



breathe easy

What is EVSE and Why it Matters to You

An electric vehicle charge station primer for corporate, government, hotel, shopping and multi-family/commercial property managers.

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Executive Summary

This white paper is a primer for readers who want to understand the basics of electric vehicle charge stations, otherwise known as Electric Vehicle Supply Equipment (EVSE). It is written to give you a fundamental understanding of this topic. And to help you determine if an EVSE program would be beneficial to you, your company or property.

This paper begins with why you would consider starting an EVSE program. Next, you'll learn about the nuts and bolts of EVSE: the hardware, software and maintenance components. And while these topics are essential to an EVSE primer, no discussion would be complete without touching upon program costs, so we explain those as well. Finally, we suggest viable next steps to help you answer the question, "Is an EVSE program right for my organization, and if so, how do I economically implement one?"

Why Should I Bother Starting an EVSE Program?

The short answer to that question is: Because Electric Vehicles (EVs) are important to your constituents. And by satisfying their needs, you derive a number of direct and indirect benefits for your company, municipality, hotel or property as Table 1 below illustrates.

You are...	Your constituents are...	Your benefits are...
ENTERPRISE (A private-sector company)	Employees, customers, investors, the media	<ul style="list-style-type: none"> ✓ Cost-effectively attract and keep great employees ✓ Reduce costly churn ✓ Enhance & promote a positive brand image ✓ Potential revenue stream or electricity cost recovery
GOVERNMENT (City, county, state, mass transit)	Employees, voters, citizens, the media	<ul style="list-style-type: none"> ✓ Meets federal and/or state mandates ✓ Supports sustainability objectives ✓ Potential revenue stream ✓ Enhance & promote a positive brand image
SERVICE PROVIDER (Hotel, private parking garage,	Guests, customers and the media	<ul style="list-style-type: none"> ✓ Boost guest satisfaction ✓ Increase occupancy rate or visitations ✓ Differentiate from competitors ✓ Potential revenue stream: Increase Revenue Per Available Room (RevPAR) ✓ Enhance & promote a positive brand image
RENTAL PROPERTY (Multi-family or commercial)	Tenants and the media	<ul style="list-style-type: none"> ✓ Boost tenant happiness ✓ Reduce churn ✓ Increase occupancy rates ✓ Potential revenue stream ✓ Enhance & promote a positive brand image

Table 1: EVSE program constituents and benefits.

Many EV drivers are passionate about the environment. They choose products and a lifestyle that supports that belief. And while they take pride in driving an EV, ownership comes with its own challenges.

The biggest issue for them is what's referred to as "**range anxiety**" or "**charge anxiety.**" That's because charging stations outside their homes are not nearly as available as gas stations. So when EV drivers are out and about they occasionally need to "top off" or fully charge their batteries to give them the peace of mind that they'll reach their next destination. EV-driver anxiety is particularly acute when they are low on battery charge and unsure of where they can get a charge. This phenomenon is so pervasive that a survey conducted by the California Center for Sustainable Energy showed that 83 percent of respondents expressed dissatisfaction with public charging infrastructure.¹ That correlates with the limited availability of charging stations in various locations as Figure 1 below shows.

¹ ["California Plug-in Electric Vehicle Owner Survey,"](#) Center for Sustainable Energy, California. 2012, p. 5. Last accessed 03-07-13.

Plug-in EV owner's access to workplace & public charging

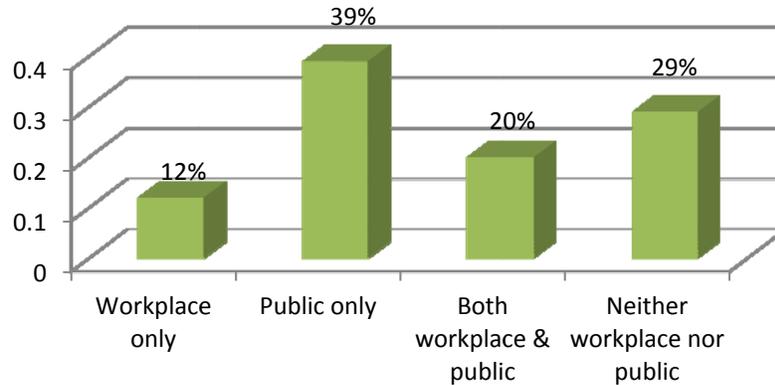


Figure 1: The availability of charging stations is relatively limited.²

The lack of charging stations motivates EV drivers to carefully plan their destinations and routes to ensure that dead batteries don't strand them. Consequently, anything you can do to help ease their anxiety, will earn you their good will and loyalty.

Given the shortage of charging stations shown in Figure 1, it stands to reason that an EVSE program helps companies attract and retain quality employees. So too may hotels, shopping and entertainment venues, public and private lots leverage an EVSE program to attract and retain customers.

The deployment of EVSE systems has taken root. They are present in many municipal, corporate, hotel and public/private lot settings to name a few. In fact, many Fortune 500 companies have implemented EVSE programs of their own, including Google, Warner Brothers and eBay.³ Most offer EVSE programs as a perk to EV-driving employees.

Battery charging solutions may also help you reduce employee and tenant churn, in addition to attracting more EV-driving customers. That translates into hard-cost savings associated with recruiting, hiring and training new employees.

There is also evidence that an EVSE program may be a viable source of revenue for certain hosts (EVSE program owner.)

Survey results confirm this by quantifying the average \$/hour respondents said they'd be willing to pay to charge their vehicles.⁴ And for multi-family, commercial and hotel properties, higher occupancy rates add to top-line revenues.

These benefits—cutting expenses, adding an additional revenue stream and bolstering your brand—all combine to make further exploration of an EVSE program worth your while.

Other names for EVSE:

- Electric vehicle charging stations
- EV charging station
- Electric recharging point
- Charging point
- Car battery charger/charging
- Electric vehicle charger
- Charger for electric car
- EV charger
- Electric car charger station

² Ibid p. 6.

³ http://www.pevcollaborative.org/sites/all/themes/pev/files/Comm_guide7_122308.pdf, last accessed 03-06-13.

⁴ "California Plug-in Electric Vehicle Owner Survey," ibid, p. 8.

What is Electric Vehicle Supply Equipment?

EVSE is the “point-of-fueling” infrastructure that delivers a safe charge to plug-in electric vehicle battery chargers. It prevents injury to operators and protects the EV components from damage. The core element of EVSE systems is the charging station.

EV charging stations have a number of features that differentiate them. A “**dumb**” charging station, for example, lacks the components and software to do anything “intelligent” beyond charging. It is a stand-alone, *non*-networked unit.

A “**smart charger**” by contrast, incorporates the software and communications devices necessary to network it with a host’s EVSE system. This capability enables the two-way flow of information. Thus, charge station managers may monitor the status of individual units, respond to malfunction and collect usage data.

Moreover, software and card readers allow managers to provision chargers to grant access to, and/or control pricing for, authorized users (via network user cards—typically free, credit cards or branded EV charging payment cards).

What are EV charging levels?

Another important charge station feature is its **charging level**. These are categorized as Level 1, Level 2 and Level 3. They range from low-level electric power (takes a long time to charge,) to high-level electric charging delivery (fast charging). Table 2 below details the features of each level.

Charge Level	Power Level	Charge Time	Description
AC Level 1 Basic, "slow," "trickle" charging	110-120V AC (alternating current)	Full charge: 10-20 hrs	The power level is equivalent to plugging into a household electrical outlet. It is best suited for smaller battery sizes such as those in PHEVs or when longer charging time is available.
AC Level 2 Fast, or "quick" charging	208-240V AC	Full charge: 4-8 hrs	The power level is equivalent to plugging into a household electric clothes dryer socket. This is the most common public charging level.
DC Level 3 Very fast charging	Converts 3-phase AC to DC	Full charge: 20-30 minutes	Best-suited for fast turnaround locations and fleet vehicle charging. DC Level 3 requires significant panel and service upgrades and consequently is the most expensive to deploy.

Table 2: EV charging level descriptions.

Deployment costs and charge times have made Level 2 chargers the most pragmatic choice for hosts today. That’s because each charging station may serve from 2-4 drivers daily depending upon usage policies and/or EV charge times. Level 3 (L3) charging stations, while optimal for most EV drivers, are often costly to install at some locations. Moreover, the only car currently available that can use L3 charging is the Nissan LEAF with its optional fast charge receptacle.

What Makes up an EVSE System?

An EVSE solution is made up of:

- **Physical components**, such as internal electronics, controllers, cord, EV-compatible plug and telecommunications devices to share data and enable network connections.
- **Software applications** to manage the charging, billing, driver access, and administration of an EVSE program.
- **On-going service** to maintain physical and software components as well as provide customer service to both EVSE owners and their driver constituents.

We'll discuss each in turn.

Physical components

Charge stations incorporate a number of assemblies and controllers.

- The power electronics assembly is the guts of a charge station. Functionally, it supplies the power to the EV's onboard battery charger. Physically, it's made up of wires, capacitors, transformers and other electronic parts.
- The charge controller serves as the "street smarts" of the charge station. It oversees basic charge functions, like the turning a charger on/off, the metering of power usage and the storing of key bits of real-time and event data.
- The network controller provides the brains of the charge station. It enables the station to communicate with its network (via an on-board telecommunications device) so that managers can monitor it and review historical event data. It also controls user access to a charging station through a series of white (authorized) or black (unauthorized) lists.
- The charge station cable and connector plug into the target electric vehicle. These components provide the conduit for a charge to be delivered.

Figure 2 highlights the major parts of an EVSE system.

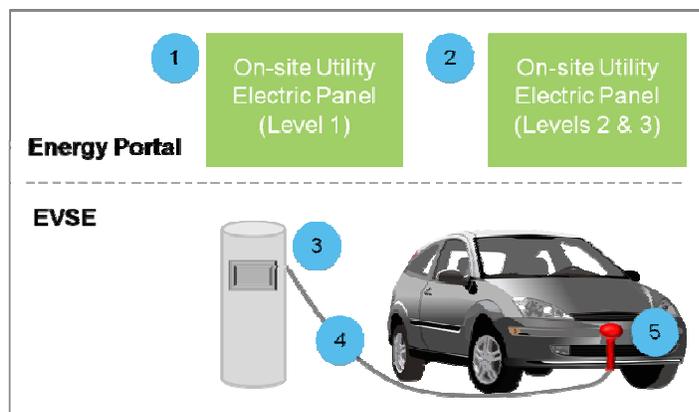


Figure 2: Anatomy of an EVSE system.

1. A charging location utility receptacle (110V wall socket) configured to supply Level 1 electrical power. The on-site receptacle/electric panel is the demarcation point between the power grid and the beginning of the EV charging station system.

2. Levels 2 & 3 EV charging stations are hardwired to an electric panel.

3. EV charging station. May be free-standing or mounted to a wall or ceiling. "Smart" charging stations include communications hardware for use with software applications.

4. EV charging station cord from charging station to vehicle plug.

5. EV charging station plug that delivers electricity to the vehicle.

Software applications

EVSE software is designed to manage and administer charge stations and their networks and should not be confused with EV applications created to oversee the electric vehicle. The software functional elements are illustrated in Figure 3 below.

EVSE network software promotes the quick deployment and configuration of EV charge stations and facilitates a two-way flow of data between the charge station and its cloud-based network control center. This functionality allows operators to remotely configure, manage, and update charge station software; set and control driver access to charging; set pricing; manage billing; and run usage reports. Software applications also enable drivers to easily locate and reserve available charge stations. Software tools can also be configured to send notifications to operators (hardware/software issues) and EV drivers ("charge completed," and "charge station available.")

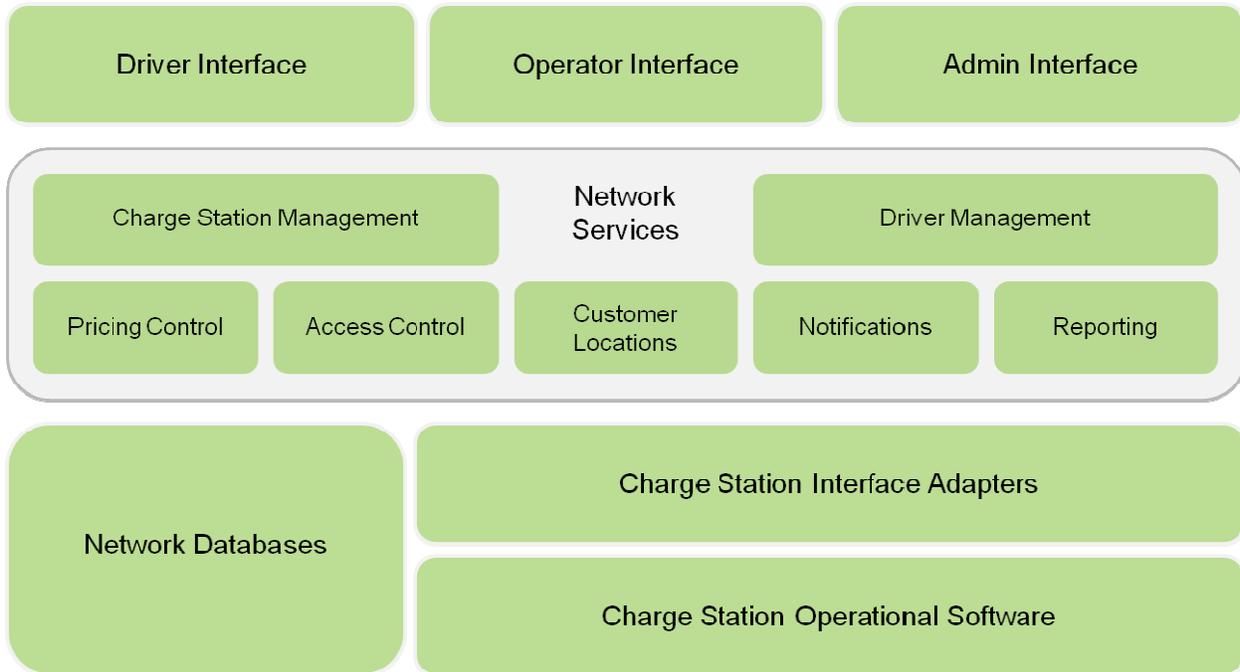


Figure 3: EVSE charge station management software functions.

On-going operation and maintenance

Once EVSE systems have been deployed, the host (owners) may maintain and administer them with an in-house employee. However, a better choice for many is to outsource their EVSE program management and maintenance to a third-party EV service company like EV Connect. Such services typically cost far less than an employee (e.g. wages, taxes, benefits.) And various services may be contracted on an á la carte basis including setting up EV driver access controls; pricing consultation if applicable; customer support to site hosts and drivers; up-time monitoring; reporting; hardware and software maintenance; and more.

“Seventy-four percent of Plug-in Electric Vehicle (PEV) owners express strong interest in workplace charging, and many businesses already see the value in installing charging.”

Source: [“Workplace Charging: Why and How,” pevcollaborative.org](http://pevcollaborative.org)

How Much Does an EVSE Program Cost?

EVSE program costs may be broken down into initial deployment costs (hardware plus installation), and ongoing costs (management and maintenance) as shown in Figure 4 below. These costs can be offset by a number of things, such as employee and customer loyalty, EV-driver fees, and/or tax incentives.

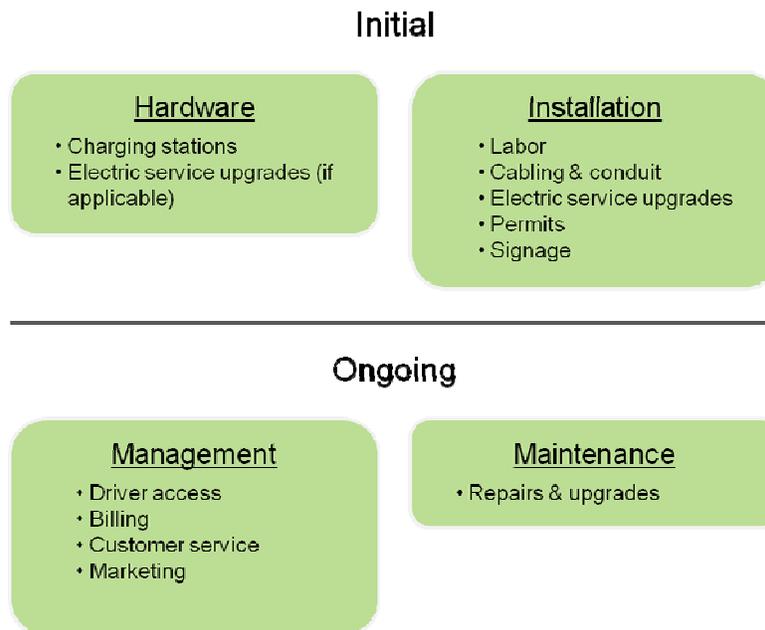


Figure 4: EVSE program cost elements.

Hardware

Charge stations range in price from as low as \$1,500 for a stand-alone (not networked with other stations) and go up to \$5,000 for a smart, networked charge station. Hosts purchasing multiple units qualify for volume pricing.

Installation

Installation fees may include labor conducted by certified electricians, necessary conduit, wire, panel upgrades, electric service upgrades, and breakers plus taxes and fees associated with any required permits. These costs can vary widely depending upon the level of charging to be offered (Level 1-least expensive to Level 3-most expensive.) Moreover, on-site factors can drive up costs. These may include the distance a charge station is situated from a suitable electric panel and accessibility to cellular connections.

Management and Maintenance

Once charge stations have been deployed, they incur ongoing operational costs. In addition to electricity costs, these may be divided into management and maintenance functions. Management activities include day-to-day customer service actions such as managing driver access, billing, providing driver support and uptime monitoring. Marketing also falls into this category as the promotion of your EVSE program to your constituents (EV drivers, employees, the media etc.) is an essential part of your success.

A maintenance regimen is likewise essential to ensure the safe and uninterrupted performance of EVSE systems. This includes such activities as preventative hardware/software maintenance as well as repairs and upgrades as needed. A good third-party EVSE vendor can provide these core services through a multi-year contract for just a few hundred dollars per charging station, per year.

Viable revenue sources and cost offsets

Both public and private EVSE programs may take advantage of new revenue streams. Parking lots, public transportation lots, shopping and entertainment parking facilities may all collect charge station fees. Such income may be divided into EV charger use plus electricity consumption fees. The amount of

income from these sources varies according to factors such as location, level of charge offered, local demand, and the decision by a host to offer EV charging as a free or low-cost (subsidized) amenity.

Beyond income from usage fees, the US federal government has authorized legislation to promote the use of alternative fuels. One such incentive is the Alternative Fuel Vehicle Refueling Property Credit. Its provisions allow for a tax credit of 30 percent (up to \$30,000 per business location) of the cost of hardware and installation for alternative fueling equipment, including EVSEs.⁵

To help inform your decision about an EVSE program, a sample ROI worksheet is shown below in Table 3. You can estimate your company's own ROI by customizing the data.

EV Charging ROI at Your Company

Benefits	\$	Sample Costs	Initial \$	Annual \$
Attract educated and stable employees	Significant \$	Charge stations		
Retain key employees	Significant \$	Installation		
Happy, healthy, and productive employees	Significant \$	*Third-party managed services		\$533.00
Market industry leadership and perception	Intangible but positive	**Electricity per station (if not covered by EV drivers)		\$823.68
Ability to cover or make money from electricity costs	Moderate \$	***Staff resources		\$0.00
Total	High	Total		

*Contact EV Connect for a quote. \$533/year based on 3-year contract for standard services.

** Average electricity costs per charge station can be estimated at 260 days per year for 8 hours each day at 3.3 kWh (average \$0.12 per kWh).

*** With EV Connect's Managed Services, your staff does not have to operate or maintain your charge stations, nor do they have to provide support to drivers.

Table 3: EVSE program ROI estimator.

What are My Next Steps?

There are many variables that factor into a decision to implement an EVSE program. And while electricity has been around for over a century, the deployment of EV charging stations can be complex.

For that reason, we suggest that you enlist the help of firms with EV-industry expertise and experience. That includes companies with a proven track-record of working with EV-certified installers, regulatory agencies and various EV charging station vendors. Such companies can assist you with every step of the EVSE program implementation process. That includes equipment acquisition and installation; the leveraging of incentives and tax credits; and the creation of a written EVSE program plan.

Ideally, your chosen vendor would be EVSE-hardware agnostic. That means that they are not contractually obligated to sell any specific brands of equipment. Consequently, they are free to pick and choose the charge stations that are right for you.

At a minimum, these firms should offer a free site assessment and quote. This document can include information about your site(s), some information about products being offered, and pricing for what it will cost to implement, operate, and maintain your EVSE program. With this valuable information in hand, you'll be able to make an informed decision about implementing an EVSE program.

⁵ Source: <http://www.law.cornell.edu/uscode/text/26/30C>.

EV Connect, Inc, is the EVSE-Industry Leader

Businesses and governmental organizations turn to us for a simple and cost-effective way to provide a turn-key EV charging program for their employees and constituents. We are an EVSE one-stop-shop, offering program design, hardware selection, charge station deployment, network management, driver support, maintenance, and more—all tailored to you and your drivers' needs. Collectively, EV Connect's team has over thirty-five years of EV charging experience and has deployed and managed thousands of charge stations.

With that amount of knowledge and leadership in the electric vehicle market, we have unmatched experience in the design, installation and management of EVSE programs. Our project managers sweat every detail—from helping you to select the right charge stations to permitting, inspections and working with your utility if necessary. All that translates into a hassle-free and cost-effective installation and operating experience for you.

Contact our EVSE specialists today to see if an EVSE program is right for you. We offer free site assessments and quotes, so there's no obligation. You'll get the information you need to make the best decision for you, your organization or property.

Phone: 888-780-0062

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EVSE Glossary of Terms and Definitions

Acronym/Term	Definition
Alternative Fuel Vehicle (AFV)	Alternative fuel vehicles may run on compressed natural gas (CNG), liquefied natural gas (LNG), liquefied petroleum gas (LPG), propane, methanol, ethanol, or electricity. Vehicles running on other fuels that meet or exceed federal clean air standards may also be classified as AFVs. Electric vehicles are also sometimes referred to by this abbreviation.
Battery Electric Vehicle (BEV) or Electric Vehicle (EV)	An EV operates only on battery-stored power as there is no internal combustion engine drive nor hybrid mode possible. Thus EV's are entirely dependent on charging stations. The acronyms "BEV and "EV" are interchangeable.
Charging Station	EVSE devices designed to charge electric vehicles at Level 1, 2 or 3. They may or may not include data communications capabilities. They may be located at a residence for private in-home use, at businesses for the exclusive use by employees of the business or located at commercial areas such as multi-family/commercial properties, malls, restaurants, hotels, mass-transit lots or businesses where they are available for use by the general public.
Connectors	A plug interface affixed to a chord to allow EVs to connect to wall plugs, Level 1, and for Level 2 and 3 charging stations to connect to EVs. Major auto manufacturers use SAE standard J1772-compliant connectors. The connector uses multi-pin conductive technology that allows a number of features that include pilot signal communication with the vehicle. The contacts have been designed to be safe and reliable with a claim of a 10,000 cycle life—about 13 years of twice daily use.
EREV	Extended Range Electric Vehicle. Uses both a gas engine and an electric motor. However, rather than using the engine to drive the car, it's used to run a generator that charges the batteries.
EVSE	Electric Vehicle Supply Equipment—the physical charger, cable, connector and management software necessary to safely deliver electricity to charge the batteries of an electric vehicle.
FCEV	Fuel Cell Electric Vehicle. Uses a fuel cell (typically hydrogen based) to generate electricity that runs an on-board electric motor.
HEV	Hybrid Electric Vehicle. Uses both a gasoline engine and an electric motor for propulsion. The vehicle's batteries are charged via a generator.
Host, EVSE host	An EVSE program owner. The owner may outsource some program elements such as installation, maintenance and customer service.
Internal Combustion Engine (ICE)	The conventional internal combustion engine is powered by gasoline but other fossil or bio-fuels may be used also.
Level 1 Charging (slow)	On-site circuit/outlet delivers 110-120V of alternating current. Typically, EV owners use a "cord set" to connect to a 120V wall outlet at 15, 20 or 30 amps. The output to the vehicle is AC current. Cord sets provide EV owners a simple, low-cost way of charging while at home or away on a trip where a Level 2 unit is not available. The low power flow leads to long recharge times. For example, to deliver an 80 percent charge to a 24 kWh battery would require about 14 hours. Due to this impractical recharge time, a large majority of electric vehicle owners will install and use the higher power Level 2 unit.
Level 2 Charging (fast)	On-site circuit/outlet delivers 208-240V of alternating current at 20, 30 or 40 amps. The output to the vehicle is AC current. Free-standing, wall or ceiling charging stations are intended for home use as well as public accessible infrastructure. The power levels range from 3.3kW to 7.6kW. This higher power output yields moderate recharge times. For example, to deliver an 80 percent charge to a 24 kWh battery would require about 4 hours assuming a 40 amp EVSE operating with an onboard 6.6kW charger.

Level 3 Charging (very fast)	Conceptually, the electric version of a gas pump intended for public accessible locations. Allows an appropriately compatible vehicle to receive a full charge in 20-30 minutes. Unlike Level 1 and Level 2 systems, Level 3 charging stations are “offboard.” That means that the direct current (DC) output to the vehicle bypasses the EV’s Level 2 onboard charger to flow energy directly to the vehicle’s battery pack.
Neighborhood Electric Vehicle (NEV)	The U.S. Department of Transportation classifies NEVs as speed-limited (or “low-speed”) and street-legal battery electric vehicles. These vehicles must have a gross weight of less than 3,000 lbs and a top speed of 25 miles per hour. Due to their low speeds, they are not subject to crash-test requirements. These vehicles are similar to golf carts that have been modified to be street legal.
SAE J1772	SAE J1772 is a North American standard for electrical connectors for electric vehicles. Its formal title is "SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler". ⁶ The SAE standard covers the general physical, electrical, communication protocol, and performance requirements for the electric vehicle conductive charge system and coupler. The intent is to define a common electric vehicle conductive charging system architecture including operational requirements and the functional and dimensional requirements for the vehicle inlet and mating connector.
Utility Rate-Standard or Domestic Rate	Standard/domestic rates are the utility companies’ standard tariff. An EV owner using this rate may incur significantly higher power bills because the standard meter associated with this rate will merely count all kWh consumed during the monthly billing period.
Utility Rate-Time of Use (TOU), also EV TOU rate	Utility rates vary according to high- and low-peak use hours. Thus the rate charged to an EV customer is based not only on the total electricity used, but also upon the time of day the energy was drawn.
Utility Rate-Whole House time of use (TOU) rate	Whole house time-of-use utility bills use tiered pricing for power use according to the time of day and season it was consumed. The lowest rates are typically in the late evening/night hours. Thus EV owners have an incentive to charge at night, during less-expensive, low-peak hours.

⁶ https://en.wikipedia.org/wiki/SAE_J1772



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