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Real-world use cases for zero-emission trucks

HEAVY TRACTOR-TRAILERS FOR GOODS TRANSPORT IN THE EUROPEAN UNION

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ABOUT THE EUROPEAN CLEAN TRUCKING ALLIANCE

ECTA brings together more than 40 European players in the road transport of goods such as leading businesses, organizations and civil society associations that share a strong commitment to accelerate the EU's transition to zero-emissions trucks. They call for clear roadmaps and binding targets to decarbonize urban logistics and long-haul freight by 2050. ECTA business members include major hauliers, logistics, and consumer goods companies in Europe and beyond. ECTA also counts some of the civil society organizations and associations with the strongest network of members and experience in transport and mobility at the European level. For more information, please visit the ECTA website: www.clean-trucking.eu.

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EXECUTIVE SUMMARY

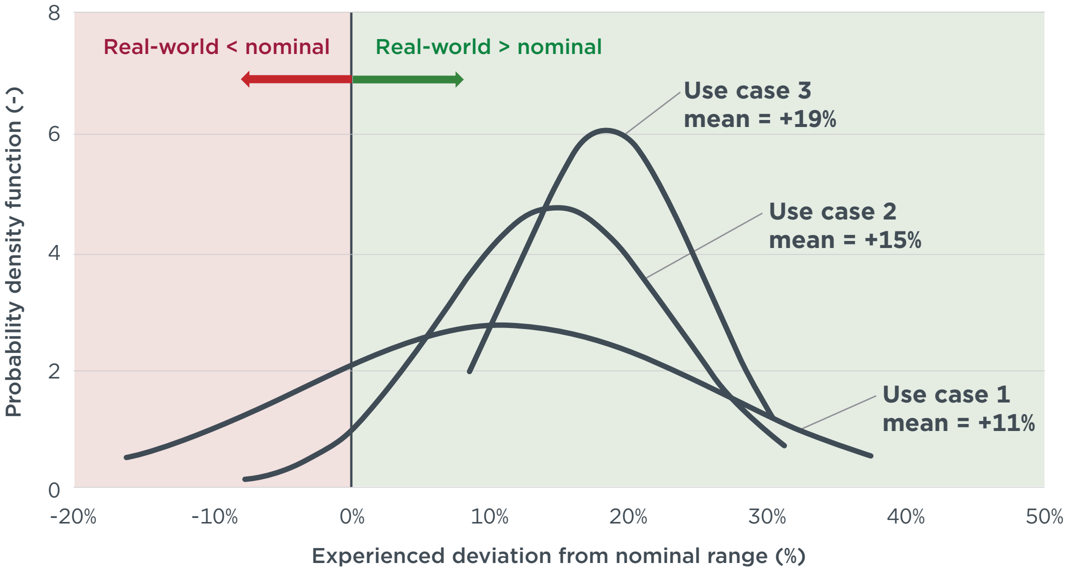
In 2024, one in ten new trucks under 12 tonnes sold in Europe was zero-emission. In the heavy-duty segment, however, zero-emission trucks (ZETs) were only 1% of the market. While electric urban delivery trucks are increasingly used in mainstream operations for last mile distribution, heavy electric trucks for regional distribution and long-haul transport across Europe are still mostly in the pilot phase. There is, therefore, little information about the real-world operation of those vehicles.

This report analyzes the real-world performance and costs of 91 electric tractor-trailer trucks deployed by participating fleets in the European Clean Trucking Alliance (ECTA). We focus on heavy tractor-trailer trucks with a gross vehicle weight above 30 tonnes used for the regional delivery of goods across three use cases—multimodal transport, quasi-shuttle delivery, and multi-destination distribution. Vehicles have similar technical specifications across use cases, with an average battery size of 530 kWh.

We find significant variations in the energy consumption of electric tractor-trailer trucks, both across use cases and within each use case, despite similar vehicle technical specifications. Energy consumption ranged from 92 to 150 kWh/km and was on average 65% lower than the consumption of equivalent diesel trucks. Real-world ranges experienced by participating fleets averaged 11%–19% higher than the nominal values advertised by original equipment manufacturers (OEMs), providing additional operational flexibility. Figure ES1 shows the experienced deviation from the advertised nominal range.

Figure ES1

Normal distribution of the experienced deviation from the nominal range as advertised by OEMs



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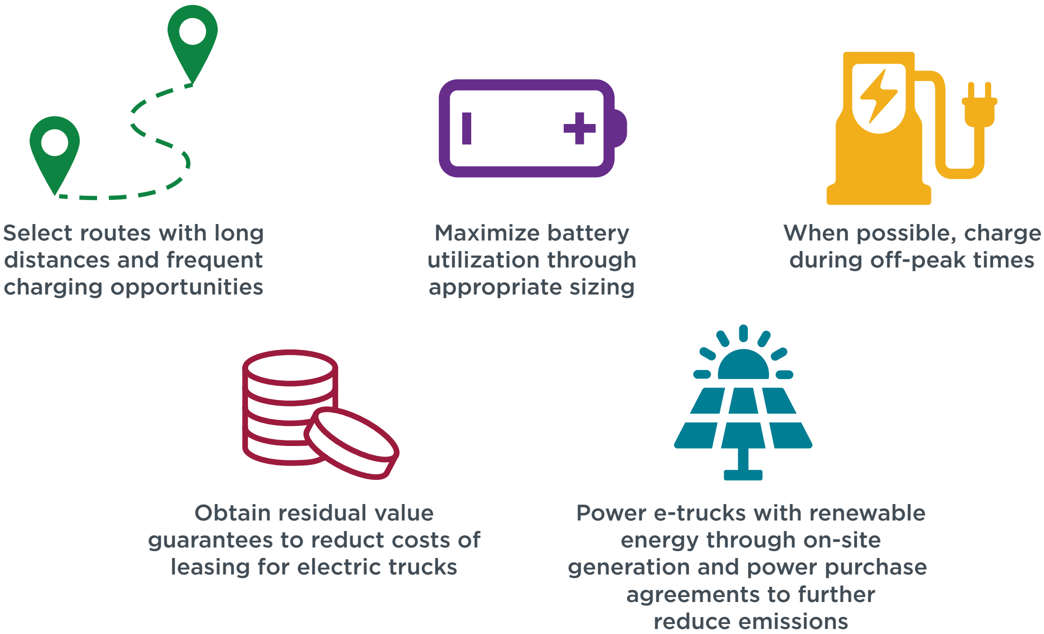
The trucks analyzed in this report tended to have oversized batteries, with an average depth of discharge across all vehicles of 44%, as fleets tend to size batteries for the most demanding day of operation. This underutilization negatively impacted total cost of ownership (TCO) parity with equivalent diesel trucks due to the high battery costs. To fully realize the economic potential of electric tractor-trailer trucks, the vehicles are best suited for use cases with high daily driving distances, provided there is route predictability and frequent charging opportunities. Charging strategies should enable high depths of discharge to maximize battery utilization, and fleets should aim to access low energy prices from local utilities, for example through off-peak tariffs. Residual value guarantees can reduce the cost of leasing, increasing the economic viability of this business model, which reduces requirements for upfront capital investments. Finally, integrating on-site renewable energy generation into depot charging can benefit both the economic and environmental performance of electric truck fleets. Figure ES2 summarizes key lessons learned and best practices extracted from this use case study.

Figure ES2

Lessons learned and best practices to optimize the real-world performance of zero-emission tractor-trailer trucks



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This analysis supports five conclusions and recommendations policymakers could consider to promote a positive business case for additional truck applications.

1. **Support the acceleration and diversification of vehicle supply.** Strong supply-side policies like the existing European CO_2 standards for heavy-duty vehicles can accelerate the diversification of product offer and promote the availability of affordable electric trucks tailored to specific use cases. In addition, demand aggregation platforms could help create a strong market signal for OEMs, hence reducing the long lead times for delivery sometimes experienced and enabling access to more competitive retail prices. Promoting increased price transparency could also support fleets in the procurement process and help ensure that competition drives down the costs of zero-emission heavy-duty vehicles.
2. **Facilitate access to affordable, decarbonized electricity.** The Affordable Energy Action Plan recently published by the European Commission puts forward measures to support fleet electrification by simplifying and expediting procedures for grid connections, lowering energy prices, and increasing the share of renewables in the European Union's electricity mix. Timely implementation of this action plan would facilitate the deployment of depot charging infrastructure. Time-of-use tariffs could also incentivize depot charging during off-peak times, such as overnight, for peak load mitigation while improving fleet TCO. Fast implementation of the European Clean Transport Corridor initiative would also expand public charging along key freight corridors.

3. **Waive road tolls for electric trucks to improve TCO.** Implementation of the Eurovignette Directive in all Member States could further reduce TCO by lowering or eliminating toll fees for electric trucks. Data analyzed in this report show that tolls can account for up to 7% of TCO.
4. **Provide risk-sharing financial instruments to support truck financing.** Risk-sharing instruments such as residual value guarantees and credit risk guarantees could attract private investment in zero-emission heavy-duty vehicles and support business models such as leasing. These guarantees can provide a more resource-efficient alternative to traditional purchase subsidy programs.
5. **Focus requirements and incentives for corporate fleets on the use cases most suited for accelerated electrification.** Use cases that enable high battery utilization and access to low energy prices are more likely to achieve TCO parity with diesel. In addition, the fleets that participated in this study indicated that customer willingness is a crucial factor for enabling electric truck deployment on selected routes. As the European Commission is working on a legislative proposal to support the decarbonization of corporate fleets, a comprehensive framework identifying the best use cases for accelerated electrification could ensure the legislation benefits both carriers and shippers.

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INTRODUCTION

The market for zero-emission trucks (ZETs) in the European Union (EU) is growing, driven by supply-side regulations such as CO_2 emission standards for heavy-duty vehicles (HDVs) and the Alternative Fuels Infrastructure Regulation (AFIR), and a desire from transport operators and shippers to decarbonize their operations. In 2024, one in ten new trucks with a weight below 12 tonnes sold was zero-emission. In the heavy truck segment, however, ZETs were only 1.2% of the market (Mulholland & Ragon, 2025).

While electric urban delivery trucks are increasingly used in mainstream operations for last mile delivery, heavy electric trucks for regional distribution and long-haul transport are still mostly in the pilot phase. As a result, there is still little information on how those vehicles perform in real-world operation. Depending on the use case (e.g., the types of goods transported, payload, and distance) and charging strategies, key vehicle performance indicators such as operational range, energy consumption, and total cost of ownership (TCO) can vary greatly. Such evidence is crucial to understand the potential and limitations of the current ZET market to meet the needs of European goods transport fleets, identify best practices for the integration of ZETs into mainstream transport operations, increase and diversify the vehicle offer to the tailored needs of specific fleets, and identify areas where additional policy support could accelerate the adoption of those vehicles.

This report analyzes the real-world performance and costs of 91 electric tractor-trailer trucks deployed by members of the European Clean Trucking Alliance (ECTA). We focus on heavy tractor-trailer trucks with a gross vehicle weight above 30 tonnes used for the regional delivery of goods. Study participants shared truck and charger operational data from vehicle telematics and charger software. They also shared additional data on vehicle, energy, and other operational costs, as well as lessons learned and best practices. Data cover different use cases, providing insight into ZET performance under a range of operating conditions.

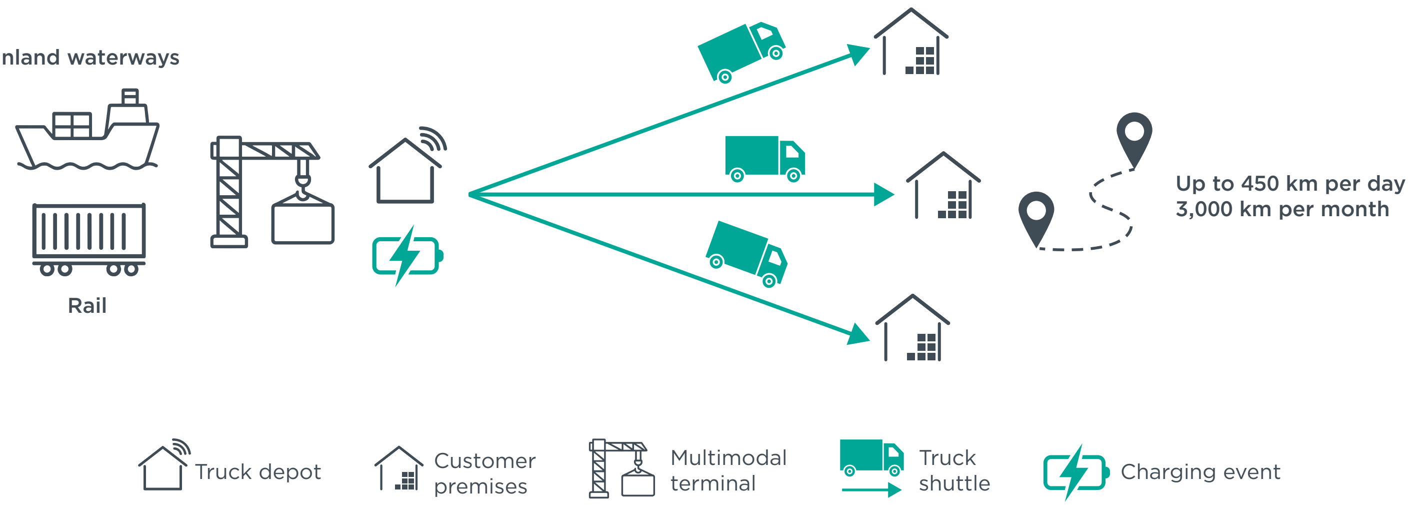
We start by reviewing the different use cases covered in the report. We then assess how the vehicles perform across use cases and with variations in operating conditions within a single use case. We then summarize lessons learned and best practices identified from the experiences of the companies that participated in this report. Finally, we provide policy recommendations related to the adoption of ZETs by EU fleets.

USE CASES

USE CASE 1: MULTIMODAL TRANSPORT

In this use case, trucks are used in multimodal freight, where road transport is combined with rail and in-land waterway transport. Trucks shuttle between multimodal transport hubs and customer sites. They operate several daily trips, amounting to up to 450 km per day. However, the average distance traveled by vehicles is much lower—about 3,000 km per month, or 100 km per day. Vehicles typically operate between 8 and 12 hours daily, leaving up to 12 hours of dwell time available for charging, and carry payloads between 3 and 25 tonnes. Figure 1 summarizes the use case. Routes are chosen for progressive electrification based on customer needs to decarbonize their transport operations.

Figure 1
Use case 1: Multimodal transport



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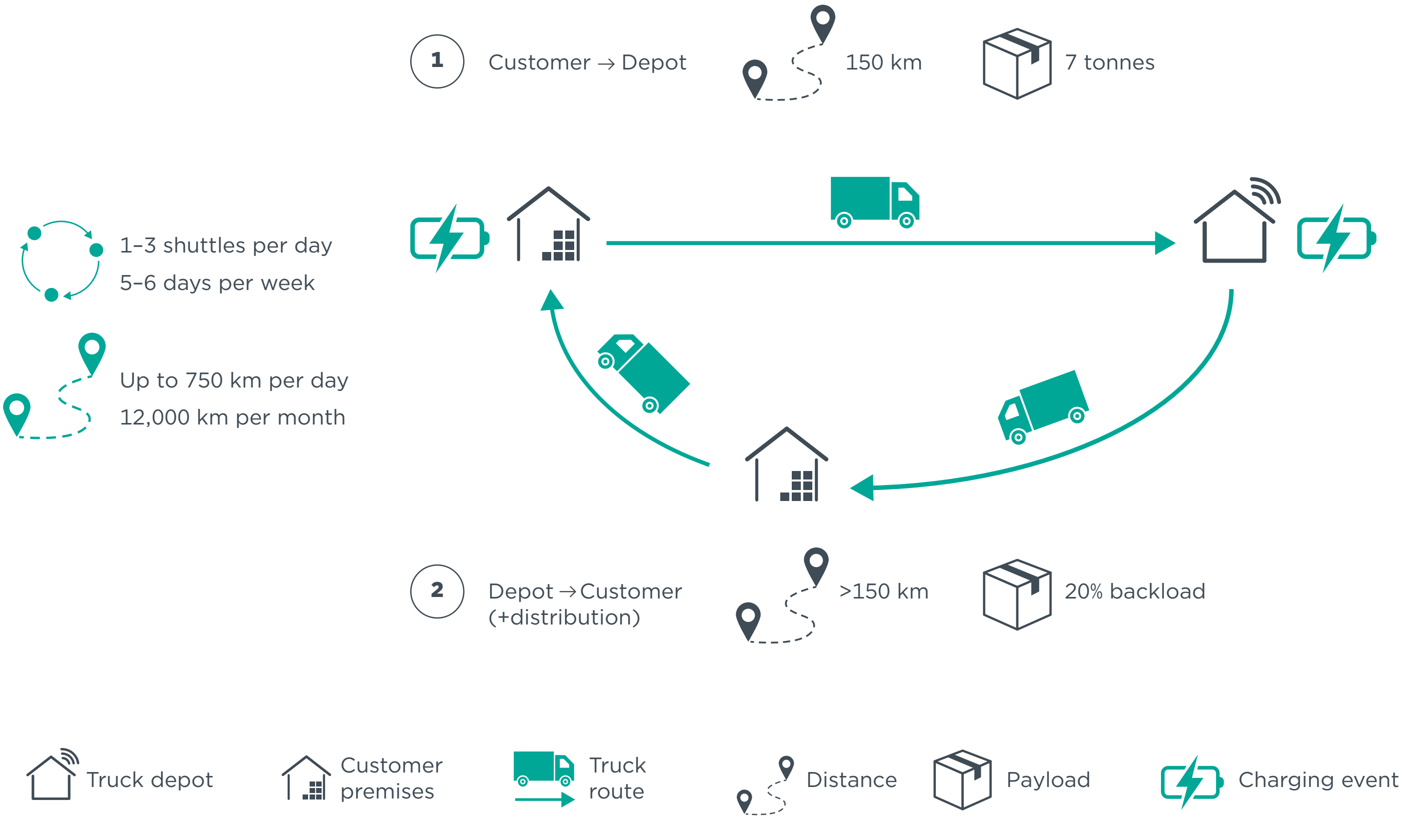
Charging infrastructure is installed at the multimodal hubs where truck depots are located. To avoid potentially costly and time-consuming upgrades to local distribution networks, the electrical load from truck charging is integrated into existing electricity consumption for other uses in a way that does not increase peak power demand at company locations. On-site stationary battery storage systems distribute truck charging loads throughout the day. When the load from other uses is low, additional power is drawn from the grid and stored in the stationary batteries for future use. This buffer can then be used to charge trucks throughout the day. When trucks require charging during times of peak consumption, they draw power from the stationary batteries. When trucks require charging at off-peak times, they draw power directly from the grid.

USE CASE 2: QUASI-SHUTTLE DISTRIBUTION

In this use case, trucks operate a quasi-shuttle service between the customer's factory, where a typical load of 7 tonnes is picked up, and the company's warehouse, which serves as a logistic hub for regional and international distribution. On return to the customer's factory, trucks leave the warehouse with a 20% backload and operate local distribution to avoid empty runs, leading to variations from the 150-kilometer route. Trucks perform between one and three round trips per day shared between two drivers, amounting to up to 10.5 hours of driving and 750 km per day. This leaves at least 13.5 hours available for charging. Trucks operate 5–6 days a week, amounting to an average 12,000 km per month, which makes this a high mileage use case. Figure 2 summarizes this quasi-shuttle distribution use case.

Figure 2
Use case 2: Quasi-shuttle distribution



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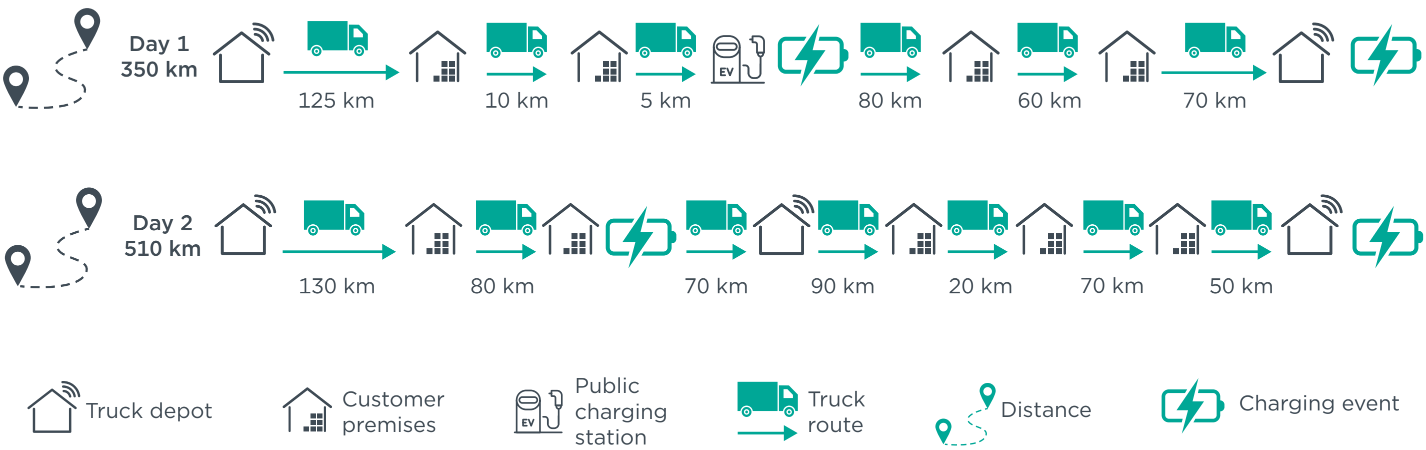
Routes are chosen for electrification based on customer needs and feasibility. This use case offers low payloads, high predictability, and frequent charging opportunities, which ensures trucks will not face electric range issues. Vehicles are charged every time they arrive on either side of the quasi-shuttle route (depot or factory), independent of the battery's state-of-charge (SOC). This strategy is known as opportunity charging.

USE CASE 3: MULTI-DESTINATION DISTRIBUTION

In this use case, electric trucks are used for distribution to multiple customers in the region around the truck depot. Vehicles drive up to 500 km per day, and an average of 6,000 km per month. Unlike the other two, this use case offers less predictability due to the nature of the distribution operations, which change every day. Figure 3 shows the driving and charging patterns for 2 days of operation, one representing an average daily driven distance of 350 km, and the other representing a high utilization day with a daily driven distance of 510 km. Vehicles operate 17 days per month on average, with high variability throughout the year.

Figure 3
Use case 3: Multi-destination distribution



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Due to the multi-destination nature of operations, vehicles in this use case have less frequent opportunities for charging at their depot. To fully recharge the battery and complete daily operations, the trucks occasionally charge either at the customer's premises or at public charging stations.

VEHICLE TECHNICAL SPECIFICATIONS

Despite the diversity of use cases, the trucks in this report have similar technical specifications. All trucks are tractor-trailers with a weight above 16 tonnes and a 4x2 axle configuration, meaning they fall in VECTO group 5, the most common vehicle group in Europe.[1] Most vehicles have a nominal driving range under 350 km, meaning they fall under the regional delivery regulatory subgroup (5-RD). Some of the newest trucks have a range of 500 km, making them long-haul trucks under the same regulatory framework (5-LH). Figure 4 shows the technical specifications of the 91 electric trucks and the number of original equipment manufacturers (OEMs) in each use case.

1 The Vehicle Energy Consumption calculation TOol (VECTO) is the vehicle simulation tool used for CO_2 certification in Europe.

Figure 4

Technical specifications of the electric tractor-trailer trucks in each use case

Use case 1: Multimodal transport
Model years: 2019–2025
# of OEMs: 4
GCVW: 30–44 tonnes
Battery size: 144–738 kWh
Range(1): 100–500 km
Time to full charge(2): 1.1–1.6 h

Use case 2: Quasi-shuttle distribution
Model years: 2024
# of OEMs: 1
GCVW: 40 tonnes
Battery size: 540 kWh
Range(1): 300 km
Time to full charge(2): 1.5 h

Use case 3: Multi-destination distribution
Model years: 2023
# of OEMs: 1
GCVW: 42 tonnes
Battery size: 540 kWh
Range(1): 300 km
Time to full charge(2): 1.5 h

(1) Nominal driving range specified by OEM.
(2) Minimum time to fully charge the battery based on the vehicle maximum charging speed and assuming 30% battery reserves in line with OEM specifications.
Note: GCVW = Gross combined vehicle weight

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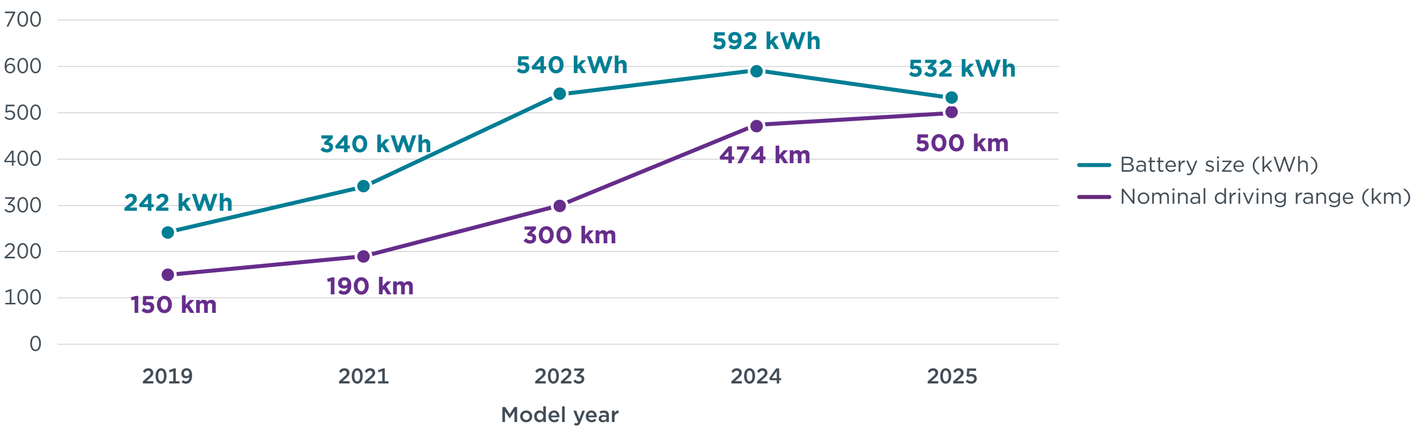
Battery sizes range from 144 to 718 kWh, with an average of 530 kWh for use case 1 and 540 kWh for use cases 2 and 3. Over the years, fleets have been able to purchase vehicles with progressively larger battery sizes, providing higher driving ranges and increasing the potential of electric trucks to replace diesel vehicles in mainstream operations. In parallel, improvements in vehicle energy efficiency have been achieved, mainly through improved aerodynamics, allowing fleets to achieve longer driving ranges with a given battery size. While the average battery size decreased from 592 kWh in 2024 to 532 kWh in 2025, the average nominal driving range increased from 474 to 500 km over the same time frame. To avoid excessive stress on batteries while charging and preserve their state of health, OEMs impose 30% SOC reserves on average, meaning only 70% of nominal battery storage capacity can be used by the fleets. Figure 5 shows the evolution of average battery size and nominal driving range from 2019 to 2025 for the vehicles in this report.

Figure 5

Battery size and nominal driving range (as specified by OEMs) of analyzed electric trucks by model year



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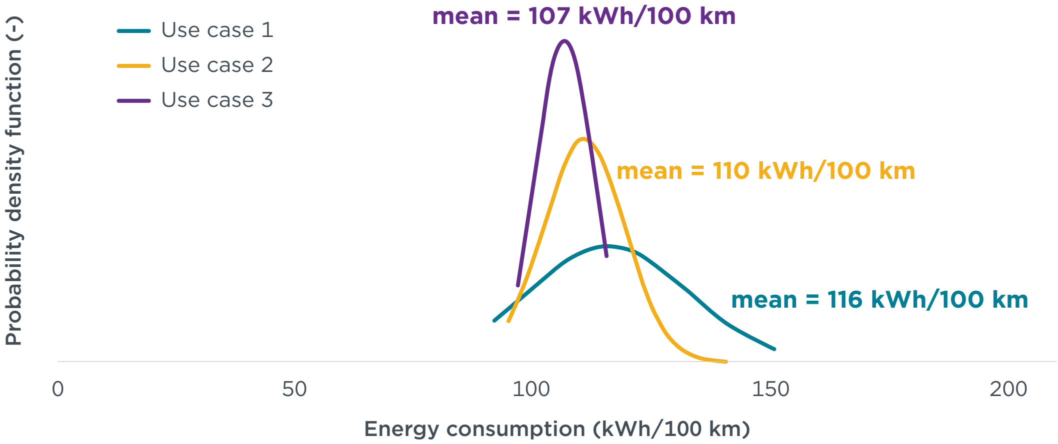
In the meantime, the maximum power at which electric trucks can charge has also increased, requiring less time to fully charge batteries. That has enabled the deployment of vehicles with larger batteries while minimizing operational delays. The first models (in model year 2019) had a maximum charging speed of 150 kW; it took 68 minutes to fully charge a truck with the average 240 kWh battery, assuming 30% SOC reserves. In 2025, the maximum charging speed for the vehicles covered in this report was 400 kW; it took less time (56 minutes) to fully charge a battery that was about twice as large (i.e., with the 2025 average 500 kWh battery).

REAL-WORLD ENERGY CONSUMPTION

We analyzed real-world energy consumption data from a subset of the vehicles in this report for which it was available. Data were extracted directly from vehicle telematics software by the participating fleets. The granularity of available data varies across use cases. For use case 1, we obtained daily average values for a period of 7 months for 30 trucks, as well as weekly values for a period of 2 months for an additional 20 trucks. For use case 2, we obtained daily average values for a period of 9 months for a single vehicle. For use case 3, we obtained monthly average data for a period of 14 months, as well as daily average data for a period of 1 month, all for a single vehicle.

Despite using similar trucks, the three use cases have different average energy consumption values and different variations in energy consumption. The mean energy consumption was 116 kWh/100 km for use case 1, 110 kWh/100 km for use case 2, and 107 kWh/100 km for use case 3. While the minimum assessed energy consumption was similar across all (92–97 kWh/100 km), the maximum varied from 115 kWh/100 km for use case 3 to 150 kWh/100 km for use case 1. Differences are mostly explained by the nature of the use cases, with payload having the largest impact on calculated energy consumption by increasing the combined vehicle weight. However, we did not obtain detailed payload information from the fleets. Figure 6 shows the real-world energy consumption for each of the use cases fitted with a normal distribution.

Figure 6
Normal distribution fitting of the real-world energy consumption for each use case



Note: The fitted curves are truncated at the lowest and highest energy consumption values for each use case.

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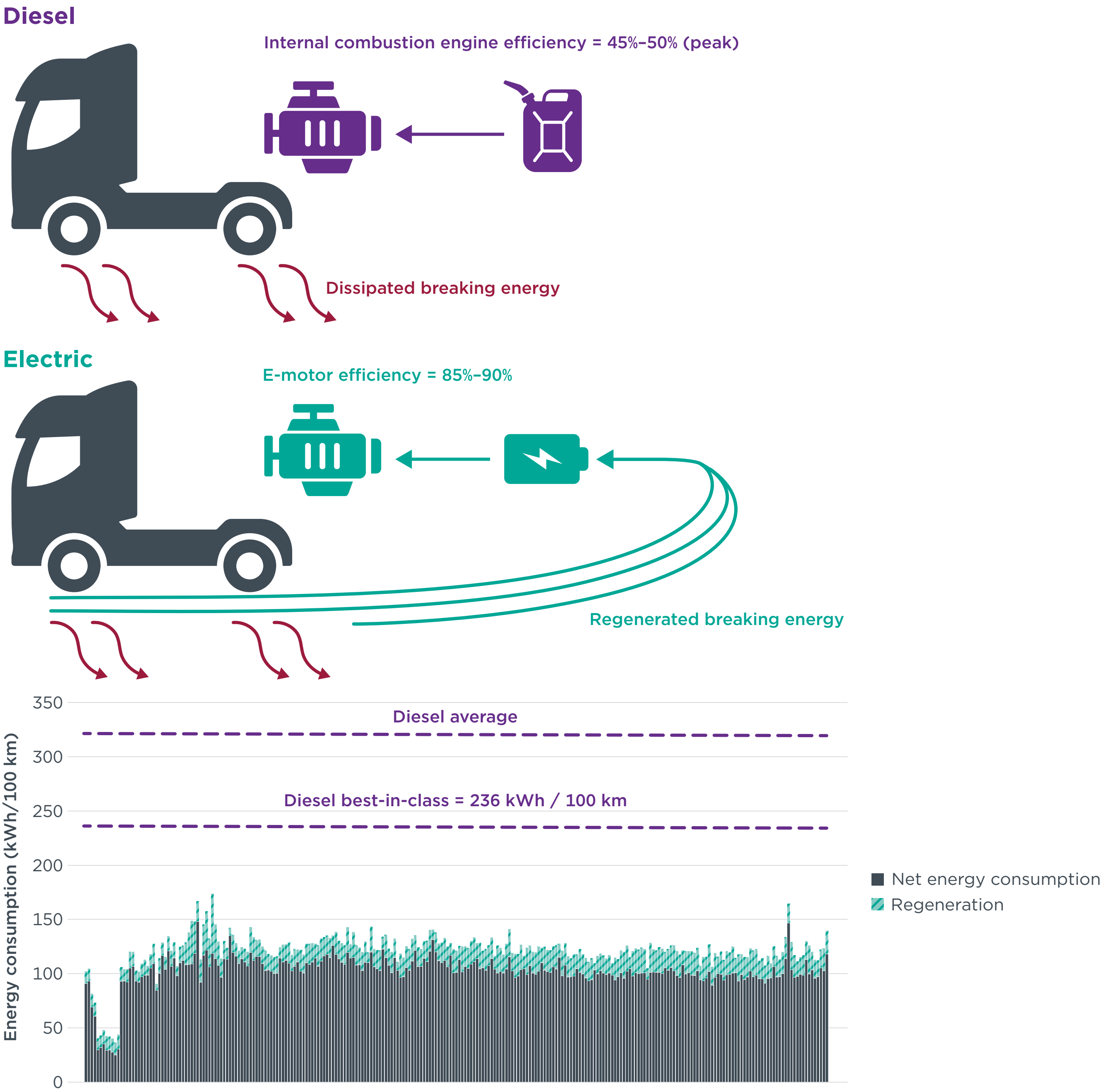
We also provide a benchmark for the energy consumption of a 4x2 diesel tractor-trailer in VECTO group 5 based on European Energy Agency certification data, as well as the energy consumption of a best-in-class diesel tractor-trailer with a gross vehicle weight of 40 tonnes, based on real-world fuel consumption testing (European Environment

Agency, 2024; VerkehrsRundschau, 2024). Across all use cases, electric trucks in this analysis consumed on average 65% less energy than an average-performing diesel equivalent and 53% less energy than a best-in-class diesel truck.

The use of regenerative braking can reduce net energy consumption in electric trucks. For the vehicles in this analysis, telematics software calculated that regenerated braking energy amounted to an average 19% and up to 32% of gross energy consumption (i.e., propulsion energy at the wheels) across all use cases; this represents significant energy savings, as shown in Figure 7. In diesel trucks, all braking energy is dissipated, resulting in higher energy consumption. The remaining gap with diesel trucks is explained by higher powertrain efficiency, which is typically around 85%–90% for electric motors compared with 45%–50% peak efficiency for internal combustion engines.

Figure 7

Comparison of energy consumption of electric trucks with regenerative breaking and diesel trucks



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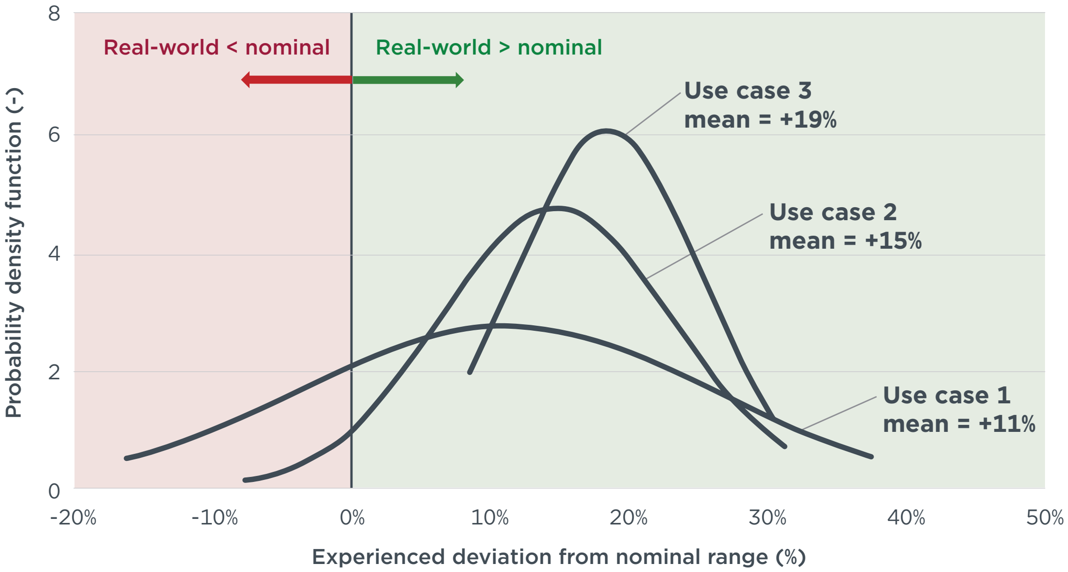
REAL-WORLD DRIVING RANGES

In most cases, the electric trucks in this analysis showed real-world driving ranges higher than advertised by OEMs. Based on battery size and the energy consumption data presented above, we calculated the real-world driving ranges experienced by fleets and compared them with the nominal ranges advertised by OEMs, which is 300 km for all the vehicles for which energy consumption is available. We assumed battery SOC reserves of 30% to calculate experienced driving ranges, in line with OEM specifications. Figure 8 shows the variation in experienced driving range compared with the nominal driving for each of the three use cases.

Figure 8

Normal distribution of the experienced deviation from the nominal range as advertised by OEMs



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Vehicles experienced driving ranges that were on average 11% higher than advertised for use case 1 (multimodal transport), 15% higher for use case 2 (quasi-shuttle distribution), and 19% higher for use case 3 (multi-destination distribution). There is no clear correlation between the predictability of a use case and the experienced driving range. While use case 3 is the least predictable because of the daily change in operations, it also has the highest driving range in average. Payload is expected to have the greatest impact on range, although payload data were not available to verify this.

CHARGING STRATEGIES

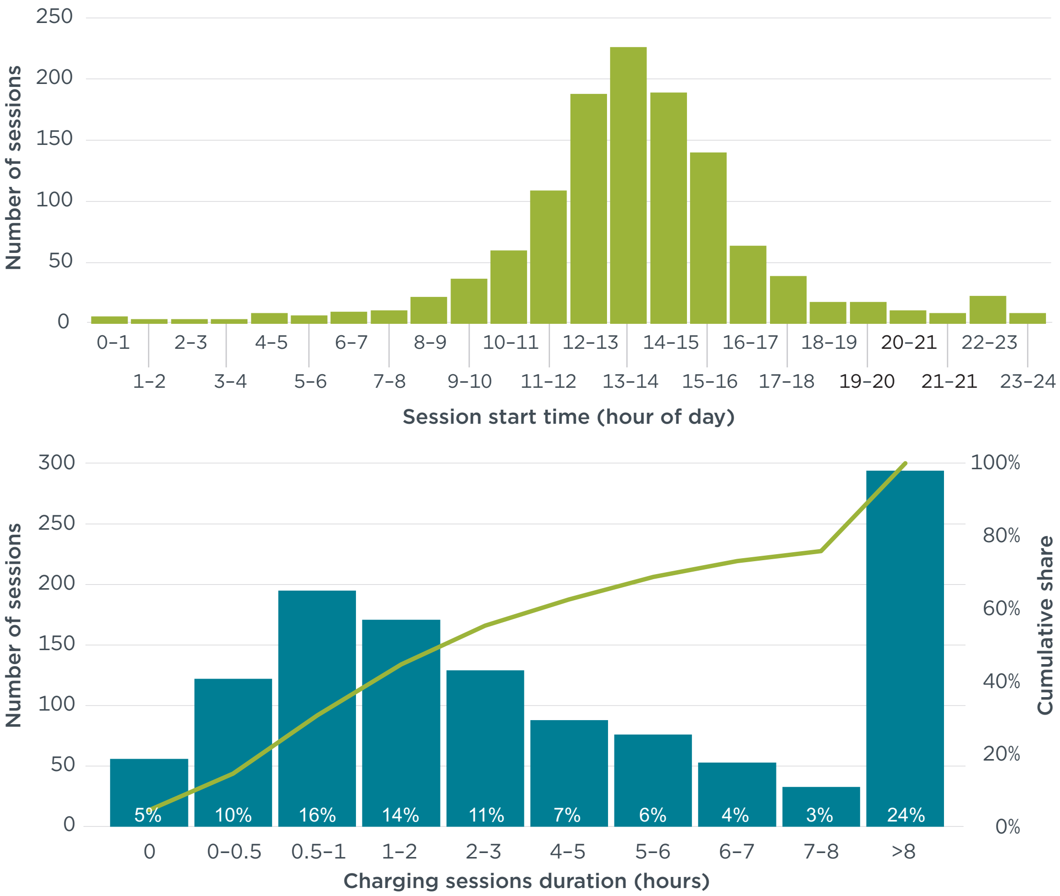
Integrating charging into truck operations is a challenge to electrification faced by fleets. It requires careful planning to address operational constraints and often entails additional investments in depot charging infrastructure. On the other hand, an effective charging strategy can help optimize battery utilization and lower electricity costs, hence optimizing the economic and environmental performance of electric trucks. Depot charging is the preferred option in all use cases, as it presents the highest potential for low charging costs through pre-negotiated energy prices and managed charging. Operational constraints do not always allow full charging at depots and sometimes vehicle ranges do not cover a full delivery cycle, requiring "top-ups" during the day. Those top-ups can occur at the depot (typically in the case of a shuttle with frequent depot returns), at a customer's premises, or at a public charging station.

We analyzed data obtained directly from charger software of more than 1,200 charging sessions from depot chargers operated across various locations in use case 1. Electric trucks can charge at the depot with either three-phase AC power up to 43 kW (the maximum achievable with AC power), or with DC power up to 350 kW (the maximum achievable with the CCS2 charging standard for Europe). Across both AC and DC chargers in this study, the average charging power is 43 kW. While this is well below the maximum charging capacity of vehicles, low-power charging is usually cheaper than higher-power DC charging due to lower equipment costs, grid connection costs, and electricity rates since those are partly based on power output (Nicholas, 2019). In use cases 1 and 3, fleets used a mix of AC and DC charging. Trucks in use case 2 charged exclusively with DC power, both at depots and customers' premises. Across all cases, chargers had an average efficiency (i.e., the ratio of energy delivered to vehicles to energy drawn from the grid) of 95%.

Figure 9 shows the distribution of charging sessions' start time and duration. Fleets in use case 1 tend to opt for longer charging sessions in the middle of the day; 80% of charging sessions start between 10 am and 5 pm and 50% start between 12 pm and 3 pm. This corresponds to when vehicles return from morning delivery rounds. Overnight charging sessions (started between 8 pm and 8 am), only represent 9% of all sessions. In addition, 24% of all charging sessions last more than 8 hours, indicating that trucks can dwell at the depot. For the durations of the remainder of sessions, 45% lasted less than 3 hours. The data show that the fleets assessed are adopting a strategy to charge vehicles whenever possible, plugging them in as soon as they arrive at depots regardless of their current SOC. Since battery storage is used in use case 1 to smooth out the power drawn from the grid, charging in the middle of the day is not expected to result in high demand charges.

Figure 9

Distribution of charging start times (top) and duration (bottom)



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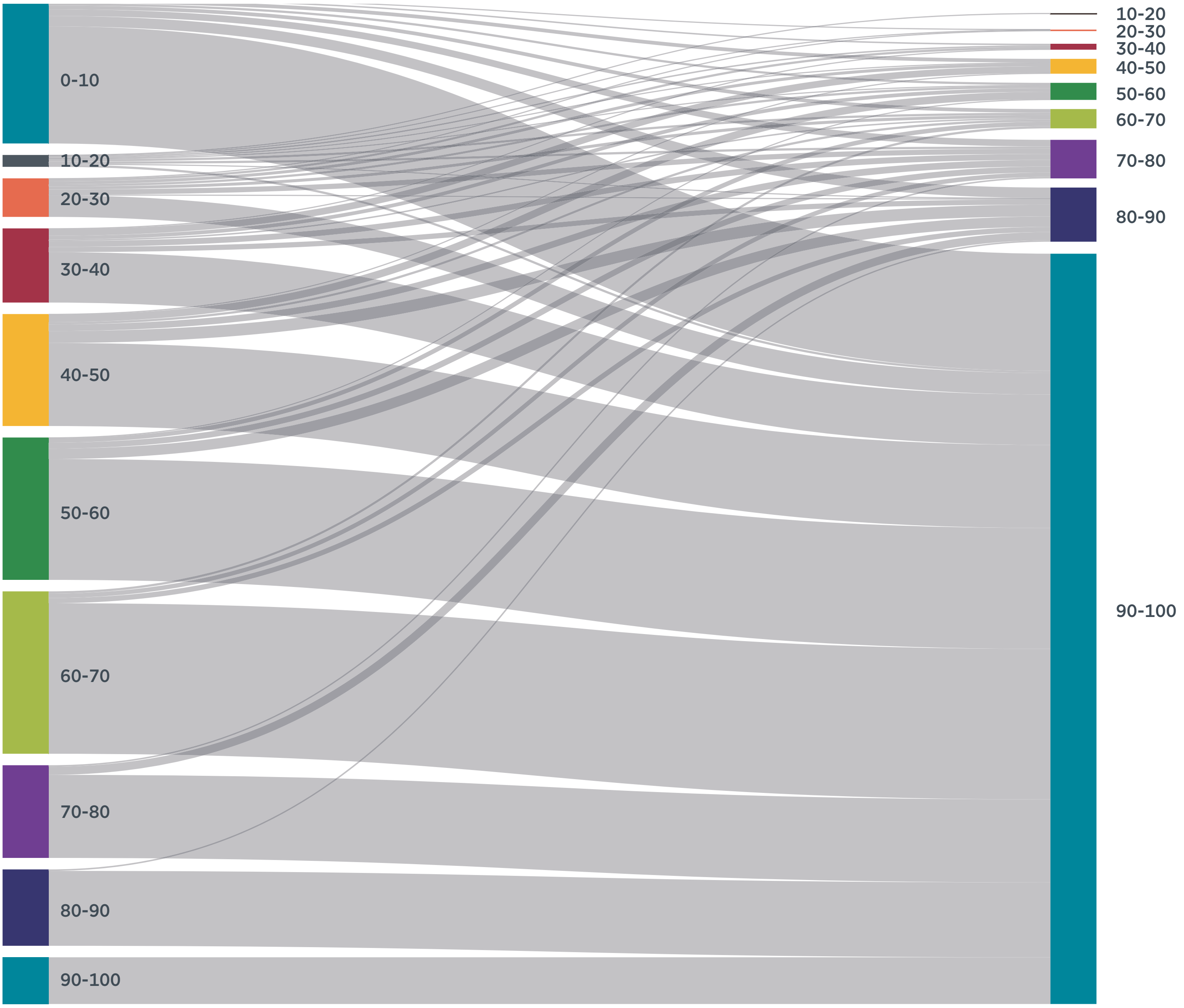
As a result of this strategy, many charging sessions only record a small growth in the SOC. Batteries tend to be charged fully, with 83% of charging sessions ending with a SOC between 90% and 100%, but they are not used to their full depth of discharge, with 58% of sessions starting with an SOC above 50%. On average across all locations, charging sessions start with a battery SOC of 50%, and end with a battery SOC of 94%. This low depth of discharge (44% on average) is a result of fleets sizing their vehicle batteries for the most demanding days of operation. It shows that batteries tend to be underutilized, which can lead to detrimental impacts on TCO. However, all chargers experience SOC values ranging from 0% to 100%, meaning that battery storage capacity is sometimes used to its full extent. All SOC values here refer to the useable SOC of the batteries, excluding the typical 30% SOC battery reserves. Figure 10 shows the distribution of starting and ending SOC across 1,645 charging sessions.

Figure 10

Flow of the starting (left) and ending (right) battery state-of-charge (%) of charging events



Note: Each side represents the share of charging events starting or ending with a specific SOC bin, adding to 100%. Line width is proportional to the number of events.

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TOTAL COST OF OWNERSHIP

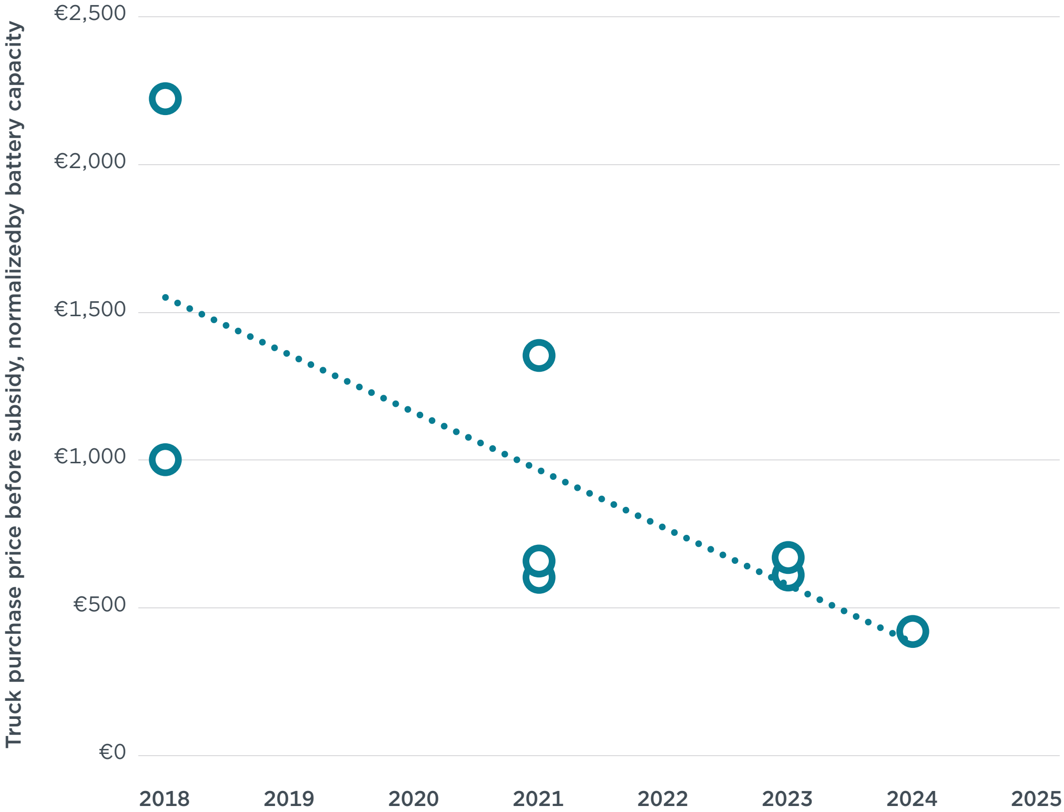
The ability of electric trucks to reach TCO parity with diesel vehicles can be a key factor for fleets deciding when to pursue electrification. While first-movers are willing to run pilots despite higher costs to learn and position themselves as pioneers, TCO parity with diesel counterparts is needed to deploy electric trucks at scale. Earlier analysis shows that, on average, battery electric trucks can become the cheapest powertrain option in all use cases by 2030 in Europe (Basma & Rodríguez, 2023). However, real-world TCO can vary greatly based on how vehicles are operated and charged. Participants in this study shared data indicating how the current vehicle market compares to this potential.

VEHICLE PROCUREMENT COSTS

Vehicle procurement constitutes a large portion of the TCO of electric trucks and is mostly driven by the cost of batteries, which can contribute to more than half of the retail price of an electric tractor-trailer (Xieet et al. 2023). Two main procurement models are used by fleets—either direct vehicle purchase or leasing, typically directly through OEMs—although new models are emerging. We obtained data on truck retail prices and subsidies from study participants that opted to purchase their electric trucks. To avoid the identification of individual ECTA members or vehicle models, we normalized the purchase price of the vehicles without subsidies by battery capacity (in kWh).

Figure 11 shows the evolution of this variable over time. Between 2018 and 2024, vehicle purchase price normalized by battery capacity decreased significantly, indicating that batteries have become cheaper over time, allowing fleets to purchase vehicles with larger battery capacities at lower prices. However, factors other than the battery price contribute to overall vehicle price.

Figure 11
Evolution of the price of electric trucks over time, normalized by battery size



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All vehicles for which we obtained retail price data benefited from national-level public subsidy programs covering between 12% and 61% of vehicle retail price, considerably reducing procurement costs, required capital investments, and TCO.

CHARGING INFRASTRUCTURE INSTALLATION COSTS

In all three use cases, fleets relied on depot charging, either overnight or throughout the day. Charger installation projects vary in scale, based on fleet size, local grid capacity constraints, and whether fleets decide to install a progressive number of chargers as they deploy electric trucks or invest upfront in a large number of chargers in anticipation of future electric truck purchases.

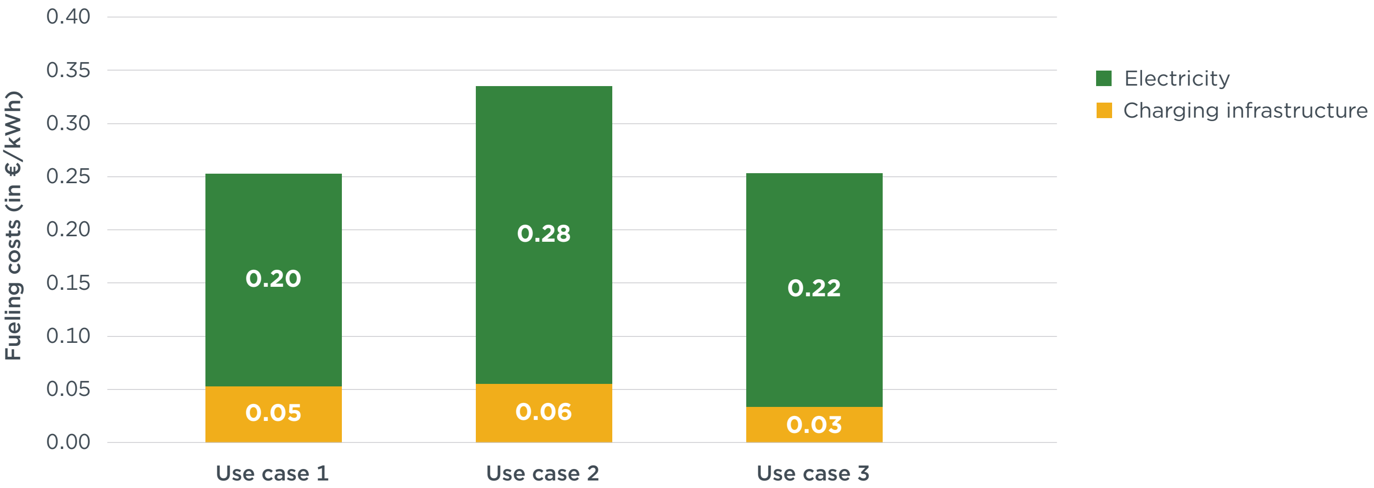
Similarly, the unit costs (per kW) of installing charging truck depot infrastructure can vary greatly from one project to another. Charger hardware typically represents a small portion of overall installation costs, with grid connection costs driving most costs. The latter can be significant if local grid capacity is insufficient, as fleets must pay for extensions to local distribution networks (including the build out of new lines and substations). While larger projects distribute labor and permitting costs across more chargers, higher grid demands can increase connection costs.

We obtained unit cost data for one infrastructure project, the installation of a 44 kW AC charger at €321/kW. Unit installation costs include the costs of charger hardware, charger installation, and grid connection. More data would be required to correlate project size and unit costs, given the complexities outlined above. A second project, for which unit costs were not available, was reportedly eligible for a subsidy covering a substantial 58% of the total project costs.

FUELING COSTS

Electric trucks have lower fueling costs than their diesel counterparts due to higher energy efficiency and lower energy unit costs. We calculate that fleets in this analysis had fueling costs between €0.25/kWh and €0.35/kWh depending on the use case. Charging infrastructure costs, distributed over an assumed ownership period of 5.5 years (in line with one of the fleets that shared data), represent between 13% and 21% of total fueling costs, with electricity costs representing the remaining 79%–87%. Fueling costs per km for all fleets were calculated by distributing charging infrastructure investment costs over the same 5.5-year ownership period, as shown in Figure 12.

Figure 12
Fueling costs in each use case



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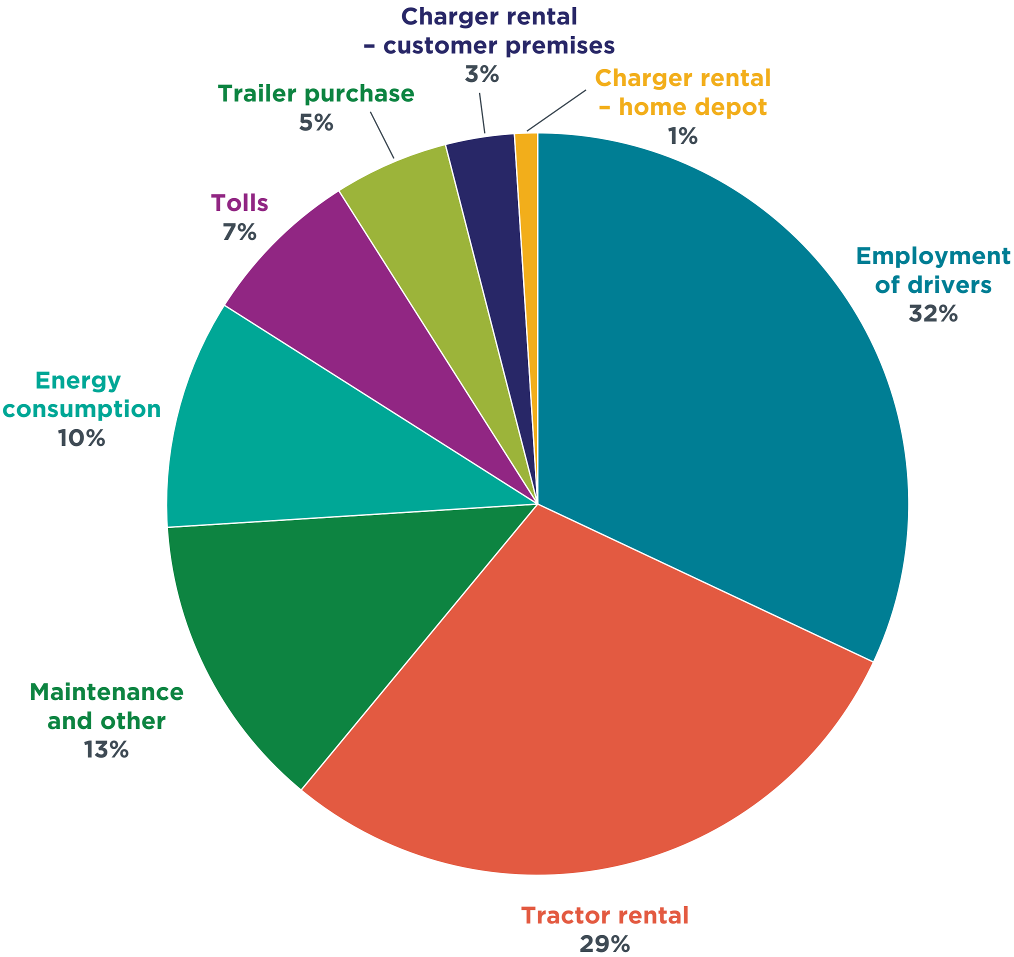
Those fueling costs correspond to savings of between 26% and 51% compared with an equivalent diesel vehicle, based on diesel fuel prices in the countries where those fleets operated as of March 2025. The key factors influencing this range of savings are the price of electricity at depots, local diesel prices, and charging infrastructure installation costs. While diesel prices are an external factor, fleets can work with local utility and infrastructure providers to mitigate the price of the other two components and maximize fuel savings. For example, several utilities in Europe are proposing time-of-use tariffs which would allow off-peak charging at lower prices (Hildermeier et al., 2025).

TOTAL COST OF OWNERSHIP

Below, we outline the TCO breakdown from one electric truck, as calculated by the operating fleet. The calculation is based on a 5.5-year ownership period, as shown in Figure 13. Labor costs are the largest contributor to TCO for that fleet, accounting for 32% of total costs, followed by vehicle procurement costs at 29%. In this case, the vehicle is leased, one of the most common procurement models in Europe, with monthly installments paid by the fleet to the leaser (in this case, the manufacturer). The lease amount is calculated based on residual value projections by the leaser. In that case, the total procurement cost we calculated for that fleet based on a 5.5-year lease period is slightly higher than the retail price experienced by other fleets that have purchased the same vehicle. The difference reflects the leaser's profit margins, as well as risk valuation due to the uncertainty around the vehicle's residual value.

Figure 13
Total cost of ownership breakdown for one of the participating fleets



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Energy costs account for 10% of the TCO, while they typically represent about 28% of the TCO for a diesel truck (Basma and Rodríguez 2023). Charger rental accounts for 4% (1% for the charger at their own depot and 3% for the charger at their customer's premises), and maintenance and other costs account for 13%. Finally, road tolls account for 7%, as the fleet operates in a country that has not yet implemented road charge discounts per the Eurovignette Directive (Directive (EU) 2022/362). The Directive allows EU Member States to vary road charges based on CO_2 emissions, hence providing substantial discounts for ZETs. Germany, for example, applies a full road charge discount to ZETs. Implementation of the Directive in the country where this fleet operates could reduce TCO by up to 7%.

Overall, the fleet reported that transport costs using this vehicle in its current use case are 50% higher than the costs of equivalent operations with a diesel vehicle. This TCO premium compared with diesel can partly be explained by the low utilization of the electric battery, as shown by the low depth of discharge highlighted above. An earlier analysis found that, with fixed specifications, including battery size, electric truck TCO performance relative to a diesel equivalent vehicle increases with increasing travel distances because there is a greater possibility of recouping the higher investment costs with lower operational costs (Basma et al. 2021). If the vehicle was deployed in a use case with longer distances traveled, it could, therefore, experience a reduced cost premium (or even a lower TCO) compared with diesel.

LESSONS LEARNED AND BEST PRACTICES

In addition to sharing data, study participants also shared their experiences with fleet electrification, enabling us to identify the following lessons and best practices.

USE CASE SELECTION

Route selection. While low travel distance use cases help to address range anxiety, they offer less of an opportunity to recoup the higher upfront costs of electric trucks compared with diesel counterparts with lower operational costs. On the other hand, high mileage use cases with low route predictability and less access to charging can pose range limitations. Use cases that combine a high travel distance with high route predictability and frequent opportunities for charging represent an ideal case to electrify trucks and lower their TCO, especially when access to low-cost electricity is possible.

Battery sizing. Fleet operators tend to choose vehicles with battery sizes that will cover the worst-case operating scenario, such as high payloads and energy consumption, low access to charging, and highly variable daily operations. However, these trucks tend to be deployed in less demanding use cases, only experiencing the worst-case conditions a few days per month at most. In addition, operational data show average real-world driving ranges are 11%–19% higher than advertised by OEMs. As a result, in most cases, only 44% of battery SOC is being used on average. Because batteries tend to be oversized for everyday operations, their underutilization negatively impacts TCO. Use cases with low operational variability present a better opportunity to reduce battery buffer, hence maximizing utilization and reducing TCO. In addition, the trend of reducing battery prices over time reduces the cost penalty of oversizing batteries, offering more flexibility for fleets while maintaining opportunities for a positive business case for a wider range of use cases.

Charging strategy. Charging management can maximize the economic and environmental benefits of electric trucks. Spreading vehicle charging throughout the day can reduce peak load and, therefore, limit the expense of upgraded grid connections. Benefits can be further enhanced with on-site battery storage, which enables additional flexibility to manage grid load and enables integration of on-site renewable energy generation. However, where time-of-use tariffs are available, concentrating charging in off-peak times, such as overnight, can offer significant TCO benefits while mitigating grid constraints. Negotiating competitive electricity contracts could, therefore, help fleets maximize fuel cost savings for electric trucks.

PROCUREMENT AND FINANCING

Delivery lead times. Participants reported generally long lead times for the delivery of vehicles and charging infrastructure projects. In some cases, a mismatch was reported in the delivery timelines of vehicles and infrastructure, leading to assets being idle at depots or the need to charge vehicles at public locations, which usually costs more. To accommodate long lead times, especially for infrastructure, some fleets anticipate future electric procurement and pre-build charging infrastructure at depots or pre-equip depots with required grid connections. While grid upgrades are usually the main reason for longer lead times for infrastructure installation, vehicle lead times are generally perceived to be a result of the low market penetration of electric trucks.

Retail price transparency. Some fleet operators also reported challenges navigating and benchmarking market prices, due to limited product offer and a perceived lower transparency on electric truck prices compared with the diesel counterparts. Uncertainty regarding residual values is also seen as challenge, given the lack of experience on battery degradation and the delayed development of a second-hand electric truck market, which usually leads to increases in the cost of leasing.

Incentives and financing. Purchase subsidies provided by several EU Member States can reduce TCO and required investment costs to procure vehicles and install infrastructure. However, the number of beneficiaries is usually limited, and even the fleet operators that benefited from the subsidies reported usually long lead times, administrative complexity, and uncertainty regarding the durability of subsidy schemes. Participants reported lead times of up to 3 years from the time of their application to the subsidy scheme to full vehicle roll out. In addition, when subsidy programs cover both, the differing timelines for vehicle and charging infrastructure procurement make it challenging to start operations.

A growing variety of alternative business models is available for fleets to reduce upfront investments; public funding could be used to reduce risk and support the development of such models. Leasing or rental-based models can focus on vehicle or charging procurement (or both) while also helping mitigate long procurement lead times and secure access to competitive prices through demand aggregation. Public funding could support such demand aggregation initiatives while reducing risk for private investment with instruments such as residual value and credit risk guarantees.

Collaboration. Transitioning trucking fleets to electric involves building knowledge on vehicle technology, charging infrastructure, and the electricity grid, and adapting operations to new constraints and parameters. A 1-to-1 replacement of diesel trucks with electric trucks usually leads to non-optimal cost performance. In all use cases in this report, fleets could rely on partners to identify the specific needs and find unique technological and business solutions to meet their needs. Trucking-as-a-service providers and OEMs can play a key role in increasing transparency on the vehicle offer, facilitating technical capacity building within fleets by sharing expertise on how to best use their vehicles, and helping fleet operators engage with charging service providers and utilities. Large shippers, which usually have more institutional capacity than transport companies (which tend to be micro, small, and medium enterprises), can also help in the development of charging infrastructure and transport planning; early truck electrification success stories often involve shippers. Fleet operators reported that the desire among their customers to reduce their scope 3 emissions played a key role in enabling the deployment of electric trucks. Finally, running pilots can de-risk electrification and help all parties learn and calibrate operations before fully transitioning. Early movers can also benefit from the support of partners such as their providing OEM when transitioning to electric fleets.

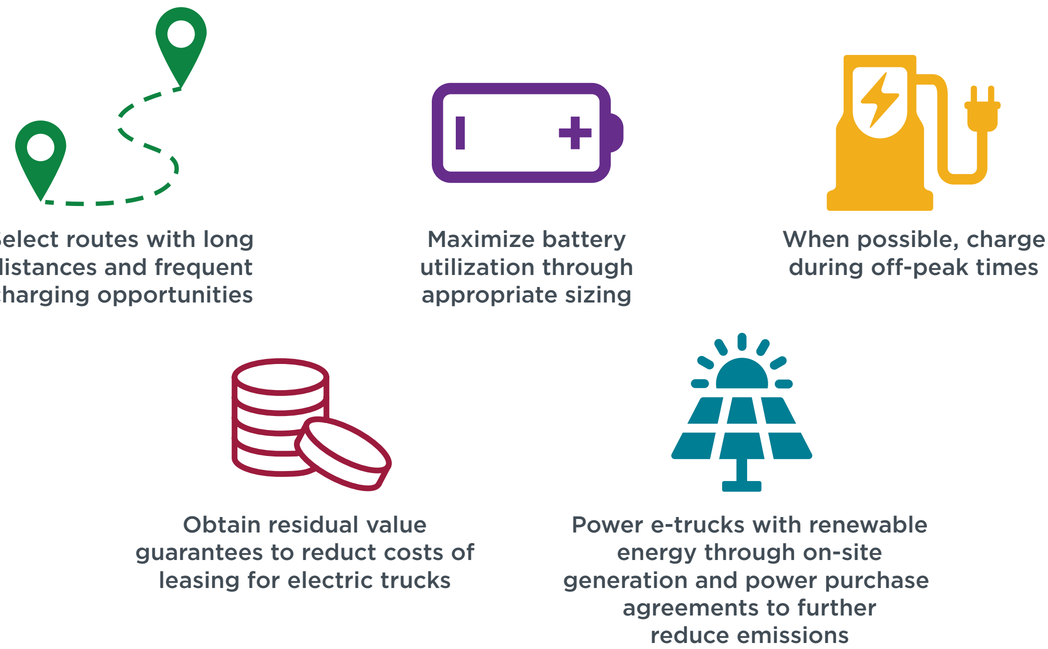
Integrated electrification planning. Fleet electrification impacts multiple activities of a transport company, including depot design, procurement of vehicles and energy, and scheduling and fleet management. While those activities can sometimes be siloed, data sharing and coordination across teams can optimize vehicle and infrastructure utilization and minimize costs. Software can enable this capacity building by helping fleet managers identify how to optimize charging strategies (for example, by making use of time-of-use tariffs) and tailor schedules to the capabilities of the vehicles.

LIFE-CYCLE EMISSIONS

Renewable energy supply. Powering electric trucks with renewable electricity can help fleets further decarbonize operations and lower electricity costs, thereby optimizing the TCO benefits of electrification. Through power purchase agreements (PPAs), fleets can secure early access to low-cost renewable energy, benefiting TCO while also supporting renewable energy producers. On site-generation of solar energy, paired with battery storage, can also help bypass the high costs and long lead times needed for upgrades to local distribution grids and reduce vehicle life-cycle emissions. Early engagement of local electricity utilities can help to identify the best solutions for specific fleets.

Figure 14 summarizes the most important lessons learned and best practices from this use case study to maximize performance the performance of electric trucks.

Figure 14
Lessons learned and best practices to maximize electric truck performance



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CONCLUSIONS AND POLICY RECOMMENDATIONS

Analysis of the real-world fuel consumption of 91 electric tractor-trailer trucks revealed significant variations in energy consumption across use cases and within each use case, despite the similar technical specifications of vehicles. Energy consumption ranged from 92 kWh/km to 150 kWh/km and averaged 65% lower than the consumption of an equivalent diesel truck. Real-world ranges experienced by the fleets are, on average, 11%–19% higher than the nominal values advertised by OEMs. However, trucks in this analysis tended to be underutilized, with an average battery depth of discharge of only 44%. This has negative impacts on the TCO of electric trucks. This can be addressed by deploying vehicles on higher distance use cases and by negotiating lower energy prices with local utilities. This analysis supports five conclusions and recommendations policymakers could consider.

- **Support the acceleration and diversification of vehicle supply.** Strong supply-side policies like the existing European CO_2 standards for heavy-duty vehicles can accelerate the diversification of product offer and ensure the availability of affordable electric trucks tailored to specific use cases. In addition, demand aggregation platforms could help create a strong market signal for OEMs, hence reducing the long lead times sometimes experienced by vehicle purchasers and enabling access to more competitive retail prices. Promoting increased price transparency could also support fleets in their procurement process and ensure that competition drives the costs of zero-emission heavy-duty vehicles down.
- **Facilitate access to affordable, decarbonized electricity.** The Affordable Energy Action Plan recently published by the European Commission puts forward measures to support fleet electrification by simplifying and expediting procedures for grid connections, lowering energy prices, and increasing the share of renewables in the European Union's electricity mix (European Commission, 2025). Implementation of this action plan would facilitate the deployment of depot charging infrastructure. Time-of-use tariffs could also incentivize depot charging during off-peak times, such as overnight, for load mitigation while improving fleet TCO. Implementation of the European Clean Transport Corridor initiative would also expand public charging along key freight corridors.
- **Waive road tolls for ZETs to improve TCO.** Data analyzed in this report show that tolls can account for up to 7% of TCO. Implementation of the Eurovignette Directive in all Member States could further reduce the TCO of ZETs by lowering or eliminating toll fees.
- **Provide risk-sharing financial instruments to support truck financing.** Risk-sharing instruments such as residual value and credit risk guarantees could attract private investment in zero-emission HDVs and support procurement models such as leasing. They can provide a more resource-efficient alternative to traditional purchase subsidy programs.
- **Focus requirements and incentives for corporate fleets on the use cases most suited for accelerated electrification.** Use cases that enable high battery utilization and access to low energy prices are more likely allow ZETs to achieve TCO parity with diesel trucks. In addition, the fleets that participated in this study indicated that customer willingness is an important factor in enabling electric truck deployment on selected routes. As the European Commission is working on a legislative proposal to support the decarbonization of corporate fleets, a comprehensive framework identifying the best use cases for accelerated electrification could ensure the legislation benefits both carriers and shippers.

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