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# Leveraging aggregated vehicle data to take the guesswork out of fleet electrification

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**Executive Summary**

Fleet operators are under pressure to decide whether vehicle electrification will meet their needs. The ability to understand and predict electric vehicle (EV) performance under different operating conditions is critical. By analyzing aggregated data from thousands of fleets and millions of trips, this paper shares Geotab's findings on real-world range, battery health and fleet EV suitability. These telematics insights provide data-driven evidence on EV capabilities, building confidence in the technology and its applications.

*Keywords: electric vehicle (EV), fleet, range, telematics, vehicle performance*

## 1 Introduction

Fleet operators are not emotional buyers. They need their vehicles to work, backed by a solid business case. Thus, building confidence in the technology will be essential for wide-scale adoption. As an emerging market, the EV industry has had limited real-world data to draw from to help overcome unknowns and to build this confidence for fleets. Fortunately, with expanding adoption, insights from telematics data can address this knowledge gap. Geotab, one of the world's largest commercial telematics providers [1] with over 3.2 million connected vehicles, has leveraged its rich collection of vehicle data to establish how EVs are performing in real-world conditions and to expose the true opportunity for commercial vehicle electrification.

## 2 Exploring the real-world performance of EVs

An EV's rated range, while helpful as a guideline, is inadequate for fleet operators who need to be confident in the capabilities of their vehicles under their unique driving conditions and duty cycles. By aggregating data from thousands of light-duty EVs driven in real-world conditions, Geotab has exposed insights into EV performance and how different driving conditions, such as temperature and speed, impact an EV's range.

### 2.1 Temperature

A common concern about EVs is how they perform in extreme weather conditions, particularly in the cold. Both hot and cold temperatures reduce the efficiency, and therefore attainable range, of an EV, primarily due to energy needed for HVAC and battery thermal management systems. Energy is used to keep the vehicle's cabin and battery at a temperature ideal for the comfort of the driver and the performance of the battery, respectively. Simply put, this means that there is less energy available to be used for propulsion.

By assessing over 5.2 million trips, we observe that efficiency can be maximized at around 70°F, outperforming the vehicles' rated range. Efficiency drops off above and below this temperature, as seen in Fig. 1 below. These findings are based on average aggregated data across different makes and models.

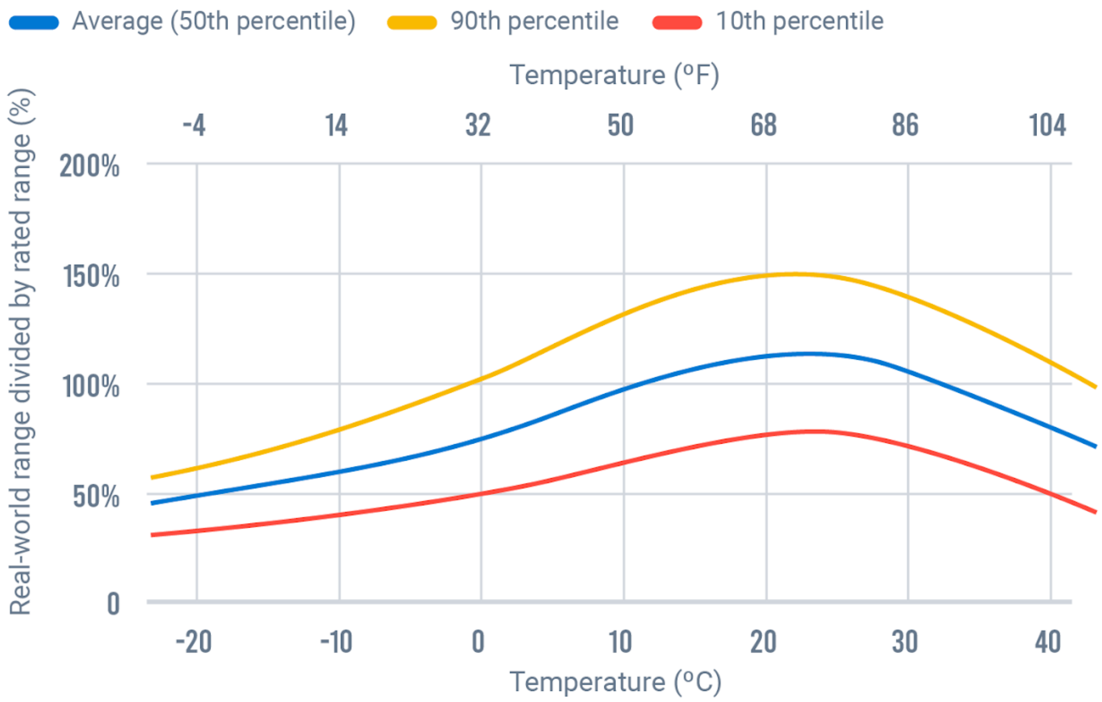


Figure 1: Temperature impact on EV range (passenger vehicles). The 10th, 50th and 90th percentiles show the distribution of trip efficiency observed, on aggregate. [2]

With this knowledge, not only can fleet managers plan their vehicle dispatch in winter accordingly, they can also take steps to reduce the impact of range loss by making some operational changes. For example, during extreme temperatures, vehicles can be preconditioned while still plugged in, allowing the vehicle and battery to start the trip at a comfortable temperature, saving energy for propulsion. Additional energy-saving tips to reduce the draw on the thermal management systems include: using the heated steering wheel and parking in the shade or covered parking area when possible.

## 2.2 Speed

The speed at which a vehicle travels, or more specifically, the drag it generates, will impact its efficiency. This fact applies to all vehicles regardless of powertrain. Drag is the force a vehicle needs to overcome to move through the air. The magnitude of drag will largely depend on the aerodynamics of the vehicle, and it changes with speed. Drag increases proportionally to the square of the speed, meaning if you double the speed, then the drag goes up by a factor of four.

Higher speeds result in additional energy being needed to move the vehicle, effectively reducing the real-world range of an EV. As seen below in Fig. 2, as speed increases, range decreases, and the impact is more acute for a light cargo van compared to a sedan.

Drag will also be influenced by the density and characteristics of the air itself, which changes with wind speed, altitude, temperature and humidity. These factors were assumed to be constant for the purpose of this analysis.

## 2.3 Combination of temperature and speed

To properly understand real-world range implications, temperature and speed cannot be looked at independently. Using de-identified, aggregated trip data, Geotab modeled the drag coefficient for a sample sedan and van to see the relative impact of speed at different temperatures on EV range [3].

The sedan was modeled by analyzing 350,000 trips from 500 electric cars of a single model and included more than 180,000 hours of driving. The light cargo van was modeled by analyzing 2.8 million trips from 2,000 electric vans, which included over 370,000 hours of driving. Both models were adjusted to represent a 65 kWh battery.

The analysis in Fig. 2 shows a tradeoff between the energy needed to overcome drag and the energy used to maintain a comfortable cabin temperature.

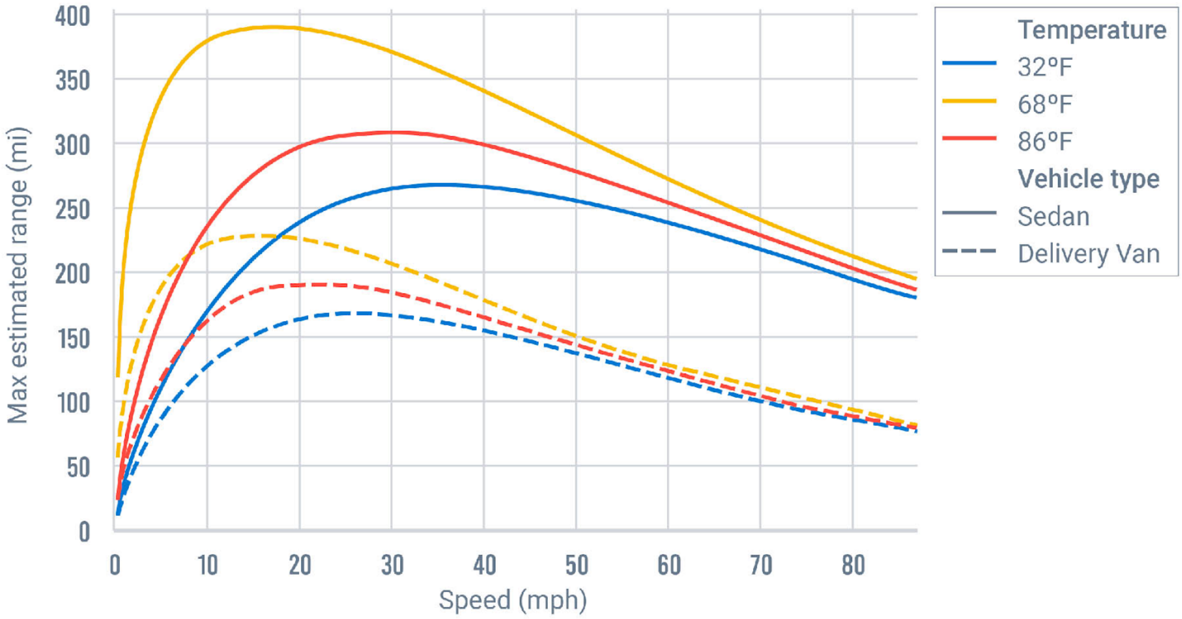


Figure 2: Maximum range for a representative 65 kWh sedan and delivery van at different speeds and temperatures.

In general, increasing the speed will allow you to reach your destination quicker, which results in less energy used by the HVAC system. But, the increased drag reduces the efficiency to the point that at a certain speed these savings are negated. This is especially true for the van, which is less aerodynamic than the sedan. In fact, the impact of temperature becomes almost negligible for vans at high speeds.

What can be taken away from this? For duty cycles consisting of mostly slower routes, seasonal variability may impact usable range and should be considered when deploying EVs. For larger vehicles, and applications where vehicles are mostly driving at higher speeds, range will be more consistent between seasons. However, to maximize range, drivers should be more mindful of sticking to the speed limit, as small increases in speed can have a noticeable impact on range.

## 2.4 Battery health

Underlying an EV's range potential is its battery capacity, which will degrade over time. In 2019, Geotab analyzed over 6,000 EVs, observing an average rate of 2.3% degradation per year [4]. A more recent analysis of newer generation EVs reveals an average observed degradation rate of 1.8% per year, with variability across vehicle models, as seen in Fig. 3.

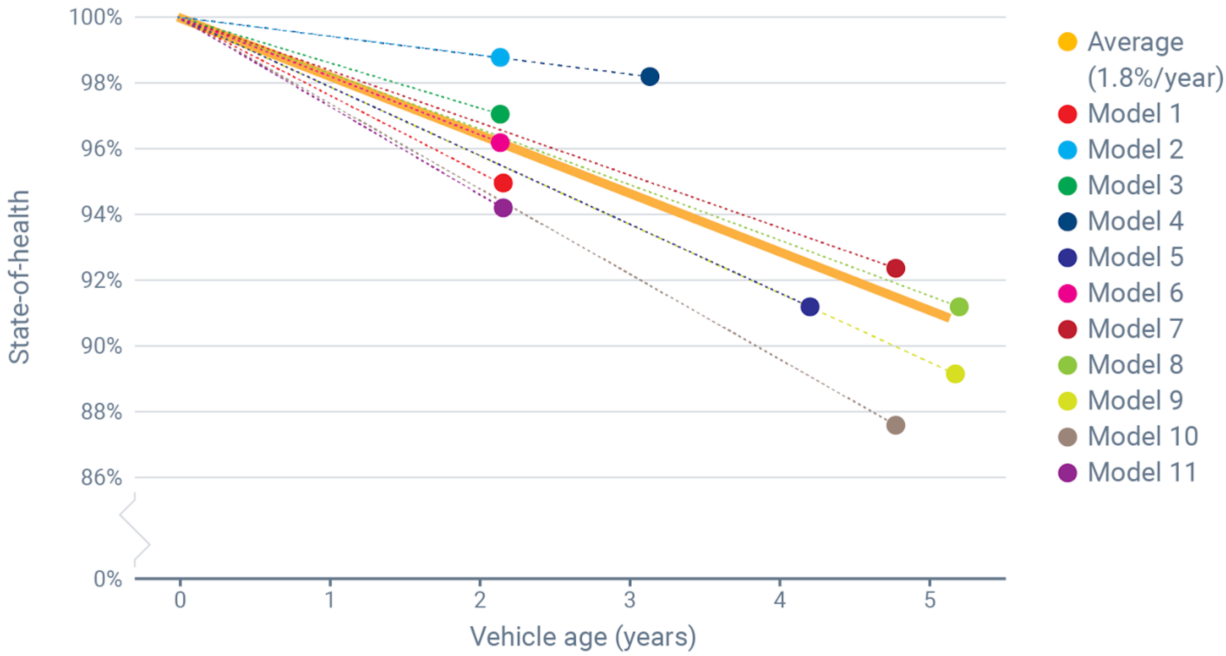


Figure 3: Average battery degradation observed by vehicle model (anonymized).

There are many factors that could influence how quickly battery capacity decreases over time, including climate, utilization, charging power, battery chemistry and thermal management technology, in addition to whether or not the vehicle manufacturer released or removed accessible battery capacity in over-the-air updates.

Interestingly, our analysis showed no observable impact on degradation rates when comparing high-use and low-use vehicles, when controlling for DC charging use. However, analyzing the same vehicle model exposed to different climates and charging power, we saw a strong correlation between those vehicles subjected to both higher temperature climates and frequency of high power charge usage. This is particularly evident with the vehicle referred to as Model 11, as seen in Fig. 4, which happens to have a much higher DC power capability than most models, charging at 120 kW on average.

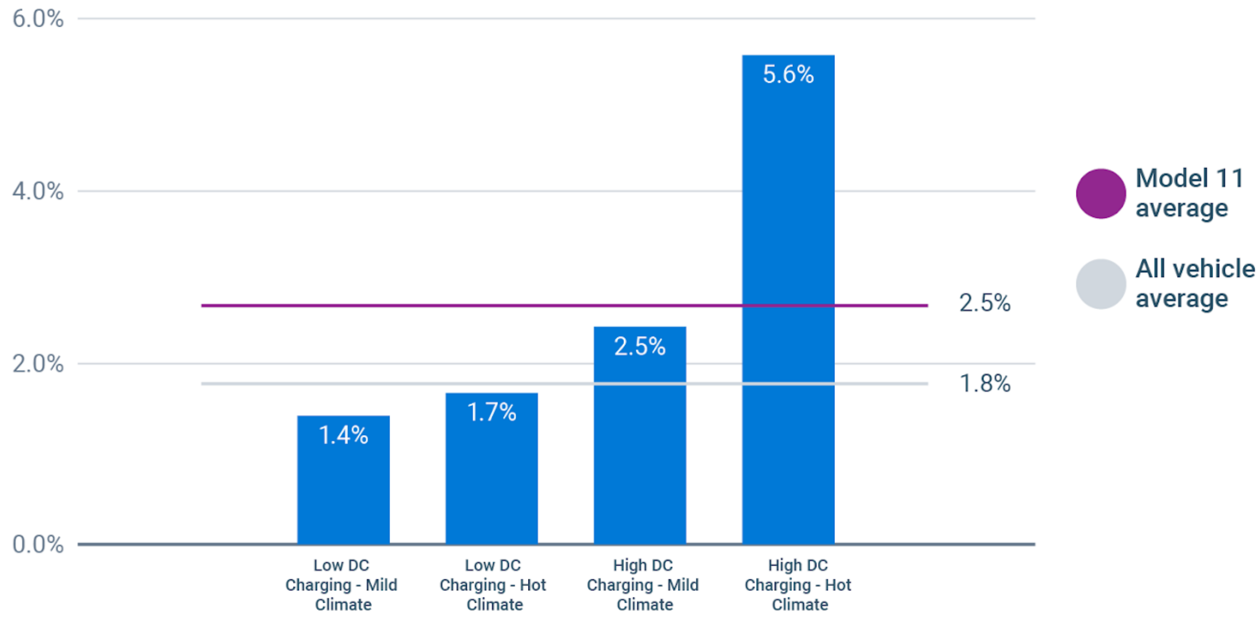


Figure 4: Degradation rates for an electric vehicle model (anonymized as "Model 11"), by different climates and use of DC fast charging. Mild climate includes regions with less than 25% of days above 25 degrees Celsius. Hot climate includes regions with more than 25% of days above 25 degrees Celsius. Low DC fast charge includes vehicles using DCFC less than 12% of the time. High DC fast charge includes vehicles using DCFC more than 12% of the time. Average DCFC charging power for this model is 120 kW.

# 3 Determining fleet EV suitability

Applying what has been learned from real-world EV performance, we can understand which vehicles can be confidently replaced by an EV. Geotab's EV Suitability Assessment (EVSA) tool takes into account the actual daily driving profile of fleet vehicles and simulates these routes with EV data to identify which could go electric and at what cost. Assessing de-identified, aggregated data from thousands of fleets, Geotab conducted two assessments to uncover these insights at a macro scale.

## 3.1 Macro suitability analysis of light-duty vehicles in Europe

To better understand the potential of fleet electrification in Europe, Geotab conducted a study that analyzed de-identified daily driving profiles of 46,000 light-duty fleet vehicles from across the continent over the course of one year (December 29, 2020 - December 31, 2021). [5] The countries included were: Albania, Austria, Belgium, Denmark, France, Germany, Italy, Luxembourg, Poland, Portugal, Romania, Slovenia, Spain, Switzerland, the Netherlands, the Republic of Ireland and the United Kingdom.

The results revealed that 86% of the observed vehicles could be replaced with a battery electric vehicle today and rely only on overnight charging at least 98% of the time. Furthermore, nearly 60% of fleet vehicles could be economically replaced with an EV, meaning they would have an equal or lower total cost of ownership when compared to a replacement internal combustion engine vehicle. These results assumed no incentives or rebates. When considering financial incentives, even a small amount can significantly increase the number of vehicles that could economically go electric. Fig. 5 shows that a €4,000 (~$4,200 USD) rebate would increase the economic viability by an additional six percentage points, while a €6,500 (~$6,900 USD) rebate would result in 68% of vehicles being economical to replace with an EV. Note: The capital cost of infrastructure was excluded from this analysis.

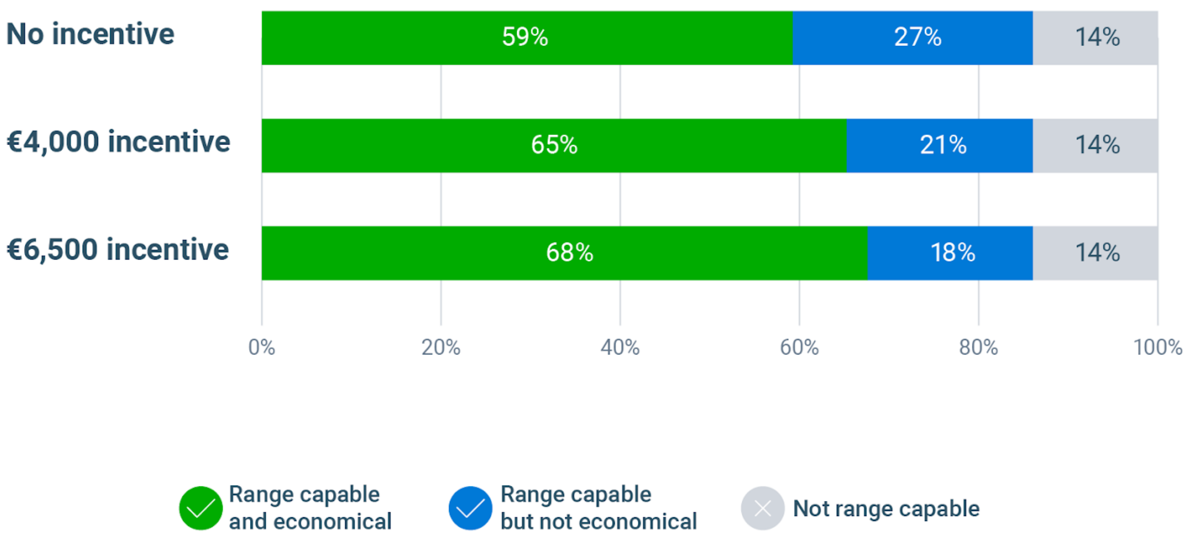


Figure 5: The change in the percentage of vehicles that could economically go electric when applying incentives for light-duty commercial vehicles in Europe.

To better understand the regional differences of fleet electrification, these results were also broken down by country. As seen in Fig. 6, EV suitability varies by country. This is a result of differences in usage as well as local fuel and vehicle prices.

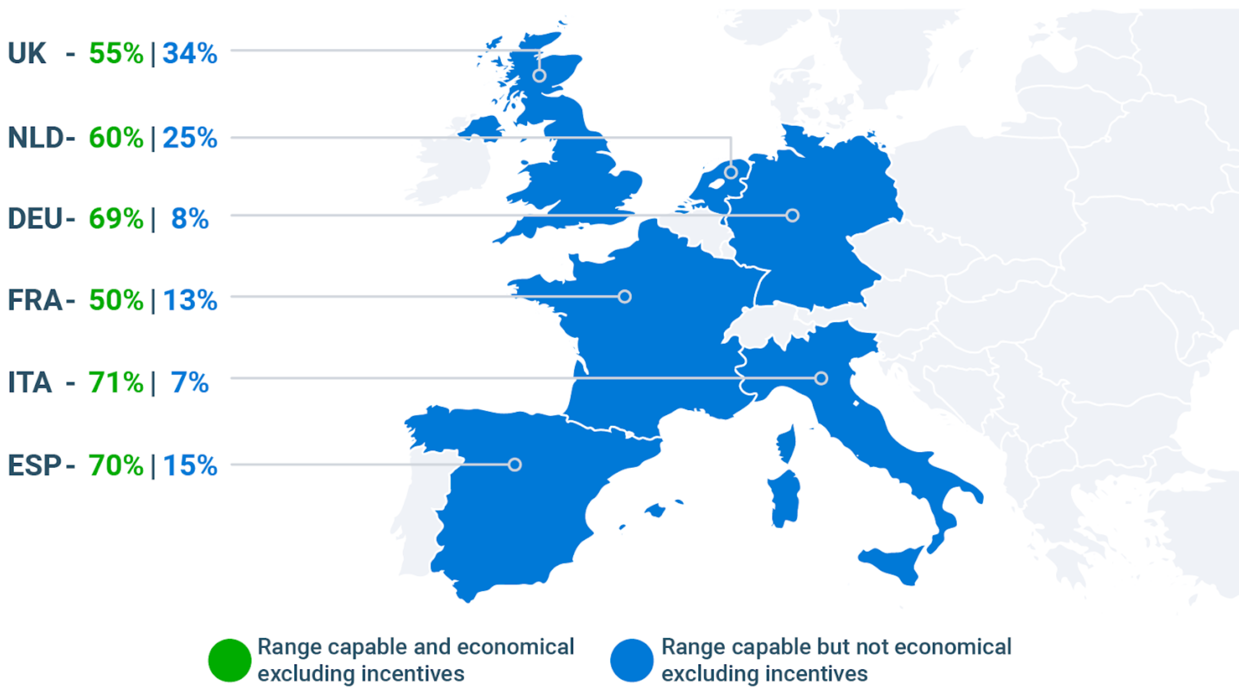


Figure 6: Portion of light-duty fleet vehicles observed in Europe that could be replaced by a range-capable EV.

The impact of rebates varies significantly between countries, with some requiring lower financial assistance to become economically viable. These differences can be observed in Fig. 7, which compares Germany and the UK. The study found that 69% of the vehicles in Germany were both range capable and economical without applying any incentives. If you included a €9,000 (~$9,500 USD) rebate, it would increase by four percentage points. Comparatively, the potential impact of a rebate is greater in the UK, where a smaller £2,500 (~$3,000 USD) rebate would increase the number of vehicles economically going electric by five percentage points.

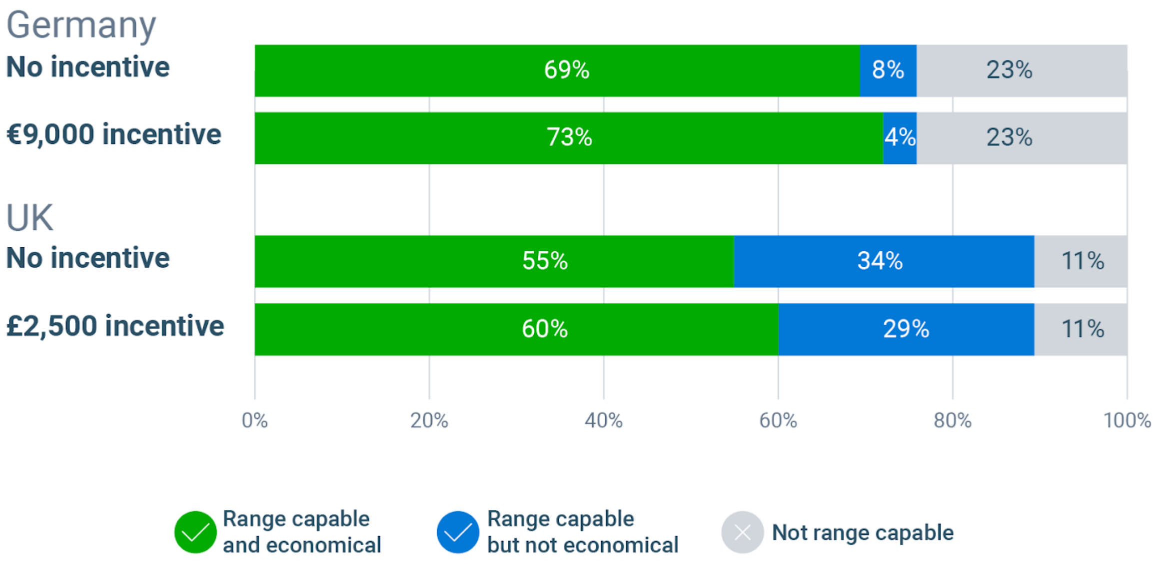


Figure 7: Portion of light-duty fleet vehicles observed in Europe that could be replaced by a range-capable EV.

Analyzing real-world commercial vehicle usage uncovers the significant potential for fleet electrification in Europe and the opportunity for savings.

## 3.2 Suitability of electric pickup trucks in Canada and the U.S.

In a similar study, Geotab looked at 12 months of daily driving data for nearly 405,000 light-duty trucks in fleets across Canada and the United States. We found that 76% of trucks drive within the EV range capabilities for at least 98% of the time over the course of the entire year [6]. In fact, 50% of the observed vehicles always drove under 188 miles in a day, which is well within the range capabilities of virtually every electric pickup truck. So while many assume fleet vehicles have categorically high utilization, this tells us that the majority of vehicles are driven well within the capabilities of EVs on the market today.

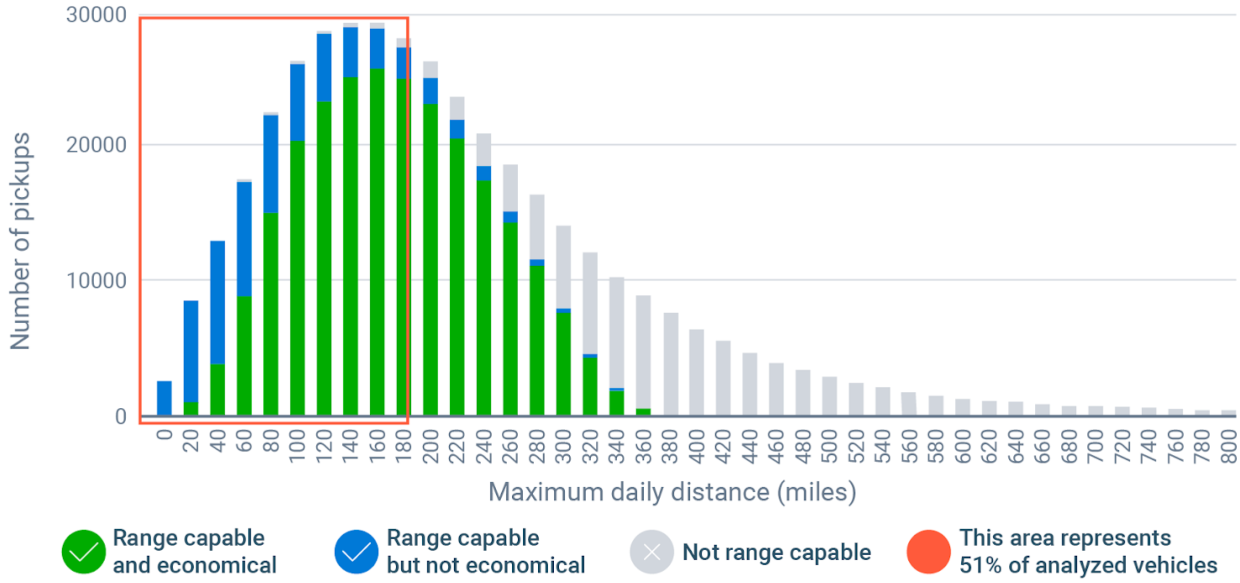


Figure 8: Distribution of maximum daily distance in a one-year period driven by Geotab-connected light-duty trucks in North America.

Another exciting finding from this study was the potential financial savings. When considering the total cost of ownership, 45% of the analyzed vehicles would save the fleet money if they were replaced by an electric pickup, even before any incentives. Fig. 9 highlights the significant impact financial incentives can have on making the transition to electric pickups economically viable. This calculation assumes overnight charging, and excludes the capital cost of charging infrastructure.

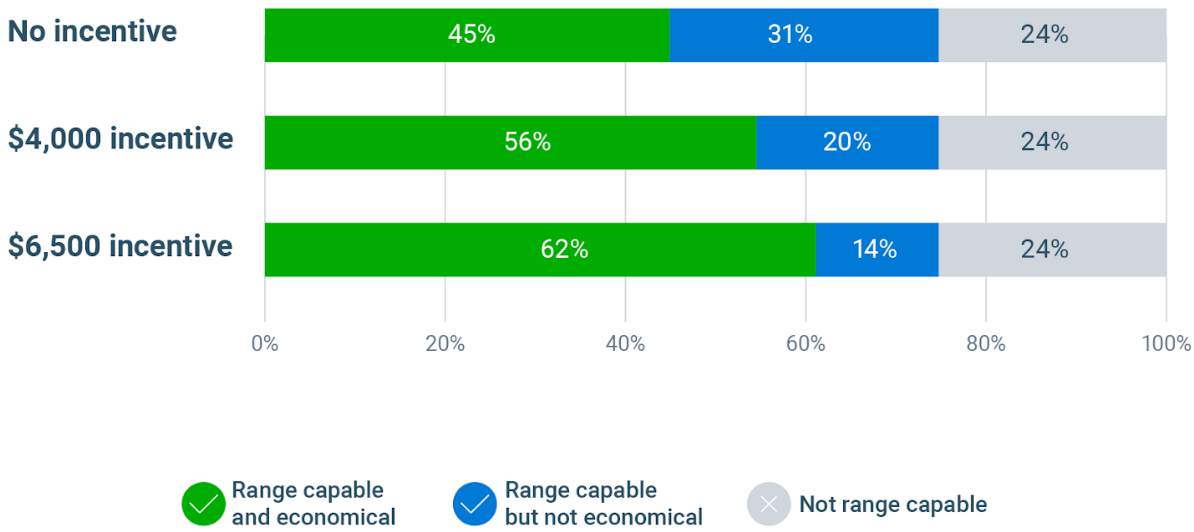


Figure 9: The impact of incentives on the total cost of ownership for electric pickup trucks in North America.

Given the immense popularity of pickup trucks in North America, transitioning these vehicles to electric models represents significant opportunities for fleets. Both for reducing overall tailpipe emissions and lower operating costs.

### 3.3 Medium- and heavy-duty electric potential

While deployments of medium- and heavy-duty electric vehicles are just taking off, leveraging aggregated telematics data can help inform how larger class vehicles are currently being used. Information about where and when they're stopped and for how long can help inform future infrastructure requirements and load impact as these vehicles transition to electric. Geotab has partnered on several projects to better understand the electrification potential and infrastructure needs for this sector.

*Charting the course for early truck electrification*, a study led by RMI, examined aggregated duty cycles of trucks domiciled in New York and California. Its purpose was to understand the electric potential for urban and regional-based vehicles. This project revealed that 65% of medium-duty and 49% of heavy-duty vehicles that reside in those states travel less than 300 miles between domicile visits, making them prime candidates for electrification. [7]

A second study with National Grid, in partnership with RMI, Calstart and Stable Auto, examined vehicle usage at highway plazas and truck stops to forecast future infrastructure and load demand. The study revealed that many sites would require twenty or more fast chargers, with some sites eventually requiring as much power as a small town. [8]

As these sectors continue to evolve, telematics data will be critical to help governments and organizations make informed decisions on future investments.

## 4 Applying to fleet-specific operations

With these lessons learned, organizations can begin to apply them at a fleet-specific level to understand their own unique challenges and opportunities better. For example, providing fleet operators with tools to monitor EV battery health and operating conditions allows them to take preventive or corrective action for vehicles exposed to known factors that can accelerate degradation. Furthermore, fleets can more confidently build out their EV adoption strategy with an EV suitability assessment that considers their specific operating requirements.

## 5 Conclusion

Aggregated telematics data not only builds confidence in EV performance but it also provides a greater understanding of where EVs are the best fit in today's fleet operations. When it comes to EV adoption, real-world data has highlighted that a large portion of analyzed fleets in North America and Europe can already go electric today and save money. Once EVs are deployed in a fleet, telematics can provide organizations with information and actionable fleet-specific insights that ensure they can get the most out of their EVs.

## Acknowledgments

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# Presenter Biography

Charlotte Argue is Senior Manager, Sustainable Mobility at Geotab, a global leader in fleet telematics. Charlotte's focus is on enabling fleets in reducing carbon emissions with data-driven solutions, and sharing aggregated insights to inform large-scale vehicle electrification strategies. Charlotte has been involved in electric transportation since 2009. Before joining Geotab she managed the Plug In BC initiative in British Columbia, delivering EV programs for fleets, charging infrastructure and public awareness. She currently sits on the board of NACFE (North American Council for Freight Efficiency) and is BC Chapter Chair for Women of EVs.