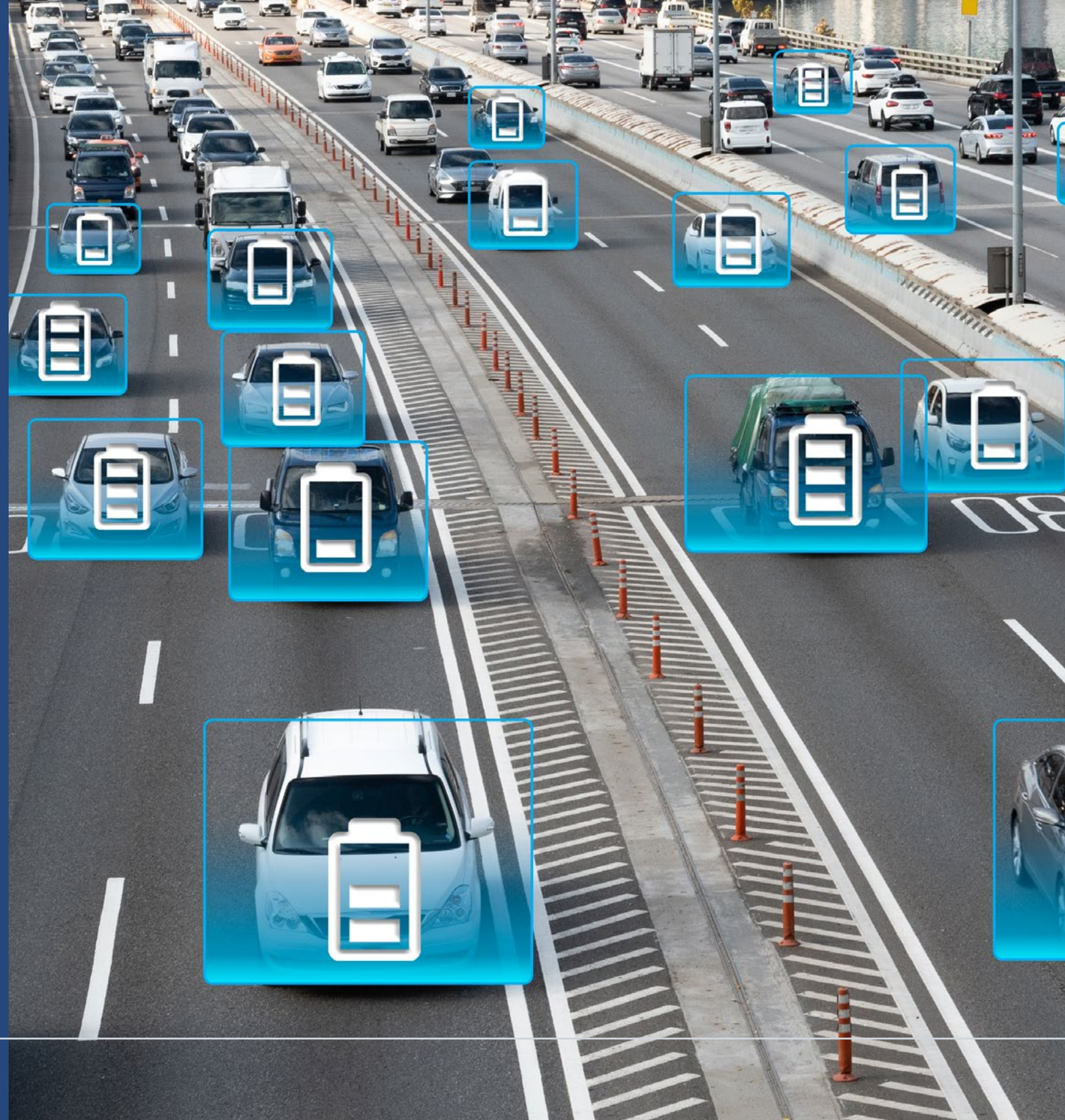
GEOTAB

The Ultimate Guide to Fleet Electrification



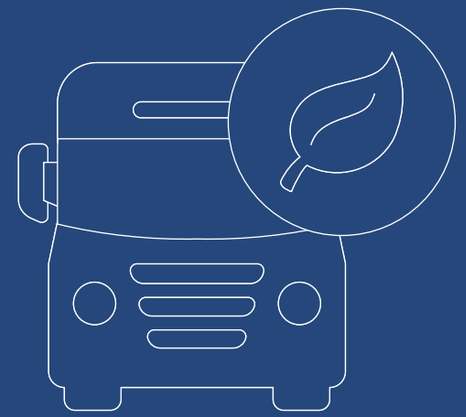
The Ultimate Guide to Fleet Electrification

This is your go-to resource for understanding the business case for electric vehicles (EVs), and how implementing them into your fleet can turn into a great investment.

If you own or operate a fleet of vehicles, you may be wondering whether an EV investment is right for your organization. Or you may be aiming to hit a sustainability target and believe electrifying a portion of your fleet is the solution.

The reality is that EVs are here to stay. It's not a question of if EVs are coming to your fleet, but when. So, where do you start?

From dealing with change-adverse operators to figuring out which vehicles can match their traditional internal combustion engine (ICE) vehicle counterparts, there are many unknowns. We're here to help you solve those challenges and set a smooth course for electrification and EV fleet management.



Ready to get started? Let's dive in.

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CHAPTER 01

What is an electric vehicle?

Your neighbor owns one, you see them in parking lots and on highways – EVs are everywhere these days. But what exactly is an electric vehicle? Let's start with the basics.

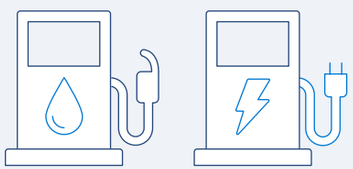
What is an electric vehicle?

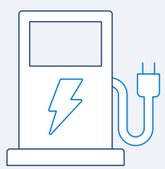
The distinguishing feature of an electric vehicle is its use of a battery and electric motor for propulsion. EVs use a battery pack to power the motor that then has to be recharged by plugging into an electrical source. Battery vehicles continue to gain momentum and while passenger cars have led the way, we're now seeing a variety of sizes and classes including electric vans, trucks, buses, forklifts and even transport trucks making their way to market.

Types of electric vehicles

Electric vehicles can be generally classified as PHEV, BEV, HEV or FCEV. Let's drill down into the key differences:

Plug-in electric vehicles





Plug-in hybrid electric vehicles (PHEVs)

+ Electric motor that can be charged by plugging in plus an ICE that runs on liquid fuel (that either helps to propel the vehicle and/or powers the battery as a generator).
+ Fuel supplements the battery as a power source, effectively extending the range.
+ Some PHEV models only use fuel when the battery is depleted, as a backup generator.

Examples include: Mitsubishi Outlander PHEV, Chrysler Pacifica Hybrid, Ford Fusion Energi and Toyota Prius Prime.

Battery electric vehicles (BEVs)

+ Fully electric vehicles with no gasoline engine.
+ Convert energy stored in battery packs to electricity to power an electric motor and turn the wheels.
+ Can recoup some charge back from regenerative braking. Once the battery has been depleted, it has to be plugged into a charging station or electrical outlet to recharge.
+ Emits no exhaust from a tailpipe. (BEVs don't even have a tailpipe!)

Examples include: BMW i3, Chevy Bolt, Nissan LEAF, Volkswagen e-Golf, Tesla Models 3, X, Y and S.

Other types of electric vehicles

Hybrid electric vehicle (HEV)

+ Not generally considered electric.
+ Small battery and electric motor.
+ Unable to charge from the grid.
+ Can only be recharged by the gasoline engine (as a generator) or through regenerative braking during use.

Examples include: Toyota Prius Hybrid, Honda Civic Hybrid and Toyota Camry Hybrid.

Fuel cell electric vehicle (FCEV)

+ Use a fuel cell to convert hydrogen storage in tanks, into electricity.
+ Have a small battery pack to increase efficiency.
+ Electricity is used to drive the electric motor.
+ While HEVs and FCEVs are classified as electric vehicles, this document focuses only on plug-in electric vehicles.

What is EV range?

EVs are advertised with a rated range – this is how far a vehicle will travel on a single charge. Real world range will depend on a number of factors including temperature, passengers or load, geographical conditions and driver habits. Electric vehicles come with different battery sizes, or capacity (measured in kilowatt hours: kWh or watt hours: Wh), depending on their make and model. Larger battery packs offer longer range.

TIP

Hot and cold climates can impact an EVs range – this is true for both consumers and of course, fleets. The Temperature Tool for EV Range can help you uncover the impact extreme temperatures will have on your day-to-day range to help you ensure you have the right vehicle for the job.

Understanding the EV battery

Electric vehicles use Lithium-ion batteries of various designs, similar to those used in cell phones and laptop computers, only on a much larger scale. Lithium-ion batteries have a high-energy density and are less likely than other types of batteries to lose their charge when not being used.

Batteries naturally degrade over time, meaning their ability to store energy and deliver power diminishes. EV batteries are covered under manufacturer warranties, and data to-date shows degradation has on average been minor. For detailed research on battery degradation in EVs, check out our analysis of over 6,300 EVs.

A number of factors can impact the speed of battery degradation:

- **High state of charge (SoC)**
- **High current**
- **High temperatures**
- **Low state of charge (SoC)**
- **Energy cycles**
- **Low temperatures**

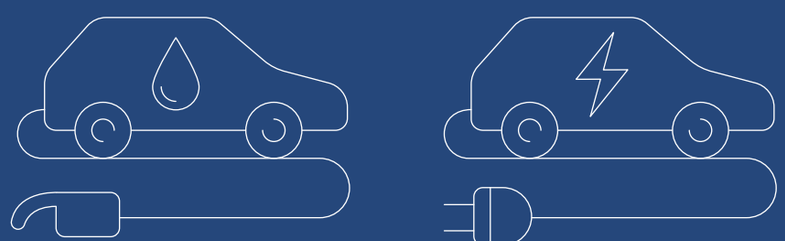
DID YOU KNOW?

Battery-powered vehicles are not a new phenomenon. In fact, electric vehicles have existed as long as gasoline-powered cars. What has changed, however, is better battery technology and growing public attention to the many environmental and economic benefits that EVs can provide.

Similarities and differences between gas vehicles and electric cars

Sitting inside an electric car for the first time, you'll notice that nearly everything is in the same place as it would be in a traditional ICE vehicle.

The accelerator and brake pedals are in the same spot. The gear shifter is located either between the seats or on the steering wheel. But, while they may look similar, there are some key differences in EVs.



1 One-speed transmission

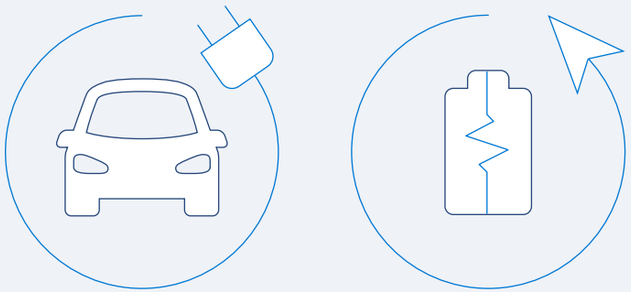
Most electric cars operate only in drive (one-speed) mode. In conventional vehicles, many speeds are needed because the combustion engine can only be operated in a narrow speed band, and the efficiency is highly dependent on the engine speed.

By contrast, electric motors operate over a very wide speed band, and can maintain high efficiency across this band. Electric motors can also provide torque in both directions so a single gear ratio can be used for both forward and reverse, unlike combustion engines.

2 Instant torque

While ICE vehicles take many revs to get to maximum torque, electric cars have access to the majority of torque from a stop. Therefore, EV acceleration is superior to equivalent gas-powered cars.

It shouldn't take long to adjust to the additional power available every time you put your foot down. This rapid acceleration is useful when drivers need to increase speed quickly to enter a highway or freeway.



Energy is captured during regenerative braking and recycled back to the battery.

3 Regenerative braking and Eco mode

A variety of EV makes and models have Eco settings to maximize vehicle efficiency.

EVs feature regenerative braking, which sends kinetic energy back to the battery whenever the driver brakes. If you brake smoothly, you will recapture most of the energy used by the car to brake. In many EV models, you can see on the main display what percentage of the energy used was captured.

Some vehicles will allow you to control how aggressively the car slows down when your foot comes off the accelerator. Regenerative braking can help train vehicle operators to accelerate and stop smoothly, by using a single pedal for most of their driving, thereby conserving energy and range. One-pedal driving is also useful in congested city driving, as the vehicle automatically slows when the accelerator is released, allowing drivers to easily slow down and speed up through traffic, without constantly slamming on the brakes.

4 No engine noise

Perhaps the most obvious difference between ICE and electric vehicles is engine noise. EVs operate on silent electric motors, so you only hear the quiet whirring and tire noise. If a pedestrian or cyclist is not actively watching the road they may not hear a slowly approaching EV.

DID YOU KNOW?

The European Union implemented a regulation requiring new EVs to be equipped with an Acoustic Vehicle Alert System (AVAS) that produces noise when traveling under 20 kmph (12 mph) so pedestrians can hear an EV approaching. This rule goes into effect on July 1, 2021. In the U.S., the National Highway Traffic Safety Administration (NHTSA) has also published a Quiet Vehicle safety standard, which mandates minimum sound requirements for new hybrid and electric vehicles by September 2020. The rule requires hybrid and all-electric vehicles to emit a sound to warn pedestrians that a vehicle is nearby, when traveling up to 18.6 mph.

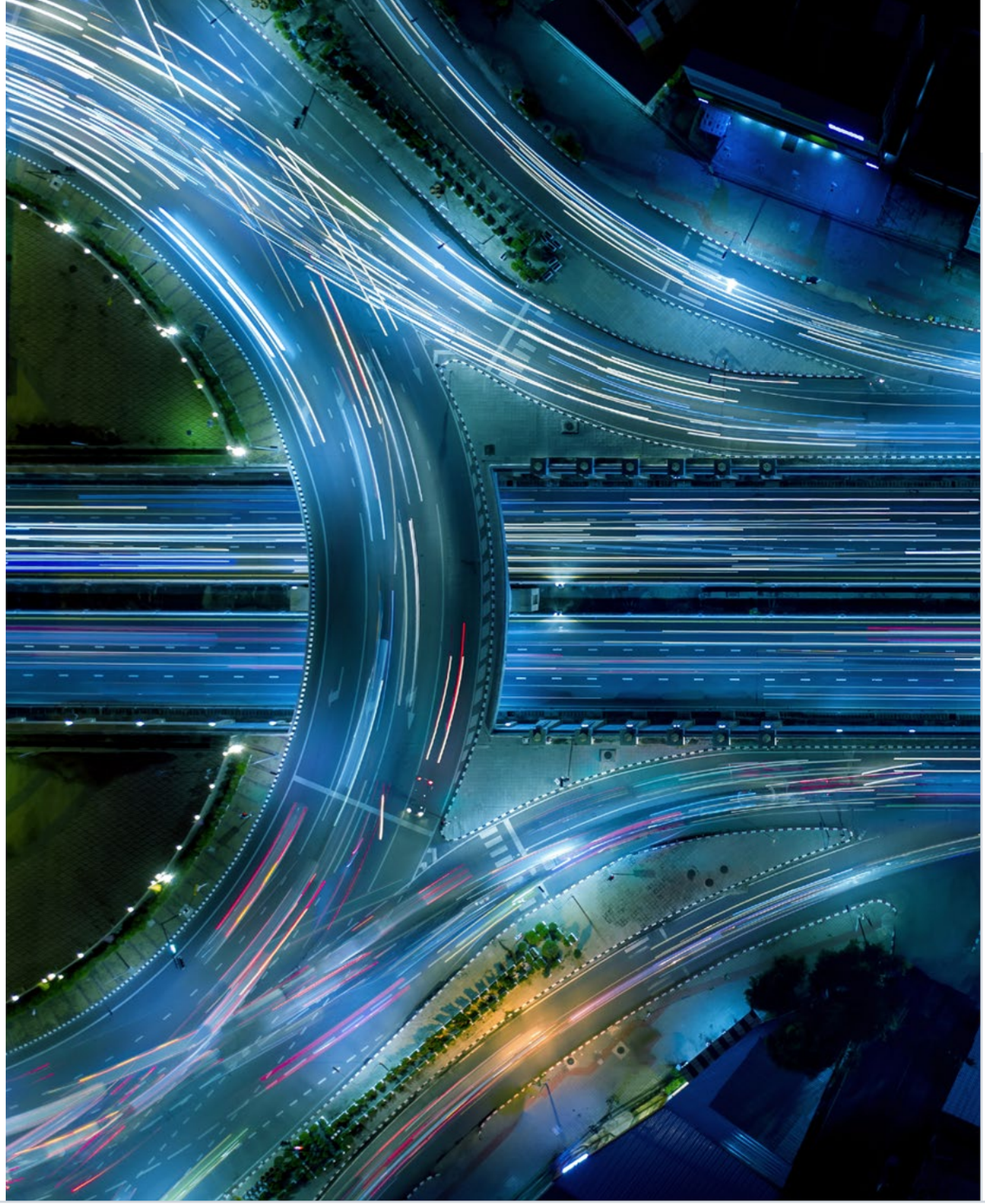
CHAPTER 02

Electric vehicle benefits for fleets

Now that you have a better handle on the basics, let's take a look beneath the surface and identify some of the key benefits for fleets considering electrification.

Even though the number of EVs on the road is proportionally small on a global scale, the electric mobility movement is expanding at a rapid pace.

The EV driving model can benefit nearly everybody, including fleets. Operators will benefit from lower running costs while drivers enjoy improved performance in some of the most cutting-edge vehicles on the planet, all while reducing negative impact on the planet's atmosphere.



KEY TAKEAWAY

BloombergNEF predicts that by 2040, there will be over 500 million passenger EVs and 40 million commercial EVs on the road.

Safety benefits

Electric vehicles have additional built-in safety benefits for fleet managers. Let's explore a few of them here.

High safety ratings

EVs must not only undergo the same safety testing and standards requirements as ICEs, they must also meet EV-specific standards for limiting chemical spillage from batteries as well as securing batteries during a collision. Plus, EV carmakers are upping the safety quotient by loading the vehicles with more standard features.

Because BEVs operate without an engine and all associated components, they are structurally safer than conventional vehicles. The space typically occupied by a combustion engine provides a larger crumple zone to absorb energy during a collision and protect drivers and passengers. And, while some collisions may result in a fire in a conventional vehicle, EV fires are extremely rare.

Thanks to the placement of the battery packs, a major benefit of an EV is that most of its weight is low to the ground and distributed more evenly. This helps to prevent dangerous vehicle rollovers, which, according to statistics from NHTSA, are more fatal than other types of vehicle collisions.

It's widely known that the extra money you pay upfront for an EV tends to come back in the form of fuel savings down the road. But those EVs will also pay dividends in fleet safety – which can, in turn, add up to real dollars in terms of insurance and collision costs.

DID YOU KNOW?

Nearly all electric vehicle models sold in North America meet or exceed the safety ratings of the leading gas-powered vehicles in their class.

Maintenance benefits

EVs have lower maintenance costs due to fewer moving parts and no particulate buildup. Fewer parts to maintain and repair means a substantial amount of money saved over the vehicle's life, but also can lead to a better safety record. Some known safety hazards of gas cars include misfiring cylinders, bad spark plugs or damaged timing belts, all of which can be dangerous if they occur while driving. EVs, in contrast, have none of these parts.

Brakes on EVs also end up with less wear and tear. Thanks to regenerative braking systems – which capture and restore energy that would otherwise be lost to friction – EVs end up putting much less strain on their brake pads.

Save on fuel

Swapping out gas-powered vehicles for EVs can help fleets save money on day-to-day expenses – one of the biggest being fuel. According to Forbes, on average, it costs less than half as much to travel in an EV than a gas-powered vehicle.

EVs are three to four times more efficient than ICE vehicles at converting energy to motion, and electricity rates are less than average fuel rates across the globe. Additionally, electricity rates tend to be much more stable than gas prices, meaning budgeting is easier with more predictable operating costs.

DID YOU KNOW?

According to a Consumer Reports study, EVs cost half as much to maintain as ICEs.

Sustainability

Electric vehicles are a great opportunity for fleets looking for ways to improve air quality to meet organizational – and even global – climate change goals.

Thanks to their zero-emission design, BEVs directly contribute to better air quality by eliminating the tailpipe emissions presented by their ICE counterparts, and reducing total emissions anywhere from 30% to 90%, depending on the energy grid.

As the COVID-19 pandemic brought into sharp focus in 2020, one noticeable side-effect of taking ICE vehicles off the road (due to stay-at-home measures to reduce the spread of the virus) was a major decline in transportation CO2 emissions across the globe.

Fleets can work to maintain at least some level of this decrease in emissions by committing to a transition to EVs wherever possible.

Budgeting

EVs have more predictable operating costs. While gas prices can be highly volatile in any given year, electricity prices tend to be more static, so fleet managers can prepare more accurate budgets.

Incentives are often available for EVs, as governments around the world continue to encourage EV adoption. While some programs target private consumers, fleets can often reap these rewards too. Working with your vehicle suppliers and reviewing incentive sites such as PLUG 'N DRIVE electric vehicle incentives in Canada and Federal and State alternative fuel incentives in the U.S. can keep you up to date on all of the possible rebates and credits for your EVs, some of which may be stackable.

Driver satisfaction

While it's normal to be hesitant when trying something new, EVs tend to win drivers over quickly with their fast and smooth acceleration, reduced noise and great handling. EVs also have a pretty good reputation among new owners, many of whom never go back to gas.

CHAPTER 03

How much do electric cars really cost?

It's no secret that electric vehicles carry higher sticker prices than comparable ICE vehicles. Even as the cost of EV batteries continues to fall and EV proponents promote the value of total cost of ownership (TCO), the biggest challenge facing electric vehicles is still affordability.

But, fear not. With EV costs set to keep falling, many industry experts predict that we are approaching a tipping point that would finally see EV purchase costs undercut gas and diesel cars post-2022. In the meantime, it's important to take into account the many financial benefits associated with EVs (refer back to chapter 2 for a refresh on fuel and maintenance cost savings), rather than focusing solely on the upfront costs.

How long does it take to recoup the cost of an EV?

Given that EVs have a higher sticker price out of the gate, the upfront acquisition costs could overshadow long-term gains. You might start to question when the fleet will break even on cost.

The answer really depends on the vehicle, the location specifics of gas and electricity prices, and how much you put the vehicle to work.

Cost comparison of three popular electric cars

We looked at three electric vehicles and compared them to their closest gas-fueled equivalents. Using U.S. national average electric and gas prices, we calculated fuel costs per mile for each model and added them to the post-credit Manufacturer Suggested Retail Price (MSRP) of each vehicle over time – or "miles," as the case may be.

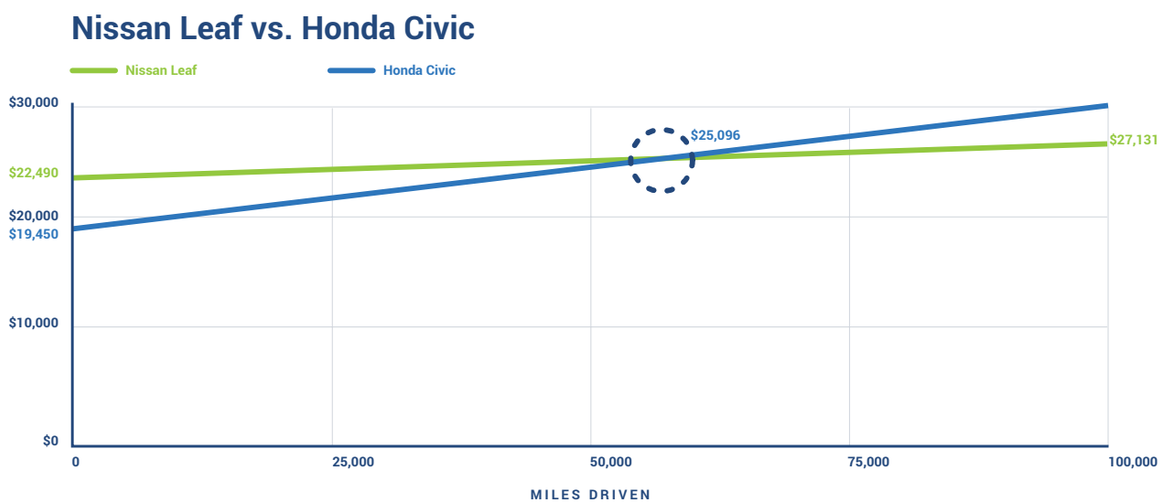
Using this simplified approach (and without factoring in maintenance costs), these plug-ins recouped their premium (and then some) during the normal lifespan of a vehicle, with some offering significant cost-of-ownership savings over time.

1 2019 Nissan LEAF

($22,490 MSRP USD *after U.S. federal rebate) vs. 2019 Honda Civic (now $19,450 MSRP USD/ 36 mpg)

The base-level 2019 Nissan LEAF is a low-cost compact EV, with a range of 150 miles on a single charge, to handle the vast majority of daily consumer and fleet demands.

The Honda Civic is one of the most popular and well-reviewed compacts on the market, but it doesn't take long before the LEAF starts paying fuel cost dividends at 56,154 miles driven.

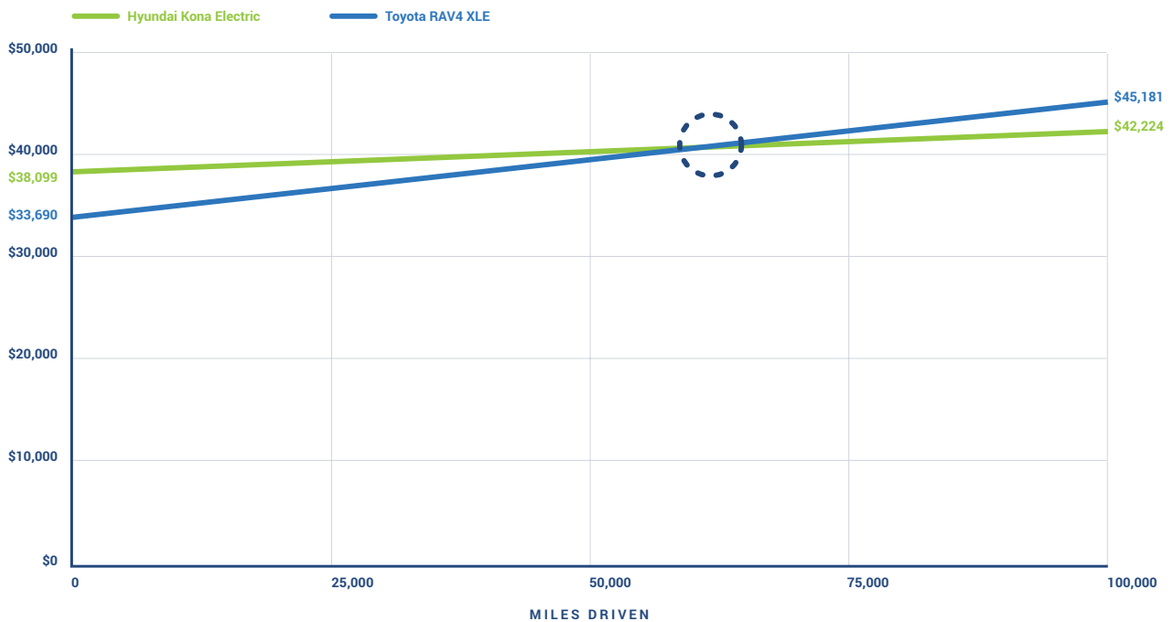


2 2019 Hyundai Kona Electric

($38,099 MSRP USD *after U.S. Federal rebate) vs. 2019 Toyota Rav 4 XLE ($33,690 MSRP USD/ 30 mpg)

The Hyundai Kona Electric with 258 miles of range takes on the top-selling Toyota RAV4. Crossover SUVs are hot in the U.S. market right now, with RAV4s at the top of the pile. Consistent with the Nissan Leaf, the Kona starts to pull ahead at 59,859 miles driven.

Hyundai Kona Electric vs. Toyota RAV4 XLE

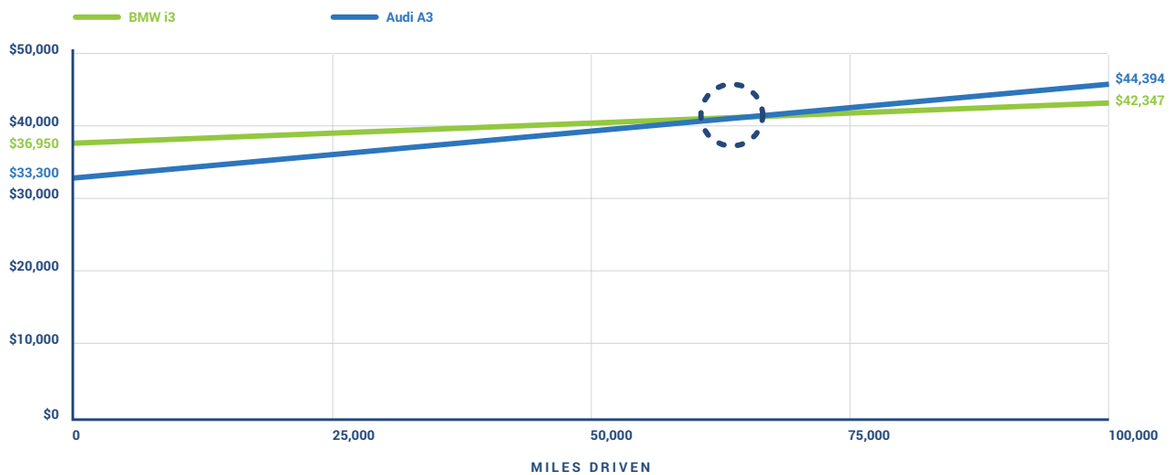


3 2019 BMW i3

(now $36,950 MSRP USD *after U.S. federal rebate) vs. 2019 Audi A3 (now $33,300 MSRP USD/ 25 mpg)

The BMW i3 is a small compact electric vehicle with a range of 115 miles. For its internal combustion analogue, we chose the Audi A3, whose mix of stylishness, performance and size appeal to a similar demographic of buyers. The i3 revs its savings engine at 64,068 miles driven.

BMW i3 vs. Audi A3



KEY TAKEAWAY

Over time, EVs will beat their gas equivalents on total spend, and the more you put your EV to work, the faster you will realize a return on the higher upfront investment. Plus, EVs simply cost less to maintain when compared with ICE vehicles.

CHAPTER 04

EVs for public fleets

As North American governments look for ways to reduce air pollution and combat climate change, all eyes turn to the transportation sector, which accounted for 28% of U.S. greenhouse gas emissions in 2018.

In order to do their part to reduce emissions, local governments can certainly do something about the vehicles employees drive in municipal fleets. Hundreds of thousands of gallons of gasoline are consumed every year, including from:

Police vehicles on patrol duty	**Parking authority vehicles circling the block in search of offenders**	**Parks department vehicles making the rounds**
Transportation services for city officials	**Street sweepers and waste collection vehicles in public works departments**	**City and school buses making their stops**

Municipal fleets play a significant part in a city's transportation emissions, and the switch to electric vehicles and hybrids is the easiest way to address the problem. Governments from Atlanta to New York City to Vancouver have already begun the transition, suggesting the solution will work, no matter what political party happens to be in power.

Many municipalities started with transitioning their passenger car fleets, but now have targets set for all vehicle class sizes. Transit authorities across the United States are also beginning to move their buses to electric.

According to CALSTART, California, Washington, Florida and Colorado lead the U.S. in zero-emission buses (ZEBs). And, because much of the technology used in ZEBs can be used in other types of medium- and heavy-duty vehicles, CALSTART expects electric shuttle and school buses, delivery vans and others to follow suit.

Motivating factors for government fleets to electrify

Here are four factors persuading governments to shift their fleets to electric vehicles and hybrids:

1 Cost savings

Los Angeles has the highest number of plug-in vehicles on the road in North America, so government officials did not have to sell citizens on the technology. When Mayor Eric Garcetti announced the city would lease 160 EVs and create the largest municipal plug-in fleet in the U.S., he cited the extraordinary savings in operating costs.

According to L.A. officials, the savings would amount to 41% for the vehicles that switched from gas engines to battery power. Compared to $0.37 for conventional city cars, EVs would cost $0.21 to operate per mile. Because of favorable incentives for plug-in vehicles in the state – which can be rolled into leases – upfront costs would also not drain city wallets in the short term.

2 Air quality control

The worst effects of air pollution are invisible, but city residents have palpable trouble breathing when particulate matter is elevated. Anyone living in congested downtown areas will notice the smell and oppressive air conditions when city vehicles are idling nearby. This quality-of-life issue can be addressed in every municipality by putting cleaner-operating EVs into service.

Air pollution from idling is of particular concern as an idling combustion engine releases twice as many exhaust fumes as a vehicle in motion. Green transportation initiatives can play a major factor in improving air quality as EVs are idle-free.

3 Smarter budgeting

Los Angeles chose to lease plug-in vehicles with purchase incentives rolled into monthly payments. This technique allows municipal budget planners to free up funds for other capital investments. For instance, cities that buy EVs through these types of government incentives, can use the money they save for infrastructure fixes like potholes or adding more bus routes.

Any city or county government looking for a way to shore up infrastructure should investigate the fleet incentives available for leased EVs and plug-in hybrids. Fiscal responsibility and improved public services are popular initiatives in every party and region; it's what voters everywhere expect governments to do competently.

4 Meeting emissions goals

Reducing emissions remains a top priority in many major cities. For example, over 400 U.S. city leaders gathered in Honolulu, Hawaii for the second annual Climate Mayors Summit.

Here are four examples of cities with ambitious sustainability goals:

+ Vancouver officials vowed to have the cleanest air of any major city on the planet.
+ New York City expanded the OneNYC plan to cut emissions 80% by 2050.
+ Seattle and Berlin commit to be carbon-neutral by 2050.
+ Manchester, UK promises to be "carbon zero" by 2038.

Each of these cities plans to meet their goals by deploying electric vehicles and hybrids in municipal fleets. In New York, Mayor Bill de Blasio's administration is replacing 2,000 gas vehicles used by city employees with plug-in models, which will slash fleet emissions 50% by 2025.

In Seattle, where transportation emissions account for the bulk of the city's greenhouse gas (GHG) pollution, the city's EV initiative extends from the public sector outward. City trucks running on diesel will convert to renewable fuel, while non-emergency vehicles in municipal fleets will convert to plug-in models. Charging station infrastructure will be accessible by Seattle residents, easing the crossover in the private sector.

HOW TO MAKE THE BEST GOVERNMENT EV PROCUREMENT DECISIONS

Every municipality hoping to create a better quality of life for citizens should explore the benefits of adding EVs to the fleet mix. Knowing how to access available incentives, budget operating costs and deploy electric models is essential when making the switch. This knowledge is only possible with data from real-world use.

CHAPTER 05

Exploring the EV market

The key to making an educated investment in electric vehicles – one that is almost certain to pay off in the long run – is identifying your fleet's needs and finding the vehicle that best matches them.

+ **How many miles do you drive each year?**
+ **How often do you travel outside of the range capabilities of mid-range EVs like the Nissan LEAF?**
+ **How much does gas and electricity cost in your area compared to other parts of the country?**

Understanding your fleet's driving patterns and how to maximize operational efficiencies can provide the additional clarity needed to take the EV plunge and reap the rewards of driving gas free. Without an accurate assessment of your current fleet's typical range and duty cycles, however, it's very difficult to determine if an EV can do the job. Using telematics data to capture existing driving profiles can help establish a baseline for going electric, or not.

DID YOU KNOW?

In states like California, gas prices are often more than 20% higher than the national average.

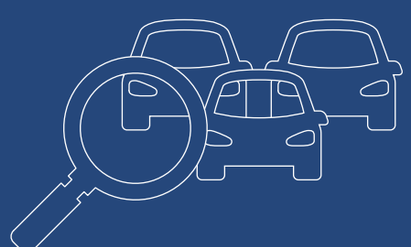
Choices, choices, choices

Given that EV prices are falling, businesses face fewer limitations with plug-in vehicles than they did in the past. Of course, with more options available, deciding on the right EV for your organization's needs has become slightly more complex.

The steady increase in light-duty passenger EVs is not to be overshadowed, as more choices become available in commercial vans, trucks and buses as well. The race to electrify the medium-to-heavy duty vehicle space is heating up, with traditional OEMs competing with market disruptors like Tesla, Rivian, Chanje and BYD offering exclusively electric vehicles.

We've looked at several EV models to determine their best use in vehicle fleets. These vehicles represent a range in size of EV models that could be deployed easily in a fleet.

This is just a small sample of the models to choose from. Here is a complete list of EV models available in the U.S.



Hyundai Kona

+ Fully electric
+ 258 miles of range
+ Charge in under one hour with DC fast charger (DCFC)
+ Popular choice for police forces in Europe

Nissan Leaf

+ Top-five ranking in fuel economy
+ 150 miles of range (extended range available in Leaf Plus model)
+ 106.3-inch wheelbase, EPA classified as mid-size car
+ Best for administrative functions with frequent travel, small parcel delivery or utility surveyors traveling short distances
+ Can be purchased under the $25,000 USD mark with federal tax credits

Mitsubishi Outlander PHEV

+ Higher seating, increased head and leg room
+ Flexible interior cargo space
+ Ideal for construction and retail service fleets
+ 4WD
+ Well suited for snowy conditions
+ 80% charge in just 30 minutes with DCFC

BYD 8TT

+ Long-range Class 8 fully electric truck
+ 483 horsepower, 1,770 lb-ft torque
+ 125-mile range with a full load
+ Anheuser-Busch has already deployed 21 of them in California

Chanje V8100

+ Medium-duty electric panel van
+ 6,000 lbs payload
+ 675 cubic foot cargo bay
+ 150 miles on a single charge
+ Touchscreen display and ergonomic interior

Although electric vehicles will not work for all fleets, for many, they do have real advantages over gas and diesel-powered vehicles. Here's a handy tool for comparing an EV to a similar gas vehicle.

"The race to electrify the medium-to-heavy duty vehicle space is heating up, with traditional OEMs competing with market disruptors like Tesla, Rivian, Chanje and BYD offering exclusively electric vehicles."

EVs are the future for last-mile delivery

When looking to identify the use cases where electric vehicles can save you money, don't pass over last-mile delivery. Expectations in the industry are that EVs will transform last mile delivery, as urban driving is seen as the perfect environment to showcase the benefits of EVs.

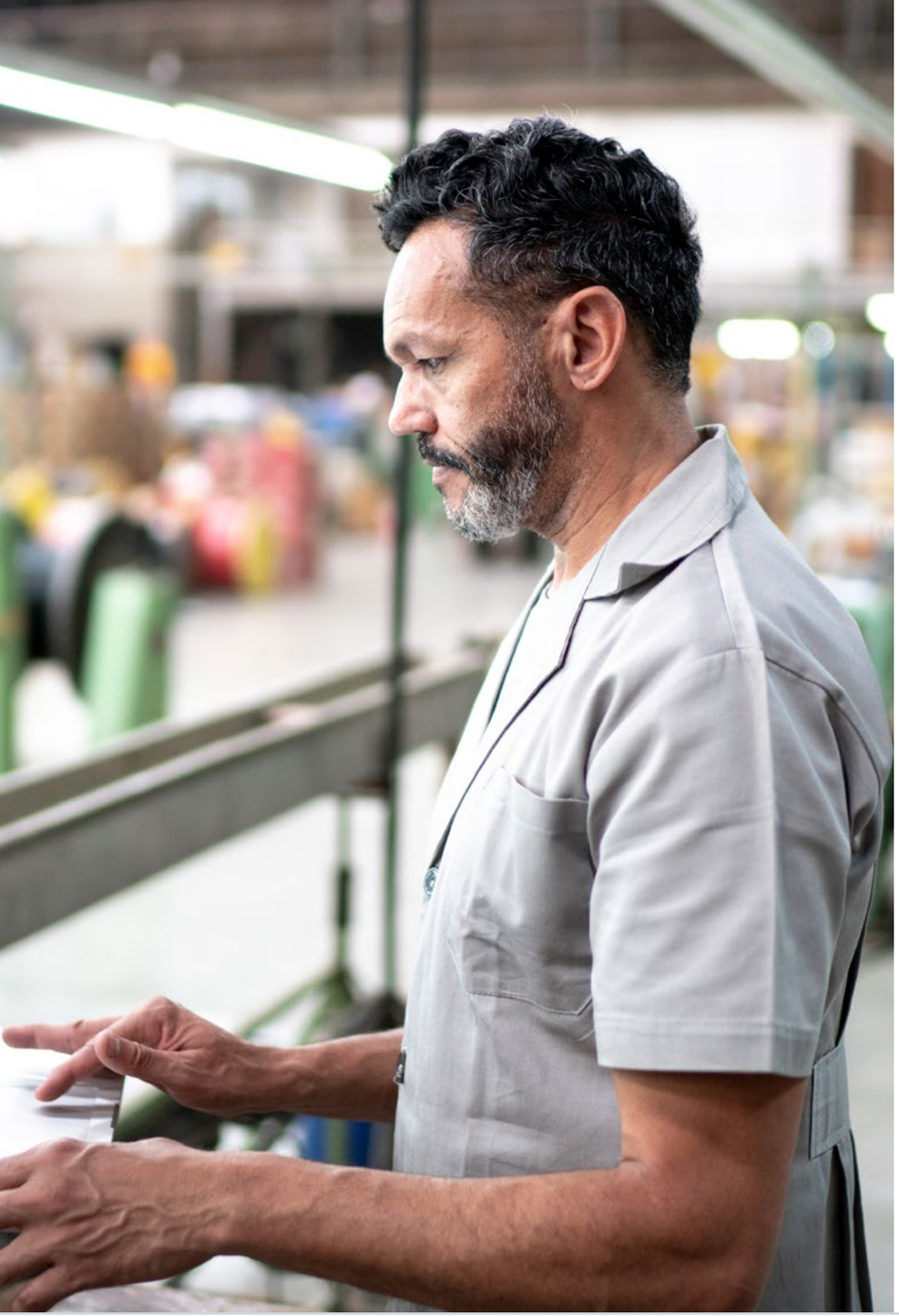
Pressure is rising from cities and their inhabitants for cleaner delivery options. EVs improve noise levels and air quality in city centers where millions of people live and work. Low-emission zones and zero-emission zones continue to emerge across the globe, gradually forcing carriers to move to electric fleets in order to cut costs and continue to serve those regions. Plus, with the growing choice of electric vehicles capable of last mile delivery, fleets are electrifying faster than ever before.

Utility fleets are embracing EVs

With more of their customers making the move to electric, utility fleets are in a unique position to embrace the transition themselves, to better understand their customers needs as well as the added stress to the grid. As an example, New Brunswick Power believes EVs will play a key role in changing the way power is generated and delivered through their smart grid infrastructure.

Rideshare and carshare companies are jumping into EVs in a big way

Increased pressure from consumers demanding green strategies, including the accelerated adoption of electric vehicles, is propelling rideshare and carshare companies to act quickly to electrify their fleets. Both UBER and Lyft have announced their plans to transition to electric by 2040 and 2030 respectively.



CHAPTER 06

Creating an EV adoption strategy

When beginning your EV adoption journey, it is important to answer three key questions to get a clear understanding of the requirements for new EVs, beyond just matching a vehicle size. Documenting your specific needs is important whether you are switching only one vehicle to electric, or all.

TIP

Looking at usage across all vehicles in a fleet, a savvy fleet manager may reassign vehicles to ensure the right vehicle is used for the right job to optimize the fleet. This way an EV isn't overlooked because of those two long trips it takes a year.

Mapping out your EV adoption strategy?

Here are some key questions to ask:

1 What is the maximum distance the vehicle drives in a day?

By determining the maximum range a vehicle completes in one day, you are able to better choose what kind of EV you require. A long-range battery EV can keep up with duty cycles over 200 miles, but you may only need a short-range EV to get the job done.

Analyzing the maximum distance driven by a vehicle is a useful first step when considering EV adoption.

2 What are my current costs for running the vehicle?

Electric vehicles are priced higher than their traditional internal combustion engine counterparts. Understanding your current ICE vehicle costs can help you choose an EV that will save you money in the future.

The higher price tag of an EV can be offset when you look at the total operational savings of the vehicle over its lifetime. As we've mentioned before, other than the obvious savings in fuel, EVs are more reliable and cheaper to maintain thanks to having only 20 or so moving parts, unlike an ICE vehicle, which has over 2,000. Plus, EV powertrains can last 200,000 miles, significantly more than that of ICE powertrains.

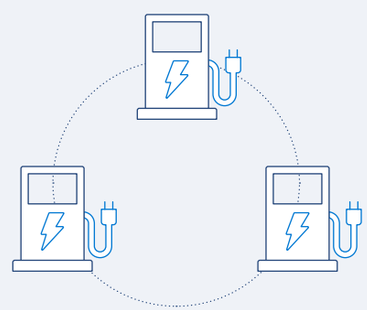
3 Where do they dwell, and for how long?

Figuring out where your fleet's vehicles spend the most time helps to build an effective strategy for deploying charging infrastructure. It will help determine how many stations you need, as well as where it makes sense to place them. This might lead to decisions about whether or not a regular wall outlet can accommodate your first few EVs.

Since each fleet's dwell time and location are unique, it's critical to use your own fleet's data when planning the infrastructure component of your EV adoption strategy.

How to plan EV charging infrastructure

One of the biggest stumbling blocks for organizations interested in adding plug-in vehicles to their fleet portfolio has been planning out EV charging infrastructure. Calculating vehicle costs, fuel savings and suitability become all the more difficult when you don't know where the cars are going to charge, how many stations will be needed and how much those stations will cost to install and use. Planning electric vehicle supply equipment (EVSE) requires examining a number of factors, and often varies widely from one fleet to the next.



Three key considerations for implementing a successful charging program

1 Where will the stations best serve your needs?

Do your vehicles typically park at:

+ Your fleet depot?
+ An office building?
+ Customer facilities?
+ Employees' residences?

Understanding where your vehicles go and what types of trips they make will be your first step in identifying the best locations for charging. Who owns (or has decision-making authority for) those facilities may also impact your charging deployment. Consider existing infrastructure: Is there currently available infrastructure in the areas your vehicles operate? Speak with local planners to find out if and where more stations are going to be installed in the near term.

A site assessment of your preferred locations with an electrician or electrical engineer will determine what electrical capacity is available, or if upgrades may be required. Site-specific considerations may include spacing and orientation of the parking and charging spaces, vicinity to the electrical service and safety features for the operators.

If you're planning a significant EV transition, communicating with your utility provider early is also important, as they may need to be involved in electrical upgrades to your facility, and they can advise on any commercial fleet rates that might be available.

Know your EV charging stations

Voltage
120V 1-Phase AC

Amps
12 – 16 Amps

Charging Loads
1.4 to 1.9 kW

Charge time for vehicle
3 – 5 miles of range per hour

Voltage
208V or 240V 1-Phase AC

Amps
12 – 80 Amps (Typ. 32 Amps)

Charging Loads
2.5 to 19.2 kW (Typ. 7kW)

Charge time for vehicle
10 – 20 miles of Range per hour

Voltage
208V or 480V 3-Phase AC

Amps
<125 Amps (Typ. 60 Amps)

Charging Loads
>25kW (Typ. 50-100 kW)

Charge time for vehicle
80% Charge in 20 – 30 minutes

2 How many charging stations will you need?

There's no one-size-fits-all formula for determining how many charging stations a fleet will need. A number of considerations come into play, including:

+ The duty cycles of the vehicles at each site
+ The balance of plug-in hybrids vs. all-electric vehicles
+ The capacity of the battery packs that will need to be charged
+ Whether the stations will be exclusively for fleet use or open to the public

For example, over a span of two and a half years, the County of Alameda, which encompasses twenty cities in the East San Francisco Bay Area, deployed 80 plug-ins into its public fleet. These vehicles were supported by 66 charging station installations over the same period, most located at a central hub in a downtown Oakland parking lot. The chargers are open to both government fleet vehicles and the general public.

3 What kind of stations will you need?

If your fleet utilizes plug-in hybrids with smaller battery packs, the ability to charge them in as many locations as possible may be crucial to maximizing their electric mileage.

Then there's the question of charge speed:

Level 1 charging

+ Sometimes referred to as "trickle charge"
+ Allows vehicles to charge using a standard 120-volt outlet in North America
+ Can take more than 20 hours to fully replenish the average EV

Level 2 charging

+ The most commonly used charge level
+ Can more than triple the charging speed

DC fast charging

+ Can bring a typical 100-mile EV to around 80 percent in just a half hour

Battery size, duty cycle and vehicle type are crucial factors in choosing between Level 1, Level 2 and (vastly more expensive) DCFC stations. Most plug-in hybrids aren't capable of DCFC charging, and in some cases may be fine with a standard Level 1 outlet, while a small fleet of all-electrics that tend to be in use around the clock (like taxis) may be best served by a shared DCFC station.

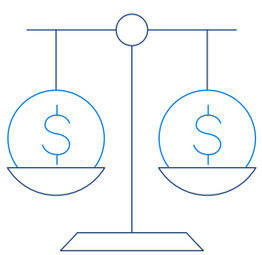
The National Renewable Energy Laboratory and the California Energy Commission have put together a helpful tool to assist you in figuring out how much electric vehicle charging you will need in your specific area.

The most compelling argument for installing no-frills charging stations is, of course, cost.

Level 2 charging stations can cost anywhere from a few hundred dollars to upwards of $5,000 USD. DCFCs are capable of adding 100 or more miles in less than an hour and start at $10,000 or more – depending upon model and installation costs.

Any decisions regarding which models of EVSE to purchase should be grounded in a firm understanding of your fleet's needs. In some cases, there's simply no getting around the need for more expensive charging equipment. If you need to control access to the stations, or want to offer charging for a fee to the public, you'll need a networked charger with RFID-reading capabilities. If you need to top off vehicles quickly for rapid turn-around use, you may decide to spring for a DC fast charger.

There are many reasons why you might decide a fast, top-of-the-line, networked charging station is the best fit. However, bigger isn't always better, and fleets can save money by sizing their equipment to take advantage of the natural dwell time of their vehicles, rather than opting for the speediest, most powerful options.



CHAPTER 07

Choosing the right EVs for your fleet

When it comes time to choose the right EVs for your fleet, your decision should consider whether the EV is capable of completing its daily duties and whether it will save you money over the long term.

When you're ready to take the first step towards procuring EVs, it's important to arm yourself with the most up-to-date information about available EVs and use real-world performance data to help inform your decision.

An Electric Vehicle Suitability Assessment (EVSA) is a tool that helps the fleet manager create a data-driven blueprint for electrification.

The EVSA analyzes fleet and vehicle data to make the case for an electric transition in a way that makes sense for the organization's budget and time frame.

The method for determining what vehicles are suitable to replace with electric can range from manual calculations and estimations in a spreadsheet, to using an automated tool that simplifies data input, all the way to commissioning consultants to prepare a fleet electrification plan tailored to the needs of the organization.

An EVSA saves fleet managers time

An EVSA allows you to be confident in selecting the right vehicles for starting the transition to EVs.

A key benefit of an EVSA is it that it can save fleet managers time by making it easy to compare EV options based on factors such as:

Retail price

EV type (BEV vs. PHEV)

Battery capacity/ range

Local availability

Maintenance schedules

The role of telematics in an EVSA

Telematics solutions provide access to a rich set of data points that can be used to refine the accuracy of an EV suitability assessment.

To start, telematics can provide accurate daily driving distance readings and compare them against the real-world range of EVs available in the market. Vehicle trip data will also highlight optimal charging locations and types, based on where and for how long vehicles dwell.

A more advanced assessment can use location information to get data on the local terrain where vehicles are driven. This data can be correlated to outside temperatures to figure out when to factor in climate control systems when modeling the EV's efficiency and range. With Geotab's support, we can help make your transition as seamless as possible.

Benefits of an EVSA

Going green also has direct financial implications in some areas. In central London, UK for example, EVs are exempt from the Congestion charge, priced at £11.50 per day. Other jurisdictions around the world are considering similar types of low emission and congestion fees.

Environmental impact

Electric vehicles provide a great opportunity for fleets to reduce their fuel consumption and carbon footprint. An immediate environmental benefit of using an EV is the elimination of idling emissions.

An EVSA can help quantify the tailpipe emissions reduction, fuel cost savings as well as any congestion toll savings. Some fleets take a holistic approach to emissions reduction when running EV assessments and identify opportunities to rightsize their fleet.

Operational requirements

Before diving into the total cost of ownership cost analysis, an EV must first and foremost be able to complete the required range. Analyzing the maximum distance driven for each vehicle in your fleet and comparing that distance to the real-world EV range provides an immediate pass or fail to help make decisions on an electric vehicle. An EVSA will analyze the daily driving range requirements (over the last 12 months, if possible, to capture business seasonality), to verify that the selected EV can complete its daily tasks on a single charge, to eliminate any concerns over range anxiety.

Financial analysis

After confirming that there are EVs capable of doing the job required, the next step is to understand the financial impact of acquiring EVs. More importantly, an EVSA can also help fleets determine whether a switch to EVs would save the fleet money over the lifetime of the vehicles.

The financial aspect of an EVSA calculates the lifetime cost of replacing a vehicle with an EV and compares it with replacing it with a traditional ICE vehicle. The following cost components are usually considered:

+ Vehicle acquisition costs (whether it is a purchase or lease)
+ Maintenance
+ Fuel and electricity
+ EV procurement incentives
+ Low-Emission Zone charges (where applicable)

An EVSA helps fleet managers understand the changes in the cost structure if they elect to acquire EVs. Typically, EV acquisition costs are higher, but the fleet will make up the difference with operational cost savings on fuel and maintenance.

It is also important to consider any EV government incentives available for the fleet. In some organizations, it is possible to unlock funds from sustainability programs aimed at reducing the organization's GHG emissions.

These funds, along with government incentives, can play an important role in reducing the total cost of ownership of EVs.

What do I get in a Geotab EVSA?

The Geotab EVSA draws on the largest dataset for real-world EV performance to offer data-driven recommendations for your fleet. It analyzes your fleet's unique patterns to identify the vehicles best suited for EV replacement. The Geotab EVSA also takes into account extreme weather conditions, financials, availability in the local market and more to help make your transition to EVs as seamless as possible.

How to rightsize

Rightsizing includes reducing the number of vehicles based on overall utilization, as well as the fleet's vehicle class composition. Ask yourself, does your fleet really need multiple pick-up trucks, or would a more cost-efficient vehicle be able to do the job just as well? Cost savings realized by rightsizing the fleet are then put towards electrifying more vehicles.

CHAPTER 08

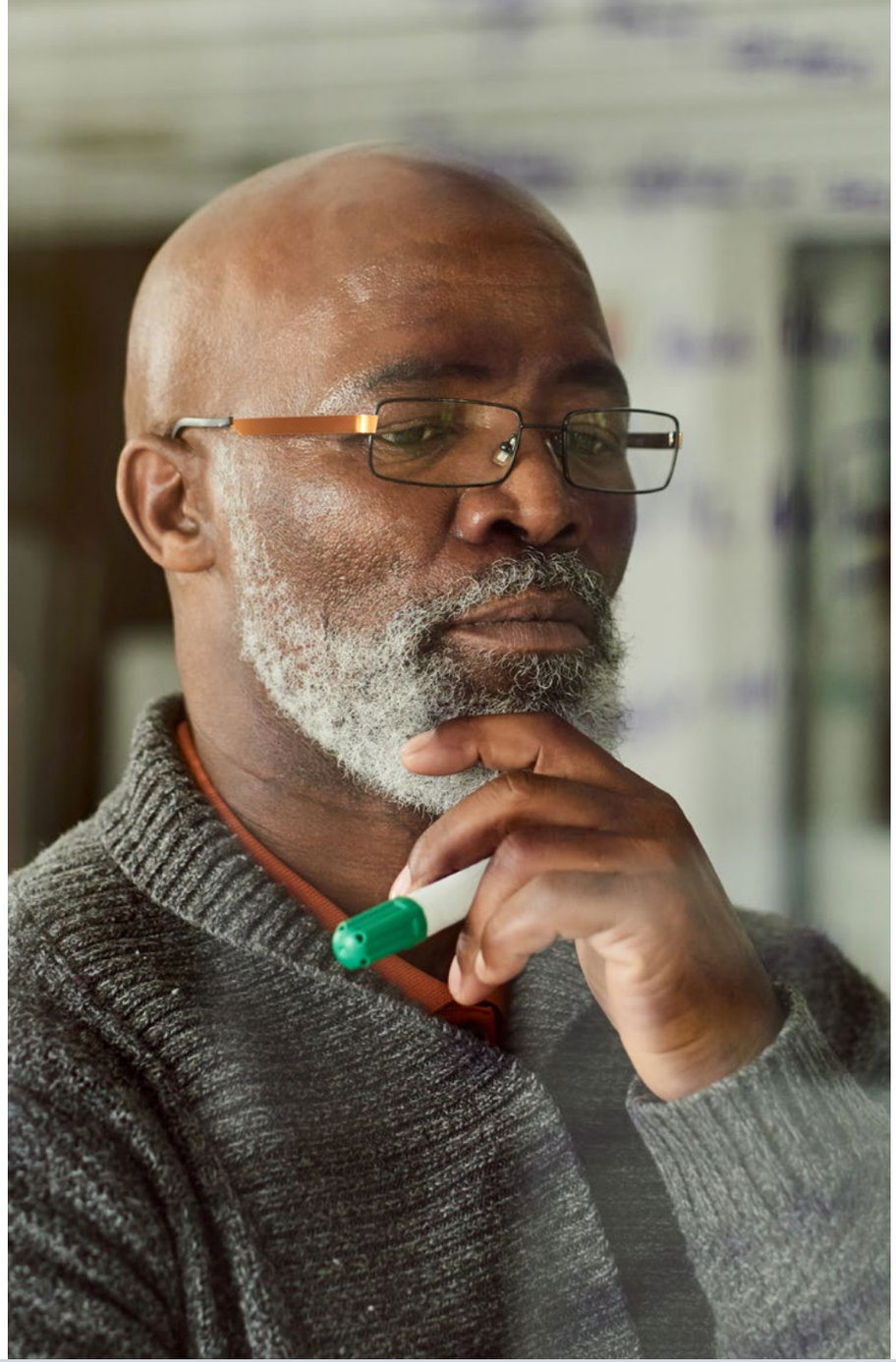
EV fleet manager FAQs

Once a portion of your fleet has electrified, it's time to shift your attention to ensure your EVs are managed effectively.

How do you apply traditional fleet management techniques to monitor performance?

Although electric and traditional fleet management is similar in some ways, there are some critical differences to be aware of. Aside from productivity indicators like utilization and downtime, EVs use different metrics that operators must understand in order to optimize fleet operations.

These metrics include, state of charge, electric miles versus fuel miles and charging details, like whether or not a vehicle has been plugged in at the end of a shift.



I've switched to EVs. Now what?

A comprehensive fleet management solution should fully support conventional, mixed and fully electric fleets. Integration of the all-in-one platform has demonstrated the ability to increase fuel efficiency, reduce operating costs, improve safety and optimize fleet capacity. EVs have unique metrics that must be properly monitored to ensure performance is optimized, while tracking range and SOC.

Let's take a closer look at some of the questions fleet managers who are in the process of transitioning to EVs should ask themselves before choosing a telematics provider.

Are my EV models supported?

An EV-friendly telematics solution should be equipped to access information for all of the models in your fleet, including EVs. While this may seem like a no-brainer, it's important to understand that EVs do not communicate vehicle-specific data in a standard way (unlike conventional ICEs). That's why it's vital to confirm your telematics provider not only supports the EV models you currently own, but they also have the historic track record and capability to support future models as your fleet expands.

What metrics should I use to monitor EVs in my fleet?

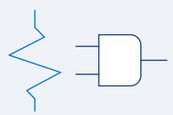
Basic monitoring of your fleet's EVs is vital to make certain you don't end up with stranded drivers. Your telematics solution should report the real-time SOC while EVs are on the road, to help you make the most efficient use of your vehicles.

Monitoring real-time SOC in percentage increments on a live map view tells you exactly which vehicles need to charge and how much they require to complete their daily tasks. You should also be able to set alerts for vehicles that should be charging but aren't.

Speaking of alerts, a telematics solution that properly supports EVs should be able to send notifications by email, SMS or web application to either the drivers themselves or to the management team.

Real-time alerts could include conditions like:

Low SOC



Optimized charging (e.g., an EV that wasn't plugged in at the end of a shift)

Charging complete

How do I know how much energy my vehicles are using?

While a conventional fleet uses fuel, EVs measure electric energy in kWh and Wh. Your telematics solution should allow you to monitor and report on the amount of "fuel" used by your EVs. This includes energy consumed while driving, as well as energy added back into the battery from regenerative braking. Monitoring the actual amount of energy each vehicle uses and produces is vital to understanding the true cost and efficiency of your EVs.

It's also important to keep an eye on your electric energy economy – a calculation equivalent to the miles per gallon or L/100km you would track with your conventional vehicles. MPG-e allows you to compare EV and ICE performance in a single fuel economy report, and provides insight into how your EVs are performing, and your typical real-world range.

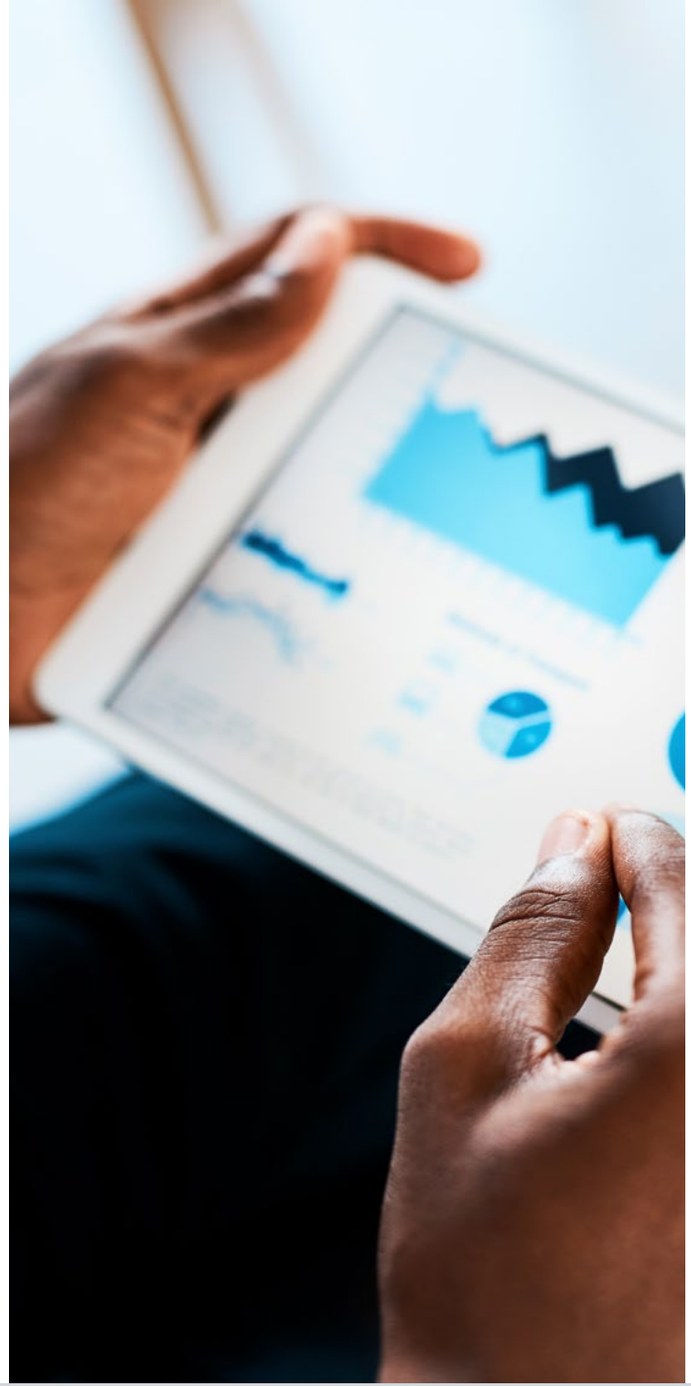
If you're adding PHEVs to your fleet, you'll want to make sure they're being used correctly and that no PHEV is being operated solely on gas. Your telematics solution should provide you with a report to show the combined electric energy and fuel consumed by each of your PHEVs over the total distance they've traveled to make sure your fleet is getting the greatest possible electric miles from your plug-in hybrids.

Charging data

The biggest difference between EVs and ICE vehicles is of course, how they "fuel up." Your telematics solution should supply you with an EV charging history log to provide insights into the SOC for each of your EVs, how they got to that charge level and how that helps you fully allocate charging costs to each vehicle. Having a complete charging history that includes where and when the EVs are charging, the length of time the EVs were charging at a specific location and the amount of energy they actually received will help form an optimized charging infrastructure strategy.

TIP

Still have questions about choosing the best telematics solution for your fleet management needs? Check out this handy checklist.



CHAPTER 09

How to optimize EV fleet operations

The EV value proposition for fleets can get somewhat complicated, but there are ways to maximize the technology's cost and emissions savings.

How can fleet managers get more out of their EV investment?

Optimize routes to maximize your electric miles while minimizing on-route charging.

Monitor charging and driving energy data to optimize EV use in the fleet.

Train operators on EV charging and driving techniques and improve charging compliance rates (e.g., introduce alerts if a car is plugged in, but not charging).

Increase utilization to take full advantage of EV range (low-use EVs don't have as fast a payback; they don't save unless you use them).

Introduce technology to share vehicles across staff and/or departments to improve utilization.

As with every other aspect of fleet planning, knowledge is a fleet manager's best weapon in combating waste with the right-sized fleet for daily vehicle runs. Using fleet telematics to know exactly how EVs are performing is the place to begin.

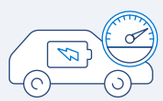
Tips for maintaining the EV battery

We now know that early concerns about battery degradation and range loss tend to have been overblown. Carmakers plan for these factors and design their vehicles to resist them to the greatest extent possible. Nevertheless, there are ways to extend the life of your battery and keep it in the best condition possible.

Some examples include:

Avoid long periods of very high or low SOC

Avoid charging in extreme temperatures



Minimize DC fast charging whenever possible

When an electric vehicle loses energy storage capacity, it could eventually render the car unusable without a costly replacement pack – which will set you back upwards of $5,000 USD depending on the model. Our analysis has shown that batteries should outlive the life of the vehicle under average usage and conditions.

Monitoring battery health will help you stay on top of any concerning trends. Telematics allows fleet managers to know how their vehicles are being used and even monitor the current health of a battery pack, including how much range has already been lost. It won't always be possible to follow the tips outlined, but creating a solid strategy to encourage EV best practices will prolong the life of your battery and save you money in the long term.

Maximizing EV range

An EV's usable range can vary on a daily basis, and will be impacted by:

+ Topography (i.e., hills)
+ Use of climate control – heat or A/C
+ Temperature
+ Speed
+ Driving habits (e.g., aggressive driving)
+ Load (number of passengers or goods)

With the use of telematics and data analysis platforms, fleets can monitor the performance and minimize the impact of many of these factors. This information can help fleet managers support drivers with feedback and general tips for improving performance.

The path to the best battery range is often specific to the vehicle model and how it's used, but in general, there are some foolproof ways to boost your EV battery range.

5 sure-fire tips to start improving EV range

1 Minimize the impact of extreme weather

After analyzing nearly 5.2 million EV trips, our data was able to show the ideal temperature for operating an EV is 70 F without impacting range. We know though that climate is out of an operator's control and in cities where temperatures regularly drop below freezing or spike near 100 degrees, EV owners need to be particularly cautious selecting and taking care of their cars to not significantly decrease their range.

Cold weather affects all vehicles, but the impact on EVs can feel particularly intense. Running an EV's heater, especially at full blast, puts a big drain on battery power. In the winter, dial down the climate control and instead rely on the heated seats and heated steering wheel (if your vehicle is so equipped) to keep things toasty, which uses far less energy. Also, preheat your car while it's plugged in so you can use the climate control less while driving.

Operating the air conditioning consumes battery power at a rapid rate as well. Try running only the fan, and not the compressor whenever possible or try rolling down the windows as operating the AC at full chill will drain the battery far quicker than driving with the windows down. Best to pre-cool the car in summer months while it's plugged in to help reduce the need to run the AC once you hit the road and advise operators to choose shade when parked on hot days.

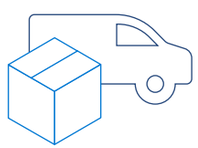
2 Go easy on the accelerator

Time may be money, but so too is electricity. Driving at excessive speeds is far less efficient for your vehicle.

In addition to watching your speed, driving smoothly is an easy way to conserve energy used from your battery so read the road ahead to reduce unnecessary acceleration and braking. An aggressive driving style often leads to heavier braking, which results in regenerative braking not being maximized.

We all tend to drive less efficiently when we're late, even though it tends to save much less time than we actually think. Optimizing vehicle use schedules and giving drivers an extra 5-10 minutes to get where they're going can have the effect of lightening his or her right foot – saving battery range and charging costs.

3 Minimize cargo weight

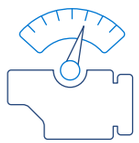


All vehicles lose efficiency the more weight they're carrying. For modest range improvements keep any non-essential weight out of the vehicle when it's in use. This may include passengers, equipment or delivery items. Every little bit counts. And of course, one trip is better than two, so optimize your trips, route and cargo to minimize miles.

4 Practice preventative maintenance

One of the best perks of all-electric vehicles is their relative lack of maintenance demands. However, something as simple as tire inflation can extend a battery's range by several miles per charge. Fleets can use vehicle data to optimize maintenance schedules and keep each EV in optimal shape during use.

5 Push past range anxiety



Studies have found that electric vehicle drivers tend to be overly cautious about running out of range. Educating drivers on how to use an EV's built-in range estimates alongside driving data and familiarity with routes should give them the confidence to get the most out of each charge. Unnecessarily cutting a trip short or delaying service to charge when more juice isn't actually needed can cost valuable time and money.

Conclusion

This guide is meant to serve you on your electrification journey but, as noted throughout, the best route to integrating EVs start to finish is with accurate and timely performance data. We've explored each necessary step to successfully electrify your fleet. As a recap, it's important to consider the basics, like:

+ What benefits do EVs bring to my fleet vs. an ICE?
+ What EV options are available to me and how much do they cost?
+ How will EVs fit in my fleet's driving cycles and where will they charge?

Once you have a solid general understanding of EVs and you're ready to take the next step towards electrification, it helps to create an EV adoption strategy built on data-driven insights to pinpoint the right EVs for your fleet.

And remember, adding EVs to your fleet is only a step toward greening your fleet and saving on fuel costs. A reliable telematics solution is vital to provide you with the data you need to monitor and optimize both the conventional vehicles in your fleet and the EVs. By having all your information in one place, you are optimizing the fleet usage, and ensuring that you are getting the maximum return on investment from your electric fleet.

For more information on EV fleet management, please visit us online.

Glossary

Eco mode – An economical mode option available in some plug-in hybrid vehicles. In order to run the vehicle more economically, Eco mode increases fuel efficiency by reducing acceleration levels and can also regulate auxiliary power in the vehicle.

Electric vehicle – A vehicle that uses a motor powered by electricity from a battery.

EV diagnostics – Vehicle system information and fault codes which can be collected via telematics and used to monitor the health of an EV as part of a vehicle maintenance program.

EVSA – An Electric Vehicle Suitability Assessment (EVSA) is a customized Geotab report for fleet and sustainability managers providing a multi-year procurement plan for EVs including ROI and a forecast of emissions reduction.

kWh per mile – The kilowatt-hours per mile (kWh per mile) represents how much electricity an EV uses in one mile driven, indicating its fuel efficiency.

Maximum range – The total number of miles an EV can be driven before it needs to stop and recharge.

MPG-e – Miles per gallon of gasoline-equivalent (MPG-e) is a metric used by the Environmental Protection Agency (EPA) to compare the fuel economy of EVs and other alternative fuel vehicles with gas-powered vehicles.

MyGeotab Rules Engine – A feature of the Geotab telematics platform that allows users to set fleet management rules for drivers such as for maximum speed limit, idling time or EV charging, then monitor compliance in MyGeotab.

Range anxiety – An EV driver's fear of running out of electricity before the end of a trip.

Regenerative braking – The process of converting the kinetic energy produced when brakes are applied in an electric vehicle into usable stored energy within the vehicle's battery.

State of charge (SOC) – The amount of battery power left in an EV, as measured in percentage.

Vehicle dwell – Where a fleet vehicle resides when it is not in use (e.g., a garage or yard).

Zero-emissions – A global movement towards sustainability based on EVs generating lower or zero greenhouse gas emissions and use of other clean, sustainable technology.

About Geotab

Geotab is advancing security, connecting commercial vehicles to the internet and providing web-based analytics to help customers better manage their fleets. Geotab's open platform and Marketplace, offering hundreds of third-party solution options, allows both small and large businesses to automate operations by integrating vehicle data with their other data assets.

As an IoT hub, the in-vehicle device provides additional functionality through IOX Add-Ons. Processing billions of data points a day, Geotab leverages data analytics and machine learning to help customers improve productivity, optimize fleets through the reduction of fuel consumption, enhance driver safety, and achieve strong compliance to regulatory changes.

Geotab's products are represented and sold worldwide through Authorized Geotab Resellers. To learn more, please visit www.geotab.com and follow us @GEOTAB and on LinkedIn.

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