Electrification of the long-distance heavy duty vehicle fleet

On-highway charging needs and challenges

March 2024

Preamble

This report was drawn up at the initiative of nine companies who formed a working group on the on-highway charging needs of long-distance road freight electric heavy duty vehicle fleet (HDVs). It represents 18 months of work and discussions that were performed in strict compliance with confidentiality and competition law. The decarbonisation of road freight transport, which is a challenge at national and European level, and the accelerated development of long-distance battery electric HDVs were two of the primary drivers for this initiative. It was necessary to undertake a methodical and structured study since a public study is yet to be carried out. The study addresses both electric charging points and road infrastructure. All stakeholders and actors involved in road freight decarbonisation will be able to benefit from this report.

Enedis, TotalEnergies, VINCI Autoroutes, Iveco, MAN Truck & Bus France, Mercedes-Benz Trucks, Renault Trucks, Scania and Volvo Trucks are therefore pleased to present this report. It is intended to be available for a wide public audience and to be widely distributed to all public bodies and actors in the sector.

Summary

The electrification of long-distance road freight in France forms a key component of the energy transition and of land use planning. Its success requires the different actors in the sector jointly planning the roll out, without undue delay, between now and 2035, of the electric and road infrastructure that is required for on-highway HDV charging.

→ CHALLENGES OF LONG-DISTANCE ROAD FREIGHT

- **Road transport in France represents 90% of goods flows** and 7% of greenhouse gas emissions. To respond quickly to European Union decarbonisation goals, manufacturers have chosen to develop battery electric HDVs, which are the main zero emissions exhaust technology. The success of this electrification strategy will depend primarily on an effective roll out of on-highway charging infrastructure.

→ ON-HIGHWAY CHARGING NEEDS

- **Three electrification scenarios** were used to analyse charging needs based on a precise modelling of the road network, stopping points and vehicle flows for electric HDVs.
- **Between now and 2035, HDV on-highway electricity consumption** is set to reach 3.5 terawatt hours, with a peak power-demand of 1.1 gigawatts. This will require 10,000 charging points to be set up for long duration stops and 2,200 to be installed for fast charging, across 519 service and rest areas.

→ IMPACTS ON ELECTRIC AND ROAD INFRASTRUCTURE

- **The analysis shows that the combined recharging needs** of HDVs and light duty passenger electric vehicles (LDVs) are extremely complementary. This updates the 2021 Enedis/RTE (France's electricity transmission system operator) study[1]: light duty passenger vehicles (LDVs) represent 90% of the peak power-demand of charging points in France for on-highway charging.
- **Therefore, a best estimate of the work needed** on the electricity network was established based on the pooled power needs of HDVs and LDVs in each stopping area. Approximately 60 high-voltage/medium-voltage substations will either need to be upgraded or created with an investment of around 630 million euros required by 2035, 91% of which would be for LDV mobility needs. Although this programme presents no technical issues, planning should begin now as it will take several years to complete.
- **Converting some HDV parking places** into charging points will potentially cause a shortage of space. Across one quarter of the road network, a minimum 50% of parking places may be fitted with charging points, whereas only one HDV in eight would be long-distance electric vehicles.

→ RECOMMENDATIONS FOR SUCCESSFULLY TRANSITIONING TO A DECARBONISED HDV FLEET

- **Establish a shared, actionable roadmap and schedule,** specifying the work that is needed on electricity networks and road infrastructure by 2027, 2030 and 2035, in line with upcoming regulations such as the AFIR[2].
- **Put regulatory, administrative and financial systems in place** to anticipate connection requests, accelerate administrative processes and optimise joint investment in the stopping areas, while specifying each actor's roles and responsibilities.
- **Implement simple, coherent incentives** with long term visibility to encourage private investment in battery electric HDV and charging infrastructure development.

(1) Enedis/RTE 2021 study on long-distance electric LDV mobility.
(2) EU Alternative Fuel Infrastructure Regulation.

Key figures for 2035

€630 M

→ Investment in electricity network infrastructure to cover the on-highway needs of electric cars and HDVs.

10,000 + 2,200

→ Number of slow and fast charging points to be installed across 519 service and rest areas to meet the needs of electric HDVs.

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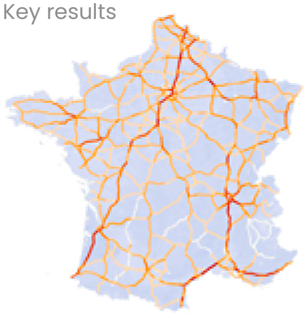

Glossary

Stopping Area : Any dedicated area providing, as a minimum, parking for vehicles travelling on motorways and major highways.

Rest Area : Stopping area without service facilities (fuel, shop, toilets, showers).

Service Area : Stopping area with service facilities.

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The challenges of electrifying long-distance road freight transport in France

1. Context

In France, road freight transport (RFT) represents almost 90% of land based freight travel and 7% of greenhouse gas (GHG) emissions(3). RFT will continue its dominance between now and 2035, even if a shift towards rail freight is envisaged.

The RFT sector is ready to decarbonise its activities swiftly to reduce GHG emissions, in line with French and European regulatory goals. To do this, manufacturers are developing battery electric HDVs, presently the foremost zero emissions exhaust technology. These vehicles are already available for urban delivery and regional transport. From 2024, many manufacturers will be producing these vehicles, which will come equipped with batteries with ranges exceeding 400 kilometres (250 miles), thereby enabling charging during regulatory breaks. As of 2025, such charging will be incredibly fast thanks to the Megawatt Charging System (MCS), a new high powered connection being rolled out across Europe.

This technology will open the way for long-distance electric road freight HDVs and their uptake by transporters. The success of this transition depends largely on charging infrastructure being extensively rolled out. This deployment would be at depots and destinations as well as on long journey highways, with charging points publicly available along the major French roads and close to logistics zones.

1.1 Initiative and goals of the study

In 2022, Enedis, TotalEnergies, VINCI Autoroutes and six European manufacturers—Iveco, MAN Truck & Bus France, Mercedes-Benz Trucks, Renault Trucks, Scania and Volvo Trucks—created a working group on electric charging infrastructure for long-distance road freight HDVs. This working group has two aims:

- To assess on-highway electric charging needs for long-distance freight travel on France’s major routes between now and 2035, based on assumptions of the characteristics of electric HDVs and their rate of penetration. In this regard, the costs of HDVs, recharging stations and of charging, as well as the total cost of ownership (TCO) of this solution compared to diesel or to other technological options, are not considered.

(3) Source: *Service des données et études statistiques (SDES) du ministère de la Transition écologique et de la Cohésion des territoires* (Data and statistical studies division of the French Ministry of Ecology), 2019.

- To estimate the impact of electric charging needs on road and electrical infrastructure, notably by evaluating the work and investment needed to adapt the electricity transmission and distribution network[4].

The working group conducted all its work in strict compliance with confidentiality and competition law. The results presented in this study aim to give those involved in the sector (public authorities, network managers, road and charging infrastructure managers, transporters and logisticians, HDV manufacturers, charging service providers) a reliable, quantified picture on a national scale of the total power demand and the peak power-demand, number of charging points and infrastructure work required so that the electrification and decarbonisation of long-distance road freight transport can rapidly be made possible and can be accelerated.

HDV and LDV[5] charging needs at the motorway service areas that they share were combined (taking into account that they will typically be charging at different times of the day and the week), to provide a better assessment of the impact of charging needs on electricity networks. The estimates of the work and the investment required on the electricity network, which are set out at the end of this document, take account of this analysis.

1.2 Assumptions used

1.2.1 Long-distance vs. regional road transport. This infrastructure impact study examines long distance freight transport using electric HDVs that need to be charged on the road. This study does not consider charging at depots nor destinations in logistics hubs. For the purposes of this discussion, long-distance journeys are defined as being of at least 350 km (220 miles) performed by HDVs with driving ranges that only allow for charging during regulatory breaks. The on-highway charging needs of smaller HDVs or those with smaller ranges that follow local or regional routes on shorter journeys were not addressed in this analysis.

1.2.2 Freight flows under consideration. The road freight considered comprises French or foreign registered HDVs using France's road system. This includes:
- National freight transport covering the entire French national territory with loading and unloading in France, undertaken by French or foreign vehicles (cabotage).
- International freight transport carried out partly within French national territory, with loading or unloading in France.
- International freight transit with loading and unloading abroad.

1.2.3 1.2.3 Volume of goods transported and HDV flows. This study is based on constant traffic over time on each major route. The study assumes that the total volume of goods carried long-distance and the total number of journeys made across French territory between now and 2035 will be stable. This is on the premise that transferring some freight to the railways and increasing the average fill rate of HDVs

(4) The rest of the report refers to the electricity network as the transmission and distribution network.

(5) Needs based on the results of the Enedis/RTE 2021 long-distance LDV mobility study, reviewed in light of current LDV electrification assumptions.

will offset the growth in freight traffic. The impact of this assumption on the results provided by the model developed in the study is low compared to the impact of the forecasted rates of penetration for electric HDVs.

1.2.4 Driving behaviour and regulations.
As there is no data on future long-distance electric HDV driving behaviour, the working hypothesis is based on driving behaviour (driving times and breaks) that is the same as that for HDVs with conventional engines. This assumption may be fine tuned using information collected over time by actors in the road freight sector.

Driving behaviour is governed by current regulations(6). These regulations impose a minimum 45-minute break for every 4 hours and 30 minutes of driving. This break can be split into a 15-minute break followed by a second lasting a minimum of 30 minutes. The regulations also limit daily driving time to a maximum of 9 hours, which can be extended up to 10 hours twice a week.

HDV manufacturers will be marketing battery EVs that are aligned to observed driving behaviour and current regulations, a necessary condition for the adoption of this technology by end users.

1.2.5 Stopping areas and major roads on the French network. The approach focuses on the French network's main arterial roads which are mostly used by HDVs. The stopping areas that are likely to accommodate the electric vehicle charging infrastructure (EVCI) for HDVs are existing public service and rest areas situated along the roads that were used for the study. Private car parks and publicly accessible stopping areas located close to but not on these major roads were not included in the study.

1.2.6 Electric HDV and charging technologies.
On-highway charging needs were determined based on a single item of electric HDV technology used to equip rigid and tractor units. This so called long-distance technology will be available from late 2024. It provides the range and charging capacity to cover long distances (at least 350 km [220 miles]), with vehicles only needing to be charged during regulatory breaks.

So called "regional" technology is not discussed here, although some of the HDVs concerned could need to be charged during a journey. This solution, offering a shorter driving range and less charging power, is used by electric HDVs with lower gross vehicle weights (GVW) and/or those on shorter journeys. In most cases, such vehicles return to the depot at the end of the day *(see p. 16: A model that is sensitive to certain assumptions)*.

The study includes two complementary charging levels: fast charging (used during short breaks from driving and based on MCS technology) and slow charging (used during longer intervals, mainly at night).

HDV mobility in France: the figures...

616,500 HDVs
registered in France at the end of 2021, including 307,400 rigid units, 219,900 tractor units and 89,200 specially constructed (or converted) motor vehicles (SCMV)(7).

1,607 Mt and **161 Bn tkm**
of freight carried nationally(8).

31 Mt and **12 Bn tkm** carried as cabotage(8).

307 Mt and **123 Bn tkm*** transported internationally (between France and Europe) and transiting through France(8).

* tkm transported over French territory (estimated).

Mt: million tonnes.
Bn tkm: billion tonne kilometres.

(6) More detailed explanation of these regulations: https://www.ecologie.gouv.fr/temps-travail-des-conducteurs-routiers-transport-marchandises

(7) Source:
https://www.statistiques.developpement-durable.gouv.fr/le-parc-de-poidslourds-est-en-legere-augmentation-au-1er-janvier-2022

(8) Sources:
https://www.statistiques.developpement-durable.gouv.fr/donnees-sur-letransport-routier-de-marchandises-trm-en-france-et-en-europe

https://ec.europa.eu/eurostat/web/transport/data/database

https://www.statistiques.developpement-durable.gouv.fr/bilan-annuel-des-transports-en-2022

The on-highway charging needs of 100% electric HDVs

2. Method: a three-step approach

The power needs of electric HDV charging stations were assessed in three successive steps:
1. Modelling the main roads on the French network. Referred to as the road network graph, it details the stopping areas as well as the start and end points of HDV journeys (origin/destination pairs).
2. Evaluation of HDV flows on this graph between each origin/destination pair.
3. Application of three battery electric HDV penetration scenarios to these long-distance HDV flows, followed by a calculation of the on-highway charging needs.

2.1 Step 1, modelling road network with main stopping areas

Mainly motorways, principal trunk roads and some minor roads with significant HDV traffic are shown in the French network graph, representing a cumulative total of 23,000 km (14,300 miles) spread over 460 roads.

The 1,374 stopping areas (service and rest areas, HDV parks) that are identified and displayed on the simplified map on page 9 (Figure 1) were taken from the Bison Futé traffic information database[9]. This database pinpoints the HDV stopping areas located along these roads and gives the total number of parking places. It was supplemented with data from the Fraunhofer ISI study[10]. This data provides the location of the stopping areas that are most frequented by HDVs across the entire European road network, based on telematic data from 400,000 European HDVs.

Six hundred origin and destination points are given in the model. The points are distributed throughout French national territory to create a sufficiently accurate road freight grid. Their definition is based on work to geographically group the surface areas of industrial, agricultural and commercial buildings, taken from the TOPO database of the Institut géographique national (French national geographic institute [IGN]). Every origin and destination point is linked to the closest entry point onto or exit point from the road network. Origin and destination points are also defined at border crossings, this ensures that the model includes all HDV journeys that start from and/or go to other countries.

(9) Source: https://www.bison fute.gouv.fr/directive sti,id_sous_rubrique10423.html

(10) Source: Fraunhofer ISI: https://www.isi.fraunhofer.de/content/dam/isi/dokumente/cce/2021/ACEA_truckstop_report_update.pdf

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2.2 Step 2, modelling traffic based on road freight data

2.2.1 Estimated annual flows of HDVs across the entire road network. The HDV flows were calculated based on the volume of goods transported on the French road network. For each European flag, the Road Freight Transport (RFT) survey and the Eurostat[8] database supply for national and international transport, transit and cabotage, tonnage of goods routed annually to and from each French department and each region in Europe. This study used 2017 as its reference year. Processing the corresponding data from these two sources enables the tonnage of goods carried on each journey (between each origin/destination pair) in the model to be evaluated.

The number of HDV journeys was calculated based on the tonnage of goods carried between each origin/destination pair using data from the RFT survey. This data indicates the laden and unladen rates of the HDVs. Each route is defined based on the three most relevant hypotheses:

- The fastest route is determined and used on the road graph in a similar manner to a GPS route calculation, taking into account average HDV speeds on the motorways and single or dual carriageway trunk roads.
- For international routes, the part using the French road network is determined in the same way.

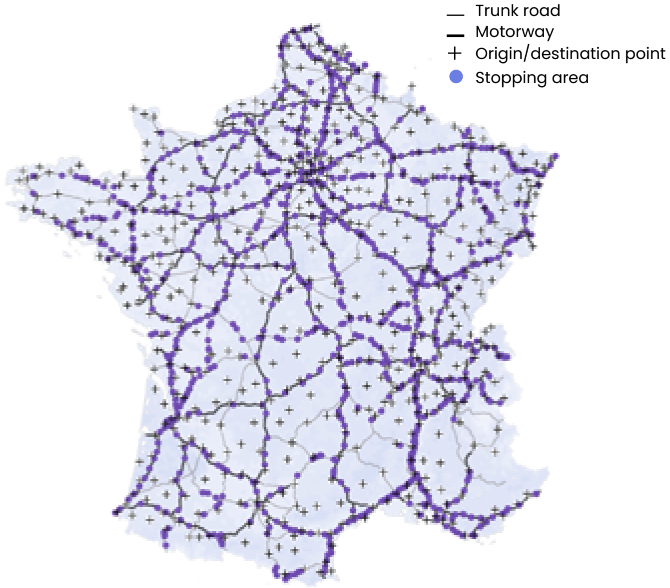


Figure 1: Road network with HDV stopping areas and origin/destination points of the journeys modelled

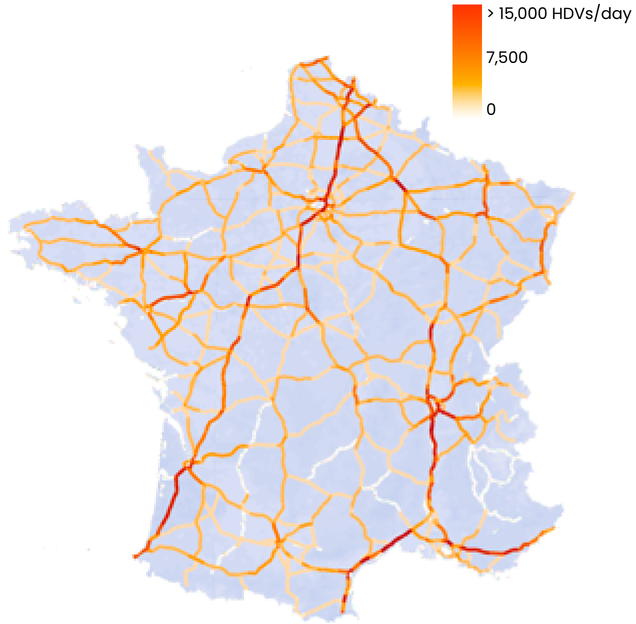


Figure 2: HDV flows (AADF) modelled

- Border crossings are fixed according to the location of the foreign origin/destination point.

The projection of all the journeys onto *Figure 2* for all the origin/destination pairs determines the annual flow of HDVs across each section of the graph.

These flow values are compared to those for the real annual average daily flow (AADF) data from 2017[11], this data includes the average daily flows of HDVs travelling over approximately 6,000 sections of motorways, trunk roads and minor roads. This comparison demonstrates that the model reproduces actual annual traffic flows as accurately as possible.

2.2.2 Journeys modelled on 10 minute time intervals. Calculating the charging power profile for stopping areas requires HDV flows to be modelled over a specific time grid. Annual flows are weighted over all 365 days of the year, using actual daily HDV flow data *(Figure 3, p. 10)*.

(11) Source: https://www.data.gouv.fr/fr/datasets/trafic-moyen-journalier-annuel-sur-le-reseau-routier-national/

Data from several sources is used to define and apply a law for distributing HDV journey start times and border crossing times for journeys that begin abroad *(Figure 4, p. 11)*. This assumption is particularly sensitive as it affects the time at which most simultaneous stops occur.

At this stage of the study, the model established uses a ten minute interval to simulate the number of journeys started between each origin/destination pair and the flow of HDVs on each section of the road graph.

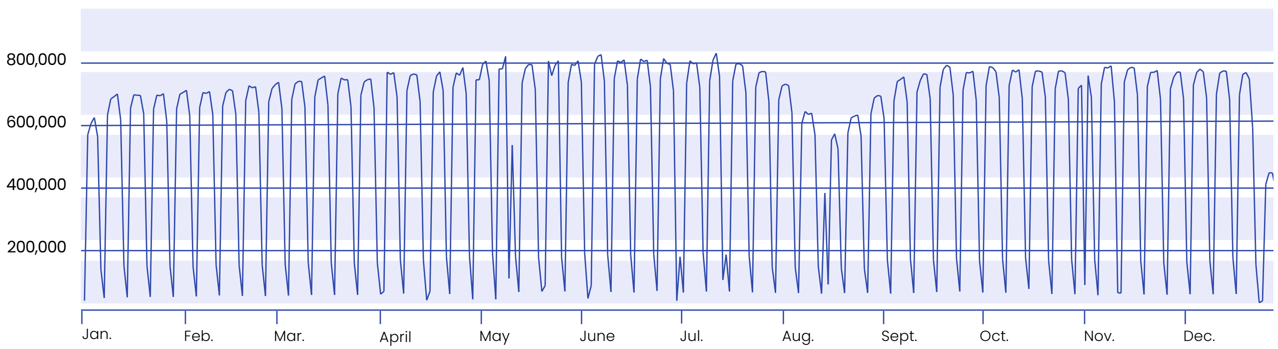
The approach used is effective for simulating long-distance journeys. However, it is not suitable for simulating short distances (urban, peri urban or even regional). Especially near urban areas, the model focuses on and therefore over estimates the flow of HDVs on main roads. This is because it relies on a graph of the road network that does not include the minor roads used for local journeys.

2.3 Step 3, three electrification scenarios for HDV mobility

Three electrification scenarios for HDV mobility are being studied for the period between now and 2035. They are based on different penetration rates for battery electric HDVs, a technology which is currently being developed by long-distance road freight HDV manufacturers. Choosing 2035 as a target allows for a penetration rate that is high enough to model charging needs for all major roads and to take on board the infrastructure required over the next ten years.

Figure 3: Daily breakdown of HDV journeys

In number of journeys – source: VINCI Autoroutes, 2017



An ad hoc analysis performed for 2030 compares the simulated trajectories with the obligations set out in the AFIR regulation passed in 2023.

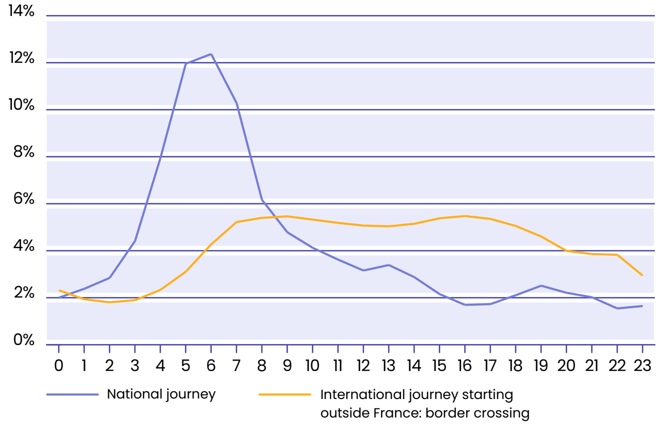
2.3.1 Electric HDV technology for long-distance journeys. The technical characteristics of the long-distance battery electric HDV solution equipped with MCS technology are summarised in the table on page 11. These characteristics will change between the first generation of HDVs marketed (technology stage 1) and those that will be marketed from 2030 (stage 2) due to a lower unitary energy consumption and an increase in charging power. The model takes into account an increase in energy consumption during the winter due to lower temperatures, as well as a reduced energy consumption during unladen journeys when HDVs are lighter.

2.3.2 Penetration rate for long-distance electric HDVs.
The three scenarios analysed in this study are referred to as medium, high and low *(Figure 5, p. 12)*.

The medium scenario is defined to meet the requirements of the European Commission's "Fit for 55" package of legislative proposals which are designed to reduce greenhouse gas (GHG) emissions by 55% by 2030, notably the legislation impacting the transport sector and HDV manufacturers. This scenario is based on a "voluntary" growth in electric HDVs led by sector stakeholders (transporters, manufacturers, logisticians and infrastructure managers), backed up by public policy support for the development of charging infrastructure and the acquisition of these EVs, both at French and European levels. This scenario assumes that road freight traffic would remain constant, and that long-distance electric HDVs and MCS equipped charging stations would be available both in quantity and with the required technical characteristics. It assumes that 20% of France's HDV fleet (all segments combined) would be electric by 2035. It is also hypothesised that 15.6% of current long-distance journeys would be carried out by electric HDVs, which will therefore be performing on-highway charging. In this scenario, long-distance electric HDVs would represent 7.8% of the total fleet.

Figure 4: Hourly breakdown of HDV journey start times and border crossings for vehicles coming from abroad

As a percentage – source: VINCI Autoroutes, 2017

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Long-distance electric HDVs: technical characteristics used

CHARACTERISTICS	Stage 1 (2025)	Stage 2 (from 2030)
Useful battery capacity(12)	580 kWh	580 kWh
Consumption	1.3 kWh/km	1.2 kWh/km
Impact on consumption unladen	-30%	-30%
Impact on consumption: winter summer delta	+10%	+10%
Average charging power, short break	620 kW	800 kW
Average charging power, long break	100 kW	100 kW

(12) Battery energy consumed by user, below rated capacity. It includes a charge and discharge range of less than 100% and an average battery ageing rate.

The high scenario is a variant of the medium, based on assumptions which encourage long-distance HDV mobility to decarbonise more quickly. That is, an incentivised regulatory framework, such as CO_2 emissions penalty systems for industry, and the mass roll out of MCS equipped public charging stations. In this scenario, 30% of the HDV fleet and 25.3% of long-distance journeys would be electric. Long-distance electric HDVs would represent 12.6% of the total fleet.

With the low scenario, electrification would start with low tonnage HDVs before moving on to long-distance tractor units. The industrial scale deployment of MCS technology would be delayed on economic, logistical or technological grounds. In this scenario, 23% of the HDV fleet would be electric by 2035, but only 5.6% of long-distance journeys would be made by battery electric HDVs.

2.4 Driving and charging behaviour dictated by regulatory breaks

The driving behaviour in this model sets electric HDV stops made during each journey and, therefore, the charging location. Two criteria are used to calculate stopping times: the regulatory driving time and the level of charge of the battery (its state of charge, SOC). The study looks at two simplified driving cycles which are shown in *Figure 6*.

Figure 5: Electric HDV penetration scenarios

Percentage of long-distance journeys by electric HDV, percentage of the total fleet that is electrified

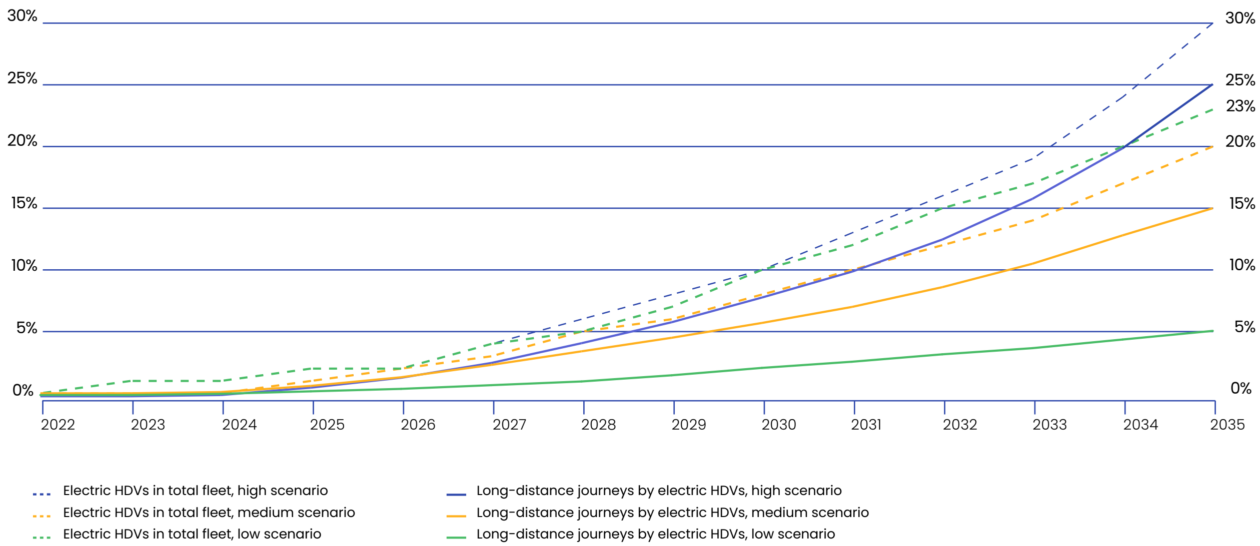
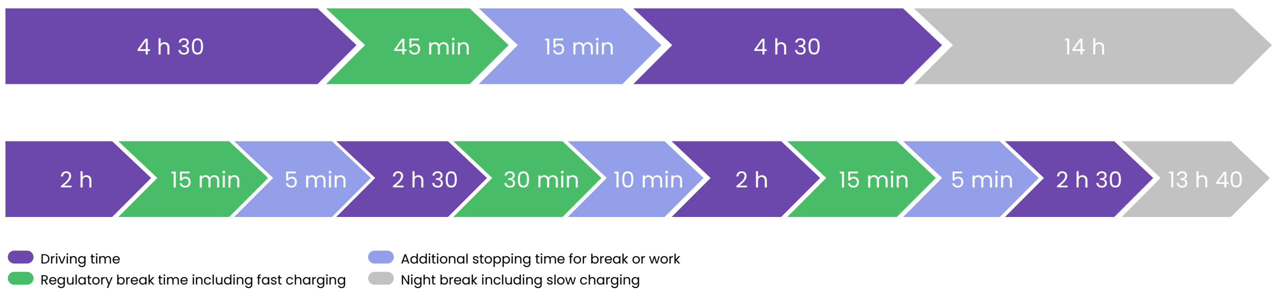


Figure 6 : Driving cycles modelled to determine stops made by HDVs on each journey



They consider regulatory driving and break times for long-distance HDV journeys.

Each journey between each origin/destination pair on the graph is simulated. At the start of a journey, it is considered that drivers begin their working day when they leave the point of origin and with the HDV battery fully charged. The model assigns a driving range and driving time at the border crossing for HDVs coming into France from abroad. Each time the vehicle passes through a stopping area the model evaluates driving time and battery capacity. If the regulatory driving time would be exceeded in order to reach the next stopping point or destination, or if the remaining driving range falls below the 10% threshold for stopping areas, a stop will be imposed.

The approach developed in the study to determine HDV stops is based on the need to stop and not the facilities in the stopping area. No attractiveness criterion is used for the stopping area, such as the presence of specific equipment or services, charging costs or even the number of spaces reserved for HDVs.

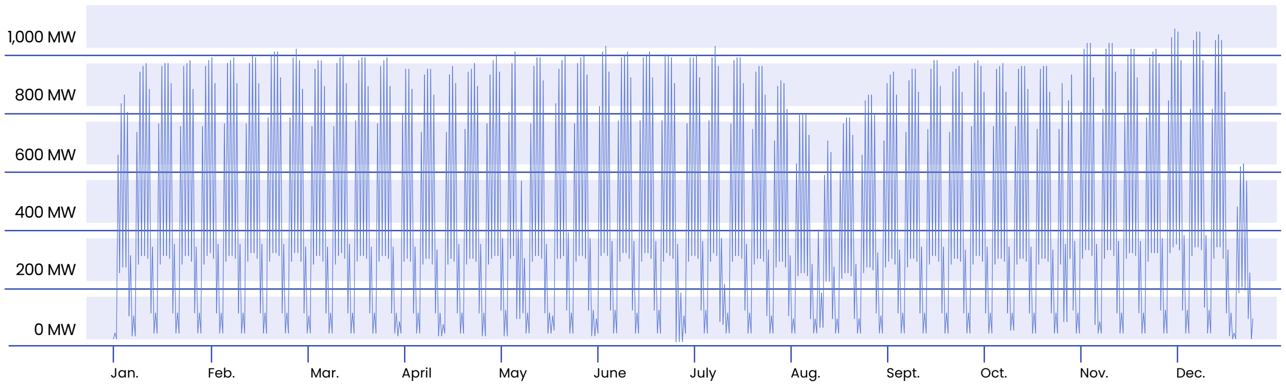
In the constructed model, fast charging only occurs at service areas during short breaks. Slow charging is used for long breaks, at both service areas and rest areas. For national journeys, the model requires HDVs to get to their destination with a battery level of at least 30%. In some cases, this determines the charging time during the last break before arriving at the destination. As a result, this final break may be shorter than the regulatory one. For international journeys, no criterion is set for charging duration. As such, HDVs can be charged throughout the regulatory break period.

2.5. Consumption and power that can be integrated into the network

Between now and 2035, the need for on-highway charging infrastructure from HDVs could involve significant energy consumption and demand for power, both of which can be readily managed by the electricity grid subject to certain conditions.

Figure 7: Annual on-highway charging power curve by 2035

Electricity consumption for on-highway electric HDV charging across the French road network (in MW) – Consolidated power demand (France)



2.5.1 Power and energy needs on the French grid.
The model focuses the total charging demand on 519 of the 1,374 stopping areas studied for HDVs including, for each stopping area, the total number of recharges, the date and the time for both fast and slow charging, based on the following three optimisation criteria:

- **Use threshold.** Non motorway rest areas, where demand for charging is too low (less than 1 MW) to justify the investment in infrastructure, are eliminated.
- **Land/space available at rest areas.** If there are not enough HDV parking places in a rest area for the number of charging points required, the additional charging needs will be transferred to the closest service areas.
- **Network of stopping areas.** A minimum level of charging infrastructure is maintained on the least frequented sections.

In 2035 the electricity consumption for on-highway electric HDV charging on France's network of main roads will represent up to 3.5 TWh/year in the battery electric HDV high scenario (2.1 TWh/year in the medium scenario), which would equate to 0.8% of French electricity consumption in 2022 (460 TWh).

The national charging peak[13] could reach 1.1 GW in the battery electric HDV high scenario (0.7 GW in the medium), this can be compared to a peak national power demand (all uses) of 87 GW in 2022. In the high scenario, the average power per service area with fast and slow charging could reach 2.5 MW. This would be 2.1 MW per rest area with slow charging. The 50 most frequented stopping areas would have an average power need of 8 MW. The breakdown of HDV stopping areas by power is given in *Figure 9*.

The charging curve for the French grid system *(Figure 7, p. 13)* reflects the distribution of HDV traffic across an average week of the year, without any power peaks over specific periods of the year. The charging needs of long-distance HDVs are concentrated on weekdays, with slightly higher demand from Tuesday to Thursday *(Figure 8)*. Power peaks occur in late morning which is linked to fast charging during lunch breaks.

(13) National charging peak: the time in the year when the simultaneous power demand across France for on-highway HDV charging is at its maximum.

Figure 8: Annual average weekly curve of the on-highway charging power by 2035

Battery electric HDV high scenario – Consolidated power demand (France)

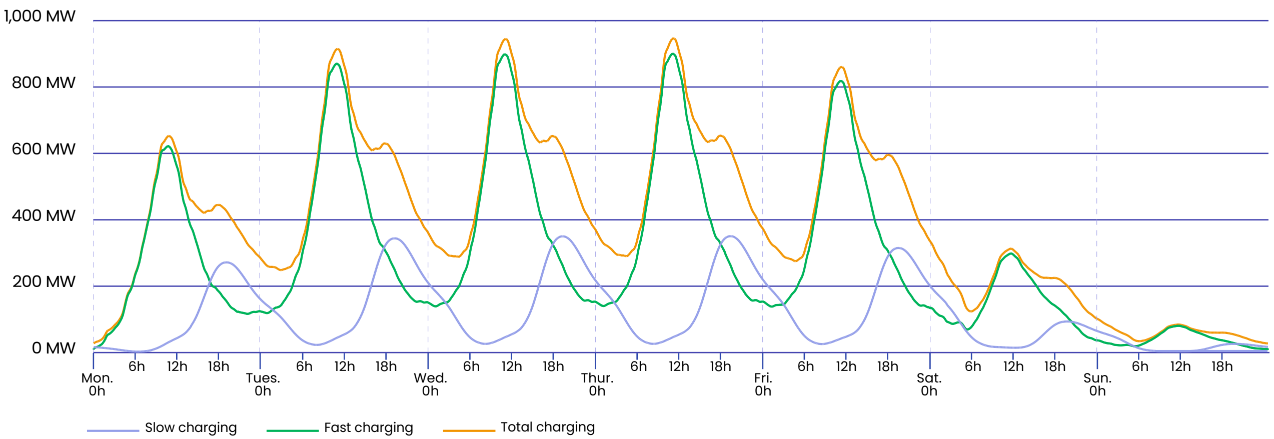
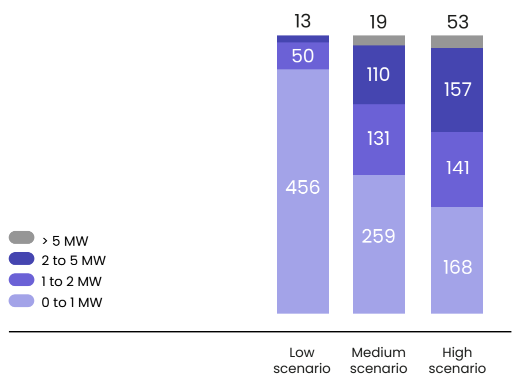


Figure 9: Breakdown of stopping areas by power

Number of stopping areas with charging points



AFIR requirements cover only a portion of the 2030 charging needs

→ Our study makes a comparative analysis for 2030 between the results of the battery electric HDV high scenario and the objectives of the AFIR[14].
By 2030, AFIR requirements will exceed the charging needs calculated by the model for 69% of the core part of the Trans European Transport Network (TEN-T)[15] and 34% of the TEN T comprehensive road network. On the other hand, AFIR alone is not sufficient to meet the estimated charging needs in 2030 on certain corridors, because:

- 31% of the core road network of the TEN-T and 66% of the TEN-T comprehensive road network have power needs that exceed the minimum defined by AFIR.
- 25% of the required charging stations are not located on the TEN-T, and are therefore not regulated by AFIR.

It should be noted that this study covers the need of charging for trucks traveling all distances above 350 km. If trucks traveling between 200 and 350 km are added, the average power demand of charging stations will increase by 15% (*see p. 16: A model that is sensitive to certain assumptions*).

(14) The AFIR's aims by the end of 2030 are: 3.6 MW accessible for each direction of travel, every 60 km (37 miles) on roads in the core TEN T, and 1.5 MW installed every 100 km (60 miles) on roads in the comprehensive TEN T.

(15) https://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/site/index_en.htm

2.5.2 Charging Requirements Analysed by Road Segment.
The model analyses power and energy needs over the 83 sections of France's road segment. A precise calculation of the power and energy needs for each stopping area was performed. Driver choice when faced with a differentiated offer of stopping areas within the same road segment was not considered because this falls outside the scope of the study, which is based on demand for charging and does not address the other factors that influence driver choice.

On the map in *Figure 10*, each road segment corresponds to all or part of a major road. It is defined by criteria of length (maximum 250 km [155 miles]) and delimited by junctions with other major roads. Power needs vary from one road segment to another. The highest demand for charging comes from stopping areas that are on the major roads which experience the highest level of traffic. For example, this is the case with the A10 motorway between Paris and Tours (42 MW/100 km [62 miles]), the A6 between Beaune and Lyon (38 MW/100 km [62 miles]) and the A1 between Paris and Lille (21 MW/100 km [62 miles]).

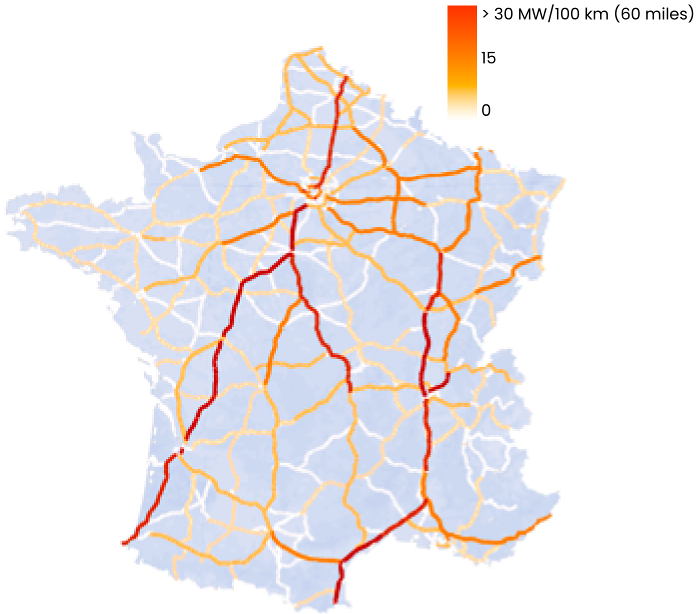


Figure 10: Charging power per section, expressed in MW/100 km (60 miles)

2.6 Significant infrastructure needs, with a land issues as early as 2035 on certain roads

The calculation of the number of charging points required to meet the need for slow and fast charging can be based on two different charging behaviour assumptions.

1. Charging method. Charging is complete once a battery reaches the desired driving range. The charging point is then available for other vehicles without waiting for the regulatory break time to end.
2. Occupation method. The vehicle is disconnected from the charging point when the regulatory break time ends, even if the battery had completed charging before this. This method has a stronger bearing on how charging point needs are considered. This also complies with current regulations on drivers' break times, during which they may not plug in, unplug or move their vehicles. This is the method that the study uses as its reference.

The charging needs set out in the battery electric HDV high scenario would involve rolling out 10,000 slow charging points for long breaks and 2,200 fast charging points across the French national network by 2035, compared to approximately 6,200 and 1,400 respectively in the medium scenario. The figures should be compared with the number of HDV spaces available: 40,300 across the 1,374 stopping areas considered. The breakdown of HDV stopping areas per number of charging points is shown in *Figures 11 a and b*.

Figure 11 a: Breakdown of stopping areas by number of slow charging points

Number of stopping areas equipped with slow charging points

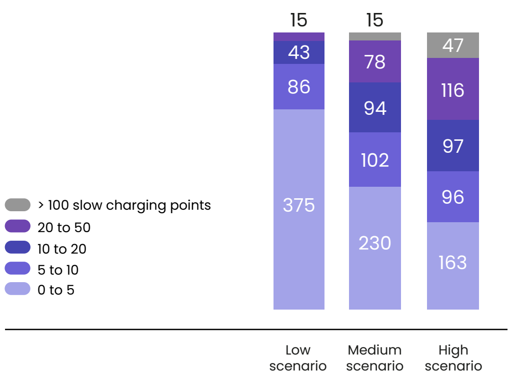
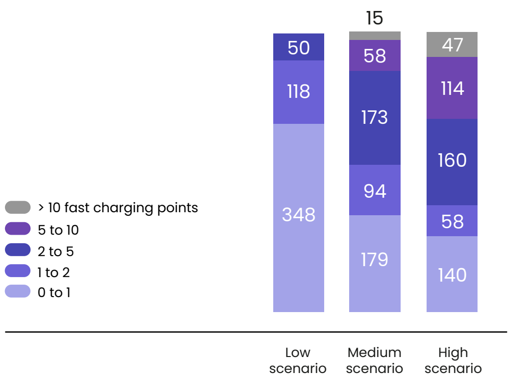


Figure 11 b: Breakdown of stopping areas by number of fast charging points

Number of stopping areas equipped with fast charging points



A model that is sensitive to certain assumptions

→ Additional calculations highlight the sensitivity of the model's output to the input parameters and to the assumptions made in this study. There are four factors that influence the results.

- **Battery capacity.** If this is low, both HDV driving range and driving time drop. The charging peak occurs in the early part of the morning, requiring more power and more charging points. By changing the usable capacity of a 580 kilowatt hour (kWh) battery to 540 kWh, the peak power-demand increases by 5% and occurs 30 minutes earlier.
- **Battery state of charge (SOC) on arrival for national journeys.** By reducing the on arrival SOC there is a decrease in both the energy consumed during on-highway charging and the peak power-demand. An on arrival SOC of 10% leads to a 15% reduction in the peak power-demand compared to an on arrival SOC of 30%.
- **HDV electricity consumption (electric transmission efficiency).** The distance travelled by an HDV before a charging stop reduces if electricity consumption increases (less efficient). The energy consumed during on-highway charging also increases, which impacts the midday peak power-demand and the number of charging points. With a 10% increase in unit consumption, the peak power-demand rises by 12.5%.
- **Use of "regional" battery electric HDV technology.** This second medium distance technology, for journeys under 300 km (185 miles) leads to an increase in peak power-demand and in the number of charging points. With a 340 kWh battery and a recharge of 300 kW, it causes a 15% rise in the peak power-demand and the number of charging points.

Key results

On-highway charging needs for long-distance electric HDVs by 2035

Total needs at national level (high scenario)

Energy
3.5 TWh

Power
1.1 GW

Fast charging points
2,200

Slow charging points
10,000

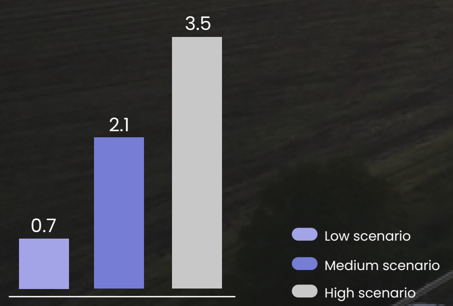
Charging needs per stopping area (high scenario, average values)

	Number of fast charging points	Number of slow charging points	Charging power in MW
Per service area	5	18	2.5
Per rest area		27	2.1
For each of the 50 most frequented stopping areas	14	58	8

Needs based on three battery electric HDV scenarios across the French road system by 2035

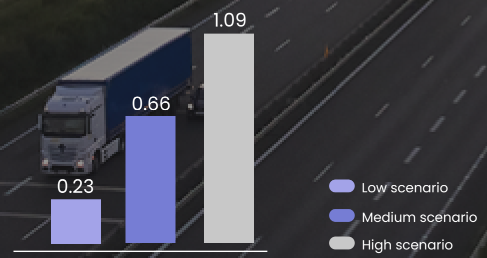
Energy needs for on-highway charging

Annual energy (in TWh)



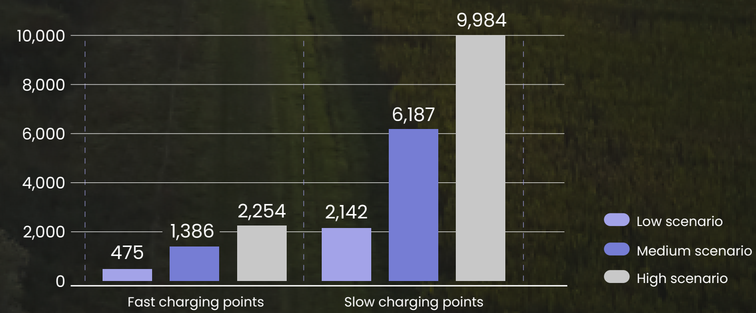
Power needs for on-highway charging

Peak power-demand (in GW)



Charging points required (slow and fast) for on-highway charging

Number of charging points



Impacts on electric and road infrastructure

3.1 The impact on the electricity transmission and distribution network

The analysis of the impact of on-highway charging needs on the electricity network, linked to the cumulative electrification of HDVs and LDVs, highlights the need for significant structural changes for approximately 60 high-voltage/medium-voltage substations. These changes are predominantly a result of LDV mobility needs.

3.1.1 The need to simultaneously consider electric HDV and LDV charging needs

To estimate the necessary changes to the electricity network, this study incorporates the charging needs of both HDV and LDV at shared motorway service areas. Taking these needs into account separately, without factoring in their complementary nature, would lead to excessive and non optimised works and investments for the electricity network.

Therefore, this study takes into account the potential interdependence between LDV and HDV charging needs at the same service area. Taking into account their different needs (they will typically be charging at different times of the day and the week), and therefore establishing a single power demand curve for a stopping area means that electrical infrastructure costs can be optimised for all actors in the value chain.

Consequently, HDV charging needs are combined with those of LDVs at motorway service areas. The LDV charging needs are taken from the Enedis/RTE 2021 study[16]. The assumptions used for this reference scenario were updated, based, in particular, on a reduction in the number of plug in hybrids (PHEVs) in favour of BEVs *(see table p. 19)*.

(16) Enedis/RTE study, July 2021. Long-distance electricity needs for motorway mobility : https://www.enedis.fr/sites/default/files/documents/pdf/enedis-etude-les-besoins-electriques-de-la-mobilite-longue-distance-sur-autoroute.pdf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The analysis covers the 412 service areas shared between LDVs and HDVs. It combines the charging curve for HDVs with that for LDVs. Only one LDV scenario is considered. For each of the three battery electric HDV scenarios (low, medium and high) the peak of the sum of the two HDV and LDV power curves is used as the design power. This peak is much lower than the sum of the power peaks of each of the two curves because the peaks occur at different times of the day and on different days *(Figures 14 and 15, p. 21)*.

The Enedis/RTE 2021 study did not cover rest areas on French motorways nor the French national road network. Therefore, this study only considers the charging needs of HDVs for these stopping areas; in total there are 107 of this type of stopping area included in the analysis.

3.1.2 Cumulative power need mainly driven by LDVs

By combining HDV and LDV charging needs between now and 2035, the charging peak[16] varies between 3.0 gigawatts (GW) and 3.2 GW depending on the chosen battery electric HDV scenario. There is a significant effect on peak power-demand coming from the asynchronous needs of the two populations *(Figures 12 a and b and 13, p. 20)*. This power peak is primarily a result of LDV mobility needs where their power-demand is concentrated on very specific periods of the year, i.e. on specific weekends (most particularly during holiday periods) when HDV traffic is particularly low.

Scenario used to estimate EV charging needs on motorways

Simulation settings for 2035	Value selected for the Enedis/RTE 2021 motorway study	Value selected for the cumulative calculation with HDV mobility needs
Share of electric vehicles (PHEV and BEV)	40% (approximately 15.6 M)	40%
Rate of PHEV among LDVs	21%	7%
Power used to determine charging needs	Power P30h[17]	Peak power
% of long-distance travel	73%	82%
Average consumption	22.7 kWh/100 km (60 miles)	22.7 kWh/100 km (60 miles)
Average speed	95 km/h (60 mph)	95 km/h (60 mph)
Criterion for stopping on arrival at the stopping area	30% battery	20% battery
Maximum state of charge (SOC) on charging	80%	80%

(17) P30h is the power needed to charge EVs at the thirtieth most congested hour at the stopping area.

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In contrast, HDV power needs are greatest on working days (when there are few LDVs on the road) and remain largely below those of LDVs during long weekends and at the start of holiday periods *(Figures 14 and 15, p. 21)*.

LDV charging needs are therefore the primary factor in establishing the power needs for service areas.

The combined (and different) charging needs of HDVs and LDVs are taken into account for motorway service areas, as previously explained. The average power per stopping area is 8.8 megawatts (MW) in the battery electric HDV high scenario. By extending this scope to stopping areas frequented only by HDVs, this average falls to 7.3 MW. The breakdown of stopping areas by power, combining HDV and LDV charging needs, is illustrated in *Figure 16 (p. 22)*.

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Figure 12 a: Energy needs for on-highway LDV and HDV charging by 2035

Annual energy in TWh based on the three battery electric HDV scenarios – Consolidated power demand (France)

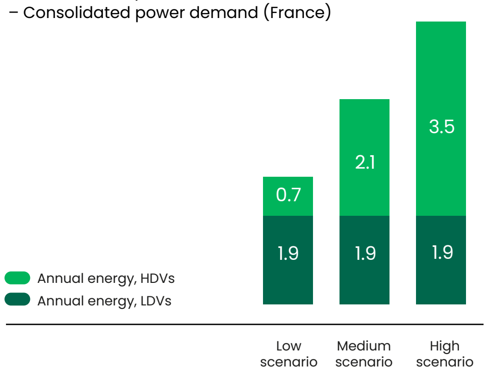


Figure 12 b: Power needs for on-highway LDV and HDV charging by 2035

Power peak in GW per the three battery electric HDV scenarios – Consolidated power demand (France)

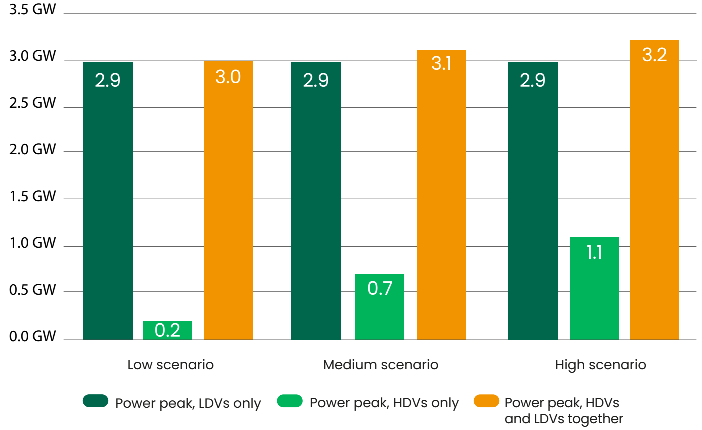


Figure 13: Annual curve for on-highway charging power by 2035 for HDVs (battery electric HDV high scenario) and LDVs

Electricity consumption for on-highway LDV (motorways only) and electric HDV charging (in MW) – Consolidated power demand (France)

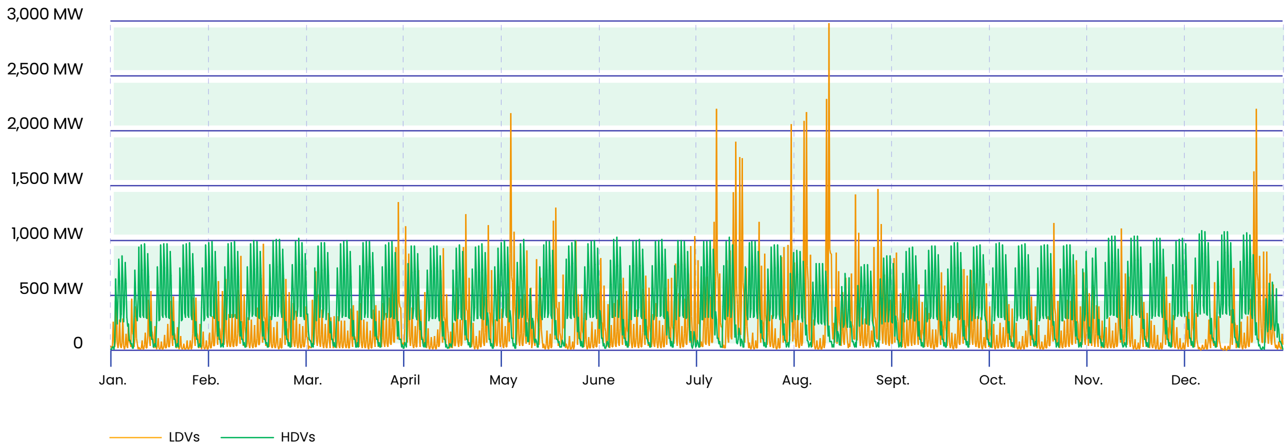


Figure 14: Weekly curves for on-highway charging power by 2035 for LDVs and HDVs (battery electric HDV high scenario) during LDV charging peaks

The LDV charging peak falls during the weekend of 12 August when there is heavy holiday related traffic

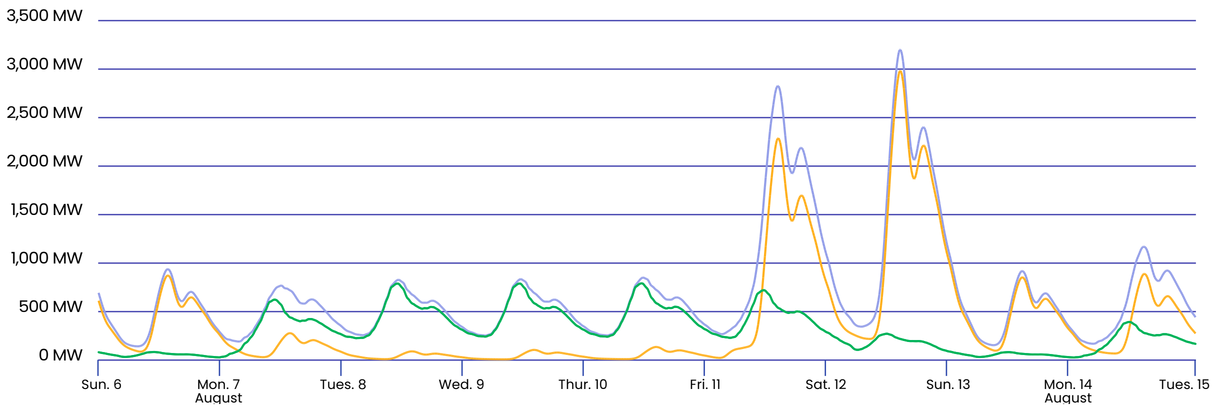
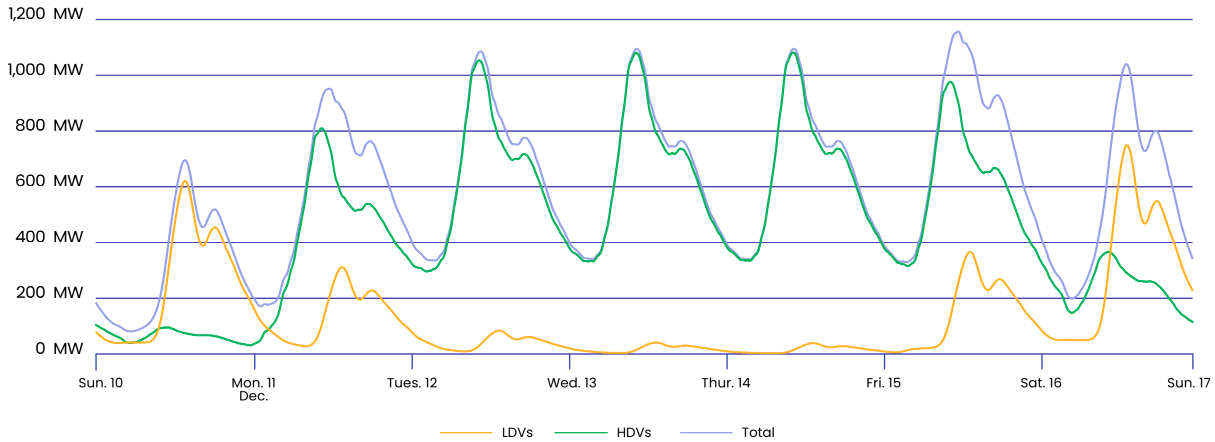


Figure 15: Weekly curves for on-highway charging power by 2035 for LDVs and HDVs (battery electric HDV high scenario) during HDV charging peaks

The HDV charging peak falls on working days in the second week of December



The combined annual electricity consumption varies between 2.6 and 5.4 terawatt hours (TWh) depending on the chosen battery electric HDV scenario, with 1.9 TWh attributable to LDVs. The energy required for HDV on-highway charging is greater than that for LDV on-highway charging in the medium and high scenarios (up to almost double in the high scenario).

3.1.3 Network infrastructure needs concentrated on the public electricity distribution network (PEDN)

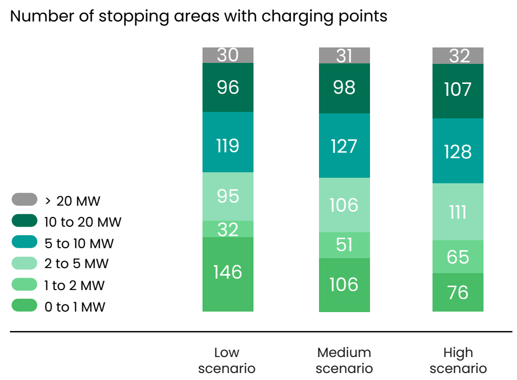
The impact study carried out for our analysis is forward-looking. It was conducted using current data from the electricity network.

The need for work on the electricity grid is calculated by simulating the connection of a stopping area to the electricity grid based on the predicted peak power-demand. This peak corresponds to the maximum demand predicted for the stopping area in 2035 and is therefore used by the model as the connection power.

The connection for each stopping area is simulated by selecting the optimal technical solution from an economic perspective. Depending on the connection power required and the design of the surrounding network, a stopping area may therefore have four types of connection.

- One or more MV-line connections may be laid underground from an existing MV feeder close to the stopping area, with or without adaptation of the existing feeder or the HV/MV transformer to overcome transit or voltage constraints.
- The creation of one or more MV-line connections direct from the closest HV/MV substation, with or without adaptation of the HV to MV conversion capacity, by modification or addition of a transformer in the substation.
- The creation of a HV/MV substation if adapting the capacity of the closest HV/MV transformer is insufficient, or if the existing network is too far away. In this case the new substation must be connected to the transmission network and therefore HV connection costs are also estimated.
- Direct connection to the transmission network (PTN) for the most demanding stopping areas when this solution has techno-economic merits, with a private HV/MV transformer station installed at the stopping area. These cases arise only rarely due to the unit costs of HV connections.

Figure 16: Breakdown of stopping areas per power: combined HDV and LDV charging needs



Between now and 2035, infrastructure needs are largely the same in all three battery electric HDV scenarios considered as they are mainly driven by LDV mobility; LDV charging needs are based on a single reference scenario *(Figure 17, p. 23)*. All these scenarios involve creating eight new HV/MV substations with the same number of HV connections, as

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well as adding or replacing between 47 and 49 HV/MV transformers. However, a large part of the work consists of creating around 690 MV-line connections since any stopping area with at least one high power electric vehicle charging infrastructure (EVCI) requires a minimum of one MV connection. This number is higher than that mentioned in the Enedis/RTE 2021 study, this is because it also includes HDV charging needs at motorway rest areas and stopping areas across the national network.

3.1.4 Investment of 630 million euros needed in the electricity network by 2035

Investment of 630 million euros is required in the electricity network between now and 2035, to connect the motorway stopping areas for the battery electric HDV high scenario. This figure includes 597 million euros for the distribution network[18], with MV and HV connections created and HV/MV substations being upgraded or built *(Figure 18)*. This amount should be considered in perspective of the 96 billion euros of investment that Enedis is planning between now and 2040.

The need for grid connections are primarily a result of LDV charging needs; they represent around 91% of the investment necessary for on-highway charging in 2035. The calculated costs do not vary significantly between battery electric HDV low and medium scenarios.

In the high scenario, investment expenditure is broken down as follows: 89% on the distribution network

(18) The investments only consider work on the public electricity network, they do not consider the internal electricity networks of each stopping area because they are not managed by the electrical network distribution company. This connection work is based on the power needs calculated in this study. It does not include other requests that EVCI managers may make (for example, for back up supply).

Figure 17: Work required on the electricity network by 2035 to connect charging stations

On-highway HDV (stopping areas on motorways and major roads) and LDV (motorway service areas) charging

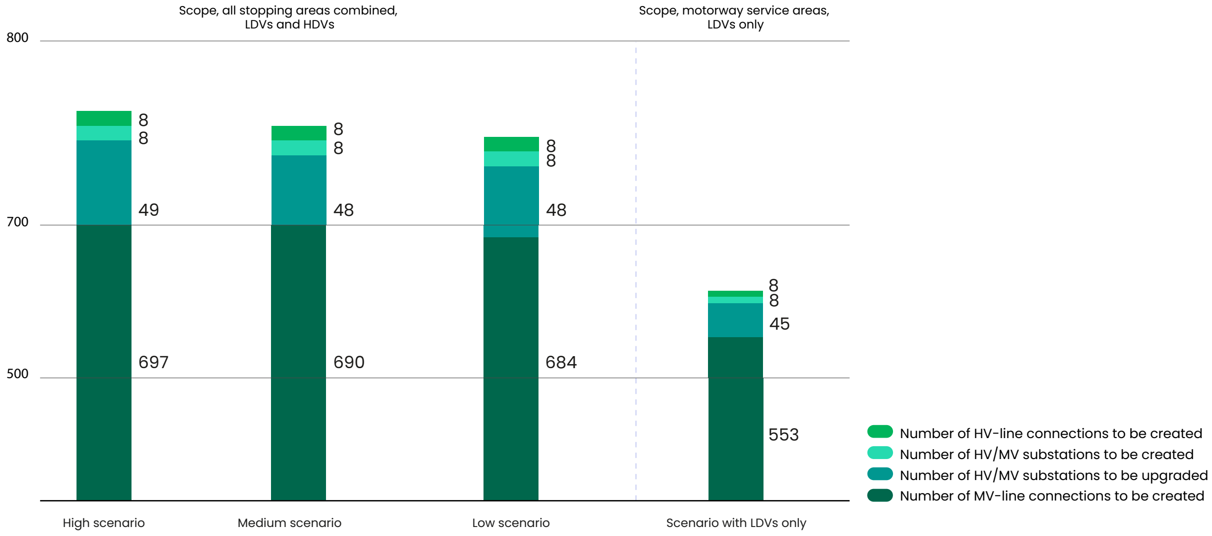
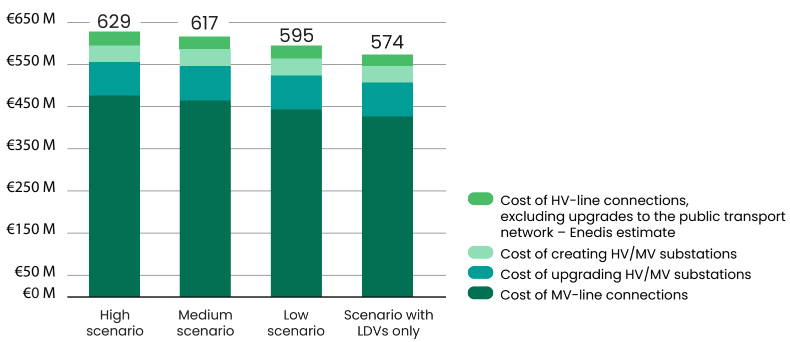


Figure 18: Investment required in the electricity network by 2035 to connect charging stations

On-highway HDV (stopping areas on motorways and major roads) and LDV (motorway service areas) charging. Total cost – in millions of euros



(creation of MV-line connections and adaptation of HV/MV substations), 6% on creating new HV/MV substations and 5% on the transmission network[19] *(Figure 19)*.

As a reminder, the Enedis/RTE 2021 study calculates the investment necessary in the network at 291 million euros between now and 2035, based on the reference scenario.

This study updates this amount by taking into account the evolution of five key factors *(Figure 20)*.

- A price effect. Updating the unit costs incorporates price changes in the sector; an additional 100 million euros.
- An LDV volume effect in 2035; an increase of 12 million euros. This is due, in particular, to an increase in the number of battery LDVs (to the detriment of PHEVs), which increases from 12 to approximately 14 million between the reference scenario adopted in the 2021 study and the present study.
- An effect resulting from the change in the peak power-demand used for design purposes by the stakeholders in the motorway sector instead of the previously used value, P30h[17]; an increase of 171 million euros.
- The addition of HDV mobility to the scope of charging services at motorway service areas; an additional 14 million euros.
- An extension of the scope of charging services at motorway rest areas and rest and service areas on major trunk roads to include HDV mobility; an additional 41 million euros.

The cost of connecting a stopping area is on average 1.2 million euros in the battery electric HDV high scenario; 25% of stopping areas have a unit cost below 0.3 million euros, with 25% requiring over 1.4 million euros

(19) Enedis estimate.

Figure 19: Breakdown of investment depending on the type of work in the battery electric HDV high scenario

Cost in millions of euros

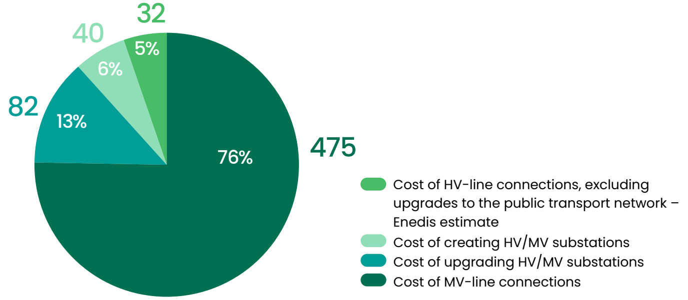
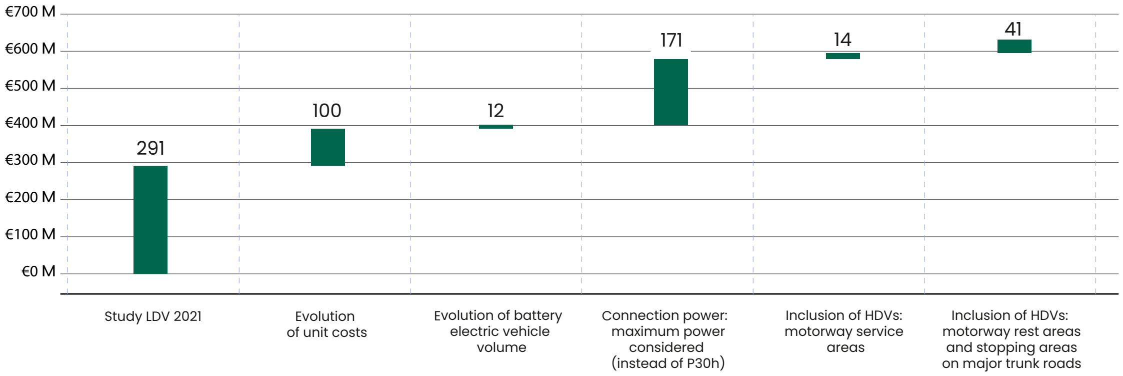


Figure 20: Change in investment expenditure on the electricity network in relation to the reference scenario in the 2021 Enedis/RTE study

Cost in millions of euros



3.2. The impact on road network infrastructure

of investment for their connection.
The gradual roll out of HDV charging infrastructure across service and rest areas on the road network will have an impact on the spaces allocated for HDV parking. These spaces will have to be adapted progressively in line with the electric HDV fleet on the road.
As a consequence, there will be two major changes.

- **Conversion of some HDV parking places into charging points specifically for electric HDVs.** This change will result in a reduction in the number of available HDV parking spaces unless land use is modified or increased; the reduction will be two and a half times higher than the rate of transition from conventional to electric HDVs in the context of existing very high usage of HDV parking spaces on certain major roads, and particularly on specific major trunk roads.

- **A reduction in space available for charging due to the space required for the charging infrastructure.** The creation of HDV charging infrastructure on a central island between two charging points or on islands where gantries and satellite terminals can be installed will necessarily entail a decrease in the space available to park HDVs during charging. Depending on the configuration chosen, between one in six and one in three spaces may be lost, accentuating the loss of HDV parking spaces for the current fleet on the road.

The study does not address the layout of HDV parking spaces at stopping areas. At present, most HDV parking spaces are in a herringbone layout. This configuration maximises the number of spaces for a given surface area. Electric HDV charging areas are intended to be pass through (no reversing required), to reduce the risk of damaging the gantries or terminals.
It would therefore be logical to plan the future design and sizing of stopping areas so that they incorporate this new charging service in the best way possible.
This should be done by anticipating the key changes and reconfigurations needed in terms of traffic circulation and layout.

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Key figures

The impact on the electricity network and road infrastructure caused by the on-highway charging needs of LDVs and HDVs by 2035

Energy and power needed for the high scenario: HDVs and LDVs alone and combined[20]

Consolidated demand (France)	Energy (in TWh)	Power (in GW)
LDVs alone	1.9	2.98
HDVs alone	3.5	1.1
LDVs and HDVs combined	5.4	3.2

Additional LDV and HDV charging needs per service area (high scenario)

8.8 MW
Average value

22.8 MW
Average value for each of the 50 most frequented stopping areas

Work on and investment in the electricity network between now and 2035 (high scenario)

57
HV/MV substations to be upgraded or created (high scenario)

€630 M
in investment in the electricity transmission and distribution network[21]

Restructuring HDV parking at service areas and rest areas

2/3
of road sections will potentially lack available space by 2035, representing the equivalent of 7,000 to 8,000 HDV parking spaces

1/3 to 1/6
of spaces may be lost in HDV parking areas depending on their configuration and future charging infrastructure

(20) For LDVs, only the charging needs at motorway service areas were considered.
(21) This amount includes the costs of HV A connections, upgrading or creating HV/MV substations and HV-line connections. It does not include the costs of upgrading HV lines. The transport network costs are an estimate by Enedis.

Key messages and recommendations

4.1 The challenge of optimising costs and reducing delays on the electricity network

4.1.1 The challenge of anticipating the work required

The work to adapt the electricity network that this study sets out represents a major undertaking. Although such work presents no particular technical issues, nevertheless it could take several years to complete, punctuated by design and planning phases, the necessary time to secure administrative authorisations, and carrying out the work itself. It could take up to five years to complete a single HV/MV substation, and over seven years to install a high voltage (HV) line.

Demand at service areas to connect electric vehicle charging infrastructure (EVCI) have, so far, come from successive increases to contracted power and each operator making connection requests. The average completion time varies between 12 and 24 months.

However, the growth in the number of EVs on the road will quickly generate network constraints for the stopping areas most frequented by LDVs. This will require major work to be carried out, which could go as far as constructing HV/MV substations and adapting the HV network. As things stand, the time required to complete such work will not allow the operators' requirements to be met and hence nor will the needs of the electric HDV fleet.

To avoid this happening, the two following actions need to occur:

- A collective anticipation of the investment required to supply the necessary power for HDVs and LDVs at each stopping area and at various points in the schedule. This provides a framework for financing the work required on the network. It will be very helpful to define how this approach will be implemented and integrated into existing contractual relations, such as those for motorway concessions or contracts binding the French state or motorway companies with service area managers.
- A review of the regulatory and operating procedures for managing short term connection requests. In most cases, the work conducted to meet this demand is insufficient to fulfil medium and long term needs.

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Without a review of these procedures, network managers will have to undertake groundwork and cable laying at stopping areas several times, thereby incurring the same groundwork costs on multiple occasions leading to excess costs of around 50% of the total cost for medium voltage (MV) connections.

This long term connection planning would optimise the work and avoid unnecessary excess costs. It would simultaneously allow the final target power to be achieved whilst ensuring that power can be increased in stages as the work to upgrade the electricity network progresses. It would also offer network managers and sector stakeholders clear visibility that would help to reduce the risks arising from any supply chain tension in the context of transforming and electrifying different industry sectors (integration of renewable energies, deployment of heat pumps, electrification of the mobility sector and of energy intensive industries).

4.1.2 The challenge of combining connections in the same stopping area

At existing service areas, the emergence of new HDV charging infrastructure and the arrival of new operators will—if nothing changes—result in requests to increase power supply that will lead to over investment in these stopping areas and non optimised connections *(see section 3.1.2)*.
To illustrate this point, requests for HDV and LDV connections independently of one another would mean needs would not be combined, which would thereby generate extra work. The study has estimated the work associated with a failure to optimise at 5 additional HV/MV substations and 7 additional HV/MV transformers for the high scenario, amounting to around 90 million euros in additional costs (+14%), *(Figure 21)*. This amount would become increasingly significant over the following years, with the growth of these two fleets.

With this observation in mind, it is important to define how to effectively ensure optimisation stopping area by stopping area, defining responsibilities as necessary (distribution network manager, road infrastructure manager or other existing stakeholders and including the creation of new stakeholders).

The cost sharing rules for these future connections should also be defined, both in terms of investment—for each new connection and each power increase—and for allocating network usage tariffs.

Therefore, the joint connection of EVCIs for HDVs and LDVs constitutes a key lever for the optimisation of the work and the costs on the electricity network, collectively and for each future operator of an EVCI.

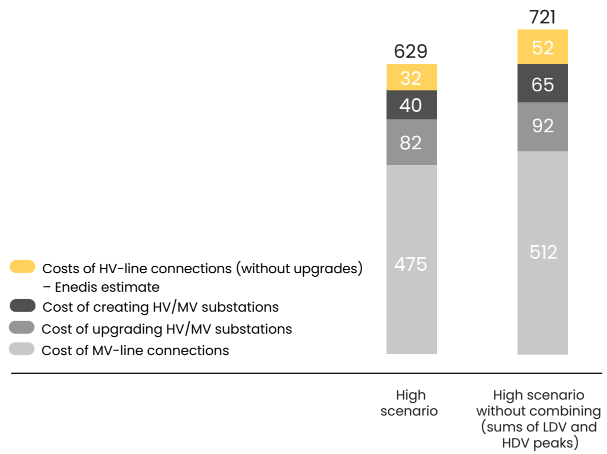
Complementary processes may also contribute to costs optimisation. For example, in a single stopping area, the charging needs for some HDVs could be covered by a charging point with a lower power than that used for this study (100 kW for long breaks and 800 kW to 1 MW for short breaks). The infrastructure rolled out in stopping areas could therefore have:

• For long breaks a subset of the charging points with power between 50 kW and 75 kW.

• For short breaks a subset of the charging points with power between 300 kW and 500 kW.

Figure 21: Investments required in the electricity network with and without combining HDV and LDV charging needs, stopping area by stopping area

Battery electric HDV high scenario, in millions of euros



4.2 The land use challenge

Between now and 2035, the roll out of electric HDV charging infrastructure on France's motorways and main arterial roads will cause a shortage of space in some areas. This is linked to two factors.

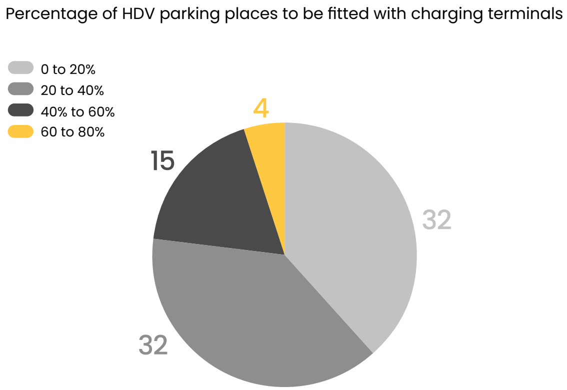
- The gradual transformation of existing HDV parking places into dedicated parking places with a charging point, resulting in a drop in the number of parking places for conventional HDVs.
- The footprint of EVCIs, with more parking places lost than charging points gained (around 10% to 40%).

Although the share of all electric HDVs in long-distance road freight will remain limited at this time (in the high scenario, 25.3% of long-distance journeys will use electric HDVs and the latter will account for 12.6% of the total fleet), from 2035 it will be necessary to incorporate the loss of parking places linked to the installation and accessibility of charging points on certain roads, as the majority of parking places will still be used by conventional HDVs.

According to the study, the redevelopment and reorganisation necessary to ensure the availability of a sufficient number of charging terminals could involve the conversion of over half of HDV parking places into charging points across almost a quarter of the road sections considered. Add to this the 40% of road sections where between 25% and 50% of HDV parking places will be lost, then two thirds of roads will potentially have insufficient HDV parking between now and 2035 *(Figure 22)*. More detailed analyses should be carried out by road type and at the level of each road section to address the issue of the potential lack of HDV parking places. These analyses should, on the one hand, identify the potential to integrate new areas of land into the road network concerned and, on the other, define the development of HDV hubs outside the road network, in particular those close to the major roads affected along with their access routes.

From an economic perspective, the approach aims to strike an optimum balance between the costs of connecting to the electricity network, which this study has evaluated, and the costs of land needed for development, factoring in the characteristics of the local electricity network and the challenges of achieving the goal of zero net artificialisation (ZNA, also called no net land take [NLT]).

Figure 22: Number of road sections according to percentage of HDV parking places fitted with charging terminals by 2035



4.3 Three main recommendations

The electrification of long-distance HDV mobility is an essential challenge for the electricity network, and for land use planning with a significant need for new and upgraded infrastructure at its core.

To be ready, on time and collectively, to support electrification of HDV fleets, assist end users in the decision to buy electric HDVs and thus accelerate the energy transition of the long-distance road freight sector, the contributors to this report have formulated three key recommendations.

1 DEVISE A SCHEDULE AND A ROADMAP

The public authorities, as land planners, need to define a shared and actionable roadmap for on-highway charging based on the mobility needs of LDVs and HDVs. This document should specify, for each stopping area: the connection power of the stopping area, in total and for each use (HDVs and LDVs), the charging infrastructure and power to be implemented by 2027, 2030 and 2035, and the roles and responsibilities of each actor. It should take account of the constraints of the electricity network and of the land required (analyses to be conducted per road section), in line with the various applicable regulations, including the AFIR.

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2 INSTITUTE REGULATORY, ADMINISTRATIVE AND FINANCIAL SYSTEMS

New regulatory and administrative systems should be put in place to:

- Anticipate power needs and connection requests and accelerate the administrative authorisation procedures to ensure that network infrastructure is available at the right time. Priority should be given to advance planning of HV/MV substations and HV-line connections which take the most time.
- Combine HDV and LDV EVCI connections at the same location and optimise their positioning to reduce investment and thus the cost to the stakeholders.
- Define the roles and responsibilities of each stakeholder to achieve the necessary investments, taking into consideration the constraints of each actor (service area operators, electricity network managers, and recharging service operators).

3 INCENTIVISATION

The roll out of on-highway charging infrastructure for electric HDVs represents a significant investment (civil engineering, reorganisation of parking areas, EVCI and connections) which will not be profitable in the initial years. A specific incentive that is simple to access and provides long term visibility, should be put in place at national level. It should be in line with the incentives offered to support funding of electric HDVs and EVCIs at depots and destinations.


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