level 3 charger is installed, and there's not less than one Level 2 EV ready space.

Because Level 3 chargers operate at 480V, they may not be applicable to every project. However, for this example let's say that the building has a 480/277V service. Using the exception, we're able to reduce the number of installed EV chargers from 10 down to only 5. This exception may be advantageous if there's a limited 208V load available, or if there are constructability concerns.

Level 2 & 3 Chargers:

EV Ready	10 Spots
EV Capable	10 Spots (Level 2)
EV Charger	1 spot (Level 3)

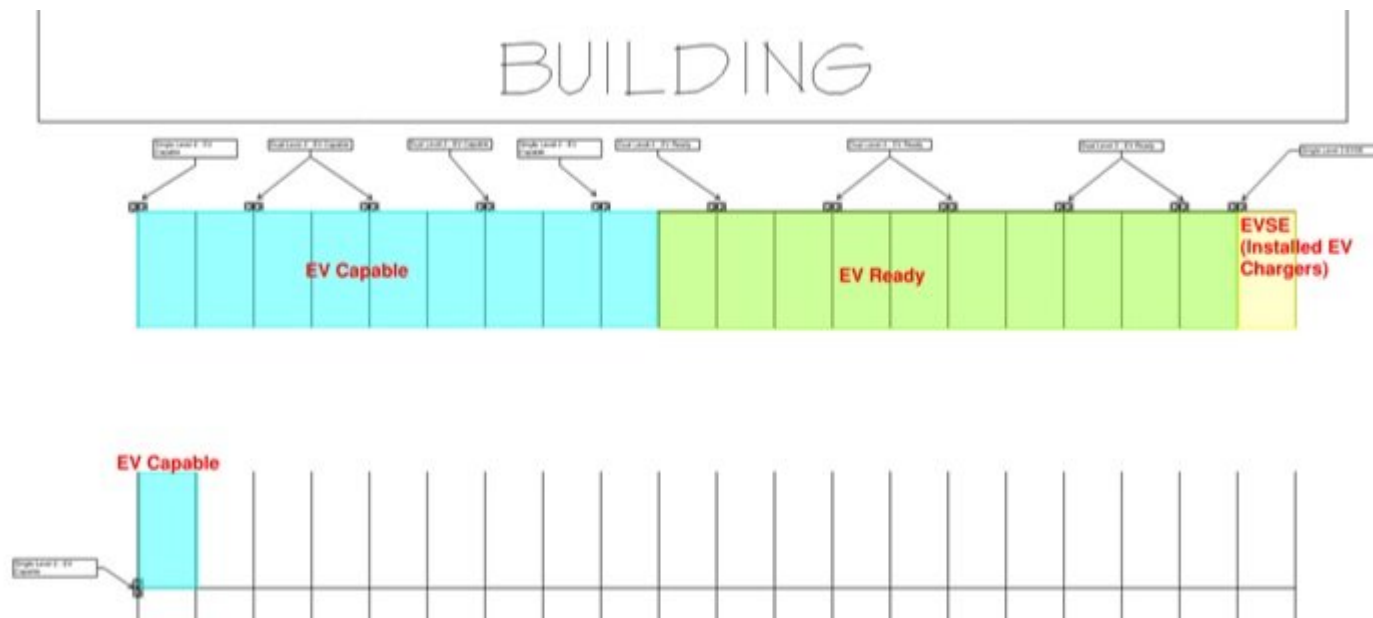


Figure 5

After determining the number of EV spaces, it's important to coordinate the locations with the Owner and architect. Also, it is important to relay this information because some Owners may want even more EV chargers than what the code requires. For large projects, coordination with the local utility company may be necessary. Level 2 and 3 chargers draw a large load and require a continuous load demand factor. This could affect the electrical service and transformer size. A larger transformer or even a secondary connection cabinet may be required.

There are several other factors to consider with EV chargers, such as low-voltage cabling, conduit considerations, and costs. Many EV chargers require a data connection as well as power. Typically, a 1" conduit is used for low voltage cabling and 1" to 2" for power conductors. While these conduits are small, it's still important to be mindful of how they will be routed and EV chargers can also have a significant cost impact. The quantity required may increase the electrical service size, there may be more labor and material needed, not to mention the cost of the EV chargers themselves. All these factors and more can affect the overall project budget, so it's important to coordinate early on. At **AE Design**, these are coordination items that we address early, so there are no surprises later in the project!

EV chargers and infrastructure requirements are becoming commonplace in many jurisdictions. It's necessary to review local building and energy codes to determine how the requirements will affect the project. Some jurisdictions, such as the City of Denver require more EV chargers and infrastructure than standard energy codes. This can present new challenges, but here at **AE Design**, we have worked on projects with one EV charger to as many as 300 chargers!

If you have any design, code, or construction questions, please don't hesitate to contact us – we'll help you out!

Helpful Definitions

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The electrical conductors and associated equipment external to the electric vehicle that provide a connection between the premises wiring and the electric vehicle to provide electric vehicle charging

ELECTRIC VEHICLE CAPABLE SPACE. A designated parking space that is provided with conduit sized for a 40-amp, 208/240-Volt dedicated branch circuit from a building electrical panelboard to the parking space and with sufficient physical space in the same building electrical panelboard to accommodate a 40-amp, dual-pole circuit breaker

ELECTRIC VEHICLE READY SPACE. A parking space that is provided with one 40-amp, 208/240- Volt dedicated branch circuit for electric vehicle supply equipment that is terminated at a receptacle, junction box, or electric vehicle supply equipment within the parking space

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE) INSTALLED SPACE. A parking space with electric vehicle supply equipment capable of supplying a 40-amp, dedicated circuit rated at 208/240 Volt from a building electrical panelboard

ELECTRIC VEHICLE FAST CHARGER. Electric vehicle supply equipment with a minimum power output of 20 kW

among multiple electric vehicle supply equipment at a minimum of 8 amps per charger



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