The complete fleet electrification roadmap

Your expert guide to sparking your transition to electric vehicles

GEOTAB

The complete fleet electrification roadmap

There is an increased focus on sustainability and organizations around the world are starting to explore ways to reduce their environmental footprint.

Fleets understand that the transportation sector plays a significant role in global carbon emissions, which is why they are doing their part to become more sustainable. Many fleets are also taking this opportunity to modernize their operations and become more profitable by adopting new technologies. With numerous government incentives being implemented, there has never been a better time to get started.

This guide is your go-to resource for understanding the ins and outs of electric vehicles for fleet applications. With this guide you will be able to make the business case for adding EVs to your fleet and learn how to operate them efficiently to get the highest return on your investment. When implemented correctly, EVs will do more than just reduce your organization's carbon footprint. Fleet electrification can produce significant cost savings and improve your overall operations.

There have been significant improvements with EVs over the last few years, making them viable for more applications. Some industries have already begun incorporating EVs, including last-mile delivery and public fleets. Whereas others, particularly the medium- and heavy-duty sectors, will still be in the early stages of EV adoption. We cover both of these scenarios in this guide and present many topics for consideration.

So whether you are driven by economic factors, sustainability targets, or a desire to create a more efficient and environmentally friendly fleet, this guide will help you reach your goal.

Ready to get started? Let's dive in.

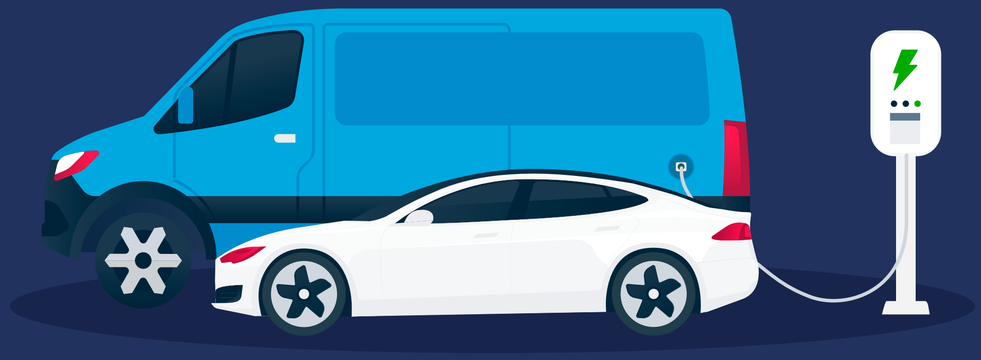


Table of contents

Introduction

The critical role EVs play in becoming more sustainable.

Everyone's sustainability journey is going to be different. To help simplify the process we have broken it down into four stages: Assess, Adopt, Accelerate and Aspire.

1 2 3 4

Assess

Assess your fleet's environmental impact

Your first step is to measure and understand your current CO_2 emissions. Once you have established this baseline data, you can begin researching sustainable fleet practices.

Adopt

Adopt sustainable fleet practices

Start taking action by focusing on areas where you can make an immediate impact. Determine where EVs fit into your fleet and begin transitioning them. Fleet electrification doesn't happen overnight, it is a gradual process.

Accelerate

Accelerate your decarbonization efforts

Now that you have a few EVs in your fleet, build on this success by expanding and optimizing their operation. This may include tactics such as route optimization, fleet rightsizing and smart charging.

Aspire

Aspire to create lasting change

Finally, use your experience and expertise to help other fleets become more sustainable. Become an EV advocate and participate in studies or events that showcase the benefits of fleet electrification to show everyone why they should go electric.

Global EV adoption trends

It is undeniable that a global shift is occurring when it comes to EV adoption. Adoption rates vary by location, with Asian and European countries outpacing the Americas, but overall EVs are becoming more mainstream. In fact, in their 2022 Electric Vehicle Outlook, **BloombergNEF** stated, “There are now almost 20 million passenger EVs on the road, 1.3 million commercial EVs, including buses, delivery vans and trucks, and over 280 million electric mopeds, scooters, motorcycles and three-wheelers."

However, it is not just a matter of more people buying EVs. Over the last few years almost every major **automaker** has announced their intention to launch new and exciting EV models. Some manufacturers, including Bentley, Mercedes, **General Motors** and Volvo, have made commitments to stop the production of internal combustion engine (ICE) vehicles altogether over the next decade or so.

Finally, governments at all levels are looking for ways to tackle climate change and many are looking at the transportation sector. One approach is to encourage EVs, with rebates and other incentives, while others are choosing to discourage the use of fossil fuel vehicles. In the U.S. and Canada alone, the governments have made billions of dollars available to encourage fleets and consumers to make the transition. Additionally, more than **30 federal, state and municipal governments** have implemented regulations with the goal to restrict the sale of new ICE vehicles in the near future.

CHAPTER 1

What is an electric vehicle?

Your neighbor owns one, you see them in parking lots and on highways – EVs are increasingly popular these days. But what exactly is an electric vehicle?

Let's start with the basics.

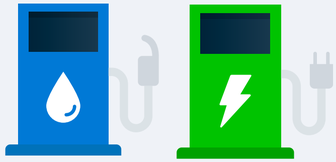
What is an electric vehicle?

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. Passenger cars dominated the early days of EVs, but now we're now seeing a variety of new vehicles enter the market including electric vans, pickup trucks, buses and even transport trucks.

Types of electric vehicles

Electric vehicles can be generally classified into four categories. Let's drill down into the key differences:

Plug-in electric vehicles

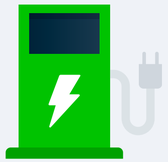


Plug-in hybrid electric vehicles (PHEVs)

- A vehicle that has both an electric motor, which is charged by plugging in, and a small internal combustion engine that runs on liquid fuel
- Has a shorter electric range but uses fuel as a supplemental power source
- Some PHEV models only use fuel once the battery is depleted

Examples include:

Mitsubishi Outlander PHEV, Chrysler Pacifica Hybrid, Ford Escape PHEV and Toyota Prius Prime



Battery electric vehicles (BEVs)

- A fully electric vehicle with no internal combustion engine
- Converts energy stored in battery packs into electricity that powers the motor and turns the wheels
- Is charged through a charging station or electrical outlet, but can recoup some charge back from regenerative braking
- Emits zero tailpipe emissions

Examples include:

Chevrolet Bolt, Ford E-Transit, Ford F-150 Lightning, Nissan LEAF, Volkswagen ID.4, Tesla Models 3, X, Y, S and Semi

Other types of electric vehicles

Hybrid electric vehicles (HEVs)

- An internal combustion engine vehicle with an additional propulsion system
- Not generally considered an EV as it cannot be charged through the electrical grid
- Its small battery can only be charged by the gasoline engine (as a generator) or through regenerative braking

Examples include:

Toyota Prius Hybrid, Honda Civic Hybrid and Toyota Camry Hybrid

Fuel cell electric vehicles (FCEVs)

- A vehicle that uses a fuel cell to convert compressed hydrogen into electricity, which powers its motor
- Cannot be charged through the electrical grid
- Emits zero tailpipe emissions

Examples include:

Hyundai Nexo and Toyota Mirai

While HEVs and FCEVs may be classified as EVs, 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 capacities (measured in kilowatt hours or kWh), depending on their make and model. An EV's battery capacity is one of the main factors that determine its range capabilities.

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. Research has shown that degradation has on average been minor and that the vast majority of batteries will outlast the usable life of the vehicle.

Learn more

A more detailed exploration of the factors that impact an EV's range, including the causes of battery degradation, are discussed in **Chapter 4**.

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 internal combustion engine (ICE) vehicle.

The accelerator and brake pedals are in the same spot, while the gear shifter is located either between the seats or on the steering wheel. Depending on the vehicles, you might notice that your dash looks very different… or is not there at all. Newer Tesla models have replaced the traditional dashboard with a large touchscreen that displays speeds and is home to the climate and other controls.

Overall, the interior will be familiar for the driver. However, there are some key differences in how EVs operate.

Single-speed transmission

Most EVs operate only in single-speed transmission. In ICE vehicles, many gears 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 internal combustion engines.

Instant torque

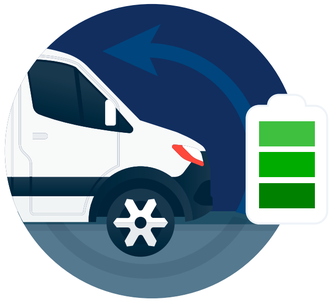
While ICE vehicles take many revs to get to maximum torque, EVs have access to the majority of torque from a stop. Therefore, EV acceleration is far superior.

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.

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.



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

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.

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.

EV-specific tires

While not necessarily a requirement, most OEMs recommend using EV-specific tires. They are designed to better withstand the EV's additional weight, resulting in them lasting longer. Also, they typically provide lower rolling resistance than traditional tires, which can increase your EV's range.

Data accessibility

Unlike ICE vehicles, EVs do not follow mandatory telematics data standards. This can make accessing the vehicle's data a challenge. Fortunately, Geotab works with manufacturers and has developed unique methods for accessing critical EV data. This topic is explored further in **Chapter 2**.

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 kph (12 mph) so pedestrians can hear an EV approaching.

This rule went 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 mandated minimum sound requirements for new hybrid and electric vehicles.

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 2

The barriers to electrification are disappearing

Early EV models were typically limited to a few sedans with smaller battery capacities and range capabilities, meaning they were primarily used as commuter vehicles within cities.

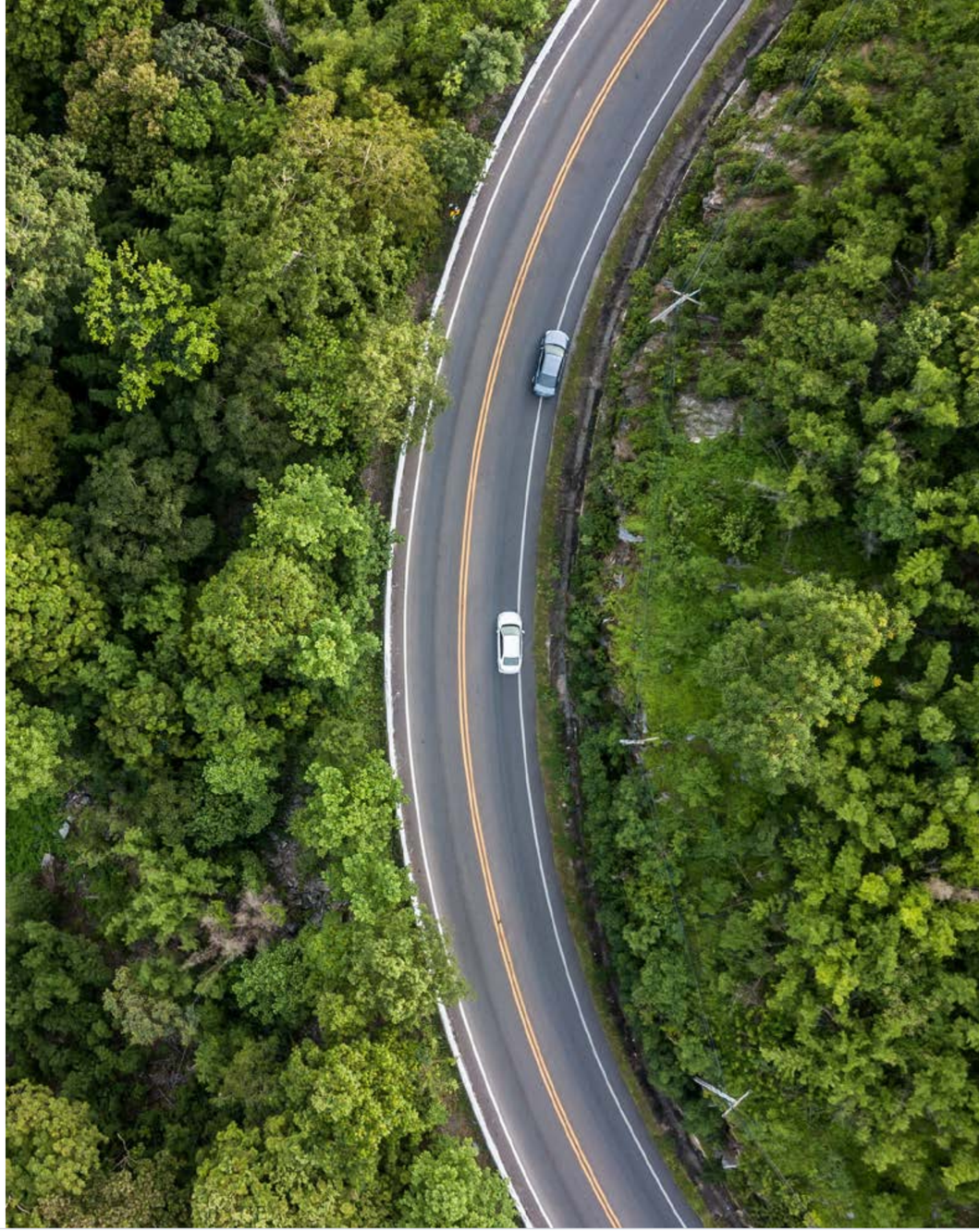
However, this is no longer the case.

Most of today's light-duty commercial EVs can travel over 250 miles on a single charge and they have expanded to other vehicle types – including vans, trucks, buses and other specialty vehicles.

Over the last decade there have been significant improvements in battery technology, which have led to vehicles that are more suited for fleet applications.

Key insight

Some industries have already embraced EVs and are further along their electrification journey. Read more about public fleets in **Chapter 6** and commercial fleets in **Chapter 7**.



Overcoming range anxiety

Range anxiety – the fear of not having enough of a charge to reach your destination without being able to charge somewhere on the road – continues to concern those who are considering EVs for the first time. While understanding range limitations is still something to acknowledge, it is not as big of a deal as most think.

Range improvements

Battery technology has dramatically improved and has resulted in EVs with greater range capabilities. Not so long ago, 250 miles of range was unheard of. Today, it is pretty standard. In fact Tesla announced that their Semi trucks will be able to travel an estimated 500 miles on a single charge.

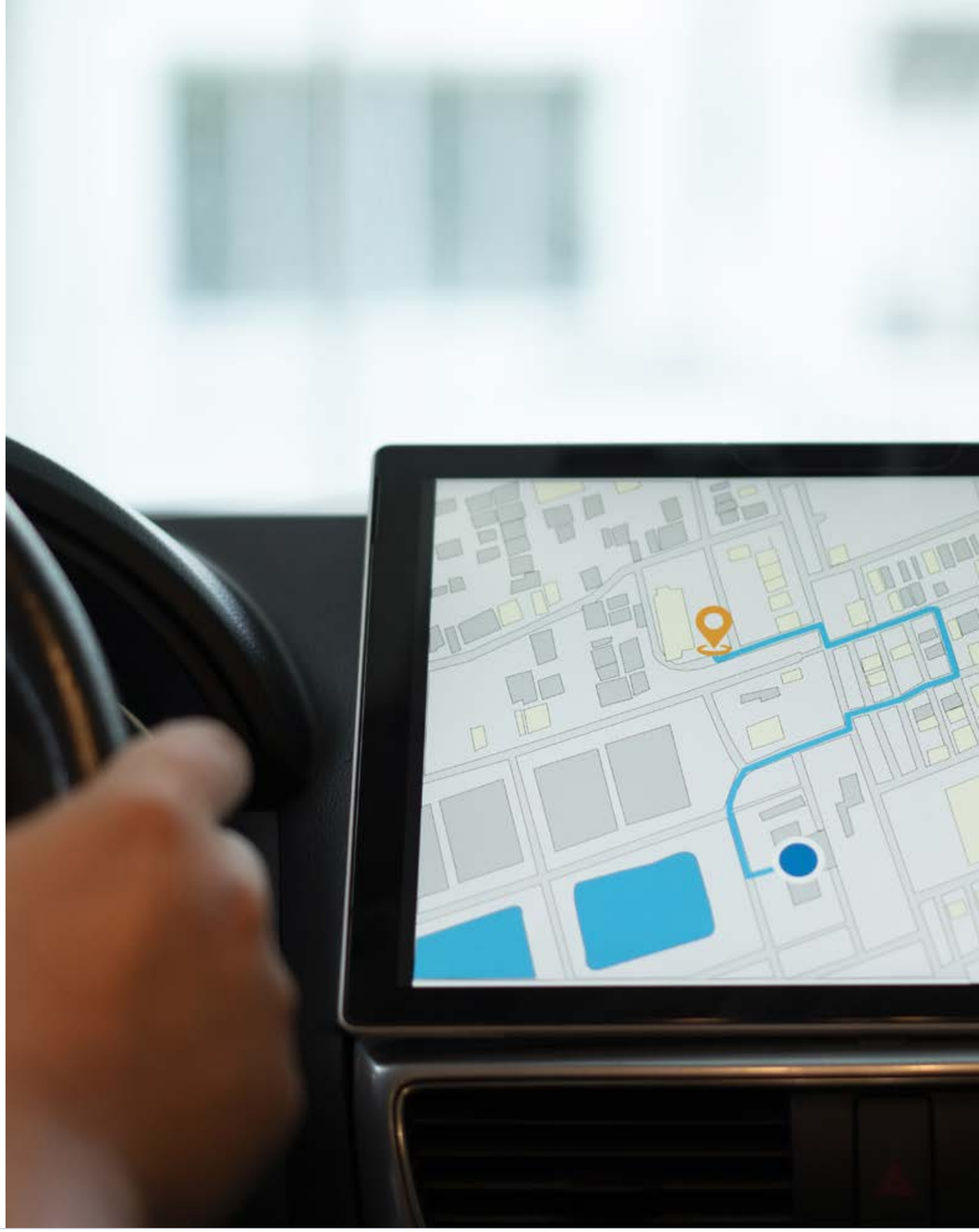
For fleets that stay local, range typically isn't even an issue as they tend to drive daily distances well within the capabilities of today's EVs.

Similar to ICE vehicles, there are also plenty of evidence-based strategies now for improving EV range, such as going easy on the accelerator, minimizing cargo weight and practicing preventative maintenance (discussed further in **Chapter 9**).

The growing charging network

Not being able to find a charger is another concern, which is partially built upon a misconception. A majority of fleets will rely on their own charging infrastructure, whether it's an on-site depot or at the driver's house. This is particularly the case for vehicles that drive less than the vehicle's range in a day. Public charging is typically more expensive and may be less ideal than using privately-owned stations. See **Chapter 5** for more information.

For those who will be using the public charging network, there is good news – it is growing quickly. Currently, there are about **140,000** public EV chargers across the U.S. and this is only the beginning. In 2022, the U.S. **Bipartisan Infrastructure Law** included $7.5 billion of funding to go towards building a national network of 500,000 EV chargers.



EV costs are falling

EVs are thought to be more expensive than their ICE counterparts, which is only partially true. Yes, currently EVs have a higher acquisition cost, although they are getting closer to price parity as battery technology becomes less expensive.

However, when determining the cost of an EV it is more important to consider its total cost of ownership. This topic is covered more in **Chapter 3**, but essentially the fuel savings and reduced maintenance costs associated with EVs can result in them costing less than an ICE vehicle over their lifetime.

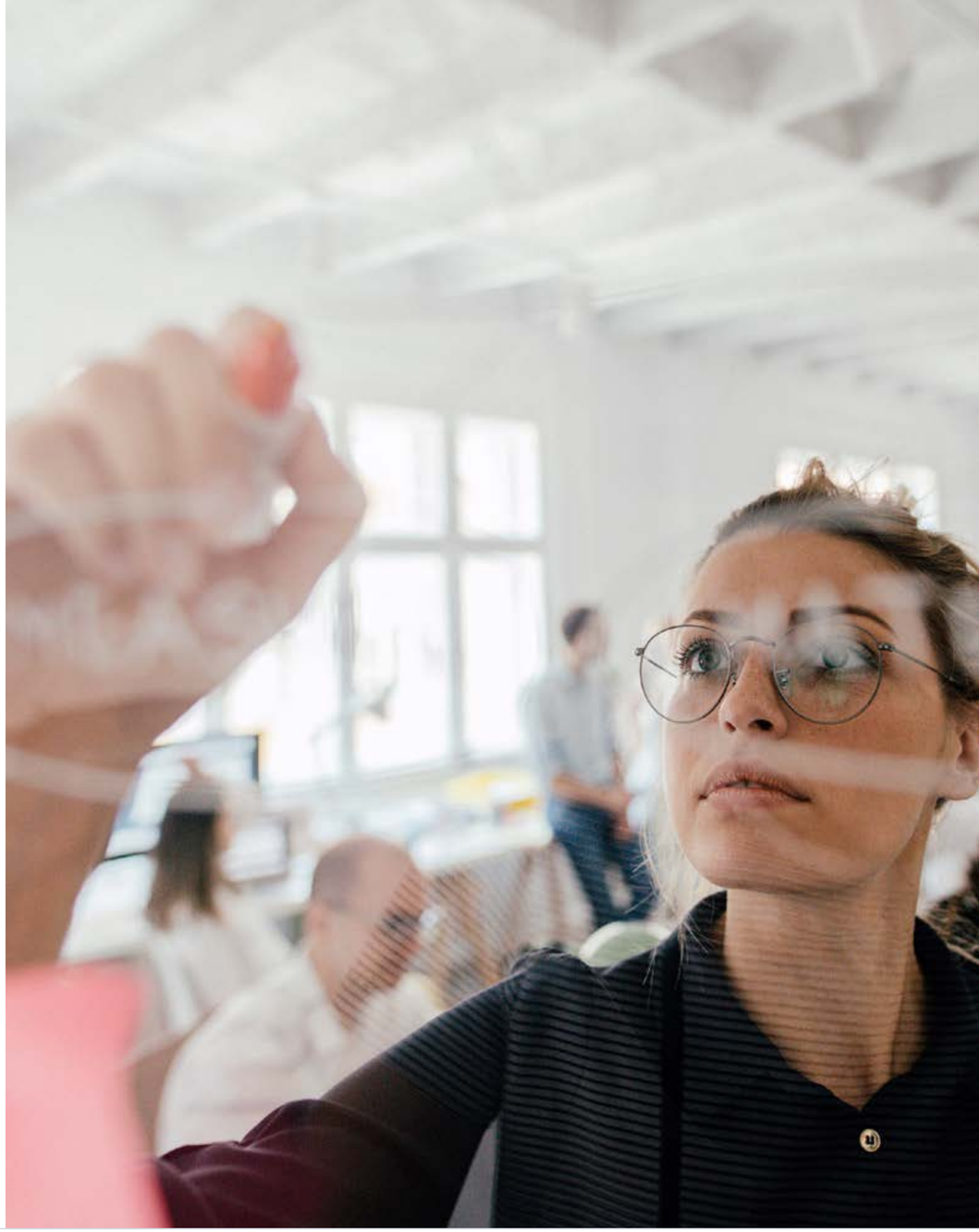
Carrying capacity is increasing

When the only available EVs were compact to mid-sized passenger vehicles, electrification was impossible for many commercial fleets. Fortunately, the current and future release of a wide variety of Class 2 to 5 EVs has solved one aspect of this problem.

Cubic footage and towing ability are vital metrics for fleet managers. Recognizing this, EV manufacturers are producing more spacious, rugged vehicles all the time – aided, in part, by lighter, smaller batteries that take up less room in the overall design.

With current electric vans boasting payload capacities ranging from 2,000 to 6,000 pounds and electric pickup trucks such as the Rivian R1T able to tow **more than 11,000 pounds** – the potential of commercial applications for the latest EVs are greatly improving.

For a deeper dive into the growth of electric medium- and heavy-duty vehicles see **Chapter 7**.



Advanced fleet management for EVs is available

As mentioned earlier, EVs are not held to the same data accessibility standards or requirements as ICE vehicles. So not only is there new EV-specific data, but it also means that accessing traditional telematics data can be more challenging.

Before telematics caught up to the EV revolution, when organizations started to procure EVs, they weren't guaranteed to have the data needed to properly manage and optimize them along with the rest of their vehicle mix. This is no longer the case.

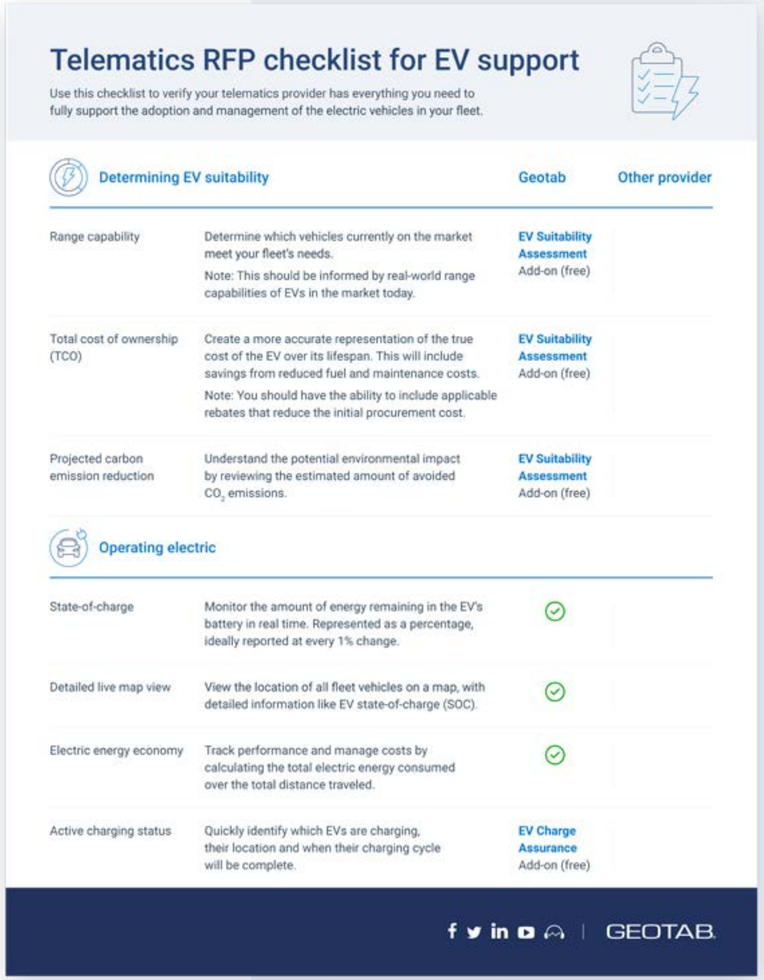
Telematics has evolved and adapted so that fleets can now collect and analyze the same vital fleet data for EVs. As fleets transition from ICE vehicles to EVs, there will inevitably be a time when managers have to operate mixed fleets. That's why it's important to choose a fleet management platform that can deliver insight on any vehicle mix.

The right telematics platform should be able to provide support for a wide range of EV models – including all classes of commercial vehicles – and deliver robust, EV-specific data such as charging and range reports on the same dashboard as ICE vehicles. This topic is covered in more detail in **Chapter 9**.

To make sure your telematics solution provides everything you need check out our **Telematics RFP checklist**.

Critical EV-specific data

- Battery state-of-charge (SOC)
- Energy added during charging (kWh and Wh)
- Max power when charging (kW and W)
- EV fuel economy metics (MPG-e or L-e/100 km)



Telematics RFP checklist for EV support

Use this checklist to verify your telematics provider has everything you need to fully support the adoption and management of the electric vehicles in your fleet.

Determining EV suitability		Geotab	Other provider
Range capability	Determine which vehicles currently on the market meet your fleet's needs. Note: This should be informed by real-world range capabilities of EVs in the market today.	EV Suitability Assessment Add-on (free)	
Total cost of ownership (TCO)	Create a more accurate representation of the true cost of the EV over its lifespan. This will include savings from reduced fuel and maintenance costs. Note: You should have the ability to include applicable rebates that reduce the initial procurement cost.	EV Suitability Assessment Add-on (free)	
Projected carbon emission reduction	Understand the potential environmental impact by reviewing the estimated amount of avoided CO_2 emissions.	EV Suitability Assessment Add-on (free)	
Operating electric			
State-of-charge	Monitor the amount of energy remaining in the EV's battery in real time. Represented as a percentage, ideally reported at every 1% change.	✓	
Detailed live map view	View the location of all fleet vehicles on a map, with detailed information like EV state-of-charge (SOC).	✓	
Electric energy economy	Track performance and manage costs by calculating the total electric energy consumed over the total distance traveled.	✓	
Active charging status	Quickly identify which EVs are charging, their location and when their charging cycle will be complete.	EV Charge Assurance Add-on (free)	

GEOTAB

CHAPTER 3

The benefits of electric vehicles

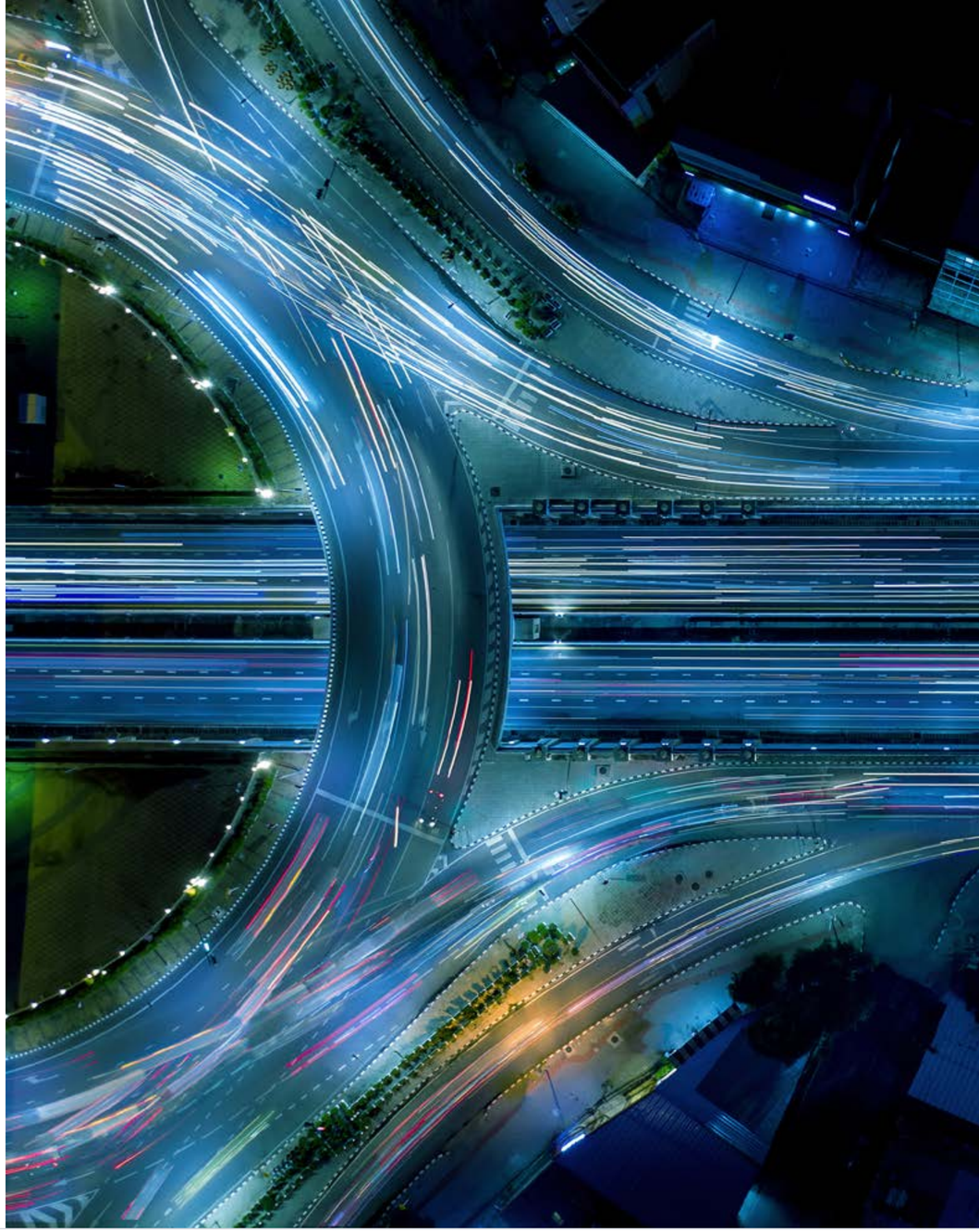
Now that you have a better handle on the basics, let's take a look beneath the surface and identify some of the key benefits for fleets considering electrification.

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. By properly incorporating EVs, operators could benefit from lower running costs. At the same time, drivers enjoy improved performance in some of the most cutting-edge vehicles on the planet, all while reducing the negative impact on the planet's atmosphere.

Key takeaway

Our study on the potential of light-commercial **European fleet electrification** found that nearly 60% of analyzed vehicles could save money by transitioning to range-capable EVs today.



A lower total cost of ownership

When you are considering adding any type of vehicle to your fleet it is important to consider its total cost of ownership (TCO). This includes the initial acquisition costs as well as all of the vehicle's expenses over its lifespan. EVs typically have a higher upfront cost than their ICE counterpart. However, in the right applications, they often have a lower TCO, meaning they will save you money in the long run.

Success story: Enterprise Fleet Management

Enterprise Fleet Management examined the potential benefits of adding EVs to their fleet. They found that up to 45% of their vehicles could be replaced with an EV, saving them $167 million over 4 years.

Read the full story **here**.

Saving on fuel

Fuel is one of the biggest costs for fleets and EVs provide the opportunity to dramatically reduce this ongoing expense. BEVs are three to four times more efficient than ICE vehicles at converting energy to motion, meaning their fuel economy is better. PHEVs, when running on electricity, also benefit from this efficiency which is why it is important that they are not solely running on gas.

On average, electricity rates are lower than fuel rates across the globe. Also, while gas prices can be highly volatile in any given year, electricity prices tend to be more static. This makes budgeting easier for fleet managers with more predictable operating costs.

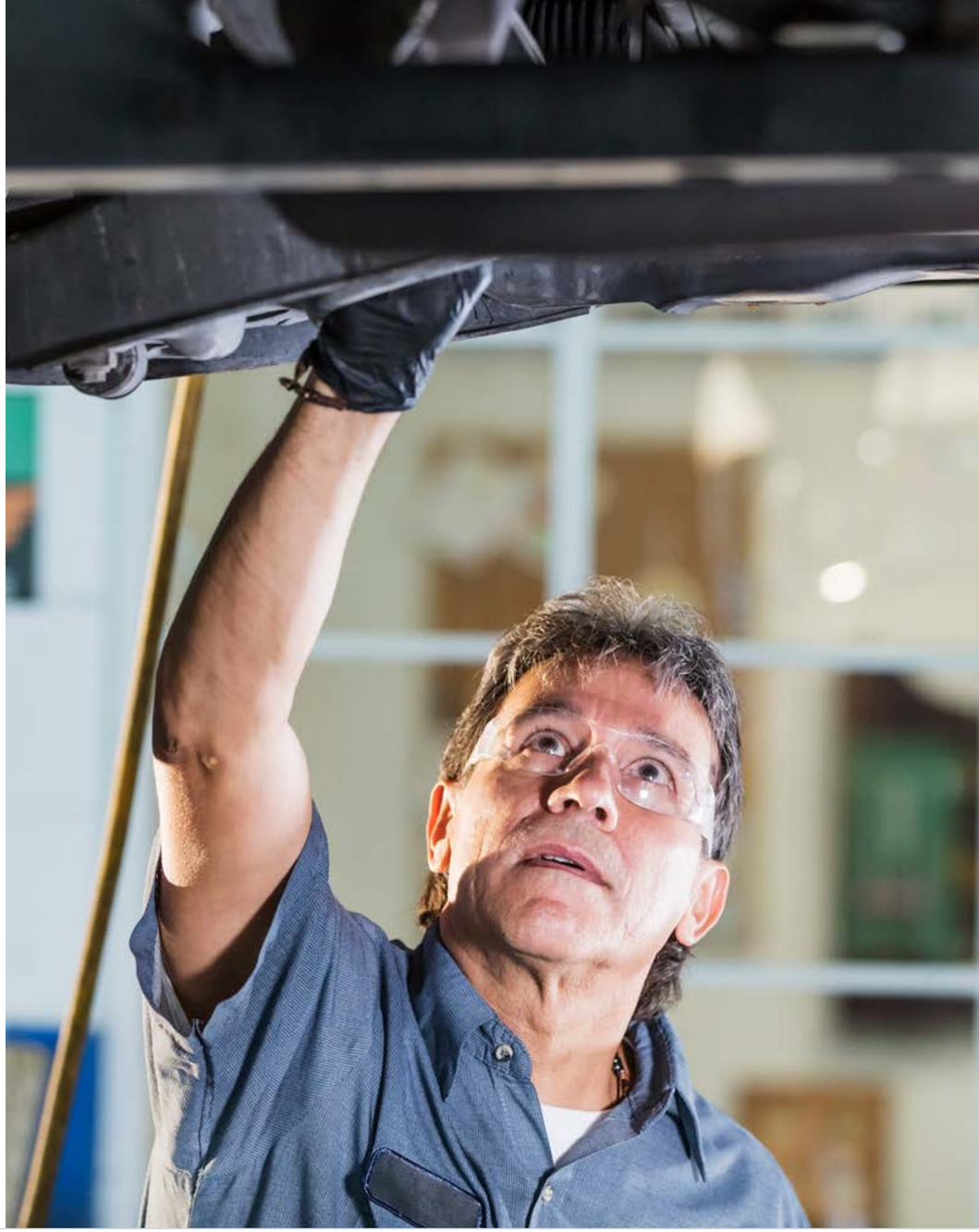
Lower maintenance costs

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, and can also 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.

Did you know?

A study funded by the **U.S. Department of Energy** found that the maintenance costs of battery electric vehicles are 40% lower than ICE vehicles.



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 vehicles

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, over time, for each model. We also included approximate maintenance costs, calculated on a per-mile basis, to determine the vehicle's total cost of ownership. As you can see in the charts below, EVs can provide significant cost savings over time and be less expensive in the end.

It is important to note that these calculations do not include any applicable rebates. By taking advantage of incentives, fleets can break even on their investment sooner.

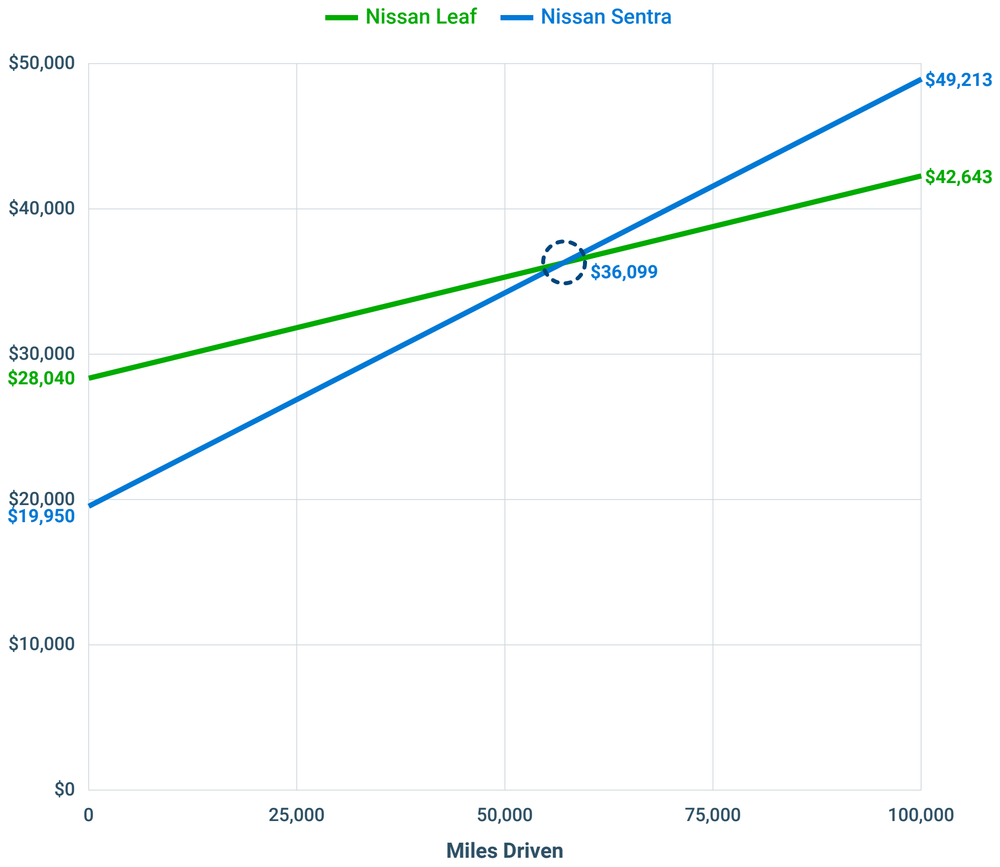
2023 Nissan LEAF vs. 2022 Nissan Sentra

2023 Ford e-Transit van vs. 2023 Ford Transit Cargo

2023 Ford F-150 Lightning XLT vs. 2023 Ford F-150 XLT

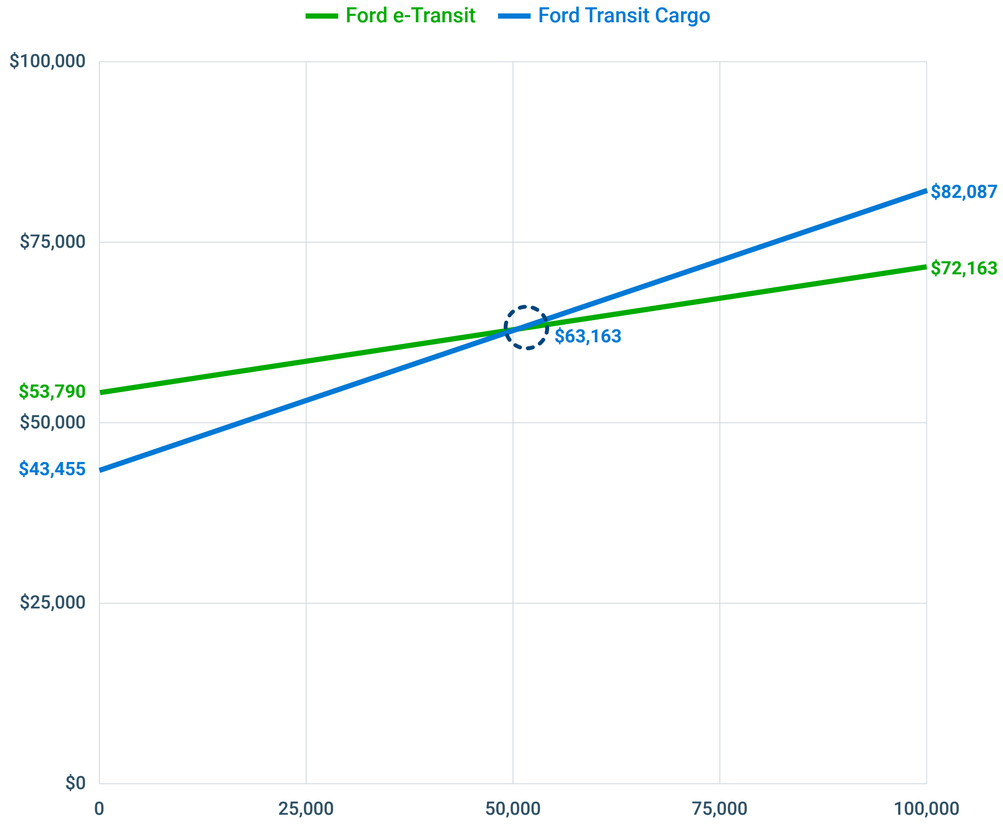
1. 2023 Nissan LEAF ($28,040 MSRP USD) vs. 2022 Nissan Sentra ($19,950 MSRP USD)

The base-level 2023 Nissan LEAF is a low-cost compact EV, with a range of 150 miles, on a single charge. The LEAF has long been one of the best-selling EVs in North America. The Nissan Sentra is a popular and well-reviewed compact car on the market, but it doesn't take long before the LEAF starts paying fuel cost dividends at 55,185 miles driven.



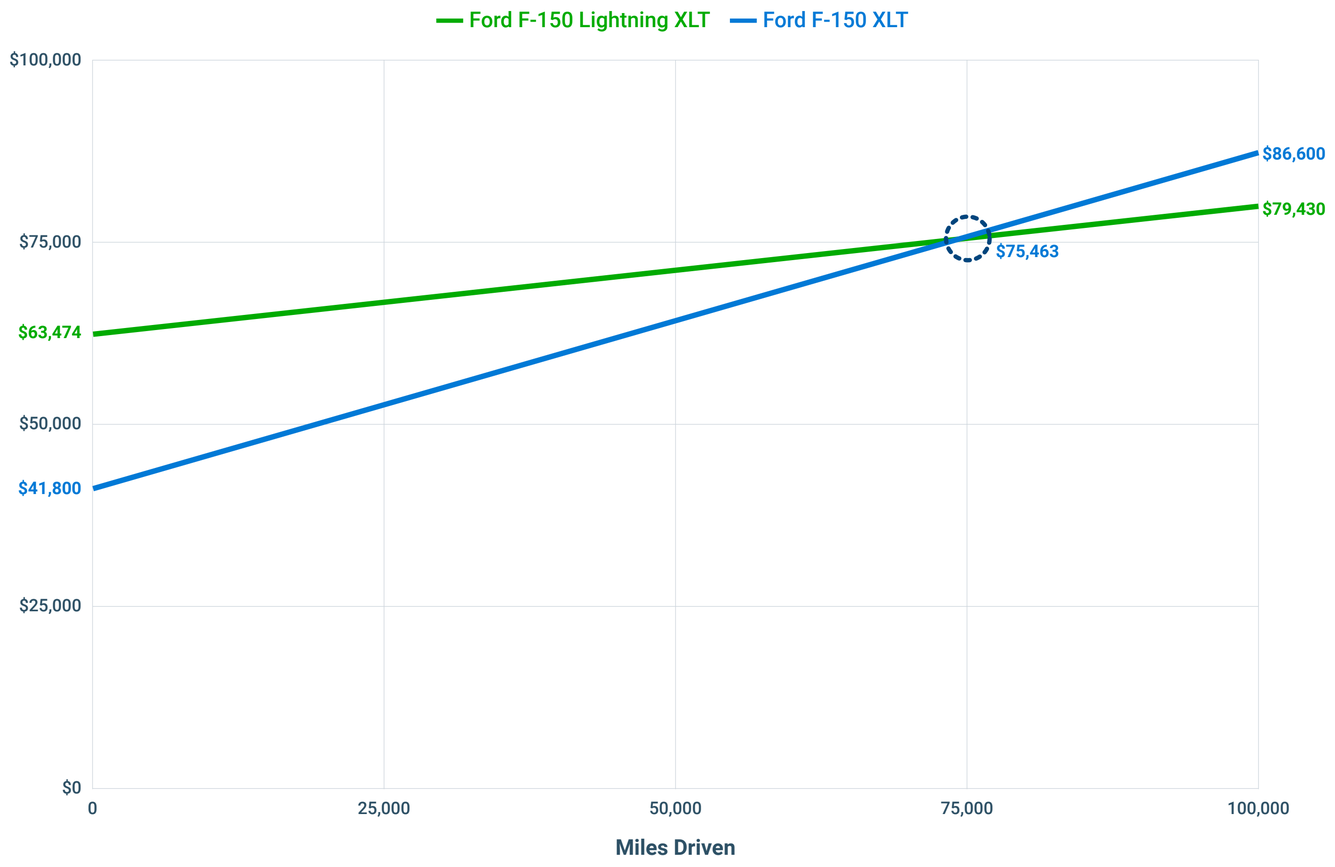
2. 2023 Ford e-Transit van ($53,790 MSRP USD) vs. 2023 Ford Transit Cargo ($43,455 MSRP USD)

The first Ford e-Transit cargo van was launched in 2022 and in its first year became the most dominant **all-electric commercial van** in the U.S. It is highly customizable and starts with a range of 126 miles. When comparing the TCO to Ford's Transit Cargo van, its ICE equivalent, it starts to pull ahead at 51,015 miles driven.



3. 2023 Ford F-150 Lightning XLT ($63,474 MSRP USD) vs. 2023 Ford F-150 XLT ($41,800 MSRP USD)

Ford's F-series pickup trucks have been the **most sold vehicles** in the U.S. for more than 40 years. The all-electric F-150 Lightning was one of the most anticipated EVs to enter the North American market and boasts a range of 230 miles. When compared to its ICE counterpart, the Lightning starts generating a lower total cost of ownership after 75,140 miles driven.



Key takeaway

Over time, EVs will beat their ICE equivalents on total spend the more you put your EV to work. The higher their utilization, the faster you will realize a return on the higher upfront investment. The sweet spot for EVs is when you have a vehicle that drives short enough daily distances, so that it doesn't need to charge during the day, but it drives enough annually to get significant savings from lower fuel costs.

Lowering CO_2 emissions

In an effort to combat climate change, governments and organizations around the world have begun rolling out initiatives to reduce their carbon emissions. EVs provide a great opportunity for fleets looking for ways to reduce their carbon footprint and meet any applicable emission mandates or goals.

Thanks to their zero-emission design, BEVs directly contribute to carbon reduction efforts by eliminating the tailpipe emissions presented by their ICE counterparts. PHEVs are still technically considered a "zero-emission vehicle," but it should be noted that they still produce CO_2 emissions when running on gas.

A common argument against EVs is that some electricity is generated by carbon intensive sources, like coal power plants. However the **EPA** has stated, "Even accounting for these electricity emissions, research shows that an EV is typically responsible for lower levels of greenhouse gases (GHGs) than an average new gasoline car."

As governments begin phasing out ICE vehicles, EVs will play a critical role in creating a more sustainable future. See **Chapter 8** for more information on regulatory requirements and mandates.

Success story: The City of Seattle

The City of Seattle has an ambitious goal of cutting carbon emissions 50% by 2025 and being fossil fuel free by 2030. Not only will EVs help them achieve this goal, they are already noticing significant savings from reduced fuel costs.

Read the full story **here**.

Higher safety ratings

EVs have to undergo the same safety testing and standards requirements as ICE vehicles, but they must also meet additional EV-specific certifications as well.

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.

BEVs offer an additional benefit since they operate without an engine and all its associated components. The space typically occupied by a combustion engine provides a larger crumple zone to absorb energy during a collision, further protecting drivers and passengers.

Increased driver satisfaction

While it's normal to be hesitant when trying something new, EVs tend to win drivers over quickly with their smooth acceleration and great handling. EVs also have a pretty good reputation among new owners, many of whom never go back to gas. Improving your drivers' day-to-day experiences with EVs can help you with employee retention and reduce turnover.

Did you know?

Since EVs are quieter than ICE vehicles, they significantly reduce noise pollution. **Studies** have shown that excessive noise can have various health implications including higher levels of stress and hearing loss.

CHAPTER 4

More on range and battery degradation

Since you now have a better understanding of the benefits of fleet electrification, it's time to expand on some of the foundational knowledge from Chapter 1.

This chapter takes a more in-depth look at the factors that influence range and battery health, and provides an overview of charging. These topics will play an important role for making the best use out of the EVs in your fleet and should help you gain a deeper understanding of the nuances of EVs.

Key takeaway

An EV's rated range is best used as a guideline. Their actual range capabilities can fluctuate depending on a variety of **factors**.

What impacts your EV's range

As mentioned in **Chapter 1**, an EVs rated range and real-world range are two different things. Ratings from the U.S. Environmental Protection Agency (EPA) and the Worldwide Harmonized Light Vehicle Test Procedure (WLTP) provide a reasonable estimate of what your range should be. However, these results are conducted in a lab and make assumptions that may differ from your real-world experiences. In fact, the range you are actually able to achieve may be higher than these ratings.

Here are a few factors that will impact your range

1. Temperature

Many people know that EVs tend to lose range in cold temperatures, however it might not be for the reason they think. While it is true that Lithium-ion batteries perform worse in extremely cold temperatures, this isn't the main cause of reduced range. The primary culprit is the auxiliary systems used to maintain the temperature in the vehicle's cabin, as well as the system that keeps the battery at the optimal temperature.

This means that your range is actually impacted by both hot and cold temperatures. Our **analysis** has found that the optimal temperature for an EV is around 70F with range dropping off as you move away from that. Simply put – energy is used for temperature control of the cabin and battery, meaning there is less to be used for propulsion.

2. Speed

The fuel efficiency of an ICE vehicle is impacted by speed, or rather drag, and this applies to EVs as well. The amount of drag a vehicle experiences will depend on the aerodynamics of the body and the speed it is traveling at. Drag increases with speed, meaning the faster you go the more energy is needed to move the vehicle.

By understanding how speed impacts your range, you may decide to alter your driving behavior. In an **analysis**, we observed that changes in temperature have the most significant impact on EV range while driving at lower speeds. We also found that larger vehicles lose range faster at higher speeds than smaller ones.

3. Payload

As with speed, payload affecting range should not be a surprise as it is the same issue with ICE vehicles. The heavier a vehicle is, the more energy is needed to move it. If possible, you should avoid any non-essential weight in order to get the most range out of your EV.

To achieve this you may want to consider optimizing your routes to avoid carrying this excess weight. See **Chapter 9** for more information on how to optimize EV fleet operations.

4. Battery health or degradation

Over time an EV's battery will degrade and lose the ability to store as much energy, permanently reducing its maximum range. A battery's condition, or state-of-health (SOH), will start at 100% and deteriorate roughly 2.3% per year based on findings from a Geotab **study**. For example, if you purchased an EV with a range of 150 miles, after five years your effective range would be roughly 133 miles.

This minimal loss shouldn't drastically impact your day-to-day operations, and the vast majority of batteries will outlast the usable life of the vehicle. There are ways to extend the life of your EV's battery, which are discussed later in **Chapter 9**.

5. Proper vehicle maintenance and driving behavior

Like ICE vehicles, EVs are the most efficient when they are properly driven and maintained. Avoiding harsh braking and acceleration, as well as making sure your tires are properly inflated, can help make sure you are getting the most range possible.

CHAPTER 5

Understanding charging

In order for your EV operations to run smoothly it is important to have the correct charging stations in place.

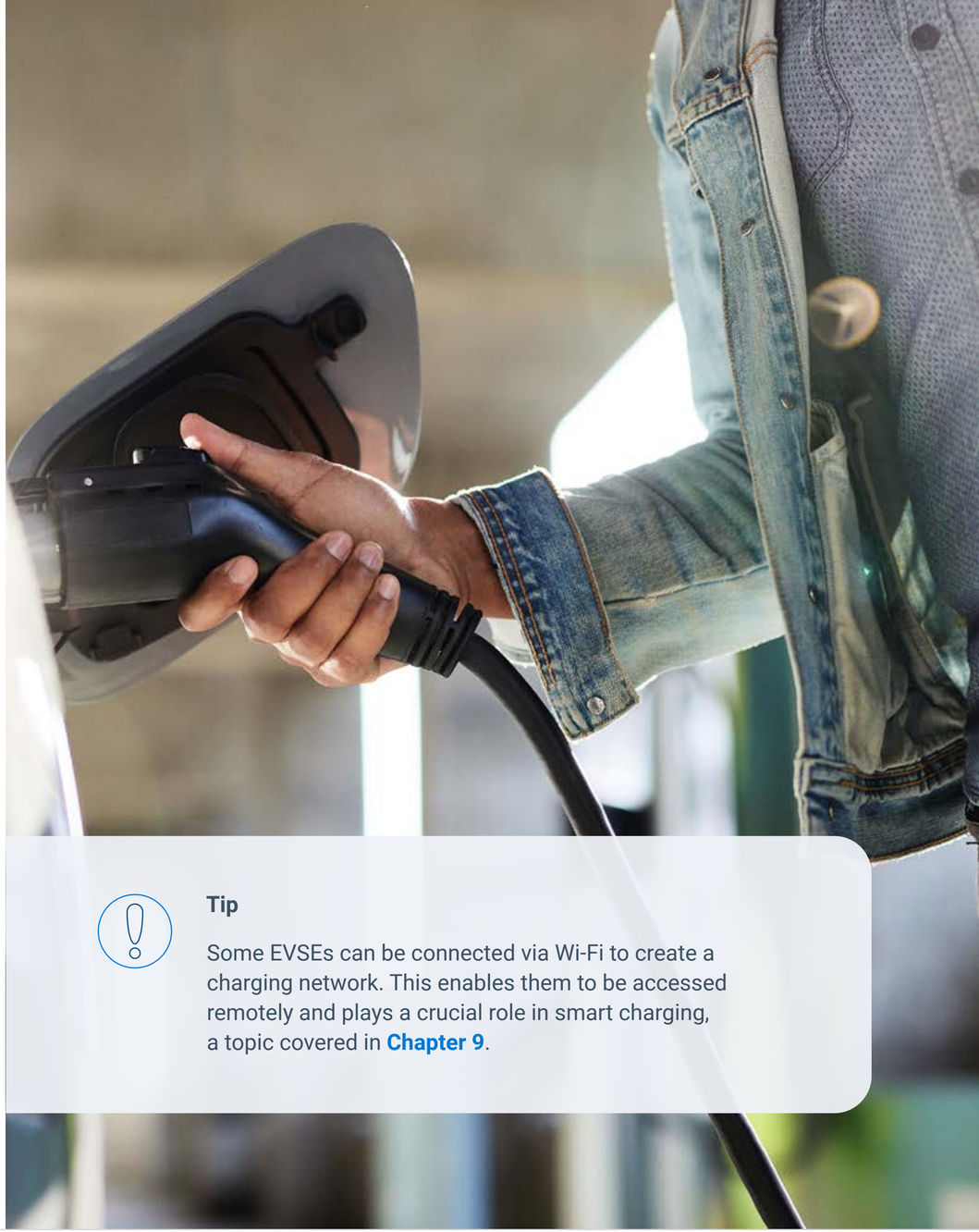
Before you can start building out this infrastructure (**Chapter 8**), you need to understand the different types of Electric Vehicle Supply Equipment (EVSE) and charger ports.

Charging levels

There are 3 different levels of charging which are determined by their power output, and resulting speed. The first two, level 1 and level 2, provide alternating current (AC) power and require the least amount of infrastructure. EV batteries store energy as direct current (DC) and use an onboard or built-in charger that converts this AC power into DC energy. The maximum power a level 2 charger can deliver is actually greater than an EV can receive. It is limited by the EV's onboard charger and most EVs are limited to 7.7 kW, with Teslas being the exception.

The other type is direct current fast charging (DCFC), which provides energy straight to the battery. These charging stations can fully charge an EV in a fraction of the time compared to the others, however they require much more electrical infrastructure.

Depending on your duty cycles, you will most likely rely on level 2 or DCFC charging for your fleet. We will dive deeper into how to select the optimal charging setup for your fleet in **Chapter 8**.



Tip

Some EVSEs can be connected via Wi-Fi to create a charging network. This enables them to be accessed remotely and plays a crucial role in smart charging, a topic covered in **Chapter 9**.

1 Level 1 Charger

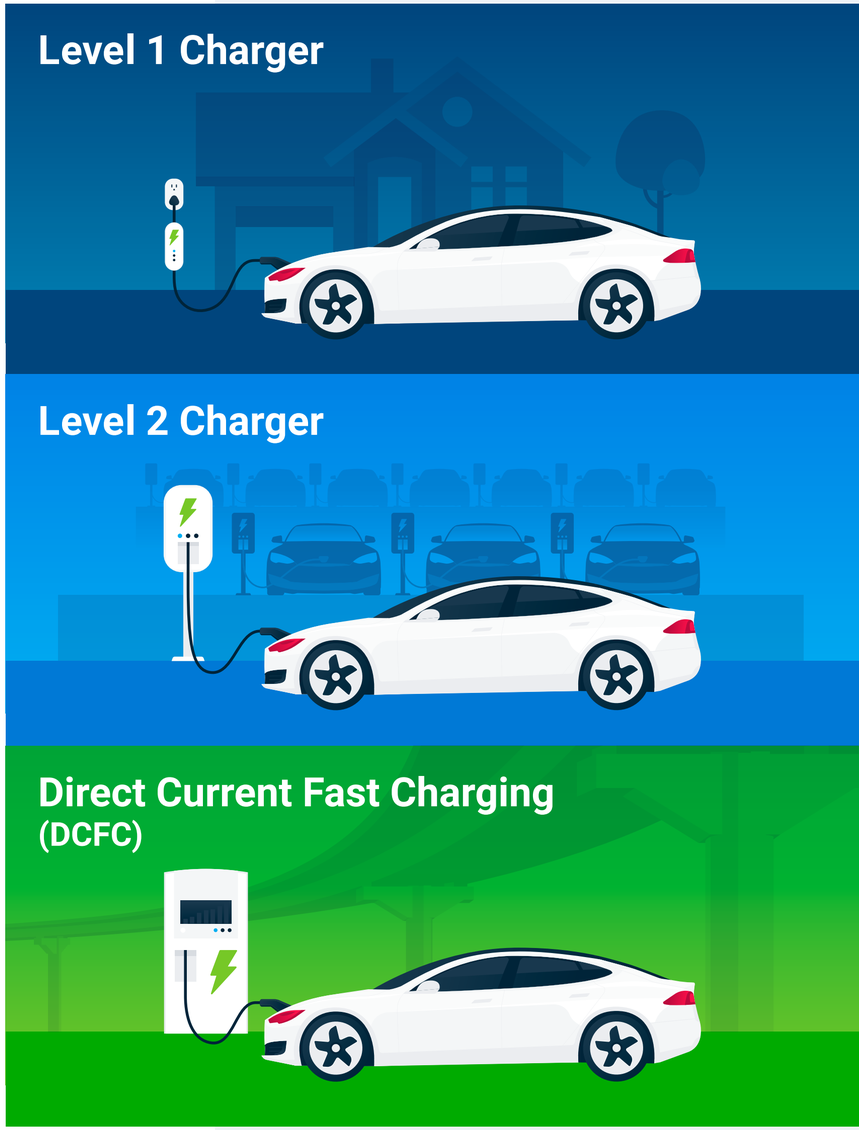
- 120V 1-Phase AC
- 12 - 16 Amps
- Maximum power up to 1.4 kW
- Provides roughly 4 miles of range per hour
- Overall longer charging periods
- Comes free with EV (excluding Tesla)
- Can be plugged into a standard wall outlet
- Less common for fleet applications
- Cannot be networked

2 Level 2 Charger

- 208V or 240V 1-Phase AC
- 12 - 80 Amps
- Maximum power up to 7.7 kW (non-Tesla) or 11.5 kW (Tesla)
- Provides roughly 25 miles (non-Tesla) or 44 miles (Tesla) of range per hour
- Can fully charge a passenger vehicle in 4-5 hours
- Must be purchased separately
- Can be networked

3 Direct Current Fast Charging (DCFC)

- 240V or 480V 3-Phase AC
- <125 Amps
- Maximum power up to 350 kW
- Provides up to 150 miles of range per hour
- Can fully charge a passenger vehicle to 80% in 20-30 mins
- Will require permits for installation
- Can be networked

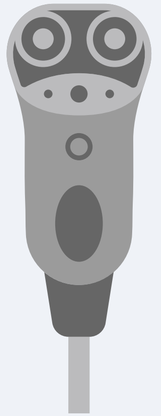
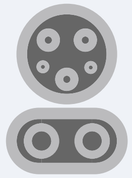
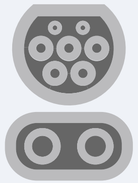


Charger ports

The charger port is the connection from the EVSE to your EV.

The connector you will use will depend on your geographic location, charging level and if it is a Tesla. Each station will typically only have one type of connection, however there are adapters available that will enable you to use them with an EVSE.

It is important to note that not every EV can be charged via DCFC, specifically most PHEVs.

	North America	Japan	EU *(and the rest of markets)*	China	All Markets *(except EU)*
AC	 **J1772 (Type 1)**	 **J1772 (Type 1)**	 **Mennekes (Type 2)**	 **GB/T**	 **Tesla**
DC	 **CCS1**	 **CHAdeMO**	 **CCS2**	 **GB/T**	

Charger location and costs

Depending on your fleet's situation you may end up charging in a variety of locations. It will largely depend on dwell time and location, as well as daily driving distances. Understanding where you are going to be charging is not only important to ensure your EVs can complete their assignments, but it also helps control charging expenses.

1. Depot or workplace charging

For most fleets, this would be the most ideal and cost-effective solution. By installing a number of level 2 or DCFC charging stations on-site you can keep track of charging schedules and maintenance more easily. This could consist of EVSEs in your parking lot or a dedicated charging area.

Determining the cost of installing these stations is difficult to estimate. It will depend on local pricing, the number of EVSEs, power requirements and related infrastructure.

The cost of charging will also depend on your local utility company. Many utilities offer commercial, time-of-use and wholesale rates. It is important to contact your utility company when you are planning your charging infrastructure so you can take advantage of any programs they offer.

2. Home charging

If your drivers take their vehicles home at the end of their day, why not charge there? Depending on how long the vehicles dwell there you may be able use the level 1 charger that is provided with most EVs. However, if you want to have fast charging and include them in a charging network, you will need a level 2 charger with Wi-Fi capabilities.

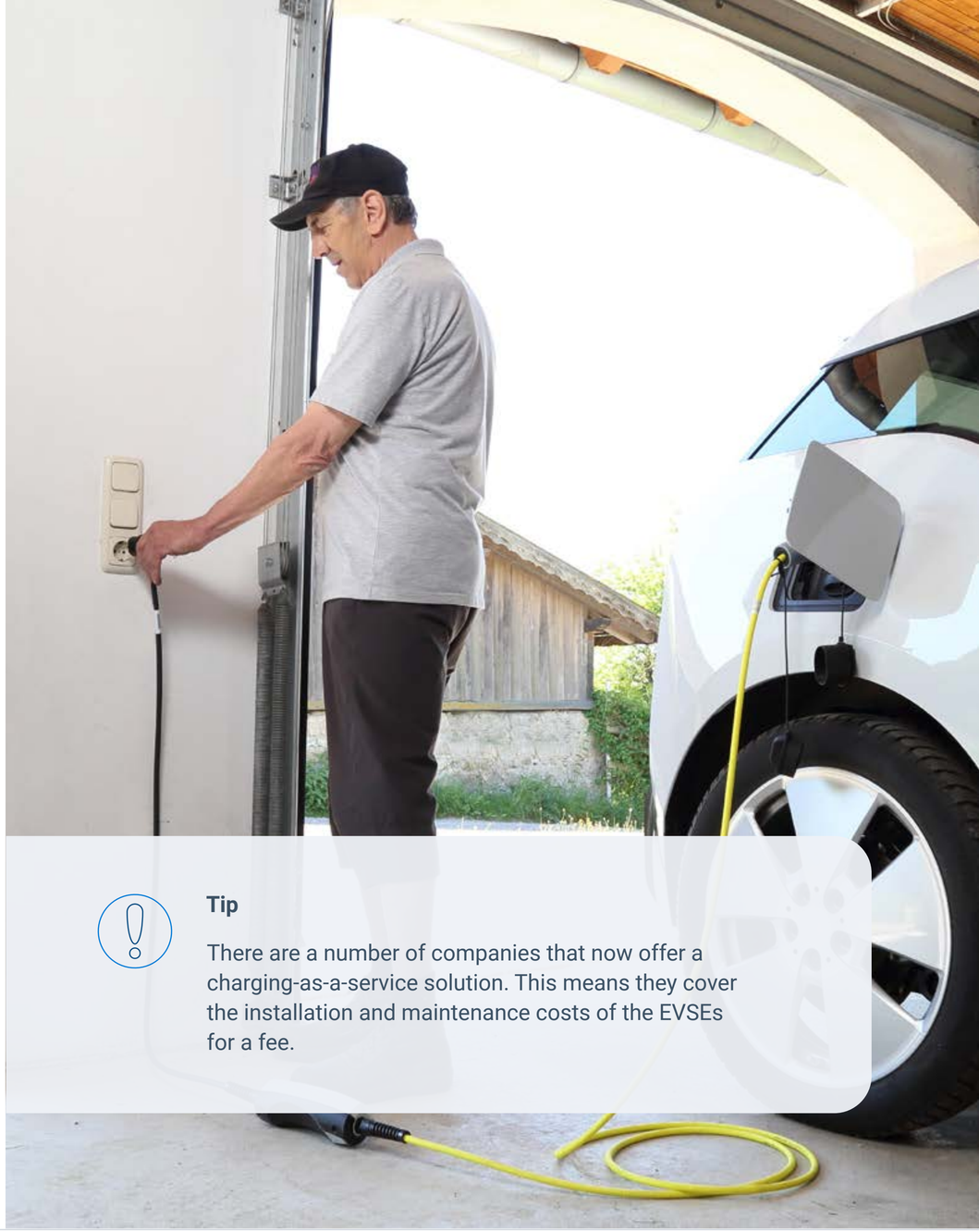
Installing a single level 2 charger is not typically expensive, although there is a chance that it may require upgrading their electrical panel. You also cannot simply remove the charging station if the employee leaves your organization.

As with depot and workplace charging, the actual charging costs will depend on local rates. It is important to understand how your drivers are billed in order to avoid any additional charges. As for reimbursing the drivers there are essentially two methods for calculating costs. You either must install an independent submeter, an additional expense, that solely measures electricity used for charging, or review your charging data provided by your telematics solution or networked charging station.

3. Public charging

Relying on public charging is not ideal for fleet applications. Although there is a growing network of public charging stations available, they are on average much more expensive than privately-owned EVSEs. Additionally, you cannot guarantee that a charger will be operational or available when your vehicle shows up. Most fleets will find it preferable to use their own stations, but this is not always possible.

Public charging networks have different methods for billing their customers and can include different fees. This includes: charging by energy (kWh or Wh), charging by the minute, time-of-use pricing, membership fees and idling fees. So while you save money on not having to install any of your own charging infrastructure, this will most likely cost you more in the long run.



Tip

There are a number of companies that now offer a charging-as-a-service solution. This means they cover the installation and maintenance costs of the EVSEs for a fee.

CHAPTER 6

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 27% of U.S. greenhouse gas emissions in 2020.

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**

Motivating factors for government fleets to electrify

Here are five factors persuading governments to shift their fleets to EVs:

1. Cost savings

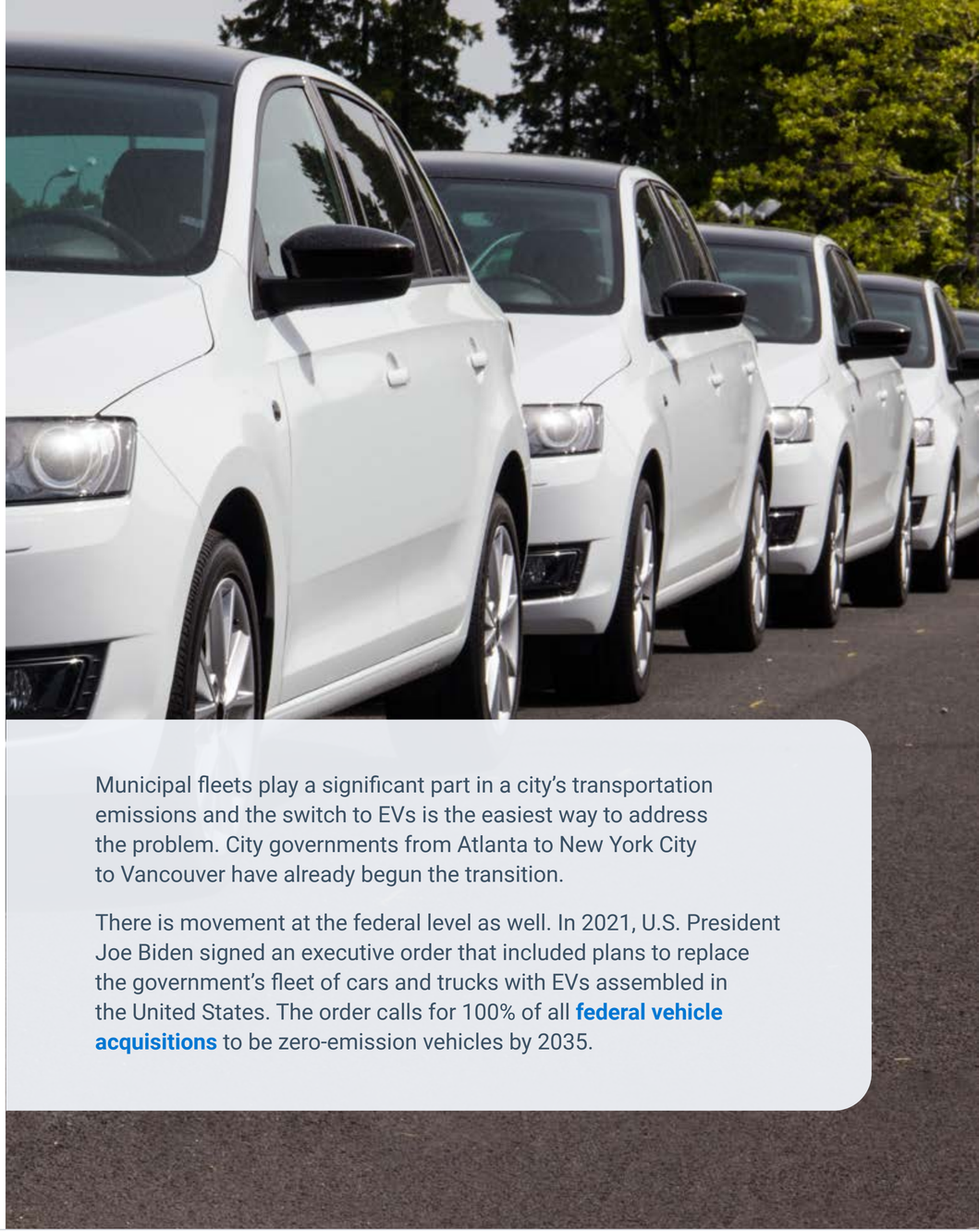
Managing operating costs is critical for any fleet. However, a government fleet especially needs to stick to a budget, since they are accountable to the public. As mentioned earlier in **Chapter 3**, EVs can have a lower TCO than ICE vehicles – a result of reduced maintenance and fuel savings.

A report from **Atlas Public Policy** highlighted the cost savings potential of electrifying the entire U.S. federal fleet, including the U.S. Postal Service (USPS). They found that the non-USPS federal fleet vehicles could save up to $1.18 billion over the lifespan of the vehicles, while transitioning the USPS fleet could result in total savings of up to $4.3 billion.

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.



Municipal fleets play a significant part in a city's transportation emissions and the switch to EVs is the easiest way to address the problem. City governments from Atlanta to New York City to Vancouver have already begun the transition.

There is movement at the federal level as well. In 2021, U.S. President Joe Biden signed an executive order that included plans to replace the government's fleet of cars and trucks with EVs assembled in the United States. The order calls for 100% of all **federal vehicle acquisitions** to be zero-emission vehicles by 2035.

3. Smarter budgeting

Some government fleets are finding creative ways to acquire EVs and inject flexibility into their overall budget. For instance, Los Angeles chose to lease EVs with purchase incentives rolled into monthly payments. This technique allows municipal budget planners to free up funds for other capital investments.

4. Meeting emissions goals

Reducing emissions remains a top priority in many major cities. Some cities have made specific climate goals whereas others have formed various coalitions focused on climate change. For example, more than 470 U.S. mayors have joined the **Climate Mayors**, a bipartisan group that focuses on climate initiatives in their communities.

Here are a few examples of cities with ambitious sustainability goals:

- New York City officials have expanded the **OneNYC plan** to cut emissions 80% by 2050.
- **Seattle**, **Vancouver** and **Berlin** commit to plans 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 zero-emission vehicles in municipal fleets. For example, the New York City fleet consists of more than 4,000 EVs and **Mayor Eric Adams'** administration has announced plans to replace an additional 925 gas vehicles used by city employees.

5. Modernizing vehicle motorpools

As vehicles age, they become more expensive to maintain. In combination with the fact that older models are generally less efficient, it is in the fleet manager's best interest to modernize their fleet. An effective acquisition plan will account for replacing these older inefficient models with EVs.

For example, **Missoula County and the City of Missoula** were faced with this opportunity. Their large fleets had both adopted goals aimed at achieving 100% clean electricity and carbon neutrality. By adopting a new approach and following an optimal fleet cycle in their motorpool, they could start incorporating EVs into their fleets while retiring older vehicles.

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 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 7

EVs for commercial fleets

In organizations where vehicle fleets are the backbone of the business, EVs are making big headway. As traditional barriers, such as limited range and carrying capacity, fall away and new EV models designed for fleets come on the market, there's no better time to consider electrification.

Adopting low- or zero-emission vehicles allows companies to save money, remain compliant amid emissions reduction regulations, reduce their carbon footprint and demonstrate environmental responsibility to their customers.

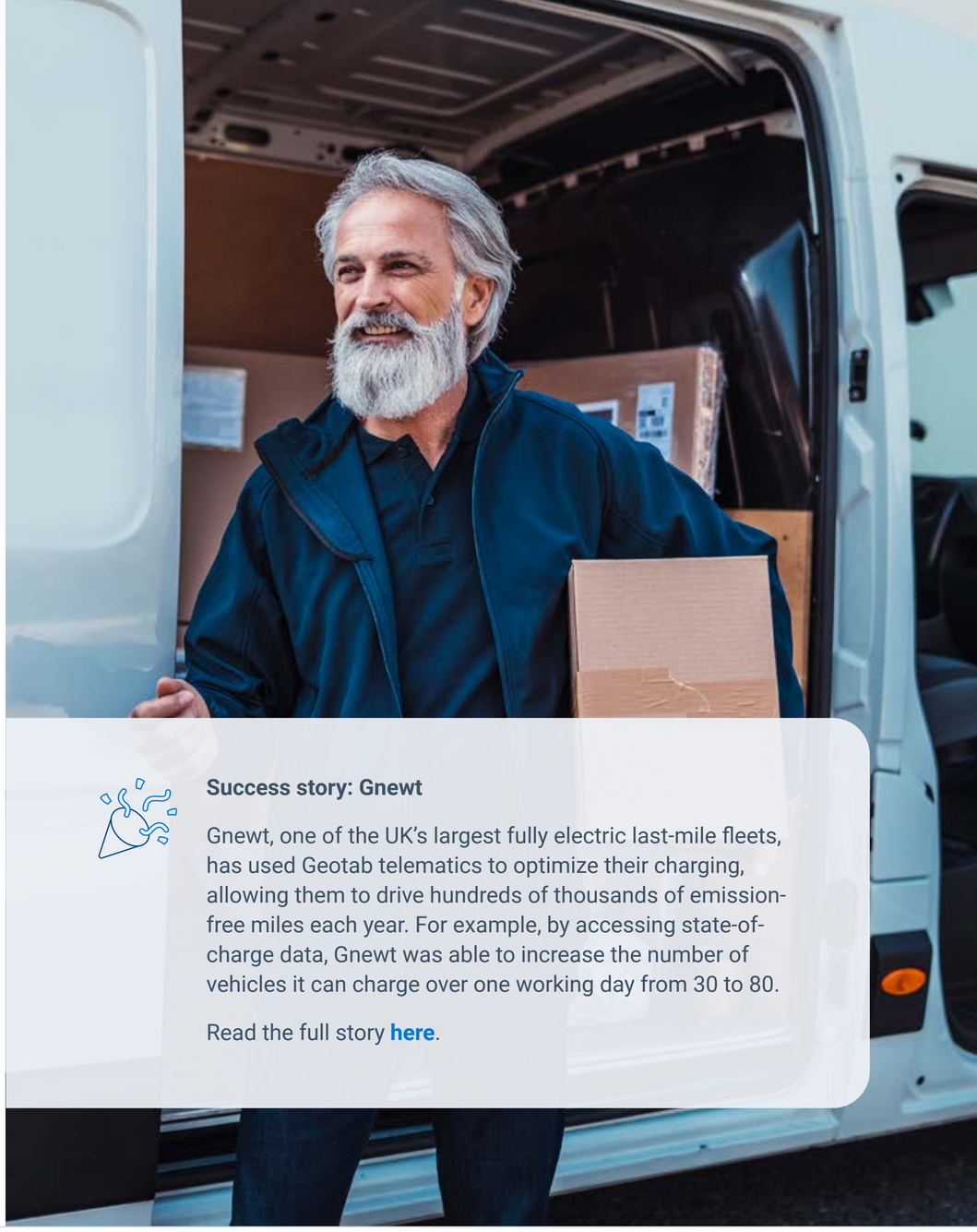
Here are just a few industries reaping the benefits of EVs in a substantial way:

Last-mile delivery

Over the last few years there has been massive growth in eCommerce and delivery services. By electrifying their fleet, delivery companies can substantially improve their cost-efficiency, while mitigating the negative environmental impacts of increased delivery traffic. According to one **study**, continued eCommerce growth will add 36% more delivery vehicles onto our roads by 2030 and create 32% more greenhouse gas than today.

Pressure is rising from cities and their inhabitants for cleaner delivery options. Low- and zero-emission zones continue to emerge across the globe. This is driving carriers to transition to zero-emission vehicles if they want to continue serving those regions and avoid fines.

The big names are leading by example. Over the last few years, **Amazon** purchased 100,000 EVs from Rivian, **UPS** bought 10,000 electric delivery trucks from start-up Arrival, and **Purolator** added to its electric fleet in Toronto and Montreal.



Success story: Gnewt

Gnewt, one of the UK's largest fully electric last-mile fleets, has used Geotab telematics to optimize their charging, allowing them to drive hundreds of thousands of emission-free miles each year. For example, by accessing state-of-charge data, Gnewt was able to increase the number of vehicles it can charge over one working day from 30 to 80.

Read the full story **here**.

Local delivery

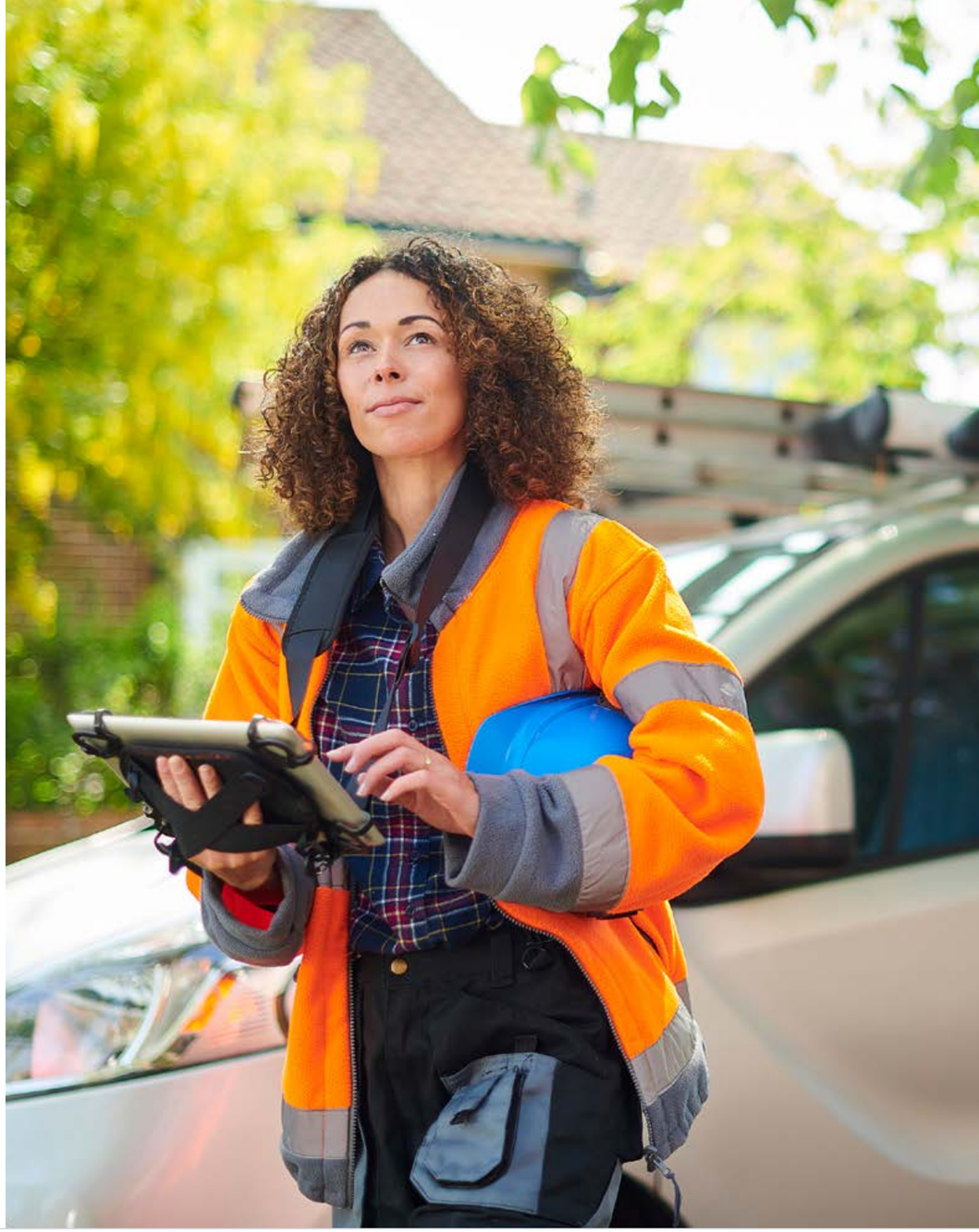
For all the same reasons that last-mile delivery is getting into EVs in a big way, other businesses are making the switch. For example, **Frito-Lay** has electrified a number of their vehicles at their snack food facility in Modesto, California. They added electric yard trucks, which operate in their 500,000 square-foot factory, and a fleet of electric box trucks to distribute their products to local retailers.

Field services

Time is money for businesses on a tight schedule. Some appointment-based companies were reluctant to adopt EVs in the past when ranges were shorter and charging infrastructure was limited – presenting the possibility of arriving late or missing service appointments. With increased range capabilities, and improved infrastructure, this is becoming less of an issue. As a result, more field service companies are adopting EVs for cost savings, regulatory compliance and environmental responsibility.

Did you know?

In 2021, the North American Council for Freight Efficiency (NACFE) conducted its **Run on Less** – Electric demonstration, which included Class 3 to 6 vans and step vans. They found that the technology is mature enough for fleets to be making investments in production BEVs.



Utilities

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 from charging.

For example, **Pacific Gas & Electric**, currently uses electric hybrid bucket trucks and extended-range electric pickups. However, they have made a commitment to create one of the cleanest transportation fleets in the energy industry with 100% of their light-duty fleet, 10% of their medium-duty fleet and 5% of their heavy-duty fleet being electric by 2030.

Pharmaceutical and healthcare

With a large mobile workforce making multiple stops – often in congested urban and suburban areas where medical offices tend to cluster – a switch to EVs in pharmaceutical and healthcare fleets makes good financial and environmental sense.

Sales reps usually cover large territories with high-value products that need to be delivered to the right people at the right time. Their vehicle requirements are usually straightforward, with relatively small capacity needs, opening up a wide range of EV options already on the market.

GlaxoSmithKline, for example, has committed to transitioning its fleet of 19,000 vehicles to EV and installing charging at 100 locations for staff by 2030.

Public transportation

In some applications, buses are particularly suited for electrification. They have standardized routes, typically travel within a smaller geographic area and are physically large, meaning they can carry larger battery packs. There are two categories of buses that have the greatest potential for electrification: transit and school. They both operate slightly differently and present distinctive opportunities.

Transit buses

Of the two types of buses, electric transit buses make the most economic sense. Given their high utilization rate and predictable routes, they benefit more from reduced fuel costs and have a lower total cost of ownership. The **U.S. Public Interest Research Group** (PIRG) determined that the annual operating cost of an eBus is less than half of a diesel model and that an electric transit bus could save over $50,000 a year on fuel and maintenance costs.

Another major reason to consider an electric transit bus is the avoided CO_2 emissions. Since these buses usually drive in urban areas with a higher population density, their impact on the air we breathe is potent. **Studies** have shown that poor air quality can contribute to cancer, asthma and heart disease.

BNEF announced that eBus sales are rising steadily, with 44% of global new sales being electric. These buses are primarily being sold in China, however there has been significant interest around the **rest of the world** as well.

Success story: DB Regio Bus

DB Regio Bus reduced their CO_2 emissions by approximately 1,400 tonnes a year by implementing a variety of sustainable fleet strategies, including adopting electric buses.

Read the full story **here**.

School buses

School buses do not drive as much as transit buses, limiting the economic benefits from reduced fuel costs. Fortunately governments see their overall societal benefits and are providing funding to help the big yellow bus go green. The **Clean School Bus Program**, a part of the U.S. Bipartisan Infrastructure Law, is providing $5 billion over the next 5 years to help transition to electric buses.

There is another unique opportunity provided by electric school buses: Vehicle-to-grid or V2G. This is the term for the ability to transfer energy from an EV back to the electrical grid. Energy would be taken during times of high demand or in emergency situations, and the EV would be recharged later. Essentially the EV acts as a backup generator. Since school buses have a large capacity battery and long dwell periods they are well suited for this practice. V2G offers operators a potential additional revenue stream – selling power back to the grid while they are idle.

Did you know?

In 2022, a new **law in New York** was passed that required all of the state's school buses to be electric by 2035. Currently New York has almost 50,000 school buses, roughly ten percent of the school buses in the country.

A note about heavy-duty trucks

Overall this is the most difficult class of vehicle to electrify and they are still in the early stages of adoption. These EVs require significantly larger battery capacities, whether it's so they can travel long distances or because the vehicles have greater power requirements. This is what presents the greatest challenge for OEMs. Batteries are still the most expensive component of any EV and the larger the battery the more expensive it is. These larger batteries can also pose challenges for charging, as the charging times and/or power requirements will increase along with capacity.

Carrying capacity can also be a problem as the tractor of an electric truck will weigh more than its diesel counterpart. This means their payload will be smaller for any given gross combined weight rating (GCWR). Long-haul trucking will also have to rely on an extensive charging network, which just doesn't exist yet.

All of this being said, there have been significant improvements with battery technology and there are still current opportunities within certain sectors. Recent wins can be seen with both **terminal tractors and regional haul trucks**. Both drive short enough distances, meaning range isn't an issue, yet they cover enough miles annually to save on fuel costs.

Even when it comes to long-haul trucking, things are changing. **PepsiCo** announced it has received the first Tesla Semi trucks, which have a stated range of 500 miles on a single charge. As this sector continues to evolve, and highway charging networks continue to grow, we will see many more opportunities for electrification.

Key takeaway

According to **BNEF**, some of the largest global medium- and heavy-duty truck manufacturers expect between 35% and 60% of their annual sales to be zero-emission vehicles by 2030.

CHAPTER 8

Creating an EV adoption strategy

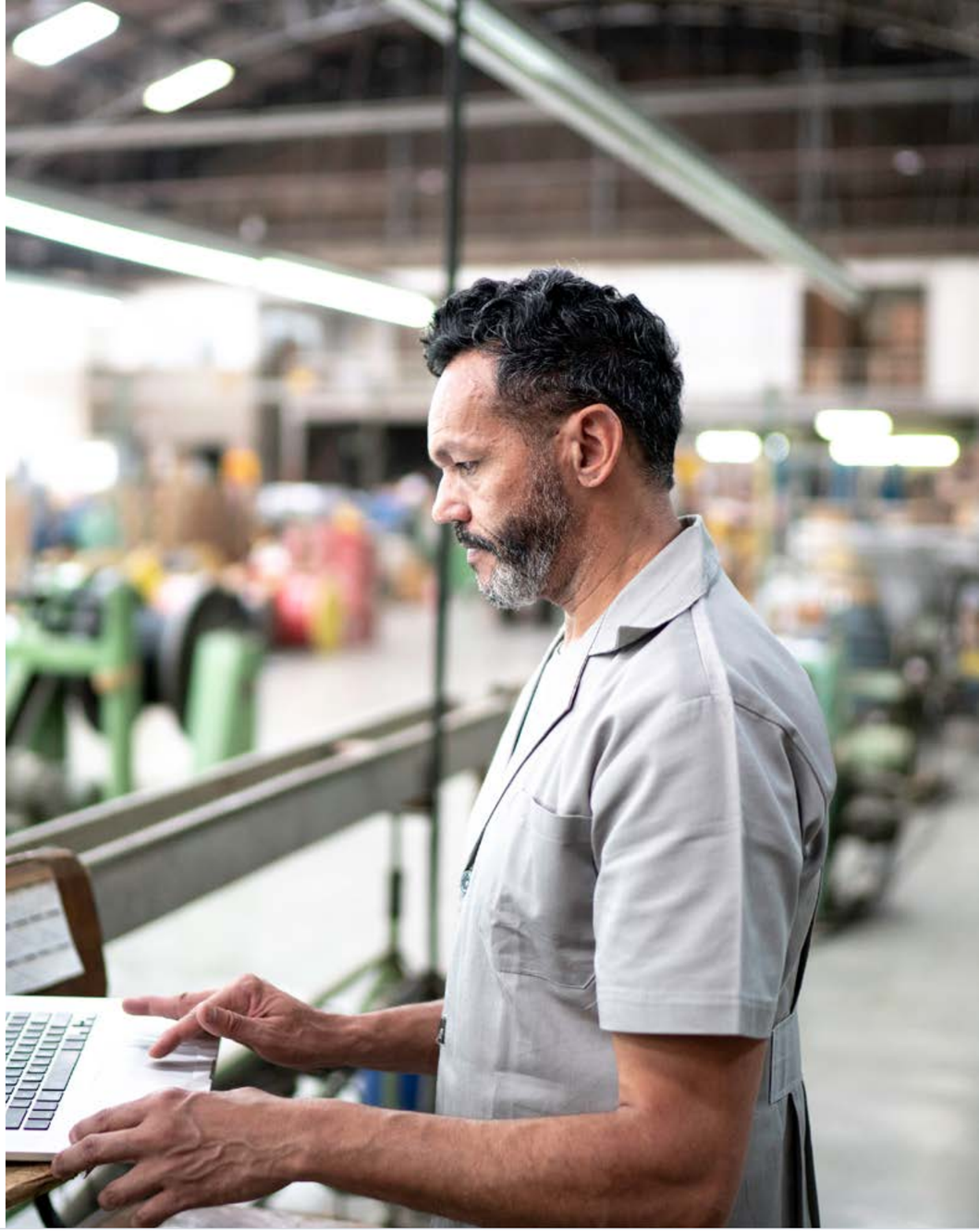
Electrifying your fleet doesn't need to happen overnight. It will be a gradual and ongoing process where you will begin replacing your ICE vehicles as they approach the end of their service life.

There is also more to consider than just the vehicle itself. You will need to plan out charging infrastructure and possibly provide additional training to drivers and maintenance teams.

Creating a comprehensive EV adoption strategy is a critical step to successfully incorporate EVs into your fleet and to assure that you receive the highest return on your investment.

Tip

You are not in this alone. Over the course of this process, organizations will work together with electric utilities, telematics providers, EVSE companies and other third-party solutions.



Understanding external factors

Before you begin investigating adding EVs to your fleet, it's important to determine the requirements that will affect your fleet and identify the types of support you will have.

Regulatory requirements, emission mandates and organizational goals

Governments and organizations around the world are focusing on finding ways to combat climate change. This focus has resulted in a number of different initiatives that will fundamentally alter how fleets operate.

For example, more than 30 countries will be **phasing out ICE vehicles** in order to reduce carbon emissions. Canada and Mexico have both implemented mandates that require 100% of all new vehicle sales be zero-emission by 2035 and 2040 respectively. Some European countries, such as **Greece** and Sweden, are implementing similar mandates that go into effect even earlier.

The U.S. is taking a more gradual approach by creating targets like 50% EV sales share in 2030 at the federal level. However, this may be superseded at a regional level, as some **states** like California and New York are considering implementing 100% zero-emission mandates as well. Depending on your location, you may not be able to procure new ICE vehicles within a few lifecycles.

Another example of a government intervention is implementing "**Low Emission Zones**." The U.K. has created zones within London that restrict the use of vehicles that produce emissions. Any ICE vehicle that enters these zones may be subjected to fines upwards of £2,000 (roughly $3,300). These zones have been widely used in Europe for a number of years and they are now being implemented in other parts of the **world** as well.

Motivation may not just come from the government, many organizations have made their own **commitments** to reduce CO_2 emissions. This could be driven by their own desires to become more environmentally friendly, or it could be a requirement from customers. It is also becoming more frequent that investors are looking for **Environmental, Social and Governance** (ESG) reports when they are deciding on potential business.

Incentives and other financial assistance

In order to help the transition to EVs there are likely a variety of different rebates or incentives available to you. It is important that you research what may apply based on your specific situation. This assistance could come from a variety of sources, such as federal, state and municipal governments or utility companies, and may include:

- Tax credits or grants for vehicle purchases in the **United States** or **Canada**
- Special electricity rates
- Rebates on EVSEs
- Low or no interest loans

Financing and EV management options

Other financing strategies, in addition to those mentioned above, can help reduce the upfront cost of acquisition for vehicles and charging infrastructure by converting the costs into smaller recurring payments.

For example, some fleets may consider operational leasing, where they can rent an EV without agreeing to purchase it after term completion or lease-purchase agreements.

Other fleets are choosing to forgo these upfront costs by working with a traditional fleet management company (FMC) or an EV-specific solution provider, sometimes referred to as "Electrification-as-a-Service." These "as-a-service" models transfer capital expenditures to operational budgets, bringing in external end-to-end offerings to manage various aspects of the vehicles and/or infrastructure. This service may include the procurement and ongoing maintenance of the vehicles and charging infrastructure for a single fee, based on a per-mile rate or a monthly/annual subscription.

Understanding regional differences

In **Chapter 4** we discussed how temperature can impact an EV's range, but this isn't the only regional difference you need to be aware of. Fuel costs and driving patterns can vary greatly depending on location, which will impact an EV's **economic viability**. If you have fleets operating in different areas you should treat each one individually.

Did you know?

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

Assessing your current fleet

The next step in creating your EV adoption strategy is understanding your existing fleet's current operations and establishing benchmarks.

Here are some key questions to ask:

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

By determining the maximum distance a vehicle completes in one day, you are able to better understand what kind of EV you require. Some more expensive EV models will have greater range capabilities, but you may only need a shorter-range EV to get the job done.

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.

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.

This topic will be discussed in more detail later on in this chapter.

How much CO_2 are my existing vehicles emitting?

Before you can track any progress you have made with your CO_2 reduction efforts, you need baseline or benchmark data. With the **right tools** you can track your own progress and even compare yourself to similar fleets to judge where you stack up.

What are my current costs for running the vehicle?

EVs are currently priced higher than their traditional counterparts, so 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 longer than ICE powertrains.

Choosing the right EVs for your fleet

When it comes time to choose the right EVs for your fleet, your decision will be based on whether the EV is capable of completing its daily duties and if it will save you money over the long term. Additionally, if you are looking to introduce EVs as part of your corporate sustainability objectives, you will also want to understand their impact on your fleet's CO_2 emissions.

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.

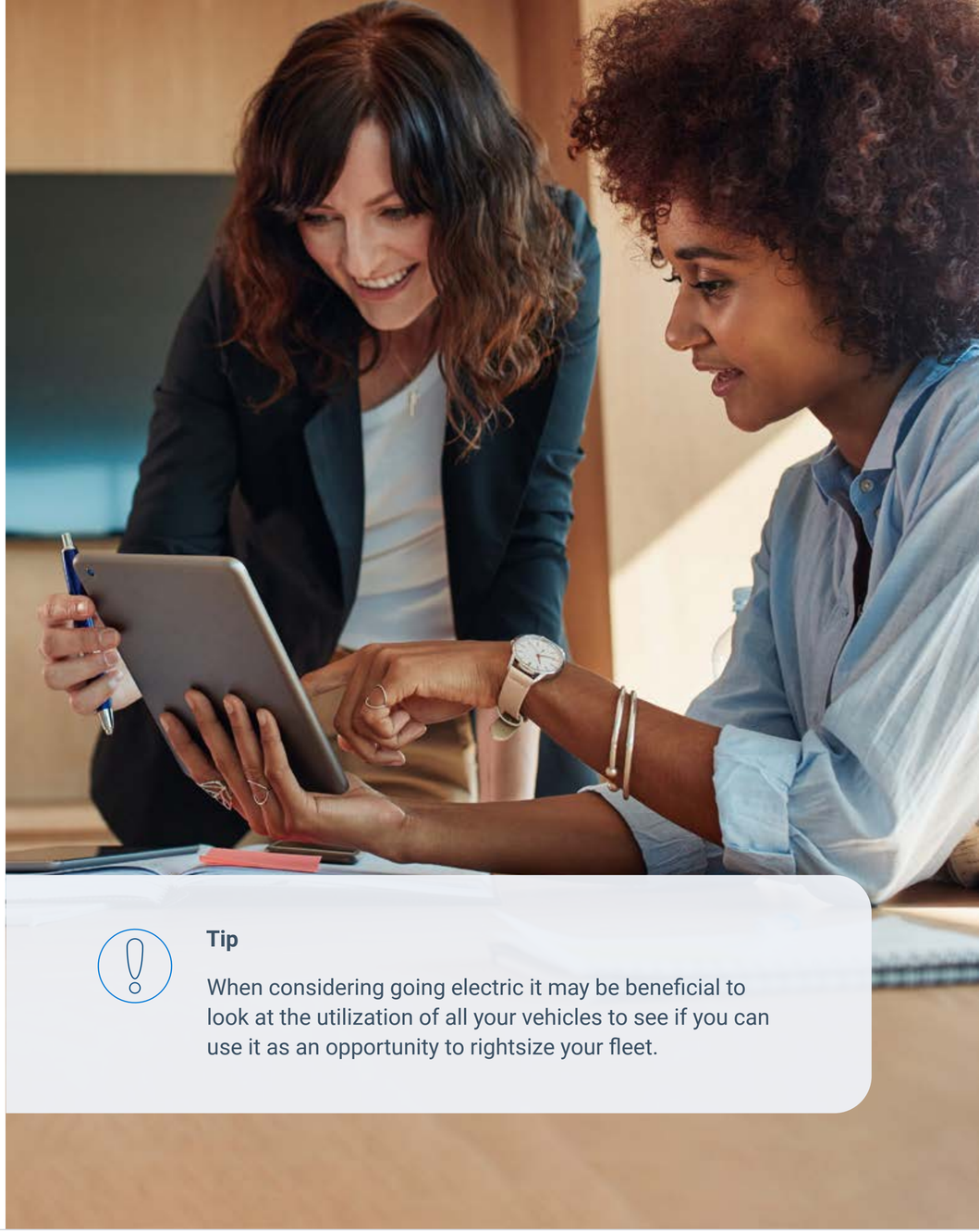
An Electric Vehicle Suitability Assessment (EVSA) is a tool that helps the fleet manager create a data-driven blueprint for electrification. The EVSA analyzes fleet and vehicle data to make the case for an electric transition in a way that makes sense for the organization's budget and time frame.

The 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 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.

This data can be correlated to outside temperatures to increase accuracy when modeling the EV's efficiency and range.



Tip

When considering going electric it may be beneficial to look at the utilization of all your vehicles to see if you can use it as an opportunity to rightsize your fleet.

Meeting operational requirements

Before diving into the total cost of ownership (TCO) analysis, an EV must first and foremost be able to complete the required range. An EVSA will analyze the daily driving range requirements (over the last 12 months, if possible, to capture business seasonality), to verify that there is a suitable EV that can complete its daily tasks on a single charge, to eliminate any concerns over range anxiety.

Uncover potential cost savings

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 an existing fleet vehicle with an EV instead of a new ICE vehicle. The following cost components are usually considered and could also be customized:

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

This analysis 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, as discussed previously in this chapter. These funds can play an important role in reducing the total cost of ownership of EVs. In a recent study on the potential of **European fleet electrification**, Geotab found that even a small rebate can significantly improve an EV's total cost of ownership.

Save time with an EVSA

You can save time researching EV options and be confident in your decisions by conducting an EVSA.

A key benefit of an EVSA is it that it takes the guesswork out of choosing the right EVs by making it easy to compare options based on factors such as:

Retail price

EV type (BEV vs. PHEV)

Battery capacity/range

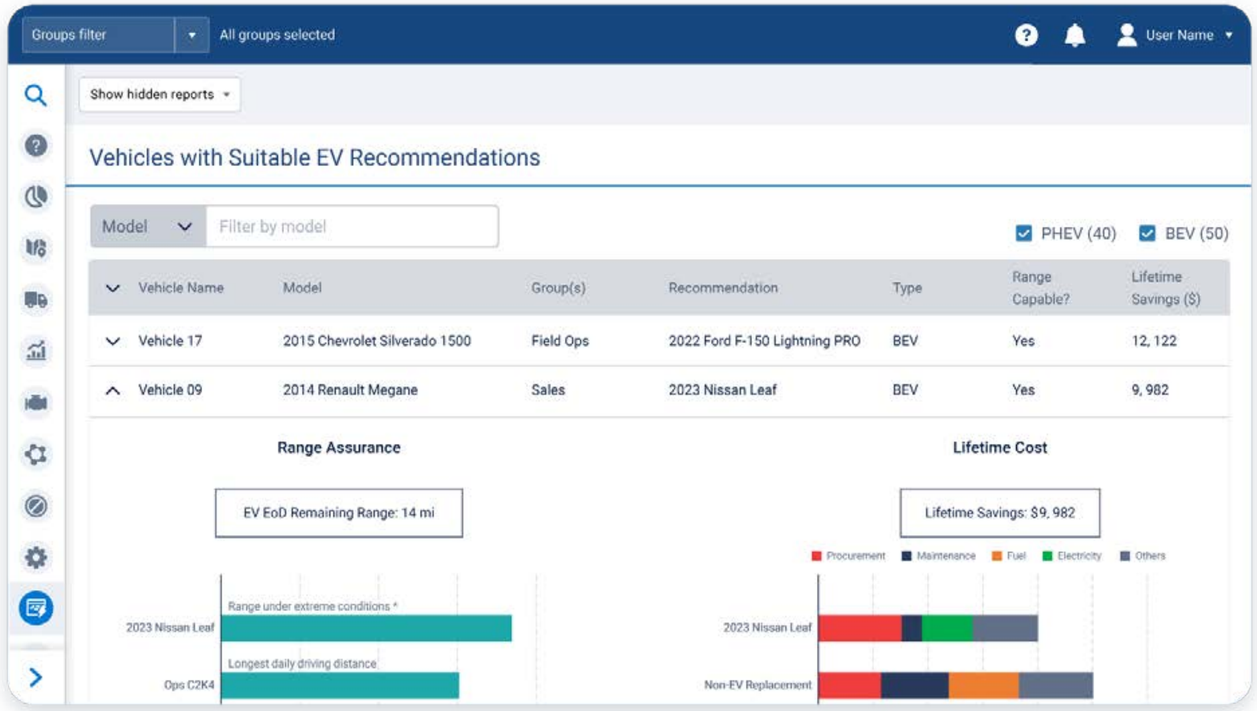
Regional ambient temperatures

Local availability

Maintenance costs

Reducing your fleet's CO_2 emissions

To help you understand the environmental impact of electrification an EVSA will provide you metrics, specifically for your fleet. You can visualize both the amount of CO_2 emissions and fossil fuels you can avoid by going electric.



The Geotab EVSA draws on one of the largest datasets for real-world EV performance to offer data-driven recommendations for your fleet.

Success story: New Brunswick Power

After running an EVSA, New Brunswick Power discovered they could reduce their fleet's CO_2 emissions by 94% and save an average of $11,735 CAD ($8,627 USD) per vehicle by going electric.

Read more

Establish charging infrastructure needs

Building out your fleet's charging infrastructure is a critical point in your fleet electrification journey and requires careful consideration. You need to answer a number of questions and each organization will have to approach it differently depending on their needs. The following questions are based on the assumption that you will solely be using your own private charging stations, as opposed to relying on public ones.

What type of charging equipment are you going to use?

In **Chapter 5** we covered the basics of the three different levels of charging. Battery size, duty cycle and vehicle type are the crucial factors in choosing between level 1, level 2 or DC fast charging stations. Level 1 charging will have limited use cases for fleets as it can take more than 20 hours to fully charge an EV.

If your vehicles dwell for longer periods of time it may be preferable to install level 2 chargers over DC fast chargers, as they are typically cheaper and have lower per-station power requirements. However, if you require your vehicles to get back on the road as soon as possible, or if your fleet consists of EVs with much larger battery capacities, then you will likely choose DC fast chargers. It should be noted that most plug-in hybrids aren't capable of DC fast charging.

How many chargers do you need?

The answer to this question will depend on the previous one – what kind of chargers are you using? It is a misconception that every EV requires its own dedicated charger. Most light-duty vehicles will be able to fully charge in 4-5 hours with a level 2 charger, meaning that you can use that same charger for multiple vehicles if they dwell long enough.

Where do you install the chargers?

This will primarily depend on your vehicle's dwell location. 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.

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.

How long does it take to build?

Unfortunately there is no one answer to this question as it will depend on the overall size and power requirements of your set-up, as well as local regulations and building codes. You will need to take into consideration: design time, applying for permits, construction, testing and inspections. All of these factors together can result in this project spanning months or even years. Talk to your utility company as soon as possible in order to get a better understanding of a potential timeline.

Identify your partners

During your fleet electrification journey you will be working with a number of different partners and it is important to establish these relationships early on.

Contacting your local utility company

As mentioned previously, calling your electric utility company should be one of your first steps. They need to be made aware of your increased energy usage and they will also be able to help you with infrastructure planning. Another important reason to contact them as soon as possible is that you may qualify for rebates or other financial assistance. This doesn't just apply to the construction of your charging infrastructure. Many utility companies will offer special electricity rates for fleets. For example, **San Diego Gas & Electric** offers a program that features a reduced charging rate and simplified billing.

Choosing an EVSE provider or service

There is a wide variety of charging equipment providers on the market to consider. Each will have their own benefits and many offer special programs specifically for fleets. You may choose to contact them directly or you may want to ask your utility company, or preferred contractor, if they have any recommendations.

Selecting an EV-friendly telematics provider

EVs have a number of unique metrics that need to be monitored in order to optimize their performance, range and return on investment. Make sure your telematics solution has everything you need to fully support the adoption and management of the EVs in your fleet by downloading our **Telematics RFP** checklist.

Don’t forget training

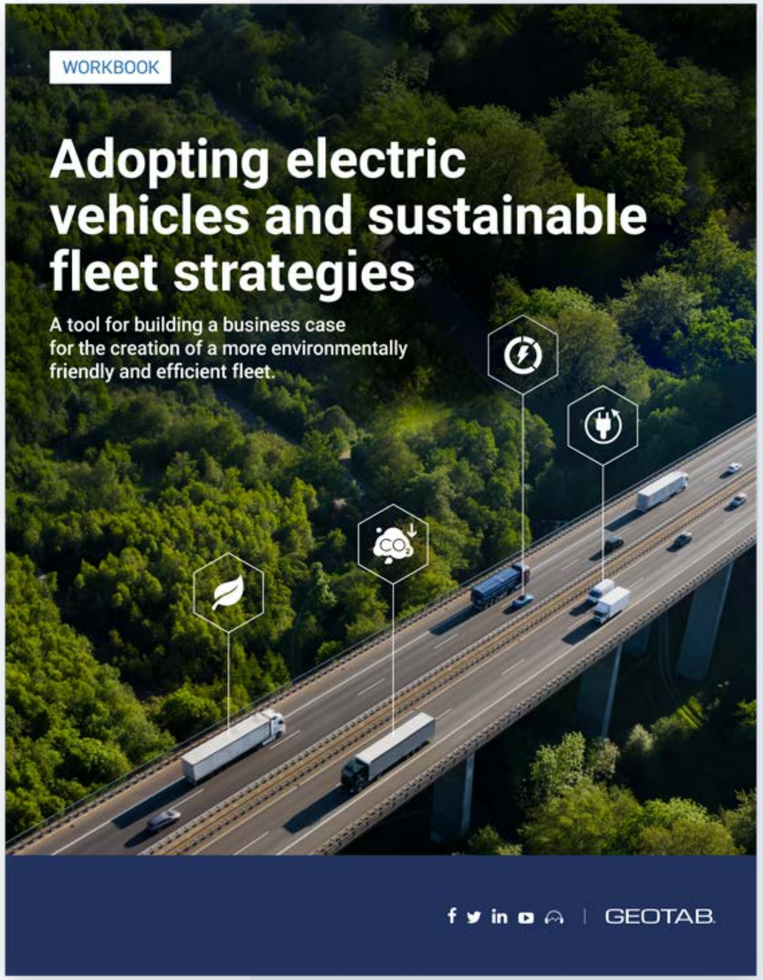
Training is an essential part of any organization. In **Chapter 1** we touched on a few things your drivers need to be aware of when handling an EV for the first time (e.g., increased torque and regenerative braking). However, there may be a few additional topics to cover including new charging routines and eco driving habits, a topic discussed more in the next chapter.

Depending on your fleet’s specific situation, drivers may not be the only ones to require additional coaching. Maintenance teams might have to become familiar with EVs and their charging equipment, while fleet managers will have to learn more about EV-specific metrics and how to monitor their performance.

Building a business case for fleet electrification

Planning and proper budgeting is a crucial step for adding EVs to your fleet.

Check out our **Adopting Electric Vehicles and Sustainable Fleet Strategies workbook** to help you build a business case.



CHAPTER 9

How to optimize EV fleet operations

Adding EVs to your fleet is just the beginning. This chapter will explore how you can get the most out of your investment by maximizing their efficiency and implementing additional sustainable fleet strategies.

How can fleet managers get more out of their EVs?

Take care of your batteries and minimize the rate of degradation.

Train drivers to get the most range out of your EVs as possible.

Increase EV utilization by rightsizing your fleet.

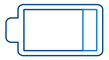
Optimize routes to complete the most tasks on a single charge.

Streamline charging with custom alerts and a smart charging program.

Tips for maintaining the EV battery

Previously in **Chapter 4** we discussed battery degradation and the impact it can have on an EV's range over time. The factors that impact an EV battery's health include: time, high temperatures, operation at high or low state-of-charge (SOC), high electric current and usage. Some of these obviously cannot be avoided, but there are best practices that can 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 if possible

Maximizing EV range

We explored the various elements that can influence an EV's real-world range capabilities in **Chapter 4**, such as temperature, speed and driving behavior. In order to get the most range out of your EVs here are some tips you can provide your drivers with.

Reducing the impact of extreme weather

Most of the reduced range during extreme weather is the result of energy being used to heat or cool the cabin. To combat this the best practice is to preheat or cool the vehicle while it is plugged in. In cold temperatures, make sure you utilize the heated seats or steering wheel, as they use less energy than the heater. In hot temperatures try to roll the windows down and park in shaded areas when possible.

Go easy on the accelerator

Driving at higher speeds reduces the efficiency of your EV, like with an ICE vehicle, meaning that it reduces its range. Additionally, an aggressive driving style often leads to heavier braking, which results in regenerative braking not being maximized. Encouraging smooth driving is an easy way to conserve energy and increase your range.

Tip

To see how temperature and speed interact with each other to impact range check out our **interactive analysis.**

Rightsizing your fleet

Rightsizing includes reducing the number of vehicles based on overall utilization and making sure your most efficient vehicles are being used as much as possible. Ask yourself, does your fleet really need multiple pickup trucks, or would a more cost-efficient vehicle be able to do the job as well? Not only does rightsizing help reduce costs, but by prioritizing the use of your EVs over your ICE vehicles you can further decrease your overall CO_2 emissions while getting the most return on your investment.

Success story: Madrid City Council

By using telematics data the Madrid City Council was able to balance the use of their EVs appropriately, rightsize their fleet and reduce their CO_2 emissions by 60%.

Read more

Route optimization

Always taking the most efficient route is an essential way to maximize the efficiency and fuel (or energy) economy of any fleet vehicle. It can play an even more important role with EVs as a way to make sure they can complete their tasks without needing to stop and charge, or they could schedule routes based around charging mid-day. You can also take this opportunity to limit carrying unnecessary excess weight in order to improve your range capabilities.

Streamline your charging

Making sure your EVs are always charged when they need to be is critical for the successful operation of your fleet.

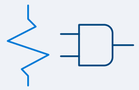
Understand state-of-charge

One of the most important EV-specific metrics to become aware of is an EV's state-of-charge (SOC). In a sense, an EV's SOC is no different than a traditional fuel indicator – it shows how "full" the battery is. By monitoring SOC in real time you can make sure that your EV will not run out of energy before reaching its charging destination. It can also be used to track EVs that are charging, allowing you to see how long until the vehicle is ready to go.

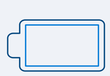
Create real-time notifications

You can create an effective program by implementing a number of real-time notifications, enabled by your telematics solution. For example you can get alerted when an EV is entering a zone, like returning to a depot, with a low charge. This informs the driver and fleet manager that the vehicle needs to be charged. You can set another notification when a charge cycle is complete and that the charger is available for another vehicle. If you have a standard charging pattern you can even set a customized alert, which could identify if someone forgot to plug in the EV at the end of a shift.

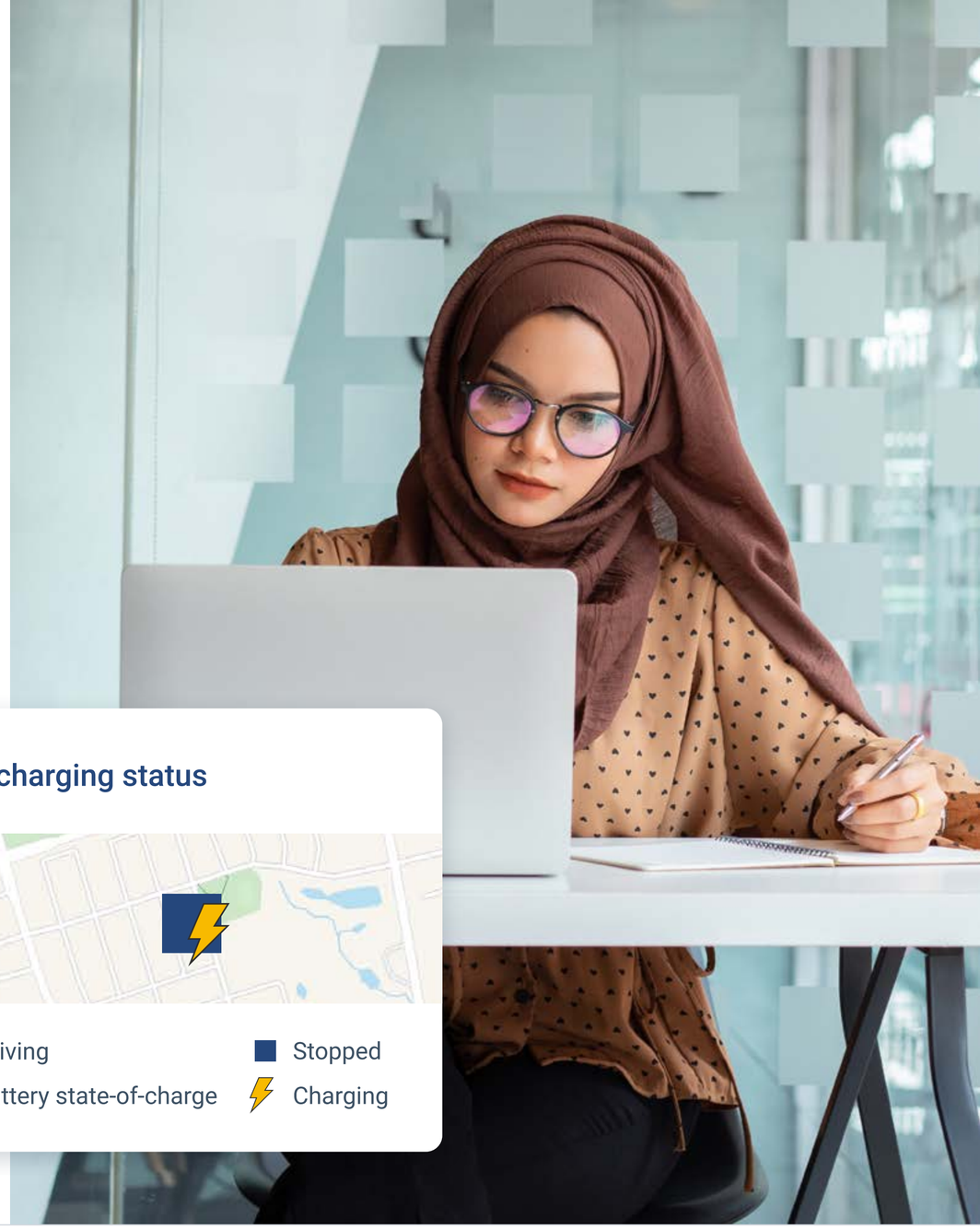
Low SOC



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



Charging complete



Review charging data

By regularly reviewing your charging history logs you can gain a number of valuable insights. This data will help you better track charging costs, time spent charging and it can help inform future charging requirements.

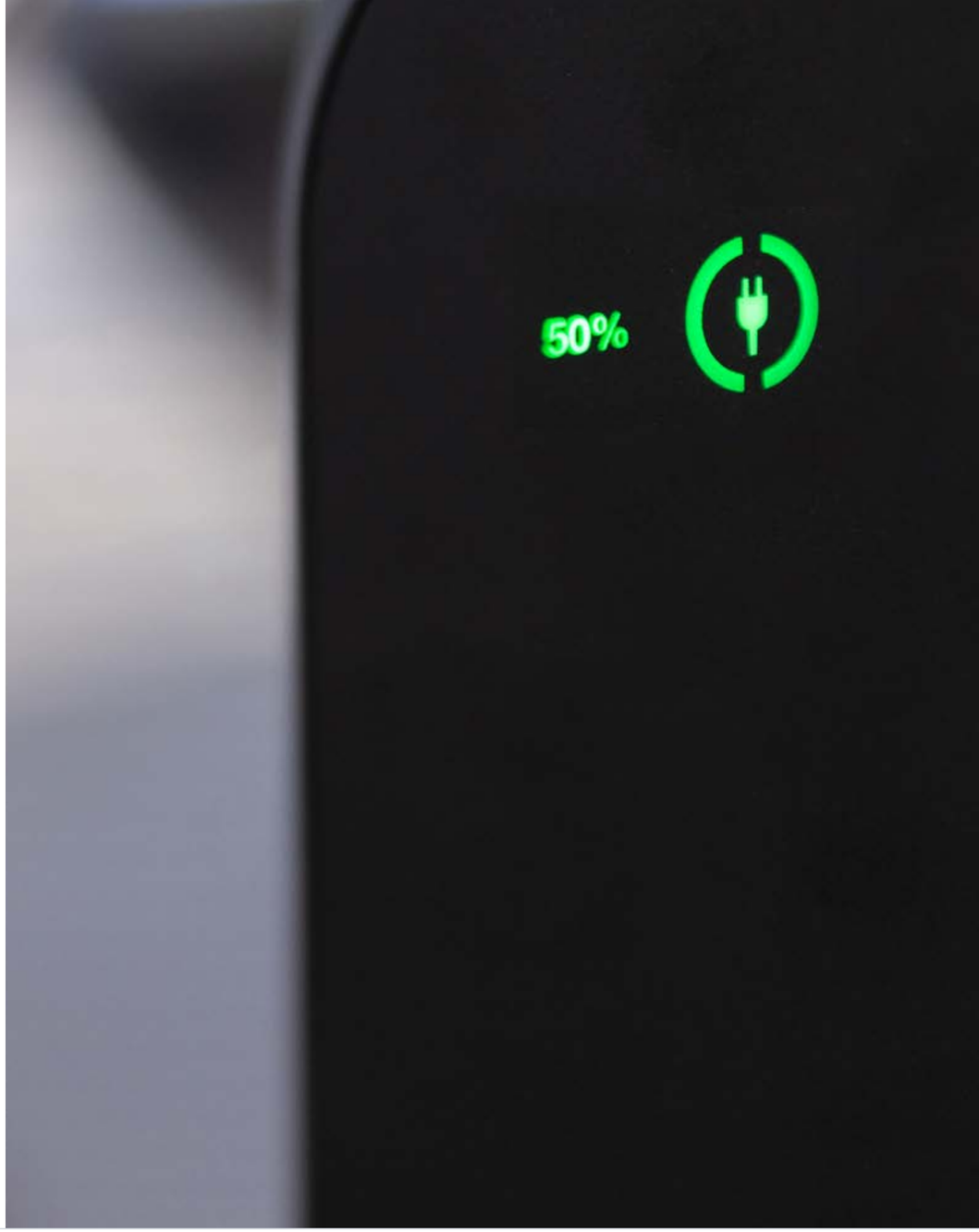
Implement smart charging

In addition to scheduling your charging based on their immediate need, you can create a program that charges your EVs during specific time periods. This is known as smart charging. There are a few reasons why you would want to delay charging your EVs. One is avoiding demand charges from your electricity provider.

Demand charges are fees that are based upon the highest amount of power (kW) used at any given time during a billing cycle. Simply put, if you use a lot of power at once you are going to be charged more. To avoid these hefty fees, you should spread out your EV charging, usually by scheduling one vehicle to start charging once another one stops.

Another reason to schedule your charging is to take advantage of a time-of-use program. Many utilities will offer different electricity rates based on the time of day, with higher prices during peak periods (typically between 5-9pm) and lower prices when demand is low (usually during overnight periods). Fleets can significantly reduce their charging costs by adhering to these practices.

Note: Networked charging stations and real-time battery SOC data is required to properly implement a smart charging program.



Monitoring performance

For every metric you would use to measure the performance of the internal combustion engine (ICE) vehicles in your fleet there will be an equivalent one for EVs. One of the key metrics to compare is fuel vs. energy efficiency.

To determine fuel efficiency you would traditionally compare driving distance to the amount of fuel used to create a miles per gallon (MPG) metric. For EVs, you would compare driving distance to the amount of electricity used. This can be measured in watt-hours per mile (Wh/mile). To simplify the comparison, your telematics platform can convert into MPGe or miles per gallon equivalent.

Tip

If you have PHEVs in your fleet, you'll want to make sure they're being used correctly and that they aren't 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.

Utilizing one platform for your mixed fleet

The simplest way to compare the EVs to the ICE vehicles in your fleet is to manage them both in a single platform. This way you know that the data is based on the same definitions and you can run a consolidated report for all the vehicles in your fleet. It allows you to directly measure their fuel consumption and operating costs.

CHAPTER 10

EV fleet manager FAQs

Fleet electrification can be a complicated topic and you may have some questions. In this chapter we have gathered some of the most frequently asked questions we have heard over the years.

1. When should I consider electric vehicles for my fleet?

Fleets should start investigating electric vehicles as soon as possible since transitioning to EVs won't happen overnight. It will require some **extra planning** and it will most likely happen gradually, a few vehicles at a time.

EVs represent more than just a way to lower your fleet's carbon footprint, they can also present significant financial benefits. Modern EVs typically have a lower total cost of ownership, resulting from lower fuel and maintenance costs, meaning that you can improve your fleet's bottom line while becoming more sustainable.

With more electric makes and models entering the market alongside incentives, there has never been a better time to start considering EVs.

2. Which fleet vehicles make most financial sense to replace with an EV?

If you are looking to add EVs to your fleet you need to consider a number of factors, such as daily driving distances, carrying capacity and dwell times. This will determine if the available models have sufficient range to complete a vehicle's duty cycle and if the financial savings from the lower operating costs outweigh the higher acquisition cost.

The best way to determine if an EV is right for your application is by reviewing your data or conducting an EV Suitability Assessment. This topic is discussed in detail in **Chapter 8**.

3. Are there EVs that have enough range for fleet applications?

Electric vehicles have improved a lot over the last few years, specifically when it comes to their range capabilities. The suitability of EVs will largely depend on your fleet's application, but there are many options available.

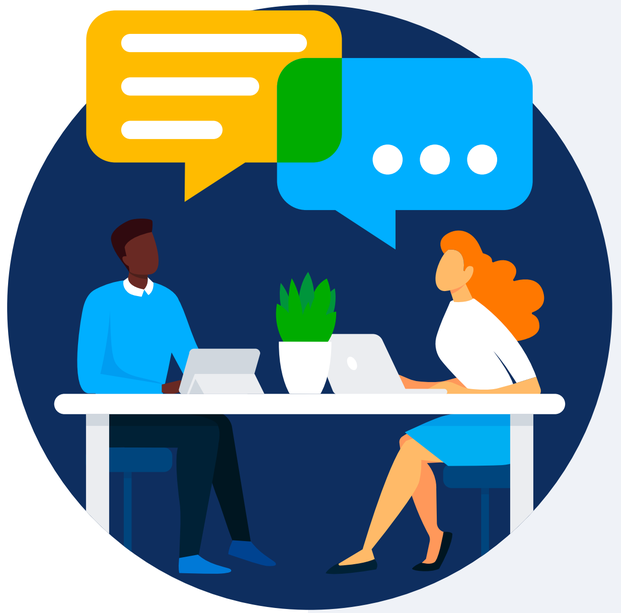
For many light-duty commercial and passenger fleets today's battery electric vehicles (BEV) will fit the bill. The majority of available BEVs have a rated range of at least 250 miles, meaning they can handle most fleets' daily driving needs on a single charge. In the **heavy-duty sectors** it is more nuanced, as some vehicle classes are farther along than others.

One important thing to consider is that an EV's usable range can be affected by several factors including temperature, payload and speed. Refer to **Chapter 4** for more information on what can impact your EVs range.

4. Why would I replace a gas vehicle with an EV when it already does the job?

In **Chapter 3** we explore all of the benefits of fleet electrification. Put simply, EVs present a number of opportunities to improve your fleet. In the right applications, they have a substantially lower total cost of ownership (TCO) than gas and diesel vehicles.

Also, there are a growing number of corporate and government mandates coming into effect in order to combat the effect of climate change. Transitioning to EVs will be critical for some fleets to remain compliant in the future.



5. How do I decide between BEVs and PHEVs?

The decision between battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) comes down to fleet application.

BEVs are fully electric and have no tailpipe emissions, making them the more eco-friendly option. In general they also have fewer moving parts, meaning that they have lower maintenance and operating costs. They also present the most cost saving opportunities, specifically if they can meet daily driving requirements on a single charge or have long enough dwell times to charge between duty cycles. However, for vehicles with less predictable or longer routes, a PHEV might be a better fit.

Review **Chapter 8** for more information on choosing the right EVs for your fleet.

6. How long does it take to adopt EVs into a fleet?

Adding EVs to your fleet requires planning and how long it takes will differ depending on each fleet's unique situation. To start, you need to create an EV adoption strategy (see **Chapter 8**).

Some fleets might take a more gradual approach and try piloting a few vehicles, as existing ones need to be replaced. Others might decide to launch a full-scale electrification program and start proactively swapping out a large portion of your fleet.

In both scenarios you will need to consider an important question: Where are your EVs going to charge? This is important because it will add time to your implementation. If you are installing a depot of charging equipment, make sure that you contact your municipal government and electric utility provider as soon as possible since timelines for approvals can vary.

In the end the process will be different for every fleet, so it is important to begin research as soon as possible.

7. I have a few EVs in my fleet, how do I know if they perform better than my ICE vehicles?

The simplest way to compare the EVs to the ICE vehicles in your fleet is to manage them both in a single telematics platform. This way you know that the data is based on the same definitions and you can run a consolidated report for all the vehicles in your fleet. This allows you to directly measure their fuel consumption and operating costs.

We discussed monitoring the performance of your EVs at the end of **Chapter 9**.

8. What do I need to share with my drivers about operating EVs in my fleet?

In **Chapter 1** we highlighted some of the differences your drivers should be aware of when operating EVs. While some of these will just take getting used to, such as the increased torque and regenerative braking, there are a few other areas that may require some extra training or monitoring.

For example, drivers of both EVs and ICE vehicles should be aware of how good driving practices can improve fuel efficiency or range. However, with EVs, temperature will also play a role as heating the cabin uses electricity which would otherwise be used for propulsion.

To avoid any disruptions you should make sure that driver training is a part of your overall **EV adoption strategy**.

9. How do I decide how many chargers I need?

Planning out charging infrastructure can be one of the more complex tasks in your EV adoption strategy. The exact way you approach this will depend on the nuances of your fleet. The total number of chargers you need will depend on dwell time between duty-cycles, the type of chargers you are going to use and where they are located.

More details on establishing your charging infrastructure needs can be found in **Chapter 8**.

10. What should I know about employees charging at home?

Allowing employees to take a company EV home has many benefits, for both the individual and company. It can be more convenient, as it reduces unnecessary trips back to the fleet yard, and it can also be more cost-effective since it can reduce the amount of on-site infrastructure required.

It is important to be aware that not everyone has access to a home charging station, particularly people living in a condo, apartment or other rental property. For more information on home charging refer to **Chapter 5**.

11. How can an EV save me money? Aren't they more expensive?

Yes, EVs currently have a higher sticker price than their equivalent ICE model. However, it is important to look at a vehicle's total cost of ownership (TCO) to understand its impact on your bottom line.

On average, electricity is less expensive than gasoline or diesel, resulting in significantly lower fuel costs over the lifespan of the vehicle. EVs also have fewer moving parts and require less maintenance than ICE vehicles, again saving money.

Check out **Chapter 3** for more information on the benefits of EVs.

12. Do extreme temperatures impact EV range?

Like with ICE vehicles, an EV's real-life performance is often different from what is published based on standardized testing. The effective range of an EV will depend on a number of different conditions including: speed, driver behavior and temperature.

Temperature is one of the more noticeable conditions and it is the one most likely to vary throughout the year. Both extreme hot and cold temperatures have an impact on range, but it is not for the reason most people initially think.

This topic is covered more in depth in **Chapter 4**.

13. 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. This is discussed further in **Chapter 9**.

14. What does EV model support mean?

EVs do not adhere to the same mandatory telematics data standards as ICE vehicles, making it harder to access the vehicle's data. This is 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. Data accessibility is discussed in **Chapter 2**.

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 creating a more sustainable and profitable fleet. 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 adopting and operating EVs visit our **Fleet Electrification Knowledge Center**.

If you are ready to get started, request a demo of our **EV Suitability Assessment**.

About Geotab

Geotab is a global leader in connected transportation solutions. We provide telematics — vehicle and asset tracking — solutions to over forty thousand customers in 150 countries. For more than 20 years, we have invested in ground-breaking data research and innovation to enable partners and customers, including Fortune 500 and public sector organizations, to transform their fleets and operations. We connect to over 3.2 million vehicles and process more than 55 billion data points a day so that customers can make better decisions, increase productivity, have safer fleets, and achieve their sustainability goals.

Geotab's open platform and Marketplace, offers hundreds of third-party solution options. Backed by a team of industry leading data scientists and AI experts, Geotab is unlocking the power of data to understand real-time and predictive analytics — solving for today's challenges and tomorrow's world.

To learn more, visit **www.geotab.com**, follow @GEOTAB on **Twitter** and **LinkedIn** or visit the **Geotab Blog**.

GEOTAB®

geotab.com