Electric Car Revolution

It's Going To Change The Automotive World Forever!

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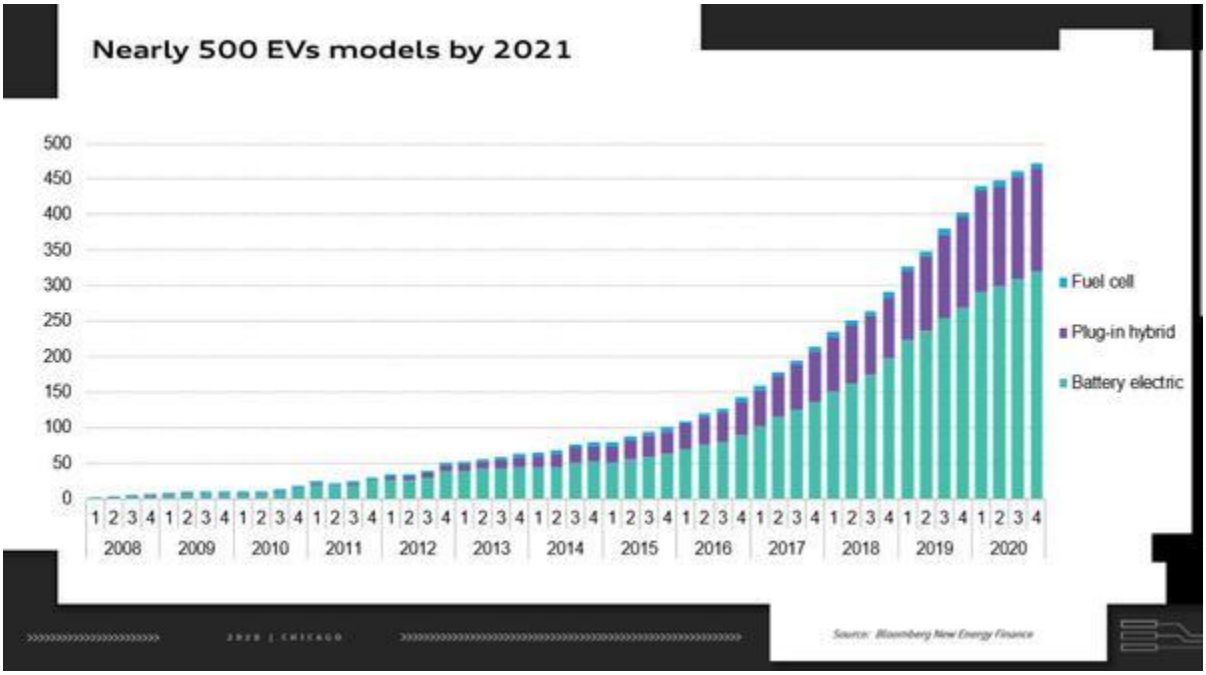
Disruptive technologies have a way of changing the world in rapid and unpredictable ways. Ten years ago, Apple introduced the Smart Phone. Today, nearly 8 out of 10 Americans own a Smart Phone, and over half of the world's population own Smart Phones. Smart Phones have literally taken over the world. In 2012, Tesla introduced their revolutionary Model S electric car. It was Tesla's first attempt at building an entire vehicle designed from the ground up, not just a conversion of an existing vehicle as was the case with the Tesla Roadster. Nobody thought Tesla would succeed as a car company let alone shake up the entire automotive manufacturing industry. Today, Tesla has sold over a million vehicles worldwide and their market capitalization is now worth more than GM and Ford combined! The rest of the auto manufacturers are scrambling to catch up with Tesla's technology leadership.

To date, electric vehicle sales haven't exactly set the world on fire. The numbers have been growing, but are still only about 2 percent of total vehicle sales in 2019. The relatively small numbers are due to their higher cost (mostly due to the expensive high voltage lithium ion battery), limited availability and public skepticism of their practicality. But all of these are rapidly changing.

EXPONENTIAL SALES GROWTH OF ELECTRIC CARS

First is the growth in sales of electric vehicles. Going back to 2011, it took almost 5 years for cumulative global electric vehicle sales to reach ONE million vehicles. Seventeen months later (2017), global electric vehicle sales had increased to TWO million vehicles. Ten months later (2018), sales passed THREE million vehicles. Six months later (late 2018), it blew past FOUR million vehicles. Less than six months later (2019) it passed FIVE million, and by early 2020 the number has now reached nearly SEVEN million vehicles! This is explosive exponential growth, and it demonstrates where the industry is headed.

Virtually every auto maker is now working to develop and produce new generations of Plug-in Electric Vehicles (PEVs). Over the next five years, we will see not dozens, but several HUNDRED brand new electric vehicles for mass production. A report from Bloomberg New Energy Finance estimates that by model year 2021, there may be as many as FIVE HUNDRED new battery electric, plug-in hybrid electric and fuel cell models available for sale!



By 2040, electric vehicles are predicted to account for over 60 percent of all new vehicle sales. How quickly that happens depends on a number of variables including the global economy, government action (or inaction) regarding climate change, regulations

regarding internal combustion engines, and ongoing improvements in battery technology , range and cost.

Right now, China has the highest number of electric vehicles compared to any other country in the world (three times that of the U.S.), while Norway has the highest percentage of electric vehicles on the road (over 50 percent of their vehicle population). In fact, Norway hopes to have nearly 100 percent of their vehicles fully electric within five years!

NEW ELECTRIC VEHICLES COMING

The new vehicles include passenger cars (both traditional sedans as well as ultra high performance super cars), SUVs and light trucks. Some of the new models that have been announced to date include:

Audi e-tron SUV

BMW i4

GM electric Hummer

Ford F-150 Electric pickup truck

Ford Mustang Mach-E SUV

Mercedes-Benz EQC

MINI electric hardtop

Nikola Badger electric pickup truck

Polestar 2 (made by Volvo)

Porsche Taycan electric sedan

Rivian R1t and R1s electric pickup trucks

Tesla Cybertruck

Tesla Model Y

Volvo XC40 Recharge SUV

Volkswagen ID.4

The point is, consumers will have more and more electric vehicles from which to choose as auto makers start to seriously transition their product lines away from internal combustion engines and move toward PEVs.

New Mustang Mach-E SUV will be a 2021 model, and will offer zero to 60 mph in under four seconds!

Tesla Cyber Truck will be offered with single or dual motor options, and be capable of towing up to 14,000 lb. while going from zero to 60 mph in 6.5 seconds.

Rivian electric pickup will have a range of more than 230, 300, and 400 mile depending on the battery pack. The 135-kWh model will be the fastest version with 754 horsepower and zero to 60 mph in 3 seconds! Who needs a Corvette with this kind of performance?

THE ISSUE OF PRICE

Today, most electric vehicles are 20 to 25 percent more expensive than gasoline or diesel-powered vehicles because of their high voltage battery. However, battery costs are coming down as worldwide production ramps up. Over the past ten years, battery costs have already dropped 87 percent, and will continue to decline. By 2025, industry experts predict electric vehicles will sell for the same price as comparable gasoline or diesel-powered vehicles. In other words, there will no longer be a price penalty for buying an electric vehicle.

PERFORMANCE AND RANGE ANXIETY

Many electric vehicles are capable of delivering impressive performance, accelerating from zero to 60 mph faster than many so-called gasoline-powered performance cars. Look at all the YouTube videos that have been posted of Tesla cars beating Mustangs, Hellcats and Corvettes at the drag strip. However, range anxiety remains a concern for some consumers even with electric vehicles that can travel up to 300 to 400 miles on a charge.

Range anxiety seems like a legitimate concern because if you run an electric car battery all the way down, you can’t just get a jump start to get your car going again (at least not yet). Your car has to be towed to the nearest charging station or electric outlet to revive the battery. But most people who own electric vehicles say this has never been a real concern for them. The car tells you how much range you have left so you can plug into a recharging station or electrical outlet before the battery gets too low. There are also

Smart Phone apps that communicate with your vehicle to keep you informed about the battery's state of charge and remaining driving range. So if you pay attention and plan ahead, there's little likelihood of running the battery dead.

Most people also overestimate how many miles they typically drive. The average American drives only about 30 miles per day, and 98 percent of most trips are less than 50 miles. These kind of ranges are well within the capabilities of today's electric vehicles. And for situations were longer trips are necessary, the availability of charging stations is addressing that issue as well.

A Bosch charging station with an electric Kia Soul.

Nearly 80,000 public charging stations have been installed in recent years across the U.S., with tens of thousands more on their way. A growing number of stores and strip malls now have reserved parking spaces where people can plug in their electric vehicle for a partial charge while they shop. Some parking garages, commuter lots and public building also have charging stations that allow convenient recharging.

How does the current availability of electric vehicle charging stations compare with the availability of gas stations in the U.S.? As of early 2020, there are about 168,000 gas stations serving almost 280 million cars and trucks (that's one gas station for every 1,667 vehicles). As for the 1.5 million electric vehicles currently registered in the U.S., that's one charging station for every 18.5 vehicles. So on a per vehicle basis, there are actually more charging stations per vehicle than gas stations!

The latest generation of super chargers can reduce charging times from hours to minutes. A 440v Tesla supercharger, for example, can achieve an 80 percent charge in under 40 minutes, and a 50 percent charge in about 20 minutes. It's still not as fast as refilling a gas tank on a conventional internal combustion-powered vehicle, but the recharging times continue to get faster and faster.

A 220v public or home charging station can typically increase the charge on a battery that is 40 percent charged up to 80 percent in about one hour. A full charge may take up to several hours to achieve.

The slowest charging is from an ordinary 110v electric outlet. A 110v electric outlet will typically deliver about 3 miles of range per hour of charging. Leaving the vehicle plugged in overnight will therefore give you about 24 to 30 miles of driving range. At this rate it may actually take a couple of days to fully charge a low battery.

GOVERNMENT INCENTIVES AND REGULATIONS

To encourage the development and growth of the electric vehicle market, many government entities have offered various rebates and tax incentives to buy an electric vehicle. The reason for doing so is because carbon emissions from cars and trucks is second only to coal-fired power generation as the leading source of man-made carbon emissions. Reducing carbon emissions is essential if we are to minimize the effects of global warming and climate change.

In the U.S. automakers have received a $7,500 tax credit for every electric vehicle they sell, up to 200,000 units. Six months after selling more than 200,000 vehicles, the tax credit drops to $3,750, then drops to $1,875 six months later, and eventually goes to zero. So as electric vehicle ramps up, most of the tax credits are going away. Even so, it's important to remember that the price difference between conventional internal combustion-powered vehicles and electric vehicles will also continue to narrow reducing the price penalty for buying electric.

One factor that may accelerate the shift to electric vehicles are proposals to actually ban the sales of new gasoline and diesel-powered vehicles in the future. Norway wants to phase out internal combustion engines by 2025, and Europe has proposed doing the same by 2030. The United Kingdom is talking about banning internal combustion engines by 2040. It's doubtful the U.S. would ever propose such a ban (except in California), preferring free market forces to determine how quickly the public adopts electric vehicles. Even so, the handwriting is on the wall that electric vehicles will proliferate and eventually dominate the market.

HOW ELECTRIC CARS WILL CHANGE EVERYTHING

Internal combustion engines will be around for many years to come, but as electric vehicle sales continue to grow it will mean big changes for the auto service and repair industries, Big Oil and how we drive from point A to point B.

Electric vehicles require almost no maintenance or service. There's no oil changes, no belts or spark plugs to replace, no filters to change (other than a cabin air filter or air filter for battery venting and cooling). Thanks to regenerative braking, brake pads are lasting upwards of 150,000 miles on most electric vehicles today. Consequently, new car dealers as well as independent aftermarket repair shops will see a decline in service revenue. The complexity of electric car technology also means many small repair shops will lack the training, experience and tools required to work on electric vehicles.

With every electric vehicle that is sold, Big Oil sees a drop in demand for gasoline and diesel fuel. The typical vehicle that travels 12,000 miles a year and gets 25 mpg burns about 500 gallons of fuel a year. With a plug-in electric vehicle, fuel consumption drops to ZERO gallons burned per year regardless of how many miles are driven. More electric vehicle sales, therefore, means less demand for gas and oil, less need for expanded drilling and fracking (and the environmental impacts that go with such endeavors), and lower profits for Big Oil.

So where will all the electrical energy come from to power the growing fleet of electric vehicles? Some of it will come from clean energy sources such as wind and solar. But realistically, much of it will come from conventional coal or natural gas-fired power plants and (horrors!) nuclear power.

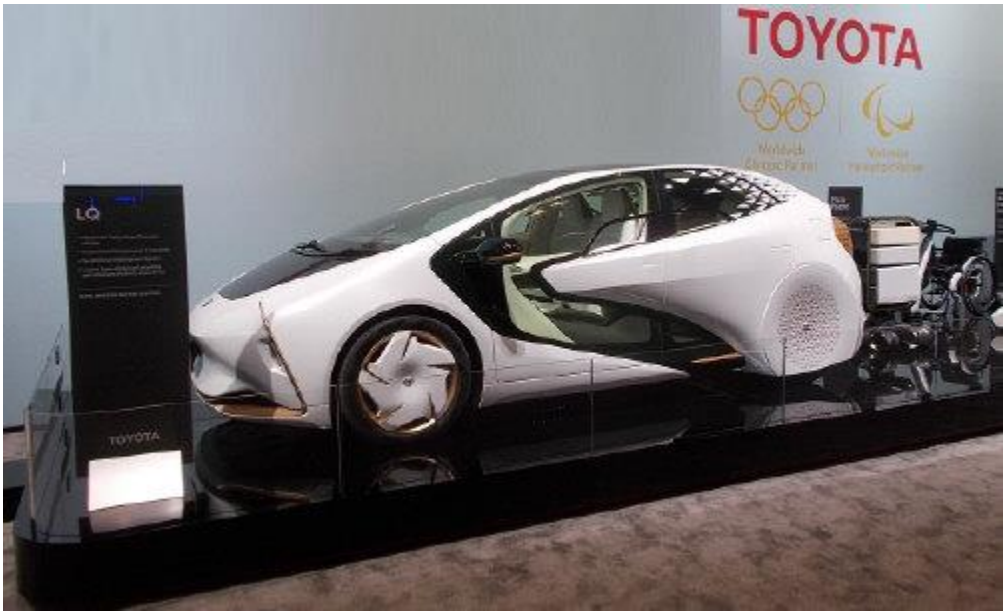
Actually, nuclear energy is both powerful and clean (zero carbon emissions), assuming there are no 3-Mile Island, Chernobyl or Fukushima type disasters. A single nuclear power plant can produce ten times as much electricity as a large wind farm (200-plus windmills), and it can do it reliably and continuously 24/7 regardless of weather or wind conditions. Although only a couple of new nuclear power plants have been built in the U.S. in recent years, the growing demand for electrical power will certainly require building many more nukes to replace older plants that are nearing retirement, as well as old coal and gas-fired power plants.

According to the U.S. Energy Administration, demand for electric power in the U.S. will grow from 4178 TWh (billion kilowatt hours) in 2019 to over 5000 TWh by 2030, and possibly much more depending on how fast electric vehicles take over.

In addition to changes in the power generating industry and how and where power is made available to electric vehicles, advances in self-driving technology will likely alter the driving experience itself.

If self-driving capabilities eventually make vehicles fully autonomous (meaning no driver input other than telling your car where you want to go), there may be a huge shift in the way people look at vehicles themselves. Cars may become simply a means of transportation rather than a status symbol. If you can't even drive the car, what difference does it make how fast it can go from zero to 60 mph? It becomes a tool to get you from one place to another . The route the vehicle takes and the speed at which it gets you there will be determined and controlled by a computer algorithm and V2V (vehicle-to-vehicle), V2I (vehicle-to-internet) and M2M (machine-to-machine)

communications via hi-speed 5G Wi-Fi connections. In other words, there will literally be no driving experience. Car makers will have nothing to sell consumers other than convenience and utility.



Self-driving cars such as this Toyota LQ concept will totally change the driving experience from one that is active and requires driver attention and input to one that is totally passive.

Some say private vehicle ownership may be replaced by some type of subscription transportation service. Why buy and maintain a vehicle when you can summon a self-driving car to your front door via your phone app when you need to go somewhere. A driverless Uber-type vehicle shows up and you pay a flat rate per mile to get from A to B. No car payments, no car insurance, no license fees, no maintenance costs, no auto repair bills, no trade-in ripoffs at the dealership, no arm wrestling a car salesman to get the best price, no problems getting financing. You just join a car subscription service and pay by the mile. That would be a real change for most of us, yet many young urban dwellers are doing just that by forgoing car ownership and using ride-sharing or short term car rentals (such as Zip car) when they need to go somewhere that is not served by public transportation or within biking or walking distance.

Electric vehicles will certainly bring about dramatic changes in the next decade and beyond, and we can only guess where they may take us. But one thing is for sure, we stand on the cusp of a revolution in transportation technology that will be as life-changing as the internet and the Smart Phone.

News Update: March 2020

VW Announces Electric Vehicle Plans

Electric vehicles are for millions, not just millionaires. That is the goal for Volkswagen Group since its commitment to the Paris Agreement on climate change last year. VW wants to be carbon neutral across its entire fleet of vehicles by 2050. A big step in that direction will be the launch of the new ID.4 electric SUV that is planned to go on sale within the next 12 months.

Based on the ID.CROZZ concept, the ID.4 is the second vehicle to use the Group's modular electric drive architecture (MEB), following the compact ID.3, and the first to be sold in America. The "ID" name stands for intelligent design, identity and visionary technologies, and the number 4 identifies the new model as a compact SUV segment.

"Climate change is happening, and it's time to do something about it," said Ralf Brandstätter, Chief Operating Officer of the Volkswagen brand worldwide. "That's where e-mobility comes in, and Volkswagen is pushing the pace of e-mobility for everyone."

With its high-energy battery pack in the floor, the ID.4 wraps a highly aerodynamic exterior around an open-space interior, with a cockpit controlled by touch or voice interactions. The ID.4 will initially be built with a rear-wheel-drive configuration, with a powerful, all-wheel-drive two-motor variation to follow. The ID.4 will have a range of more than 250 miles.

The ID.4 will initially be produced at the VW Zwickau plant, with production expanding in 2022 to VW's plant in Chattanooga TN.

Volkswagen Group says its worldwide target for electric vehicle production is 1.5 million EVs by 2025. “We’re going to invest 11 billion euros ($12.3 billion) in electromobility, more than any other automaker, with the aim of getting it out of its niche and making it affordable for all,” said Brandstätter."

News Update:April 27, 2020

Toyota passes 15 million hybrid electric vehicles global sales

Toyota crossed the symbolic milestone of 15 million hybrid vehicles sold since the 1997 launch of the Prius, the first full hybrid mass-produced car.

Now offered on 44 individual models across a wide range of size and body types, Toyota's hybrid electric technology has reduced CO2 emissions by more than 120 million tonnes worldwide. Toyota currently offers 20 different Hybrid Electric Vehicles (HEV) models in their Toyota and Lexus brands, which in 2019 accounted for 52 percent of total sales volume, and 63 percent in West Europe.

In Europe, the company has sold over 2.8 million hybrid cars, allowing it to be a leading automaker towards EU CO2 reduction targets of 25g/km in 2020 and 2021.

Toyota’s hybrid technology not only reduces global warming CO2 emissions, it also allows drivers to cover more than 50 percent of their journeys in and around the city in zero emission mode, offering an affordable way to improve air quality in urban cities.

Toyota’s decision to develop hybrid electric vehicles started over 25 years ago when Takeshi Uchiyamada led a team to develop a car for the 21st century, one which would reduce greenhouse gas emissions and other harmful pollutants. The first-generation Prius was launched in 1997 around the time of the Kyoto Protocol signing, which gave new momentum to the environmental movement.

Although hybrid vehicles have been a big success for Toyota, they believe the future will be a mix of Plug-in Hybrid vehicles (PHEV), Fuel Cell (FCEV) and Battery Electric (BEV) vehicles. By 2025, Toyota plans to launch 40 new or updated electrified vehicles, including at least 10 Zero Emission (ZEV) vehicles.

News Update: August 8, 2020

GM Announces New Line of All-Electric Vehicles

GM announced plans to build the Cadillac Lyriq, an all new electric luxury SUV that has a range of more than 300 miles using GM's latest battery technology. The Lyriq will begin production first in China, then the U.S. in late 2022.

The Cadillac Lyriq is just one of 20 new electric vehicles that GM plans to bring to market by 2023. The Lyriq will be built on a new modular platform that can be configured up to 19 different ways, depending on the model. These include 400 and 800 volt battery packs with capacities ranging from 50 to 200 kWh. The modular platform can also be fitted with front, rear or all-wheel drive. The Cadillac Lyriq will initially be offered with rear-wheel drive and a performance-oriented all-wheel drive package. It will also have a 100 kilowatt-hour battery pack that can handle DC fast charging rates over 150 kilowatts and Level 2 charging rates up to 19 kW.

Key to GM's new electric vehicles are all-new battery packs. The Ultium battery has a nickel-cobalt-manganese-aluminum chemistry that uses aluminum in the cathode to reduce the need for rare-earth materials such as cobalt more than 70 percent. The next generation Ultium batteries will be manufactured at a new factory now being built in Lordstown, Ohio.

Everything You Want to Know About Electric Cars

Volkswagen press release: Aug 18, 2020

The electric revolution will be coming soon to a street near you. Volkswagen will soon reveal the production version of the ID.4 electric SUV, part of a worldwide strategy to deliver millions of electric vehicles to help combat global climate change.

Electric vehicle owners know the joys of driving and owning a battery-powered model. But if you are on the fence about whether an electric vehicle may be right for you, VW put together this Q&A to answer your questions.

OWNING AN ELECTRIC VEHICLE

Why should I buy an electric vehicle?

Electric vehicles have zero direct emissions from driving and can help reduce carbon dioxide emissions compared to traditional vehicles. Researchers suggest that there may be no way to combat global warming without millions of electric vehicles worldwide. They are fun to drive and quiet on the road, plus you can recharge them at home. They are also far more efficient at using energy compared to liquid fuel vehicles, which waste about two-thirds of their fuel as heat and friction.

Simply put: Electric vehicles are the future of personal transportation.

Why is Volkswagen building so many EVs?

VW has pledged to make its global business carbon neutral by 2050, and electric vehicles will help make that possible. By 2025, VW plans to build about 1.5 million electric vehicles a year worldwide, including vehicles produced at its new U.S. factory in Chattanooga Tennessee.

Are Electric vehicles as safe as regular vehicles?

Yes. All VW electric vehicles are subjected to intense safety testing. They must meet rigorous safety standards and crash tests required by law, and often exceed these standards.

Are the batteries in EVs just versions of what I have in my phone or laptop?

While most electronics use some form of lithium-ion battery today, the chemistry and design of an EV battery is quite different than those used in consumer electronics.

The battery in my phone only lasts a few years. Will I have to replace the battery in my EV?

EV batteries in vehicles are not designed to be replaced like those in phones, and it is rare for an EV owner to face that issue. EVs are designed to provide a certain amount of power for many years of ownership. While all batteries can lose charging capacity over time, VW EVs have several strategies to help combat that process, from liquid cooling to energy reserves. For example, the Volkswagen e-Golf came with an eight-year or 100,000-mile (whichever occurs first) limited warranty on the battery pack.

CHARGING AN ELECTRIC VEHICLE

How long does it take to charge an EV?

That depends on how much power the charger can provide, and how fast the vehicle can accept it. There are three general levels of charging power:

Level 1 is your typical 120-volt plug. Most EVs can get roughly 2-5 miles of range per hour of charging at one.

Level 2 chargers are the most common; they run off 240-volt circuits and can add about 12-25 miles per hour of charge. Most charging is either Level 1 or 2, and about 80 percent of all vehicle charging takes place at home.

Level 3 is commonly known as DC fast charging and requires special equipment with heavy-duty cables and inverters. These systems typically are only found at public charging stations and used for occasional recharging on long-distance drives. A Level 3 charger can recharge an EV battery to 80 percent capacity in roughly 30-40 minutes. (Charging speeds at a DC fast charger slow for the final 20 percent of capacity due to heat buildup.)

Because the power coming out of an outlet is typically alternating current (AC), and vehicle batteries rely on direct current (DC), that electricity has to be converted, and the vehicle's onboard converter can only handle a certain amount at a time. That is why fast charging uses DC. It bypasses the onboard converters. Charging times can also be affected by temperature extremes; very hot or cold weather can slow charging rates and lower the total amount of energy the battery can hold.

Can I plug in anywhere, or to any EV charger?

Not quite. All Level 1 and Level 2 chargers use the same standard plug, but there are different plugs for DC fast charging. It can be a bit frustrating, but more automakers are moving to use the Combined Charging Standard (CCS) already used on all Volkswagen Group EVs.

Volkswagen EVs come from the dealer with a Level 1 charger that plugs into a standard three-prong, 120-volt outlet. However, if you have a driveway or a permanent parking place, you will likely want to get a Level 2 charger installed at your home. Many apartment buildings and parking garages are also installing Level 2 chargers nationwide. There are about 59,000 public Level 2 CCS chargers available in the United States, along with about 2,500 CCS DC fast chargers, and more are being built.

What if I do not have a set parking place?

That is one of the challenges that VW, along with companies like Electrify America, have been working to overcome. Some EV owners may be able to rely on charging at their workplaces, or paid public charging. Other firms are building chargers that can be added to public streets.

How much energy does an EV battery pack hold?

The non-scientific answer is: A lot. According to federal energy data, the average U.S. home uses 30.5 kilowatt-hours of energy a day. The smallest battery pack in the Volkswagen ID.3 electric hatchback sold in Europe could power that typical home for a day and a half. The largest available pack for the ID.3 holds 82 kilowatt-hours of energy – or roughly 5,500 times that of your smartphone.

Can I plug my vehicle into an outdoor charger if it is raining?

Electric vehicle charge ports and plugs use software to confirm they're properly connected before sending electricity to a battery, and they're designed to work in all weather conditions.

DRIVING AN ELECTRIC VEHICLE

EV people say driving one is fun. What's so fun about it?

It is the very nature of electric driving. Your gas-powered engine makes its maximum torque and horsepower when it revs up to a few thousand revolutions per minute. An electric motor makes its maximum torque the instant it begins spinning, and it makes for a great driving experience. The last generation Volkswagen e-Golf was as quick to 30 mph as the same-generation Volkswagen GTI, even though the GTI had nearly 100 horsepower more than the e-Golf.

Volkswagen EVs will come in rear-wheel-drive and all-wheel-drive versions, and the VW electric vehicle chassis locates the battery at the bottom of the car, giving it a low center of gravity designed for better handling.

EVs are also quiet to drive because there is no engine noise or exhaust noise.

How far can I go in an EV?

Every EV in the United States has an EPA rated range estimate for a full charge. In daily use, EVs offer a constantly updated estimate of available range, based on your current driving data, your recent past driving history and other factors such as temperature and HVAC usage. Your range estimates may be lower in winter or higher in summer than the official number; batteries tend to work best at moderate temperatures and lose some capacity in extreme cold or heat.

What about range anxiety? Is it something I should worry about?

Range anxiety can happen to EV owners, but it is no different than planning your fill-ups in a gasoline-powered vehicle. According to federal data, the average American commuter was traveling about 35 to 40 miles per day before the pandemic; the next generation of Volkswagen EVs starting with the ID.4 are engineered to have EPA estimated ranges that well exceed those daily driving needs. Beyond that, the number of public charging stations continues to grow, and more tools than ever are available to help EV drivers find a charging spot.

What is regenerative braking?

EVs all work the same way: Batteries feed electric power to a motor, which turns the wheels. One of the ways EVs can help save energy is by regenerative braking, which simply reverses that flow -- using the wheels to turn the motor and send power back into the batteries.

VW EVs have a sophisticated set of sensors and software that lets drivers decide how much regenerative braking they want, and whether they want the system to kick on the moment they take their foot off the accelerator pedal. At higher speeds, you may want to coast as far as possible. In stop-and-go traffic, the regenerative braking can make driving even more efficient.

While regenerative braking can handle a lot of speed reduction, EVs do also have traditional friction brakes. The software system ensures a safe engagement of the traditional brakes as needed.

What kind of tires do EVs have?

EVs typically come with low rolling resistance tires that help extend their range while still providing assured handling. These typically do not cost more to replace than comparable regular tires.

Are the wheels on an EV different from those on other vehicles?

Well-designed EVs minimize aerodynamic drag as much as possible to maximize their range. Wheels designed to smooth the air flow around the car can make a noticeable contribution to range in most EVs.

What about a transmission?

VW EVs do not have a traditional multi-gear transmission and do not rquire them. The motor connects with the wheels via a single-speed gearbox. You can set different driving modes that offer either more sporty acceleration, or those that can help save energy and are designed to extend your driving range.

SAVING THE PLANET WITH AN EV

Do EVs really reduce carbon dioxide compared to gas vehicles?

Yes, they can over time, especially when they use renewable energy sources.

While EVs do require slightly more energy to build, they can make up that CO2 deficit and then some over their useful lifetimes. Exactly how much less CO2 emissions driving an electric vehicle results when compared to driving a gasoline-powered vehicle depends on the source of the electricity the owner uses for charging, which varies by geographic region. Low or no CO2 power generation includes nuclear pwoer plants and green power generation such as wind and solar. As electric grids continue to move toward cleaner power generation (which also includes substituting less expensive and cleaner burning natural gas for coal), the CO2 benefits of EVs will continue to grow. But even at today's mix of energy sources in the United States, electric vehicles can have a significant CO2 benefit, as most emissions are lower for electricity generation than burning gasoline.

Do electric vehicles cost more or less than comparable internal combustion engine vehicles?

Electric vehicles typically have higher MRSPs than comparable gas-powered vehicles due to the expense of batteries. That said, many electric vehicles, including the upcoming Volkswagen ID.4, qualify for government incentives, such as a potential U.S. federal tax credit of up to $7,500. They can also be cheaper to run, as the cost of charging is generally lower than the cost of gas to drive a comparable distance. Plus there are fewer parts that need servicing (i.e., no more oil changes), which can result in lower scheduled maintenance costs. Depending on how long you own the car and how much you drive, these lower costs may help offset an EV's initial higher purchase price.

Volkswagen's strategy to make electric vehicles more affordable and available for millions of people involves driving down the cost of the components, including batteries.

How much does it cost to charge an EV?

If you charge at home, your EV recharging costs are based on your electric rates. In some places, EV owners can get special programs from their electric utilities that offer special discounts for charging at night or during off-peak times. The current U.S. average price of residential electricity is 13 cents per kilowatt-hour. At that rate, a full recharge of most EVs today would cost less than $10, which is much less than a comparable tank of gas in a conventional vehicle.

Public chargers range from free to more expensive than home charging for DC fast charging, depending on their power levels and networks. In general, charging your EV is still less expensive than filling up a tank of gasoline.

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Best Electric Cars (Edmunds)

Listing of Every 2019 and 2020 Electric Cars and SUVs (Cars & Driver)

Electric Vehicle Resources:

Electric Auto Association

EVObsession

Plug In America

Ultimate Guide to Charging an Electric Car