

LEARNING MADE EASY

Enel X Special Edition

Smart EV Charging

for
dummies[®]
A Wiley Brand



Electric
Vehicles 101

Why businesses
& drivers go electric

Why smart EV
charging matters

Brought to
you by

enel x

Steve Kaelble
Lauren Burke
Elise Benoit



Smart EV Charging

Enel X Special Edition

**by Steve Kaelble,
Lauren Burke,
and Elise Benoit**

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Smart EV Charging For Dummies® , Enel X Special Edition

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Introduction

People have been driving motorized vehicles for well over a century. Styles have certainly evolved, as various makes and models have earned revered places in pop culture and owners' hearts. And high-tech features are downright amazing these days. What has stayed constant most of that time is the internal combustion engine inside the vehicles we've been driving.

Finally, that is changing, too, as electric vehicles make ever-faster inroads into the driving experience. That has enormous implications for the environment, the cost structure — and the process of filling up the tank. There is, in fact, no gas tank on a fully electric vehicle, but rather a battery that can be recharged at places as convenient as your own garage.

Replacing gas stations with electric vehicle charging stations at home and beyond has already altered the travel routines of millions around the world. Through smart charging, you're not just plugging in the battery, you're tapping into a technological resource that makes your car ownership experience smoother, more convenient, and less expensive.

Smart charging is a breakthrough for more than just car owners, though. It's a way for businesses of all kinds to better serve their customers and their employees, while demonstrating their commitment to the planet. And it offers brilliant capabilities allowing utilities and power grid operators to reduce costs while building more reliable and environmentally friendly systems.

About This Book

Smart EV Charging For Dummies, Enel X Special Edition is your guide to the new paradigm of electric vehicle charging. For those heading down the path of electric vehicle ownership, it offers essential information about how charging works, what kind of charging setup will meet your needs best, and how you can keep your car at-the-ready cost efficiently. For business owners, it spotlights how smart charging stations in your parking lot can put you on the map for attracting customers and hiring the best talent. And for those in the utility business, the book explores how smart charging integrates into grid operations to offer valuable data and services.

Foolish Assumptions

Though we don't know you, we can assume a few things based on the fact that you picked up this book. At least one of these things might be true about you:

- » You're a driver who wants to save money and make a positive environmental impact by getting an electric vehicle, and you need to know how charging works.
- » You own a business of some kind, and you're wondering if you'll gain by putting in charging infrastructure.
- » Your business is electricity, and you want more info about how smart charging can improve your operations.

Icons Used in this Book

Throughout the pages of this book, you'll spot icons in the margins. They're there for a reason. Here's what they mean.



REMEMBER

If you're not inclined to take in every word on these pages, be sure not to miss the essential paragraph next to this icon.



TIP

Here you'll find some helpful advice for making smart charging work for your situation.



TECHNICAL
STUFF

Smart charging is high-tech that simplifies life. But if you want the techie details, you'll find some here.

Beyond the Book

We can't fit all the facts about smart charging into this slim volume. If you want to know more, go to <https://evcharging.enelx.com>.

IN THIS CHAPTER

- » Understanding electric vehicles
- » Exploring EVs and charging technologies
- » Comparing electric vehicles with gas-powered wheels

Chapter 1

Ushering in the EV Era

The world's economy would be nowhere without wheels. Vehicles have enabled our economy for generations and inspired pop culture from Mad Max to Pixar's *Cars* movies to countless songs such as The Beatles' "Drive My Car," War's "Low Rider," and Tracy Chapman's "Fast Car."

This chapter takes you out for a spin in the most important evolution in wheels since gasoline replaced horses. It offers a description and history of electric vehicles, outlines various technologies, compares electric versus gas, and introduces smart charging concepts.

Powering Up Electric Vehicles

An electric vehicle is pretty much what it sounds like: a vehicle that is propelled by electricity. Of course, nothing is quite as simple as it sounds, but the reality is, one of the many advantages that electric vehicles offer is that their method of propulsion is, indeed, simpler than what we've all been driving up until now.



REMEMBER

That's because of what an electric vehicle doesn't have: an internal combustion engine. That's the kind of engine that's been propelling most cars since Henry Ford started mass-producing the Model T.



TECHNICAL
STUFF

An internal combustion engine transforms chemical energy into mechanical energy. Fuel, usually diesel or gas, is mixed with air and ignited, and the resulting force pushes pistons or turns rotors or turbine blades. It takes a whole lot of moving parts to make it all happen, and the technology has gotten more and more complicated over time, even as the basic concept has remained the same.

An internal combustion engine is what an electric vehicle *doesn't* have. What it *does* have is an electric motor. That's a machine that turns electrical energy into mechanical energy. The motor has a magnetic field that interacts with electric current running through a wire winding. *Voilà!* A shaft turns.



REMEMBER

It takes a whole lot fewer parts to make this magic happen. As a result, turning electricity into mechanical energy is far more efficient than harnessing chemical energy. Electric motors can be as efficient as 90 percent, meaning that only a little bit of the energy gets lost in the conversion from electricity to mechanical energy. An internal combustion engine may be just 25 to 50 percent efficient, which means there's a lot of potential energy in the fuel that gets wasted on the way to making the pistons move. Generating and distributing electricity is also a lot more efficient than producing and delivering gas or diesel.

So why have we spent all these years driving around in vehicles propelled by less efficient, more complicated, dirtier internal combustion engines? Because until recently, filling up a gas car was a lot easier than charging an EV. In the early 1900s, electric cars shared the road with gas-powered cars, but the proliferation of gas stations supplied by cheap oil quickly made the internal combustion engine a winner.

The reality is, inventors were working on electric cars decades before the first gas-powered cars hit the road, but battery technology lagged and was too expensive. Meanwhile, gas-powered cars took off and never looked back — until relatively recently.



REMEMBER

What has completely changed the picture is the evolution of better, more affordable batteries, thanks to lithium-ion technology. That's what allowed Tesla Motors to get into the electric car business back in 2003, and what persuaded Nissan to create its all-electric Leaf model in 2010. Today, just about all of the major car companies are developing and selling electric vehicles, and more and more people are buying them.

Drivers who used to be turned off by high price tags for EVs are encouraged by substantially lower sticker prices now. That's possible because the batteries in today's electric cars cost 85 percent less than they did just a few years ago. Meanwhile, drivers who were worried about running out of juice while out and about are feeling better about the range of electric car batteries and the ease of charging. Most popular models today will run at least 200 miles on a charge, and the average is closing in on 300.



REMEMBER

Add in one more factor: the rise of renewable energy production. A lot more people are tapping into solar energy, or signing up to have their power sourced from wind farms. Charge your car on this kind of energy and you can feel very good about reducing your environmental impact. And if you're charging from your own solar panels, you'll be slashing your driving costs significantly.

Understanding EV Technology

The number of cars on the road powered at least in part by electricity has been on the rise since the late 1990s. But not all vehicles with electric motors are the same. Following is a rundown of the various kinds of electric vehicle technology.

Embracing the hybrids



REMEMBER

Toyota introduced its Prius models in 1997, and the world saw the potential benefits of spinning car tires with an electric motor. The Prius is what's known as a *hybrid electric vehicle*, the most popular of many hybrids on the roads today.

A hybrid has both an internal combustion engine and an electric motor. Most of the propulsion comes from the internal combustion engine, while the electric motor pitches in to increase the fuel economy. The electric motor is hooked up to batteries that recharge as the car brakes. There's mechanical energy in the car's movement, and special brakes convert that mechanical energy into electric energy to be stored in the batteries. That electric power is then used to power the electric motor, which creates mechanical energy again.

It's a pretty ingenious idea that has created vehicles with significantly better gas mileage. But it still requires gas to be burned. Some hybrids can run totally on the electric motor at low speeds before the internal combustion engine kicks in, but most need the gas engine to be running most or all of the time.

Plugging in the hybrid



REMEMBER

A *plug-in hybrid electric vehicle* is similar, but it has an alternate way to gather a lot of its electrical energy: by plugging in. A plug-in hybrid will typically have a more powerful electric motor that can do much more of the work, compared with a traditional hybrid. And it will have bigger batteries that can store more electricity.

In fact, many plug-in hybrids can run entirely on electricity, as long as the battery range holds out. That range may be somewhere from 25 miles to 50. For many owners with a relatively short commute, that's all the driving they need in a day before pulling into the garage and plugging it in. But when they happen to drive beyond the battery range, the gas engine kicks in and takes over until the battery can be recharged again.

All battery, all the time



REMEMBER

And then there's the BEV, or *battery electric vehicle*. That's a vehicle that has no internal combustion engine at all. It gets all of its propulsion through the electric motor. This is the space that Tesla pioneered, then Nissan with its Leaf and Chevrolet with its Bolt.

For most EV enthusiasts, this is the ultimate goal — a vehicle that is totally electric, putting out no emissions at all. For a BEV, it's vital to maximize the battery range, and also to make battery charging as fast and efficient as possible.

As noted, most of the battery electric vehicles for sale these days have a range of at least 200 miles, which is great. But without the right charger in the garage, recharging can take a seriously long time. On the other hand, a charging solution such as the JuiceBox 40 can get most BEV batteries up to full charge in eight hours, or even less.

In all of these vehicles, the cost of the battery makes up a large part of the overall sticker price. That's especially true with battery electric vehicles, which need the biggest and most powerful batteries, and that's why the earliest BEVs were more expensive than other cars.

That cost difference is shrinking all the time, though. Battery technology is getting better and cheaper, bringing more affordable BEV models onto the market. Progress on this front has been so dramatic that many BEV buyers now enjoy a lower total cost of ownership (and you'll find more details on total cost of ownership elsewhere in this book).

Spotting EV and Charging Station Differences

Most electric car buyers are motivated by either the desire to save money or to save the planet, or both. Vehicles with electric motors virtually always have lower emissions than their fully gas-powered counterparts, and BEVs produce no emissions at all. And it can be cheaper to run on electricity than gasoline.

Comparisons are tricky, though — there are a lot of apples-and-oranges questions to consider. Not all EVs are equal, nor are all charging stations.

If emissions are your interest, and you're hoping to reduce your environmental footprint, you may as well start at the beginning with the manufacturing of the vehicle. No matter what kind of car, the manufacturing process is resource-intensive, and creates emissions.



REMEMBER

EV critics like to point out (correctly) that the process for making an electric vehicle actually has somewhat higher emissions than the process for manufacturing cars with internal combustion engines. That is certainly ironic, but that fact needs to be considered in the broader context. Building that EV may have created 15 percent more emissions, but operating that EV once it rolls out of the factory will create at least 40 percent fewer emissions over its lifetime.

The big picture is, the EV's environmental footprint is significantly smaller. Battery electric vehicles don't emit greenhouse gas emissions — that is *zero* tailpipe emissions. And it's not just greenhouse gases you should be thinking about. Internal combustion engines produce a bunch of other pollutants that aren't good for anyone's health, and a BEV doesn't emit any of those bad things, either.

But wait, aren't there emissions from the power plants that create the energy you're putting into the batteries? Well, that depends. Wind or solar or hydro power plants? No. Coal or natural gas? Yes. But studies have found that you and the planet will still come out ahead, even if your power supply has emissions upstream. Depending on how clean your energy mix is, the environmental impact of running your EV is like driving a car that gets 80 or 110 miles per gallon or more, which is much more efficient.

One more point about your energy mix and how clean it is: The reality is that your energy mix varies from one time of day to another. There are times of the day when renewable sources are most productive, and times when they're less so. What if you could do most of your car charging at times when renewable energy sources are at their peak and the mix is cleanest? That would reduce your carbon footprint the most.



REMEMBER

That's one of the great benefits of smart charging. JuiceNet Green software, in fact, figures out when you need your full charge to be completed, then pays attention to the energy mix, and automatically ensures that your charge happens in the cleanest possible way.

Electric versus Gas Vehicles

So, which is the better bet, electric- or gas-powered vehicles? If you're reading this book, odds are you have a hunch electric is the ideal choice. Here are some reasons why you're right:

- » **Maintenance costs:** You have lots and lots of moving parts in your gas-powered car, and a lot of wear and tear. Oil changes, filter changes, hoses, belts, and more. Over five years, maintenance can run just under \$1,500 on average. A lot of these things don't even exist on an EV. Brake pads do, but they tend to last far longer on an EV thanks to regenerative braking.
- » **Operating costs:** Consider the average gas-powered car, driven the average number of miles, filled with gas at the average price. It'll cost you \$1,650 in fuel costs every year. Now consider the Chevy Bolt, powered by energy at the average cost. The bill comes to \$525 for the same number of miles driven. More on costs in Chapter 2.
- » **Convenience:** What if you could just drive home and plug in, and never visit a gas station? That'll save you a lot of hassle (and you might even cut down on the tempting junk food at the gas station checkout line).
- » **Health and wellness:** With an EV, you'll drive around knowing you're doing your part to reduce pollution and stave off climate change. Good for your health, your neighbors' health, and the planet's health.

IN THIS CHAPTER

- » Charging your EV
- » Identifying the different charging connectors
- » Understanding smart charging
- » Calculating the costs

Chapter 2

Smart Charging 101

Intigued by the idea of driving an electric vehicle into your garage and plugging into the future? It's an exciting concept that can ultimately save you money and help you feel better about the impact you're having on the environment.

This chapter gets into greater detail about the process of charging your electric vehicle. It explores the different charging levels and the various kinds of connectors that let EVs plug in for their power. It introduces the concept of smart charging and begins to describe just how important it is. And it offers details about the cost differences between electric vehicles and their gas-powered counterparts.

Charging Your EV

Home is where the heart is, and it turns out that home is also where the charge is, at least most of the time. Studies have found that people who own electric vehicles primarily charge them at home and over 80 percent of all EV charging happens at home. Typically, drivers pull into the garage, plug in the car, and let it charge until they're ready to go out again.

Sounds simple enough, but there are details to consider. The first is, are you using a level 1 charger, a level 2, or something else? There's a lot of devil in this particular detail.

Read on for details about various kinds of chargers, but as you do, keep in mind that most owners don't usually pull into the garage with a nearly depleted battery. Given that the average American drives just 29 miles a day, a recharge at home is usually a matter of topping off the battery. It's not like waiting until your gas-powered car is nearly empty and then making a special trip to the gas station. It's more like plugging in your phone in when you get back home from an errand, which is a whole lot more convenient.

Charging at level 1



REMEMBER

A typical electric vehicle will come with a 120-volt level 1 portable charger. It's a perfectly useful charger, as long as you know its limitations. It's a comparatively low-power device that puts in enough charge every hour to move the car 3 to 5 miles.

If your car is a plug-in hybrid and you have a fairly long commute, you may be able to achieve a full charge overnight with a level 1 charger, since that type of car has a battery range of just 25 to 50 miles or so. If you drive a battery electric vehicle and run down much of the battery during the day, an overnight level 1 charge won't fully recharge the battery. It might be enough if you have a relatively short commute, but otherwise, level 1 is not going to meet your needs for everyday use.



TIP

That's not to say there aren't reasons to keep a level 1 charger handy in the trunk. It's small and portable, usually under 5 pounds. It's never hardwired, and usually plugs into a standard electrical outlet. And if you need to top off the battery while you're visiting Aunt Marge, a portable level 1 charger is indispensable.

Upping to level 2

Do you have an electric stove or electric clothes dryer? Odds are that it doesn't have a standard 120-volt plug. You can get a stove or dryer that runs on 120 volts, but it's going to have limitations in its ability to satisfactorily cook your dinner or dry your clothes. That's not unlike the limitations of a level 1, 120-volt electric vehicle charger — good for some circumstances, or in a pinch, but not ideal.

A level 2 charging station pulls 240 volts, like your more typical (and better) electric range and electric dryer. It's a vast improvement in your electric vehicle experience.

Consider a JuiceBox level 2 charging station as an example. It can recharge your EV as much as 13 times faster than what you can achieve at level 1. With a level 2 charger, your charging rate could be 12 to 70 miles for every hour plugged in (and if you're an average driver, that might cover all the miles you drive on a typical day). Really, level 2 is your best bet for backing out of the garage with an overnight-charged battery electric vehicle ready for a busy day of driving.

Compared to a level 1 device, a level 2 charger is bigger and heavier. It could weigh up to 30 pounds, though some models, such as lightweight JuiceBox, can be a little as 18 pounds.



TIP

Some level 2 devices are hardwired into your home's electrical system, but many have plug-in versions. Getting a plug-in level 2 charger is a great option, because it's easy to install, and easy to take with you to charge elsewhere if you know you'll have access to a 240V outlet. And you can get a standard plug on a charger such as the JuiceBox 40, which hooks into the same 240-volt (NEMA 14-50 or NEMA 6-50) outlet that most kitchen ranges use.

How fast you charge at level 2 depends on how many amps your charger is pulling. Here's a general breakdown:

- » **16 amps:** 12 to 15 miles of range per hour
- » **24 amps:** 18 to 22 miles of range per hour
- » **32 amps:** 25 to 30 miles of range per hour
- » **40 amps:** 32 to 35 miles of range per hour
- » **48 amps:** 36 to 45 miles of range per hour
- » **80 amps:** 65 to 70 miles of range per hour

Charging up to level 3

The very fastest charge happens at level 3, but it's not likely to happen in your garage. Level 3 uses DC power. That's *direct current*, as opposed to AC or *alternating current*, which is what flows through the outlets of most homes and commercial buildings. Level 3 is often referred to as *DC fast charging*.



REMEMBER

DC charging can happen at much higher voltages, as high as 800 volts. That'll get a lot of EVs most of the way to a full charge in a half hour.

All that sounds great, until you find out how much it costs. A single DC fast charger run about \$23,000 on average for a 50 kilowatt system. And in most residential areas, you're not even likely to find the kind of current needed. So, it's good to know what DC fast charging is, but don't get your hopes up for running it into your garage. You may, however, find it as an option in public charging locations.

Spotting the Different Charging Connector Types

It's mentioned above that you can get a charger that'll plug right into the same kind of 240-volt outlet that your stove uses. It's worth spending a little time getting to know the connector types that come out the other side of the charger, because there are variations. If you've tried to find a plug that matches your wearable fitness device, among the many possibilities, this consideration will sound familiar.



REMEMBER

The good news is that there is some amount of standardization — it's not entirely a Wild West situation. For the most part, just about every EV in a particular country or part of the world will use the same kind of connector. Here are some terms and facts to know:

- » **J1772:** Every electric vehicle manufacturer except for Tesla uses this connector type for EVs sold in North America, for both level 1 and level 2 charging. Tesla has its own connector, but it also has an adapter allowing you to charge a Tesla with a J1772 connector. So, if you're in North America and find a charging station that uses this connector, you're in business, no matter what you're driving.
- » **CCS (Combined Charging System):** This is the most commonly used connector for DC fast charging in North America. It uses the same inlet as the J1772 but adds a couple more pins.
- » **CHAdeMO:** This is the official standard for DC charging in Japan, and it's also the DC connector used in North America by Nissan and Mitsubishi. Unlike the CCS, this one doesn't share any parts with the J1772, which means it has a separate inlet on the car.

- » **Tesla:** As mentioned above, Tesla has its own connector, which works for level 1, level 2, and DC fast charging. And all Tesla models come with an adapter that'll let it use a charger with a J1772 connector. But the converse is not true. You can't plug anything but a Tesla into a Tesla-built charging station.
- » **IEC 62196 Type 2:** This is the standard used in Europe by just about everybody except Tesla (though the Tesla Model 3 uses the Type 2 connector rather than the proprietary Tesla connector). The standard electricity in Europe is 230 volts, not 120 like it is in North America, which means there's no such thing as level 1 charging in Europe. As for DC charging, the CCS connector used there is kind of like the one used in North America, except it piggybacks onto and adds extra pins to the Type 2 rather than the J1772.



TIP

The important point is that, wherever you are, there is a significant amount of standardization. In the U.S. and Canada, all EVs can charge using a J1772 charging station. If you're looking for a public charging station, there are smartphone apps such as PlugShare and JuicePass from Enel X that will tell you where to go and let you know what kind of connectors you'll find. And as for buying a charging station for your garage, every unit for sale in your market will come with whatever the industry standard is in your area.

Understanding Smart Charging

Humans have been flipping on the light switch for generations. It's mostly a manual thing — turn on the light when you go in a room, switch it off when you leave.

But lately, more and more people are hooking up their lights and coffeemakers and draperies and garage doors and lawn irrigation systems to smart devices. Many of the things in the home can now be remotely and intelligently controlled to achieve various benefits. Think of smart charging as something along those lines, but even more sophisticated.

It takes a bit of background to tell the story. Most things that are electrical in nature make connections with the power grid that delivers power from generation sources to end users. A lot of

behind-the-scenes effort goes into ensuring that there's a perfect balance between electric supply on the grid, and demand for that electricity.



That balancing act is always challenging, especially when the supply goes up and down, and when demand rises or falls. Just about everyone wants more power from renewable sources, and jurisdictions such as the state of California have set lofty goals for using more wind, solar, and other renewable energy. But those supplies are more active at some points than others — sunny or windy days, for example. It's vital to shift usage around as much as possible to take that into account.

Smart charging technologies, such as those enabled by JuiceNet software, can make a big difference. The software is cloud-connected and super-intelligent. The simplified, big picture goal is to try to juice up the grid's demand when the supply is especially hot, by charging vehicles then.

The growing network of JuiceNet-enabled smart charging stations provides utilities with valuable data for planning and analyzing demand, easing grid congestion, and maximizing the use of wind and solar energy. That's smart for ensuring reliable power supplies that are as clean as the earth needs them to be.



For the consumer, there are smart benefits as well. A quality smart charging system will charge the vehicle as quickly and efficiently as possible, ensuring it's powered up and ready when it needs to be. It can also take advantage of special electric rates by charging the car when the power costs less. That's smart all around.

Driving for Dollars

Why do you want to drive an electric vehicle? Making an environmental difference is an excellent reason, whether you care about cost differences or not. But who doesn't want to save money? Read on for thoughts about how electric vehicles compare with gas-powered wheels, cost-wise.

Calculating the sale price

The relatively early stages of the electric car story featured pretty high sticker prices. And even today, Kelley Blue Book says the

average full-size car runs roughly \$35,000, while the average EV is about \$10,000 more than that.

On the other hand, there are several EV models that come in below \$35,000, so the earlier tales of electric vehicles being prohibitively expensive are fading into history. A lot of variables determine the sale price, including which type of EV you're considering (see Chapter 1 for more on the three main EV types). And EVs are eligible for state and local incentives that can significantly reduce the cost of purchase.

Operating the vehicle

This comparison starts out tricky, based on the apples-and-oranges fact that gasoline and electricity are two very different things. That said, it's possible to calculate the average price of gasoline and the average price of electricity, and then figure out how many miles you can drive per gallon or kilowatt-hour.



REMEMBER

You can get out a calculator and do the math if you want — but in case you've got better things to do, let's just skip ahead to the answers. On average, it costs \$9.83 to drive a gas-powered car 100 miles. For an electric vehicle, it's \$5.27. And you can potentially do better than that with smart charging, which ensures you're getting the lowest charging rates possible. (Just try that at the gas pump!)

And then there are maintenance costs. As explained in Chapter 1, there are a lot fewer moving parts in an electric vehicle. That's fewer parts to maintain and replace, from fan belts to spark plugs to fuel filters. And no internal combustion means less corrosion, which also reduces the need for replacement parts. All in all, EV owners typically save about \$800 a year on maintenance.

What if you have to replace your EV battery? Yes, that can be quite expensive. A Nissan Leaf battery could set you back at least \$5,000. But here's the good news. Most EVs have outstanding battery warranties, as long as eight to ten years and 100,000 to 150,000 miles. So, typical drivers are not likely to face this expense.

Getting ready for charging



REMEMBER

Your situation will determine what kind of charging station you'll need in your garage, but there's a good chance you'll want a level 2 smart charging station. A smarthome EV charging station will run somewhere from \$500 to \$900, and you may need to

spend another \$300 to \$2,000 for installation, depending on your home's electrical system. In many areas, local utility incentives are also available to cover part of the installation costs.

Those who cheer for gas-powered vehicles will often point out that your gas wheels need no such thing in the garage. But charging in the comfort of your home to top off your battery while you are sleeping, cooking, or watching TV is more practical than having to take special trips to the gas station when your tank is getting empty. And when you consider the big picture, you'll realize how much you save on operating costs and that you can come out ahead in the long run.

Cashing in on incentives

You may be eligible for attractive government incentives that encourage the purchase and use of electric vehicles. Federal incentives have been getting less generous over the years, but many states have incentive programs of their own.



TIP

It's definitely worth checking out the possibilities, and groups such as Plug In America offer the details online for various jurisdictions. Depending on where you live, you could easily save \$1,000, \$2,000, or even more, which is at a minimum enough to offset the cost of putting in a charging station.

- » Charging at home
- » Choosing your charger
- » Charging outdoors
- » Charging in a multifamily environment

Chapter 3

Smart Charging at Home

Buying an electric vehicle means thinking about how and where you're going to charge the vehicle. The most popular answer to that question is: home.

This chapter explains why the home is the greatest place to charge your EV, and spells out the details you'll need to consider as you make plans for home charging. It lists helpful details guiding your charging station choice, explains the extra considerations if you're charging outside the garage, and explores the possibilities of charging in multifamily housing developments.

There's No Place Like Home

If you're like a lot of people who are considering joining the ranks of EV owners, you may be having trouble getting past one anxiety: Will you be able to charge up where and when you need to, and without having to wait around idly while the battery charges up? That's not something you have usually thought about with your gasoline-powered vehicle. You're never far from a gas station, and it only takes a few minutes to fill the tank and speed off.

Here's the thing: That's an outdated paradigm. The realities of charging up your electric vehicle have a lot more in common with the way you keep your smartphone and laptop charged up. Typically, you plug in your phone and computer overnight while

you're sleeping, and they're ready to go in the morning. Or, you charge up while you're at work.



REMEMBER

Turns out, that's how most EV owners charge their vehicles, too. Studies have found that more than 80 percent of the charging takes place at home, and they're just topping off the battery most of the time. Drivers pull into the garage or carport, plug in, then head inside for dinner and a good night's sleep. Second in line: charging at the workplace. The need to charge at a public station is, for most people, an infrequent edge-use case, not a regular occurrence.

So, the fueling-up paradigm that involves driving to a public station, putting in a credit card, and filling up the tank applies significantly less to the EV experience. And it turns out, most owners really like the new way of doing things. Here are some significant advantages:

- » Charging takes place at a convenient location. You don't have to drive out of your way and wait for an open pump.
- » No need to touch a gas pump handle. Not to gross you out or anything, but studies have found the handles on gas pumps to be by far the most germ-laden thing you'll touch on the way to work.
- » Plugging in doesn't leave you or the soles of your shoes smelling like gasoline.
- » Charging costs less than filling up the tank, as outlined in Chapter 2.
- » Perhaps best of all, get a smart charger in your garage and you can leave every morning with a "full battery."

Choosing Your Charger

When you drive off the lot with your new electric vehicle, you'll probably have a portable, level 1 charger in the trunk. It's small, handy, but quite possibly inadequate for the kind of EV experience you're hoping to have. It's powerful enough to fill up the small battery on a plug-in hybrid, but not enough for the much bigger batteries found in BEVs, or battery electric vehicles.

So, what you'll most likely be in the market for is a level 2 charger. For more details on the differences between level 1 and level 2 chargers, flip back to Chapter 2. Otherwise, read on to learn more about how to pick the level 2 device that will meet your needs the best.



TIP

There are a lot of options vying for your attention. A great place to begin is to see what the experts have to say. You'll find buyer's guides online that answer questions, compare the possibilities, and offer ratings. You probably spend some time on this research step when you buy a car, and it makes just as much sense when you're buying a charging station.

Here are some details to consider:

- » **Safety certification:** Be sure you get a charger that is certified by Underwriters Laboratories, now known by most people simply as UL. The seal of approval is a good indicator of safety and higher quality. There are some lower-cost chargers out there that aren't UL tested and certified, so keep an eye out.
- » **Length of the cable:** Think ahead here. Charging stations come with cables of different lengths, some as short as 12 feet. Depending on where your power source is and where the charging port is on the car, that might be enough for now. But sometime in the future, you may get a different EV with a port in a different spot that requires a longer cable to reach, so be sure your cable will reach anywhere in the garage or driveway. In most cases, 20 feet or more is best.
- » **Enough juice:** Again, think ahead and don't get a charger that's underpowered. Aim for one that delivers at least as much power as your vehicle can accept (and having extra amps available is fine, as your car will only drink in as much power as it's able to accept). How many amps will your EV accept? Most these days are fine with at least 30 amps, so a charger delivering 32 is a good idea. Better yet, consider 40 or 48 amps, to future-proof your investment.
- » **The right outlet:** With some level 2 smart charging stations, you can choose to hardwire or plug into a 240-volt outlet. Note that there are different kinds of outlets. A JuiceBox 40 can plug into a standard NEMA 14-50 or 6-50 outlet, which is the same one that most cooking ranges use. Most electric

dryers use a different outlet, called a NEMA 14-30. In any case, you're not likely to have this kind of outlet in the right place in your garage, so you'll probably need to have an electrician put one in.

- » **A powerful enough circuit:** The circuit that your charger hooks into needs to be rated at enough amperage to run whatever charger you choose. And again, you may want to think ahead. What if you get a second EV? If your circuit isn't sufficiently powerful, you might need to upgrade it or add another one. An alternative is power-sharing, which JuiceBox smart chargers can do. That allows coordination between chargers when you've got more than one hooked to the same circuit. (Note that the International Code Council is recommending that building codes start requiring new homes to be ready for EV charging from the get-go.)
- » **Rated for outdoors:** If your installation is outdoors, be sure it's built for the weather. And read the fine print, because some that say they're "outdoor rated" aren't really rated for extreme weather. You'll want one rated NEMA-4 for extreme weather, not just NEMA-3. There's more detail about outdoor installations in the next section.
- » **Other technicalities:** Be sure your home has enough excess capacity to add a circuit for this purpose, and consider how far the electrical panel is from the garage. Check with your municipality, because some won't allow installation of plug-in level 2 chargers, even if they're UL-listed. In that case, you would need a hardwired version. The municipality can also let you know what permits are required. And be sure your home is properly grounded.
- » **And is it smart?** A charger that isn't a smart charger (call it "dumb" if you like) just supplies power to the car when it's plugged in. Smart chargers can do that, too, but they can also schedule charging times to take advantage of reduced time-of-use rates. Some can participate in utility demand response programs, which are good for rebates. And some like JuiceBox charging stations can even integrate with your Amazon Alexa or Google Home system.

Charging in the Great Outdoors

Most of the information included above about home-based charging is applicable no matter where you're installing your charger. There are some extra considerations, though, if your charger is going to be outdoors — under a carport or in the driveway, for example. That's where a lot of people park, and outdoors is a perfectly suitable place to charge.

Your vehicle was certainly built to be outdoors. Even the port where you plug in the cord was designed with harsh weather in mind, able to flush water and drain out while it's being charged. When the cord is connected, it creates a watertight seal, so you're good.



REMEMBER

That said, you still need to think about the charging station itself. It must be designed for all weather conditions, and be water- and fire-resistant. All JuiceBox home charging stations are, but that's not true about all devices on the market, so you need to check.



TIP

Then consider how you install it. Certainly, if the charger is in the garage, it's not only protected from the elements, but also from animals and people. Outside, that's not the case, so you can consider buying a special enclosure to protect the equipment in an outdoor installation. Even a fully weatherproof charging station can benefit from being installed inside a protective enclosure, especially if you might upgrade one day and want to resell it.

One other option for charging a car that you park outdoors — install a charging station in the garage and get a cord long enough to reach outside. This is certainly a viable way to go, but you must be sure the cord has a safe path to the outdoors. If it must run across where the garage door closes, you'll need to leave the garage door slightly opened to keep from damaging the cord.

Charging in a Multifamily Environment

How about multifamily living environments? Plenty of people who live in condominiums or apartments also have an interest in owning electric vehicles. The charging considerations are a bit different.

First of all, from the perspective of the developer or property owner, providing vehicle charging capabilities can be a real selling point for attracting and retaining residents. Not to make any rash generalizations, but a resident who cares about the planet may be just the kind of responsible dweller a lot of property managers would like to have.

That said, there are considerations in multifamily environments that aren't factors in single-family garages or driveways. How do charging stations fit in with other parking arrangements? What's the electrical service access? How do you account for billing? Are there legal matters to consider?



TIP

The U.S. Department of Energy offers a wealth of resources for property owners, managers, and homeowners associations. There are detailed guides that start from the beginning and work through implementation and installation. There are templates for surveying residents to learn more about their interests and preferences. There are decision tools, case studies, and videos. Just search the department's Alternative Fuels Data Center (<https://afdc.energy.gov>) for information about multifamily vehicle charging.

IN THIS CHAPTER

- » Maximizing your EV charging investment
- » Putting a charge into your perks
- » Encouraging sustainability
- » Putting your business on the map
- » Installing a charging station

Chapter 4

Smart Charging at Work

Home may be the most common place for charging, but commercial locations represent an up-and-coming additional option. There are lots of great reasons to put charging stations at your business for employees and customers to plug into.

This chapter explains how to get the most out of your company's investment in electric vehicle charging. It outlines why charging stations are an attractive benefit for employees, how they might help attract new customers, and why they're great for demonstrating corporate responsibility. And it gives some basic tips for companies ready to step into the EV-supporting future.

Maximizing Your EV Charging Investment

Perhaps you run an office-based business operation. Or a manufacturing facility. A distribution center. A coffee shop. Whatever it is, you're certainly not in the business of electric vehicles, and in particular, charging their batteries.

Well, you may *think* you're not in the business of charging EVs, but perhaps you should be. Yes, it's one more thing to think about, but there are some significant benefits to consider. For starters, it's a great way to create goodwill, with your customers as well as your employees.



REMEMBER

Many people, particularly millennials, really want to connect with companies that care about sustainability and the health of the planet. It's a growing phenomenon, and it is driving decisions about where to shop and where to work. Buyers want to purchase products or services that are created in a responsible way. And workers want to be part of responsibly creating those goods and services.

You also might be in the business of electric vehicle charging because your company has a fleet of EVs. A growing number of organizations are switching some or all of their corporate fleets to EVs because of the lower cost of ownership and positive environmental impact. For example, one study predicted that commercial and passenger fleets in America may add up to 8 million EVs within the next decade, and those vehicles will need infrastructure to charge.



TIP

But to begin with, getting into the charging business can actually bring in some dollars. As interest in EVs has grown, so has the list of attractive incentives provided by governments at all levels. Incentives can, in fact, cover most or even all of the cost of installing charging stations. That's pretty remarkable, when you read on and see just how many ways those stations can benefit your business.

Adding a Charge to Your Perks

Finding and keeping talented workers is one of the biggest challenges facing most employers these days. You need every trick and tool you can find to make your job opportunities appealing. It turns out that making the workplace EV-friendly is one of those tools, and it's one a lot of competitors may not have caught onto yet.



REMEMBER

The number of EV drivers keeps growing, and of that population, U.S. Department of Energy surveys have found that three-quarters have a strong interest in workplace charging. Also, about three-quarters of all Americans drive to work alone. That adds up to a big and ever-growing population that would love to plug in at work.

Also, consider the fact that millennials, a highly sought segment of the workforce, are showing an increasingly strong interest in sustainability. Not just in their buying decisions, but across all aspects of their lives, including their careers.



REMEMBER

Indeed, one survey found that 64 percent of millennials consider a company's social and environmental commitments in their job-hunting decisions and won't work for a company that doesn't demonstrate strong social responsibility. More than 80 percent say they'll be more loyal to an employer that helps them contribute to social and environmental issues, and nearly 90 percent say being able to make this kind of difference through their work makes their job more meaningful.

In short, this is a group of attractive workers who prefer to work for one of the environmental "good guys." There are lots of ways to demonstrate that's who you are as an employer, by installing charging stations and, if you operate a corporate fleet, by converting vehicles to EVs.

Adding charging stations for employees does a number of positive things:

- » **It helps with recruiting:** It's true anywhere, but especially in such labor-competitive places as the San Francisco Bay Area, Boston, Los Angeles, and Seattle. Everyone is fighting for talent, and this is a magnet that will draw great workers to your team. The Department of Energy has found that 90 percent of EV drivers who have workplace charging opportunities rate that perk highly.
- » **It makes employees' lives easier:** In many traffic-snarled areas, special high occupancy vehicle (HOV) lanes are reserved for people who carpool or drive efficient vehicles, such as EVs. That helps ease the commute. And onsite charging means your EV-driving workers have one less thing to worry about while on the job.
- » **It incentivizes green behavior:** Those charging stations, which could potentially offer free charging and prime parking spots, show that you want your team to join the ranks of green, EV drivers. You're rewarding them with convenience and free fuel. Beyond that, you're helping make their EV ownership possible in the first place by ensuring

they can charge while they work. And because you've made it work for them, they can qualify for EV-ownership incentives that boost their personal bottom line.

- » **It promotes both sustainability and pride:** The prouder your employees are to be part of your team, the more they'll want to stay on the team. If your company is seen as a leader in earth-friendly behaviors, your workforce will smile.

Encouraging Sustainability

You can't help it, really. Don't you feel just a little bit better about buying something that you know was created through sustainable practices? Truth is, that's not just you. Consumer research indicates that's a widespread attitude, and smart companies are benefiting from that sentiment.

Nielsen, for example, did a study involving the purchase of three popular items: coffee, chocolate, and bath products. Those are three different things, but the research found that in each category, products with legitimate sustainability claims enjoyed a higher growth rate than products that couldn't make those claims. Sustainable coffee brands grew at a rate that was 11 percent faster than non-sustainable counterparts. Sales of sustainable bath products grew 13 percent faster, and sustainable chocolate 2 percent faster.



REMEMBER

Not only that, buyers tend to be willing to pay more for sustainable products. A Nielsen study of younger consumers found that two-thirds are willing to pay more for a product with a stronger sustainability claim.

With that in mind, consider what it says to have charging stations for your customers or adding EVs to your fleet. That's not just a highlight on a TV ad or an asterisk on a baby food label. You're clearly putting your money where your mouth is. You've got a legitimate sustainability claim, and it's staring potential customers right in the face as they're driving up to your establishment or seeing your vehicles around town. You're making an emotional connection with every customer who cares about sustainability — even those who don't currently own an EV, for that matter. That's powerful marketing.



TECHNICAL
STUFF

And that's not all. A lot of forward-thinking companies are pursuing *LEED certification*. That's short for Leadership in Energy and Environmental Design, and it's a program used worldwide to certify green buildings. Attaining LEED certification is a great way to demonstrate a commitment to sustainability, and adding charging stations is a great way to earn credits toward LEED.

Another attractive certification is called the Greenhouse Gas Protocol, or GHGP. That's a series of standards and tools for managing a company's greenhouse gas emissions. One element in measuring your company's impact involves employee commuting activity. By installing charging stations, you can encourage employees to ditch their gas-burners, and that in turn helps reduce your emissions from the GHGP perspective.

It's all part of your company's overall *corporate social responsibility*, or CSR. That's an increasingly important buzzword, and it includes your company's charitable giving and volunteerism, as well as your commitment to social and environmental efforts. And it also includes trying to reduce your organization's carbon footprint.



TIP

If improving sustainability is a motivator for your company, you'll want to maximize your impact. Going with smart charging technology helps in that regard. You'll gain access to a dashboard such as JuiceNet Enterprise, which helps optimize your charging energy use and creates reports on usage.

This kind of management technology also can interface with your electric utility and help it implement its own strategies for integrating renewable energy into the grid. You can help the utility synchronize EV charging with the highest levels of cleaner energy, or hit the "pause" button on charging at high-load times when too much charging will require an increase in higher-emission generation.

Putting Your Business on the Map

So, there are emotional reasons why some customers will want to patronize your business if you offer access to charging stations. Green-minded customers want to support companies that are helping humanity transition toward electric mobility. But there are also purely practical reasons.



REMEMBER

Think about it. If you're driving an electric vehicle and have a choice about where to park and shop, there are many times it simply makes more sense to park where you can charge. The Sierra Club profiled one Pennsylvania bed-and-breakfast inn that offers charging stations for those who check in and stay the night. The business found that the extra perk helps it compete with other overnight accommodations that don't offer it. People chose this particular B&B because they knew they could wake up and have a fully charged vehicle in the morning.

Or, consider the example of a restaurant that offers charging stations to its patrons. First of all, some people will pick that restaurant over another, so they can multitask and charge their vehicle while filling their stomachs. But the benefit also can increase their "dwell time" by as much as an hour. They're enjoying the hospitality, want to get a bit more charge, so they order dessert and coffee. That's more money in that restaurant owner's pocket.



REMEMBER

Note the headline above, "Putting Your Business on the Map." That's not just a metaphor. That is a literal benefit. You'll show up on maps on EV charging apps and other resources directing EV owners to places they can power up.

Try typing "*EV charging stations near me*" into Google Maps. Look at all those pinpoint points that immediately pop up. There's even an icon denoting a charging station. Wouldn't you like for your business to show up when someone does a search like that? Charging stations also are mapped on such apps as JuicePass from Enel X, along with scheduling and cost details and the ability to reserve a connector.

One restaurant owner in New Jersey has his own EV and installed a charging station in the back so he can charge while at work. He decided to also install a couple stations in front. Sure enough, he often gets customers who pull up and plug in before they walk in the door. Oftentimes they tell him that they had never heard of his establishment until they did a map search and saw the restaurant listed among the results.

Installing a Charging Station

If you've read this chapter up to this point, you may be thinking, "there's no time like the present for getting my business onboard with EV charging." That's an excellent conclusion!

After all, though the majority of EV charging still happens at home, the second-most-common place people park and charge their cars is at their workplace. For those EV drivers, a charging station at work adds a lot of flexibility and is a great relief for battery-range anxiety. And in fact, some EV owners don't have a charging station at home, so for them, a workplace charging option is essential.

Companies taking the step now are on the cutting edge of a movement. It's really just a matter of time before even more employers will be forced to consider taking this step. It's one of those things that builds upon itself, snowballing toward greater adoption. The more workplace charging options there are, the more people that will be encouraged to buy an EV, which further increases the need for workplace charging.



TIP

So, how do you go about adding a charging station to your workplace? It's not something most business owners have done in the past. But the good news is, you don't have to be an expert, because there is help available. Enel X, for example, not only provides charging stations but has expertise available to help businesses make this exciting leap into the future. Enel X, in fact, has worked with thousands of businesses of all sizes on their smart energy infrastructure projects.

You'll be surprised how seamless the transition can be, moving from an old-fashioned parking lot for gas-powered cars to an environment welcoming to EV-driving employees and customers. For companies planning to put in at least four stations, Enel X offers free consultation, working hand-in-hand to create a tailor-made system.



REMEMBER

There are three main capital cost expenditures that go into this kind of installation:

- » **Make-ready infrastructure:** This varies greatly by site, but is usually the most costly and time-consuming part. These expenses include all the necessary electrical infrastructure for operating the charging stations, a conduit for wires, a new concrete pad for parking, new signage, and restriping of the lot.
- » **Installation:** This is typically on top of make-ready costs, so don't overlook it.

» **The charging stations:** This is the actual technology you're installing. You'll have to decide whether they'll be networked chargers (connected to the internet) or non-networked chargers. For most incentive programs, they'll need to be networked. A networked installation allows you control over the stations, and it's necessary if you plan to restrict use to certain people or collect a fee for charging. Technology such as JuiceNet Enterprise offers the ability to control access for authorized users, providing drivers an app. You can pass through relevant costs to drivers and control who uses the stations. This is especially helpful for installations in multi-family housing.



REMEMBER

Your company also may be pleasantly surprised at the incentives that can reduce or even totally offset the cost of your installation. Roughly 50 different programs can be found across 25 states. What's available depends on where you're located, but many municipalities and utilities have programs that support local commercial charging installations.

You may even be able to combine multiple incentive opportunities for an even greater benefit. A major California utility, for example, covers 100 percent of make-ready costs, while multiple other programs provide up to \$6,000 per port. Sacramento and its municipal electric utility have offered rebates for commercial users that choose to install Level 2 or Level 3 charging stations — anywhere from \$6,500 to \$80,000, depending on the type of technology. Massachusetts also has a 100 percent make-ready incentive and a \$5,000-per-port offer.

The catch, however, is that good things don't always last. Many programs have participation limits or deadlines or sunset dates. Check out the possibilities now, for sure, and be ready to act promptly to ensure you're able to access whatever you find.

IN THIS CHAPTER

- » Finding a station
- » Making the connection
- » Setting the price
- » Making public charging work for you

Chapter 5

Smart Charging on the Go

If you're an electric vehicle owner, you're likely to be doing the vast majority of your charging at home. If you're lucky, you may have access to a charging station at work, too. For the most part, that'll be all the charging you need, but every now and then, you may need to plug in somewhere else.

This chapter explores your options for charging on the road. It discusses how public charging operates, how to find a station, and how to know which connector is right for you. It also shares what you need to know about the costs of public charging.

Finding Power

The first step to public charging is, of course, finding out where you can charge. This is as easy as picking up your smartphone. You can download an app such as PlugShare, which is packed with information about public charging stations. Apps such as EVmatch and AmpUp can help you find peer-to-peer charging. Or you can just Google it, asking where to find a charging station near you. Enel X JuicePass will also help you locate JuiceBox charging stations on the go.



TIP

If you're planning a trip, you can even map it out in advance. Using PlugShare, for example, all you have to do is tell the app where you're going, and it'll tell you where to find charging stations along the way (there are thousands of locations to choose from). You'll learn which restaurants and hotels have charging stations and what types of power and connectors are available. And you can build the necessary charging time into your trip plan.

Depending on the charging station, you'll need an access card or app provided by the operators offering charging services. It's a good idea to register with several charging networks to access as many stations as possible. That said, there's a movement to have more open access payment methods and pay by credit card instead of having to download multiple apps or carry multiple registration cards.

Making the Connection

Also like your smartphone, you'll need the right plug for a proper connection. The options can appear a bit confusing to those new to EVs, but it's really not as complicated as it might seem. The right connection depends on what kind of car you're driving, where in the world you're located, and what kind of power you plan to plug into. And fortunately, public charging stations offer all plug types, so no matter what car you drive you can find the right plug to charge your car.



REMEMBER

In North America, virtually every EV manufacturer other than Tesla uses what's known as the SAE J1772 connector, often referred to as the J-plug for short. That's good for both level 1 120-volt charging and level 2 240-volt charging.

And while Tesla has its own proprietary connector, it also provides an adapter so that its car owners can plug in anywhere that offers a J-plug connection. On the other hand, only Tesla drivers can plug into a Tesla charging station.

To keep it simple, remember that level 2 public charging stations, which use alternating current in North America, offer universal charging, as all production cars, including Teslas with an adapter, can use these stations to charge.

Level 3 is for DC charging, or direct current. This is often known as DC fast charging, and as its nickname implies, it's how you get the fastest charge possible while you're out on the road.

Most EVs use a connector type known as CCS for DC charging. That's short for *Combined Charging System*. What's meant by "combined" is that the CCS connector starts with a standard J-plug and then adds two more pins for DC charging.

There's also a Japan-developed DC charging format known as CHAdeMO that you'll find on Nissan and Mitsubishi models for DC charging. It's an entirely different plug, not one based on the J-plug. And then there's Tesla, which has its own connector type. The bright side for Tesla owners is that this proprietary connector is the only one needed for all three levels of charging. All other drivers will simply have to make sure to grab the correct cable to charge their cars when using public DC fast charging stations.

And one more variation to consider. If you're in Europe, you won't be using a J-plug. The standard there is known as the IEC 62196 Type 2 connector. Every manufacturer there uses this plug, except for Tesla.



REMEMBER

Note that there is no level 1 charging in Europe, since higher voltage is the standard. If you're going with level 3 DC fast charging in Europe and you're not driving a Tesla, you're probably going to plug in with a CCS connector, just like you would in North America. The only difference is that this CCS connector starts with a Type 2 plug and adds a couple pins (rather than building upon a J-plug like in North America).

Setting the Price

So, how much will it cost you to charge your EV at a public charging station? It all depends. To begin with, it varies based on where you are and what time of day it is.

That's because the cost depends on the local cost of electricity. And electricity costs are quite different from one place to another. On top of that, in some areas the rates are higher at high-demand times, because the utility wants to encourage charging at other times in order to balance out the load on the grid.

Rates can range anywhere from about 8 cents per kilowatt-hour in Nevada to 19 cents in California. What this means is that charging up in California will cost more than in a lot of other places (and that kind of price difference is true with gasoline, too). Ultimately, state regulation will dictate what charges are permissible.



REMEMBER

With that geographic detail out of the way, now consider the pricing model. There are essentially three different models that you might encounter: pay-as-you-go, monthly subscription, or free. Of course, free is the most appealing, but outside of free, pay-as-you-go is the most popular option.

That said, it's not always quite as simple as pay-as-you-go. There may be a combination of that with a membership requirement. Being a member of a charging network makes things as simple as possible. Some networks charge a subscription fee, but many have free membership. You just download an app and enter a payment method, and your transactions are speedy.

When you're buying pay-as-you-go, whether as part of a network or as a guest, there are different ways that your actual charge might be calculated. Most common is a "by the minute" charge rate.



REMEMBER

If you're buying "by the minute," there's no standard or guarantee as to how much power flows into your battery each minute. But many stations will provide an assurance, such as a "20-minute supercharge." Some places may have an idling charge, because they want to assure that drivers will pull away when they're done charging and open up the station for someone else.

What about free? Yes, it's out there. You're most likely to find free charging at a place that wants to draw you in to spend money in a different way, such as by buying dinner and then hanging around for dessert, plugging in while shopping at your local mall, or topping up when you are working out at the gym. Many businesses offer free charging to their customers, so you have many opportunities to get a free charge.

Making it Work



TIP

A few thoughts for successful charging on the go:

- » Every EV is different in terms of how long it takes to charge. And the time also depends on what level charging you're using, the state of the battery, and the outside temperature. You'll want to plan your travels based on what you learn about your car's needs — plan for appropriate stops long enough to allow sufficient charge and of course remember to top up your battery whenever you can, rather than wait till it is completely drained.
- » Use proper etiquette in public charging stations. Once you're done charging, be sure to move your car so someone else can use the station. Most charging networks notify you via their apps when your car is ready to go.
- » If you happen upon a public charging station but there's a non-electric vehicle parked there, notify the appropriate authorities as it is illegal for gas-powered cars to park in EV charging spots. If you can snake your cord around and make a connection anyway, at least consider leaving a note so the driver might be more courteous next time.

IN THIS CHAPTER

- » Improving the grid
- » Integrating with the grid
- » Balancing the EV load
- » Creating incentives

Chapter 6

Smart Charging on the Grid

This chapter explores where EV charging fits into that intricate picture, simultaneously increasing demand for electricity while offering new ways to help utilities manage that demand. Information covered here includes ways smart charging can integrate with the grid to help utilities balance the load and improve the grid. And it explores how incentives can help persuade customers and automakers to be part of the solution.

Improving the Grid

To those in the electricity business, the following statement is probably obvious, but for the rest of the light-switch-flipping public, it may be less so. The more electric vehicles that are on the road, the more strain they put on the electric grid. Think of all the gas that gets pumped at all the gas stations at every major intersection. Now imagine more and more of that tire-spinning energy being delivered to cars through the power grid rather than through gas pump nozzles.



REMEMBER

The bottom line is, as the number of EV drivers increases, the resulting boost in peak energy demand may require updates to the electric grid that delivers power from generation source to end user if the infrastructure is not “smart.” Upgrades aren’t exactly cheap, though if you think of them on a per-car basis it doesn’t sound insurmountable. California utilities have studied how much EV-related upgrades have cost over the past few years, and they’re averaging about \$17 per vehicle. Furthermore, “the price of electricity is more stable than oil prices because it can be generated from diverse sources and US electricity markets are regulated. In constant dollars, and when expressed in equivalent gasoline prices, the national average price of electricity as a vehicle fuel has remained around \$1 per gallon (\$0.88 to \$1.17 per gallon) over the last 15 years. Average US gasoline prices between 2002 and 2017 ranged from less than \$2.00 to more than \$4.50 a gallon” according to the Union of Concerned Scientists.

What’s more, there are ways to mitigate the need for upgrades. Perhaps most noteworthy, it’s estimated that smart charging can save grid operators anywhere from 30 percent to 70 percent in upgrade costs. That’s a savings of hundreds of millions of dollars a year, perhaps even billions.

It’s also important to weigh the costs of upgrades against the increased revenues that utilities collect by selling a lot more electricity to EV drivers. Some utilities are now projecting that they’ll gain more in new revenues than they’ll need to spend in upgrades. That’s good news not just for utilities and EV drivers, but for all customers, because if those predictions bear out, it could drive down rates for everybody.

Don’t forget that the grid is getting cleaner all the time. Sources of renewable energy are continually becoming more cost-effective, and as they do, utilities are moving in that direction. That said, sources such as wind and solar tend to be intermittent, creating supply-and-demand challenges. Read on to learn how smart charging technology is helping mitigate some of those challenges.

Integrating With the Grid

Consider that traditional light fixture mentioned at the start of the chapter. You reach over and flip the switch, and the light goes on or off at your command. Now consider today’s smart fixtures

that are integrated into such technologies as Amazon Alexa or Google Home. The system can control the lights on a schedule, synchronize them with the sunset, turn them off or on with a smartphone swipe from miles away, respond to a voice instruction, or dim them on command. That's the difference between a smart light switch and, well, a dumb one.



REMEMBER

EV charging bears some similarities. The “dumb” charging approach is simply plugging in and charging, right then and there. Smart charging, on the other hand, pays attention to such factors as the time of day and any associated energy rate discounts or peak demand rates. And like smart light switches, smart chargers can integrate with bigger monitoring and control systems — in this case, the electricity grid that delivers power. That creates even more powerful opportunities.

Consider the example of Enel X's fleet of JuiceNet-enabled smart charging stations. Those stations are, of course, the way EV owners keep their vehicles charged and ready to roll. That's pretty cool in and of itself. But together, those smart charging stations also operate as a grid resource for wholesale energy markets.



REMEMBER

Linked through a cloud IoT software platform that's integrated into the grid, these smart charging stations collectively create a giant, virtual energy storage battery made up of chargers and the vehicle batteries they charge. The JuiceNet cloud platform is the smart management system for this virtual storage system.



TECHNICAL
STUFF

In California, thousands of units of Enel X residential chargers and other JuiceNet-enabled devices collectively make up over a 70-megawatt virtual battery, which continues to grow. It's spread across the state, concentrated in major population areas. It's not just a network of battery chargers — it's a collection of distributed energy resources, controlled by a cloud software platform, installed through an initial capital outlay by EV owners themselves.

The EV owners who are part of this amazing collection are part of a rewards program. They're rewarded for essentially delivering energy services to the utilities, by curtailing their charging at certain times and shifting their consumption to low demand periods.

The system of JuiceNet-enabled charging stations provides utilities with a wealth of valuable data. That allows utilities to analyze and model how this kind of smart charging can participate in wholesale and retail markets. And that data can help them maximize how they use renewable wind and solar energy in their territories.

This virtual battery is, in fact, already active in independent system operator wholesale markets. It provides day-ahead and real-time energy commodities, and dynamically manages charging loads in response to instructions from grid operators. That ultimately reduces wholesale energy costs while mitigating the challenge from the intermittent nature of renewable energy sources.



TECHNICAL
STUFF

Integration of smart charging into the grid offers a lot of pluses. Here are some of the services that JuiceNet-enabled charging stations can provide the grid through low-latency cloud-based dispatch:

- »» Energy services
 - Day-ahead market
 - Real-time market
 - Load shift/building
- »» Capacity
 - Forward markets, such as resource adequacy
 - Day-ahead markets
 - Avoided capacity charges
 - Distribution upgrade deferral
- »» Ancillary services
 - Spinning reserve
 - Non-spinning reserve
 - Frequency regulation

Balancing the EV Load

Here's the trick that utilities and grid operators must achieve all the time. It's a balancing act, quite literally. They must deliver enough energy to meet the demand, even at peak levels that only happen a few times a year. And, conversely, they must also figure out what to do at times when their supply is greater than the demand. Think, for example, about a really bright, sunny, windy day — a great time to collect solar and wind power, but what if Mother Nature is producing more power than humans need at the moment?



REMEMBER

Smart charging is emerging as part of the solution to that load-balancing quandary. Consider the Enel X JuiceNet services as an example once again. The aim is to maximize charging activities at a couple of ideal times. When there's excess supply from renewables such as solar and wind, that's a great time to suck that excess into EV batteries. Beyond that, it's ideal to schedule as much charging as possible when there is less competing demand from other kinds of electricity uses. That is often in the overnight hours, when most people have turned out the lights, and the lower overnight temperatures are allowing air conditioners to run less.

A study of two major California electric utilities demonstrates how well this can work. Both utilities use various means to encourage charging at off-peak times, and smart charging makes that easy for consumers to achieve. According to the study, from Synapse Energy Economics, both utilities report that the vast majority of EV charging is taking place during off-peak hours.

California is, of course, a hotbed of EV popularity, and the state is doing a lot of thinking about what the electric future of transportation will look like. There's increasing discussion of *vehicle-grid integration*, or VGI. A law passed in the fall of 2019 calls on the state and its utility industry to work on strategies for getting the concept right.

Two of the most talked-about VGI approaches have their own acronyms:

- » **V2G:** This is short for *vehicle-to-grid*, which describes a two-way interaction between EVs and the electric grid. Put simply, it involves what happens when EVs are parked and plugged in. With V2G in operation, power can flow from the grid to the car . . . or back from the car to the grid when needed.
- » **V1G:** This is the kind of smart charging most people are doing now. It's sometimes known as *unidirectional managed charging services*, and it's a one-way flow of power, from the grid to the car (but managed through the magic of smart charging).

Creating Incentives

Most people have a natural desire to do the right thing — such as maintain the environment for future generations. But it sure doesn't hurt to give people a bit of a nudge in the right direction, through financial incentives and the force of governmental

regulation. As mentioned earlier in this chapter, California is a leader in making things happen, with regard to both reducing vehicle emissions and transitioning to an electric grid that's carbon-free.



REMEMBER

The state has adopted ZEV, short for the *zero-emission vehicle* program. The aim is to encourage automakers to move toward vehicles that have no tailpipe pollution. Automakers earn ZEV credits related to the percentage of vehicles that are electric, non-electric, or somewhere in between. (A plug-in hybrid, for example, is one of those ZEV types that's considered to be transitional.)

Want to know why vehicle buyers now have more than three dozen EV options? This kind of program is one of the reasons. The program is managed by the California Air Resources Board but has also been adopted by more than a dozen other states, from Oregon to Maine. The accounting gets a bit complicated, but automakers are able to manage their compliance across these multiple states — if they are ahead of the goal in one state, that can help them comply in states where they're behind.

And then there's SB 676, the California state law signed in late 2019. It recognizes the ever-increasing interest in EVs from a consumer perspective, and the impact of such programs as the ZEV initiative. It underscores the need to be out in front of the curve with EV charging.

The law is aimed at moving ahead quickly but wisely, creating vehicle-grid integration (VGI) solutions now that will succeed in the near-term and scale effectively.

And then, of course, there are incentives for getting more consumers behind the wheel of an EV. There are broad-scale programs at the federal and state levels aimed at charging up the sale of EVs. But there are also lots of local and state rebates and tax credits and other incentives geared directly toward purchasing and installing EV charging equipment. Many electric utilities also are offering incentives of varying kinds, from special rates to help paying for charging stations.

Buying and driving an EV is not only good for the planet, but it makes a lot of sense financially, too. There's never been a better time to get onboard this ride into the future.

IN THIS CHAPTER

- » Cashing in on EV savings
- » Boosting your business with charging stations
- » Charging more smartly
- » Saving the planet

Chapter 7

Key Takeaways About EVs and Smart Charging

As an individual, there are a lot of good reasons for driving an EV and plugging into a smart charging station. As a business and an employer, there are plenty of benefits that smart charging can bring. As a utility, smart charging is smart for operations. This chapter offers examples all around.

Saving Money as a Driver

Until recently, electric vehicles seemed a bit like a luxury. There weren't all that many models, and their sticker prices were far above a lot of people's budgets. As production totals have risen more recently, the price per unit has dropped. And dramatic reductions in battery costs have really brought EVs much more in reach for the average driver.

Now that the price to acquire the wheels has fallen, it becomes more practical to focus on the cost of operation, where an electric vehicle really offers an advantage. There are a lot of variables that go into figuring the cost of gas per mile vs. the cost of electricity, but electric vehicles can easily go twice as far per dollar spent. Electric vehicles have fewer moving parts and lower maintenance costs, too.

Making Employees Happier

Having smart charging stations outside is a sign that you care about easing the daily routines of your EV-driving workers. If they know they can plug in while they're working, that's a plus for their time management. They just might be more punctual, too, because in a lot of places, EV drivers are allowed to zip along in the faster, high-occupancy vehicle lanes. Less traffic, more productivity. Some employers even make the charging station a free perk. That's a way to drop some extra spending money right into employees' pockets.

Helping People Find You

Just like smart charging stations make your business stand out among potential employees, they also put you on the map as a company to do business with. EV drivers want to couple charging with other convenient activities like grocery shopping, running errands, and so on and will favor businesses that offer a place to plug in. For EV drivers that take a long-distance road trip, hotels and pit stops that offer EV charging as an amenity become a part of the destination and an integral part of the driver's plans. Once the driver successfully uses the public charging station, the driver is also more inclined to use it again on their next long-distance journey.

Being Recognized for Sustainability

More and more Fortune 500 companies are making pledges and public commitments to sustainability, to win customers and employee loyalty. That kind of philosophy can take many forms, and one of them happens to be supporting the move toward electric-powered mobility.

That's because a lot of emphasis is placed on reducing your company's carbon footprint. If you're manufacturing something, you might be able to adjust your processes to use less energy or emit less pollution. And any kind of business can switch to more efficient lighting or heating, and acquire energy from renewable sources.

If your company operates a fleet, you can make an impact by switching to electric vehicles. If not, you can still offer home and workplace charging stations to encourage employees to drive EVs. Every time you succeed at that, you can cross off some of your carbon impact.

Easing Challenges for the Grid

Although EVs will invariably increase demand, networks of smart chargers like those enabled by Enel X JuiceNet technology can help ease the stress on the system. JuiceNet links smart charging stations across a wide territory into what effectively is a giant, virtual energy storage battery. The smart charging capabilities allow that virtual battery to schedule or curtail charging when supply is low and a reduction in demand will help, while ensuring the driver gets a full charge by their next trip.

These capabilities can be traded on wholesale markets to help balance the supply and demand on the grid. That, in turn, reduces costs for grid operators and helps the system run more smoothly. And it provides a nice counterbalance to the impacts of desirable but challenging renewable sources. That helps clean up the grid, for the benefit of the planet.

Getting Help to Get in the Game

As noted above, lower-priced electric vehicles are easier than ever to find these days. But you're not entirely on your own when you're making the move to electric, because incentives will ease the financial path.

Various levels of government and different jurisdictions offer financial incentives in the form of rebates or tax credits. You may qualify for a break to help purchase the vehicle, and depending on what you buy and where you live, you could be talking thousands of dollars. But wait, there's more! You also may qualify for deals that will help offset the cost of the charging station, in some case wiping out the cost altogether.

Charging in a Smart Way

If your utility charges higher rates at peak times and lower rates when the demand is less, you're going to want to take advantage of the lower rates. You can juggle that calculation yourself, or leave it up to your smart charging station to figure it out. It's really a worthwhile investment, because smart charging ensures that your car is ready to drive off whenever you need it next, while keeping your charging costs as low as possible.

Reducing Emissions

Emissions from internal combustion engines are among the major contributors to climate change. Our planet would be better off without the greenhouse gases coming out of tailpipes, and we'd all also be better off without the other pollutants. Zero emissions sounds pretty attractive.

That's what you get from an EV. Zero tailpipe emissions. No need for a tailpipe, really. But, you say, what about the electricity. Doesn't electric generation also play a big role in climate change? Yes, a lot of it does. But you may be able to power at least some of your driving with renewable energy, and even if your power comes from coal, studies show you're still adding less bad stuff to the air per mile you drive. A lot less.

Charging on the Level

Figuring out the basics of vehicle charging is as easy as 1-2-3. You'll be charging at one of those levels.

Level 1 is charging using regular 120-volt electricity. In North America, that's what most outlets deliver, so it's easy to find. But at level 1 you'll only get enough charge in an hour to go a few miles. Even overnight charging will leave you with fairly low range in the morning.

Level 2 is 240-volt electricity, like what's running your electric stove or clothes dryer. It's far faster, able to offer a full charge overnight.

Level 3 uses direct current, or DC power, for a superfast charge. Public charging stations may be level 3, so you can plug in and be back on the road after a reasonably short wait time.

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Enel X North America has ~4,500 business customers, spanning more than 10,000 sites. As a leading provider of smart electric vehicle charging infrastructure, Enel X also sold over 130,000 charging stations across the globe. Access low and no-cost EV infrastructure incentives with Enel X today to modernize your parking operations for years to come.

Ride into the future of electric vehicles

Electric vehicles have been gaining the hearts and minds of drivers for over a decade, and the electric future is officially here. Electric vehicles (EVs) are more affordable than ever; they're able to fit well into most people's driving habits, and they're changing lives and business practices. This book introduces the breakthrough known as smart charging, explains what it means for electric vehicle owners, gives insights to business owners, and explains how it can improve grid reliability, economics, and environmental performance.

Inside...

- Explore how EVs hit the mainstream
- Calculate why electricity beats gasoline
- Understand the basics of car charging
- Learn how charging works at home
- Invest in smart charging in the workplace
- Drive off and charge on the go

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