EUROWAG

Electromobility in the CRT segment

Market Overview and Case-study

Industry paper 2022

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Contents

Foreword

Electromobility has been very prominent in the news cycle since EU environment ministers reached an agreement in late June to end the sale of cars and light commercial vehicles with combustion engines in Europe by 2035.

This White Paper is focused on a very different part of the road transport sector – the "heavyweight" category: medium- (MDV) and heavy-duty (HDV) electric vehicles, or eTrucks. In this area, while progress is certainly being made, the transition to electromobility has been slower for a wide range of reasons which are explored in depth in this report.

Effective problem-solving has to start with a detailed, realistic understanding of the challenges. In the case of eTrucks, that means understanding the market, the current stage of technological development, the legislative context and the main barriers to implementation. Crucially, it also means understanding the commercial road transport (CRT) sector, an essential pillar of our economy and one in which more than 90% of companies are small, family-run businesses operating on tight margins and low access to capital.

The purpose of this White Paper is to provide everyone who is invested in the CRT sector's transition to electromobility with a comprehensive, in-depth assessment of the current state of play for eTrucks.

Eurowag's contribution to this discussion comes from two main sources:

First, our in-depth industry knowledge, gathered through working closely with more than 15,000 trucking business customers across Europe – many of which we are helping to transition their fleets to mixed or fully electric vehicles, as well as delivering a full suite of support services for the ongoing maintenance of electric fleets.

Second, our primary mission in e-mobility is to connect the ecosystem around road transport and enable a seamless value exchange between industry participants. This gives us both a panoramic view of the market and a rare level of independence, because we have no commercially-driven bias in how it develops.

However, the White Paper does not merely draw on Eurowag's experience. To understand eTrucks properly, it is essential to consider as many relevant perspectives as possible, which is why I am delighted that other leading companies in the sector have contributed to the report – specifically, E.ON, Last Miles Solutions, ABB, Vodafone Business, Sygic, Eco-Movement and Volvo Trucks. They have helped ensure that the White Paper offers a genuinely 360° view of the eTrucks market.

Their insights are also crucial to understanding the most significant challenges to the energy transition, which are analysed in the report. I personally see three at the very top of the priority list: bringing the total cost of ownership (TCO) of an eTruck down to the level of diesel engines as quickly as possible, ensuring SMEs have the financing they need to be able to purchase an eTruck, and providing the money and energy capacity necessary to build a network of Megawatt Charging System points across Europe at a density, and with sufficient space, to service the kind of rapid growth in eTrucks that we would all like to see over the next few years.

These are major tasks, and to address them at the speed and scale required, policy-makers will need to be bold and coordinate their efforts – both within countries and internationally.

These are crucial challenges, both for the CRT sector and for society as a whole. I hope that this White Paper proves to be a platform on which policy-makers and other stakeholders build so that solutions can be found to meet them.

Martin Vohánka
Founder of W.A.G. and Chairman of the Board of Directors of the company
W.A.G. payment solutions, a.s.

Executive summary

Within the road transport sector, the transition to zero-emission vehicles has been slowest in the medium- (MDV) and heavy-duty (HDV) categories, with MDVs and HDVs currently generating about 70% of Europe's road freight CO2 emissions. However, the transition to electromobility has begun, with eTrucks expected to take a market share of over 20% by 2030.

This White Paper is designed to provide an overview of the current ecosystem around eTrucks in Europe. It has been written by Eurowag with input from other leading companies in the industry: E.ON, Last Miles Solutions, ABB, Vodafone Business, Sygic, Eco-Movement and Volvo Trucks.

The White Paper is split into five parts:

The first provides an overview of the eTrucks market as it currently stands, including the legislative context in which it is developing.

The second focuses on technology, describing the current stage of eTruck development and identifying areas where technological progress can help to accelerate adoption.

The third section of the report considers the impact of eTrucks on the environment. It starts by examining their impact "well-to-wheel", a much broader perspective than the "tank-to-wheel" approach, which is commonly used, before moving on to a full cradle-to-grave life cycle assessment (LCA), using the ISO-standardized method to evaluate the environmental impact at every stage of an eTruck's life.

The fourth chapter focuses on charging infrastructure, one of the main obstacles to the development of electromobility in the commercial road transport sector. It includes a new index of European countries which is based on a comprehensive assessment of how ready they are for eTrucks. The index has been created specifically for this report and ranks countries based on a single total score so that comparisons can be made between them.

The final section of the report considers e-mobility from the perspective of those people handling day-to-day operations with the new eTruck technology – particularly trucking businesses and fleet owners. In so doing, it reveals some of the barriers to the adoption of eTrucks, but also the opportunities that are available through the use of smart technology.

1. The current state of play

E-mobility calling for heavy duty

As of 2022, electromobility is widely recognized as a global megatrend that will significantly shape the future of the automotive industry. It has already penetrated the area of passenger cars and light vehicles, with substantially growing numbers of newly registered BEVs and PHEVs each year. 2020 was a landmark year for electric vehicles – 3.1 million were sold, which is a 39% increase from 2019. (Canalys, 2020)

2020 marked yet another milestone. Electrification of the automotive industry started entering the "heavyweight" category – medium (MDV) and heavy-duty (HDV) vehicles, or eTrucks – which brings a lot of opportunities and challenges to automotive OEMs, charging infrastructure build-out, charge point operators, mobility service providers and so forth. The large-scale adoption of eTrucks will require coordination across the entire value chain.

1.1 Electric truck market: key data and trends

Global and European road freight

There were more than 6.2 million medium and heavy commercial vehicles on EU roads in 2020, up 1.7% compared to 2019. With around 1.2 million trucks, Poland has the largest fleet by far. Trucks are, on average, 13.9 years old in the European Union. With an average age of 21.4 years, Greece has the oldest truck fleet, while the newest ones can be found in Luxembourg (6.7 years) and Austria (7 years). 0.24% of trucks on EU roads have a zero-emission powertrain, up from 0.04% in 2019.

Based on the current demand pathway, global freight demand will triple between 2015 and 2050. (International Transport Forum, 2019) World HDV sales share is estimated to reach 10% in 2025 (net-zero scenario). (BloombergNEF, 2021)

Road to reduce emissions

Transport CO2 emissions remain a major global challenge, as the data clearly shows. Road freights account for 53% of CO2 emissions in the category of global trade-related transport in 2022, and will rise to 56% by 2050 if current trends continue. (WEF, 2021). The hardest-to-abate types of vehicles, MDVs and HDVs, currently generate about 70% of European road freight CO2 emissions. (WEF, 2021) However, the transition to zero-emission technologies has already begun.

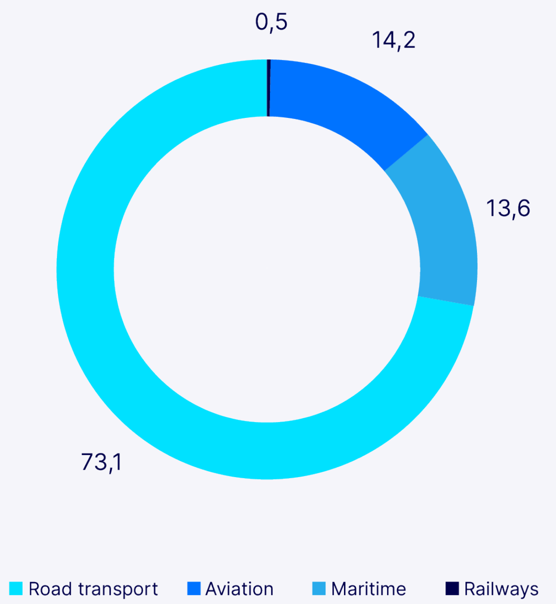

FIGURE 1 – Transport CO2 emisions in the EU (%), CO2 Emissions caused by European transport (both commercial and private transport included) Source: European Environment Agency

eTrucks in the fleets

Although the road is set, the wheels of eTrucks have just started to turn. In 2021, there were 409 newly registered heavy-duty BEVs in the EU (Figure 2), and 983 BEVs in European fleets in total (Figure 3) (EAFO, 2022). When it comes to alternative fuels, the heavy-duty segment still relies predominantly on natural gas (LNG, CNG). The same can be said of light commercial vehicles (LCV), but this segment has a head start in electric mobility compared to HDVs. The share of eLCVs in European fleets has been growing steadily since 2012, reaching more than 166,000 in 2021.

Legislation pushes (see Chapter 1.5) coupled with technological progress are further shifting the current development in the benefit of BEV category, and electric trucks are predicted to be the dominant alternative powertrain to diesel. We see legislation having a similar effect as in 2015 in the passenger car segment (Figure 4).

> **China accounted for nearly 90% of electric truck registrations in 2021, down from nearly 100% in 2017. Sales in the United States and Europe have begun to rise rapidly in the past few years, driven by an increase in available models in those markets, policy support, rapidly improving technical viability and economic competitiveness of electric trucks in certain applications.**
>
> **IEA,2022**

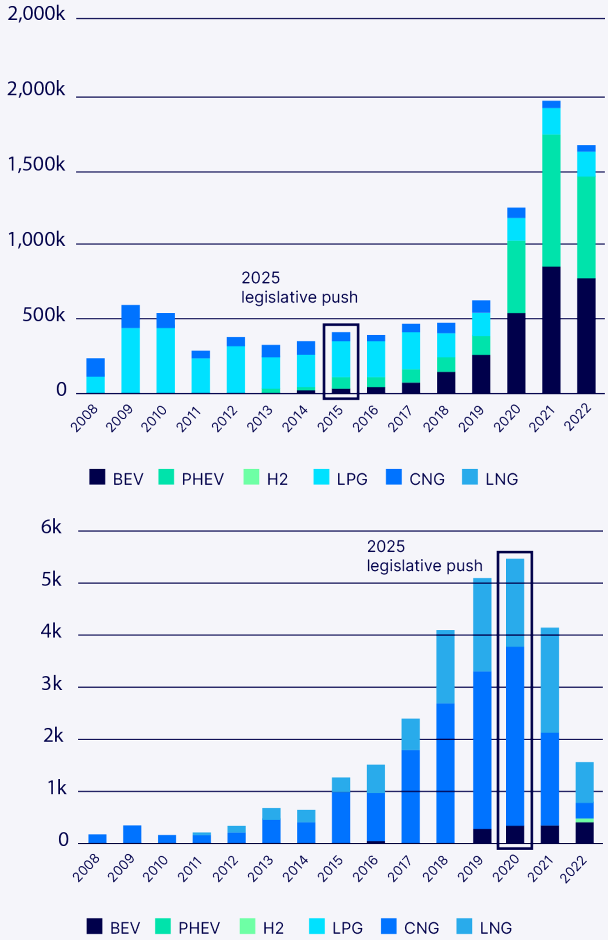

FIGURE 4 – Number of newly registred alternative vehicles (passenger cars vs. heavy trucks comparisonSource: EAFO

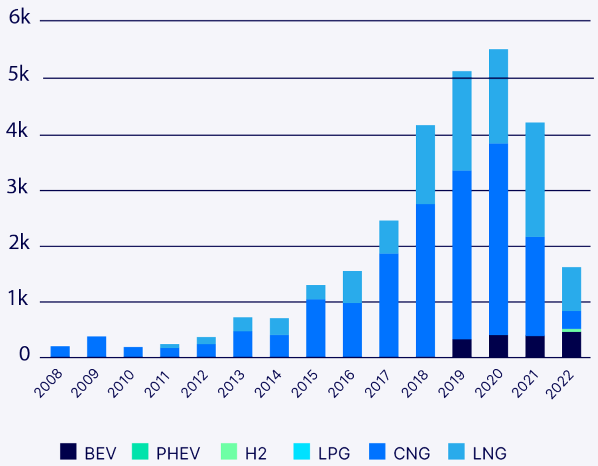

FIGURE 2 – Number of newly registred alternative fuelled (BEV, PHEV, H2, LPG, CNG, LNG) trucks (N2&N3). Source: EAFO

Total number of alternative fuelled (BEV, PHEV, H2, LPG, CNG, LNG) trucks (N2&N3).

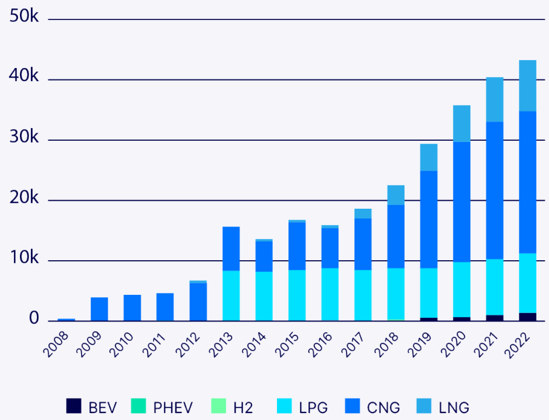

FIGURE 3 – Total number of alternative fuelled (BEV, PHEV, H2, LPG, CNG, LNG) trucks (N2&N3). Source: EAFO

1.2 Truck manufacturers' perspective

The technological and commercial success of battery-operated passenger cars has encouraged OEMs to translate this technology into LCVs, MDVs and HDVs. This is driven by the legislation incentives (Chapter 1.4) and by increases in technology efficiency – meaning that smaller batteries will soon be capable of powering heavy-goods vehicles (see Chapter 2). (Nykvist, Olsson, 2021) Advances in battery technology and the process of recycling battery cells after they are no longer capable of powering eTrucks are also improving the overall life-cycle assessment of electric HDVs (see Chapter 3).

All major truck manufacturers are launching their first generations of eTrucks suitable for daily operations, while the goals set for the future slightly differ. Scania aims for 50% of their truck sales in 2030 to be battery-electric, and MAN's goal is to have 60% of urban and regional delivery and 40% of long-haul truck sales to be zero-emission by the same date. Volvo's target is to have zero-emission trucks account for half of their sales in Europe by 2030, whereas its subsidiary Renault Trucks intends to reach 35%. (Transport & Environment, 2022) This will go hand in hand with abandoning the development of ICE trucks – a goal some manufacturers have already announced, and European Commission energy laws encourage (Chapter 1.4). (EURACTIV, 2021)

Milestones to 100% Eletrification: Trucks

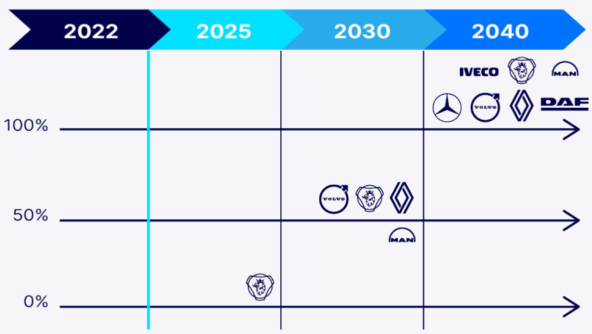

FIGURE 5 – Truck manufacturers' timetable to achieve net zero carbon emissions (data from April 2022). Source: Eurowag

In its recent research, the McKinsey Center for Future Mobility suggests that by 2025, 4% of all MDV and HDV sales in Europe will be zero-emission (ZE) vehicles. Although this number still won't be able to sufficiently reduce the CO2 emission to align with legislative goals, it's a significant growth seen in just a 3-year perspective. Moreover, that share could grow to 37% by 2030, representing about 150,000 ZE vehicles.

1.3 Infrastructure challenges

Such rollout demands adequate support in the form of at least 8,000 of high-power public and semi-public charging points suitable for trucks in the EU, with the number increasing to more than 20,000 in 2030.

As of 2Q 2022, there were about 500,000 publicly accessible charging points in the EU. (Eco-Movement and Sygic, 05/2022) Such data, however, change every day. One of the reasons is a different approach to data reporting on national levels. In addition, there are several smaller entities in each European country that are building charging points at fast pace, so the official European Alternative Fuels Observatory data may not always be completely up-to-date.

Infrastructure density, however, is not the only parameter. With heavy goods transportation focused on main roads, ports, and terminals, a smaller number of charging locations would likely be required than is needed for electric cars. (see Chapter 4)

One parameter appears to be crucial in the HDV segment: charging points power output. More than 90 % of all public charging infrastructure are AC charging stations, mostly with 22 kW or less. (ChargeUp Europe, 2022) Large manufacturers agree that the move to electric trucks will depend on fast charging facilities in key locations. (Nykvist, Olsson, 2021) Based on the optimal power output of 350 kW required for eTrucks, there are currently 3,500 charging points suitable in the EU (see Chapter 4.2). However additional filters as station dimension suitable for HDV must be applied.

1.4 Legislation incentives

Legislation incentives frame the freight industry's journey towards zero-emission vehicles. We see pressure from legislators and decision-makers to reduce CO2 emissions at the supranational level (European Union) and the level of individual countries, cities, and organizations. The regulations aim to reduce CO2 emissions by taking a variety of measures.

CO2 LIMITS FOR VEHICLE MANUFACTURERS

European Union

EU legislative incentives are one of the most important drivers of electromobility. In 2019, the EU adopted the first-ever CO2 standards for new HDVs. The Regulation sets average fleet reduction targets of 15% by 2025 and 30% by 2030 relative to a 2019/2020 baseline. (Climate Action, 2022) In its justification, the European Commission specifically notes the increasing environmental burden of road freight traffic.

The Regulation (EU) 2019/1242 is expected to reduce 54 million tons of CO2 between 2020 and 2030. It should also bring net savings for transport operators, save hundreds of millions tons of oil, and generate additional jobs. (Figure 6) Accordingly, the EU introduced the so-called zero- and low-emission incentive mechanism (see more in Chapter 2.1).

It is important to note that besides aforementioned Regulation (EU) 2019/1242, EU's CO2 standards for heavy-duty vehicles rest on two other pillars. First, the CO2 certification regulation, adopted in December 2017 as Regulation (EU) 2017/2400, which uses the computer simulation software VECTO to measure heavy-duty vehicles' CO2 emissions and fuel consumption for a wide variety of complete truck and trailer configurations. Second, the CO2 monitoring and reporting regulation, adopted in June 2018 as Regulation (EU) 2018/956.

Per contra, Transport & Environment, Europe's leading NGO campaigning for cleaner transport, argues that measures introduced by Regulation (EU) 2019/1242 are insufficient. According to the NGO, the regulatory ambition needs to be significantly increased and the EU should also phase out the sales of most internal combustion engine trucks by 2035 – a step some countries call for and the EU already considers in passenger cars segment. (Reuters, 2022)
That might happen in the early 2023 review of the Regulation,

when the Commission should also “assess the extension of the scope to other vehicle types such as smaller lorries, buses, coaches, and trailers.”11 (Climate Action, 2022)

Expected key benefits of the legislation

- Ca 54 million tons of CO2 reduced between 2020 and 2030
- Oil savings of more than 200 million tons of oil up to 2040
- Additional jobs compared to a business as usual scenario
- Significant net savings for transport operators

Targets and penalties

Referring to 2019 results the CO2 emissions must be reduced by:

- 15 % in 2025
- minimum 30% in 2030 (tbc.)

Targets are relatively distributed for each HDV group:

- 4×2 for more than **7,5t**
- 6×2, 6×4 and 8×4 - **all weights**

Penalty per exceeded gram is:

- **4000 €** in 2025
- 6800 € in 2030 (tbc.) = multipled by sold vehicles

Figure 6 - Key aspects of regulation (EU) 2019/1242

World

The EU is not the only one taking strong measures to reduce transport-caused CO2. Comparable methodology for CO2 emission limits is being applied in many other countries around the world. In 2020, California adopted the world’s first truck CO2 sales target. 15 other US states will follow, covering one-third of the total US truck market. (Transport & Environment, 2022) China is discussing replacing its green car credit system with a new policy that focuses on reducing carbon emissions on a broader scale. The current system credits automotive OEMs for selling electric or fuel-efficient vehicles. (Reuters, 2021)

Incentives to support electric vehicles often go hand in hand with penalty schemes based on high tax or fee burdens placed on the sale and operation of conventional vehicles. More than 20 countries – including emerging economies such as Cabo Verde, Costa Rica and Sri Lanka – have announced the full phase-out of internal combustion engine car sales over the next 10-30 years. Additionally, about 120 countries have announced economy-wide net-zero emissions pledges that aim to reach net zero in the coming few decades. (IEA, 2021)

LOW AND ZERO EMISSION ZONES

CO2 reduction is also initiated on a lower administrative level, as many municipalities around the world are creating so-called low emission zones (LEZs) or zero emission zones (ZEZs), which often means that fossil-fueled vehicles are banned from entering some or all of the city’s territory. (Figure 7) In ZEZs, only battery- or hydrogen-powered vehicles are allowed to enter. The number, size, and strictness of LEZs and ZEZs will probably grow in time, with more and more LEZs gradually becoming ZEZs.

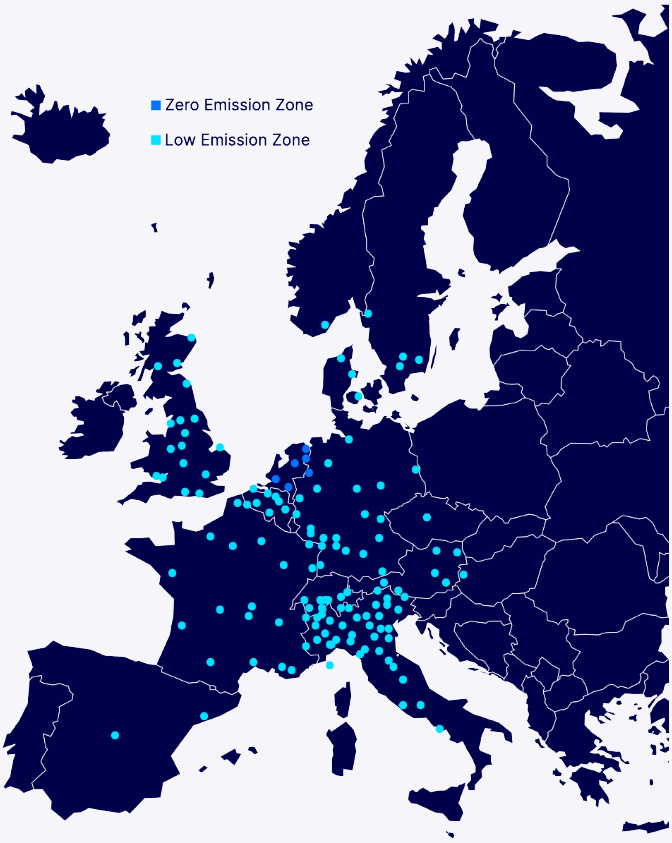

FIGURE 7 – Map of low and zero emission zones in Europe. Source: Urban Access Regulations EU

TOLL AND VIGNETTES INCENTIVES

Operating clean trucks will bring road haulers significant operational cost reductions as many countries introduce “green discounts” for electric and hybrid electric vehicles. As a result, ZEVs in some countries are exempt from the toll. In the EU, revisions to rules on road tolls were adopted by the European Parliament in February 2022. The new rules are set to encourage road transport decarbonization, make the tolling system more coherent and motivate fleet owners to deploy battery-electric (and hydrogen) HDV, for which they will receive considerable toll discounts of at least 50% on distance-based road tolls. (EUR-Lex, 2022)

> **Eurovignette road charging reform means that road haulers operating zero emission trucks can expect a 50% discount on road tolls by early 2024. Such a discount can save up to €12,000 a year.**
>
> **EURACTIV, 2022**

COMPULSORY QUOTAS FOR PUBLIC INSTITUTIONS AND MUNICIPALITIES

National and supranational legislation can also introduce quotas on the purchase of "clean vehicles" for public institutions and municipalities. Such an example is the European Clean Energy Directive, which introduces a minimum percentage of clean (i.e., low- and zero-emission) vehicles in the aggregate public procurement across an EU member state. The Directive requires public purchasers and private companies operating public transport services to consider energy consumption and environmental impacts when purchasing and leasing road vehicles. (European Commission, 2019) Similar efforts can be seen in key industry players, who are implementing ESG values into their strategies and aligning their objectives with them.

CHARGING INFRASTRUCTURE MEASURES AND INCENTIVES

An adequate network of charging points is one of the most important precondition for the success of commercial transport electrification, especially when it comes to long haul electric trucks. To ensure that such network comes into existence and its timely roll out, EU and local governments should continue to support the development of charging networks. The need for supporting policies is all the more important because the business case for very fast charging infrastructure (above 1 MW, see Chapter 4.4) is still uncertain – especially in the early days of eTrucks. (IEA, 2022)

In July 2021, the European Commission proposed to transform the Alternative Fuels Infrastructure Directive into the Alternative Fuels Infrastructure Regulation (AFIR). It's the first regulation to set mandatory minimum power and distance targets for HDV charging: every 60 km of the core trans-European network for transport (TEN-T) with a power output of at least 1 400 kW (at least one individual power output of 350 kW) by 2025 and 3 500 kW (at least two individual power outputs of minimum 350 kW) by 2030.

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The Alternative Fuels Infrastructure Facility, as part of the EU Connecting Europe Facility transport programme, will make EUR €1.5 billion available by the end of 2023 for electric fast charging and hydrogen refuelling stations on the TEN-T network.

IEA, 2022

On national level, countries allocate fundings to further enhance building of sufficient charging infrastructure. Sweden, for example, supported building HDV charging infrastructure along country's main transport corridors with 550 million SEK. (IEA, 2022) The National Knowledge Platform for Charging Infrastructure (NKL) in the Netherlands have published a roadmap for deployment of a HDV charging network, along with project for testing heavy-duty charging solutions. (NKL, 2021)

OTHER MEASURES AND LEGISLATION

There are many other tactics and legislation that lawmakers and decision-makers use to reduce CO2 emissions. Specifically in the European Union, the following legislation defining the business framework is worth mentioning: Renewable Energy Directive (RED III), Energy Performance of Buildings Directive, Policy on Trans-European Transport Network, Energy and Environmental State Aid guidelines and Value Added Tax Directive.

Other measures worldwide include local financial and non-financial incentives for private and corporate persons deploying ZEVs, such as reduced/zero road tax, city tolls, or priority lines in cities. Some others include taxes on the private use of company cars, compulsory installation of charging points in new buildings, and many more.

1.5 Fleet operations adjustments

The broader deployment of eTrucks is still a matter of the future, with many barriers causing some road freight companies to take a reserved approach. As of now, the purchase price of heavy-duty BEVs is still approximately 100–350% higher than a comparable ICE (diesel) vehicle (Vijayagopal, Rousseau, 2021; Sharpe, Basma, 2022). However, the price ratio is highly variable and depends on the specific type of vehicle and, especially, driving range. It is important to note that this estimation does not take grants and incentives into account, or that many concerns will be compensated by lower operating costs. Another factor that may affect the high estimate is the future total cost of ownership (TCO), which may soon become competitive and drive prices down. Even when looking at this situation from all angles, electric vehicle financing is one of the biggest challenges fleet owners face.4 (WEF, 2021)

The current state (and often lack) of charging infrastructure is another concern frequently mentioned by fleet owners and a cause of so-called charging anxiety. Although adopting eTrucks will demand partial changes in fleet operations, including retraining staff, adjusting routes, and building depot charging stations, advantages prevail in the long-term perspective. (see Chapter 5)

2. eTrucks technology

As outlined in the previous chapter, deploying zero-emission MDVs and HDVs is an inevitable part of the mission to tackle growing emissions of CO2 caused by the global transport and freight industry, together with subsequent environmental threats. This chapter will examine how technology serves this purpose, specify the crucial technological aspects of eTrucks and describe their development stage. We will also identify areas where technological progress can significantly help to accelerate the adoption of battery-electric trucks.

2.1 Legislation impact on technology deployed by manufacturers

Technology is a vital part of the shift to zero-emission road transport as the non-technological changes – such as reduction of transport or shift to different, more sustainable modes, i.e. rail – have a limited role. Behavioral change at a massive scale is complicated, slow, and finally, all advanced economies rely heavily on car-dependent systems. (Plötz, 2022)

Chapter 1.4 examined legislation incentives aimed to reduce road freight CO2 emissions. Many of them favor electric (and fuel cell vehicles) for a straightforward reason – from a tailpipe ore integrated approach – i.e. life-cycle assessment – in Chapter 3.) Whereas broader deployment of fuel cell electric vehicles is still a matter of the future, battery electric vehicles are being implemented on a massive scale due to their relatively easy maintenance and already developed charging infrastructure.

As a result, legislation has an unmistakable influence on the technology deployed by truck manufacturers. Strict CO2 emission limits (measured in gCO2/tkm) set by the European Union have, in particular, a big impact on the type of vehicles produced in the EU. The EU manufacturers (seven brands from five parent manufacturers are responsible for almost all truck sales in the EU) should meet the first emission targets in the relatively short time frame of a few years (15% in 2025, see Chapter 1.4). However, HDV manufacturers have prepared for a similar scenario well in advance and have been investing in the development of LEVs and ZEVs for the last few years.

As shown in Figure 8, the implementation of the European legislation has several phases. The targets are expressed as a percentage reduction of emissions compared to EU average in the reference period (1 July 2019–30 June 2020). From 2025 onwards, manufacturers must reduce their CO2 emissions across the entire fleet of newly registered vehicles by 15% (relative to the 2019/2020 baseline). This target is set to be achievable using technologies that are already available on the market. In the second phase, from 2030 onwards, OEMs will have to reduce their emissions by a further 15%, i.e. a total of 30%, relative to the 2019/2020 baseline. The path to meeting the legislator's obligations could be described as a continuous reduction (see Figure 8) with binding milestones in 2025 and 2030. This gives individual manufacturers freedom to time their reduction efforts and flexibility to balance emissions between the different groups of vehicles within their portfolio.

At the same time, the European legislation introduces adequate incentives for early adopters, i.e. those manufacturers that succeed in reducing their emissions beyond the obligations even before 2025 and 2030.

In this case, manufacturers will receive credits which they can then use to meet the binding targets. In addition, between 2019 and 2024, they are incentivized with so-called "super credits" that reward their efforts to meet their commitments for 2025 in the early stage. Although the incentives cover both ZEVs and LEVs (latter defined as vehicles with emissions below 50% of the reference CO2 emission of the sub-group to which the vehicle belongs), the tailpipe approach together with the coefficient applied is significantly more profitable in the case of zero-emission vehicles – such as BEVs. In a super -credit system, a multiplier of 2 applies for ZEV, and a multiplier between 1 and 2 applies for LEV, depending on their CO2 emissions. (European Commission)

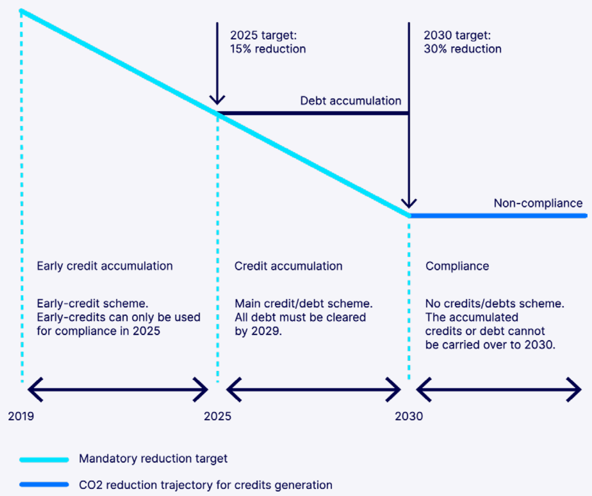

FIGURE 8 – CO2 reduction trajectory to 2030 set by EU legislation. Targets are specific for each European manufacturer. Incentives are prepared for those who get below the desired reduction trajectory and reduce their emission before 2025/2030. Source: International Council on Clean Transportation

The super-credit system is replaced by a benchmark-based crediting system from 2025 onwards. Benchmark-based credits can be applied until 2030. In both super-credit and benchmark-based system, ZEVs not subject to the CO2 targets are accounted in the incentive mechanism but can only contribute to a maximum of 1.5% CO2 emissions reduction. Buses and coaches are excluded from the scheme. The Regulation shall be reviewed in the beginning of 2023 in order to consider its possible extension to buses and other types of HDVs and set targets for 2035 and 2040.

Due to this methodology, we will see many more battery -powered trucks on the road in the near future than, for example, plug-in hybrids. Battery-powered vehicles are number one zero-emission powertrain technology. Based on the existing regulatory framework, ACEA estimates that about 40,000 battery-powered MDVs and HDVs will be needed on European roads by 2025 and this figure will have to increase to a minimum of 270,000 eTrucks by 2030. (ACEA, 2022)

The second major zero-emission powertrain technology, fuel-cell electric, is expected to become widely available during the second half of this decade (2025-2027).24 (ACEA, 2022) However, some argue that the window of opportunity to establish a relevant market share for hydrogen cars is closing. (Plötz, 2022)

2.2 Batteries – the vital element

Be it passenger cars, buses, or trucks, in terms of technology, electromobility revolves mainly around batteries – they are the key component that significantly influences the price. The fundamental difference is the battery size needed to supply energy for heavier vehicles, making its voluminous battery pack a crucial part of eTruck's cost. Battery equipment of individual eTruck models greatly depends on the particular use case (e.g. desired range or payload, see Chapter 2.3). For this reason, the battery configuration of eTrucks is variable – it needs to be tailored to the specific purpose for which the vehicle is being purchased.

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Nickel-based chemistries, such as nickel-manganese-cobalt (NMC) and nickel-cobalt-aluminium (NCA), were dominant in the electric car battery market in 2021 with 75% of cathode material demand share due to their advantages for driving range. Lithium iron phosphate (LFP) chemistry has regained sales over the last two years, reaching an EV cathode material demand share of 25%.

IEA, 2022

Due to the significant size (and thus price) of battery packs deployed in eTrucks, advances in battery technology are the key to industrial competitiveness in the transition to clean energy. In 2021, automotive Li-ion battery demand was 340 GWh – more than twice the level of 2020. This increase is driven by the rising number of battery electric passenger cars (registrations increased by 120%). Battery demand for other transport modes (including medium- and heavy-duty vehicles) increased by 65%. The average battery capacity of an passenger BEV was 55 kWh.18 (IEA, 2022)

Heavy-duty vehicles of course demand significantly higher battery capacity than passenger cars. The battery size of the first-generation eTrucks is between 264 kWh (Volvo VNR) to 540 kWh (Volvo FM/FH). This creates a challenge as large batteries mean an increased vehicle payload – for instance, a battery pack of 600 kWh is equal to more than 3,5 tonnes. (INSIDEEVs, 2021) **Battery size, associated truck weight, usage (e.g., cargo type), and desired range are thus among the critical variables that future eTruck owners will need to consider.**

As demand for batteries grows, the weighted average cost of automotive batteries declined 13% from 2019 to 2021, and a further 6% from 2020 to 2021. Although the bite of rising costs throughout the supply chain was felt in the second half of 2021, overall prices continued to fall. This was mainly due to the adoption of the low-cost cathode chemistry known as lithium iron phosphate (LFP) which reduced the use of expensive cobalt in nickel-base cathodes. However, higher prices for raw materials can increase average battery pack prices in 2022. This could affect even low-cost chemistries like LFP. (BNEF, 2021) IEA estimates that the battery pack prices might increase by up to 15% from the 2021 weighted average price if metal prices were to remain at level from first quarter of 2022. Between January 2021 and May 2022, nickel prices almost doubled, lithium prices increased more than sevenfold and cobalt prices more than doubled. (IEA, 2022)

From a long-term perspective, BNEF predicts that by 2024 average pack prices should be below $100/kWh. At the same time, as demand rises, many new battery plants are under construction and battery manufacturers have signaled large investments in the automotive market. (IEA, 2021) This creates a promising environment for battery-powered trucks, whose large batteries make up approximately about 30% of their cost. (König et al., 2021) However, this figure may vary. Different sources usually report 25–60%, depending on the size of the particular battery pack. Innovations in energy density (meaning lower battery weight) and chemistry, and manufacturing techniques (meaning lower price), could significantly accelerate the market penetration of electric trucks.

2.3 eTrucks development stage

While advances in battery technology driven by the passenger cars sector help OEMs to reduce costs and increase the usability of eTrucks, it is mainly CO2 reduction targets for heavy-duty vehicles together with customer demands that have brought most manufacturers to invest in electromobility. Many of them have announced new electric truck models: over 100 models have been announced for medium freight trucks (3.5–12 tonnes gross vehicle weight) and over 50 models for heavy freight trucks (more than 12 tonnes gross vehicle weight). These trucks will essentially be the first generation of battery-electric trucks and have proposed ranges of 250 km in medium freight trucks and 300–350 km range in heavy freight trucks.24 (Plötz, 2022) Range distances will increase with the next generations of electric trucks as the technology evolves rapidly.

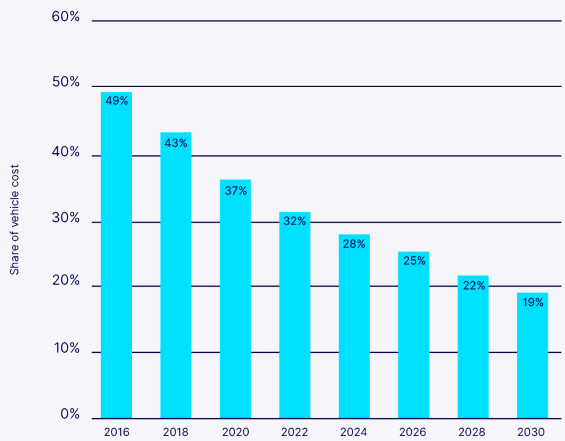


FIGURE 10 – Projected battery costs as a share of large battery electric vehicle costs from 2016 to 2030. Share of battery costs in large BEV vehicles. It is expected that the share of battery costs will decrease in time. Source: Statista, 2022

New opportunities that come along with electromobility bring new customers, and manufacturers that anticipated electromobility entering the heavy-duty segment gained (and will gain) an important market advantage. On the other hand, the opportunity window opens for new players as even established manufacturers in this segment are starting from the scratch.

"

Customers who buy eTrucks are different from those who have traditionally deployed ICE vehicles in their fleets. They are often multinational corporations that are concerned about their carbon footprint and want to reduce CO2 emissions wherever possible, and throughout the entire supply chain.

Petr Jirásek, Electromobility Key Account, Volvo Trucks

Electromobility also brings challenges – one of the most talked-about is the limited operation range of battery-electric vehicles. This might be an issue, especially in the CRT segment that emphasizes efficiency and maximum operational use of vehicles. eTruck manufacturers are developing new models that can cover longer routes without recharging to diminish so-called "range anxiety" among their customers (more on this topic in Chapter 5). Advances in battery technology support the case. Currently, the operation range of first-generation electric HDVs is about 300 km and is expected to increase in the following eTruck generations (Figure 11).

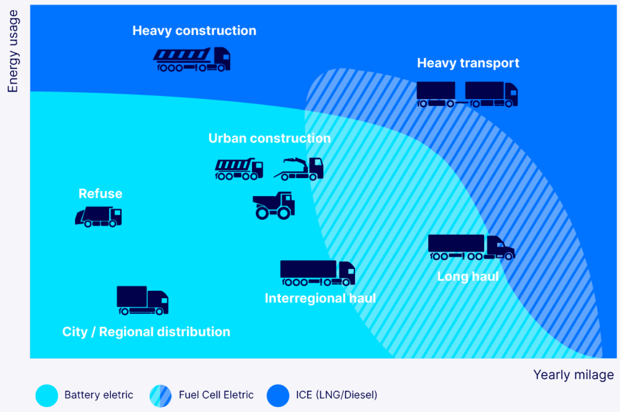


FIGURE 12 – A mix of products will be requered in 2030 to support -50% CO2. To satisfy both the customer needs and CO2 reduction targets, OEMs will need to include several types of HDVs in their portfolio. In short term, battery-electric HDVs will be deployed mainly in use cases with lower and medium operation ranges (urban and regional distribution). Source: Volvo

However, to penetrate the mass market, simply expanding the operation range is not sufficient. For eTruck manufacturers to succeed with customers, it requires not only technology, but also cost-efficiency. There are currently no technical barriers that prevent OEMs from building eTrucks with a 1000 km range – it just requires enough battery cells.241 (Plötz, 2022) It is the enor mous price of such a hypothetical model that is the real obstacle. Moreover, with a compulsory 45-minute break every 4,5 hours mandated by the EU – during which the vehicle can be charged – such a model would bring no real advantage in the vast majority of use cases. Manufacturers need to carefully listen to their customers to introduce BEV models that will meet market requirements on both costs and usage (Figure 12).

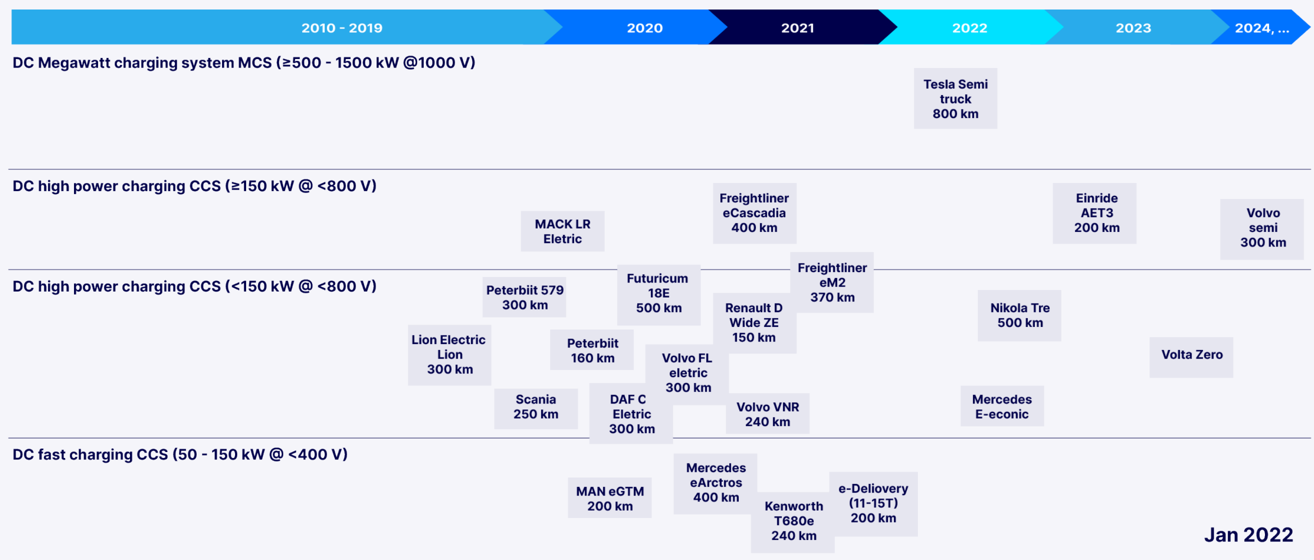


FIGURE 11 – Introduction of electric heavy-duty trucks. Source: ABB

2.4 Market situation and prospects

In the discussion about what is technically possible regarding future energy technologies, associated costs cannot be omitted. In the long term, costs are decisive.241 (Plötz, 2022) In this regard, the benefits of eTrucks grow with increasing mileage. Moreover, battery-electric vehicles' minimal maintenance expenses will also be a part of the equation that might bring customers to eTrucks in the following years. The high energy efficiency of BEVs could be the key market advantage over other alternative powertrains such as FCEV (see Chapter 3).

> **According the Guinnes World Records, the world record for eTruck mileage was set in June 2021. At the Continental Contidrom test site in Germany, a Futuricum electric truck drove distance of 1099 km with a single charge. On November 25, 2022, Tesla demonstrated the possibilities of eTrucks outside of the test track, in real-world operation. Without charging on the way, Tesla Semi completed a 500-mile drive (804 km) between Fremont and San Diego, CA, USA. The eTruck was fully loaded with 36,700 kg (81,000 lbs) gross combination weight, travelled in highway speed and over 4,000 ft of elevation.**
>
> **Tesla, 2022**

Customers will probably demand improvements in single charge mileage to overcome range anxiety. Nonetheless, looking at the current data from the CRT industry, the electric vehicle operation range (ca 300 km) might not be an obstacle. About 50 % of all trucks do not travel more than 300 km a day (see Chapter 5). If there is adequate charging infrastructure (see Chapter 4), electric trucks will be able to recharge during the driver's mandatory rest periods. Moreover, continuing improvements in battery energy density could save about half a tonne of electric long-haul trucks' payload by 2025. (Transport & Environment, 2021)

3. eTruck's life cycle and sustainability

To assess the environmental aspects of eTrucks concerning their entire life cycle and sustainability, we will focus on life cycle assessment (LCA) in this chapter. This ISO-standardized method assesses environmental impacts associated with all the stages of a product's life – from raw material extraction through materials processing, manufacture, distribution, and use. Therefore, life cycle assessment is the most commonly used tool to determine the actual environmental impact of battery-powered trucks. Specifically for automotive industry, a sub analysis of LCA called well-to-wheel assessment is also being widely used. For the purpose of this study, we will first examine the well-to-wheel perspective in Chapter 3.1, using the methodology of a recognized joint study published by JRC (the Joint Research Centre of the European Commission), EUCAR and Concawe. (JEC, 2020) We will then proceed with a with a full cradle-to-grave perspective of LCA in the following subsections.

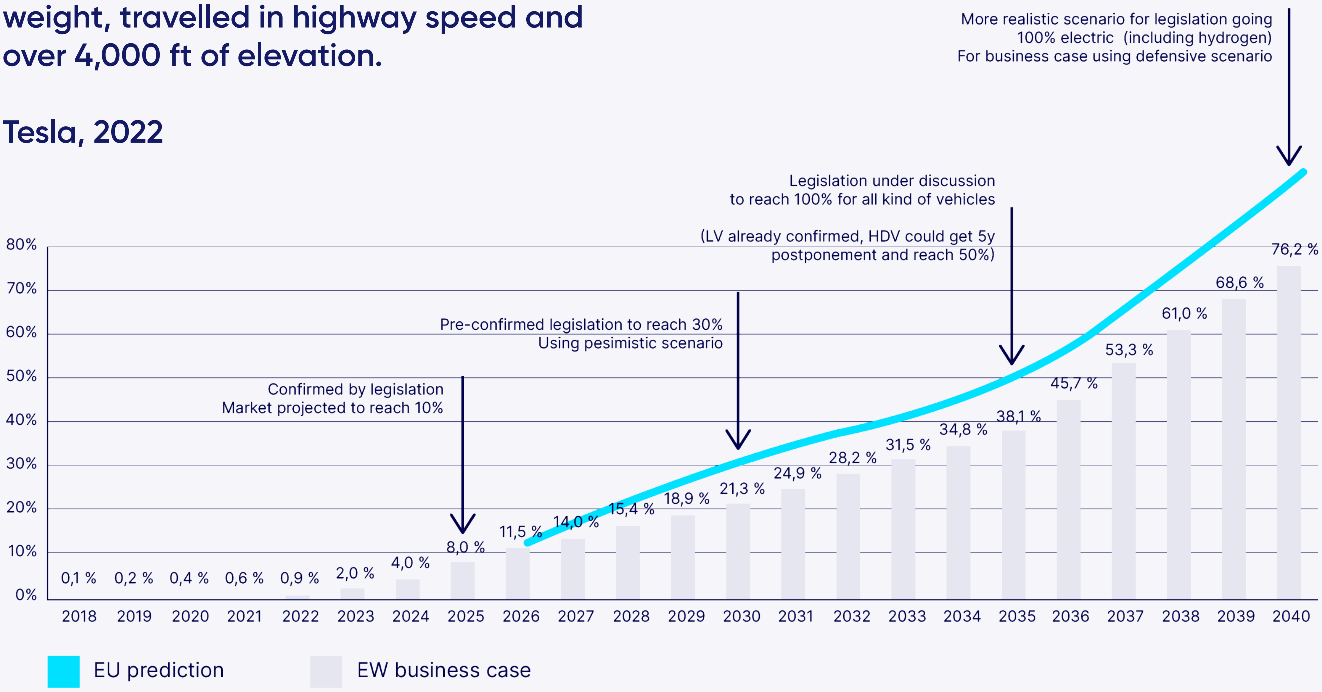


FIGURE 13 – Share of EV trucks on total # of new trucks. Addressable eTruck market. Development of eTruck market will follow the trend set by the LV. We expect that by 2030, total market share of the eTrucks will be around 21%. Source: Eurowag

3.1 eTrucks in well-to-wheel perspective

In the previous chapter, we explained the key features of the technologies that battery-powered trucks use and the reasons (legislative, technological, and others) why many believe battery-powered trucks represent the future of freight transport. However, some metrics, such as the aforementioned legislation, reflect only on the CO2 emissions produced by the vehicle itself – the so-called "tank-to-wheel" (TTW) approach. As it is our task to objectively describe all aspects of eTrucks, in the following paragraphs we will take a closer look at a more comprehensive, holistic approach to the environmental impact of eTrucks.

To obtain a bigger picture, we need to take a different stance – the well-to-wheel (WTW) approach. **It analyses how both fuel production pathway and powertrain efficiency impact greenhouse gas emissions and/or total and fossil energy use.** The WTW analysis consists of two areas: the well-to-tank and the tank-to-wheels components (see Figure 14).

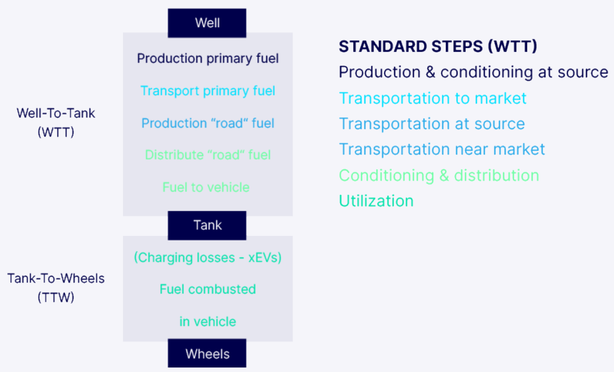


FIGURE 14 – Scope of the well-to-tank analysis. Source: JEC, 2020

While the already mentioned tank-to-wheel analysis (TTW) refers to a subrange in the energy chain of a vehicle (this subrange extends from the point at which energy is absorbed at a charging point or a fuel pump, to discharge, ie. being on the move), it is preceded by the well-to-tank (WTT) chain. This area represents the subrange of fuel supply from the production of the primary fuel, transport of the primary fuel, production of the road fuel and distribution to fuel supply (i.e. transport to the charging point or fuel pump and eventually fuelling the vehicle).

If we look at the results of the JEC 2020 study in each category, we find that in TTW approach, fully electric and fuel cell alternatives offer zero GHG emissions and significantly higher energy efficiency, up to 2.5 times for catenary electric vehicle.330 (JEC, 2020)

In the case of WTT, the calculation is much more difficult and complex as there are a huge number of scenarios that contribute to the variability of the results (especially the conversion pathways chosen and the feedstock/resource used). The variability, especially in the case of electricity, is illustrated in Figure 15. When EU mix is considered, electricity falls among the most WTT energy-intense pathways, together with liquefied bio-methane (LBM) and synthetic OME. However, when produced from biogas, electricity, together with hydrogen, offer the possibility to achieve negative WTT emissions. It again highlights the importance of the conversion pathways chosen and the feedstock/resource used, as the impact of using battery-powered vehicles strongly depends on these variables.

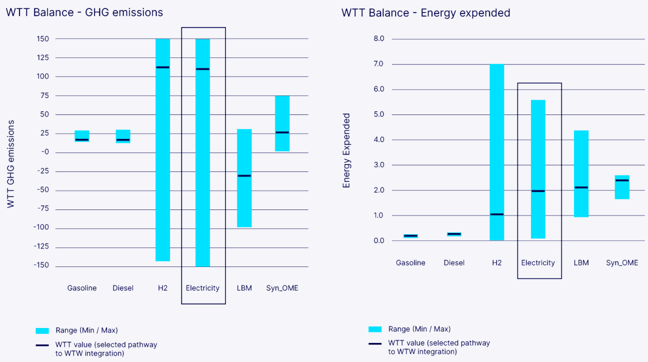


FIGURE 15 – Comparison of WTT values of different fuel production pathways. Source: JEC, 2020

Let's take a look how battery-powered trucks perform in comprehensive WTW analysis. Not surprisingly, here again are the results strongly affected by the electricity source (see more in Chapter 3.3). In HDV segment, battery electric vehicles (BEV) and catenary electric vehicles (CEV) show lower GHG emissions for the selected electricity pathways than a similar HDV with CI engine fuelled with conventional, crude oil-based diesel – the only exception is when the electricity is gained from coal. This means that the precise impact of implementing eTrucks can by analysed at country level, based on its electricity mix.

However, the battery-electric technology (and other xEV powertrains) is expected to improve significantly towards 2025+. Together with the decarbonisation if the electricity, this could lead to significant GHG emissions reductions.
In case of the theoretical 2025+ EU mix, reductions up to 40% versus the equivalent 2016 technology can be observed in HDV type 4 (see Figure 16).330 (JEC, 2020)

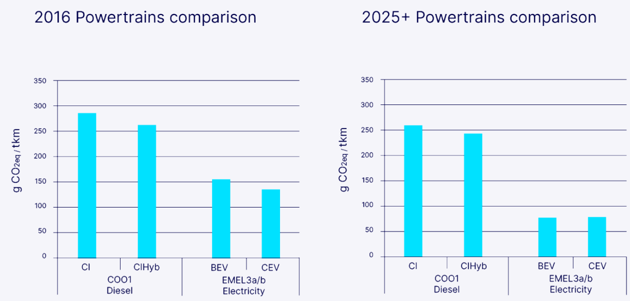


FIGURE 16 – Decarbonisation of electricity in 2025+ scenario could lead to significant GHG emissions reductions (HDV type 4). Source: JEC, 2020

In the future when all electricity mix is low carbon, the well-to -wheel scenario in term of energy efficiency could look more like Figure 17. As you can see in Figure 17, the battery-powered eTrucks achieve very high energy efficiencies of around 70–90% in this future WTW model. First, the WTT chain of a BEV is greatly simplified compared to other propulsion types as the electricity produced is itself the fuel and no further steps are needed. Energy is slightly lost in transportation and storage, and minimally in charging. Secondly, the vehicle itself retains the same high efficiency from a TTW perspective. Electric motors are known for their high efficiency, reaching 85–90%. BEVs also use regenerative braking to recapture and reuse energy that would otherwise be lost in braking. This also ensures that no energy is wasted by idling. (FuelEconomy.gov, 2022)

The low efficiency of the internal combustion engine, where – similarly to a conventional light bulb – most of the energy is converted to heat, is fairly well known. Only about 14–30% of the energy from the fuel you put in a conventional vehicle is used to move it down the road. (EEA, 2016)

Hydrogen propulsion is not doing much better in terms of efficiency. Unlike an ICE vehicle, it's a zero-emission drive, but with significantly lower energy efficiency than a BEV vehicle. Hydrogen is an energy carrier, not an energy source, which means that there still needs to be a lot of work done for hydrogen to move a truck. Most data indicates that the efficiency of a hydrogen engine at the current state of development is between 25% and 35%. (Volkswagen, 2022)

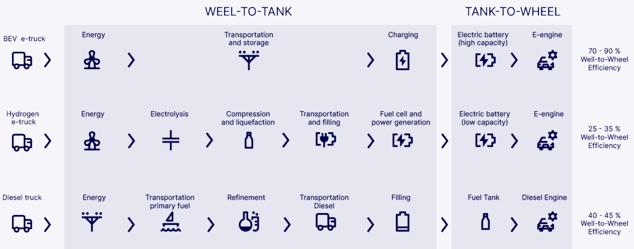


FIGURE 17 – Energy efficiency comparison per propulsion type (well-to-wheel perspective) in future low carbon electricity scenario. Source: ABB

It is also important to note that there is currently no truck manufacturer that is mass-marketing hydrogen-powered trucks. Development is in the pilot project phase. If customers are interested in purchasing ZEVs, battery-powered vehicles are currently the only option. Therefore, in terms of LCA comparison, the following paragraphs will focus on the comparison of the two available technologies, BEV and ICE.

3.2 Life cycle of an eTruck

A truly comprehensive assessment of the environmental impact of eTrucks is provided by the aforementioned life cycle assessment. This method takes into account the entire life of a product, in our case a truck, from cradle to grave, i.e. from production to end-of-life.

At the beginning of their life, trucks start with an initial disadvantage. The production of batteries, the main part of a BEV (see Chapter 2), generates a large amount of emissions. The production process for the battery cells is very energy-intensive, and as a result, the climate impact of producing an electric vehicle is significantly higher than its diesel equivalent.

However, this difference is quickly compensated for in the context of the vehicle's future lifetime. The benefits of zero-emission technology will soon become apparent in the environmental impact. After a certain number of kilometers, the amount of emissions generated evens out. The length of this period can vary. Scania's study indicates that if we consider the European energy mix of 2016, the break-even point comes after a distance of just 68,000 kilometers. Given a projected service life of 500,000 kilometers for this kind of vehicle, the electric truck will emit 38% fewer greenhouse gases into the air than its diesel counterpart. (Traton.com, 2022)

3.3 Impact of the energy mix

There is one big 'but'. As we already stated in section 3.2, the fundamental variable that affects the environmental impact of BEVs is the energy mix, i.e. how the electricity consumed is produced. The study states that if eTrucks ran only on 100% renewable electricity, the savings would be as high as 86%. In that case, the tipping point would come after about 33,000 kilometers. That's usually a few months in trucking parlance.374 (Traton.com, 2022)

What if the energy was derived from burning fossil fuels? Then the eTrucks would, on the contrary, perform much worse in terms of LCA rating, even compared to ICE – see Figure 15. Some truck manufacturers, such as Volvo, recognize that LCA is an extremely important aspect of eTruck investment and that this metric takes many variables into account – including country of operation and its energy mix. Therefore, they offer LCA evaluation through a calculator on their website.

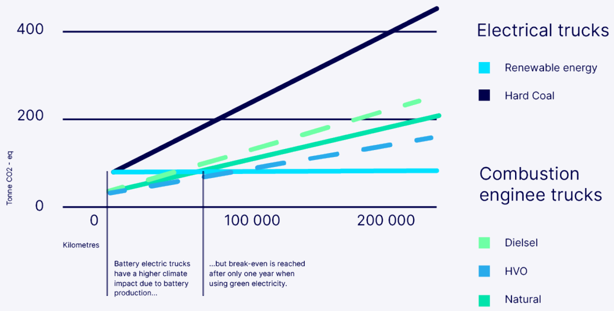


FIGURE 15 – A truck 's emission break-even per energy source. If powered by electricity from a renewable source, the life cycle assessment of an electric truck will show a very low climate impact. Source: Volvo

3.4 Old batteries, new opportunities

Another factor that is likely to improve the life cycle assessment of eTrucks is battery recycling. Manufacturers are rethinking what happens to the vehicle, especially its battery after it reaches the end of its life. They aim to have as much circularity as possible to ensure that raw materials are kept in a loop as long as possible to eliminate waste and pollution. Such circularity would bring resource efficiency and significant cost-saving opportunities.

There are several possibilities for what happens to the battery when it is no longer suitable to power an eTruck: a vehicle powered by an aged battery with reduced capacity can be used in another application, for example on shorter distances. If further use of the battery in transport is no longer possible, such batteries can be used as stationary energy storage.

The emerging electric battery recycling market creates new business opportunities. Volvo, for example, has set up a new subsidiary, Volvo Energy. Its mission is, among others, to create an attractive and sustainable circular business model for second-life batteries.

Recycling also offers great potential since batteries can be almost completely recycled. For that reason, manufacturers aim for completely circular battery life. This means establishing battery refurbishing, remanufacturing and recycling networks, optimizing battery logistics, and designing its second life.

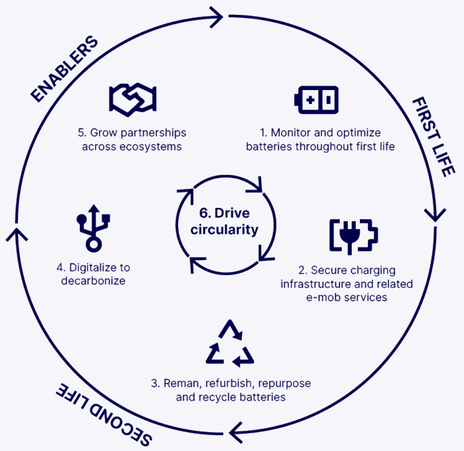


FIGURE 16 – Necessary steps to reach full circularity of BEVs' battery. Source: Volvo

However, considering the lifetime of a battery, the need for recycling is likely to occur somewhere around 20 years of battery age. Given that the first eTrucks are just hitting the road, this means that currently, the market does not have enough end-of-life batteries to recycle and use in electromobility. While the use of already recycled batteries will have a further positive impact on the life cycle assessment of eTrucks, we will probably have to wait a few years to get to the desired circularity.

To make electromobility truly future-proof, manufacturers are already preparing for the challenges (such as collecting batteries, gathering data to optimize their first and second life performance, and monetization). It seems like an insightful move, given that the battery recycling sector has great potential. Electric vehicle battery recycling was estimated at USD 138.6 million and is expected to reach a CAGR of 41%, hitting 2.27 billion by 2026. (Market Data Forecast, 2022)

4. Charging infrastructure

Infrastructure is usually identified as one of the main challenges of electromobility. No wonder. The success of the electrification project and thus the decarbonization of commercial freight transport depends to a large extent on the density of the charging network, its performance, reliability, and other variables. Moreover, what we see here is a typical "the chicken or the egg" dilemma. Is a good and sufficient charging infrastructure the basis for mass deployment of eTrucks, or will infrastructure development naturally follow once eTrucks are on the road? In this chapter we look at this critical aspect of electromobility in detail: the charging ecosystem, the current state of infrastructure, charging points, charging capacity, and related technologies. We will also take a look at the broader scope of the problem, i.e. the overall impact of electromobility on the electricity grid and the possibilities to optimize the distribution of electricity in the future, such as vehicle-to-grid (V2G) technology.

4.1 eTruck charging ecosystem

The charging infrastructure is not just a specific charging point where the driver charges his vehicle. It is a complex ecosystem consisting of many critical areas (Figure 17) and the mass proliferation of eTrucks brings entirely new demands on it. While the current charging infrastructure for BEVs is constantly evolving – especially with the increasing use of battery-powered passenger cars – charging eTrucks has its specificities that often cannot be met by the already existing network of charging points. These are mainly the following factors:*

Size of a charging location and its throughput/passability: eTrucks have specific space requirements. The current charging points often simply cannot fit eTrucks. Moreover, most of the charging stations are not currently built as "drive-through" and this may be an issue in a small area as turning around an HDV requires a lot of space. Builders can take inspiration from current truck parks that are always designed to be passable.

The power output of a charging point: eTrucks need much higher charging power. Due to the size of their battery and the workload demands, charging points for eTrucks need to have a higher power output than those for cars, providing faster charging. The optimal charging power for eTruck starts at 350 kW.

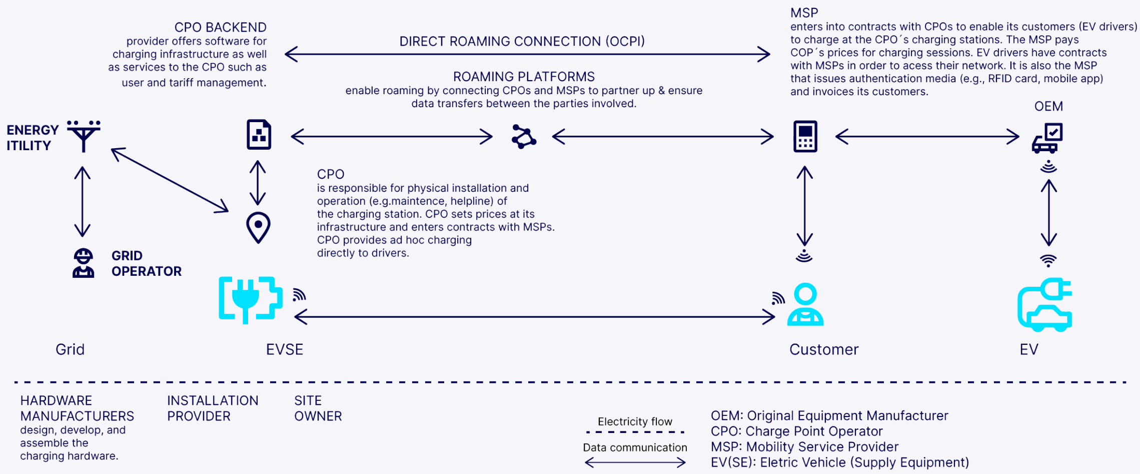


FIGURE 17 – The EV charging ecosystem - roles & responsibilities. Charging ecosystem. Source: ChargeUp Europe

*There are some other aspects such as payments and invoicing options, roaming, etc. These will be discussed in Chapter 5.

The density of a charging infrastructure: The commercial operation of eTrucks will also require that major transport corridors are equipped with a sufficient number of charging points for battery-powered MDVs and HDVs. Other destinations – depots, logistics and distribution centers, etc. – will also need to be equipped with optimal charging solutions.

Reliability of a charging location: In a heavily time-based industry like CRT, eTruck dispatchers and drivers need to make sure that the location where they plan to recharge will be functional, with optimal charging power, and available. Otherwise, there is a risk of queues at charging stations and delaying deliveries. This requires additional, often real-time, data about a charging point.

However, not only factors mentioned above mitigate eTrucks' use of the current charging infrastructure. It's also different driver's behavior, patterns and CRT needs that require specific approach to charging locations. Planning routes and charging sessions will be different from what the transport industry was used to with ICE vehicles. Thus, in the first phase of electrification, we expect most of the charging sessions to happen in the **non-public and semi-public charging locations**. In the following section, we describe the individual types of such charging locations to understand its differences and characteristics.

4.2 Typology of charging locations

DEPOT CHARGING

Depot charging will be the dominant charging solution for the first generation of eTrucks. There are several reasons for this. First, eTrucks are being initially implemented in the applications where it is easiest: urban and regional delivery. Due to their limited range, pre-established routes, and operation during the day, these applications will be optimal for first-generation eTrucks. The results of the CE Delft's study on charging infrastructure in city logistics showed that depot charging was the primary option (78% of charging sessions), especially at night (64% of depot charging sessions). (CE Delft, 2019)

Due to its practicality, efficiency, and better control over charging costs (possibility to use low electricity tariffs), depot charging will likely stay the dominant type of charging also in the future. Haulers and depot operators should therefore invest early in their electric vehicle charging solutions. The construction of charging points and establishing (or upgrading) a grid connection can be quite a long procedure – the process can take up to 3 years, although precise times can vary across EU member states and between distribution system operators.10 (ChargeUp Europe, 2022) This, of course, applies to all types of charging locations.

Because its common that depot and truck operators are different entities, new commercial model needs to be established to guarantee their cooperation in vehicles recharging. To ensure that charging facilities in depots will be built with sufficient pace, a regulation should be considered – e.g. an obligation for any new loading/unloading facility to be equipped with a charging point suitable for eTruck (i.e. charging power of 350 kW or more) and, at the same time, with digital connectivity allowing eMobility providers to connect. Existing depots could be incentivized by public subsidies, should projects comply to certain standards and connectivity requirements.

DESTINATION CHARGING IN DISTRIBUTION AND LOGISTICS CENTERS

Charging at distribution and logistics centers during loading and unloading is the next logical step to extend the range of eTrucks. Charging at the destination can add up to several hundreds of kilometers of range per day (see Figure 19). In addition, this will not make much difference to the daily operation of eTrucks as trucks typically stay on site for more than 30 minutes during loading and unloading. In this scenario, charging would take place directly in the loading area. Due to the limited charging time, a more efficient charging solution must be considered for destination charging (350 kW or more).

Another alternative of destination charging are public charging hubs built very close to destination points, e. g. logistic or distribution centers. Such charging solution would consist of several charging stations dedicated to trucks that can serve customers of multiple companies, especially if charging infrastructure at the loading/unloading area is not ready, available or possible. This scenario would be very similar to what we see today when truck parks for ICE vehicles are located close to logistic/industrial areas. Possibility of serving more purposes at once (e.g. refueling/recharging, guarded parking, refreshment for drivers) is another benefit of this solution.

In the CE Delft city logistics study, destination charging accounted for 16 % of all charging sessions. Further deployment of destination charging can be expected within 1–2 years.

PUBLIC AND SEMIPUBLIC CHARGING

Infrastructure density and parameters

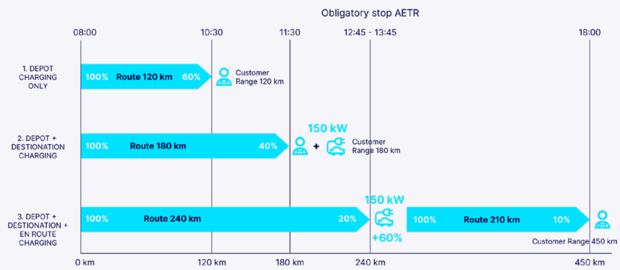


FIGURE 19 – eTruck range according to infrastructure development. Different range scenarios of today's eTruck generation, depending on available charging locations. To calculate the example, we used Volvo FH electric truck with range up to 480 kilometres. In the figure, we see that this eTruck can be used for various use cases, depending on charging behavior and charger availability at the depot [1], at the destination [2] or when the public charging hub en route is available [3]. As the charging infrastructure develops, the operating range of eTrucks will extend. Source: Eurowag

The ability to charge an eTruck on the road without worry is one of the key challenges facing electromobility. Firstly, the current level of infrastructure needs significant investment and development. Out of more than 500,000 publicly accessible charging points in Europe (please note the total amount of charging points change dynamically, see Chapter 1.3) more than 50% are located in just three countries: the Netherlands (114,000), Germany (84,000) and France (81,000). (Eco-Movement, 08/2022, and Sygic, 2022)

* 45 minutes is the mandatory break time under EU law and AETR rules. Long-haul drivers need to take this break every after a driving period of no more than 4.5 hours4,5 hours. The maximum daily driving time is 9 hours, which means that after 9 hours of driving in a day, a driver needs to take a rest period, ie. at least 11 continuous hours of rest (called a regular daily rest period)..

If we limit the network to charging points with optimal power output for eTrucks (350 kW or more), the number declines approximately to 3,500 unevenly distributed public and semipublic charging points across the EU (see Figure 20).

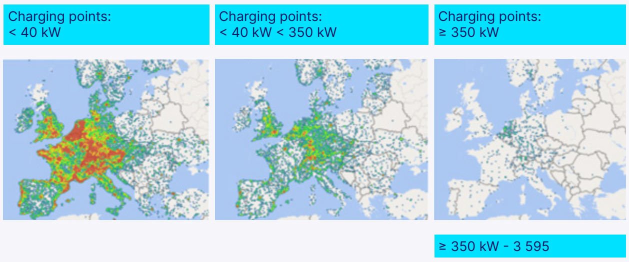


FIGURE 20 – Charging points density based on charger output. Source: Sygic maps, May 2022

High power charging points are necessary for eTrucks: to fully charge an average 400 kWh eTruck battery (see Chapter 2.2) during the mandatory break time of 45 minutes, the power output of a charger needs to be 750 kW or higher. Such a high-power infrastructure demands considerable investments – a single charging point could cost between €200,000 and €350,000. (McKinsey, 2022)

However, when assessing if an existing charging location is suitable for electric trucks, the power output is not the only parameter to consider. Other parameters, such as charging station dimensions or truck road accessibility towards a charging point, are crucial (for more details see Chapter 4.1). Considering all these limitations, we expect the actual number of charging points suitable for electric HDV to be even lower than 3,000. Currently, no such database of charging points with full limitations exists. Nevertheless, companies such as Eco-movement or Eurowag already work on a solution.

In 2025, we expect there need to be at least 8,000 of high-power public and semi-public charging points suitable for trucks in the EU, with the number increasing to more than 20,000 in 2030.

Recently, a study conducted by Fraunhofer on behalf of the European Automobile Manufacturers' Association (ACEA) has been published, stating recommended locations where to start installing dedicated charging points for electric HDV. These locations were prioritized based on the most frequent truck corridors/roads and truck-required stops.

Daimler Truck, Traton and Volvo have started a joint venture for an electric truck charging network. They plan to build and operate at least 1,700 high-capacity green power charging points on and near motorways and at logistics hubs in Europe. The three partners want to invest a total of €500 million euros for this purpose.

Electrive.com, 2022

The study mentioned that by 2027, around 3,126 charging locations will be needed (if we consider at least 3–4 charging points per location, the total number would climb up to 9,000–12,500 charging points). (ACEA, 2022)

This brings us to the question that many industry players are asking: Who will be deploying these dedicated charging points for HDV and who will finance them? A single charging point may cost a significant amount, starting at €40,000, and additional resources are needed to ensure sufficient energy at the location. There are already announced partnerships and joint ventures between OEMs planning huge investment and development of HDV charging infrastructure. However, if the deployment should be in certain speed, incentives and subsidies on national and European level need to be established. More about the legislation and subsidies can be found in Chapter 2.4.

EUROWAG CASE STUDY: Are the European countries ready for truck electrification?

Index Goal

As shown in the previous paragraphs, the readiness of Europe's infrastructure for electric trucks is still in question. Seeing that eTrucks impose specific charging requirements, there are several challenges and obstacles to a fully functional charging infrastructure on European roads. We have therefore taken a comprehensive look at the readiness of individual European countries. To this end, we have created a unique index that indicates how ready each country is for HDV electrification. The index also allows countries to be clearly compared and provides an exceptional view of the European charging infrastructure.

Index Methodology

Firstly, the most recent and reliable data covering eMobility topics were gathered. These include information about charging infrastructure, vehicles/fleets, legislation, and green policies from various sources (EAFO, ACEA, Sygic and Eco-movement).

When developing the index analysis, we concentrated on the following parameters:

- No. of all charging points and no. of charging points ≥ 350kW [source: a combination of Eco-movement 02/2022 and Sygic 05/2022]
- Share of electrification of passenger vehicles to all fuel vehicles [source: EAFO and ACEA 01/2022]
- Share of electrification of HDV and MDV to all fuel HDV and MDV [source: EAFO and ACEA 01/2022]
- Policies implemented [source: EAFO 04/2021]

Each parameter shows us certain aspect of preparation for electrification. We divided each parameter into 3 subgroups, labeled with colors as in the traffic lights:

- **Good**
- **Moderate**
- **Limited**

Within each of the subgroups, we assigned a value for each of the countries. "Limited" are values between 0–5p. "Moderate" are values between 5–10p and "Good" are the values between 10–15p. The maximum amount per one parameter is 15p. The special parameter is the "policy" parameter, where we have 4 values per all countries based on the level of the policy implementation:

0p – no policy implemented,

5p – 1–3 measures of local policy, incentives or tax benefits implemented,

10p – 4–6 measures of local policy, incentives or tax benefits implemented

15p – 7 or more measures of local policy, incentives or tax benefits implemented.

To calculate the country INDEX, values of the different parameters are considered with the same significance.

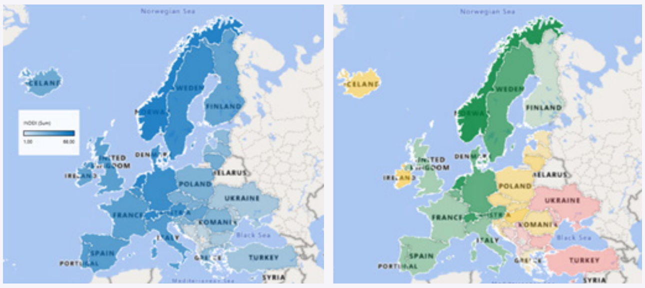
We need to mention that not all European countries have all the data publicly accessible via our sources. In such case, parameter is marked as "grey" and the value of this parameter is 0.

Index Results

Northern and western European countries have shown a leading position in their preparation for HDV electrification. The most prepared country according to the Index is Norway, with a total Index point of 68, closely followed by Netherlands and Switzerland. Sweden and Germany also made their way to the top 5. The Latin Bloc – Italy, Portugal, Spain, and France – reached high index scores as well.

Medium readiness has been seen in Baltic countries and central Europe. Eastern European countries and countries missing relevant data ranked at the bottom of the index.

For the study results, see Figure 21 and Table 1, which is the list of countries ordered by the final index score from highest to lowest.



Top 15 countries with the highest score:

Country	Score
Norway	68
Netherlands	65
Switzerlands	63
Sweden	58
Germany	57
Denmark	54
Austria	53
Belgium	52
Italy	47
Portugal	46
Spain	45
Luxembourg	44
France	44
UK	44
Finland	40

FIGURE 21 – Map of countries, labeled by index results. Source: Eurowag

TABLE 1 – European countries index ranking

COUNTRY	All charging points	Charging ≥points 350kW	Share of EV passenger cars to all	Share of EV HDV/MDV to all	Policy implemented	INDEX
Norway	● (light)	● (light)	● (light)	● (light)	● (light)	68
Netherlands	● (light)	● (light)	● (light)	● (light)	● (medium)	65
Switzerland	● (light)	● (light)	● (light)	● (light)	● (light)	63
Sweden	● (light)	● (light)	● (light)	● (medium)	● (light)	58
Germany	● (light)	● (light)	● (light)	● (medium)	● (medium)	57
Denmark	● (light)	● (light)	● (light)	● (medium)	● (light)	54
Austria	● (light)	● (light)	● (medium)	● (medium)	● (light)	53
Belgium	● (light)	● (light)	● (light)	● (dark)	● (light)	52
Italy	● (light)	● (light)	● (medium)		● (light)	47
Portugal	● (light)	● (light)	● (medium)	● (medium)	● (light)	46
Spain	● (light)	● (light)	● (medium)		● (light)	45
Luxembourg	● (medium)	● (medium)	● (light)	● (light)	● (dark)	44
France	● (light)	● (light)	● (light)		● (dark)	44
UK	● (light)	● (light)	● (light)	● (medium)		44
Finland	● (light)	● (light)	● (medium)	● (dark)	● (medium)	40
Hungary	● (medium)	● (medium)	● (medium)	● (dark)	● (light)	39
Ireland	● (medium)	● (medium)	● (light)	● (dark)	● (medium)	39
Iceland	● (medium)	● (dark)	● (light)		● (light)	35
Lithuania	● (dark)	● (medium)	● (medium)		● (light)	32
Slovakia	● (medium)	● (medium)	● (medium)		● (medium)	29
Czechia	● (medium)	● (medium)	● (dark)		● (medium)	29
Poland	● (medium)	● (medium)	● (medium)		● (dark)	28
Romania	● (medium)	● (medium)	● (dark)		● (medium)	25
Croatia	● (medium)	● (medium)	● (dark)		● (medium)	25
Slovenia	● (medium)	● (medium)	● (medium)		● (dark)	25
Latvia	● (medium)	● (medium)	● (dark)	● (dark)	● (medium)	22
Estonia	● (dark)	● (medium)	● (medium)		● (dark)	21
Greece	● (medium)	● (dark)	● (medium)		● (light)	20
Cyprus	● (dark)	● (dark)	● (light)		● (dark)	13
Turkey	● (medium)	● (dark)			● (dark)	13
Bulgaria	● (medium)	● (dark)			● (dark)	10
Ukraine	● (light)	● (dark)			● (light)	10
Malta	● (dark)	● (dark)			● (dark)	7
Liechtenstein	● (dark)	● (dark)			● (dark)	6
Moldova	● (dark)	● (dark)			● (light)	3
Serbia	● (dark)	● (dark)			● (light)	2
Andorra	● (dark)	● (dark)			● (light)	2
Montenegro	● (dark)	● (dark)			● (light)	1
Gibraltar	● (dark)	● (dark)			● (light)	1
Bosnia and Herzegovina	● (dark)	● (dark)			● (light)	1
Albania	● (dark)	● (dark)			● (light)	1
Republic of North Macedonia	● (dark)	● (dark)			● (light)	1

Nitty gritties of road freight transport

New charging points also need to be built with eTrucks in mind. Therefore, they should not only be designed (i.e. with optimal spatial dimensions and power output) but above all also accessible for freight transport purposes only – i.e. semi-public charging locations. This will prevent a designated, spacious truck charging point from being randomly occupied by a passenger vehicle.

> **Charging infrastructure suitability for medium and heavy-duty vehicles is an emerging issue that will become dominant in the following years. There will be higher demands on infrastructure reliability and associated detailed, trustworthy infrastructure data.**
>
> Sjors Martens, Eco Movement

Battery-powered freight transport will also bring higher demands on the other aspects of charging infrastructure. More and more emphasis will be put on detailed information about the charging point: whether it is functional, what are its operating hours (whether it is accessible for overnight charging), what are the payment and roaming conditions (i.e. whether a particular carrier can charge at this particular point), what is the predicted availability (how busy this charging point is), whether it is available or occupied at any given moment. Closely related to this is the possibility of reserving charging sessions, which is an emerging issue for the future.

To reserve, or not to reserve

While carriers, shippers, and drivers are likely to be in favor of reservation systems to ensure they can recharge when they need to, the day-to-day operation of such a system has many challenges. Even a short delay of a vehicle along the way (which is hard to avoid in road transport) could create confusion in the charging queue, especially for fast charging where charging sessions are relatively short. There is also a question of whether vehicles currently at the charging point should be prioritized. After all, the business goal of charge point operators is to maximize the use of the charge point they operate. It is hard to imagine that the booking system would give priority to a vehicle that is not yet on-site (and it is uncertain when, or even if, it will arrive). On the other hand, this creates another business opportunity for many players as booking and reservation of the charging could be organized as hotel booking. In such case, a system couldn't be for free and booking a charging point would presumably incur a charge. Then the backend systems of the charging stations need to be prepared for a request for such solutions from OEMs or charging infrastructure developers.

A system used in the US is one of the possible alternatives to charging spot reservations: Drivers can only book a charging session at the charging point. In that case, a digital queue is created. It has several benefits: drivers are assured of getting their turn, plus they get an estimation of when that will be. The system eliminates confusion on the spot and ensures that the charging point is at maximum capacity at the same time.

Preventing charging anxiety

Although challenging and costly, immediate investments in infrastructure are necessary. **If key stakeholders (fleet owners, dispatchers, and drivers) become distrustful of charging infrastructure, it will significantly slow down the implementation of eTrucks in the fleets.** Infrastructure for battery-powered vehicles needs to – at least to some extent – catch up with the current fueling infrastructure to provide the desired certainty of available charging on the road (and the time spent there). The research conducted by Shell and Deloitte, reflecting 158 road freight stakeholders, confirms when citing one of the interviewees: "No operator will take a chance on a new truck unless they are certain they will be able to fuel or charge it." Around 80% of interviewees in the research considered lacking access to fast battery charging a limiting factor. (Shell & Deloitte, 2021)

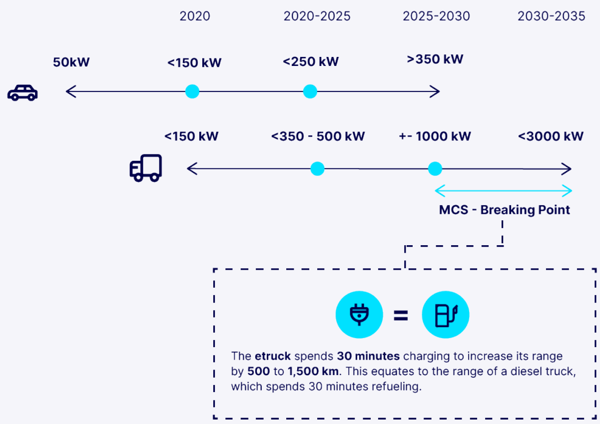


FIGURE 22 – Development of the charging power output between 2020 and 2030/35, and its relevance for passenger cars and trucks. Source: Eurowag

Efforts to satisfy demands for fast charging infrastructure are already on their way. Charging power for electric trucks starts at the level where today's infrastructure for electric passenger cars ends (150–250 kW, see Figure 22). As mentioned, optimal charging power for eTrucks starts at 350 kW. Moreover, the introduction of the megawatt charging standard (MCS) with more than 1000 kW of charging power – currently under development – is going to balance the disparity between refueling ICE and recharging BEV. With megawatt charging, the time spent at the charging stop and obtained mileage would be equivalent to diesel trucks, which nowadays spend approximately 30 minutes refueling. Data shows that we could achieve refueling/recharging parity by 2030–2035. In the following chapter, we will thus examine the impact of MCS and charging power output in overall on infrastructure, grid and electric trucks deployment.

4.3 Power output

Charging of battery-powered electric vehicles is covered by standards that ensure the compatibility and interoperability between chargers and vehicles, whether it is a car or a truck. The European charging connector standard is called CCS2 – the EU mandated the use of this standard in 2014. This standard allows both AC and DC charging and provides power at up to 350 kilowatts. One of the competing standards is called CHAdeMO. It uses a different connector and communication protocol and is mainly being implemented by Asian car manufacturers in their vehicles. In Europe, there were about 9,200 charging points with the CHAdeMO standard in 2019. (CHAdeMO) Charging points are usually supplied compatible with both of these major standards.

While the standards ensure the universal usability of charging points and protect investments in battery-powered vehicles, the charging power output varies. This is because the charging needs depend on the specific eTruck and the application for which it is used. There is a large number of use cases, from medium power depot charging to ultra-high power on-route charging. Thus, to some extent, existing technology serves (and will serve) eTrucks well, mainly in intercity applications. At the same time, it is undeniable that to implement eTrucks for long range, it will be necessary to develop a more powerful charging solution.

"

The specific charging solution and its power always depend on the needs of an individual customer. A customer operating intercity transport and charging only overnight will choose a different charging solution than an interregional hauler. Just as the customers pick specific models of eTrucks, they also select and tailor their depot charging solution.

Miroslav Kuželka, ELEM Division director, ABB

FUTURE IS MEGAWATT

That solution will be the megawatt charging standard (MCS), which will allow charging from 1 to 3MW. The current peak power target is 3.75 MW (3,000 A at 1,250 V). This level of power is more than seven times that of the CCS Combos 500 kW peak. According to National Renewable Energy Laboratory (NREL) – a national laboratory of the U.S. Department of Energy – at 3.75 MW, a single car would consume the equivalent power to the average of 3,200 US homes. It would transfer an average home's daily energy use in around 28 seconds. The first implementation will be, however, 1,5 MW.

The MCS charging connector and cable, intended for charging large battery electric vehicles – such as heavy-duty trucks, but also buses or aircraft – are under development. The standard focuses on Class 6, 7, & 8 commercial vehicles, but could easily be used for any large battery electric vehicles (BEVs) with huge battery packs and the ability to accept a >1MW charge rate. At the same time, battery producers and OEMs need to develop battery packs and vehicles that can receive such power.

A megawatt charging system is currently under development and the first pilot projects are underway. The MCS will require a new approach to the management of charging points and the grid (more in Chapter 4.4). MCS will be a cutting–edge solution but is unlikely to completely displace CCS2. Indeed, for many use cases, it will not even be needed. MCS is expected to be used in long-distance road transport corridors, where it will be necessary to fully charge an eTruck in the 45 minutes of a mandatory break. However, in overnight charging, MCS is unnecessary and charging points will probably make do with the current CCS2 standard. Such clever use of a mix of charging solutions can direct power supply to where it is needed, all through effective power grid management.

To test out MCS solutions on a long-distance truck corridor, the German government started a project called HoLa. Energy supplier Heliox supplied 600 kW MCS charging solutions for trucks in 4 depot chargers along the route from Dortmund to Berlin. The core partners, responsible for providing and operating the vehicles, are Daimler Truck, TRATON, MAN, Scania and Volvo. The project has started in September 2021 and will be held till 2024.

4.4 From the grid's perspective

The increasing number of battery-powered vehicles – including trucks – in operation and the related development of fast charging points will also bring new demands on energy suppliers and the grid. The fact is, eTrucks can shift these requirements by leaps and bounds. There is therefore a constant need to develop transmission and distribution systems to prevent the grid from becoming a bottleneck of charging infrastructure.

The main criterion when developing a charging infrastructure is the available power in a given location. It is important to note that this capacity applies to the whole site, not to a specific charging point. If more than one vehicle is charging at a given location, the available power must be divided between them, or possibly other systems demanding energy. For this reason, it will be crucial to develop efficient charging management that decides how the energy is distributed, without exceeding the maximum available power (which is penalized by energy suppliers).

While the first generation of eTrucks will largely be recharged with the current CCS2 standard, energy distribution systems will be increasingly needed for the next generation eTrucks with MCS compatibility. As seen in Figure 23, the energy management system will consist of several layers. The base layer contains the systems for managing a given locality, the local controller. These can be supplemented with additional stationary energy sources, such as batteries, for peak shaving. The top layer is then the optimization of energy availability for a given locality – clever energy management – with a virtual power plant.

> **The charging point must be supplied with power at all times, even when no one is using it. Because of that, an always -vacant charging location incurs significant costs for the CPO. It is therefore important to plan the infrastructure in such a way that the cost of building and operating the charging location is recouped through the use of the charger.**
>
> Jakub Kott, EON

The available energy for charging is also reflected in the infrastructure data available to eTruck operators. This is because the available energy determines the expected actual charging speed. Maximum charging point speeds are one thing – but this parameter is not always achieved. The other is the energy available at any given time, which depends on many variables such as vehicle capabilities, current charging load, or current grid capacity.

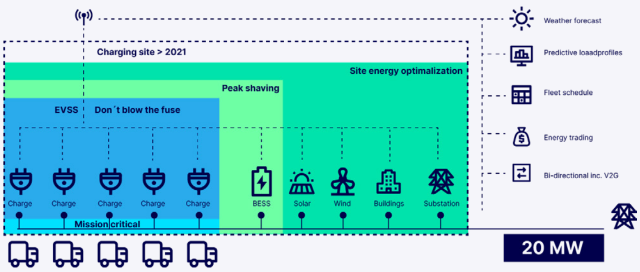


FIGURE 23 – Evolution of the EV charging site. Energy management system consisting of several layers will ensure maximum charging optimization. Source: ABB

4.5 Future is interconnected

As can be seen from the paragraphs above, the future is moving towards closer system connection and overall interconnectivity. Stakeholders are interested in reliable data – the criteria will be increasingly close to a zero-fault policy. Therefore, progressively smart and advanced tools such as artificial intelligence and deep learning will be used to manage huge datasets and eliminate errors. Interconnectivity will manifest itself at all levels – in network management, in the multi-way communication of individual systems, and, last but not least, in the interconnection with services, especially in the passenger car sector. The charging service may be part of the accommodation or other service offerings in the future.

The Internet of Things and 5G connectivity in particular will be key accelerators of connected systems. Returning to the area of charging infrastructure, the practical benefits of interconnected systems are diverse: A parking puck that knows if the right vehicle is in the charging spot; a charger that communicates with the network what power is available; telematics systems in vehicles that, thanks to 5G, will be able to receive and send full-fledged data on battery status, location, ETA or load, with minimal data latency; or two-way vehicle communication with other systems, such as V2G (vehicle-to-grid), V2I (vehicle-to-infrastructure) or V2X (vehicle-to-everything).

The latter systems cannot be omitted in the outlook, being major trends. In the area of charging infrastructure, the most relevant system is vehicle-to-grid (V2G). It is a system in which electric vehicles communicate with the power grid to sell demand response services by either sending electricity to the grid or throttling their charging rate. This system is particularly relevant when considering the future growth of renewable energy. Such electricity production means output that fluctuates depending on weather and time of day. V2G could stabilize the grid through vehicles, allowing electricity to be stored and discharged if needed.

> **Worldwide, 1 million devices connect to the IoT network every month. Interconnectivity provided by the Internet of things is growing at a rapid pace. In the future, this will allow the eTruck to communicate anywhere – with the network, the infrastructure or even with another vehicle.**
>
> Jana Křížová, Vodafone

When it comes to road freight transportation and eTrucks, as for now, V2G seems to be a pipe dream, even though eTruck's bulky battery stores a huge amount of electricity.
The problem is that freight vehicles are designed for maximum use. However, for a V2G system to work, the vehicle needs to be stationary and connected to the grid. This misses the primary purpose of investing in eTrucks. In addition, the charging and discharging of the battery, which is more frequent in a V2G system than when the battery is only charged from the grid (one-directionally), inevitably affects the life of the battery, usually counted in recharge cycles. The implementation of V2G into the MCS standard is also an issue. Therefore, it looks like V2G will not be the use case for corporate fleets and MDVs and HDVs anytime soon.

5. Operation of eTrucks in the fleet

Everything we have described in the chapters above are areas necessarily related to electromobility and battery -powered trucks. However, it is the customers – the haulers, fleet owners and other companies, and their employees – who will be handling the day-to-day operations with the new technology. It will be necessary to adapt to it in many ways. How? In this chapter, we will look at the aspects that the real-life operation of eTrucks brings. We will take a closer look at the initial implementation of eTrucks, their operation in mixed fleets, the total cost of ownership, and the changes that eTrucks bring to fleet management, dispatchers, and drivers. Many of these changes will be facilitated by smart technology. As a result, electromobility can help fleets to be more efficient and in the future, its benefits far outweigh the initial costs of implementing eTrucks in fleets.

5.1 Managing mixed fleet – opportunities and challenges

In the initial phase, companies will implement eTrucks gradually, experiencing the technology "hands-on" first on short- to mid-range use cases that are optimal for first-generation battery-powered vehicles. Technology is ready for it. Data shows that **in the EU, almost half of road freight kilometers are trips of less than 300 km a day, representing 90% of the transport operations** (Figure 24). (Transport & Environment, 2020)

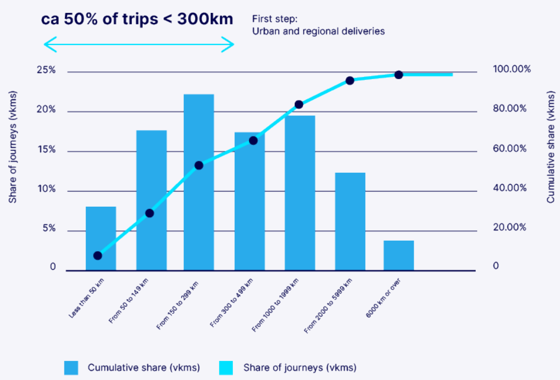


FIGURE 24 – Truck mileage - 50 % of all trucks do not travel more than 300km a day. First-generation eTrucks (with 200 to 300 km of range) can already cover most of the urban and regional delivery requirements. Source: Eurowag

At the same time, companies will continue to use conventional ICE trucks for other common applications (e.g. long-range deliveries, etc.). This gradual introduction will result in **mixed (or hybrid) fleets**, which means that companies will have to learn how to manage the demands of two technologies in one fleet. While fleet managers are accustomed to operating ICE trucks, battery-powered vehicles bring new variables to the company's operations: the need to consider battery capacity and range, charging infrastructure, hence route planning, and much more. Fortunately, several solutions on the market already cover such needs and thus make the operation of mixed fleets much easier (read more in Chapter 5.2).

The challenges of transition to battery-powered eTrucks are:

Key challenges

- Estimation and maximum range vehicles can travel on a single charge
- Understanding the availability and necessity of charging points on routes
- Dedicated charging infrastructure on the company premises/ parking/d epot
- Dedicated charging infrastructure on customer premises
- Higher purchase price of an eTruck in comparison to conventional ICE vehicle
- The insurance costs
- The residual value of an eTruck

Moderate challenges

- Payments for charging to be included in the company systems
- Planning a trip taking into consideration all the vehicle parameters and needed necessary stops; delivery stops
- Maintenance factors such as battery health management
- Driver behavior may affect the health of the battery and affect the life of the vehicle
- Fleets also need to consider driver adaptation to eTrucks to ensure efficient charging
- Range depending on weather conditions and the season (winter or summer)

The opportunities of the transition to battery-powered eTrucks are:

- Low carbon fuel
- Zero tailpipe emissions
- Low noise
- Driving comfort
- Easier maintenance (no need for additional oils and Ad-blue additions)
- Recuperation and driving behavior may help to keep the vehicle healthier (less maintenance needed compared to ICE vehicles)
- Higher utilization because some restrictions do not apply (reduced noise allows night driving, driving over weekends etc.)
- Access to zero and low emission zones

5.2 The growing importance of data

To find a balance between opportunities and challenges battery-powered vehicles may bring, companies need to assess the feasibility and determine which vehicles are optimal to make the switch. To do that, fleet managers should carefully collect and analyze accurate data on the current fleet – i.e., fuel usage, daily mileage, and resulting potential cost savings.

It implies that for the successful and cost-effective operation of fleets (be it hybrid or all-electric fleets), it is even more important to have tools that can collect and evaluate such information. As we have mentioned in Chapter 4.5, a codependent electromobility ecosystem will rely heavily on data and, at a higher level, interoperating digital platforms.

Moreover, the right tools can streamline fleet operations in many ways: they allow drivers to conveniently refuel or recharge, simplify the administrative burden associated with fleet and charging expenditures and track vital data about the operation (hours worked, drivers' driving style, current vehicle range) as well as the vehicles (state of charge, battery capacity, and battery health status). **It is the ability to collect the right data and feed it to the right systems that determine how quickly and efficiently a company can harness the undeniable benefits of electromobility.**

The solution lies in telematics systems (Figure 25) and smart digital platforms that can analyze the data from these systems and help draw operational conclusions, either in real-time or through in-depth reporting.

Description	BEV	PHEV
SOC State of charge [%]	X	X
Fuel Status [l]	-	X
Charging in progress	X	X
Charging cable connected	X	X
T2C Time to full charge [min]	X	X
Range (Electric) [km]	X	X
Ramge (Fuel) [km]	-	X
Temperature traction battery [°C]	X	X
12V Battery [V]	X	X
Charging current [A]	X	X
Charging voltage [V]	X	X
Total energy consumed [kWh]	X	X
Total fuel consumed [l]	-	X
Actual output corrent [A]	X	X
Battery Total re-charge [kWh]	X	X
Battery Total energy throughput [kWh]	X	X
Battery charged capacity	X	X
Battery maximum capacity	X	X
Traction battery State of Health (SOH)	X	X
Inside air (cabin) temperature	X	X
Outside air temperature	X	X

FIGURE 25 – Telematics solutions are able to deliver crucial real-time data about vehicle which optimizes fleet operations. Source: Eurowag

5.3 Total cost of ownership

The total cost of ownership, or TCO, is a critical part of the assessment of suitability for electrification. TCO represents the costs across the entire lifecycle, i.e. the purchase price, operating costs, and retiring of the vehicle. When calculating TCO, hard costs and soft costs should be included – from prices of vehicles and electricity to costs related to corporate image, ESG performance, and driver satisfaction. Therefore, the TCO calculation of an eTruck can be estimated by analyzing the following aspects:

PURCHASE PRICE

The purchase price of an eTruck is undoubtedly an important part of the TCO calculation. In the case of battery-powered trucks, the purchase amounts can reach multiples of conventional ICE trucks. Financing such an investment can be challenging for haulers as it requires high upfront capital expenditures (capex). Although the investment will eventually reduce operating costs, the transition period means expanding capex spending for new BEVs plus higher opex of running mixed fleets.4 (WEF, 2021)

Leasing and financing models remain unresolved – financial institutions may refrain from such uncertain and expensive asset financing, especially when lacking solid information about eTruck residual value. Purchase subsidies are therefore crucial to improve a relative TCO of an eTruck. Together with new leasing products tailored for zero emission vehicles, they can encourage implementing BEVs and other zero-emission vehicles into fleets.4 (WEF, 2021)

TAXES

This parameter relies heavily on the country of operation and related grants, incentives, and tax breaks for new and more energy-efficient trucks (see Chapter 1.4).

MAINTENACE

eTrucks consist of fewer moving parts than ICE vehicles, which means significantly fewer repairs and maintenance. Study conducted by Sustainable Freight Research Center at UC Davis calculated that compared to diesel trucks, current battery electric trucks can reduce maintenance and repair costs by 12% and possibly up to 29% in the future (see Figure 26). (Wang, Miller, Fulton, 2022)

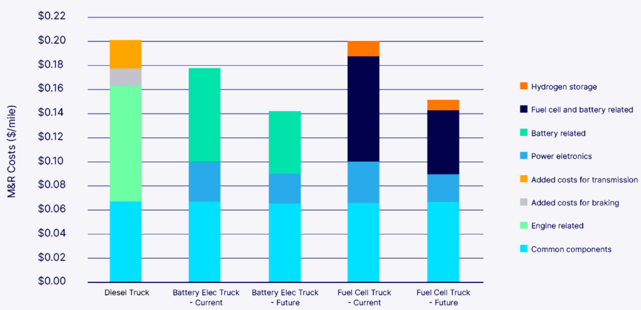


FIGURE 26 – Maintenance & Repair Costs Comparison across Truck Technologies. Comparison of maintenance and repair costs (diesel vs. battery powered trucks of first and future generation) Source: A STEPS+ Sustainable Freight Research Program Technical Paper, 2022

In addition, battery-powered vehicles may extend preventive maintenance schedules for brakes and tires due to the regenerative braking system. However, battery replacement needs to be considered. The length of the battery lifecycle depends on ambient temperature, depth of discharge, recharging cycles, and charging levels. Vehicle batteries usually need to be replaced when their capacity drops to 80% of their original capacity.

OPERATING SCHEDULE

When calculating TCO, a duty cycle of BEVs must be considered, including the operating temperature of the vehicle or another regional specific (route profiles and seasoning), average driving distance, maximum driving distance, and total annual mileage.

ELECTRICITY COSTS

Electricity cost changes depending on the country, energy provider, time of the day, or peak demand hours. The higher electricity demand of the company premises needs to be considered in the case of depot charging, also concerning other systems that will consume energy and the possibility of implementing a charging management system (see Chapters 4.1 and 4.4).

TOLL COSTS

Toll costs are to consider when calculating eTruck TCO. The reason is that annual tolling costs can reach up to €25,000 per truck, or one-quarter of the total cost of owning the vehicle. (CleanTechnica, 2020) At the same time, some countries already introduced toll discounts for battery -powered vehicles, which brings road haulers significant operational cost reductions. For example, trucks are exempt from tolls in Germany (100% discount for zero-emission trucks until 2026). On the EU level, emission-free trucks will get at least a 50% discount on road tolls by early 2024. Such a discount can thus save up to €12,000 a year (see also Chapter 1.4).

Prolonging battery life

Factors impacting lithium-ion battery health are the age of the battery, high temperatures, operating at high and low states of charge, high electric current, and usage. To prolong EV battery life, it is important to:

Avoid full or empty charges. It is ideal to keep SoC between 20–80% and only charge 100% for long trips

Minimize fast charging. When possible, slow charging, for example overnight, is better for the health of the battery.

Avoid hot temperatures when parked by choosing shades.

Use EV regularly.

EUROWAG CASE STUDY: Real toll savings for one of the most used truck routes

To demonstrate a real-case calculation, we will use one of the typical freight routes between Stuttgart, Munich and Wells. This route crosses the border between Germany and Austria, so we'll have to take both toll systems into account. While electric trucks are fully exempt from toll charges in Germany, the charges in Austria for zero emission trucks are significantly discounted. In our case, the heavy-duty 40t truck is considered. For such EURO 6 diesel truck in Austria, the toll rate is 0.42332 €/km, while the same-size electric truck is charged 0.10577 €/km. **The total annual toll savings for a truck commuting on this route reached €26,709.**

Toll calculation case:

Route: **STUTTGART – MUNICH – WELS**
Distance: 478 km (DE: 367km, AT: 111km)
Toll (Diesel) total: 111.54 € (DE 63.25€, AT 48.29€)
Toll (Electric) DE: 0 €/km
Toll (Electric) AT: 0.1057 €/km
Yearly mileage: 130,000 km
Yearly Toll costs (Diesel): 29,900 €
Yearly Toll costs (Electric): 3,191 €
Yearly Toll savings: 26,709 €

DEPRECIATION

Although we were seeing faster depreciation in the battery -powered passenger vehicle segment than is the case with ICE vehicles, eTrucks are unlikely to follow a similar trend. The cause of passenger car depreciation was faster battery degradation in the first-generation battery-powered passenger cars. As technology has advanced, the first generation of eTrucks are already high-quality vehicles that use advanced technologies to prevent battery degradation. Nevertheless, the depreciation of the vehicle must be taken into account.

In urban duty cycles, battery-electric trucks of any size become the cheapest option for several use cases in the 2020s.

TOTAL COST OF OWNERSHIP SUMMARY

Although BEVs require a major investment as they are more expensive up front, in most scenarios, fleet electrification results profitably. Apart from the financial benefits it offers (such as toll exemption), deploying battery-powered vehicles requires less maintenance since they have fewer moving parts than a conventional vehicle, they cost 35% less per km, and electricity is cheaper than fuel. In fact, according to a report by BloombergNEF, eTruck prices are expected to be more comparable to ICEs by 2023, while TCO parity is expected in just a few years, by 2025. (Bloomberg, 2021) With the right incentives in place, this could even apply to long-haul trucks with an 800 km range. (Transport & Environment, 2021)

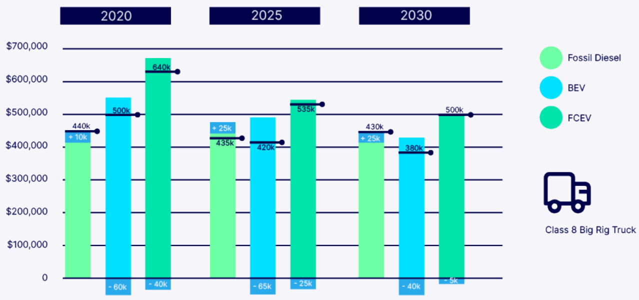


FIGURE 27 – TCO of HDV (EU France, 2019/2020). Strong incentives push eTrucks in the lead of cost efficiency in selected EU markets. Source: Eurowag

5.4 Fleet management

For fleet managers, switching a fleet to run on electricity involves not only the task of selecting the right types of vehicles but also adapting fleet management processes to the new technology. This means thinking about driver adaptation, and the need for direct integrations of fuel and charging data, including payment and billing management, load management, smart charging possibilities, etc. In addition, to prepare for mixed fleet management, they shall offer support to drivers, strengthen data analysis and reporting, and understand the variables in mixed fleet fueling aspects. For instance, they will need to actively **align the dwelling time with the charging schedule to optimize the charging costs**.

Fleet management processes will need to consider some changes in telematics systems regarding metrics that must be tracked to not only gain efficiency and profitability but also avoid drivers' range anxiety. The most important one is the real-time SoC (State of Charge), which allows managers to see whether a vehicle is ready for the route. Additionally, range calculation plays an important role since it is affected by external aspects such as weather or geographic regions (elevation). Also, charging stations are significant since checking charger types, speeds and financial rates will be favorable to plan routes, charge vehicles during off-peak hours, and secure further savings. Overall, real-time metrics reporting and evaluation through the right telematics solution will be critical for optimized maintenance of vehicles and to ensure driver safety (see Chapter 5.2).

"

Guaranteed availability, including reservation possibilities, and high reliability of HDV charging locations will be essential to accelerate the adoption of eTrucks, as the trucking business requires reliable delivery planning.

Eric van Voorden, CEO, Last Mile Solution

5.5 Dispatcher perspective

In large companies, fleet managers tend to have fewer tasks since there are also dispatchers who oversee the fleets in real-time. They are the ones who plan routes and track real-time data from the drivers and vehicles constantly, while proactively solving issues. The fleet management system helps dispatchers to:

- See the entire fleet in real-time, thanks to continuously updated maps.
- Fast and easy route planning. Plan optimal routes for trucks based on size and load, fuel, and charging prices.
- Get accurate truck and driver data from anywhere.

When planning a route, it is necessary to consider all vehicle parameters, stops and other specifics of commercial freight transport and its legislation. This includes, for example, AETR rules, which specifies driving and rest times for professional drivers in the EU and other countries. AETR rules state that after a 4.5-hour drive, the driver must have a minimum 45-minute stop. This time can be used effectively for charging as the vehicle is parked anyway. Fleet management systems are playing an increasingly important role in this respect, significantly facilitating the work of dispatchers. These smart digital platforms are able to take into account all available data in real time, be it telematics, vehicle and driver information, need for compulsory stop or traffic and weather data, and plan the route accordingly.

5.6 Drivers perspective

From the driver's perspective, adding eTrucks to fleets means they must adapt to different fueling options and vehicle performance. To achieve this, support from fleet managers and digital platforms will be crucial. It will be necessary for managers to train drivers on how to use the technology inside BEVs if they want to maintain productivity. This new training is essential to ensure safety, regulatory rigor, and operating experience.

Although some drivers may be excited by announcements of carbon-neutral goals within a company, some of them may resist the transition due to the fact they have never driven an eTruck and possible range and charging anxiety. Therefore, it will be necessary for them to understand the unique parameters of BEVs, such as the regenerative braking that helps recharge the vehicle's battery, which will undoubtedly affect driving performance or battery behavior in different circumstances. Reliable navigation will help to reduce charging anxiety (Chapter 5.7) while the right fleet management tools (Chapter 5.2) will allow drivers to charge at available and convenient stations, just as they were used to with conventional trucks.

Moreover, conducted testing proved that eTrucks can outperform ICE vehicles in terms of drivability. They produce fewer noise emissions and vibrations, which increases driver's comfort and reduces driving fatigue. (Electrec, 2018)

5.7 Navigation

When it comes to navigation, the electric drive is a key yet not the only special element when planning routes for eTrucks. Regardless of propulsion type, speed and on-time arrival is crucial in commercial transport, as any delay means increased costs (e.g. prolonged driver's hours, higher driver fatigue, truck amortization), not to mention potentially unhappy customers. Navigation and planning solutions should thus evaluate data from several sources and integrate them with routing information which is a vital part of the eTruck experience. These provide both dispatchers and drivers with range confidence, facilitate and accelerate the adoption process, and at the same time eliminate potential negative experiences enroute.

Several key factors should be considered when choosing an appropriate eTruck navigation solution:

1. Vehicle data

By adding real-time telematics data to the route calculation, the navigation app is able not only to adjust the route according to the static vehicle data but also to correctly predict various factors that might influence its driving range. These include higher weight and current to the engine, lower energy recuperation, the ability to preheat the battery when a new charging point is added to the trip to extend driving range, and more. The route can be dynamically adjusted to improve efficiency and provide the best driving experience according to all this information.

2. Truck-specific restrictions and parameters

Due to the nature of commercial transportation, the shortest route may not be always suitable for heavy-duty vehicles. In those scenarios, an appropriate alternative has to be planned out. A dedicated navigation system enables to plan routes based on the size and type of the vehicle, set the maximum speed, length, height, weight, width, number of axles, types of transported hazardous material (HAZMAT), and many other truck-specific parameters. Advanced route planning enables to avoid toll roads, U-turns, or prefer right turns to guarantee compliance, efficiency, and safety for all shapes and sizes of commercial BEVs. Moreover, obligatory AETR stops that trucks need to take based on current legislation, should ideally be planned within an advanced route planner together with charging stops.

3. Charging

Charging anxiety still plays a part in electric vehicle buying decisions. Even though eTrucks are currently mostly used on shorter routes and recharged overnight at depots and logistic centers, the electric experience – especially for new and potential drivers – can be a little unnerving. Therefore, the navigation solution needs to show electric vehicle-related points of interest (POIs) and integrate data from e-mobility providers and filter out the relevant ones. Using these inputs can guarantee the peace of mind for drivers and dispatchers alike, checking for available charging locations, selecting chargers suitable for eTrucks (considering parking size and charging power), offering reservations in advance, and payment afterwards. All this without switching to another app or leaving the truck.

4. Driver behavior

To minimize the risk that a new eTruck driver will carry over bad habits acquired while driving vehicles with internal combustion engines, the navigation can also serve as a real -time driver coach – monitoring key indicators that influence driving range, such as speed, acceleration, braking, and cornering. Based on these variables, it can recommend drivers adjust their speed to reach the next charging point or adapt their acceleration and deceleration habits.

5. Live traffic

Although the power consumption of electric vehicles in traffic is better than that of internal combustion engine cars, congestion can dramatically change even shorter trips. Having a quality live traffic provider, which processes data from millions of users is essential to correctly predict vehicle range and calculate the most efficient route.

> "
> **Smart platforms will enable drivers to use navigation functionalities – tailored to eTrucks – with integrated charging services, all accessible via a single application.**
>
> Martin Strigač, Sygic

6. Weather

By integrating the current and forecast weather into the routing algorithm and combining this data with the information mentioned above, the navigation and route planning apps can better evaluate, estimate, and calculate the route and maximum driving range. They will take into account the different behavior of batteries in cold or hot weather, usage of air conditioning or heating (and all other auxiliaries impacting the vehicle's power consumption), and also changes in the rolling resistance of the wheels and their pressure when driving in different weather conditions.

Above are the six essential aspects any reliable routing and navigation solution for electric trucks needs to consider. In the future, navigation technologies will become part of broader digital platforms designed to efficiently process operational elements and available data. AI using prescriptive and predictive analytics will then gradually replace the role of humans in journey planning and management. Therefore, when looking for a suitable navigation solution for their vehicles, OEMs, fleet managers, and dispatchers should consider vendors that combine long-time experience in navigation with the latest e-mobility expertise and insight.

Abbreviations and acronyms

AC	alternating current
ACEA	European Automobile Manufacturers' Association
AETR	European agreement concerning the work of crews of vehicles engaged in international road transport
AFIR	Alternative Fuels Infrastructure Regulation
BEV	battery electric vehicle
CAGR	compound annual growth rate
CCS	Combined Charging System
CNG	compressed natural gas
CPO	charge point operator
CRM	commercial road transport
DC	direct current
EAFO	European Alternative Fuels Observatory
eMSP	eMobility service provider
ESG	Environmental, Social and Governance – a set of standards measuring a business's impact on society, the environment, and how transparent and accountable it is
ETA	estimated time of arrival
EV	electric vehicle
FCEV	fuel cell electric vehicle (hydrogen-powered)
GHG	greenhouse gas
HAZMAT	hazardous materials
HDV	heavy duty vehicle
HEV	hybrid electric vehicle
CHAdeMO	a DC charging standard for electric vehicles (from „charge de move")
ICE	internal-combustion engines
LCA	life-cycle assessment
LCV	light commercial vehicle
LEV	low-emission vehicle
LEZ	low-emission zone
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MCS	Megawatt Charging System
MDV	medium duty vehicle
NGO	non-governmental organization
OEM	original equipment manufacturer
PHEV	plug-in hybrid electric vehicle
POI	point of interest
RED	Renewable Energy Directive
SME	small and medium-sized enterprises
SoC	state of charge
TCO	total cost of ownership
TEN-T	Trans-European Transport Network
TTW	tank-to-wheel
V2G	vehicle-to-grid
V2I	vehicle-to-infrastructure
V2X	vehicle-to-everything
VECTO	Vehicle Energy Consumption Calculation Tool
VIN	vehicle identification number
WTT	well-to-tank
WTW	well-to-wheel
ZEV	zero-emission vehicle
ZEZ	zero-emission zone

Partners and acknowledgements

E.ON Drive

About

E.ON is an international company headquartered in Essen, Germany, employing more than 70,000 people in 15 European countries. The company supplies energy to more than 50 million residential and business customers. As one of Europe's energy leaders, E.ON plays a vital role in creating a sustainable, modern and decentralized energy world. E.ON promotes clean mobility on a pan-European scale and is building a network of charging stations for electric vehicles. In the Czech Republic, E.ON Energie supplies energy to 1.3 million customers. It supplies households and businesses, small municipalities and large cities. It is the second largest supplier on the domestic market and the Czech leader in purchasing energy from renewable sources. It accounts for a quarter of the total volume it buys. In addition to energy supply, it offers a range of other solutions for its customers. It helps with heating, lighting, solar power plant construction, finds plumbers and electricians and handles subsidies. More about the company can be found at www.eon.cz.

Why eTruck?

Within the framework of the Fit for 55 initiative and the drive to decarbonise transport, the electrification of freight transport is one of the key points and therefore needs to be given the necessary attention. The issue of eTruck charging brings new challenges to the field of electromobility and demands on the infrastructure itself. Thanks to our extensive experience in passenger transport charging, we are ready to meet these challenges and provide our customers with a solution without compromise.

Last Mile Solutions

About

Founded in 1997 by Eric van Voorden and Johan Brouwer and headquartered in Rotterdam, the Netherlands, Last Mile Solutions is one of the largest and fastest-growing EV charging platform providers in Europe, with more than 67.000 charging stations integrated and a total of over 300.000 connected through roaming connections. The services are being used by more than 453.800 users in over 22 countries. Last Mile Solutions' industry-leading platform enables Charge Point Operators (CPOs), E-mobility Service Providers (eMSP), Utilities, Automotive Companies and Car OEMs, Fleets & Lease Companies, and Municipalities to offer EV charging solutions to their customers.

Why eTruck?

Prognostics tend to indicate that the future of transportation will have a shift to electricity also in the CRT sector in the next years. In this sense, we intend to prepare for what is coming and provide the services that will meet our customer's expectations at the same time with the one's of their own end customers.

Looking at the past, adoption of passenger electric vehicles had a slow start, followed by numbers doubling each year. We believe the same will happen on regards to CRT.
We expect that our actual customers, the charging point operators, will extend their infrastructure to meet CRT demands and us, as a platform provider, will support them in this transition and at the same time get ready for new customers.

ABB

About

ABB E-mobility is leading the way to a zero-emission mobility future with smart, reliable and emission-free electric vehicle charging solutions from homes to highways.
For more than a century, ABB has been at the forefront of electrical infrastructure. They have consistently invested in delivering power for the transportation of tomorrow, bringing the digital and physical worlds together across market leading charging hardware, ABB AbilityTM enabled digital services and energy and fleet management solutions. Today, ABB is the world leader in EV charging solutions and the partner of choice for the world's biggest electric vehicle OEMs and nationwide EV charging network operators, having sold more than 680,000 electric vehicle chargers across more than 85 markets.

In the Czech Republic, more than 550 public charging stations have been commissioned in cooperation with leading energy distributors.

Why eTruck?

Heavy vehicles have a significantly higher environmental burden in terms of emissions compared to passenger cars. While representing less than 4% of the vehicles on our roads, heavy vehicles are responsible for more than 40% of global road transport emissions.
Logically, their transition to emission-free propulsion makes much more sense.

Their „predicted" operation in terms of route and time also mean they are highly suited to the electric transition. For example, a vehicle intended for municipal waste collection has a clearly defined route and time. Its charging can therefore be very well planned and thus the problem of range is eliminated. In addition, it moves in urban areas where the emission-free benefit is incomparably higher than, for example, a long-distance truck outside a built-up area.

So as trucks become electrified it the sensible starting point has beenwith light trucks for delivery and urban services. As battery technology, recharging and available infrastructure further develops, there will be a greater focus on heavier vehicles (e.g. long-distance tractors)

ABB sees great potential in this segment for the future. Therefore, the development of high-performance MegaWatt recharging technologies for heavy vehicles is being intensively pursued.

vodafone business

About

Vodafone Business is part of the Vodafone Group, the telecommunications leader in Europe and Africa. We help businesses of all sizes grow through digital communications technology. We work with major international companies, government projects and ambitious start-ups around the world. We provide services on a global scale as well as on a regional and local level. Whether it's mobile, fixed or integrated communications, the Internet of Things (IoT), cloud services, mobile private networks (MPNs) or online security. We connect people, places and things that are business-related, wherever they are. In the Czech Republic, Vodafone provides services to more than 4.5 million customers, of which 1.6 million are business SIM cards. We already cover 70 % of the population with our state-of-the-art 5G network.

Why eTruck?

Vodafone is committed to reducing its overall carbon footprint and this applies to the car fleet and the solutions offered. Today's technology allows companies to build their fleet on a modern foundation. They significantly facilitate the transition to electromobility and automated corporate carsharing.

VOLVO

About

Volvo Trucks provides complete transport solutions for demanding customers. It offers a wide range of vehicles for urban, regional, long-haul and heavy haulage. Customers benefit from a global dealer network of 2,200 service centers in more than 130 countries. Volvo trucks are manufactured in 13 countries. In 2021, approximately 123,000 Volvo trucks were sold worldwide. The core values recognized by Volvo Trucks are quality, safety and respect for the environment. Volvo Trucks is part of the Volvo Group, one of the world's largest manufacturers of trucks, buses, construction machinery and marine and industrial propulsion equipment. The Volvo Group also provides comprehensive financing and service solutions.

Why eTruck?

Volvo Trucks has set ambitious CO2 reduction targets, such as the Paris Agreement. One way to achieve these targets is by offering electric trucks. Stricter regulations on carbon emissions are undoubtedly pushing the technology forward, as are efforts to improve air quality and reduce noise - especially in large urban areas. Another important aspect is transport efficiency. Electric trucks can make deliveries at night and off-peak hours and, compared to their diesel counterparts, can go to more places, including inside buildings. We believe it is becoming a key competitive advantage to offer zero-emission electric transport solutions. Volvo Trucks aims for half of its total truck sales to be electric by 2030.

eco-movement

About

Eco-Movement is the leading platform for EV charging station location data. It's our mission to make charge point data simple and accessible. The platform integrates data from thousands of Charge Point Operators into a uniform, accurate and complete database, using a multitude of smart algorithms. Custom enrichments such as Predicted Availability are added by the in-house Data Science team.

Eco-Movement has full coverage in Europe, North America, and beyond, with over 600.000 verified connectors. As a fully independent data provider, it has a very strong focus on data quality and completeness. Eco-Movement data is used by navigation providers, OEMs, institutions and e-mobility service providers; clients include industry leaders like Eurowag, TomTom, HERE, and the European Commission's EAFO portal.

Why eTruck?

As Eco-Movement, we want to make charge point data accessible and simple, so all EV drivers can benefit from it. We believe the number of eTrucks will grow rapidly, and eTruck drivers have a great need for complete, accurate and up to date information about charging stations. We are determined to provide our clients with all the data they need to give eTruck drivers the best possible charging experience.

Sygic

About

Founded in Bratislava, Slovakia, in 2004, Sygic is a Deloitte Fast 50 Company and, in 2012, was added to Deloitte's Fast 500 EMEA listing. In 2009, Sygic produced the first-ever turn-by-turn navigation app for the iPhone. The company was the first offline navigation vendor supporting Apple CarPlay and Google's Android Auto™. Sygic GPS Navigation as the most popular Sygic app has reached over 200 million downloads worldwide. The real-time Traffic Lights add-on has been recognized as a top CES 2020 innovation. Thanks to its EV mode, Sygic was honored by a Global Champion Award 2021 for its contribution to a sustainable and innovation-driven Europe. Sygic's solutions are also navigating more than three million professional drivers and two thousand fleets globally.

Why eTruck?

Electromobility and alternative fuels are the future of road transportation. However, routing and driving commercial EVs and trucks still presents unique challenges. At Sygic, we believe that these can be solved by providing the dispatchers and drivers with EV-specific routing and navigation – complete with information regarding the compatibility and availability of charging points, to always reliably reach your destination.

EW EUROWAG

About

Eurowag brings smart on-road mobility solutions to go far on the road, in business and in life. We offer a full payment network and mobility services ecosystem for larger, mid-size and smaller CRT companies. Customers benefit from global size network services across 30 countries in Europe and middle East. Our 15 000+ satisfied customers can access online all products and services via Client portal 24/7 and manage fuel cards, Europe-wide toll solutions, automated VAT and Excise duty refunds and set up fleet management solution. Our main purpose is to create sustainable financial and technological solutions for the benefit of the transportation industry, society, and environment. We have committed to help our customers compete and grow in low carbon, digital economy.

Why eTruck?

It's about balancing profit, planet & people. We care about world we live in. We innovate structural solutions to empower the CRT industry's transition to a low-carbon future. Together we go green.

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