GEOTAB

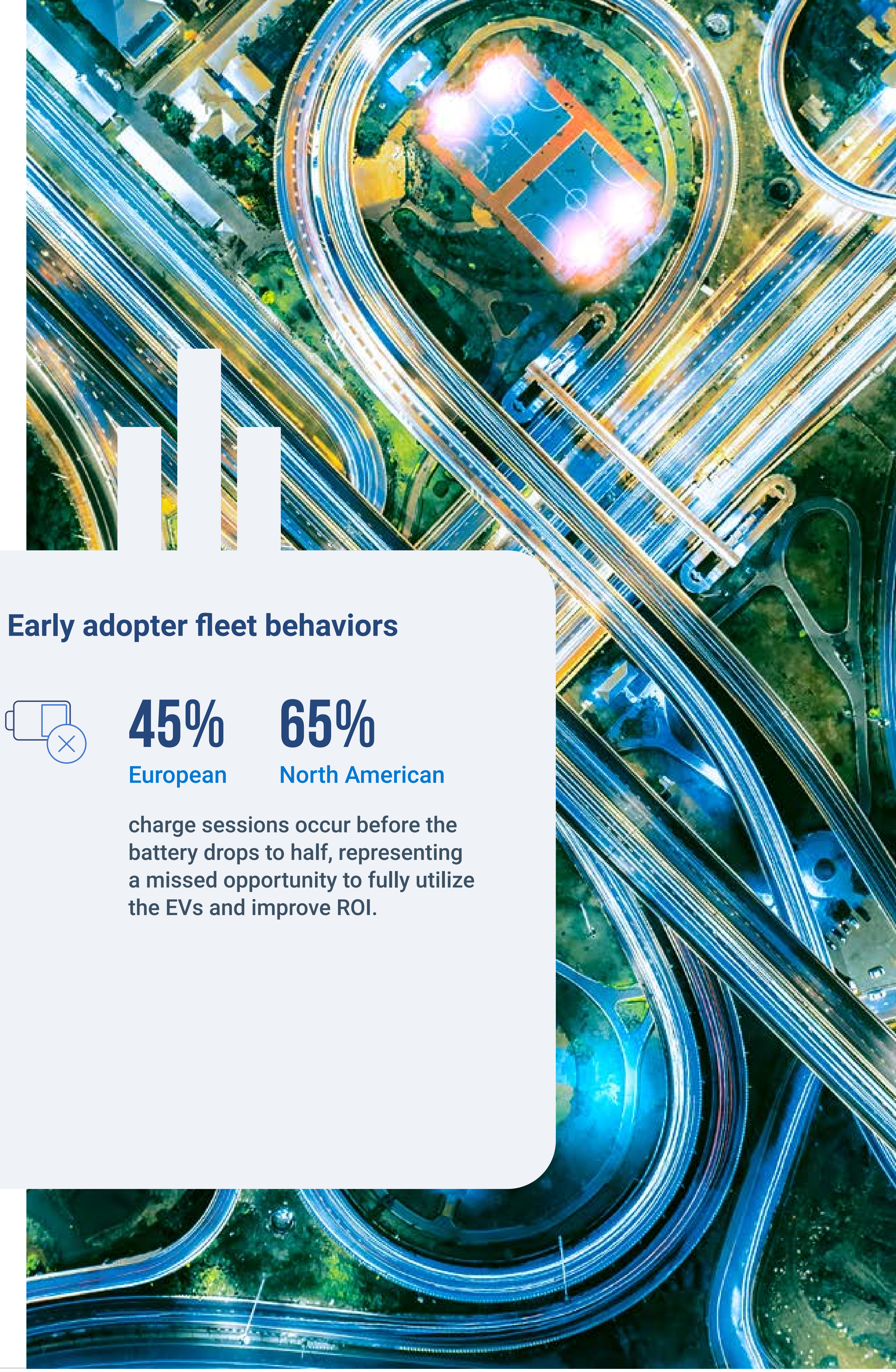
Taking charge

On the road to the EV future

2024 Report

Executive summary

We're entering an exciting time for fleet electrification. The opportunities are growing for fleets to electrify, and in doing so, they can reduce their total cost of ownership (TCO) while meeting their carbon reduction goals. This study highlights how EVs can transform today's fleets, using real-world data insights from over 1.3M vehicles across seven countries: The United States, Canada, the United Kingdom, France, Germany, Italy and Spain. It also analyzes data from over 5,200 early adopter fleet EVs to understand the decisions fleets make once they adopt these vehicles, and how these can influence asset utilization and resulting TCO.



Study highlights

Light-duty EV Suitability Assessment

75%
of the analyzed light-duty vehicles could be replaced with a range capable battery electric vehicle today.

2.2B
gallons
of fuel would be saved over the next seven years.

41%
of vehicles were economically viable and could save fleets money over their lifespan.

19M
metric tonnes of CO_2
emissions would be avoided during that time.

Medium- and heavy-duty EV potential

53%
of heavy-duty trucks never exceeded 400 miles, even on their longest driving day.

200

63% Door-to-Door
49% Hub & Spoke
60% Local

medium-duty vehicles never exceeded 200 miles in a day, within the mileage range of several class 3-6 EVs on the market today.

Early adopter fleet behaviors

45% European
65% North American

charge sessions occur before the battery drops to half, representing a missed opportunity to fully utilize the EVs and improve ROI.

Some markets are more developed, while others may take some additional time. But by digging deeper into region-specific driving and charging data, we can see that EVs are both operationally and economically viable for a large number of fleet applications today.

Introduction

With a growing number of emissions targets and regulations, fleet managers from across the globe are taking a closer look at fleet electrification.

Most understand that adding EVs to their fleet will help reduce their CO_2 emissions and that they'll play an important role in their organization's future. However, questions remain on how much it will cost, and whether the current models are up to the task.

This report shows that not only are EVs suitable for many fleet applications, but they may also represent an opportunity for significant cost savings over the lifespan of the vehicle.

Using data intelligence to assess light-duty fleet electrification potential

This study delves deep into real-world telematics data to understand the feasibility of transitioning from internal combustion engine (ICE) vehicles to electric vehicles (EVs) within light-duty fleets. Spanning a year, from June 1, 2022 to May 31, 2023, we analyzed the daily vehicle usage patterns of approximately 750,000 commercial vehicles across seven countries: The United States, Canada, Spain, Italy, Germany, France, and the UK.

By analyzing the data using Geotab's EV Suitability Assessment (EVSA), this research provides insights into the number of vehicles that can feasibly be replaced by currently available EVs. The analysis also quantifies the economic and environmental benefits of such a transition. Detailed assessments were conducted at a regional and country level, offering a comprehensive view of the electrification potential across these regions.

Exploring electrification opportunities for medium- and heavy-duty vehicles

As the transportation industry pivots toward zero emissions, the focus often rests on passenger vehicles; yet, there's a growing opportunity for commercial trucks. And since medium- and heavy-duty vehicles have a lower comparative fuel economy and greater vehicle miles traveled (VMT) than other vehicle classes, the tailpipe emissions savings of transitioning these vehicles can be sizable. This portion of the report considers telematics data from approximately 500,000 class 3-8 trucks, operating within Canada and the U.S., from June 1, 2022 to May 31, 2023.

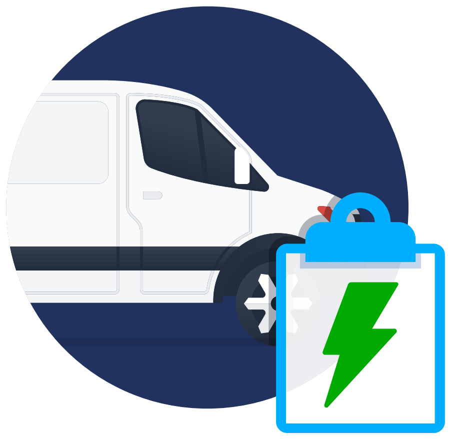
By categorizing data based on vocation and vehicle class, we provide valuable insights into the feasibility of transitioning these larger vehicles to electric, taking into account factors such as daily driving distances and dwell durations.

EV charging behaviors and what we can learn from early adopters

Finally, the report takes an in-depth look at the charging behaviors of over 5,200 fleet-operated EVs across North America and Europe, from June 1, 2022 to May 31, 2023. By examining where and how these fleet EVs are charged, we illuminate the intricacies of current EV deployments, offering insights into their true utilization and charging requirements as well as the potential for improved performance and ROI.

Our analysis reveals trends such as the typical number of charging stations an EV visits, the prominence of AC charging, and the average battery levels fleet operators are allowing their vehicles to get to before charging.

Key findings from this report



Light-duty EV Suitability Assessment

- 41% of vehicles were suitable for electrification
- On average, fleets could save around $16,000 per vehicle
- European fleets currently have a higher rate of EV suitability than North America

Investigating medium-/heavy-duty electrification potential

- Locally operating vehicles are prime for electrification, with many not exceeding 200 mi a day
- The electrification potential in Door-to-Door vocations is higher for heavy-duty (78% not exceeding 200 mi a day) than for medium-duty vehicle classes (63%)
- The majority of vehicles spend more than 10h parked on their highest utilization day, except Long Distance vehicles

Charging behavior analysis

- More than 50% of European and North American fleet vehicles charge in just 1-2 locations
- Most charging occurs outside of the core business hours
- 45% of European charge sessions and 65% of North American charge sessions occur before the battery drops to half, showing the potential for greater utilization and reduced TCO

SECTION 1

Potential fleet electrification for light-duty vehicles in North America and Europe

Of all the different classes, light-duty vehicles currently provide the greatest opportunity to go electric.

This is due to the light-duty market being more established, resulting in more vehicle options, as well as the vehicles generally having less demanding duty cycles than the other vehicle classes.

In order to highlight the overall potential of fleet electrification in the light-duty space, this macro analysis leveraged Geotab's Electric Vehicle Suitability Assessment (EVSA) tool to look at a number of factors, including:

- What percentage of vehicles could be replaced with a range capable battery electric vehicle (BEV)?
- Would a fleet save money by replacing an existing vehicle with an equivalent electric model?
- What would the financial savings be over the lifespan of the vehicle?
- How much fuel could be saved and what is the potential amount of tailpipe emissions that could be avoided?

Additionally, we will dive deeper into factors that influence EV suitability such as daily driving distances, the impact of incentives and whether or not daytime charging is used.

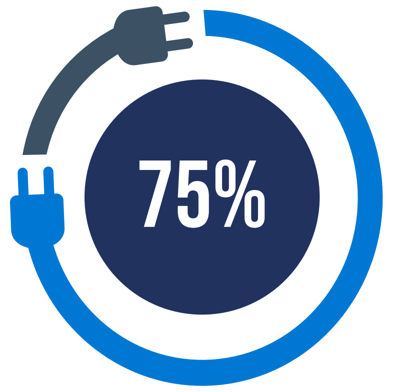
What is an EV Suitability Assessment (EVSA)?

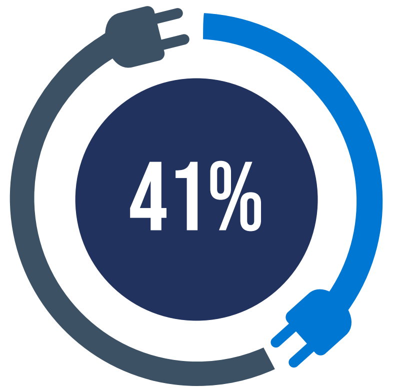
Geotab's EVSA tool uses telematics data to understand a fleet's specific needs to make a tailored EV adoption recommendation. It maps the fleet's driving patterns against real-world EV performance metrics to pinpoint which vehicles in the fleet can be replaced with an EV available in the local market. The tool also provides a forecast of the financial savings and environmental benefits of making the switch.

Refer to the **methodology section** for details on all assumptions and definitions leveraged in this study.

Close to half of fleet vehicles could save money by going electric

In total, we analyzed a year's worth of telematics data for roughly 750,000 light duty ICE vehicles from across the United States, Canada, Spain, Italy, Germany, France and the UK. Of these vehicles, 75% would have a range capable EV replacement, while 41% were EV suitable and could be economically replaced with a range capable EV.

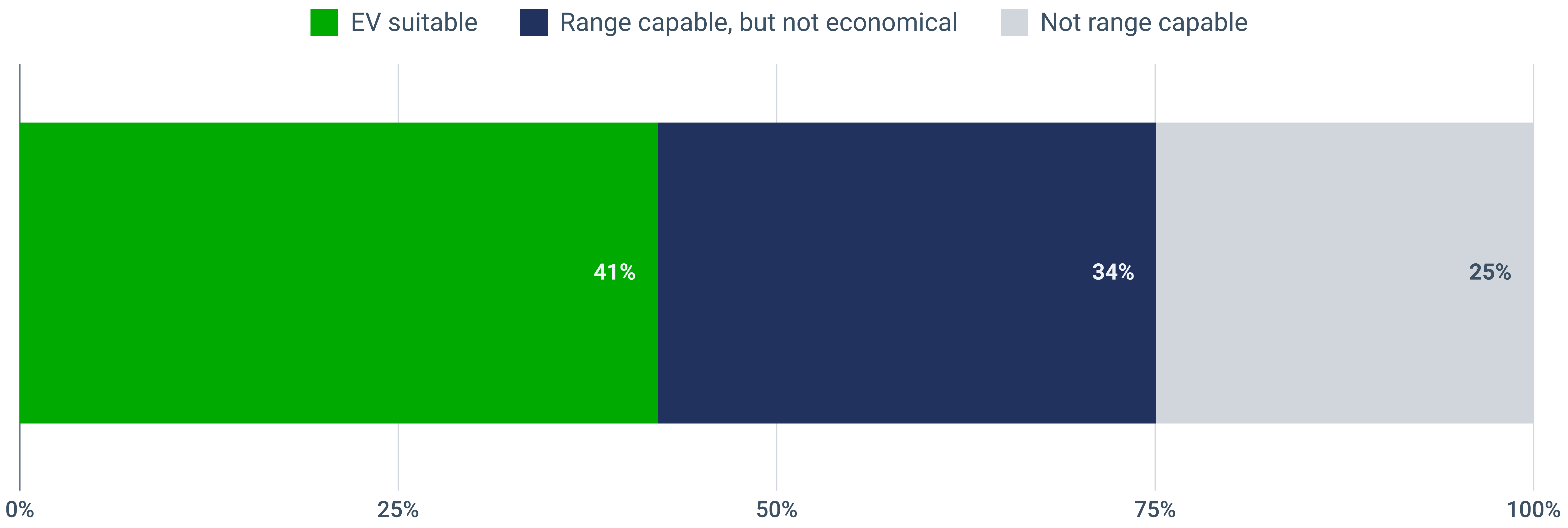




Topline results over a seven-year lifespan

- Potential savings: $4.9B US dollars or an average of around $15,900 per EV suitable vehicle
- Fuel saved: 2.2B US gallons across all EV suitable vehicles
- Avoided tailpipe emissions: At least 19M metric tonnes of CO_2 across all EV suitable vehicles

Vehicles with suitable EV recommendations



Defining EV suitable and range capable

When evaluating the suitability of replacing an ICE vehicle with an EV, we look at two essential factors: Is there a range capable electric model that can meet the existing daily driving requirements and does it make economic sense to make the switch?

For a replacement to be considered range capable, it needed to be able to drive 98% of the days that year on a single charge. This 2% margin was allowed for outlier days to exclude abnormal driving distance days outside of standard usage.

In order for it to be considered suitable, the EV would have to be both range capable and economical – it has a total cost of ownership (TCO) that is lesser or equal to a new replacement ICE model. The TCO included the acquisition cost along with fuel and maintenance costs over a seven-year lifespan. This calculation does not include any rebates and assumes zero residual value for both ICE vehicles and EVs.

Fleet electrification plays a major role in carbon reduction initiatives

In an effort to combat climate change, many governments and organizations around the world are taking steps to reduce carbon emissions. By electrifying the EV suitable vehicles in this study, fleets could avoid producing over 19M metric tonnes of tailpipe emissions. According to the EPA, **this is equivalent to the amount of CO_2 sequestered over the course of a year by a forested area of 22.7 million acres, more than 10 times larger than Yellowstone National Park.**

Comparing North American and European electrification potential

Reviewing data at a macro level can provide some interesting insights and give a general overview of what might be possible. However, the portion of EV-suitable vehicles varies by country, based on several region-specific factors including typical driving patterns, different acquisition costs, model availability, fuel costs, electricity prices and regional climate. When separating the countries in North America (Canada and the United States) from those in Europe (France, Germany, Spain, Italy and the United Kingdom), you can see clear differences in their overall potential.

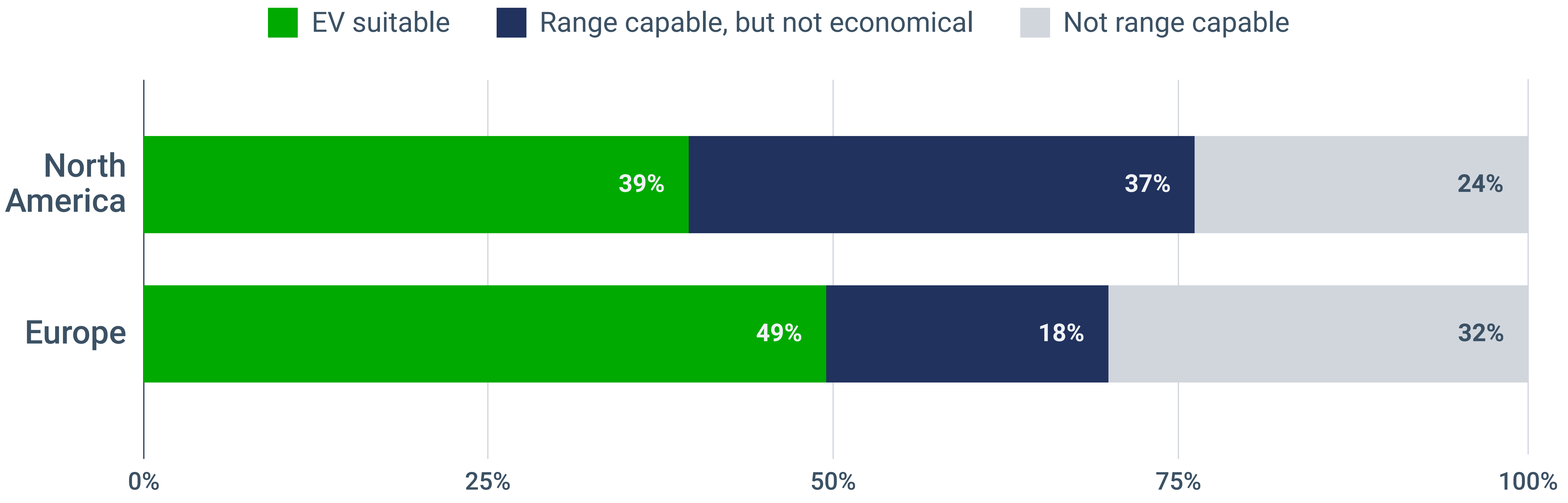
Note: All savings are represented in USD.

North American lifetime savings per EV suitable vehicle

- Potential savings: $15,500
- Fuel saved: 7,600 USG
- Avoided tailpipe emissions: 66 metric tonnes of CO_2

European lifetime savings per EV suitable vehicle

- Potential savings: $18,400
- Fuel saved: 4,700 USG
- Avoided tailpipe emissions: 40 metric tonnes of CO_2



Interesting fact

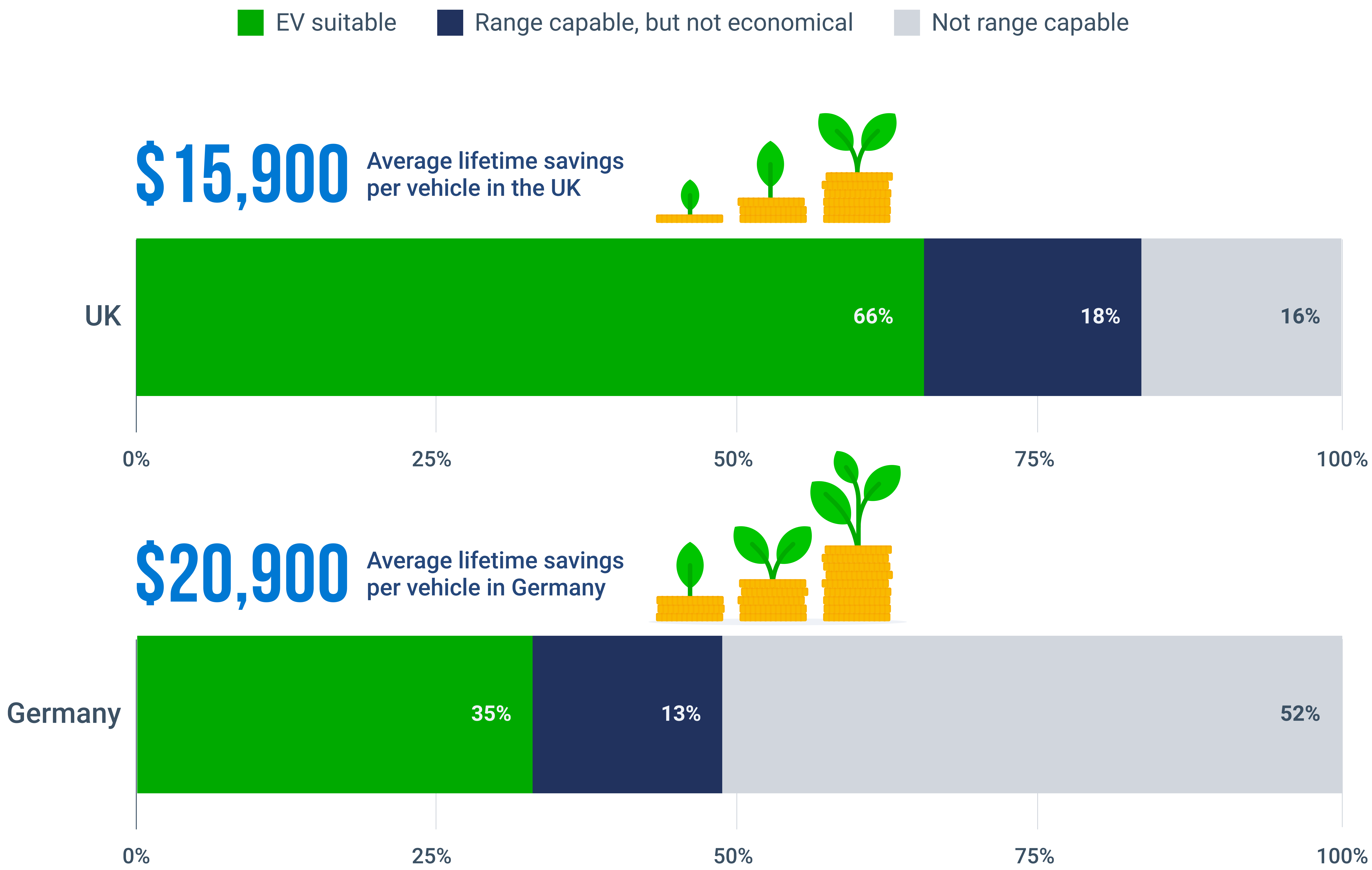
The potential savings across both North America and Europe only include vehicles that were deemed EV suitable. By including vehicles that were range capable but did not meet the TCO requirements, the average lifetime savings across the fleet is around $1,900 per vehicle.

In general, the European countries have a higher rate of economic suitability and could potentially save more on a per-vehicle basis.

In fact, for most of the European countries, the savings accumulated over the lifespan of the vehicle could potentially cover the acquisition cost of an additional entry-level EV.

There are still differences between these countries as they have their own unique operating conditions. For example, if you compare Germany and the UK, you can see that UK has more range capable vehicles, indicating they drive shorter daily distances. However, of the economical range capable vehicles, the average savings in Germany is 30% higher than the UK.

Regardless of which country was observed, there was one resounding message – there is an opportunity for organizations to start electrifying their fleets.



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Fleet driving patterns influence electrification potential

Driving patterns have a major impact on fleet electrification potential as they determine whether a suitable replacement vehicle is available that satisfies the vehicle's range needs while saving the fleet money. In this part of the analysis, we will look at how far vehicles drive, how much they are utilized during their week and what role vocational driving profiles play in EV suitability.

EV suitability is impacted by both average and maximum daily distances

Understanding vehicle usage is a critical component when considering EVs for fleet applications. Knowing the average and maximum daily driving distances can help determine whether an EV would have the range capability to meet those requirements. Vehicles in the U.S. covered similar average daily miles compared to most regions, but travelled further on their longest driving days. Those longest days challenge EV range capability. Vehicles in Europe tend to have shorter maximum distances, with those in the UK driving the shortest distances overall.

An important insight that we observed was that although the maximum daily distance is reaching the range limits of some EVs, around half of the vehicles never traveled further than the range capabilities of the more common models.

North America

48%

- **48% of vehicles** never exceed 250 miles in a single day
- Average daily distance: 78 miles
- Average max. daily distance: 356 miles

Europe

52%

- **52% of vehicles** never exceed 250 miles in a single day
- Average daily distance: 68 miles
- Average max. daily distance: 293 miles

A quarter of vehicles drove three days per week or fewer, leaving room for improvement by increasing utilization

While daily driving distance is a limiting factor for range capability, having a lower TCO plays a significant role when deciding to go electric. The factor that contributes most to an EV's TCO is its utilization and the majority of the potential savings are the result of lower electricity costs compared to fuel prices. Simply put, the more an EV is driven, the greater the fuel savings.

We observed that 27% of North American and 17% of European vehicles were driven for three days or fewer per week. This may indicate underutilized assets, suggesting that some fleets could combine the duties of these vehicles. The vast majority of these would have an EV replacement that is range capable but not economically viable. Rightsizing the overall fleet and retiring underutilized assets could likely improve the economics of electrification, provided the daily distance driven remains within the EV's range.

In addition, it is likely that some of the vehicles already identified as EV suitable are not being utilized to their full potential. In North America, a vehicle driven on average for two days or fewer per week has a less than 11% chance of being EV suitable. In comparison, when a vehicle is driven four days or more per week, the suitability jumps to about 50%.

On the other hand, In Europe, a vehicle when driven on average for two days or fewer per week has a less than 26% chance of being suitable vs compared to a vehicle that has driven four days or more, has an average of 60% EV suitability.

By increasing these vehicles' utilization, fleets could further increase the ROI of going electric and reduce their number of underutilized vehicles.

TIP: Optimize your operations prior to transitioning to EVs, or you risk incurring unnecessary costs. By implementing sustainable strategies, such as rightsizing and route optimization, you can make sure you are getting the most out of your assets.

Vocations with shorter or more predictable routes have the highest potential for EV suitability

For classification purposes, fleet vehicles will sometimes be grouped by industry. However, this can pose challenges when evaluating the potential for EVs. Vehicles within the same industry may drive and charge in a very different manner. For example, a pizza delivery vehicle and a catering van are both in the food industry but have very different behaviors. A different way to classify them is by the job they do. This is also known as a vocation, which better reflects how they generally behave.

Geotab breaks down vocation into five categories: Door-to-Door, Hub-and-Spoke, Local, Regional and Long Distance. For the previous examples, the pizza delivery vehicle would be classified as Hub-and-Spoke since they make multiple round trips from a central location. Given the typical driving distances, the catering van would be classified as Local.

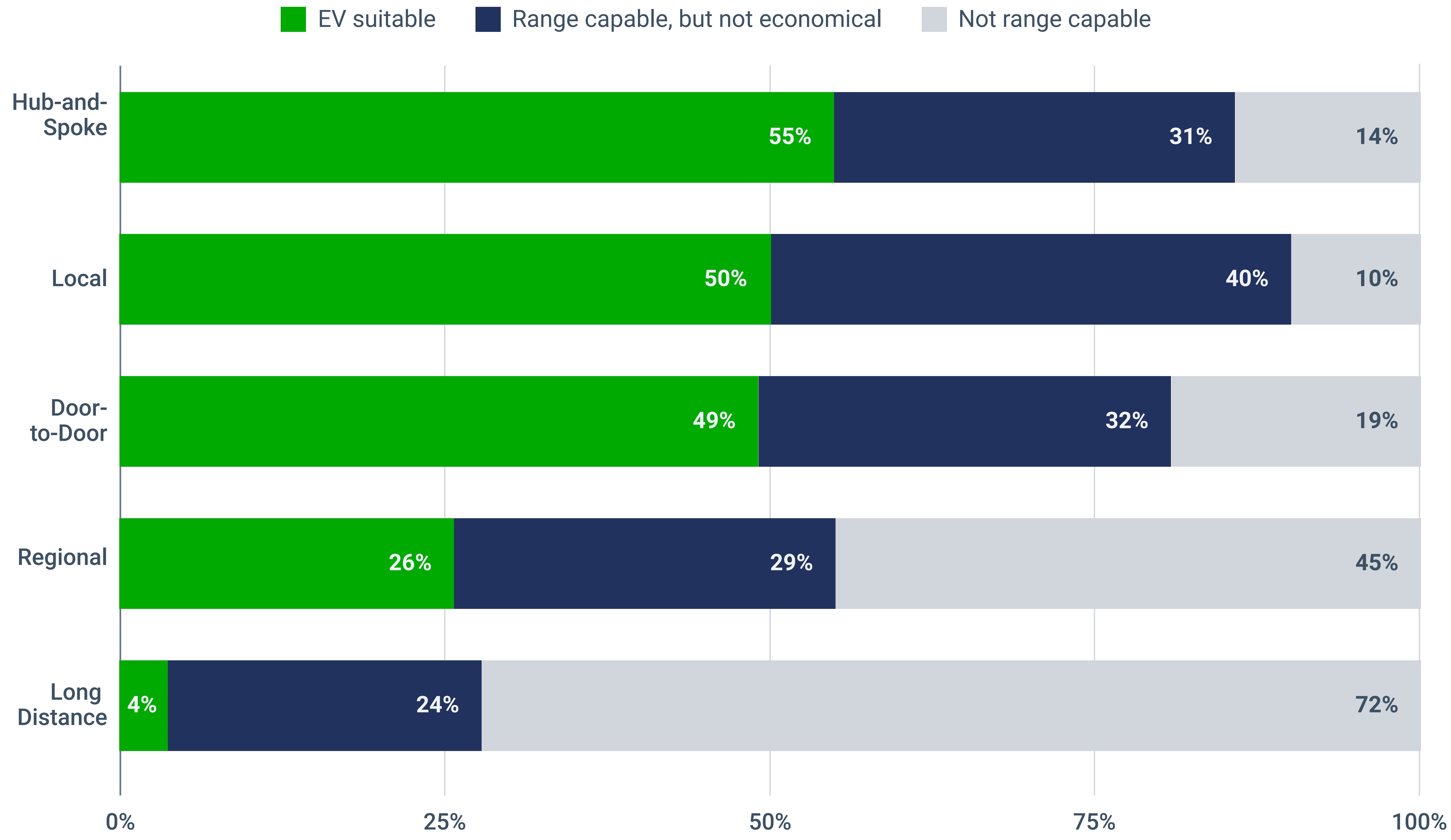
Vocation	Daily driving behavior
Door-to-Door	• Makes significantly more stops than most and tends to spend very little time per stop.
Hub-and-Spoke	• Makes multiple round trips from a singular location or centralized hub.
Local	• Remains within an area of 150 miles. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.
Regional	• Drives beyond an area of 150 miles and tends to rest in the same location often. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.
Long Distance	• Large range of activity and typically does not rest in the same location. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.

When reviewing the data for these analyzed vehicles, a clear, but unsurprising pattern emerges – EVs are more suitable for vocations that stay within a smaller geographic area and have more predictable routes. Vehicles that were classified as Door-to-Door, Hub-and-Spoke and Local were therefore more suitable for electrification.

As seen in the chart to the right, a very low portion of vehicles categorized as long-distance would be suitable to electrify, whereas for fleet vehicles in hub-and-spoke, door-to-door or local vocations, around half could save money if they went electric.

EV technology continues to improve and we will continue to see new models with greater capabilities. However, even once there are EVs with greater range capabilities available, they will still have to deal with some hurdles, such as the fact that the vehicles classified as Long Distance don't typically rest in the same location – making charging more difficult. Also, range capability is largely dependent on a vehicle's battery capacity. Since the battery is the most expensive component of an EV, it would mean that these longer-range models would be more expensive.

EV suitability by vocation



Other ways to influence electrification potential

There are other changes fleet managers can make to influence electrification potential. To highlight the impact of each tactic, we showcase them independently. However, all of these could be implemented at the same time, further improving the results.

Even a modest rebate can make a significant difference in electrification

The TCO calculations presented above exclude rebates or financial incentives. Factoring in incentives can notably enhance the economic viability of EVs, reducing the overall total cost of ownership. By applying a $5,000 rebate, the number of vehicles that could economically go electric in North America increases by 11 percentage points and in Europe by 6 percentage points.

Region	EV suitable with no incentive	EV suitable with a $5,000 incentive
North America	• 39%	• 50%
Europe	• 49%	• 55%

A different way to approach this is to consider the cost of becoming more sustainable. Fleets around the world are becoming more accountable for their carbon footprint and many will need to meet specified emission reduction targets.

In our analysis, any increase in the TCO for a range capable EV compared with an equivalent ICE would classify it as not economical. However, ***21,600 vehicles (or 3%) of those not economical vehicles were within $1,500 of breaking even.*** This cost, when spread out over the lifespan of the vehicle, may be deemed insignificant for fleets looking to accelerate their transition.

Extending vehicle replacement cycles improves EV suitability

During this analysis, it was assumed that all vehicles would have a lifespan of seven years, although replacement cycles can vary between different fleets. However, since EVs have fewer moving parts, it is conceivable that they could have a longer usable lifespan than their ICE counterparts. As most of the cost savings for EVs are a result of saving on fuel and maintenance, extending the lifespan of the vehicles increases the likelihood that they will be suitable for electrification.

To highlight the impact of a vehicle's lifespan on suitability, we ran a few different scenarios. By increasing the lifespan to 10 years, the number of vehicles considered EV suitable in North America increased by 13 percentage points and 6 percentage points in Europe. Alternatively, by reducing the lifespan to five years, suitability dropped by 11 and 9 percentage points, respectively.

Region		5-year lifespan	7-year lifespan	10-year lifespan
North America	• EV suitability	• 28%	• 39%	• 52%
	• Avg. lifetime savings	• $10,200	• $15,500	• $23,700
Europe	• EV suitability	• 40%	• 49%	• 55%
	• Avg. lifetime savings	• $13,400	• $18,400	• $27,300

In both scenarios, the vehicles in North America were impacted more than the ones in Europe. One plausible explanation for this is that the savings potential in Europe, from combining lower EV acquisition costs and higher fuel savings, makes it more likely that they will break even sooner. This would mean that the vehicles in North America take longer to reach the cost savings required to be considered suitable and extending the lifespan will have a much larger impact. One consequence of extending the lifespan of the EV is some loss in range through battery degradation. Geotab has observed a loss of 1.8% battery capacity per year on average, which may impact range capability for longer routes over time.

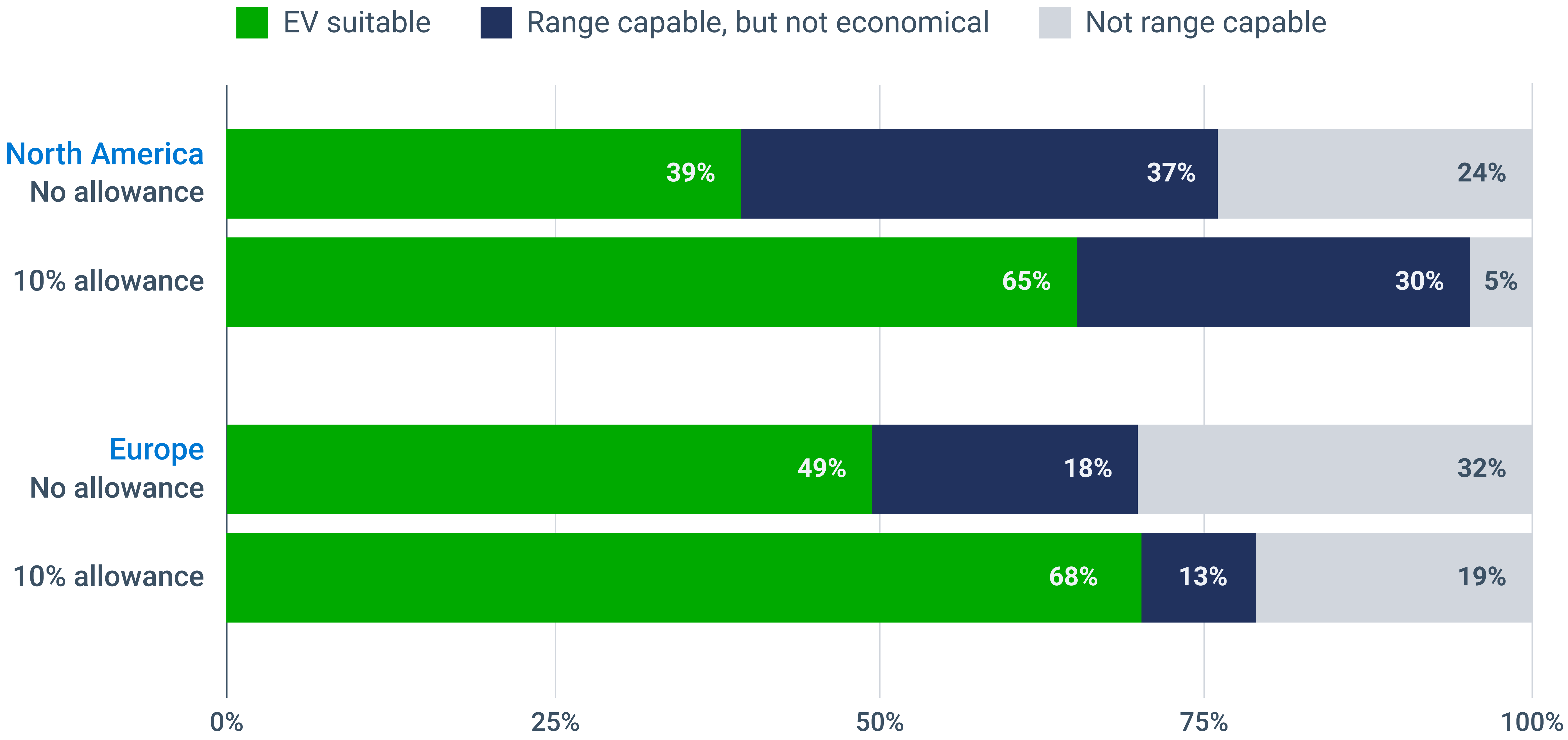
More vehicles will have a range capable replacement if you allow occasional daytime charging

As previously mentioned, for our analysis to consider an EV replacement as range capable, it needs to be able to complete its daily driving requirements on a single charge. However, this is not necessarily a requirement for all fleets. Some might be able to charge during the day, whether it is a planned stop at an owned depot or opportunity charging at a public station and customer sites.

If vehicles are allowed to be occasionally charged during the day, the number of vehicles deemed range capable increases. To showcase this, we adjusted the analysis to allow additional charging on 10% of days when the vehicles are being driven. This greatly increased the number of vehicles that would be EV suitable, particularly within North America, which leaps from 76% to an astonishing 95% range capability, with 65% being economical.

There are two insights that can be gleaned from this data. Firstly, there was most likely a number of long-range EVs that were deemed range-suitable replacements, but that came at a high price tag. By allowing some daytime charging, it unlocked a set of less expensive, shorter-range models or trims that could now do the job while also saving money. Secondly, the jump in range capability indicates that many of these vehicles, while occasionally traveling long distance days, for the most part, are well within EV range. These outlier trips might be workable either with daytime charging or by reallocating vehicles and routes.

Allowing daytime charging in North America and Europe



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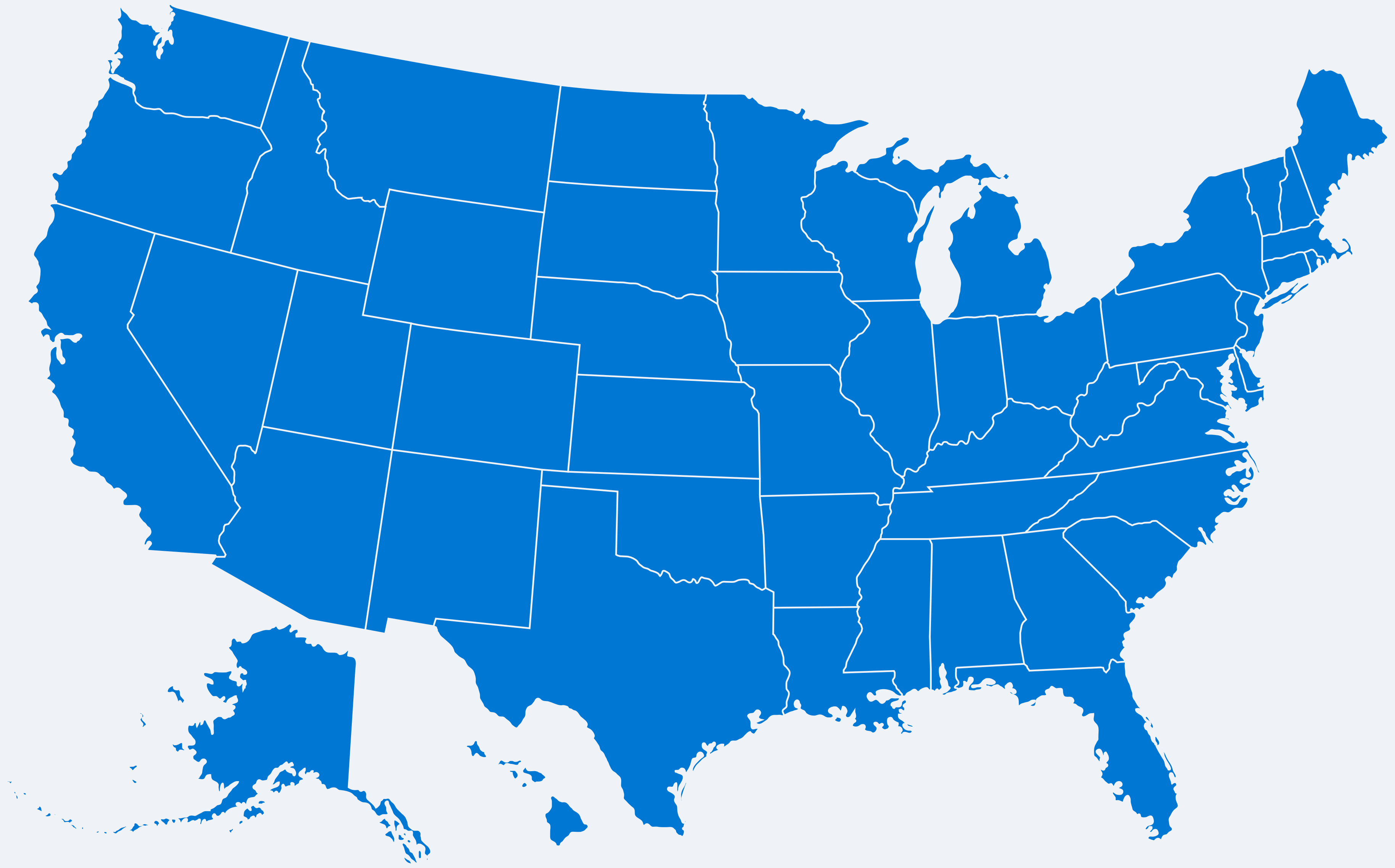
As the market changes, EVs will become more economical

The majority of potential savings for an EV are a result of lower electricity costs compared to fuel costs. As fuel prices increase, so do the potential cost savings and with many countries implementing sustainability initiatives like carbon taxes, we are likely to see further increases in the future. Electricity prices will inevitably rise as well, but there is generally less volatility. At the same time, as battery technology becomes cheaper and new models enter the market, EVs should move toward parity compared to ICE vehicles. These factors make going electric even more favorable.

Reviewing EV potential by country

This next section analyzes EV potential at a country level. Note that the values have been adjusted to reflect local currencies and units of measurement. We have remained consistent with our assumptions from our **methodology** unless stated otherwise. Where we reflect suitability based on incentives, we reflected the available incentives in the local markets as of the time of writing. It should be noted that the incentives may not apply to all vehicle classes and applications, so fleets should review how incentives apply to their specific vehicles.

United States



Driving profile

Average daily driving distance:

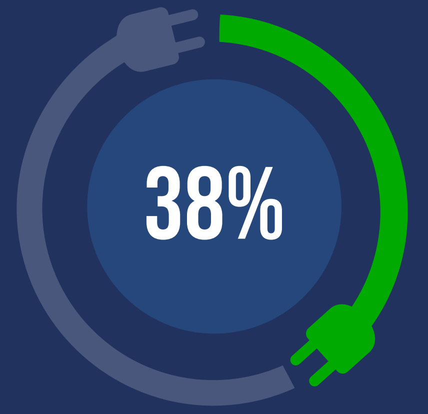
- 79 miles

Maximum distance daily:

- 369 miles

% of vehicles never exceeded 250 miles in a day

- 46%



of vehicles are EV suitable

Lifetime savings per EV suitable vehicle

Potential savings

$15,000

Fuel saved

7,800 USG

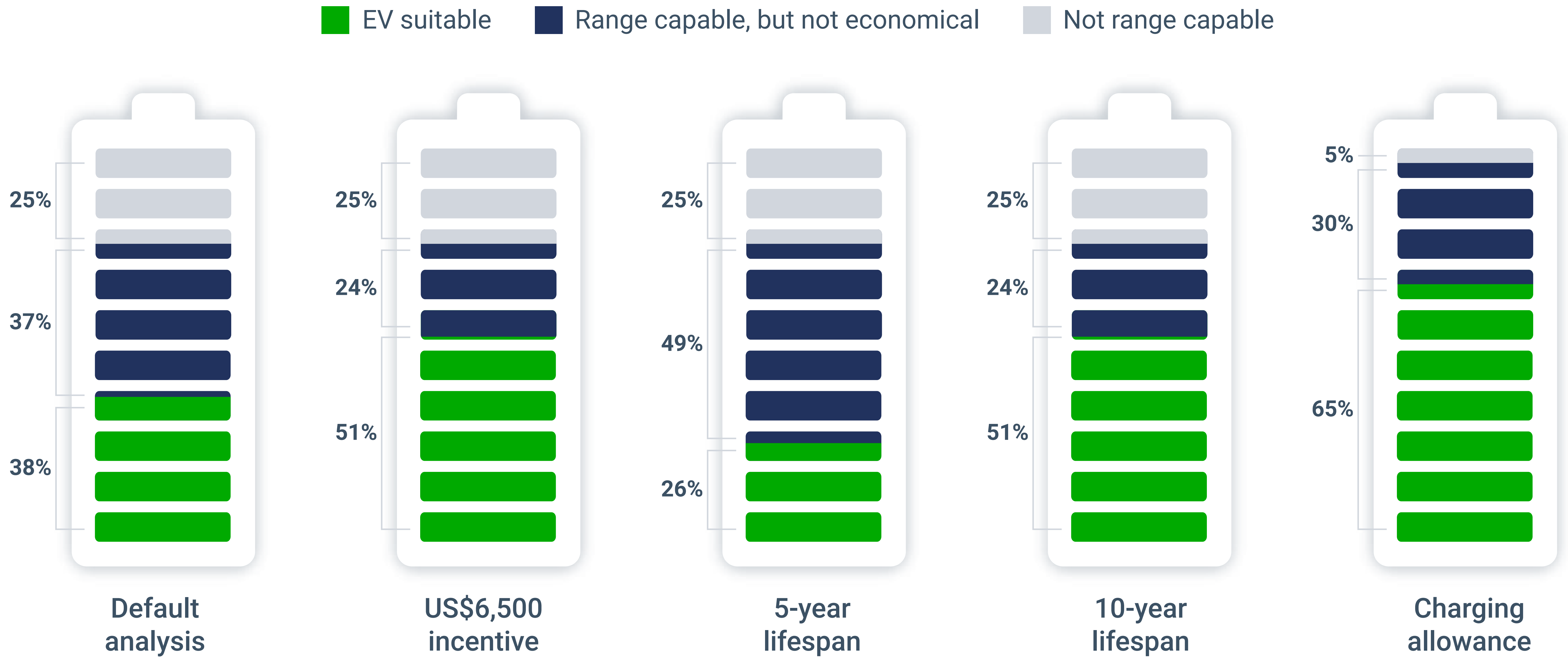
Avoided tailpipe emissions

68 TONNES OF CO_2

Influencing electrification potential in the United States

Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, having a 10% charging allowance in place or increasing the replacement cycle, EV suitability increases. Additionally, a charging allowance will increase range capability.



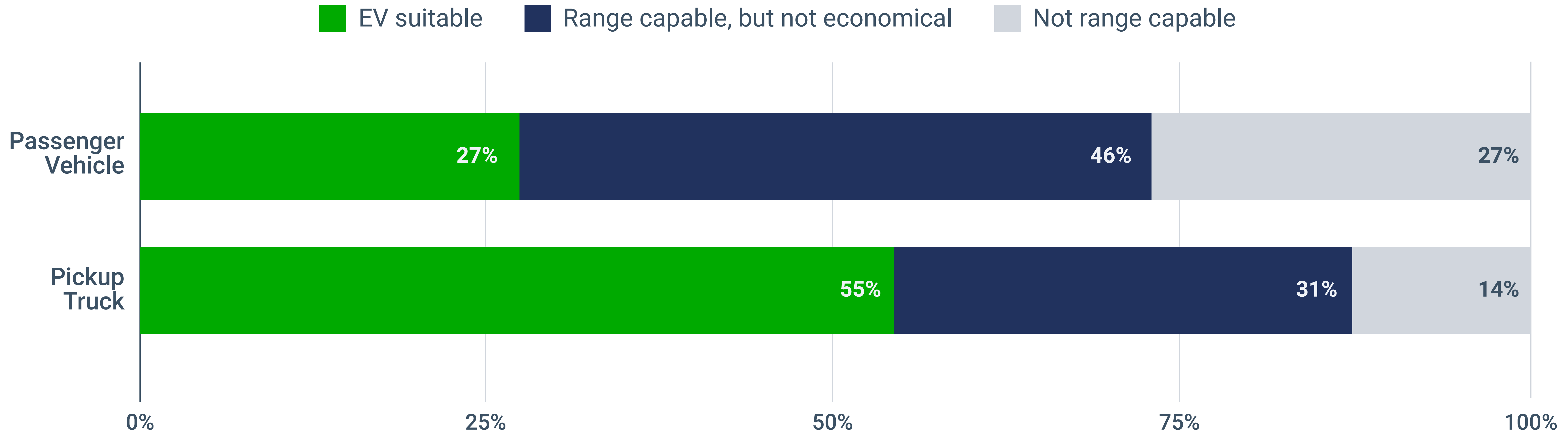
> In the US, it takes longer for fleets to break even on their investment due to their low fuel cost and large difference between ICE and EV purchase price. As a result, increasing replacement cycles to 10 years can make a notable difference in EV suitability.

Charlotte Argue
Senior Manager, Sustainable Mobility, Geotab

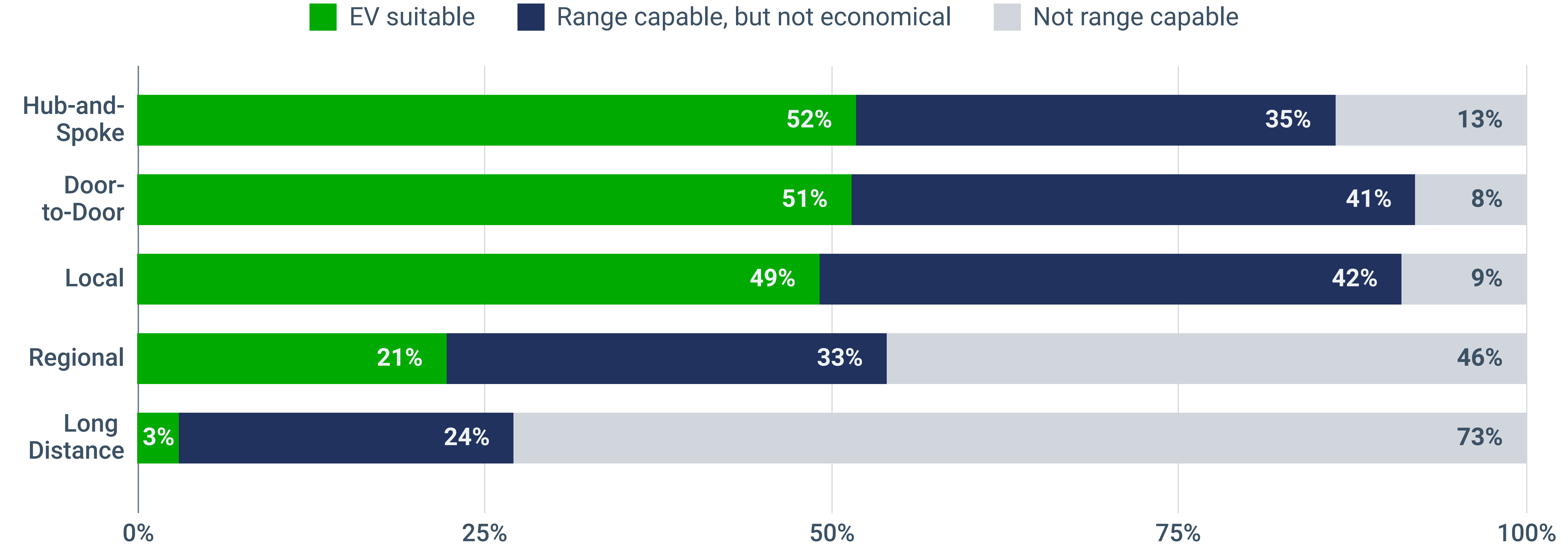
Some vehicle types are more suited for electrification than others and to explore this, we analyzed vehicles based on vehicle class. Passenger cars were some of the first commercially available EVs and when discussing electric vehicles, they are often what people visualize. Over the last few years, electric pickup trucks have entered the market and they are set to shift this paradigm.

Pickup trucks are immensely popular in the U.S. Our analysis found that the current models available met the range requirements of 86% of the analyzed trucks* – the highest rate of all classes. More importantly, because of their high rates of utilization, they are much more likely to save fleets money. In fact, the portion of pickups that were deemed suitable was almost double that of passenger vehicles. This is most likely the result of fuel saving, as ICE trucks have a much lower fuel efficiency.

EV suitability by vehicle type and the potential of electric pickup trucks - United States



EV suitability by vocation - United States



**Trip payload and towing data for the analyzed ICE vehicles were not included in the analysis.*

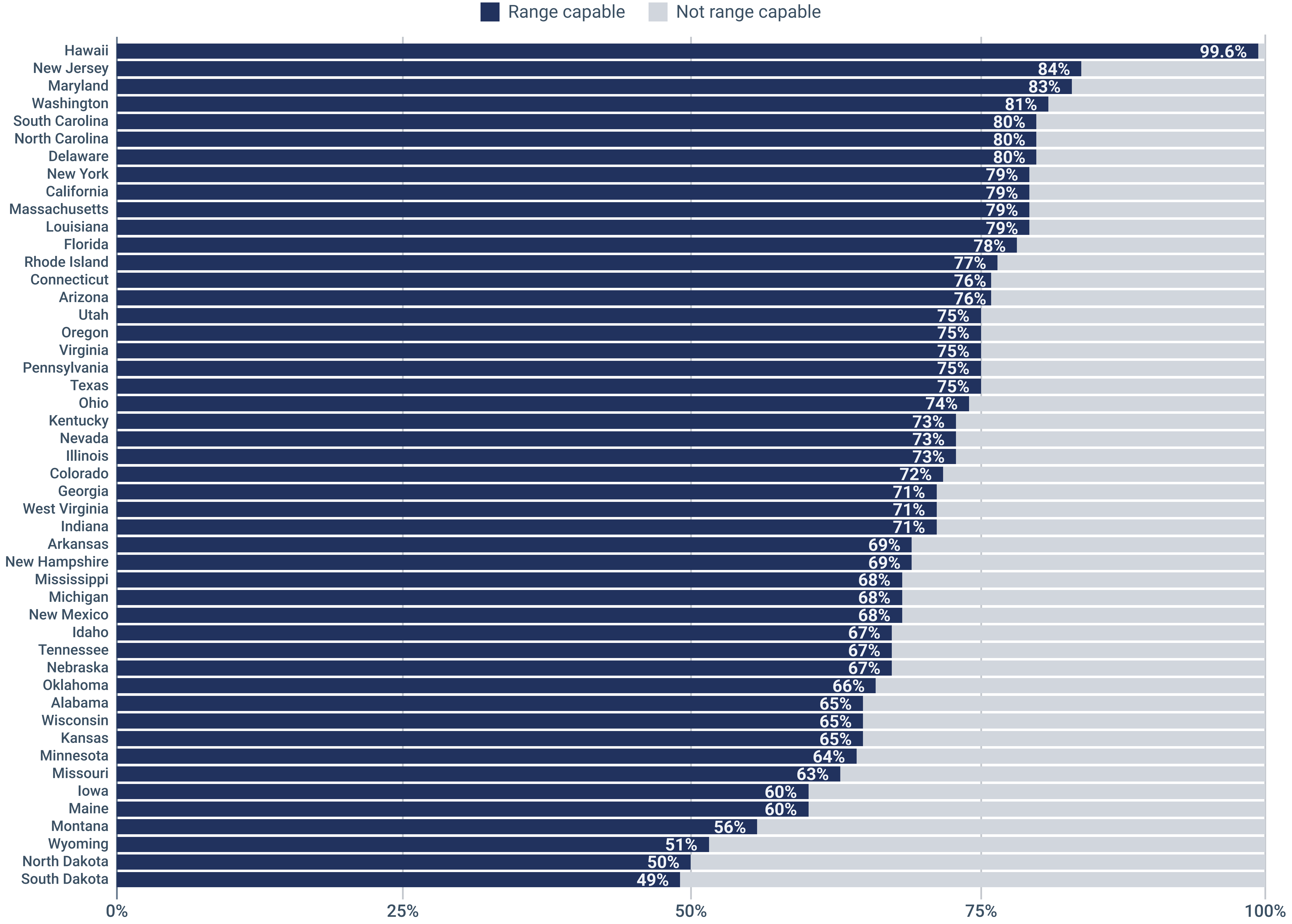
High-level data insights are helpful when initially evaluating EVs but it is important that fleets conduct their own analyses. There are numerous local conditions that can influence whether it makes sense to transition to EVs – for example, local fuel and electricity prices.

Geography will also greatly influence a vehicle's duty cycle, which in turn impacts its range requirements. When you review capability at a state level, you can see a wide range of variability.

For example, Hawaii is geographically constrained by water. This limits the distances vehicles can travel in any one day – leading to a higher percentage of range capability. Alternatively, vehicles driven in states with a lower population density, such as those in the Midwest, tend to drive longer daily distances.

Note: Some states were excluded from this analysis as they did not meet the requirements of Geotab's data privacy policies for sample size.

Range capability by state and the importance of localized data - United States



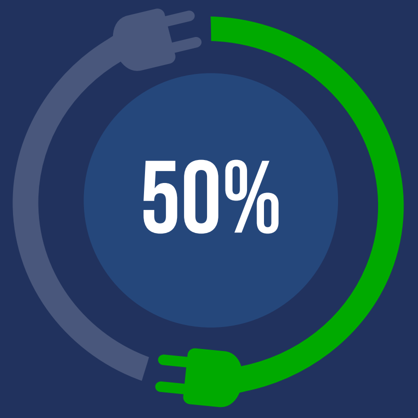
Canada

Driving profile

Average daily driving distance:
- 103 km

Maximum distance daily:
- 430 km

% of vehicles never exceeded 350 km in a day
- 50%



of vehicles are EV suitable

Lifetime savings per EV suitable vehicle

Potential savings
C$24,200

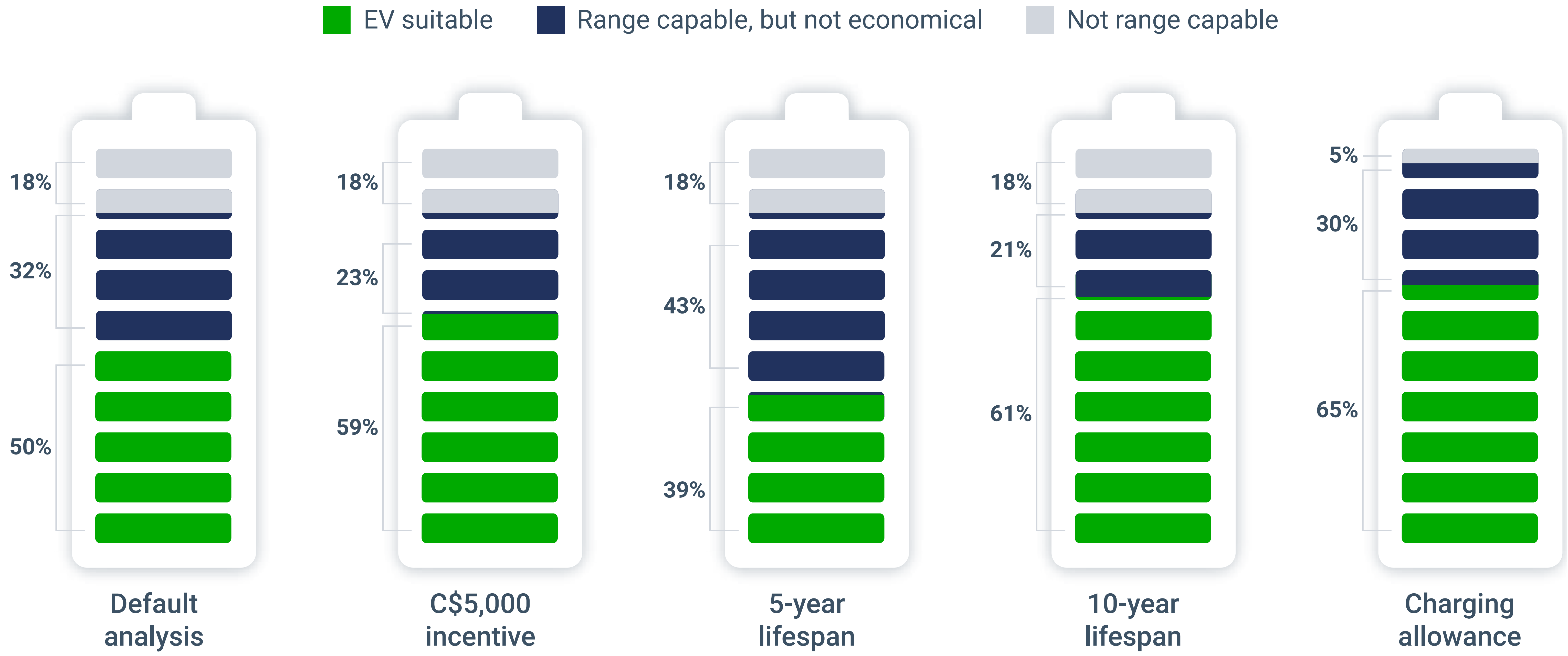
Fuel saved
24,000L

Avoided tailpipe emissions
55 TONNES OF CO_2

Influencing electrification potential in Canada

Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, having a 10% charging allowance in place or increasing the replacement cycle, EV suitability increases. Additionally, a charging allowance will increase range capability.

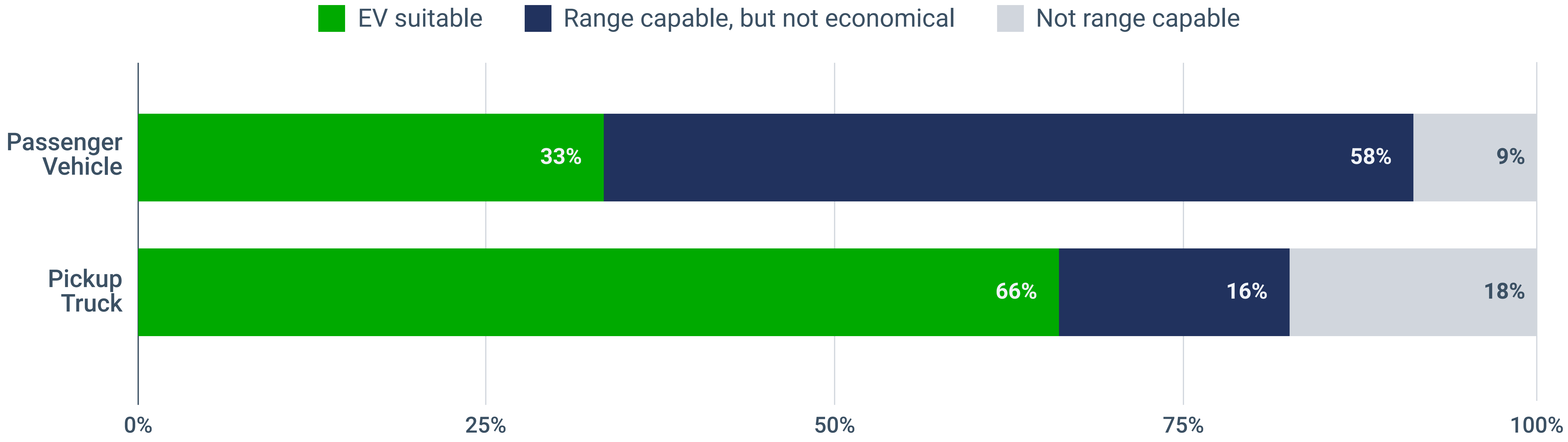


In the context of electrification, certain vehicle types are better suited than others. To explore this, we conducted an analysis based on vehicle classes. While passenger cars have historically been at the forefront of electrification, recent years have seen the introduction of electric pickup trucks, bringing about a transformative shift in this narrative.

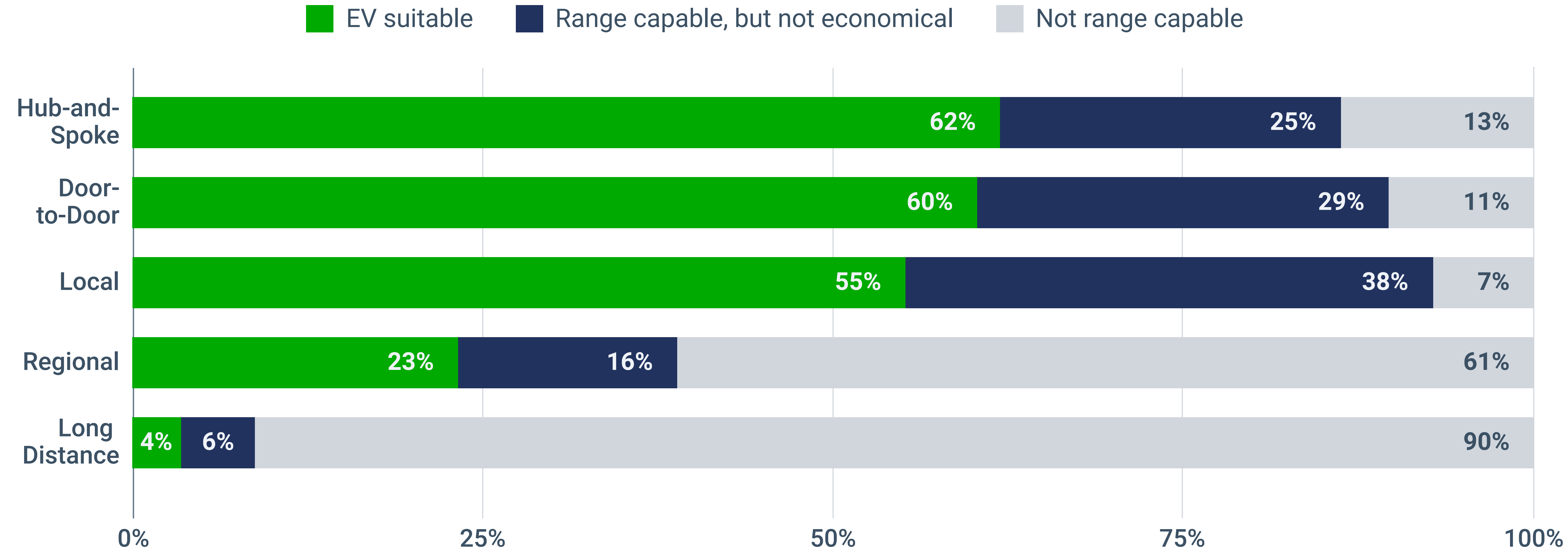
Of all of the vehicle classes analyzed, passenger cars had the highest portion of range capability, with 91% of the vehicles having a range capable replacement available. However, compared with pickup trucks, they had a lower rate of suitability. The majority of pickups that had a range capable replacement could potentially save money over their lifespan.*

**Trip payload and towing data for the analyzed ICE vehicles were not included in the analysis*

EV suitability by vehicle type and strong case for electric pickup trucks - Canada



EV suitability by vocation - Canada



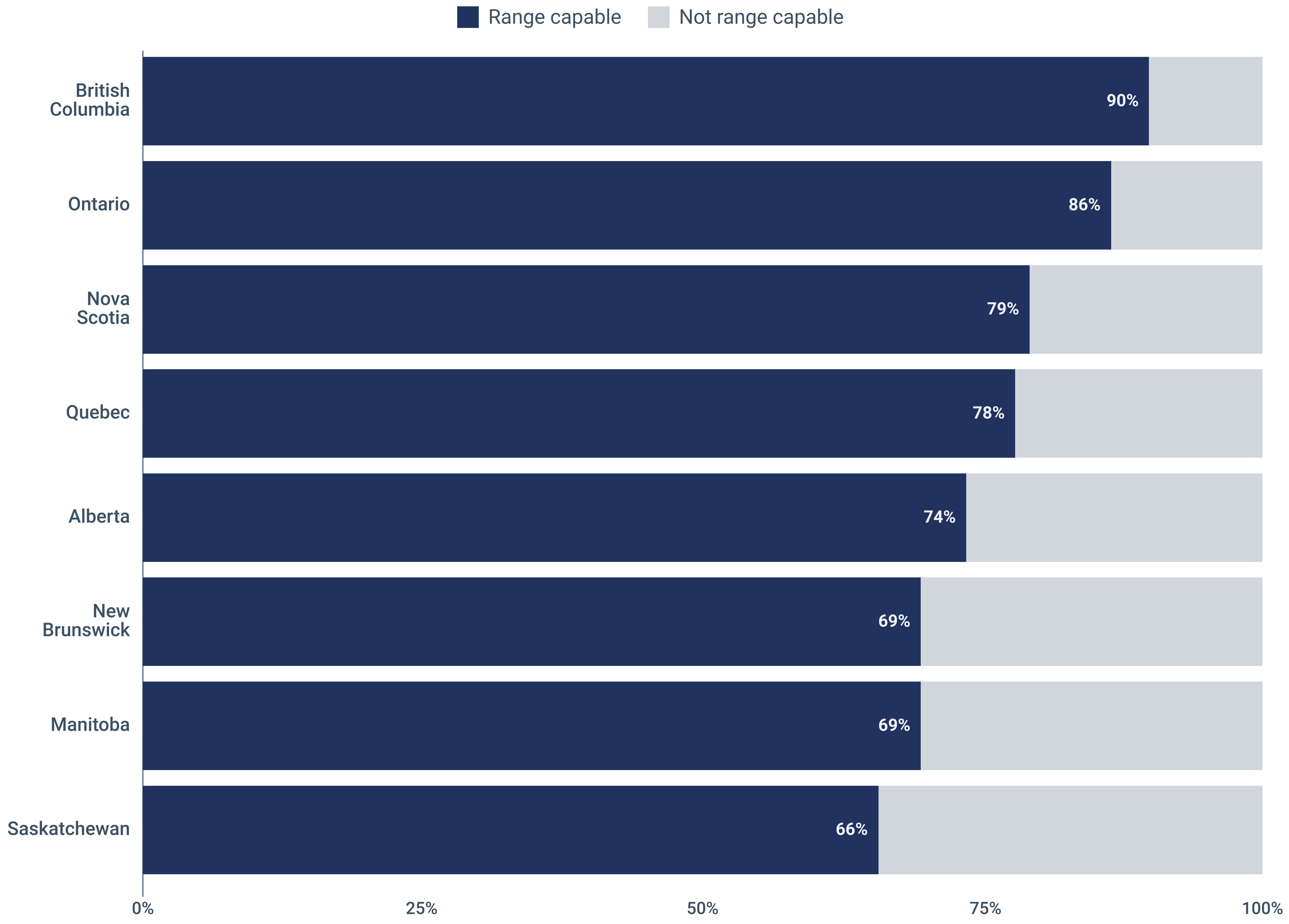
A fleet vehicle's duty cycle will vary depending on its location – impacting the range requirements.

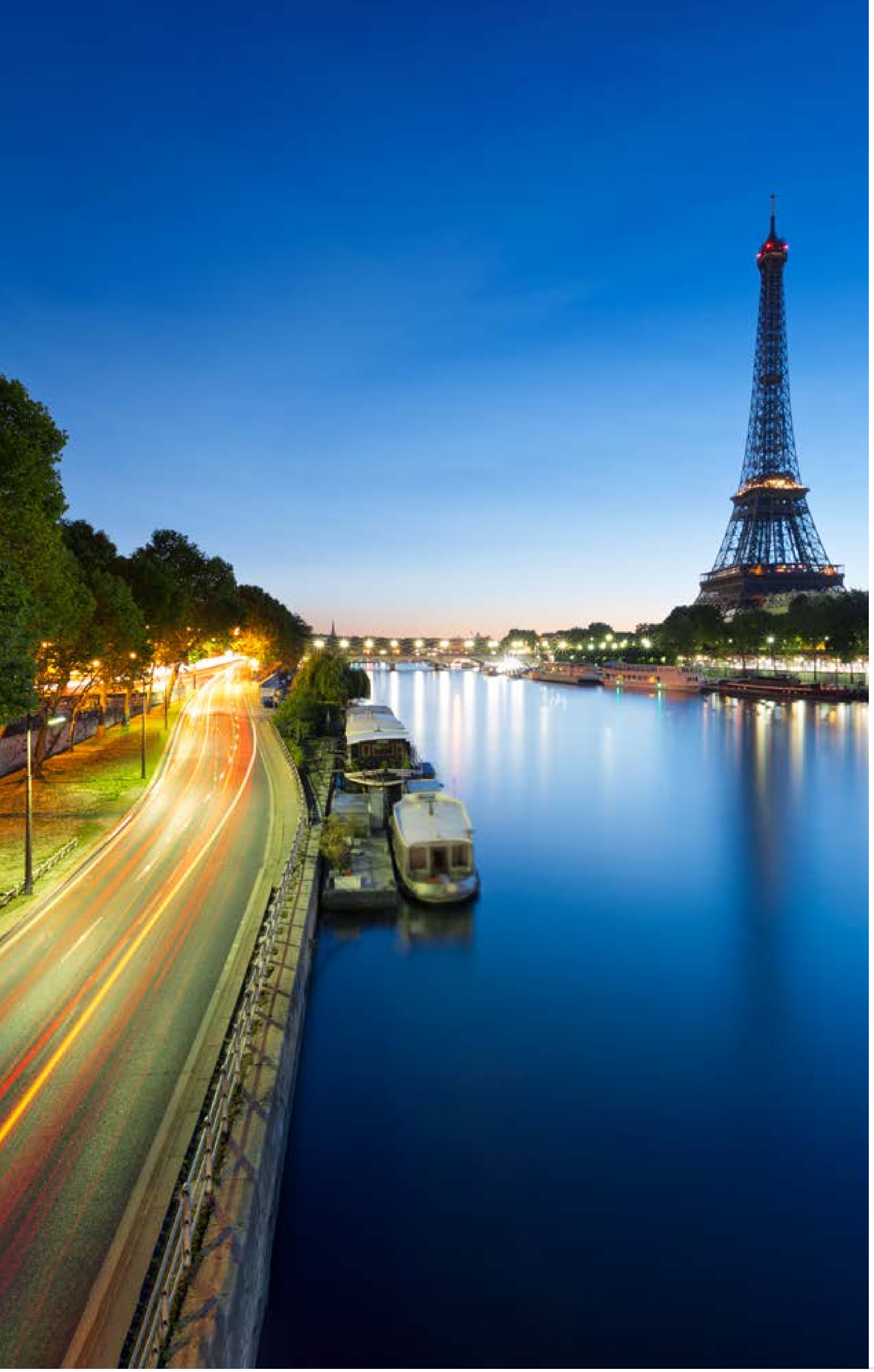
British Columbia and Ontario are both geographically large provinces in Canada, yet we observed that fleet vehicles have a high tendency to keep their daily driving within EV range.

Even in the more rural prairies, over two thirds of fleet vehicles in our study could be replaced with an EV and meet their daily range requirements, suggesting there is opportunity for electrification in regions with lower population density.

Note: Some provinces and territories were excluded from this analysis as they did not meet the requirements of Geotab's data privacy policies or the terms of the sample size.

Range capability by province and the importance of localized data - Canada





France

Driving profile

Average daily driving distance:

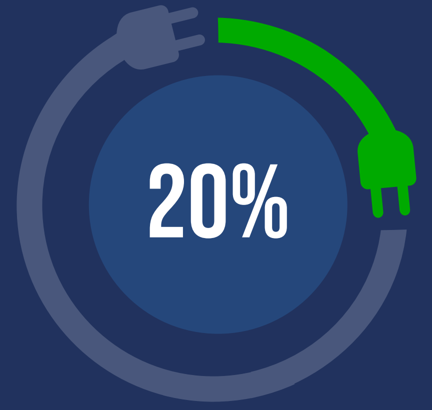
- 127 km

Maximum distance daily:

- 581 km

% of vehicles never exceeded 350 km in a day

- 33%



of vehicles are EV suitable (no incentive)

Lifetime savings per EV suitable vehicle

Potential savings

€17,300

Fuel saved

21,600L

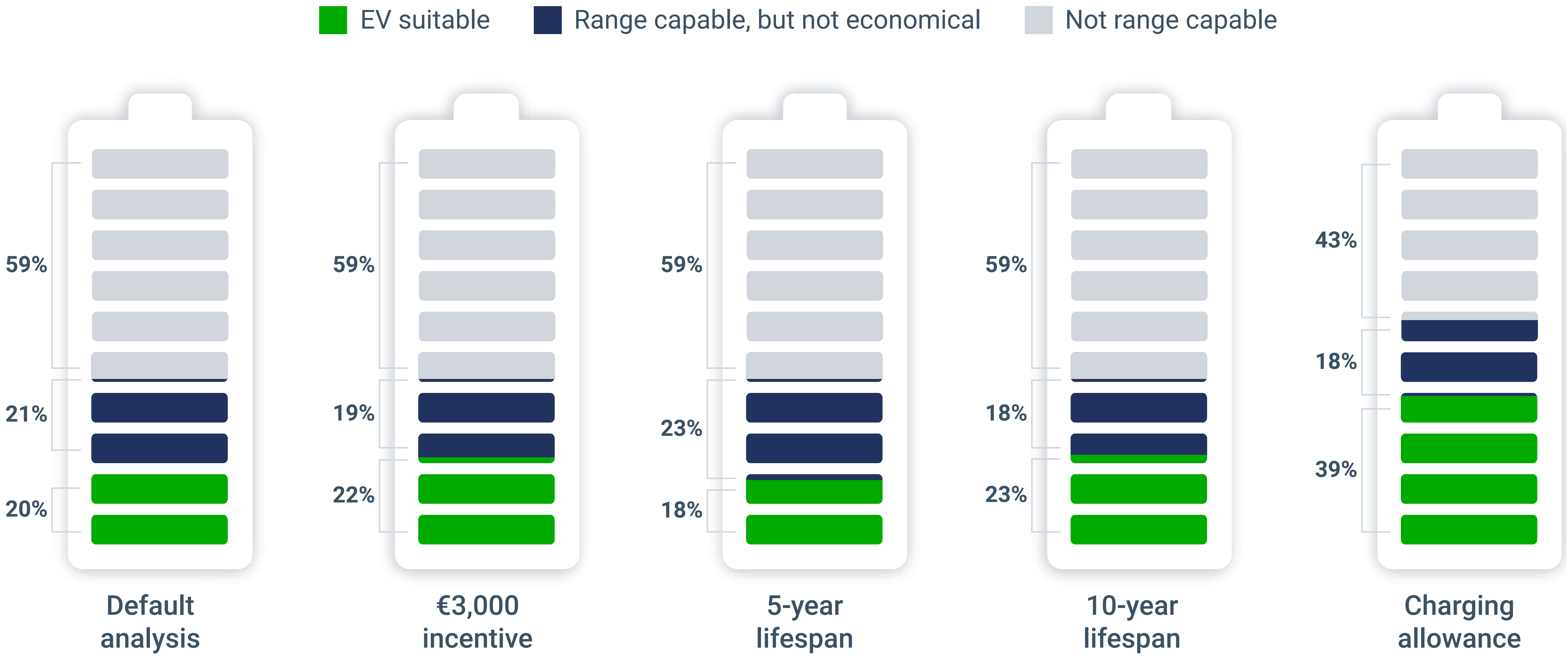
Avoided tailpipe emissions

49 TONNES OF CO_2

Influencing electrification potential in France

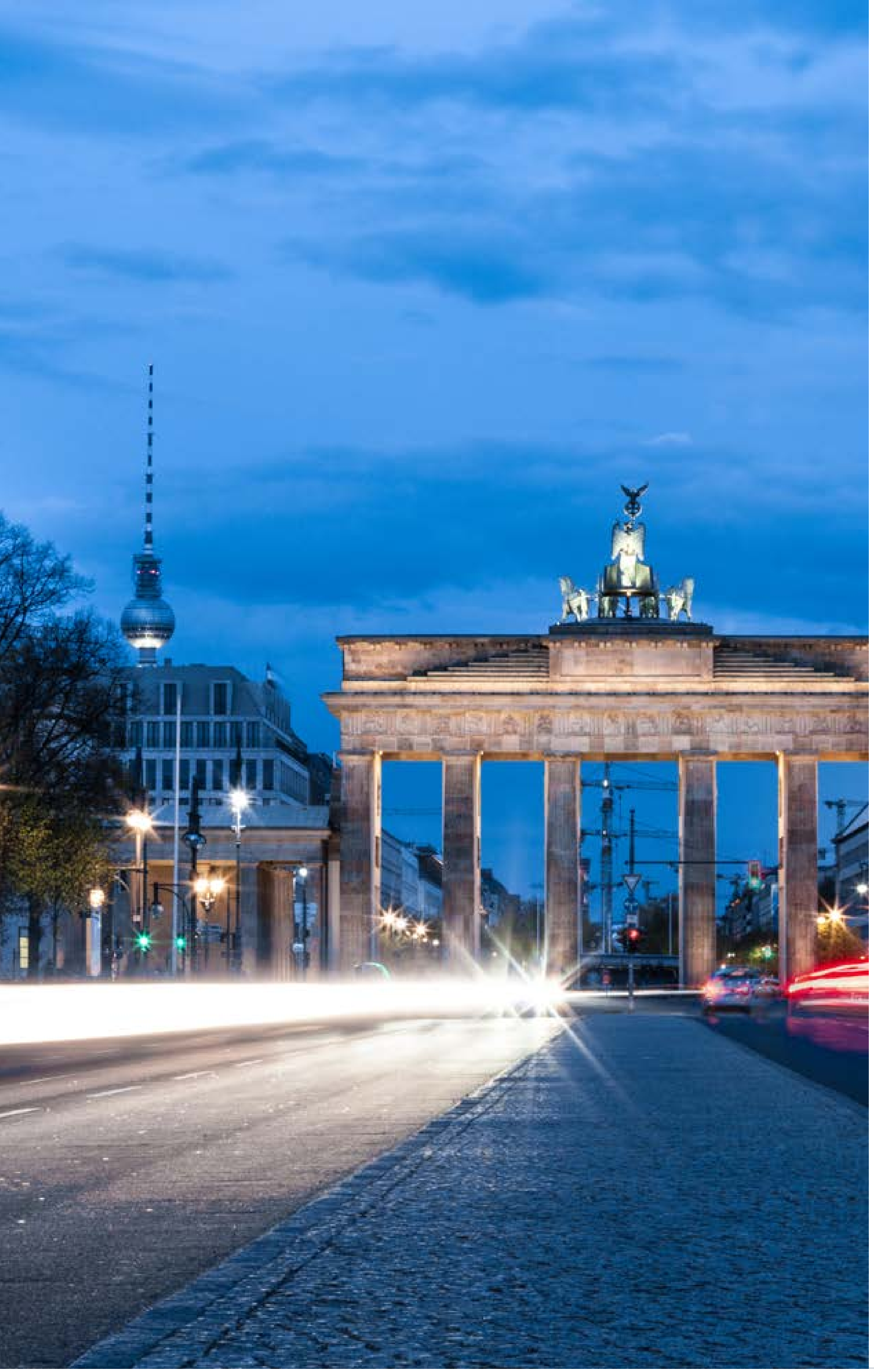
Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, allowing daytime charging or increasing the replacement cycle, increases EV suitability. A charging allowance additionally will increase range capability.



> By allowing daytime charging, France's EV suitability almost doubles. Daytime charging does not need to take time away from the vehicle's job by having it charge fully - it could occur whenever the vehicle is naturally stopped, such as loading or for customer visits.

Charlotte Argue
Senior Manager, Sustainable Mobility, Geotab



Germany

Driving profile

Average daily driving distance:

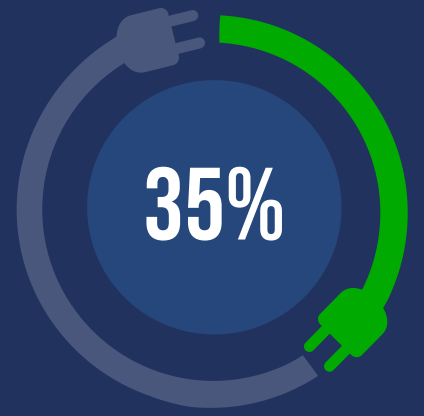
- 131 km

Maximum distance daily:

- 432 km

% of vehicles never exceeded 350 km in a day

- 56%



of vehicles are EV suitable (no incentive)

Lifetime savings per EV suitable vehicle

Potential savings

€12,200

Fuel saved

20,000L

Avoided tailpipe emissions

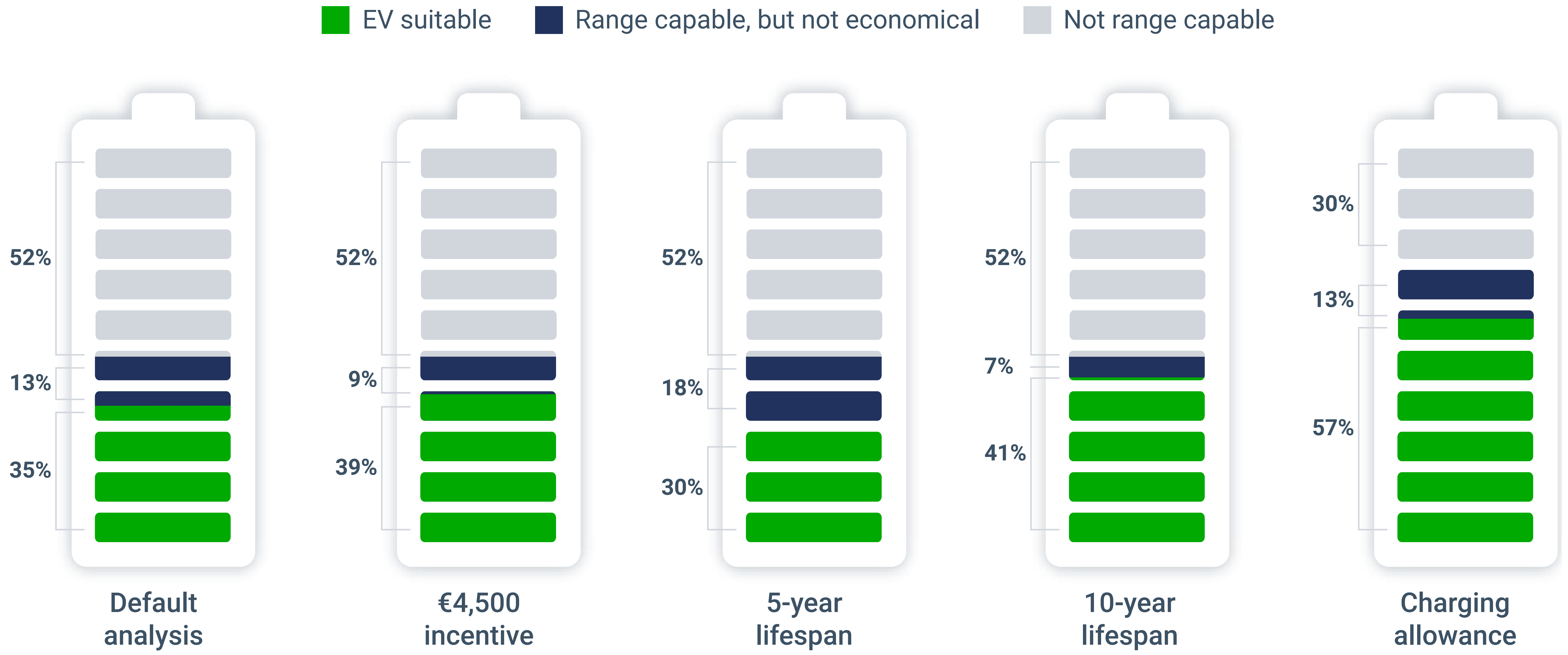
46 TONNES OF CO_2

GEOTAB

Influencing electrification potential in Germany

Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, having a 10% charging allowance in place or increasing the replacement cycle, EV suitability increases. Additionally, a charging allowance will increase range capability.



Italy

Driving profile

Average daily driving distance:

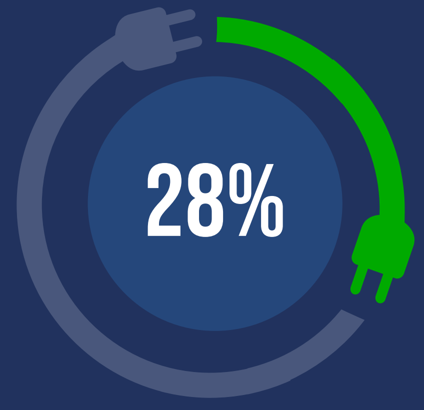
- 121 km

Maximum distance daily:

- 448 km

% of vehicles never exceeded 350 km in a day

- 51%



of vehicles are EV suitable (no incentive)

Lifetime savings per EV suitable vehicle

Potential savings

€20,300

Fuel saved

15,900L

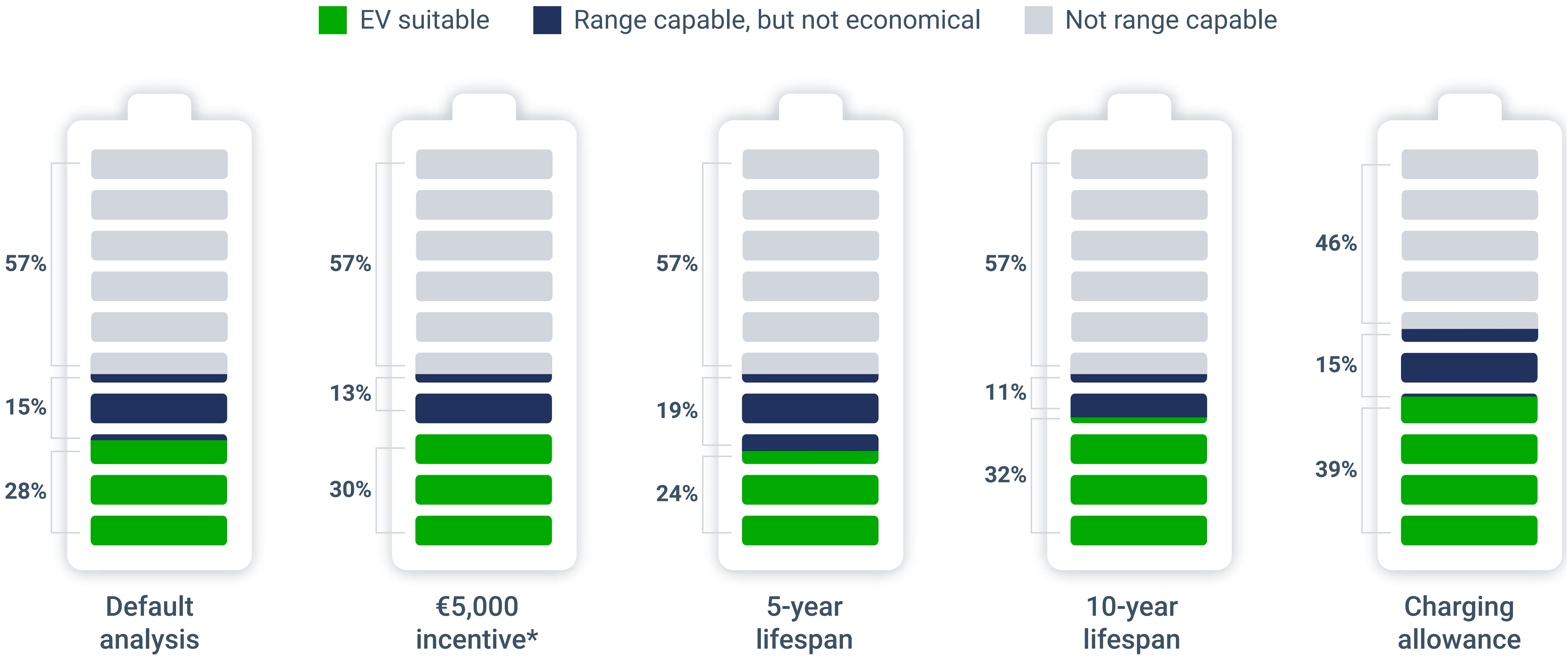
Avoided tailpipe emissions

36 TONNES OF CO_2

Influencing electrification potential in Italy

Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, having a 10% charging allowance in place or increasing the replacement cycle, EV suitability increases. Additionally, a charging allowance will increase range capability.



> In some European countries like Italy and Germany, the business case for EVs today is high, making additional levers like vehicle incentives and vehicle lifespan less impactful.

Charlotte Argue
Senior Manager, Sustainable Mobility, Geotab

*Including scrappage

Spain

Driving profile

Average daily driving distance:

- 123 km

Maximum distance daily:

- 427 km

% of vehicles never exceeded 350 km in a day

- 53%

43% of vehicles are EV suitable (no incentive)

Lifetime savings per EV suitable vehicle

Potential savings

€12,100

Fuel saved

18,800L

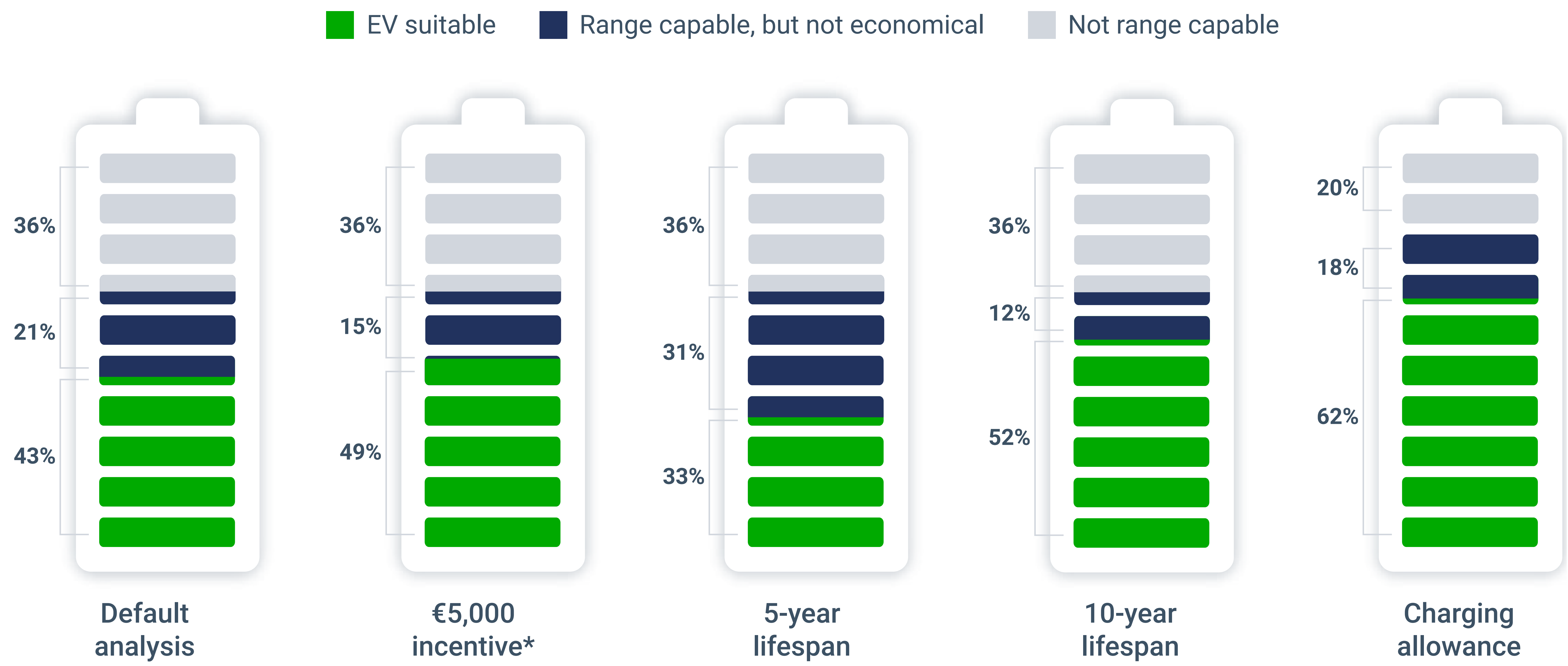
Avoided tailpipe emissions

43 TONNES OF CO_2

Influencing electrification potential in Spain

Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, having a 10% charging allowance in place or increasing the replacement cycle, EV suitability increases. Additionally, a charging allowance will increase range capability.



*Fleets of up to 500 vehicles may receive a maximum benefit of €2.5m, equivalent to €5,000 per vehicle

United Kingdom

Driving profile

Average daily driving distance:

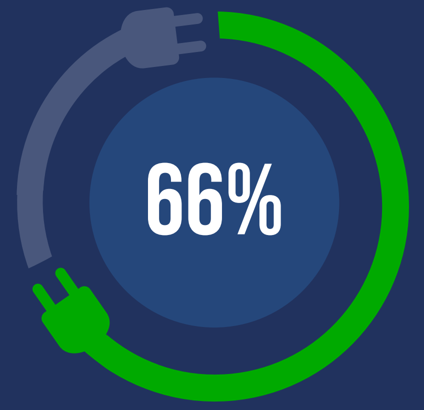
- 58 miles

Maximum distance daily:

- 287 miles

% of vehicles never exceeded 250 miles in a day

- 49%



of vehicles are EV suitable (no incentive)

Lifetime savings per EV suitable vehicle

Potential savings

£7,300

Fuel saved

17,100L

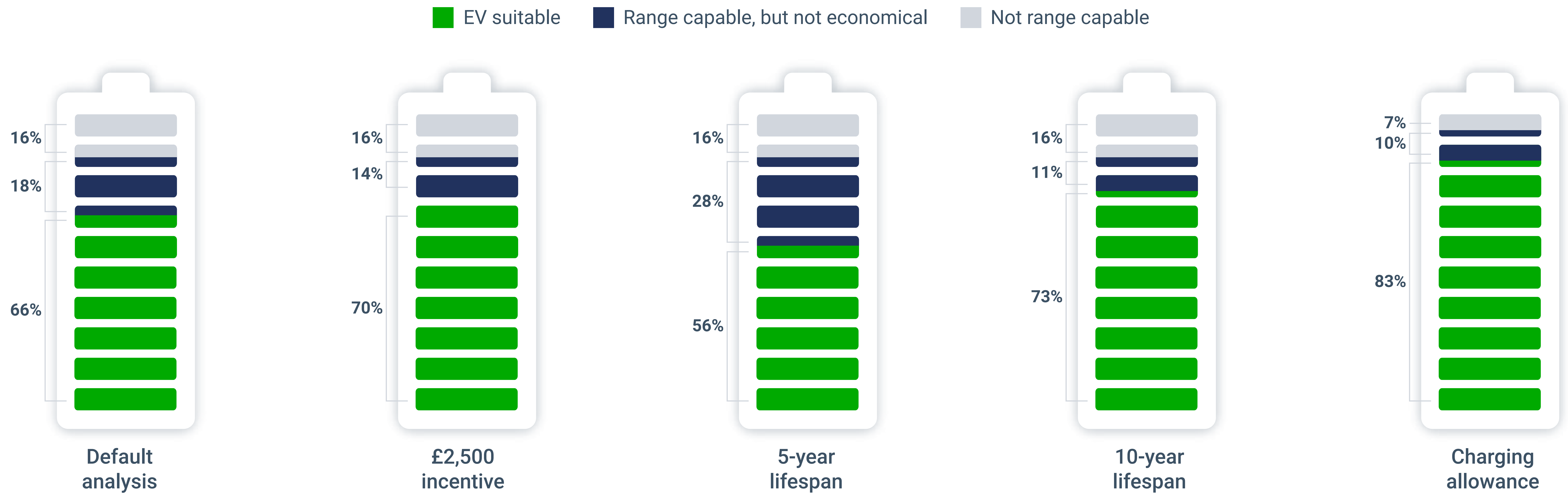
Avoided tailpipe emissions

39 TONNES OF CO_2

Influencing electrification potential in the United Kingdom

Fleet managers can influence the number of vehicles that could be electrified through a number of levers.

By leveraging incentives, having a 10% charging allowance in place or increasing the replacement cycle, EV suitability increases. Additionally, a charging allowance will increase range capability.



TIP: Try our interactive country dashboard

Explore how each country ranks for EV suitability, cost savings and avoided emissions in our interactive experience. You will be able to adjust the analysis to include how factors like government incentives, extending the lifespan or adding a charging allowance impact those ranks. Visit **geotab.com/taking-charge** today.

SECTION 2

Evaluating the capabilities of medium- and heavy-duty EVs in North America

Until recently, the majority of fleet electrification has largely been limited to light-duty vehicles and select larger vehicles – mainly buses.

This stems from the fact that there were limited electric medium- and heavy-duty models available. However, as EV technology has improved, there has been an increased number of vehicles entering the market and they are becoming a more viable solution.

This portion of the report analyzes de-identified telematics data from roughly 196,000 medium-duty and 324,000 heavy-duty ICE trucks from across North America. It highlights which of these vehicles behave in a way that makes them suitable for electrification by focusing on two key factors of their duty cycle: Driving distances and dwell time. Both play a significant role in determining whether an EV could meet range requirements and have sufficient opportunity to recharge when it is stopped. For more information about this analysis, refer to the **methodology section**.

Note: This study does not consider different driving conditions such as speed, temperature and payload that will impact an EV's usable range. Understanding these conditions will help determine what battery size and vehicle capabilities will be needed to complete the job specific to each fleet and route.

Class	Definition
Medium-duty	• Class 3-6 trucks that weigh between 10,001 and 26,000 lbs.
Heavy-duty	• Class 7&8 trucks that weigh more than 26,000 lbs.

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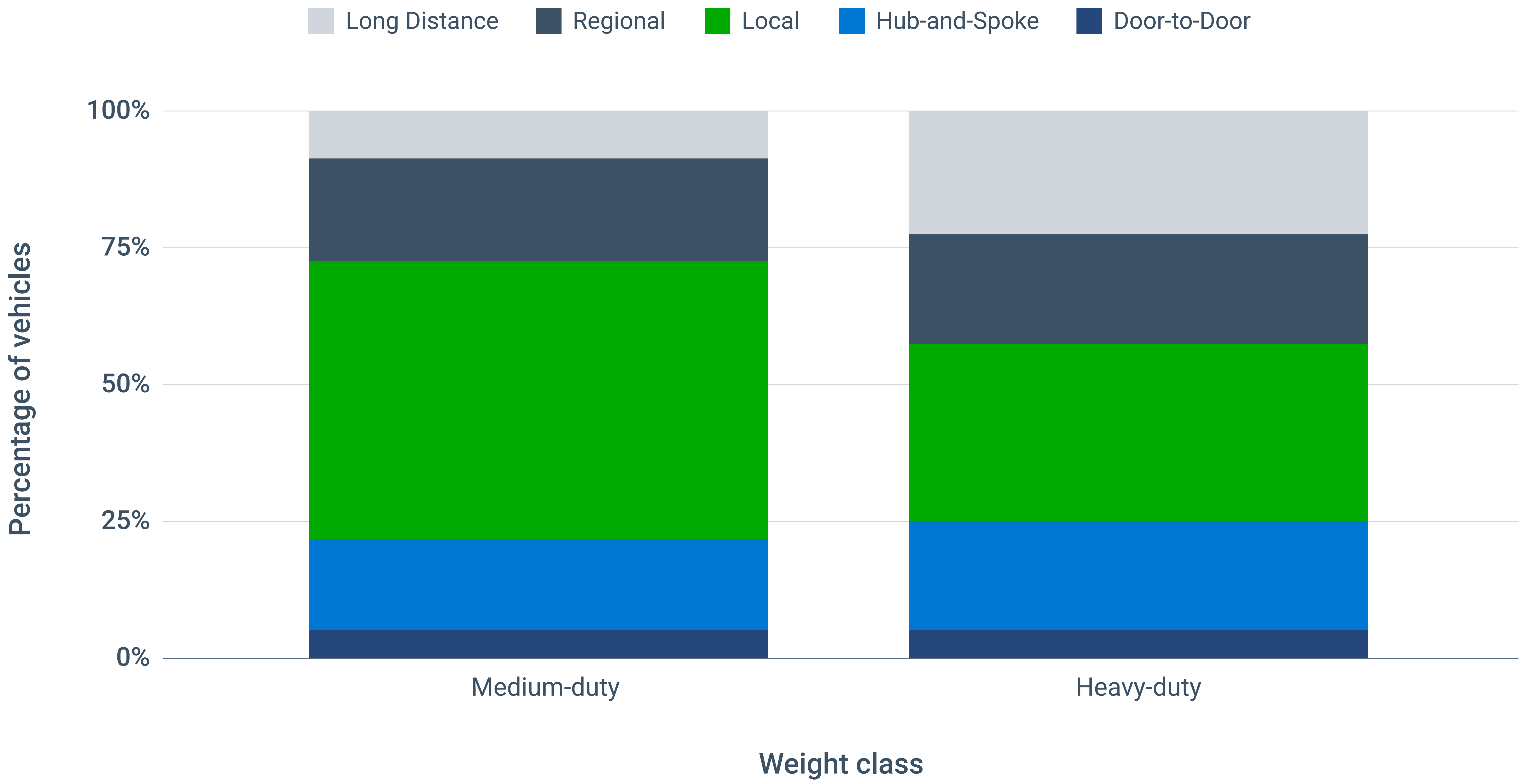
The importance of vocation

Every fleet will have different requirements and behaviors, but by breaking out the vehicles by the job they do (also known as vocation), we can look at general trends. The vehicles analyzed in this section have been sorted into one of five vocations across the medium- and heavy-duty truck space as follows:

Medium- and heavy-duty class vehicle breakdown by vocation



Vocation	Daily driving behavior
Door-to-Door	• Makes significantly more stops than most and tends to spend very little time per stop.
Hub-and-Spoke	• Makes multiple round trips from a singular location or centralized hub.
Local	• Remains within an area of 150 miles. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.
Regional	• Drives beyond an area of 150 miles and tends to rest in the same location often. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.
Long Distance	• Large range of activity and typically does not rest in the same location. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.

Many trucks drive well within the estimated range for EVs on the market today

One of the limitations of EV trucks today compared with their ICE counterparts is having shorter ranges. Being confident that the EV can fulfill the requirements of the fleet is paramount. Knowing how far vehicles are really being driven each day can provide insight into EV suitability. Our analysis shows that there are many applications where electric trucks are likely capable of meeting the range requirements of today's fleets.

To explore range requirements, we analyzed both the average daily distance driven and the longest driving days of the year. As expected, vocations that have a smaller area of operations have the most potential – especially in the medium-duty class. While vehicle daily distance is one indicator for electrification potential, EV range capabilities will depend on the vehicle selected, as well as the trip-specific payload, speed and topography. Understanding payload requirements and trip variability is going to be critical in order to make sure to deploy the right vehicles for the right job.

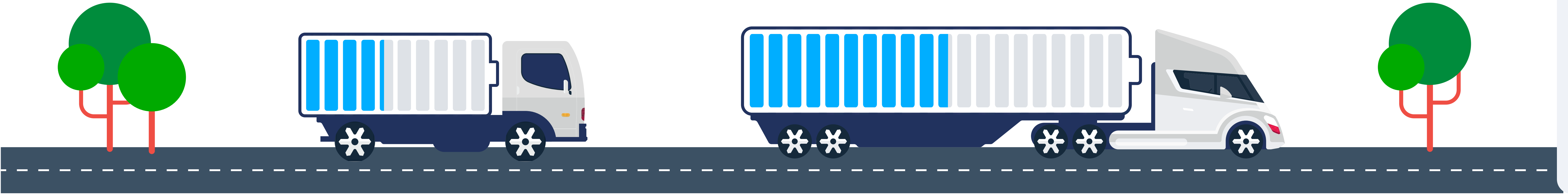
The medium-duty vehicle class is ripe for electrification

When reviewing vehicle driving behavior over the course of a year, 81% of medium-duty trucks drove less than 150 miles per day on average and 43% never exceeded 200 miles – even on their longest driving day. Today, there are several class 3-6 EVs available with a range of 200 miles or more, meaning that based on today's driving patterns, many fleet vehicles in our analysis may have a good opportunity to go electric.

If you exclude Long Distance and Regional vocations, there's an even more encouraging story. Looking at the longest driving day of the year, 63% of Door-to-Door, 49% of Hub & Spoke and 60% of Local never exceeded 200 miles in a day.

Medium-duty
Never exceeded 200 miles
43%

Heavy-duty
Never exceeded 400 miles
53%



There are plenty of opportunities for heavy-duty EVs

Perhaps surprisingly, many heavy-duty trucks also stick to local operations, although they generally tend to have longer driving distances than their medium-duty counterparts. Over the course of the year, 58% of heavy-duty trucks drove less than 200 miles per day on average, and 53% never exceeded 400 miles, even on their longest driving day. Focusing in on the local vocations, 78% of Door-to-Door, 27% of Hub & Spoke, and 52% of Local never exceeded 200 miles in a day over the course of the year. Interestingly, the electrification potential in Door-to-Door vocations is higher for heavy-duty than for medium-duty vehicle classes.

Over the last few years, we have seen an increased focus on vehicle innovation for Class 8 electric trucks. As an example, in late 2022, Tesla started delivering their Semis, which have a stated range of up to 500 miles on a full load. In our analysis, Regional trucks drove a median distance of roughly 250 miles and Long Distance trucks drove 430 miles. While these vehicles do show a fair amount of variance in driving distances, there are still opportunities in heavy-duty vehicle classes to electrify, as evidenced by several fleets participating in **NACFE's Run on Less Electric - DEPOT**.

TIP: In order to help fleets and governments understand the estimated range capabilities of vehicles on the market, CALSTART has created the **Zero-Emission Technology Inventory** (ZETI) tool.

A quick note on charging capabilities

Charging times will vary depending on three main factors:

- How much energy can the battery hold - measured by the total battery capacity (kWh)
- How full is the battery - measured by its current state-of-charge (SOC), and
- How quickly is the battery being filled - measured by charging power (kW)

In general, the greater the battery capacity, the longer it will take to charge and an empty battery will take longer to charge than one that's half full. The power, or speed at which the battery is filled, is determined by both the charging equipment and the vehicle's capabilities. DC chargers provide much higher levels of power than AC chargers; some of which can power up to 350 kW or even a megawatt.

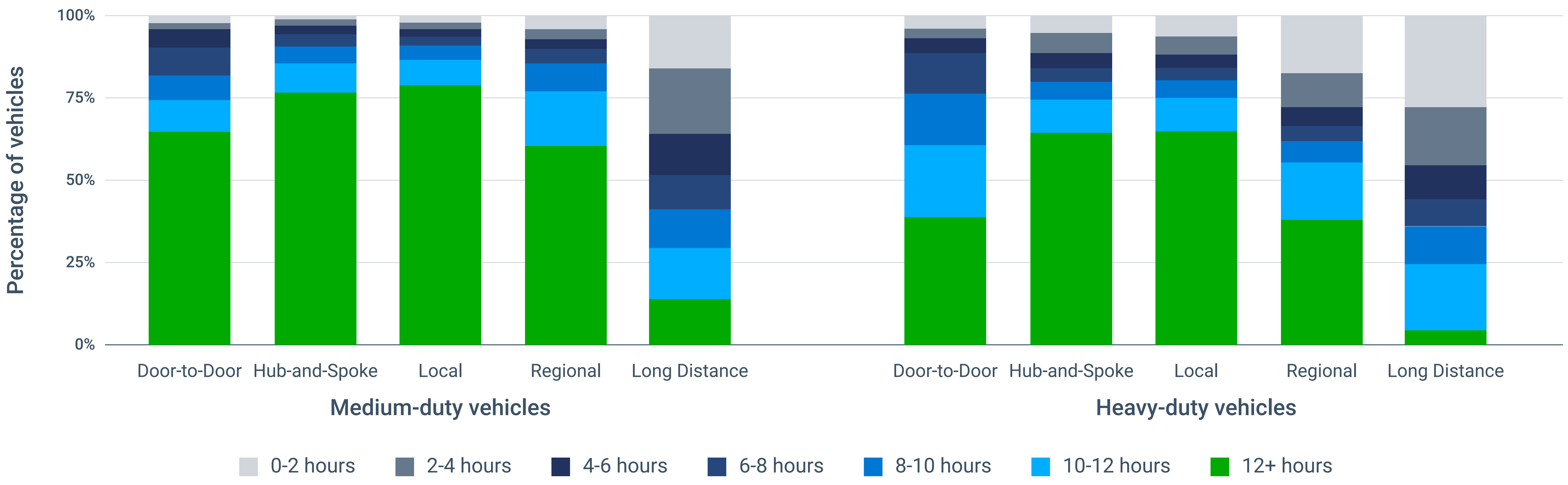
However, not all vehicles will accept that level of power, and will limit what is actually dispensed into the vehicle.

Even on their most utilized days, the majority of trucks spend a long time parked

Understanding how far a vehicle drives is not the only factor determining if it is suitable for electrification. Another major consideration is its dwell time. Given charging takes longer than refueling with gas or diesel, the optimal time to recharge is when the vehicle is stopped or parked during its normal duty cycle. Vehicles that are constantly on the go will have a greater challenge electrifying without compromising their uptime.

In order to evaluate charging potential, we reviewed how long vehicles dwell on their highest-use days – the days of the year where driving time is highest and dwell time lowest. Overall, we found that with the exception of the Long Distance vocation, the majority of vehicles spent nearly half of the time parked in a 24-hour period; at least 12 hours and 10 hours for medium-duty and heavy-duty, respectively.

Proportion of vehicles and their dwell duration by vocation



Although this data represents a cumulative amount of time over a 24-hour period, we also observed that the majority of the dwell time usually comes from one single stop. These findings indicate that for many trucks, there would be ample time to charge if they were to transition to EVs – assuming charging is deployed where the vehicles park. By looking at your fleet's dwell data, you can validate which vehicles have a better potential to electrify based on having sufficient opportunity to charge during their normal duty cycle when they are naturally parked.

Medium- and heavy-duty EVs are going to revolutionize the transportation industry

Light-duty EVs may have enjoyed the spotlight for a while, but it's time to make room for the big guys. Fleet managers should start evaluating their options as their existing vehicles start reaching the end of their lifespans. For vocations that operate more locally and have more predictable routes, electrification can be achievable today from a range and charging opportunity perspective.

You aren't in this alone. There are a number of associations, think tanks and service providers that are investing heavily to help fleets gain a deeper understanding of their potential for electrification. In addition to studies like this from Geotab, check out results from NACFE's **Run on Less** Electric Depot.

SECTION 3

Charging behavior of North American and European early adopter fleets

We've proposed that EVs are well suited for many fleet applications, but how are EVs actually being used and charged in fleets today?

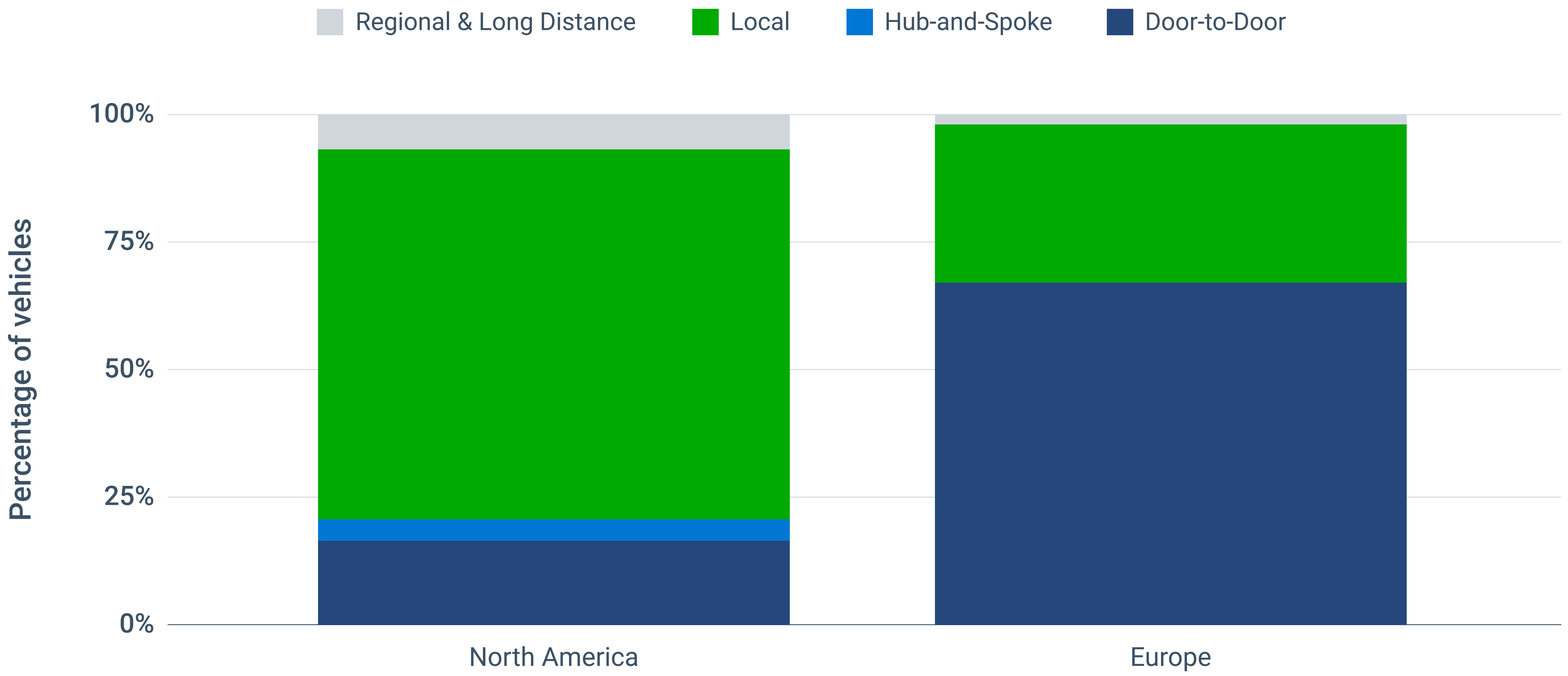
Charging behaviors of fleet EVs can unveil significant insights for both fleet managers and policymakers. Analyzing aspects such as frequency of usage of charging locations, charging times and state-of-charge at the time of charging can illuminate patterns and preferences that are crucial for optimizing charging infrastructure deployment, enhancing grid management, and improving the overall efficiency of fleet operations.

This section of the report will take a more in-depth look at the charging behavior of more than 5,200 EVs in early adopter fleets across North America and Europe over the course of a year. Refer to our **methodology section** for more information. The analysis predominantly included passenger and light-duty commercial vehicles, with larger EV trucks and buses making up only roughly 4% of the analysis.

Vocational makeup

When sorting fleet vehicles by their job (or vocation), we found that the vocational makeup is quite different between the two observed regions. For example, the majority of the analyzed vehicles in Europe are classified as Door-to-Door. This may influence the overall results when reviewing the data at a regional level.

Vocational breakdown of the vehicles analyzed between North America and Europe



Note: In adherence with Geotab's data privacy policies and sample size requirements, the vehicles in the Regional & Long Distance vocations have been combined into a single group and the European Hub-and-Spoke vehicles have been removed.

Vocation	Daily driving behavior
Door-to-Door	• Makes significantly more stops than most and tends to spend very little time per stop.
Hub-and-Spoke	• Makes multiple round trips from a singular location or centralized hub.
Local	• Remains within an area of 150 miles. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.
Regional	• Drives beyond an area of 150 miles and tends to rest in the same location often. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.
Long Distance	• Large range of activity and typically does not rest in the same location. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.

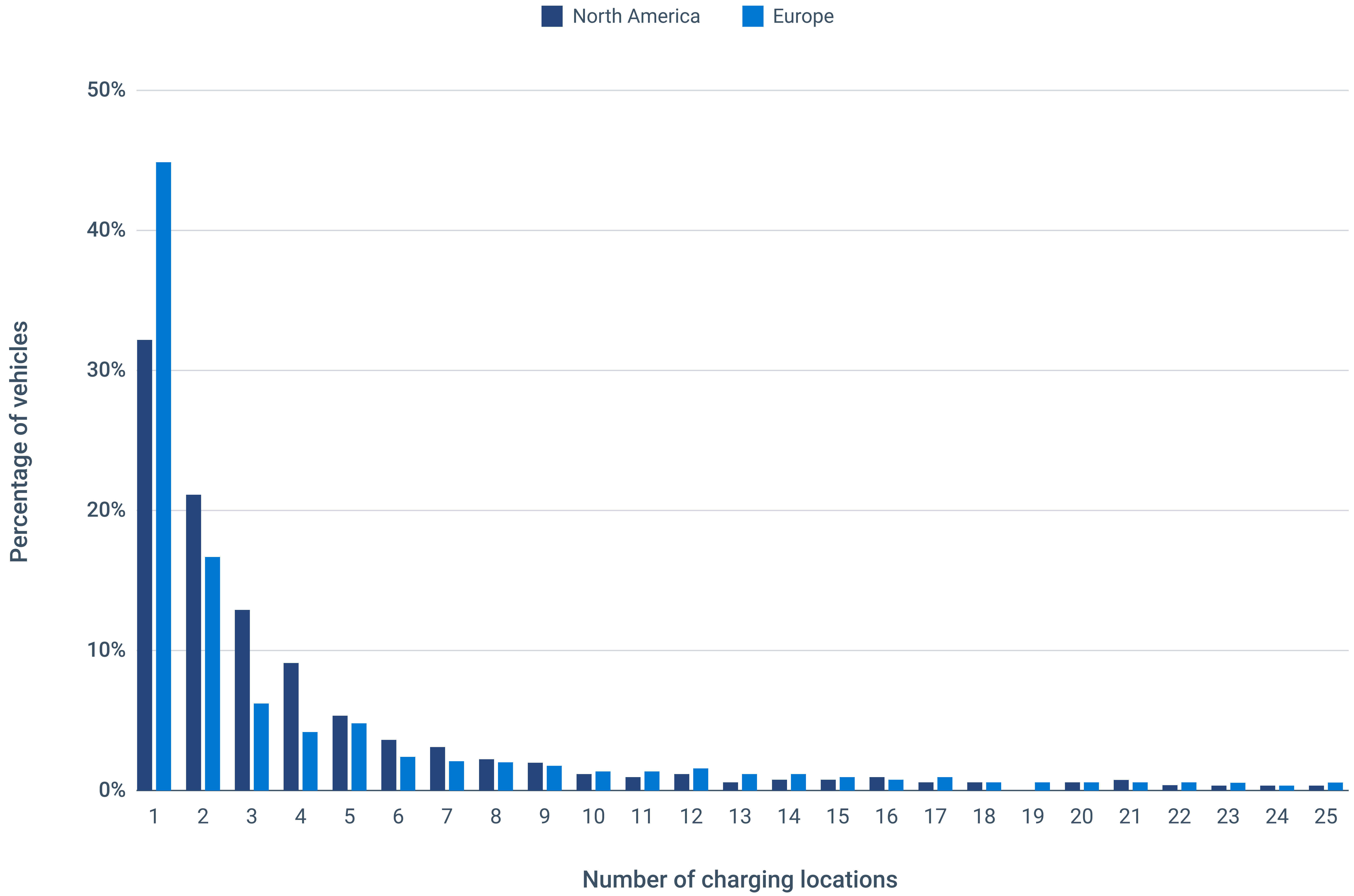
Most fleet vehicles only charge at a few locations

When reviewing charging behavior, we found that a significant proportion (more than 50%) of fleet EVs in both North America and Europe only ever charge at one or two locations; the percentage of vehicles that used additional locations drops off rapidly from there.

This charging behavior should not be overly surprising. The EVs currently on the road today are most likely the ones that were the “easiest” to deploy – vehicles with predictable routes, that return to the same domiciles each day and have the ability to charge onsite at the fleet’s facility or the driver’s home, if it is a take-home vehicle.

This aligns with the overall makeup of the vehicles in this analysis. In the future, as fleets begin adopting EVs in “tougher-to-electrify” vocations and as charging infrastructure expands, we may see a change in this overall pattern.

Regional differences in the number of charging locations



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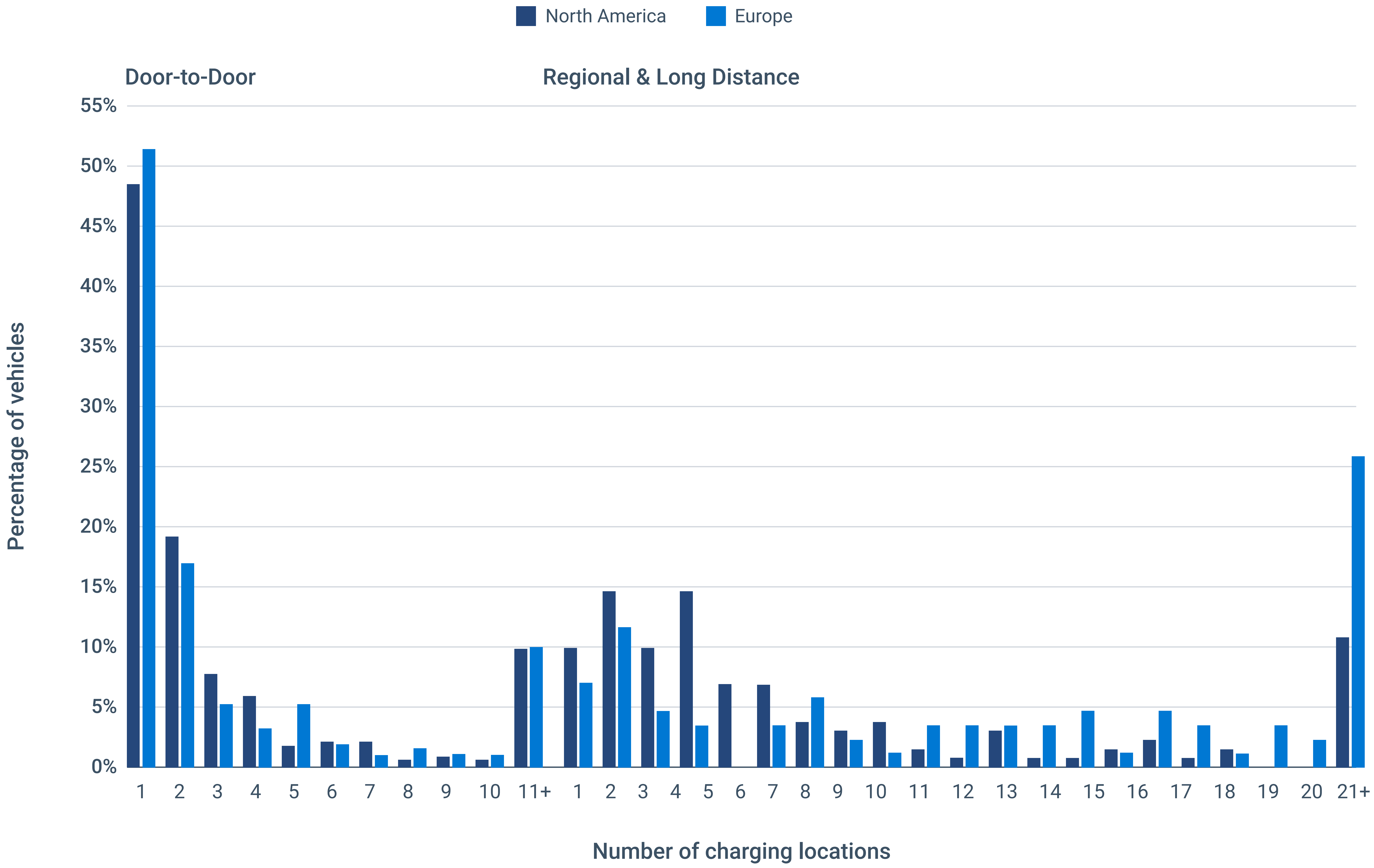
Grouping vehicles by vocation unveils some patterns: Door-to-Door, as well as the Hub-and-Spoke and Local vehicles, are vocations that drive within a 150 mile area, and therefore are staying close to a "home base." These vocations relied on far fewer charge locations than Regional & Long Distance vehicles, which are driving further afield and seem to rely on multiple charging locations rather than one dedicated spot. In Europe, EVs in Regional & Long Distance vocations are utilizing more charging locations compared to North America, which likely speaks to Europe having a more robust charging network.

They simply have more options to charge along their routes or potentially at customer sites. This aligns with our findings that 25% of the Regional & Long Distance vehicles in Europe used 21 or more unique charging locations over the course of the year, as opposed to only 13% in North America.

Insight

In July 2023, the **European Union** passed a law to dramatically increase the number of publicly available chargers. By the end of 2025, there will be a system of fast chargers every 37 miles along the Trans-European Transport Network system of highways. In the U.S., the **National Electric Vehicle Infrastructure Formula Program** (NEVI) was created under the Infrastructure Investment and Jobs Act to support the strategic build out of EV charging infrastructure. The initial fund of $5 billion requires the installation of DC fast charging stations no further than 50 miles apart along major freeways and highways.

Regional differences in the number of charging locations by vocation



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Fleets are conservative with when and how they charge their EVs

Understanding where charging happens is only part of the story – the other questions are when and how. In our analysis, we looked at both what time of day EVs were charging as well as what charger type they used. While both of these factors have their own independent impact, they also influence each other.

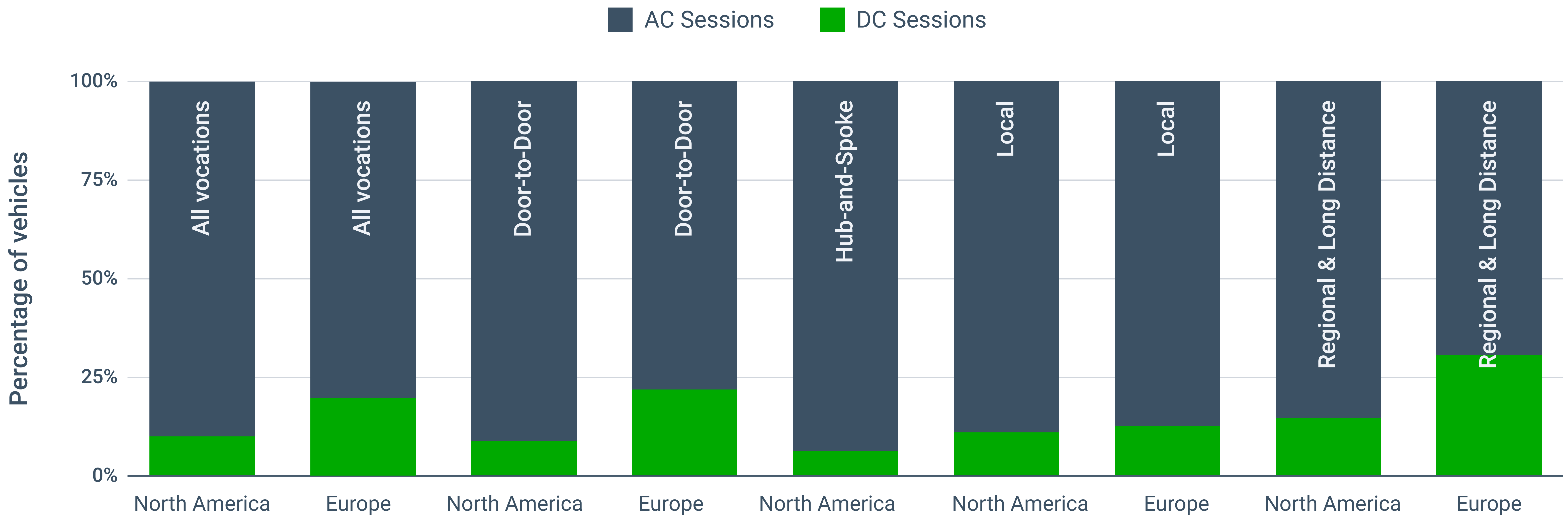
There is more than one way to charge an EV and the terminology is different depending on your location. To simplify this, the charging has been grouped into either AC charging or DC charging.

Light-duty fleet EVs are relying on AC charging

Overall, AC charging accounted for the majority of all charging in both regions and across all vocations. European vehicles did utilize DC charging almost twice as much as North American vehicles, but it still only accounted for 20% of their total charge sessions. There are a few possible reasons for the higher rates of DC charging. For one, Europe is further along in terms of widespread EV adoption and because of this, has more publicly available DC chargers – allowing for more opportunity charging. Additionally, with the more mature market, fleets may be more willing to invest in this more expensive infrastructure at their own depots.

Looking at the vocational breakdowns, Regional & Long Distance vehicles used DC charging the most. This finding also coincides with the previous insight that these vehicles are most likely to use multiple charging locations throughout the year.

Proportion of charging sessions by type, region and vocation



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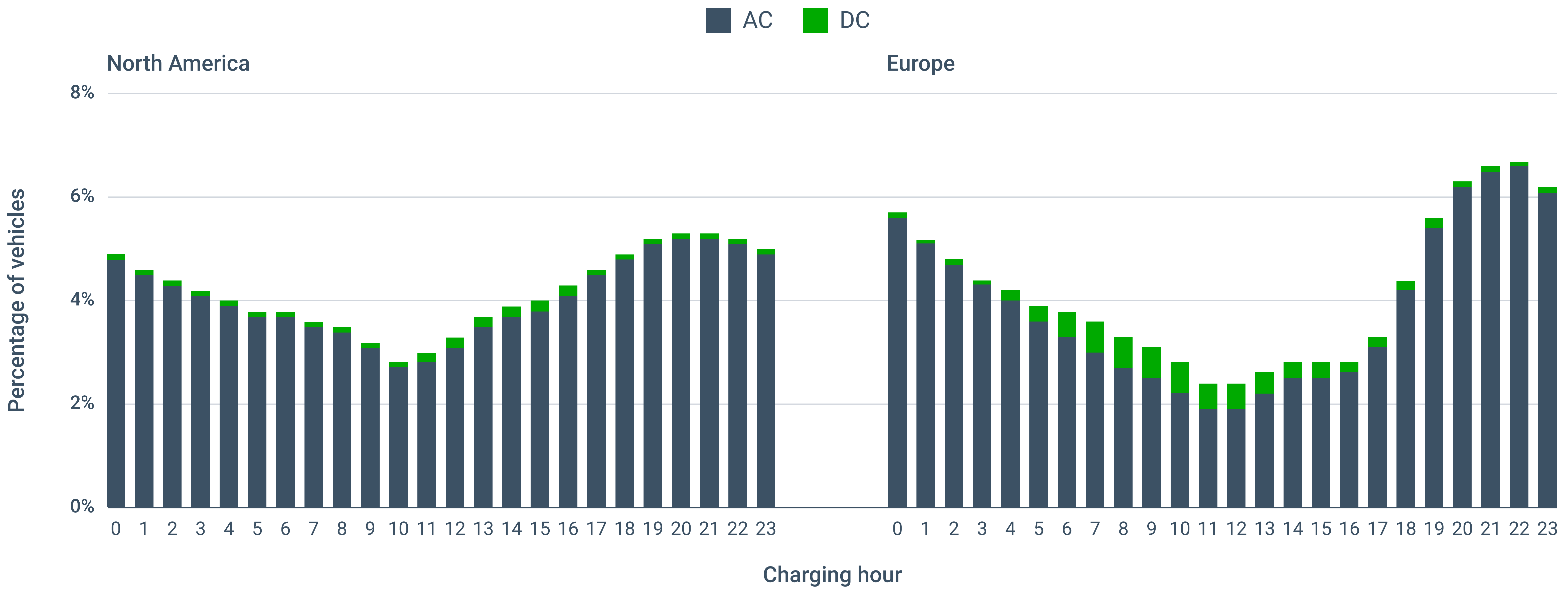
Fleets make sure they're ready for the next day by largely charging outside of 'core' work hours

In the charts below, we have broken out the percentage of charging sessions by hour of day for the entire year. It should be noted that we observed that not all vehicles were charged every day that they drive.

The dip in the middle of the day indicates fewer sessions are occurring during typical "work hours" (between 9 a.m. and 5 p.m.) while charging peaks in the evening. In Europe, a notable increase in DC charging occurs during daytime hours, indicating that these fleets are taking advantage of opportunity charging during the day. In North America, the daytime dip is slightly less pronounced, with charging sessions more evenly spread out.

Proportion of charging sessions at different times



These graphs represent the proportion of total charging sessions that occur at some point during that hour, irrespective of the length of the sessions. For more details, refer to the ***methodology section****.*

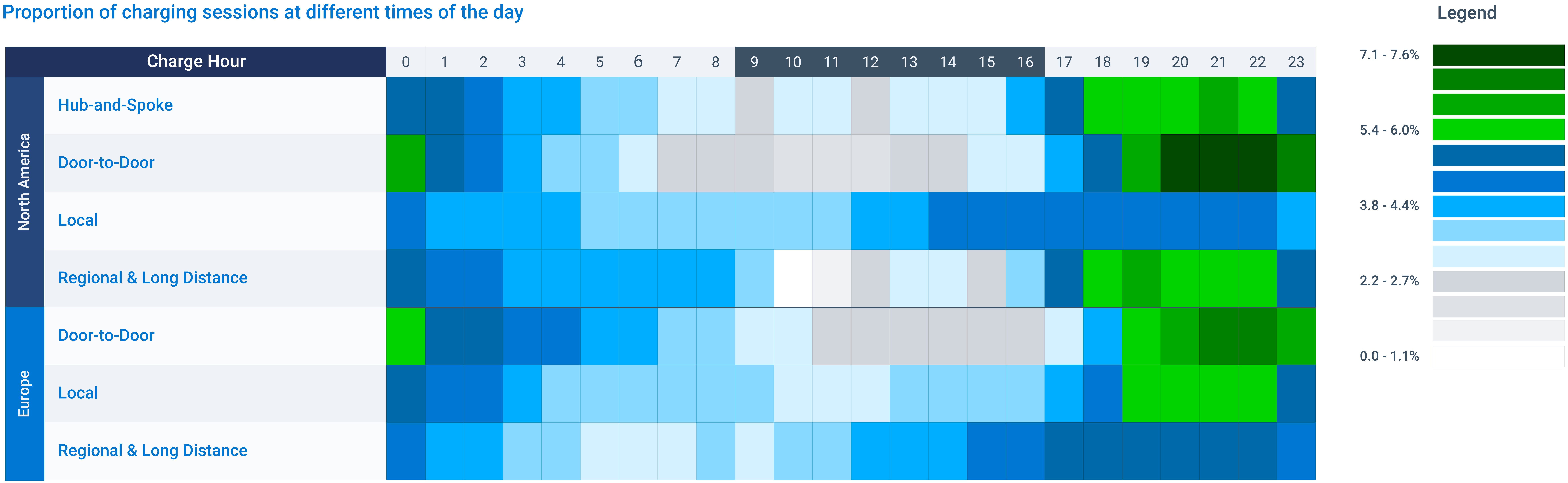
> Fleet operators have access to a powerful toolkit for a successful EV transition: connected vehicle data. Insights from EV data can reveal whether the vehicles are maximized and charging is optimized, ensuring investments pay off.

Charlotte Argue

Senior Manager, Sustainable Mobility, Geotab

While charging is generally more concentrated outside the core work hours, for the North American Local and European Regional & Long Distance vocations, the charging is more evenly distributed throughout the day. This could be due to these vocations covering further distances or more diverse routes – which in turn require more frequent charging. Counter to the European Regional & Long Distance charging behavior, it is surprising to see the low amount of charging happening between the hours of 10 a.m. and 12 p.m. in North America.

Proportion of charging sessions at different times of the day



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Fleets charge more often than they need to

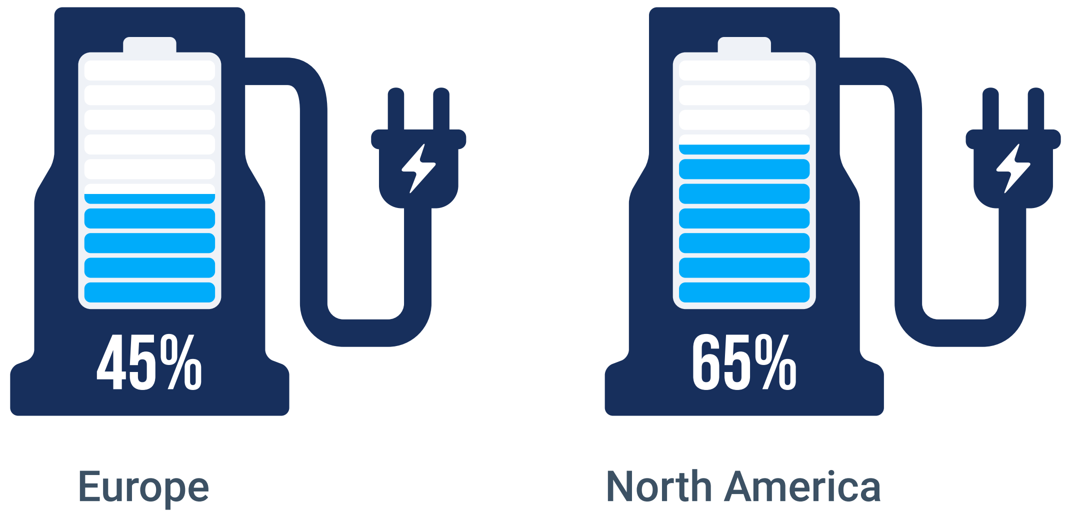
An EV's state-of-charge (SOC) is a representation of how much energy is left in the battery – essentially the EV equivalent of a fuel gauge.

Most fleet vehicles observed were charged conservatively and never depleted their batteries. In fact, 45% of European charge sessions and 65% of North American charge sessions happen before the battery drops to half. A third of charge sessions in North American start with a battery state of charge that's above 70%.

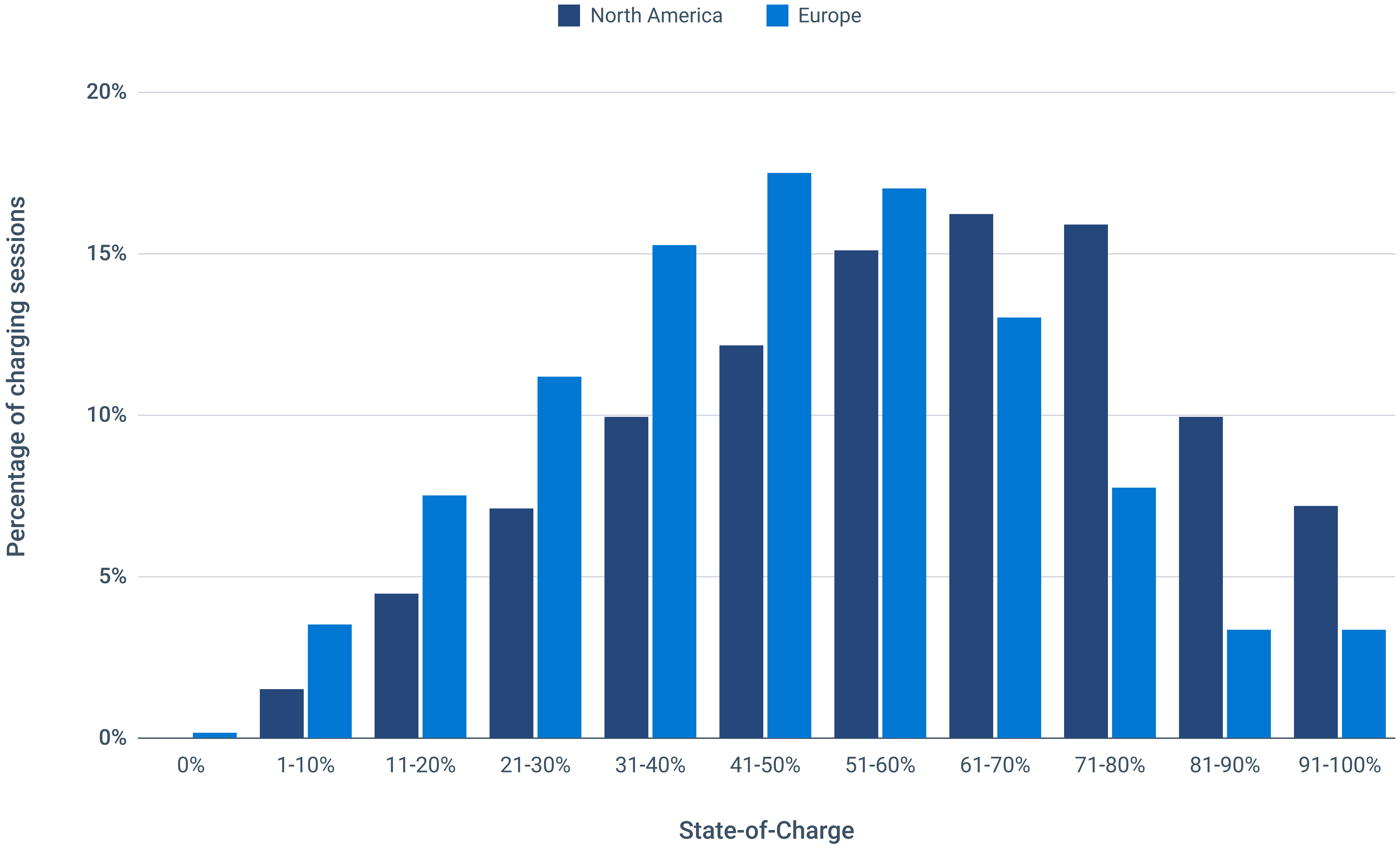
This is a missed opportunity to utilize an EV to its full potential, since many EVs can go well over 100 miles at 50% SOC.

EV adoption in Europe started gaining momentum earlier than in North America. This familiarity, along with more publicly available charging, seems to provide a greater level of comfort and European fleets may not feel the need to charge at every opportunity. They may also be more comfortable planning longer routes for their EVs and seem to be more willing to allow the SOC to drop to a lower level.

% of charge sessions that happen before battery drops to half



Charge session by their starting state-of-charge



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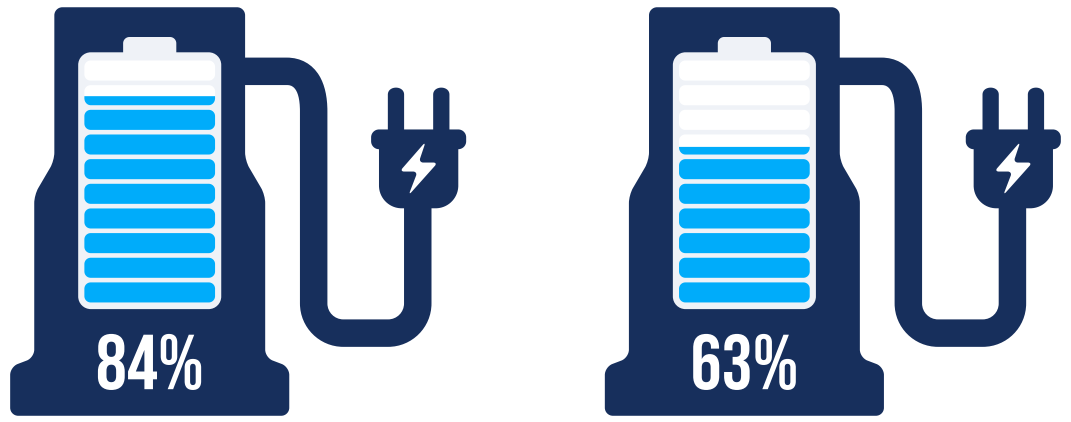
When fleets charge, they charge to full

We were also interested in whether EVs were being charged fully. For this study, we considered any charge session that ended when the SOC was 91% or greater to be fully charged.

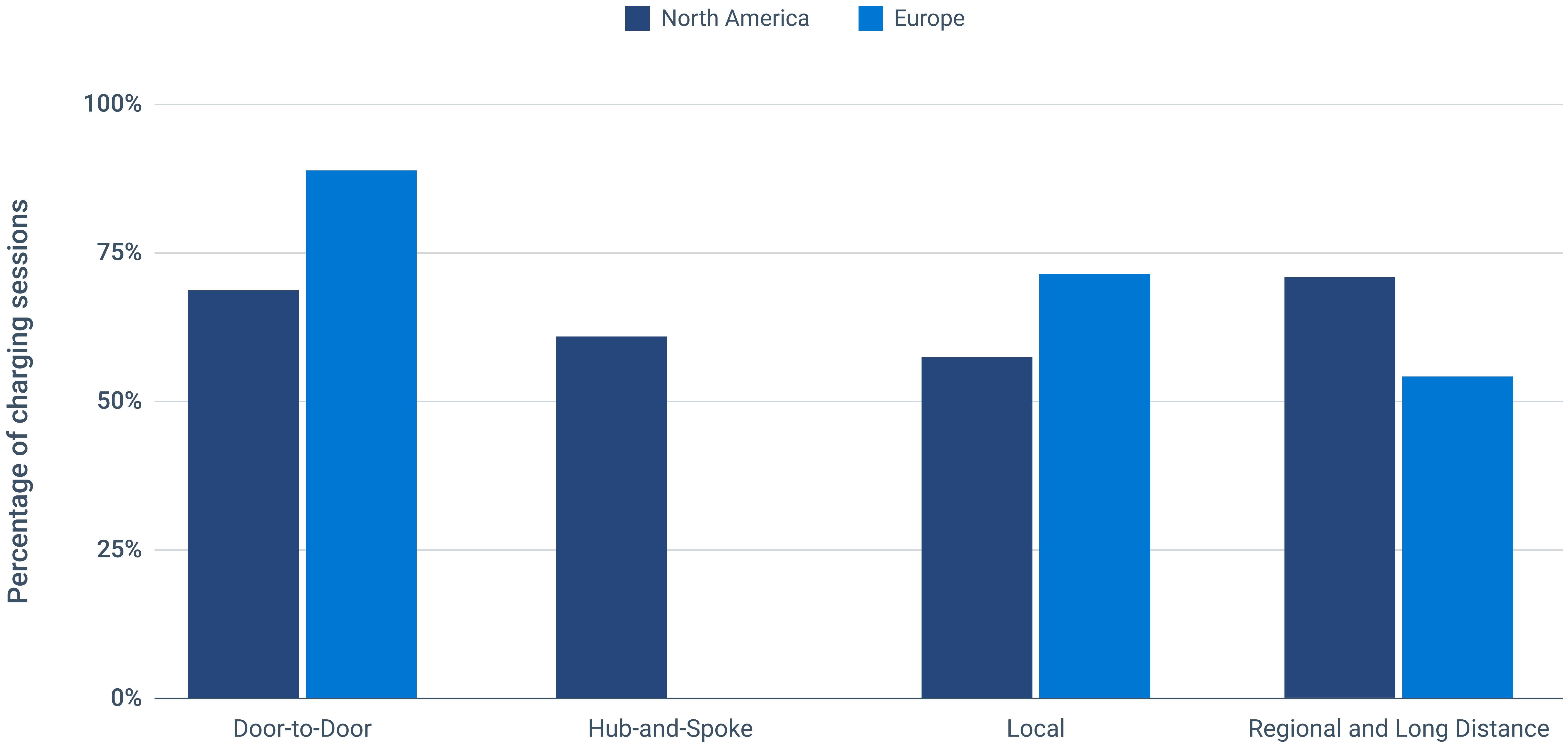
Regardless of region or vocation, the majority of charging sessions ended when the vehicle was fully charged. However, a significantly larger percentage of European charging sessions, around 84%, result in a fully charged battery compared to their North American counterparts, where only 63% charge to full. One possible explanation for this is that the vehicles being used in Europe may contain a higher portion of earlier generation models that do not have the capability to stop charging automatically at a predetermined SOC – a feature most newer EVs offer to help prolong the battery life.

% of charge sessions resulting in fully charged battery



Europe North America

Charging sessions that end with a fully-charged battery



These findings, in combination with the fact that most fleets tended not to let their vehicles go below a 50% SOC, highlight that fleets are:

- Overly conservative with how they use their vehicles and what routes they send them on
- Opting to charge their vehicles more often and for longer than they need to, or
- Using an oversized battery for the application and could have fulfilled their duty cycle with a shorter range EV.

Early adopter fleet experiences provide learnings for the next generation of EV adopters

Fleet electrification has a learning curve. Running pilot deployments at a smaller scale can be a helpful tool for fleets to test the waters, allowing them to become more comfortable with an EV's capability. Early adopter fleets are paving the way, highlighting that the more time they spend with EVs, the more comfortable they seem to become. Findings from aggregated data like this study highlight the importance of data to identify performance improvements in their fleets.

For their existing fleet EVs, this could entail:

Maximizing utilization

1. Monitor EV usage and measure how much battery capacity is being used, with a goal to increase EV utilization in the fleet.

Rightsizing

1. Deploy those EVs with larger batteries in more strenuous or longer duty cycles.
2. As ICE vehicles come to their end of life, evaluate if an existing EV could already do the job by increasing its utilization in lieu of purchasing another vehicle.

Optimizing charging

1. Manage charging to ensure the vehicle is ready for its next deployment.
2. Delay or limit charging if it's not needed.
3. Take advantage of favorable electricity rates ("off-peak") in regions where the rate changes, depending on the time of use.

Note: As the fleet considers expanding its EV operations, leveraging insights from early deployments and conducting an EV Suitability Assessment can help you make more informed decisions.

We’re entering an exciting time for fleet electrification

Armed with real-world data from over 1.3M fleet vehicles across 7 countries, the story our study tells is clear.

Fleet electrification is no longer a pipe dream or a solution solely for organizations intent on reducing their carbon emissions. Instead, across all regions studied, our data shows that there are ever greater opportunities for fleets to electrify, reduce their TCO and meet their carbon reduction goals.

EVs can satisfy a large portion of daily range needs for light-duty fleet vehicles in North America and Europe, and by incorporating some day-time charging, an even greater opportunity is unlocked. What’s more, they can provide significant savings opportunities while also supporting the company’s emission reduction objectives.

Fleets looking to make the move to electric have a number of levers they can use to prepare their fleet for the transition - through rightsizing, utilization and route optimization. Leveraging incentives, identifying daytime charging opportunities and adjusting the service lives of vehicles are ways fleets can better incorporate EVs and drive positive ROI.

Macroeconomics, like fuel and electricity costs as well as available government support, vary between countries and even at a regional level. Data-informed decision-making starts by understanding the regulatory and economic variables for fleet electrification and pairing those with your own fleet data in order to create the most accurate electrification blueprint.

Today’s medium- and heavy-duty vehicle usage patterns challenge our assumptions about what EVs could do for those classes, especially where fleets operate more locally. With a number of fleet vocations driving within the capabilities of current EV trucks and spending a long period of time in a day parked, medium- and heavy-duty vehicle classes have an opportunity to go electric today based on range and charging requirements alone. The time is ripe to assess the options available on the market today and evaluate those against each vehicle’s driving and dwell patterns to determine if there is an EV fit.

> “We’re in the middle of a transformative shift for the industry. The technology is accelerating by leaps and bounds, meaning EVs can do the job in more applications each year. There’s also global collaboration to accelerate the shift to zero-emissions. The road to an EV future is only getting started and I am excited for what lies ahead.

Charlotte Argue
Senior Manager, Sustainable Mobility, Geotab

Once fleets adopt EVs, their operating behaviors provide an early glimpse into the opportunities and challenges that fleets face in practicality. Charging behaviors, particularly regarding to the number of locations and the time of charging, are largely aligning with those fleet vocations that are more suitable for electrification today. How often and how much they charge their vehicles point to fleets being more conservative in their EV deployment, leaving potential to increase EV utilization and improve ROI. European fleets, which tend to be more mature in their EV adoption, seem to be more comfortable than their North American counterparts – perhaps as a result of having more experience with their vehicles' capabilities, and more charging options. Despite that, fleet operators can likely do more with their current EVs and should look to use good fleet practices to maximize their operations. Route and vehicle optimization, asset utilization and rightsizing help match their existing vehicles' capabilities with the need of the job at hand, while also helping inform future procurement decisions.

With data on your side and the learnings of early adopters to make your journey more certain, there's really nothing stopping you from moving your fleet towards an electric future.

To begin your EV adoption journey, Geotab has a number of resources available to you. Visit our **Fleet Electrification Knowledge Center** for a curation of research, real-world fleet success stories and educational resources in one convenient location. From there, download our related **ebook**, a step-by-step guide covering the full fleet electrification journey.

If you're ready to take the next step in your sustainability journey, discover how Geotab can help you take the complexity out of electrifying your fleet by visiting **geotab.com/ev**.

Methodology

The studies analyzed de-identified, aggregated data from Geotab's connected vehicle platform between the dates of June 1, 2022 - May 31, 2023 in accordance with Geotab's privacy policies.

Section 1: Potential fleet electrification for light-duty vehicles in North America and Europe

This section analyzed the driving patterns of light-duty ICE vehicles driven in North America and Europe over a one-year period, in order to identify vehicles that could be replaced with a battery electric vehicle. The study did not consider plug-in hybrid electric vehicles (PHEVs). The study assumed that vehicles were in service for seven years, unless stated otherwise, and were purchased, not leased. A vehicle was assigned a vocational profile by analyzing the most common driving pattern over the time period. Any currency conversions used an exchange rate average from May 1, 2022 - April 30, 2023.

EVs were considered range capable if they could meet the vehicle's daily driving distance on a single charge each driving day over the one-year period, and had at least 15 miles of range left at the end of the day. We discounted 2% of trips that would represent outliers outside of the standard usage.

For an EV to be considered EV suitable, it needed to be considered range capable and have a total cost of ownership that was equal to or lower than that of a comparable new ICE vehicle replacement. Total cost of ownership includes the local cost of procurement and maintenance as well as the local fuel and energy costs as of July 2023, but excluded resale value. Capital cost of infrastructure was not included.

Estimated avoided emissions are solely tailpipe emissions and do not account for emissions generated through energy production or vehicle manufacturing. Emissions calculations are based on the emissions factor of 2.29 kg of CO2 per liter of gas. The **U.S. EPA Greenhouse Gas Equivalencies** online calculator was used to compare the aggregate reduction of CO2 across all EV suitable vehicles to the amount of carbon sequestered by a forested area.

Section 2: Evaluating the capabilities of medium- and heavy-duty EVs in North America

The study analyzed driving and dwell behaviors of medium-duty (class 3-6) and heavy-duty (class 7&8) internal combustion engine trucks, excluding buses. The analysis considered all trips and dwells, aggregated by day based on local time, to identify the distance traveled and cumulative time stopped. Different driving conditions (speed, temperature and payload), which will impact an EV's usable range, were not considered. A vehicle was assigned a vocational profile by analyzing the most common driving pattern over the time period.

Section 3: Charging behavior of North American and European early adopter fleets

Focusing on battery electric vehicles, this section examined driving and charging data from passenger cars through to light-, medium- and heavy-duty vehicles (classes 1-8) in North America and Europe, excluding rental vehicles. All times are based on the vehicle's local time. The study defined a charging location as those areas where a charge session occurred. In order to distinguish charging locations from one another, we utilized Geohash 5, equivalent to a 9 square mile area, meaning that any session occurring in that area would be considered to be part of a single charging location.

Charging sessions were identified by AC, which groups Level 1 and Level 2 together, or DC charging using Geotab's onboard telematics devices. A charge session would be counted if it lasted longer than 1 minute. Charging hours were based on whether a charging session, either AC or DC, occurred at any point during that hour. As a result, a charge session may be counted towards several charging hours depending on when the charge session began and ended. A vehicle was assigned a vocational profile by analyzing the most common driving pattern over the time period.

Vocation details

Geotab has a patented machine learning algorithm which is used to determine the purpose or job (vocations) of the vehicles from which we collect data. Vocations are classified as follows:

Vocation	Description	Examples
Door-to-Door	• The vehicle makes significantly more stops than most per work day but also tends to spend very little time per stop.	• Last-mile delivery • Waste collection
Hub-and-Spoke	• The vehicle spends many of its work days making multiple round trips from a singular location (a centralized hub). • Typically the vehicle would average over one round trip per working day, with round trips accounting for the majority of its total mileage.	• On-demand services or delivery • Suppliers
Local	• The vehicle's range of activity is below 150-air-miles, thus qualifying it for the short-haul exemption under Hours of Service Regulations. • In addition, the vehicle does not exhibit behavior in line with other vocations such as Door-to-Door or Hub-and-Spoke.	• HVAC • Beverage distribution
Regional	• The vehicle has a wide range of activity over the 150-mile threshold for short-haul exemption but tends to rest in the same location often. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.	• Building supplies • Fuel carrier
Long Distance	• The vehicle has a very large range of activity and typically does not rest in the same location. • The vehicle is also neither Door-to-Door nor Hub-and-Spoke.	• Freight trucking • Rental or company vehicles

About Geotab

Geotab is a global leader in connected transportation solutions. We provide telematics — vehicle and asset tracking — solutions to over 40,000 customers in 150 countries. For more than 20 years, we have invested in groundbreaking 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 4 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 offer 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 **X** and **LinkedIn** or visit the **Geotab Blog**.

This ebook is intended to provide information and encourage discussion on topics of interest to the telematics community. Geotab is not providing technical, professional or legal advice through this white paper. While every effort has been made to ensure that the information in this white paper is timely and accurate, errors and omissions may occur, and the information presented here may become out-of-date with the passage of time.

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