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WHITE PAPER

Electricity for the industrial vehicle sector

November 2019
FFC, AVERE FRANCE and URF as part of the work of the PFA

SUMMARY

FOREWORD
(PFA, FFC, AVERE France and URF)




The development of electromobility is a strong component of the strategic contract - agreed between industry representatives and government authorities - to which the automotive industry signed up on 22 May 2018.

The industrial and urban vehicle industry has been committed for many years to improving energy efficiency and cutting polluting emissions.

In this context, in September 2018, the PFA (Plateforme de la Filière Automobile et Mobilités - Automotive and Mobility Platform), in agreement with the COFIT (Comité d'Orientation de la Filière Industrielle du Transport - Transport Industry Guidance Committee) tasked the Fédération Française de Carrosserie - French Bodywork Federation (FFC), in partnership with AVERE France and the URF, with steering a Professional Work Group to study the conditions for developing industrial electric vehicles (ranging from light utility vehicles through to 44 tonnes).

For the first time, this group brought together all the stakeholders involved in developing electromobility in road haulage:

- manufacturers, distributors and repairers of industrial vehicles,
- battery manufacturers,
- recharging infrastructure,
- road haulage contractors and hire companies,
- logisticians,
- power suppliers and distributors,
- public administrations (ADEME, DGE, DGEC).

This white paper:

- takes stock of the current supply in electric industrial vehicles and confirms its relevance with respect to road haulage uses (distances and tonnage),
- outlines development prospects while respecting technological and energy neutrality,
- and makes proposals to government authorities to speed up the development of the electric vehicle sector.

The industrial and urban vehicle sector has set itself the objective of achieving carbon neutrality in road haulage. Electromobility is a means to achieving this. However, support from government authorities is indispensable to obtain its economic relevance and therefore the success of this transition.

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PREFACE
by Patrick Pélata, Consultant, former Executive Vice President, Renault

With the onset of rapid global warming, we have no choice: It is necessary to act fast, very fast, to reduce greenhouse gases. This means cutting CO_2 in road haulage. Light and heavy utility vehicles represent 11.5% of emissions in France. As with cars (15.5%), these emissions have dropped more slowly over the past 20 years than other industrial, tertiary and residential sources. At what pace? -30% demanded by 2030 and -15% from 2025 according to European regulations [1] or the French National Low Carbon Strategy [2]. Then, for 2050, both target complete carbon neutrality in line with the GIEC [3]. This is a major turnaround.

To that is added another challenge, that of eliminating health problems caused by local emissions of NOx (generating nitrogen) and particles that have led large cities to legislate in their territories with Zones à Faibles Emissions (ZFE - Low Emission Zones), excluding diesel vehicles more or less rapidly. It is true, for example, that the fleet of diesel light utility vehicles, heavy goods vehicles, coaches and buses produces 48% of NOx emissions in the Greater Paris Area [4].

How can road haulage emissions be drastically cut without unsettling this key, growing but fragile economic activity that runs on very low and highly fragmented margins? What are the possible and realistic solutions available to professionals in the sector today and tomorrow? This is the main issue addressed by this White Paper, drafted by a broad sector-based collective. And it is eagerly awaited!

This current offer is therefore not suitable yet for inter- or even intra-regional requirements. It is therefore necessary to focus its deployment on urban and suburban transport: deliveries, postal services, waste collection, bus services, etc. By the way, it is in fact mentioned that electric buses are already a cost-effective choice. For longer distances, besides biofuel, several solutions are being developed: increase in the density of battery power and size, supercharging (80% battery life in 30 minutes), rapid battery changing, "electric" motorways by ground contact, induction or overhead lines for trucks.

Finally, the White Paper reviews the new ecosystem to be set up and obstacles to be removed: recharging terminals, regulations for high-powered terminals in businesses and car parks, personnel training for the whole new value chain, etc. Much therefore remains to be done...

Patrick Pélata

SOURCES

[1] - 31% (2030 / 2021) for light utility vehicles. -30% (2030/2019) and -15% (2019-2025) for Heavy Goods Vehicles.

[2] - 31% (2030/2015) for the transport sector as a whole

[3] GIEC: Groupement d'experts intergouvernemental sur l'évolution du climat - Inter-governmental group of experts on climate change

[4] Appraisal of atmospheric emissions in Greater Paris Area in 2015. AirParif, April 2019.

CHAPTER 1

ELECTROMOBILITY OF INDUSTRIAL VEHICLES TO MEET REGULATORY AND SOCIETAL REQUIREMENTS

The transport industry has to deal with two distinct major challenges:

- air quality and urban pollution caused by traditional polluting emissions
- global warming caused by greenhouse gases, CO_2 emissions for industrial vehicles.

In reaction to legislation passed in recent years, very significant gains have been achieved on cutting CO_2 emissions and on the question of polluting emissions negatively impacting air quality. Since 1990 (Euro 0), polluting emissions of industrial vehicles have been drastically reduced: -97 % for NOx, and -98 % for particles... At the same time, while vehicles have become more understated, they have become more productive: Commercial speed has doubled, power has tripled and the carried load has increased by 30 %... whereas CO_2, consumption and therefore emissions have halved.

THE PARIS AGREEMENT

In December 2015, at the Paris Climate Conference (COP21), 195 countries adapted the very first, legally binding universal climate agreement, aimed at containing the increase in the planet's temperature by 2°C or even 1.5°C by 2100 compared to 1990.

To do that, carbon neutrality (net zero CO_2 emissions) should be reached on the global level in around 2050. To help the industrial vehicle sector support these ambitious policies, several international initiatives aiming at sharing best practices have been set up, in particular, the increase in electric transport. This is the case for example with the International Transport Forum, the EV30@30 or the EV Pilot City Programme launched within the Clean Energy Ministerial.

EUROPEAN LAW

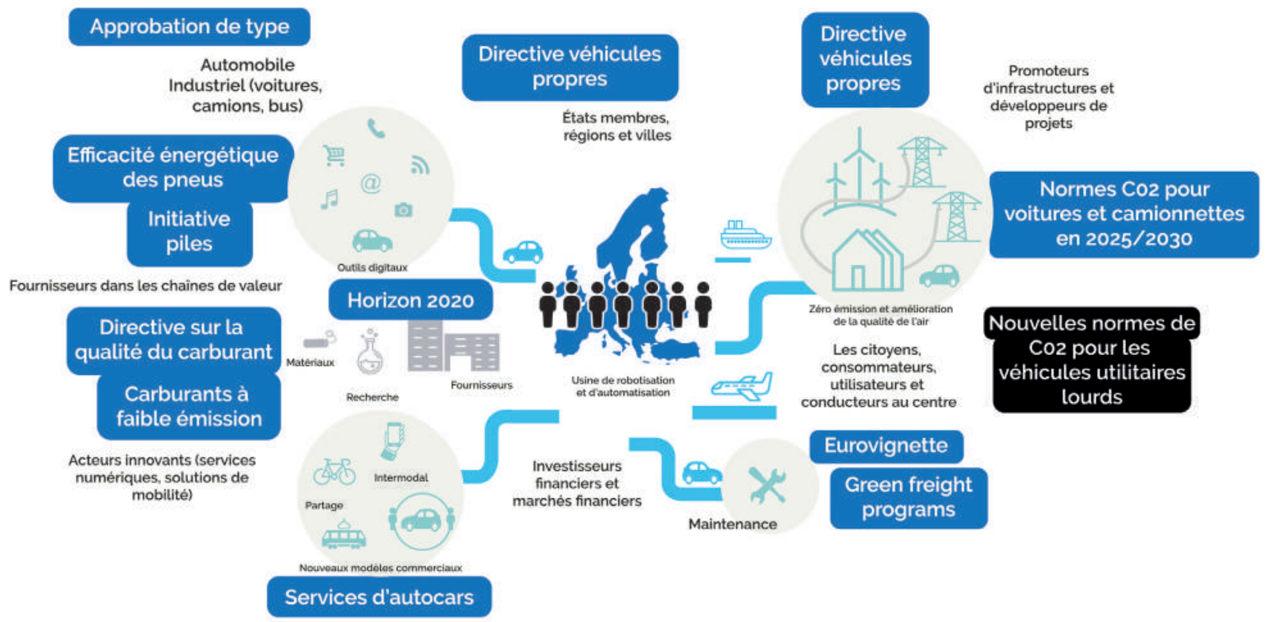
In 2016, Europe adopted a European strategy on low-carbon mobility. It specifies that between now and the mid 21st century, greenhouse gas emissions generated by transport must be at least 60% lower than 1990 levels and target carbon neutrality.

On 18 April 2019, the EU adopted brand new legislation on CO_2 emissions for heavy goods vehicles. It imposes a 30% reduction of CO_2 by 2030 for new industrial vehicles, with an intermediate target of 15% by 2025 (compared to reference CO_2 emissions based on monitoring data for the period ranging from 1st July 2019 to 30 June 2020). Manufacturers must also ensure that low emission or local zero emission vehicles represent 2 % of the market share of new vehicles by 2025, in order to counterbalance the constant increase in emissions due to road traffic, a quarter of which is attributable to heavy utility vehicles. The European Commission must also propose new objectives in 2022 for the post-2030 period, as laid down by the Paris Agreement.

The European Commission and member States have adopted a series of directives and regulations establishing norms for a set of pollutants, in particular ozone, particles (PM10) and nitrogen dioxide (NO2), fine particles (PM2.5).

Within this framework, the control of emissions by mobile sources, the increase in the quality of fuel as well as the promotion and integration of requirements regarding environmental protection in the transport and energy sectors are part of these objectives.

Snapshot of the main EU policies on mobility



SOURCE:

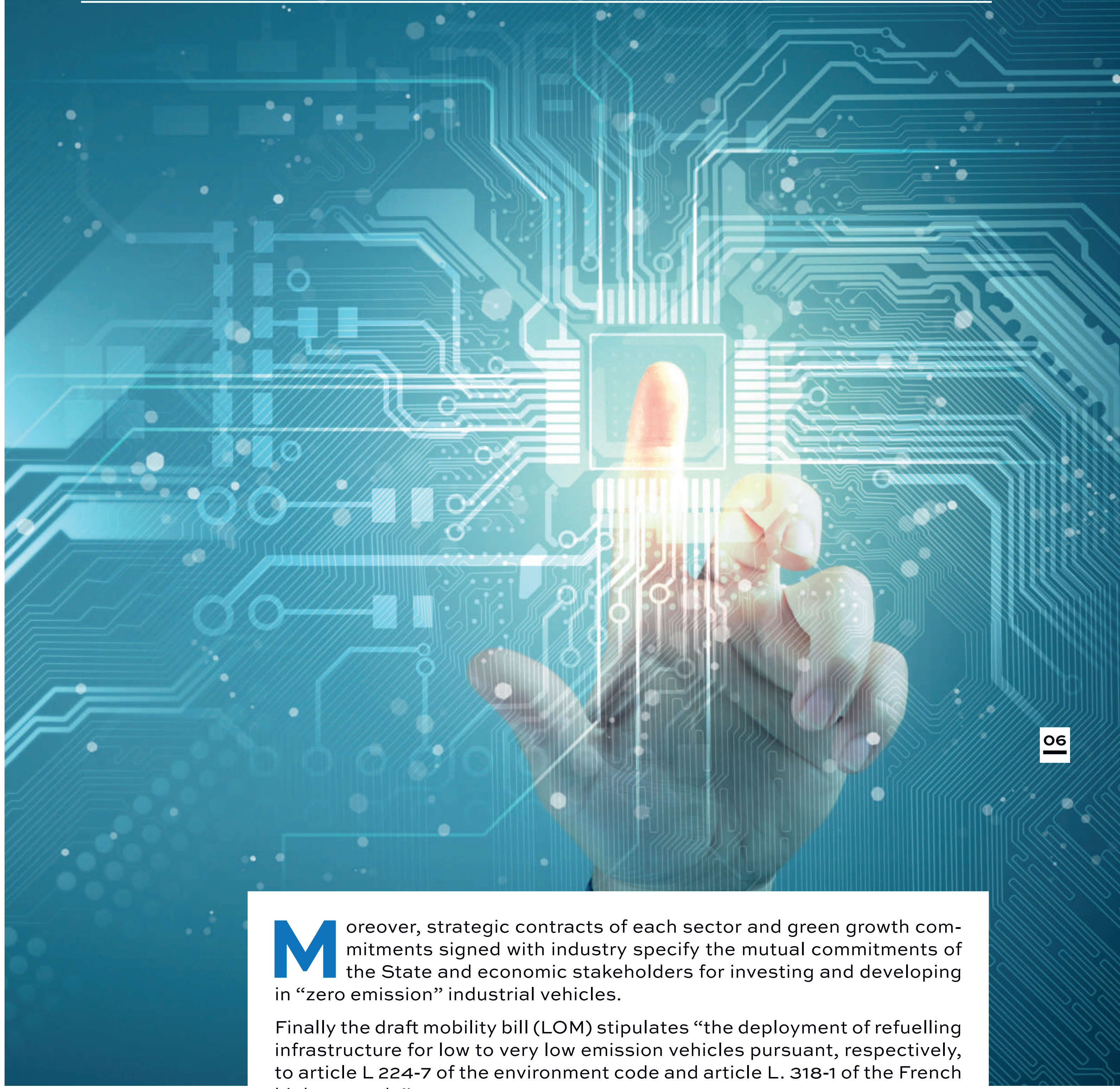
https://eur-lex.europa.eu/resource.html?uri=cellar:0c10fd76-59db-11e8-ab41-01aa75ed71a1.0001.02/DOC_1&format=PDF

FRENCH LAW

In France, the 2015 Act bearing on energy transition for green growth (LTECV) lays down a development strategy for clean mobility. It presents orientations and development actions targeting clean mobility. It thus defines a 10% objective in renewable energy in transport by 2020 and 15% by 2030.

In article 37, it itemises the obligations bearing on State bodies and local authorities to purchase low-emission vehicles when renewing their fleets.

Electric buses, coaches and heavy goods vehicles are defined as low-emission vehicles and therefore fall under the State's and local authorities' obligations to renew vehicle fleets.



Moreover, strategic contracts of each sector and green growth commitments signed with industry specify the mutual commitments of the State and economic stakeholders for investing and developing in "zero emission" industrial vehicles.

Finally the draft mobility bill (LOM) stipulates "the deployment of refuelling infrastructure for low to very low emission vehicles pursuant, respectively, to article L 224-7 of the environment code and article L. 318-1 of the French highway code".

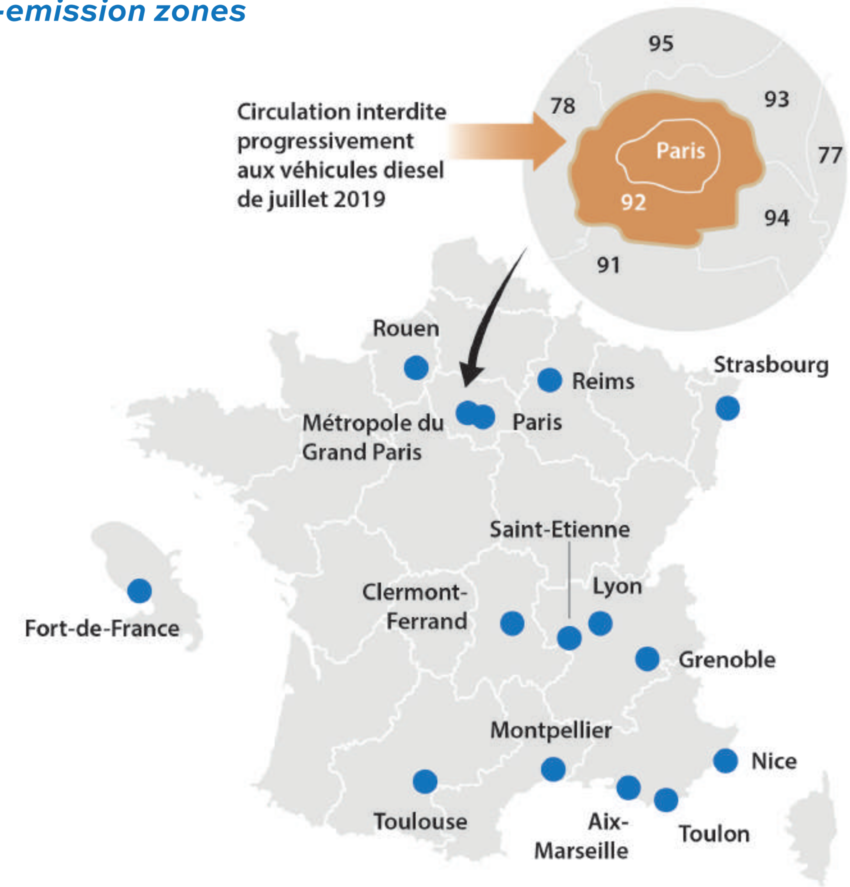
The strategy for the development of clean mobility is part of the multi-annual energy programme (PPE) and defines a roadmap for France and its energy mix. A new draft decree framing the PPE set out by the energy transition act (article 176) was proposed in January 2019. This text is currently being debated and takes up the potential objectives defined by the new PPE regarding the number of plug-in electric and hybrid vehicles in circulation at the end of 2023 and end of 2028. Ongoing discussions on the PPE also cover 400 battery powered electric heavy goods vehicles and 200 hydrogen electric heavy goods vehicles among the 21,000 low-emissions heavy goods vehicles in 2023 and 11,000 battery-powered heavy goods vehicles in 2028 among the 65,000 electric vehicles.

LOW-EMISSION ZONES

To deal with the sanitary issues comprising poor air quality as well as the issue of exceeding regulatory thresholds of particle and nitrogen dioxide concentrations, 15 low-emission zones (ZFE) have already been deployed or are currently being deployed on the French territory.

In the long term, the draft mobility bill (LOM) shall require all urban districts with a population of more than 100,000 and those affected by the Atmosphere protection plan (PPA) to consider the implementation of a ZFE.

Low-emission zones



SOURCE:

Ministry for the Ecological and Inclusive Transition

CHAPTER 2

A RANGE OF INDUSTRIAL ELECTRIC VEHICLES ADAPTED TO CERTAIN USES

(CCFA and CSIAM contribution)

THE OFFER AVAILABLE FOR GOODS HAULAGE

In 2018, on the global level, the electric car fleet exceeded 5 million vehicles, representing a doubling of new registrations in one year, whereas the two-wheeled vehicle fleet reached 260 million units and electric buses 460,000 units, i.e. 100,000 units more than in 2017. It should be noted that of these 100,000 buses, 99% circulate in China, the remainder mostly in Europe. For goods haulage, the electric vehicles most used were light utility vehicles, reaching 250,000 units, whereas electric truck registrations, a recent addition to the market, amounted to about 1,000 and 2,000 units in 2018 on the global level.

In this context, French manufacturers have committed to developing a range of electric vehicles and promoting the testing of hydrogen-powered vehicles. This is embodied in a strategic contract agreed by the automotive sector. This strategy is part of the European environmental energy transition policy that aims to uphold commitments taken within the framework of the Paris Climate Agreement, and therefore support the emergence and development of 100% electric vehicles

In France, the Renault group started to market electric buses in 2002 and a range of 26-tonne electric trucks in 2012 for household waste trucks, of which more than 50 units are currently in service.

On the large light utility vehicle segment (vans), Renault and Renault Trucks have marketed the Master ZE since 2018. This vehicle is fitted with a new-generation Lithium-Ion battery that is completely recharged in 6 hours. Its range in NEDC mode is 200 kilometres but varies with real use between 80 kilometres in the most demanding situations (heavy load, high speed driving in winter conditions) and 160 kilometres.

This vehicle is available in 4 van versions, offering an overall volume of 8 to 13 m^3 and a payload of 1 to 1.1 tonne, and 2 flatbed versions capable of transporting up to 22 m^3.

In April 2019, PSA announced the launch of electric versions of its Boxer and Jumper vans which will have two different ranges, depending on the version: 225 kilometres (NEDC) for the L1 and L2 lengths, and 270 kilometres (NEDC) for the L3 and L4 lengths.

In all, a hundred or so electric vehicles were marketed in 2018 on the van segment and the same volume had already been registered in the first 6 months of 2019. Perfectly adapted to last-kilometre deliveries, electric vehicles have strong short-term growth potential on this segment.

On the heavy goods vehicle segment, Renault Trucks has been experimenting with electric trucks (100% electric or hybrid) for more than 10 years with partner customers. It has thus compiled fundamental information on their use, battery behaviour, recharging infrastructure and maintenance.

After ten years of testing in real operating conditions, Renault Trucks revealed its complete range of vehicles in June 2018. It ranges from 3.1 tonnes to 26 tonnes and therefore meets all urban uses: delivery, distribution of goods and collection of waste. These are the Renault Master Z.E, Renault Trucks D Z.E. and Renault Trucks D Wide Z.E.

Renault Trucks D and Renault Trucks D Wide Z.E. will be made in the manufacturer's plant in Blainville-sur-Orne as of 2020, while the Renault Master Z.E. is already available in the network. The D Z.E. will be available in a 16-tonne version for urban distribution and controlled temperature distribution (refrigerated). The D Wide Z.E, will be available in a 26-tonne version, optimised to collect waste.

Urban deliveries of parcels and goods is mainly done using vans with a 3.5 tonne payload. Vans designed for urban logistics represent almost 25% of the segment, which nevertheless amounts to a market between 20,000 and 50,000 vehicles per year, for a country like France, and a fleet of several hundred thousand vehicles. These vehicles are perfectly suited to the tasks they need to accomplish: They access urban centres but maximise volume to avoid useless journeys and optimise the delivery person's load. These vehicles return daily to the depot and are ideally electrically-powered due to the regular mileage and possibility of recharging at night.

The electromobility of industrial vehicles is already growing, and can increase through the constant lowering of battery prices, the development of recharging structures and the environmental aspirations of customers.

Given the available technology and legislative provisions, urban applications covering relatively short distances (a range per round of 100 to 300 kilometres per day) will comprise the initial market, moving gradually towards regional applications.

The development of infrastructure to recharge heavy vehicles will require several stages:

- recharging of electrical vehicles at depots, which need to be fitted with charging infrastructure,
- implementation of recharging terminals on loading/unloading sites for (fast) intermediate recharging,
- development of a network of stations on long-distance routes together with the development of reservation and payment tools.

The potential of the electric market will broadly develop over the next 5 years, rising from a few niche segments to all urban and regional applications between 2025 and 2030. In the longer term, hydrogen or solid batteries will open up other prospects for electric vehicles, namely on longer routes.

The following therefore exist:

- 100% electric vehicles: battery (BEV: Battery Electric Vehicles) or fuel cell electric vehicles that supply an electric powertrain (FCEV: Fuel Cell Electric Vehicle),
- non-rechargeable hybrid vehicles (HEV: Hybrid Electric Vehicle), and plug-in hybrid vehicles (PHEV: Plug in Hybrid Electric vehicle) on which the battery can also be recharged by an external recharging socket and REEVs (Range Extended Electric Vehicles).

The main advantages of electric vehicles are:

- "Zero local emissions (HC, CO, Particles, NOx)", thus allowing access to low-emission zones that are developing everywhere (more than 200 to date in Europe),
- "Zero emissions of CO_2 during use",
- low emissions over the whole industrial cycle. Like all alternative energy, the energy and environmental footprint "from cradle to grave" is partly dependent on the carbon content of the producing country's energy mix of the vehicle's various components and its fuel. We here note that the French energy mix has a positive carbon footprint with a 91% carbon-free mix i.e. 65 g of CO_2 /kWh, source: SNBC2011),
- contribution to national energy independence,
- the cost of operation (operations and maintenance) is lower than for combustion engine vehicles (excluding the recharging infrastructure, recharging times, cost of purchase and residual value of the vehicle, the residual and replacement value of the battery depending on its ageing).
- real driving comfort for drivers,
- low noise and vibration.

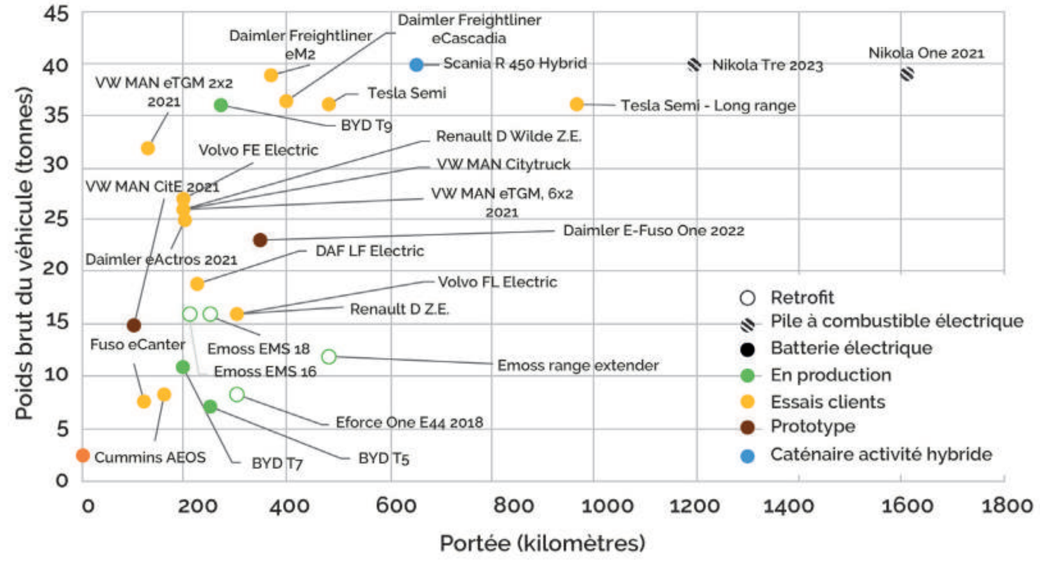
The first versions of electric heavy goods vehicles have batteries with a range of around 100 to over 200 kilometres. These ranges are confirmed by electric urban buses that have been in use for over 2 years now. These characteristics correspond to "carrier" vehicles making city-centre deliveries from suburban logistics centres or urban tasks and fit into the segments of the following markets:

- 3.5 tonne vans (fleet of around 1,000,000 vehicles with 100,000 registrations a year on the French market) and carriers between 6 and 16 tonnes, dedicated to urban deliveries or tasks (around 25,000 vehicles operating in the current fleet with more than 4,600 registrations per year, all energy sources combined),
- carriers of 16 to 19 tonnes running short-distance rounds in urban and suburban environments, 9,000 vehicles, all energy sources combined, with more than 1,800 registrations per year.
- 26- to 32-tonne vehicles fitted with specific bodywork: waste collection skips, hookloaders, skips or concrete mixers, or even refrigerated trucks.

The current market open to electric vehicles of less than 19 tonnes therefore amounts to 6,200 registrations per year, corresponding to an operating fleet of almost 40,000 vehicles.

100% electric industrial vehicles of up to 26 tonnes arrived on the market in late 2019 and are featured in the appendix. There have been several announcements of new models for 2020 with new presentations at the Solutrans fair by the major European manufacturers.

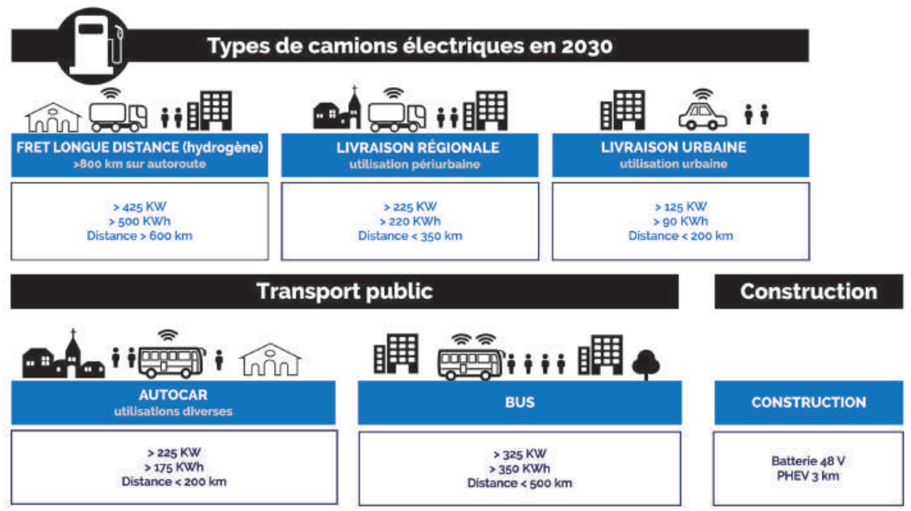
Models of electric heavy trucks announced for launch in the coming years



SOURCE:

Global EV Outlook 2019, AIE. Note: electric heavy goods trucks here have a gross weight heavier than 15 tonnes. Models launched in 2019 or before if not indicated otherwise.

Electro-compatible use segments



SOURCE:

Automotive and mobility industry, Development of the technological mix and CO_2 emissions of industrial vehicles by 2035

CO2

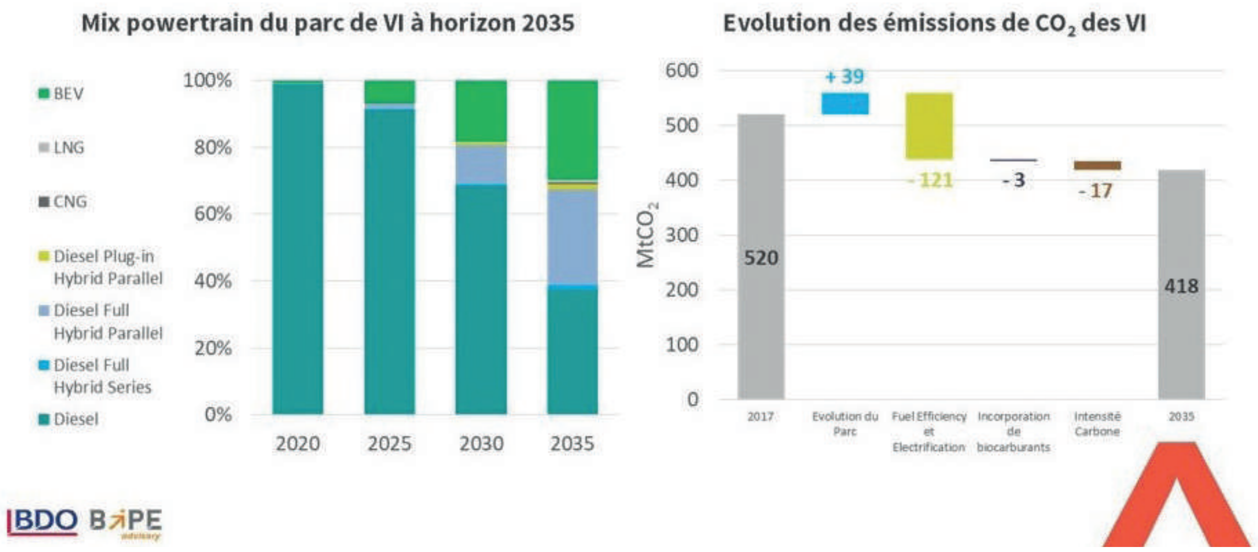
Improving the energy efficiency of engines and promoting electric powertrains are some of the major measures to reduce CO_2 emissions linked to transport.

As seen in the previous section, this momentum is already present in the private vehicle segment and will develop for industrial vehicles with high growth of sales, tending towards all-electric and hybrid.

With an industrial vehicle fleet comprising 60% of electrically-powered vehicles (fully or partly) in 2035, CO_2 emissions of industrial vehicles in Europe would fall by 20% by 2035 (Green Constraint scenario).

CO_2 emissions of industrial vehicles in Europe will fall by 20% between 2017 and 2035 thanks to alternative technologies.

Typology of engine powers of the industrial vehicle fleet by 2035 and development of CO_2 emissions of industrial vehicles



SOURCE:

Study by the PFA (11.2018 - Development of the technological mix and C2 of industrial vehicles by 2035).

NOISE EMISSIONS

Electrically-powered engines not only reduce air pollution, they also impact noise pollution. This is a real advantage in the city, especially for delivery vehicles that increasingly circulate in restricted circulation zones. The same applies to waste collection trucks that often operate at dawn or dusk and move very slowly through the streets; The operation of electric vehicles therefore strongly helps decrease noise pollution in cities.

THE MAINTENANCE AND SERVICING OF ELECTRIC INDUSTRIAL VEHICLES

The maintenance of vehicles traditionally represents a very high proportion of the operating cost of industrial and urban vehicle fleets.

Electric vehicles, from this angle, offer significant advantages, with:

- the reduction by almost 50% of the use of the braking system through the recovery of energy on deceleration, which incurs savings on brake pads, disks, etc.
- the removal of the clutch and gearbox or automatic box with its converter (overused in urban use),
- the end of oil changes as an electric engine does not require lubrication,
- the removal of belts (alternator, compressors, engine compartment).

Operators of electric buses and the first electric truck fleets highlight the savings made on spare parts and labour costs.

In general, there is a reduction of maintenance costs of around 25 to 35%, perhaps even of 50%, compared to identical diesel vehicles that can be accounted for in the first estimates and tests conducted.

CHAPTER 3

ALTERNATIVE ENERGY

LIQUID FUEL

For some purposes, the use of liquid fuel cannot be avoided. There are solutions, still at the demo level, for certain captive fleets (XTL/HVO100, B100, ED95, etc.).

Biodiesel

A renewable biofuel mainly made from vegetables oils, biodiesel has been used for many years as a component of diesel: B7 for classic diesel (7% of biodiesel) or B30 for certain captive fleets.

Since 2018, French law has opened the possibility of using B100 in captive fleets. This solution requires a few adaptations to the engine and a shortening of oil change intervals.

It can reduce CO_2 emissions from well to wheel by around 60% (CO_2 trapped by the plant during its growth) compared to diesel vehicles and is a valuable alternative for long-distance applications where a greater CO_2 effort needs to be made.

Bioethanol

ED95 biofuel is made for its virtuous cycle, based on the reprocessing of residues (grape pomace, molasses, fermentable waste, etc.) and consists of 95% pure alcohol. Its production satisfies sustainability criteria. It allows a 90% reduction in CO_2.

XTL

XTLs are synthetic fuels that can be made from several sources. The most valuable for their CO_2 impact are products made from vegetable oils or residues (HVO). Other solutions are currently being developed to complete the range (BTL, E-fuel, etc.).

They offer the enormous advantage of being used, without any specific adaptation, on existing engines (subject to authorisation of course) and may reduce CO_2 emissions from well to wheel by 90%.

This developing segment could therefore be interesting for long-distance or construction applications.

White Paper – Industrial Electric vehicles

HYBRID VEHICLES

A hybrid vehicle combines the use of at least two separate energy sources to operate its powertrain.

There is therefore a great variety of so-called hybrid technologies: thermal-electric, CNG-electric, thermal-pneumatic, battery-hydrogen hybrids, etc.

It is commonly understood, even though this is not always the case, that a hybrid vehicle combines the standard components of a heat engine (diesel, petrol, etc.) with electric components.

CNG/BIOCNG VEHICLES

The CNG/BioCNG alternative and the issues presented in greater detail in the white paper on CNG/BioCNG.

The CNG/BioCNG solution is immediately available and has been tried and tested for decades. It offers a sustainable alternative to traditional fuel and cleaner mobility for "low-emission" industrial vehicles.

A CNG vehicle emits 95% fewer fine particles and 50% fewer NOx than the Euro6 standard threshold. Recognised by public authorities, CNG vehicles, receiving the Crit'Air 1 rating for "low-emission" industrial vehicles, can access the following local zones: ZCR (Zones de Circulation Restreintes - Restricted Circulation Zones), ZFE (Zones à faibles émissions - Low-Emission Zones), PPA (Plan de protection de l'atmosphère - Atmosphere Protection Plan).

CNG/BioCNG can also very significantly reduce noise emissions: -50%. (https://www.afgnv.org/wp-content/uploads/2018/11/PFA-Livre-blanc-GNV-2017.pdf). With 19 TWh of biomethane produced in France by 2023 (equivalent to around 100,000 PL), bioCNG, which is miscible with CNG, is distributed in practically all French and European stations through an equivalence system between production in rural zones and use in urban zones.

With 27.7 million vehicles worldwide, CNG/bioCNG is a multi-purpose solution for users of several applications: urban, regional deliveries, works, intra- and inter-city transportation of passengers, school buses, collection of household waste, long-distance, etc.).

CNG/bioCNG-Elec hybrids can significantly improve the electric range of vehicles with BioCNG-powered generators (range extenders). Embedded battery recharging systems, called Range Extenders, power batteries from motors supplied with BioCNG whose function consists in supplying the battery pack. Technology is used to reduce the size of batteries and, consequently, their cost. These systems can be suspended in zero-emissions zones in hyper city centres.

The TCO (Total Cost of Ownership) of CNG/BioCNG vehicles is comparable with that of diesel vehicles and is even more competitive for those covering very long distances.

Supported by considerable national and European production infrastructure, CNG/BioCNG vehicles remain very close to our technological and industrial foundations, while offering an excellent CO_2 footprint.

HYDROGEN VEHICLES

The hydrogen vehicle is fitted with an electric engine like the battery-powered electric vehicle. However, in contrast to the latter, fuel cell electric vehicles are powered by hydrogen embedded in a hydrogen tank. This power, in varying degrees, completes the electricity embedded in the battery. Electric power will therefore be produced on board the vehicle by a fuel cell.

Ultimately, hydrogen vehicles offer undeniable environmental benefits, as they only emit steam through their exhaust pipe and therefore no local pollutants such as nitrogen oxide and particles.

The cells are a succession of membranes on which a diffuser is stuck on each side. They are inserted between 2 silk-screened metal plates that diffuse hydrogen and oxygen on each side. The exchange of protons through the membrane creates an electrical imbalance and therefore the electric current that generates electricity.

Hydrogen, which is stored in pressurised form in the tank, and oxygen from the surrounding air, combine in the cell to produce electricity, water and heat. This electricity powers the vehicle's electric engine. Like the battery-powered electric vehicle, the hydrogen vehicle emits no pollutants into the atmosphere through its exhaust.

To make sure the gas remains confined in the tank and to ensure the safety of users, if the vehicle is involved in an accident, the tanks sold are subjected to an approval process governed by EC regulation no. 79/2009. The structure of the tank is adapted to the nature of the gas stored.

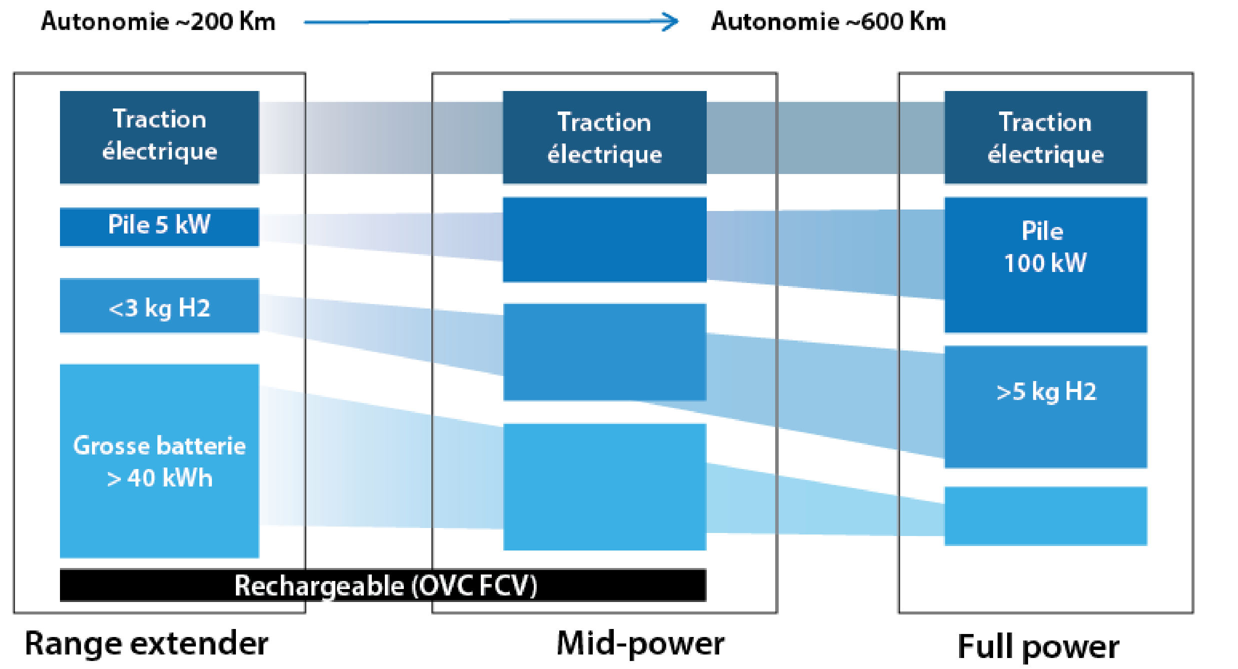
Working from the outside in, it consists of the following layers:

- an airtight envelope: the material used is specifically chosen to guarantee impermeability to hydrogen,
- a composite structure supports external constraints to which the component may be submitted during its life cycle (accidents, aggressive external factors, etc.) This composite material consists of carbon fibres deposited by filament winding, coated by a thermo-hardening matrix. For vehicles weighing less than 3.5 tonnes, tanks sold bear up to a nominal pressure of 700 bar,
- an outer protective layer, in fibreglass, is used to identify impacts or aggressive external factors to which the part is subjected during its life cycle, without visually altering the appearance of the composite structure.

Hydrogen vehicles also have batteries to back-up the cells to provide the electric engine with enough power and retrieve energy on braking, as with battery-powered vehicles. There are several fuel cell/battery configurations possible. A small battery for example will simply allow the vehicle to benefit from more instant power if necessary.

Conversely, a vehicle already fitted with a battery may receive a low-power fuel cell to extend its range: this is what is known as a Range Extender (REX). Intermediate systems called "mid-power" systems are also being developed. The battery in these cases is always rechargeable by mains and by a fuel cell providing 50% range and power required.

The different types of FCEV (Fuel Cell Electric Vehicles) for private and utility light vehicles



SOURCE:

Technical position of hydrogen vehicles 2019 - PFA

The range of a hydrogen light vehicle is currently around 500 to 600 km and the user can fill up on hydrogen as they would petrol, within three to five minutes.

Hydrogen therefore offers interesting features for commercial vehicles, with ongoing developments, including the CATHYOPE project in France, H2 Share in Belgium and Netherlands and H2 Haul, involving 16 26- to 44-tonne heavy goods vehicles which will be deployed in the South of France and Belgium.

Demonstrations of heavy goods vehicles are also currently organised (Toyota, Scania, etc.), with the arrival of heavy goods vehicles announced for 2023 (Hyundai, Nikola, etc.).

VW, Mercedes, PSA and Renault have announced the launch of 3.5-tonne vans fitted with fuel cells. They could be launched as early as 2020.

Hydrogen power is promising in that its production process can be completely carbon-neutral. The electricity running through water causes its separation into gaseous oxygen and hydrogen, through hydrolysis. It is therefore possible to convert electric energy produced by renewable sources at times when there is no immediate need for it to store it in the form of hydrogen. This process could replace the current hydrogen production process using Methane which has the disadvantage of producing large quantities of CO_2 .

CHAPTER 4

BATTERIES

DESIGN AND CONSTRUCTION

Batteries of industrial electric vehicles are more or less identical to those of private electric cars of which there are thousands circulating in France and hundreds of thousands worldwide. They require no maintenance at all. They are monitored by the embedded battery management system (BMS).

Private cars have battery packs whose embedded energy ranges between 30 and 85 kWh (according to their size and performance).

Industrial vehicles (trucks, buses and coaches) are fitted with packs whose embedded energy ranges between 100 and 300 kWh, depending on the tonnage and type of vehicle.

The weight and volume of batteries chosen by the vehicle manufacturer are defined according to the applications (bodywork type) and purpose of the vehicle. The sizing issue of battery packs on industrial vehicles is to achieve a good compromise between range and the weight of the installed pack.

Batteries are inserted in industrial vehicles in the form of packs and housed in a dedicated slot where they are accessible without compromising the use and bodywork of the vehicle. The objective is to maintain the vehicle's payload (weight and volume).

On urban buses, battery packs are housed under the roof but do not reduce the number of passengers and are accessible with appropriate means at bus depots.

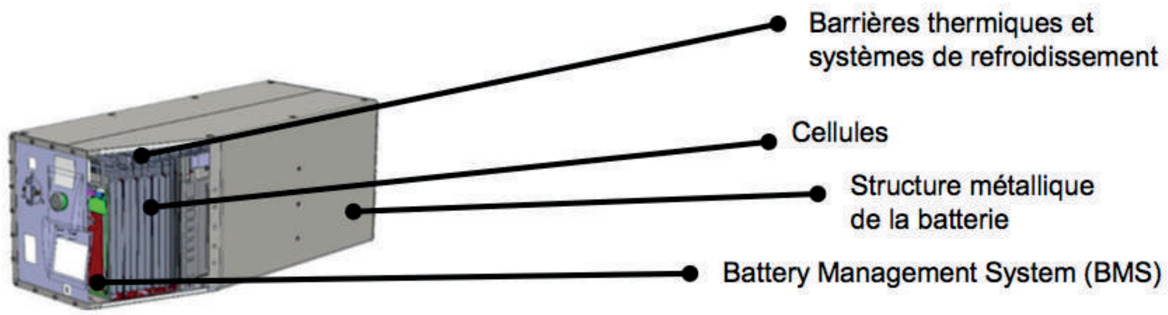
On trucks, battery packs are housed either in the wheelbase of the vehicle on the right and left-hand side, or just behind the truck cabin in a dedicated chassis.

Automotive battery technology is now mature. Battery manufacturers use different types of chemicals based on lithium which is the common denominator of the different solutions and offers by each meeting a specific need. There are also two major battery families: Lithium-ion with all its variants and lithium polymer. Lithium titanate (LTO) batteries are for applications requiring ultra-fast high power recharging. They are mainly dedicated to urban buses circulating on specifically designed lanes with recharging terminals at the terminus fitted with connecting devices and transformers and very high powered chargers.

Today, available batteries have a minimum range of 150 km for a 19-tonne bus or truck fitted with slow recharging batteries (i.e. in 6 to 8 hours). Energy density gains of around 10 to 25% have in fact been observed over the past 2 years.

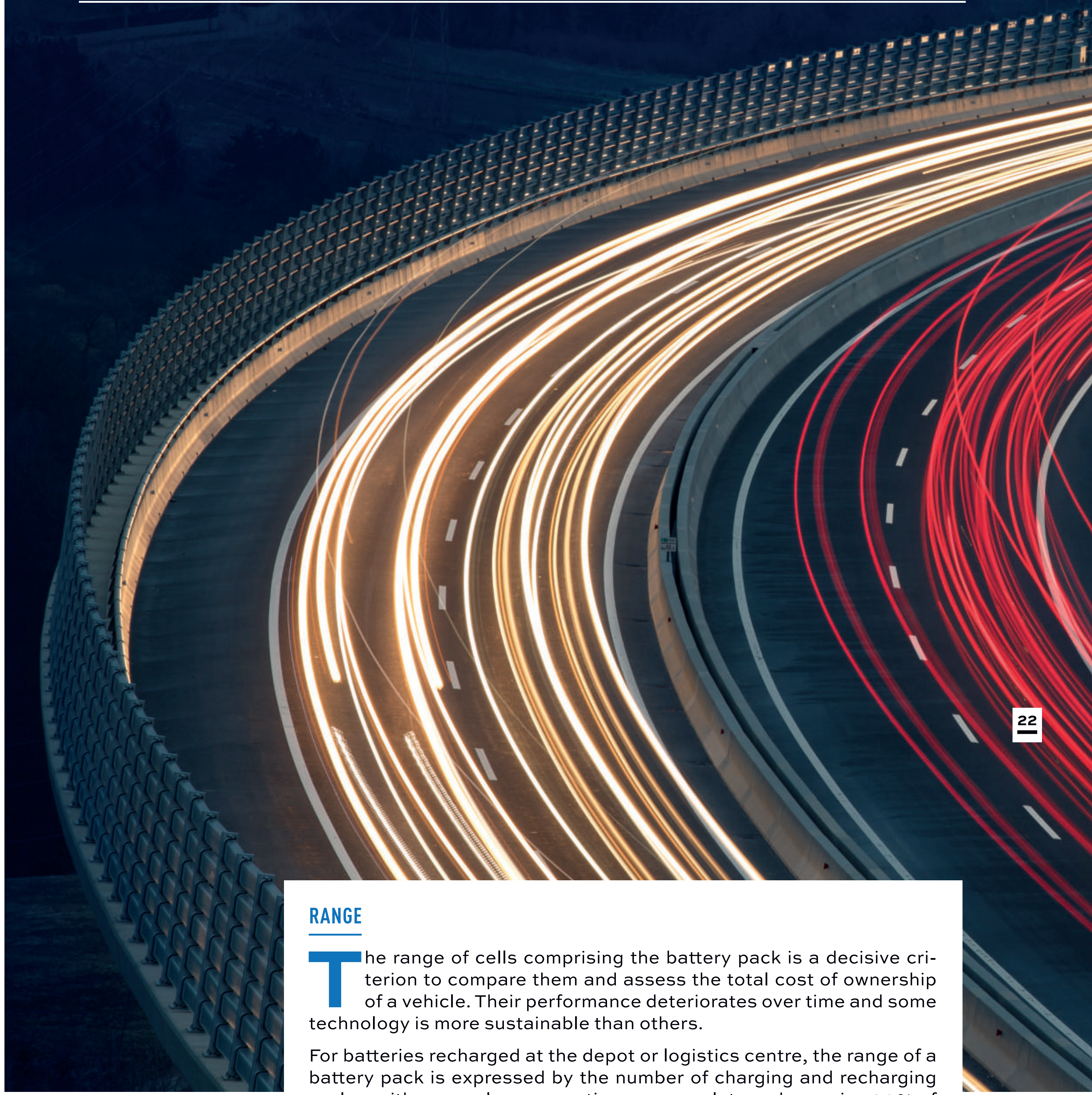
The range of electric vehicles has constantly improved and the price of the "onboard kWh" has reduced. Battery packs for industrial vehicles currently available can, for instance, offer a range of around 150 to 300 km for a 19-tonne bus or truck, depending on its type of use.

The battery also contains a battery management system (BMS: Battery Management System). Acting as the battery's "brain", the BMS is an electronic circuit that is indispensable for safe use of lithium-ion batteries. Three functions are covered: safety by preventing critical events, performance by increasing battery range and communication by exchanging information with the host system (this function makes the battery system smart). Everything is integrated into a mechanical structure which inserts the cells into a protective cell.



ENERGY DENSITY

A battery's energy density determines the quantity of electric energy (watt/hour) it contains in a volume or per weight unit. Two measuring units are used: the kilowatt hour per litre (kWh/L) or kilowatt hour per kilogram (kWh/kg)



RANGE

The range of cells comprising the battery pack is a decisive criterion to compare them and assess the total cost of ownership of a vehicle. Their performance deteriorates over time and some technology is more sustainable than others.

For batteries recharged at the depot or logistics centre, the range of a battery pack is expressed by the number of charging and recharging cycles, with one cycle representing one complete recharge, i.e. 80% of the total capacity of the battery pack, given that it is usual to consider 300 days per year as the number of days of use for an urban industrial vehicle (truck and bus).

The replacement of the battery pack after 2,500 cycles (i.e. around 7 to 8 years) has now been confirmed and the 3,000 cycles are not an unrealistic target and should become the benchmark for the years to come. Some manufacturers already guarantee this range with results approaching the levels of initial performance.

RECHARGING TIME

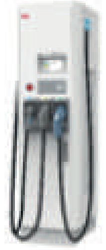
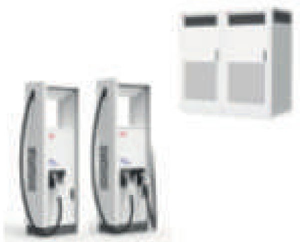
In mobility applications, this factor is increasingly important. The most advanced technology accepts increasingly higher charge currents to reduce stoppage of vehicles due to charging. Depending on the battery pack installed, the charging time is expressed as the number of Cs, with C representing the battery's capacity to absorb the charge current. That unit is expressed in amp hours (A.h).

The battery recharging time directly depends on the power that the recharging infrastructure can offer and what the vehicle and electric capacity available at the depot are capable of absorbing.

For example, it will take a depleted vehicle, with a battery of 200 kWh, 4 hours to recharge with a 50 kW power charging system of 2 hours with a 100 kW charger.

The European charging standard is called Combo CCS 2.

LES PUISSANCES DE CHARGEURS EN COURANT CONTINU STANDARDS

Type de charge	Charge lente DC	Charge accélérée DC	Charge haute puissance DC
Puissance	20 - 25 kW	50 kW	150 - 350 kW
Temps de charge référence bus ou camion 200 KW.H	6 à 8 heures	2 à 4 heures	Environ 1 heure
Design			

CYCLING OF BATTERIES

Over and above 2,500 to 3,000 cycles, battery performance falls by around 20%. A heavy goods vehicle battery after its first life therefore maintains 80% of its capacity. It is possible to extend this "first life" in several ways:

- the most simple consists in using the battery in a vehicle covering fewer kilometres, requiring a shorter range between charges,
- the 2nd possibility consists in marketing these batteries in lighter vehicle applications in terms of energy requirements and therefore range. The delivered power is not affected by this ageing, only the range is,
- the 3rd is to convert to a stationary system. In this system, when added to a natural source of energy, batteries have a life cycle of 10 to 20 years, after which their capacity is only around 40%. This third option is already up and running but will be more economical once developed on a large scale.

The battery recycling sector, although new, is already organised in Europe with players such as Véolia, SNAM and Suez. 60% of battery components can be recycled.

Even though it is too early to determine the compared value of batteries in terms of their first life, it nevertheless exists. It is significant and will contribute to the future cost-effectiveness of equipped electric vehicles.

RAW MATERIALS AND CRITICAL MATERIALS

With more than 3 million private electric vehicles in circulation, of which almost 40% are in China (AIE, 2018), the automotive fleet has become increasingly electric in recent years. This trend could however have major consequences, especially on the raw materials market such as lithium, used in Li-ion batteries.

A strong increase in electric vehicles worldwide (up to 75% in 2050, all vehicles put together) could significantly reduce the safety margin in lithium supplies (ratio between consumption and reserves).

However, actual global lithium reserves were quadrupled between 2005 and 2017 in response to the massive deployment of Li-ion battery technology. In the long-term, the supply risk from a geological standpoint seems low.

However, the dynamics of the long-term balance of raw materials markets teaches that, even though there is no geological criticality regarding resources, different forms of vulnerability remain - economic, geopolitical and environmental - as current production is concentrated in Australia, Chile, Argentina and China. These 4 countries represented about 80% of global production in 2016. The lithium market is therefore still dominated by a small number of companies and the concentration of stakeholders entails considerable uncertainty about future lithium prices.

Besides lithium, 66 % of cobalt reserves, a mining co-product of nickel and copper, are concentrated in the Democratic Republic of Congo. With almost 7 million tonnes of resources for a production of 123,000 tonnes in 2016, the geological profile of cobalt suggests a resources-production ratio of around 57 years.

For the nickel market, this ratio was about 34 years in 2016 and the main uses of the metal are now found in the battery sector (20%) and the production of stainless steel (60%). Historically, nickel prices are extremely volatile and investments less favourable than those of the non-ferrous metal sectors. Caution however is recommended with respect to the use of these ratios which are only indicative of the criticality of these materials, which could be transitory. Research in Europe and the USA on the next generations of solid batteries could produce major improvements in energetic density, volume, weight and price and could exclude the use of lithium or cobalt.

CHAPTER 5

RECHARGING INFRASTRUCTURE AND ITS **IMPACT ON THE ELECTRIC GRID**

The increased presence of electric road vehicles is one of the most promising solutions to reduce CO_2 emissions. To apply it to road haulage, vehicles need to be fitted with a large number of batteries or a lower quantity requiring more frequent recharging. Although some manufacturers like Tesla have announced the launch of vehicles with a larger range, the related business case is not yet satisfactory. For vehicles with a lower onboard range, less than 200 km, recharging is a factor limiting their use for long-distance transport.

90% of industrial electric vehicles (trucks and buses) are mainly for depot recharging of vehicles, for 6 to 8 hours, which for many vehicles could last all night long. Direct recharging in alternating current is only possible for very small vehicles, as the onboard charger only accepts low intensity currents.

Recharging structures for heavy goods vehicles already deployed allow recharging with stations offering 50 to 100 kw in power. In the very short term, available stations will upgrade their power to up to 150 kw. These solutions could shorten recharging times and provide the possibility of more intensive use of the vehicle. All industrial vehicles have sockets with the European Combo standard. There are therefore no compatibility problems.

An additional alternative is to electrify motorways themselves, with the installation of a recharging infrastructure on the slow lane usually set aside for heavy goods vehicles.

On major road routes, it is possible to imagine a combination of static recharging with recharging stations on service areas and dynamic recharging on the right-hand or slow vehicle lanes to reduce pressure on one single recharging location.

STATIC ELECTRIC RECHARGING SOLUTIONS

The first step in the electrification of a site is to check feasibility of an electric connection to the electric grid. The possible duplication of a connection to the grid could be necessary depending on the haulage contractor's activity and the cost of such a system must be studied, case by case, depending on the infrastructure to be set up to reach the expected level of availability.

Transformation and distribution of energy during depot parking

Studies on the installation of main transformer(s) and the conditions of installation of such recharging equipment for night parking need to be undertaken. Their aim is to define integration conditions of this equipment in the depot parking environment. The first will be to define the architecture of electric distribution adapted to the need.

Last metre connection

Standard vehicle powers of 50 or 100 kW must be chosen for recharging stations, depending on recharging requirements associated with available time at night or during the day, according to the vehicle's use. It is also necessary to make sure that the products purchased are interoperable on European COMBO2 standards.

Whenever necessary, systems may be added which could do away with the use of ground cabling (mast or reel for example).

Conditions for operating permit and control of the fire hazard

For bus depots, it is necessary to abide by the decree applicable to bus electric charges defined with the inspection of classified installations and fire services to comply with regulations. This decree is used to define minimum safety distances between vehicles and property boundaries for their parking and the type of protection facilities needed in case of fire (laying of firewalls depending on distance from neighbours, implementation of extinguishing systems, etc.).

The introduction of recharging stations on sites leads to a loss of parking space of about 5%. There are no specific recommendations for the parking of electric trucks.

Management and operation of recharging facilities

The implementation of a charge supervision system is to be recommended as it allows the monitoring of its effectiveness and contributes to the general safety of the system (vehicles and infrastructure). This system also optimises recharging infrastructure to meet demand and adjusts electric consumption with the energy contract taken out by the fleet manager.

For maintenance, recharging terminal manufacturers offer technical support and remote supervision of terminals through subscription packages.

DYNAMIC ELECTRIC RECHARGING SOLUTIONS

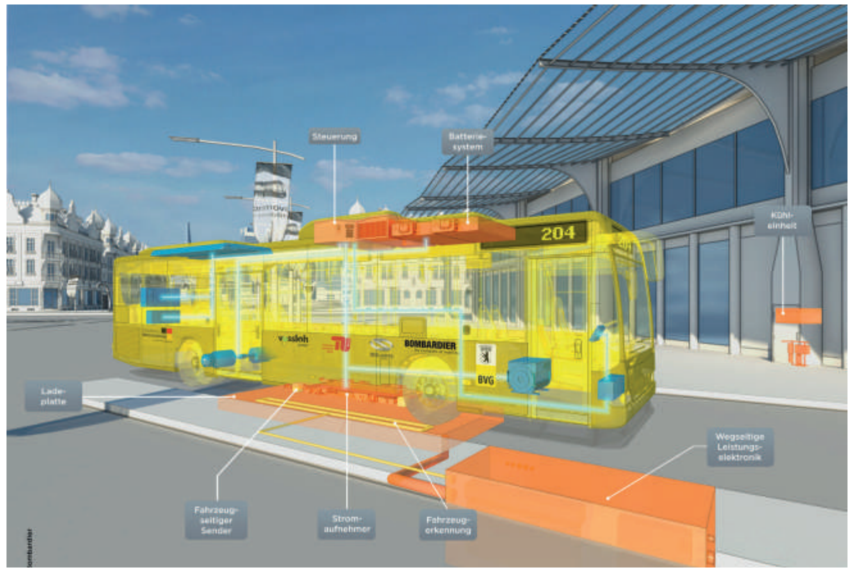
There is a growing number of solutions being developed or tested for the electrification of roads. This growing interest is driven by the benefits brought by this solution including the reduction of CO_2 emissions.

For example, the "all electric" solution with dynamic recharging is the most interesting in terms of total cost of ownership as demonstrated by the figure below produced by Cambridge Econometrics for the European Climate Foundation.

Today, there are several dynamic electric recharging solutions that are being developed and tested: There are three types of solutions: inductive by the ground and conductive by the ground and by overhead lines. Each type of solution has its advantages and disadvantages. All these solutions are applicable to contexts that are specific to each lane.

For example the inductive solution implies a contact-free transfer of energy, with no visible equipment, from copper reels placed under the road which are only activated when the electric vehicles fitted with receivers pass over them. However the integration of reels into the road is a very complex and costly process. The dynamically transferred power is limited by the effectiveness of the context and for health reasons due to the level of magnetic fields involved. For these reasons, this solution seems more appropriate for static charging of light vehicles at low power (< 50 kW).

Ultra-rapid recharging for buses: Bombardier – Primove –Inductive solution



The overhead lines solution, proposed by Siemens, takes advantage of the experience of rail and allows sufficient energy transfer of around 400 kW to supply the powertrain of an electric heavy goods vehicle and recharge its batteries. The main weak points of this solution are the overhead line which is an obstacle for exceptional convoys, construction machinery, helicopters needed to land for emergency evacuations, etc. Furthermore, this solution is only applicable to semi-trailers where the pantograph can be installed on the towing vehicle.

Siemens eHighway – electrified road in Frankfurt

The "conductive by the ground" solution, with its power track on the ground, is a good compromise with simpler and less costly integration than the "inductive" solution. It offers the same advantages as the overhead solution but without its disadvantages.

Alstom electric road (Volvo test lane in Sweden)

As far as the vehicles are concerned, the solutions described above are of interest to operators. Despite the purchase price being impacted by the integration of this new technology, the operating cost will be significantly reduced due to savings made on energy and the maintenance of their work tool. The ERS (Electric Road System) solution allows electric vehicles fitted with a retractable current sensor to be supplied or to recharge their battery when they drive through an electric motorway section. This dynamic recharging of electric vehicles avoids recharging times while the vehicle is stationary and the multiplication of recharging stations at motorway service areas. It also helps limit the quantity of batteries to be embedded and therefore impacts the purchase price.

Technical solutions are emerging and several experiments are under way in many countries: Sweden, USA, South Korea, Germany, France, Italy, etc.

But what obstacles need to be lifted for their broad deployment and when would that be possible?

Although technologically good progress has been made, it is necessary to gear up from testing on one or two vehicles to a demonstration with hundreds of vehicles implementing and highlighting the availability of the system, its maintenance and its operation in representative conditions. Time is also needed to set up the industrial tool to supply the necessary equipment producing long electric road infrastructure at an acceptable price.

The management of investments to produce electric road corridors will only be possible with positive business cases. Yet the economic model has not yet been defined in terms of investment, operating or maintenance management or of the regulatory framework. The profitability of the first corridors remains an issue as they will be necessary to get the movement started but will be used by few electric vehicles at first. The ramp-up will not necessarily be enough to guarantee a return on investment. For this reason, the first significant investments must be subsidised on the local, national or European level.

The choice of a large-scale solution and its standardisation to ensure that it is implemented in different countries is an unavoidable step. Although motorway management companies and operators are watching the arrival of the electrification of their networks with interest, they are not yet ready to adopt for a specific solution. In terms of standardisation, work has been launched on the European level (creation of CENELEC work groups) but it will take several years to obtain usable standards.

In the long term, electric networks must be adapted to satisfy this new demand in terms of production capacity and to roll it out in the relevant zones. The production of carbon-free electricity is one of the necessary conditions to make the electric road a relevant solution to reduce CO_2 in road transport.

To conclude, the deployment of the first electric road corridors over hundreds of kilometres should be possible between 2025 and 2030. This medium-term deadline seems rather distant but it is an evolution that will make a strong impact on the future of road transport. It takes time to develop the technology, maintenance and operation of new infrastructure, the economic model and the regulatory framework.

Many hurdles need to be overcome to achieve this objective. One of the first is to completely validate the technological solutions. Hence the proposal of supporting the testing of one of the most promising solutions that has not yet been tested on public roads: the ground supply solution.

This experiment could be carried out as part of a partnership between France and Sweden on Innovation and sustainable solutions. This agreement has just been extended to a three-party agreement with the inclusion of Germany for the future of mobility with electric road systems (ERS). Among other things, it now aims to set up cross-border demonstrators.

IMPACTS ON THE ELECTRIC GRID

The RTE AVERE study, published in May 2019, analyses the impacts of electric mobility on the electric transport network and the conditions of success for electromobility. Within this context, the analyses factor in the development scenarios of different types of vehicles, in particular heavy goods vehicles. The different scenarios built rely on the sector's estimates and are based on the deployment of 50,000 to 150,000 vehicles (heavy goods vehicles and buses), on the road in 2035.

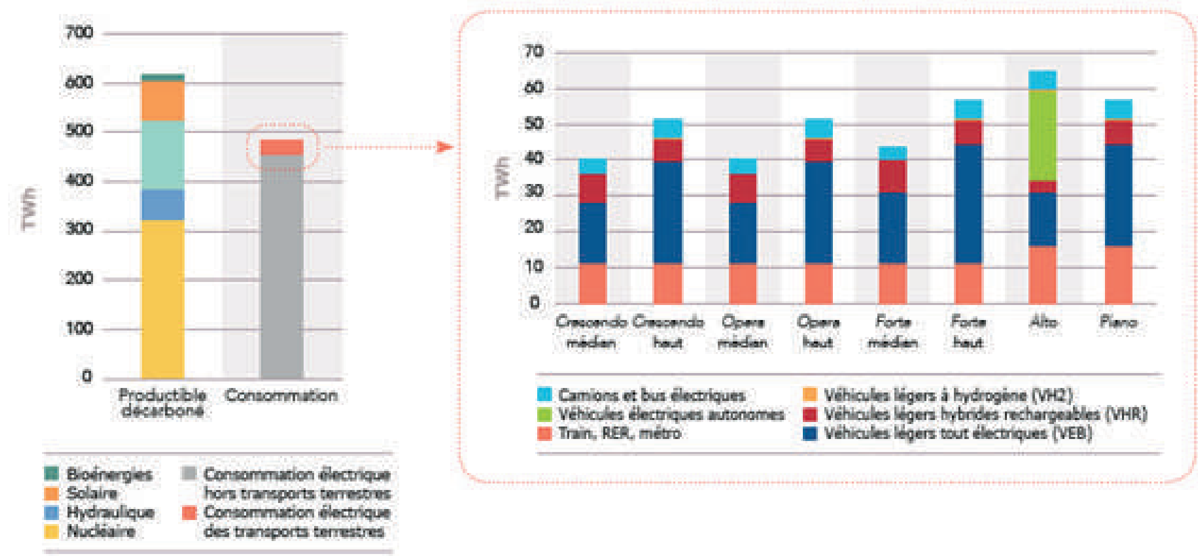
The different projections by manufacturers (scenarios of the Automotive and Mobility Platform - PFA) and by government authorities (the ambitions set out in the multi-annual energy programme and the national low-carbon strategy) are based on a total of more than one million electric vehicles in circulation in France by 2022-2023, (PPE deadline), and capable of reaching 7 to 16 million units (private vehicles and light utility vehicles) in 2035 (i.e. between almost 20% and more than 40% of the total fleet).

The left-hand graph below demonstrates that terrestrial transport represents around 50 TWh for total consumption of around 500 TWh, i.e. less than 10%. The right-hand diagram shows that buses and trucks represent around 5 TWh of this total, i.e. 10% of consumption dedicated to terrestrial transport. In all, the ambitious hypothesis of the fleet only affects 1% of total consumption for trucks and buses.

The impact of electric trucks and buses on consumption will therefore be very low and easy to absorb by the transport network.

Annual electric consumption producible by the carbon-free electric fleet by 2035

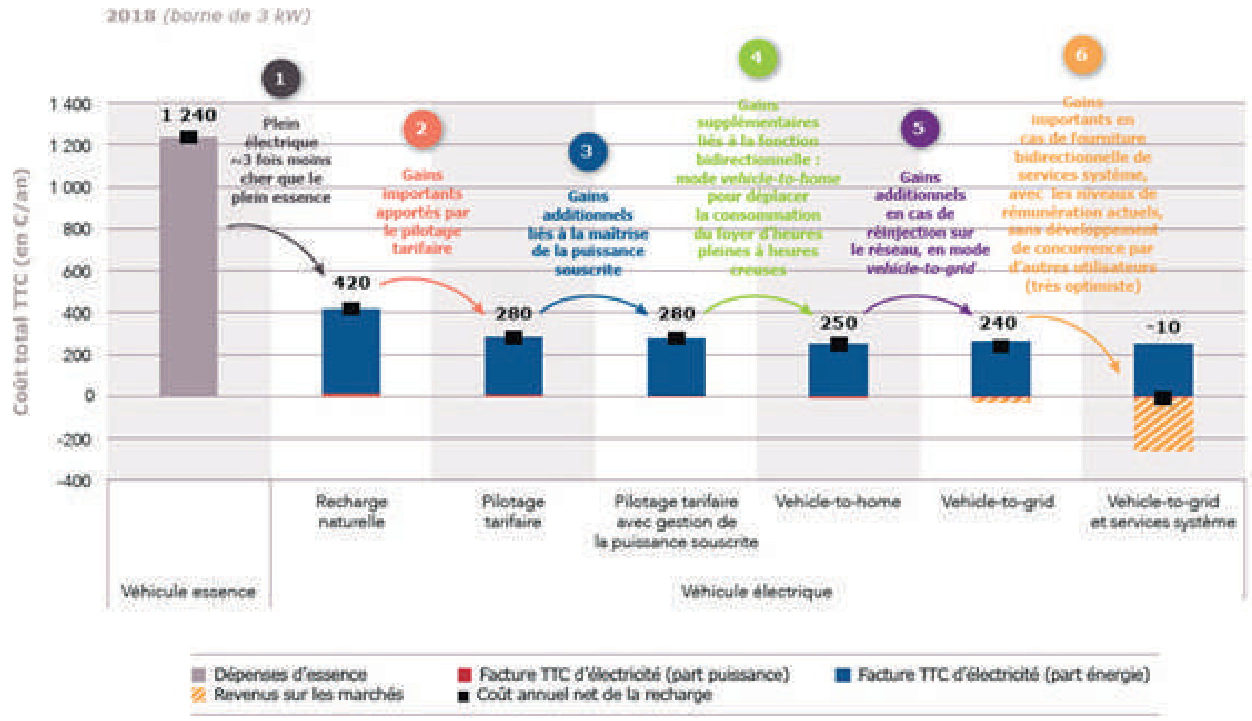
Figure 8. Consommation électrique annuelle et productible du parc électrique décarboné (EnR et nucléaire) français à l'horizon 2035, selon les orientations publiques sur l'évolution du parc de production d'électricité



SOURCE:

RTE AVERE published in mid-May 2019.

Annual fuel consumption for a motorist, depending on the recharging piloting mode



SOURCE:

RTE AVERE published in mid-May 2019.

The graph below shows that electric mobility produces a fuel cost 3 times lower than fossil fuel. This cost is divided by 5 through simple and available price optimisation technology (recharging at off-peak times, reinjection of electricity available in the battery into the grid at peak times)

White Paper – Industrial Electric vehicles

CHAPTER 6

THE TOTAL COST OF OWNERSHIP OF (T.C.O.) INDUSTRIAL ELECTRICAL VEHICLES

In transport, electrification is justified by strong improvements in the economy of electric vehicles, reaching the same level of costs as conventional fuel vehicles in the early 2020s for light utility vehicles.

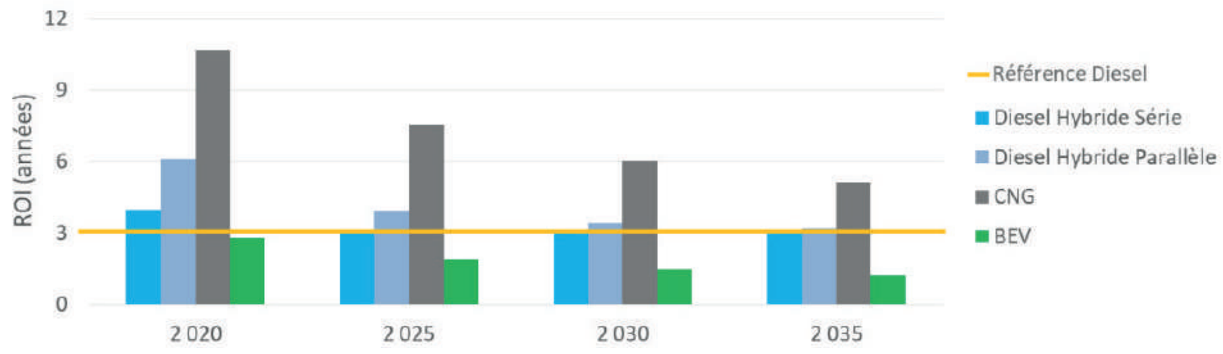
A McKinsey study published in early 2019 and based on European data effectively shows the growing competitiveness of electric trucks. Benefiting from technology developed for buses in particular, whose industrialisation was launched on the European market in 2018, electric trucks will progressively show a total cost of ownership that is equivalent to or even lower than combustion engine trucks; initially for last kilometre delivery logistics, then for regional and intercity transport.

The major trends highlighted by the study are as follows:

- In all segments, except for long-distance heavy goods vehicles, electric vehicles will become the least costly option within the next 5 to 10 years.
- The costs of electric vehicles will rapidly fall, mainly due to a reduction in battery costs.
- The timetable running up to equal total cost of ownership (TCO) in the United States and China is comparable to that of Europe. China is slightly ahead of Europe whereas the United States are slightly behind, owing to differences in fuel taxation and subsidies for electric vehicles.

The 2018 PFA automotive and mobility industry study itemises the ROI per vehicle segment.

ROI for buses. *PFA automotive and mobility sector study 11/2018*

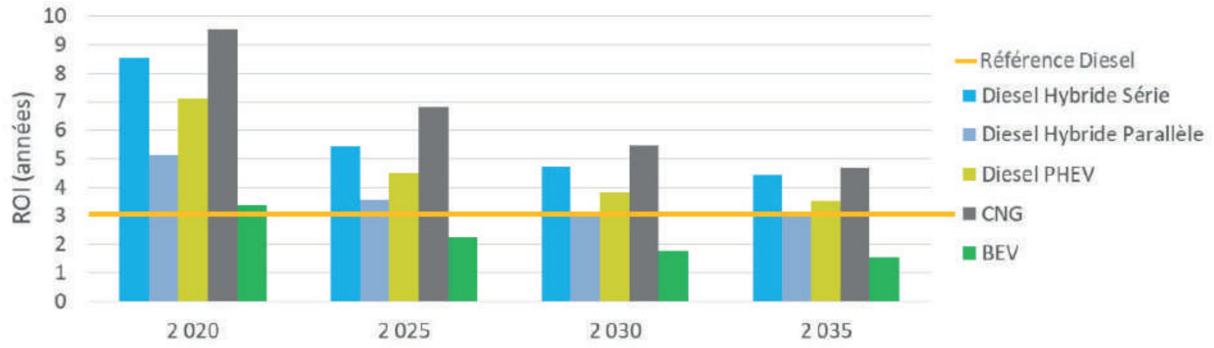


In the bus segment, the BEV will remain the most profitable technology in terms of purchasing and use costs. The ROI will be under 3 years as of 2020. Compatibility of use is the factor limiting the dissemination of this technology.

Hybrid vehicles, even though they are adapted to the bus segment, remain more costly but could take significant market share in the event of the stoppage of 100% ICE diesel technology in 2030.

As Fuel Cell technology does not produce a gain with use in this scenario, its ROI is not calculated and its integration will depend on TCO logics not modelled here,

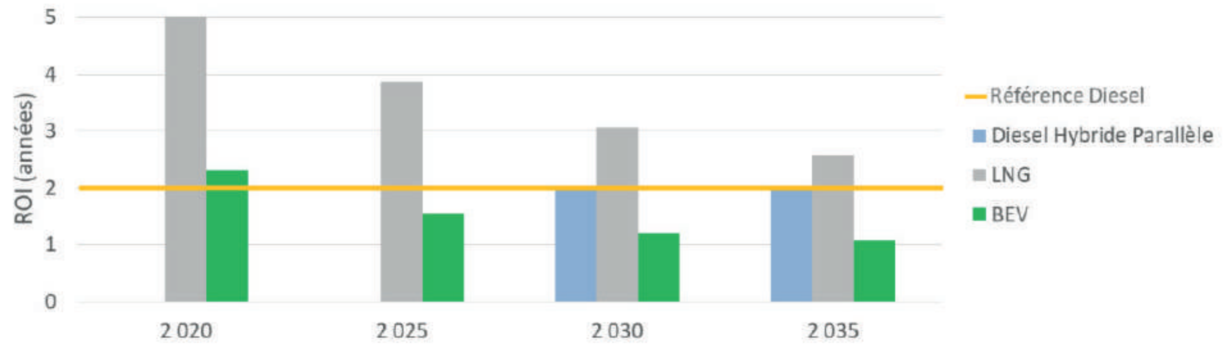
ROI for the "construction" segment. *PFA automotive and mobility sector study 11/2018*



By the diversity of uses in this segment, several types of technology are compatible with construction vehicles.

BEVs are once more the most economically advantageous but their integration will strongly depend on the compatibility of use.

ROI for the "long distance" segment. *PFA automotive and mobility sector study 11/2018*

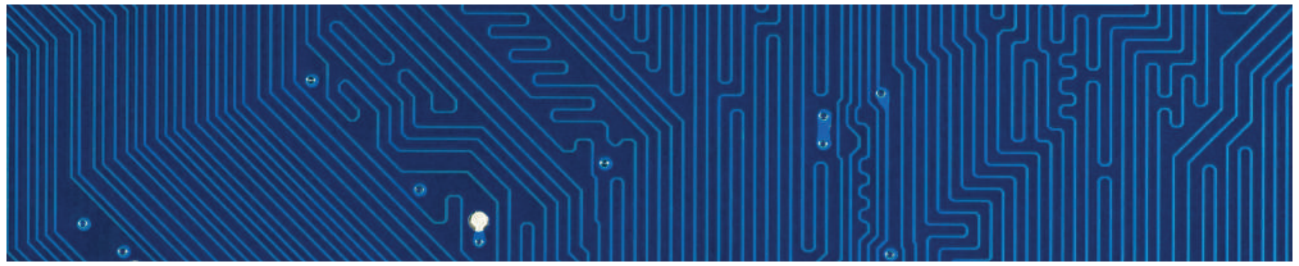


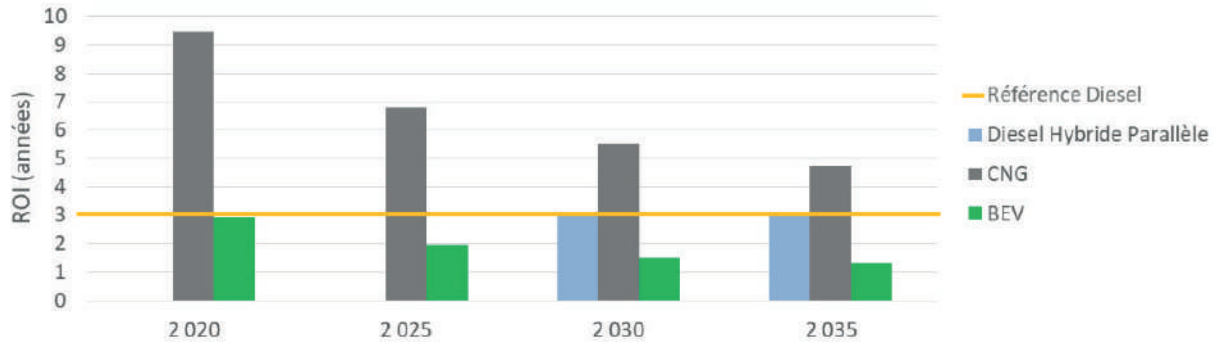
For "long distance" freight, when the technology is mature, the BEV (Battery Electric Vehicle) and LNG (Liquefied Natural Gas) will be the only viable alternative technology compared to diesel as 100% hybrid vehicles do not offer sufficient consumption gains in this segment, unlike coaches.

BEVs are already competitive with diesel and their ROI will fall below two years as of 2020. The integration of technology is currently limited by the absence of supply and the use of vehicles should not be a long-term curb as 70% of journeys are less than 300 kilometres.

LNG shall become extremely competitive as of 2025 and should then take advantage of a development dynamic of infrastructure promoting the increased market share of the technology.

ROI for the "regional delivery" segment. *PFA automotive and mobility sector study 11/2018*



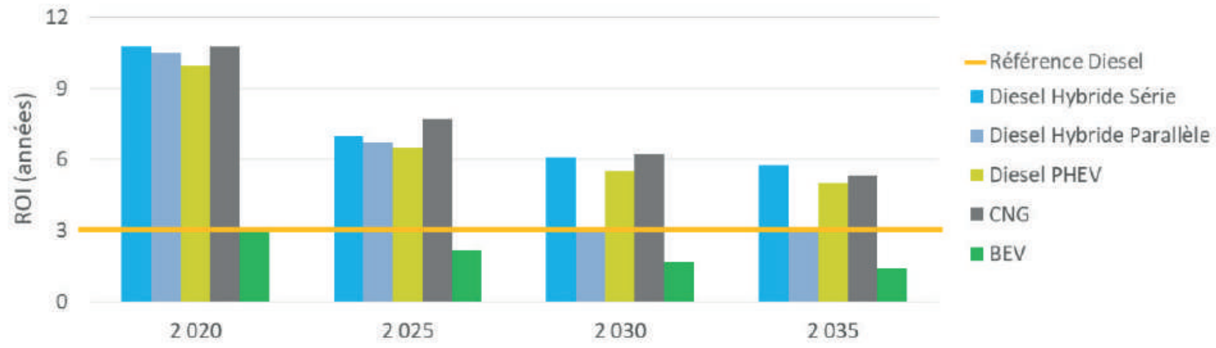


In the regional delivery segment, the BEV and CNG (Compressed Natural Gas) are the two only profitable alternatives to diesel in the long-term as hybrid technology does not offer sufficient consumption gains.

From 2030, CNG will become more profitable than diesel and could take significant market share.

The BEV will remain limited to vehicles running journeys shorter than 350 kilometres (about 70 % of the market) and will compete with CNG technology.

ROI for the "urban delivery" segment. *PFA automotive and mobility sector study 11/2018*



Many types of technology are compatible on the urban delivery segment. It covers a mixed cycle of urban, interurban and motorway use.

The BEV remains the most economically viable technology but will be limited by compatibilities of use.

By 2035, excluding the BEV, only CNG will fall within the 3-year limit in terms of ROI and could very strongly take market share from diesel.

CHAPTER 7

THE EVOLUTION OF JOBS AND CAREERS IN THE AUTOMOTIVE INDUSTRY

EVOLUTION OF JOBS

Electromobility (mass transit or goods haulage) raises major challenges for the automotive sector. New skills are needed, whether for performing new activities or more generally for adapting new careers, or even creating new ones. The aim is to anticipate, prepare changes to come, train and adapt human resources to the new challenges of electromobility upstream (R&D, integration, production) and downstream (distribution, services, maintenance, recycling). Appropriate evolution of training should help anticipate transitions and guarantee a sustainable match between supply and demand for jobs in the sector.

Ongoing developments in the automotive sector imply new careers and a transformation in current jobs. As the 2018-2022 Strategic contract of the automotive sector dated May 2018 highlights, the industrial sector has to deal with three disruptions:

- technological, with the electric engine, batteries and, soon, the fuel cell and onboard hydrogen storage,
- digital, with connected, smart, autonomous vehicles and the emergence of subjects as complex as the protection of data held by a vehicle,
- societal, with new mobility possibilities for mass transit and goods haulage.

The “evolution of activities” and “skills requirements” tables below show that the whole sector (upstream, downstream) has needs in terms of adapting workstations, engineering (R&D), specialists (vehicle sales, mobility advice, etc.) and above all in qualified personnel to manufacture and service vehicles.

There are different training schemes which can be organised in different educational modes, separately or together:

- study-work programmes: professionalisation contracts, apprenticeship contracts, retraining or promotion through study-work programmes (Pro-A),
- distance training: virtual classes, chats, forums, interactive lessons, etc. to adapt to each person’s progress,
- short training courses: specialised courses, support at the workstation,
- certifying training targeting a CQP, organised into blocks of skills or training for a qualification ranging from the CAP to an engineering degree,
- accreditation of prior experiential learning (VAE),
- continuing training is a major issue to support current personnel and future technicians. Finally, the development of the appeal of careers in the sector for young people in initial training and the support of employees in the sector are fundamental and key factors for success in the transition from combustion engine transport vehicles to electric engine transport vehicles.

EVOLUTION OF CAREERS

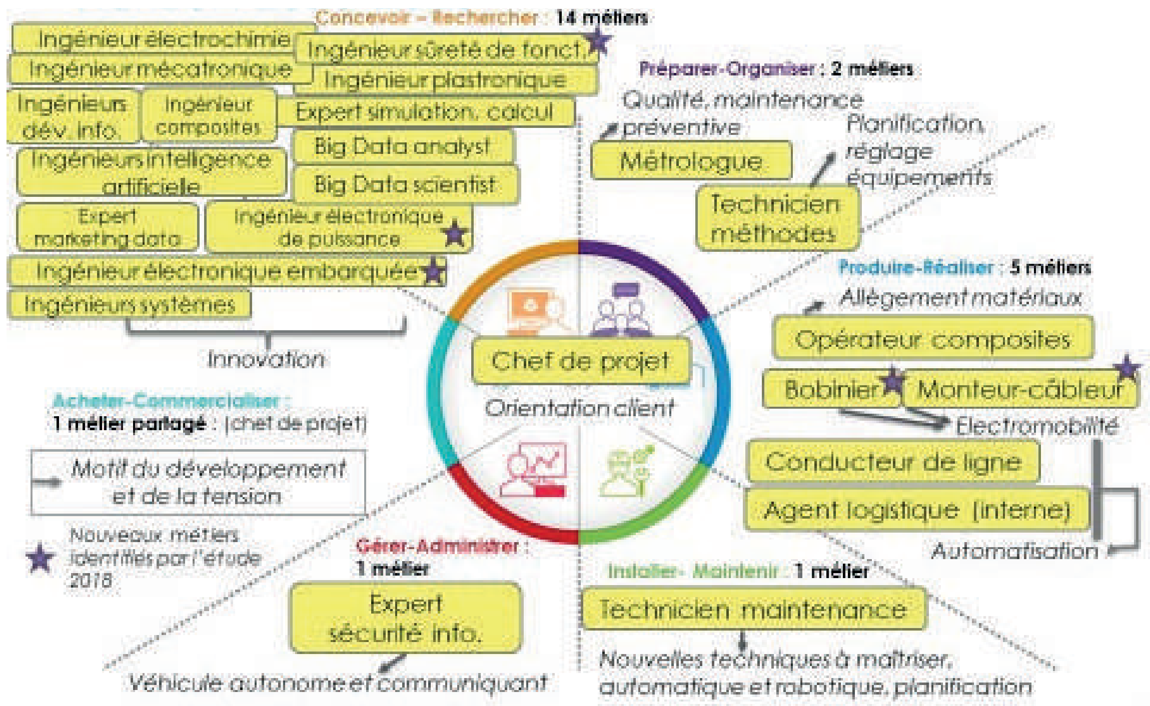
Sector - upstream

The Observatoire des Métiers de la Métallurgie conducted two studies in 2016 and 2018 respectively aimed at describing and quantifying the effects of the changes that impact automotive manufacturing, in particular, industrial vehicles Electromobility (electric and hybrid engines, autonomous and connected vehicles) was one of the changes studied and one with the highest impact on employment and skills requirements (with the industry of the future).

The study showed that the development of electromobility calls on key profiles, especially in design and R&D:

- electro-chemical engineers (battery design),
- operating safety engineers (for autonomous and connected vehicles)
- mechatronics and smart plastics engineers (autonomous and connected vehicles),
- IT development engineers and other careers linked to digital development (big data analysts and scientists, artificial intelligence, IT safety experts),
- embedded electronics engineers (autonomous and connected vehicles, battery management systems).

Mapping of careers in development and under pressure in automotive manufacturing between now and 2025.



SOURCE:

Observatoire de la métallurgie, 2018 MBJD study

In workshops, electromobility mainly boosts careers in the assembly of electric and electronic components, as well as that of winders (industrial equipment control) for the production of electric engines.

The response to these changing careers and the weakening of others is covered, in the Observatoire study, by continuing training courses designed to encourage the mobility of employees exposed to these changes.

The industrial vehicle sector has been studied by other surveys commissioned by the CARA cluster in Auvergne-Rhône-Alpes, with the support of the PFA (automotive and mobility sector platform) and the PIA;

This work has highlighted results comparable to the general automotive sector study (Observatoire des métiers de la métallurgie) and the crucial issues of developing skills and of difficulties in recruiting industrial vehicle maintenance technicians. More precisely, several vehicle design careers have been enriched with new skillsets:

- Electronics knowledge, proficiency in professional English and mechatronics for mechanical design engineers,
- IT development (in particular, database modules), embedded systems electronics, knowledge of electromagnetic standards and radar and radio-transmission technology, telecommunications standards and protocols, professional English, mechatronics and smart plastics for electronic design engineers,
- proficiency in professional English for mechatronic engineers and smart plastics engineers,
- knowledge of electromagnetic standards and radar and radio-transmission technology for IT security experts.

The Industrial Vehicle Maintenance Technician profile must develop skills in:

- assessment of the technical level of the electromechanical intervention,
- knowledge in electricity and electronics,
- knowledge of electric and hybrid engines,
- knowledge of repair methods and processes of live electric systems.

Unlike the manufacture of light vehicles, where the replacement of combustion-powered vehicles by electric vehicles or the reduction of diesel engines are a reality that could incur the loss of around 15,000 jobs in France, jobs in industrial vehicle manufacturing should not be negatively impacted, at least not in the short term, by the development of electromobility. At the moment, projects and investments announced by manufacturers tend to make electromobility a job creating opportunity.

It is however necessary to watch the impact that the development of the electric vehicle fleet could have on vehicle servicing needs as these models require higher maintenance, given the lower number of wear parts.

Sector - downstream

Careers (source: ANFA branch report, 2018 issue)	Companies	Employees
Trade and repair of industrial vehicles	3,871	24,171
Demolition-recycling	396	3,375

Source: GNFA	Vehicle sales - mobility advice	Sales of parts	Rental / fleet manager
Evolution of activities	Recommending the right vehicle for a specific use	Re-use parts	New mobility services
	New "vehicle + related services" mobility services	Post-equipment	Vehicle fleet management - last kilometre delivery
	New tools to sell vehicles and/or service	Reconditioning and storage	Recommendation of the right vehicle for a specific use
	Mastery of information technology and logistics in one's field	Mastery of information technology and logistics in one's field	Mastery of information technology and logistics in one's field
Skills required	Marketing and sales approach on sustainable development and uses	Management of parts (new, re-used, warranty returns, recycling)	Elevated, underground, urban, suburban, extra-urban parking: inclusion of the fire, chemical, ATEX, electrical risk
	Reinforcement of the notion of service: new mobility and related services	New requirement in terms of quality, health, environment	Definition of infrastructure (work, charging station: electric, hydrogen)
	New technology and uses	Electric-chemical risk management linked to batteries	Reinforcement of the notion of service
	Elementary knowledge of charging stations, installation, operation	Conditioning and shipping electric-chemical risk components	Vehicle fleet logistics and management

Source: GNFA	Service-repair-rescue	Bodywork – paint	Deconstruction - recycling

Evolution of activities	Intervention on electric vehicles	Intervention on electric vehicles	Intervention on electric vehicles
	Authorisation of operations depending on the activity and risk	Authorisation of operations depending on the activity and risk	Authorisation of operations depending on the activity and risk
	Maintenance and diagnostic of complex systems linked to new technology	Use of re-use parts	Recycling of materials, identification and management of re-use parts
	Waste management	Waste management	Waste management
	Mechanical systems replaced y electrotechnical - mechatronic systems	New materials	Recycling of batteries, conditioning and shipping of risk components: electrical, chemical
Skills required	Technology (connected vehicle, electric AC compressor, electric powertrain)	Technology (connected vehicle, electric AC compressor, electric powertrain) New materials	Technology (connected vehicle, electric AC compressor, electric powertrain) New materials
	Electrotechnical and mechatronic skills, new intervention methods (maintenance, rescue)	New requirements in terms of quality, health, environment	New requirements in terms of quality, health, environment
	Management of the electric risk, ATEX (standard, regulation, authorisation)	Management of the electric risk, ATEX (standard, regulation, authorisation)	Management of the electric risk, ATEX (standard, regulation, authorisation)
	Diagnostic and servicing of complex systems	Evolutions of intervention and repair techniques	Evolutions of intervention techniques

SOURCE:

GNFA: Groupement National Formation Automobile: www.gnfa-auto.fr

White Paper – Industrial Electric vehicles

CHAPTER 8

INDUSTRY STAKEHOLDERS: TESTIMONIALS

FNTR

The road haulage sector has a long-standing commitment to the energy transition of vehicle fleets. This commitment is active, in particular through the EVE (Engagement Volontaire pour l'Environnement - Voluntary Environmental Commitment) programme and the "Objectif CO_2 - Les transporteurs s'engagent" label, but also through partnerships with institutional stakeholders in alternative energy (GrDF, Sigeif, etc.), manufacturers, local authorities, etc. to involve haulage contractors in projects offering an alternative to diesel power. It is therefore important for businesses in this sector, using road vehicles as their production tool, to safeguard investments, while having the possibility of making strategic choices for a successful energy transition.

Today, there is still a large and varied number of logistic systems where diesel remains the major energy. Environmental requirements commit the haulage sector to an indispensable energy mix.

The criteria for solutions to be chosen for a balanced economic and technical ecosystem are: varied availabilities and ranges of vehicles, supply networks, adapted and accessible maintenance, adaptations of logistical organisations and cost control.

Testing on electric heavy goods vehicles until now have not yet proved an economic balance for the user.

User findings and feedback:

1. One single alternative energy will not satisfy the needs of all the haulage sector. It will therefore be necessary to find an energy mix,

2. A truck with a maximum allowable total mass of 3.5 tonnes can cover between 150 and 700 km/day. The shorter range of industrial electric vehicles limits the range of possibilities to small vehicles (light utility vehicles) and intra-urban road haulage activities.

3. The economic balance of road haulage is very fragile and operates with a net margin of 1 to 2%. Vehicle purchase or rental prices are therefore very precisely calculated. Recharging times, the vehicle's residual values and battery, the evolution of electricity prices, taxation, the cost of use of infrastructure, the cost of recharging infrastructure and of the reorganisation of logistics flows needs to be factored into the TCO. The low margins and tight cash flow do not make it easy to obtain bank guarantees.

4. In addition to recharging infrastructure costs come normative security and available power constraints.

5. The scenario of solar panels on the roofs of warehouses is unfortunately not currently viable as electric power requirements, in view of the panels' yield, would require thousands of square metres of panels.

In the current state of electric technology, major improvements are therefore expected by road hauliers.

LA POSTE

Profitability

The economic profitability of an electric vehicle and its advantages over a combustion-powered vehicle need to be calculated through an overall cost approach, factoring in the cost of ownership and cost of use. Although an electric vehicle is today more expensive than an equivalent combustion-powered vehicle, its use offers major cost-cutting opportunities. The fuel bill is a major item for a business' internal costs. The economic benefit depends on the distance covered and the vehicle range.

Reducing the insurance claims ratio

The experience of La Poste in this area has shown that electric vehicles offer improved driving conditions compared with combustion-powered vehicles, reducing the fleet's accident rate, thereby reducing repair and bodywork costs as well as sick leave. Insurance premiums are also reduced.

The fight against global warning

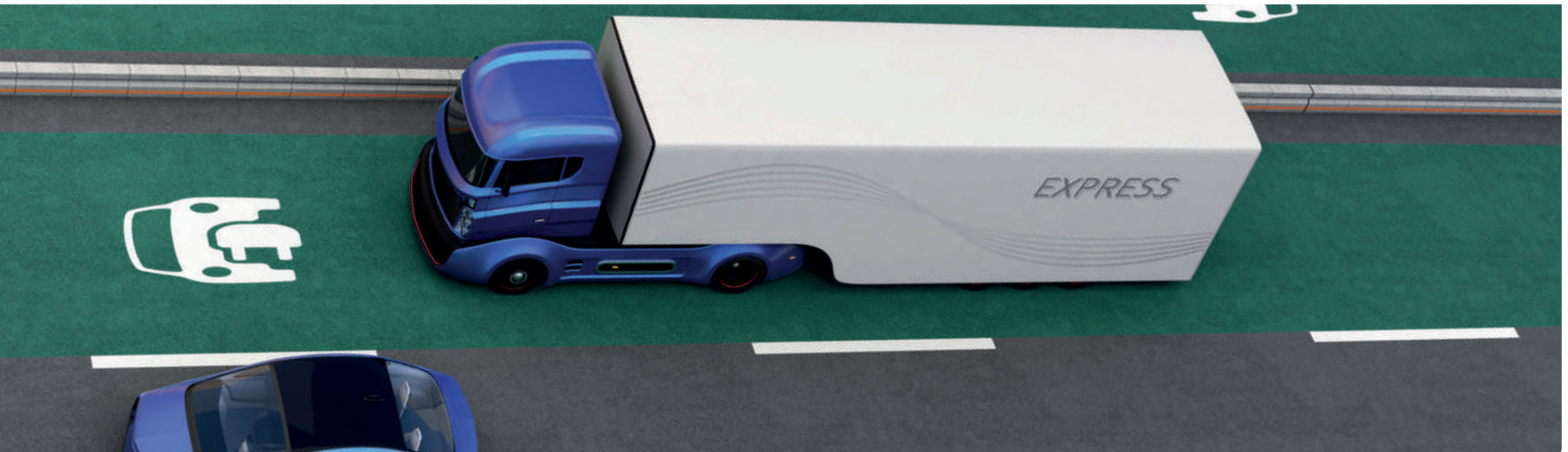
The CO_2 footprint of an electric vehicle must take into account greenhouse gases resulting from the production of electricity. They vary depending on the initial type of energy used, and from country to country. If the average energy mix of West European countries comprises more than 51% of fossil fuel in electricity production, France has the advantage of producing a large proportion of low-emission energy (in France, the share of fossil fuel only represents 9.9% of the energy mix). With an average of 83 grams of CO_2 per kWh, French production of French electricity leads European countries for its low CO_2 emissions. At La Poste, the replacement of a light utility combustion-powered vehicle by its electric equivalent saves 3 tonnes of CO_2 per year. The deployment of 10,000 electric vehicles would therefore allow a reduction of 30,000 tonnes per year of CO_2 emissions.

Performance adapted to the uses of la Poste

The characteristics offered by new generation electric vehicles and their diversity perfectly meet the needs of the collection and distribution of postal products, in particular for light utility vehicles operating in low-emission zones in significantly long rounds.

Improved working conditions

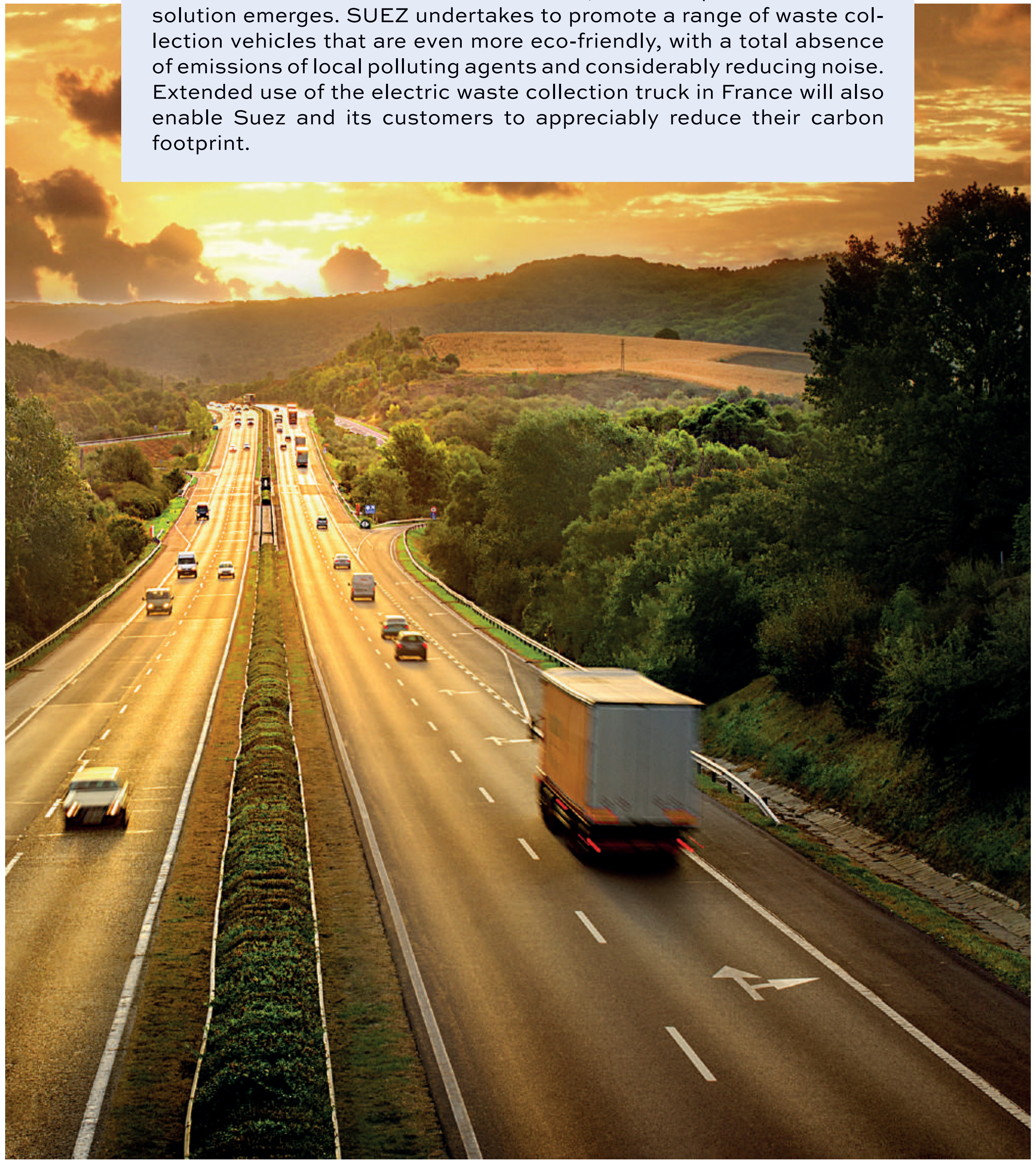
An electric vehicle is particularly silent, both inside and outside. This is therefore an undeniable benefit for its driver. It also helps reduce noise pollution in cities. The absence of a gear stick and clutch allows smooth driving. It is a crucial point for a postman's round with each round representing an average of 250 stops and restarts on short journeys, all in fits and starts. These factors make electric vehicles ideal for postal distribution. User feedback shows that driving an electric vehicle, due to better anticipation, makes the driver more focused on the road and is less tiring and even relaxing.

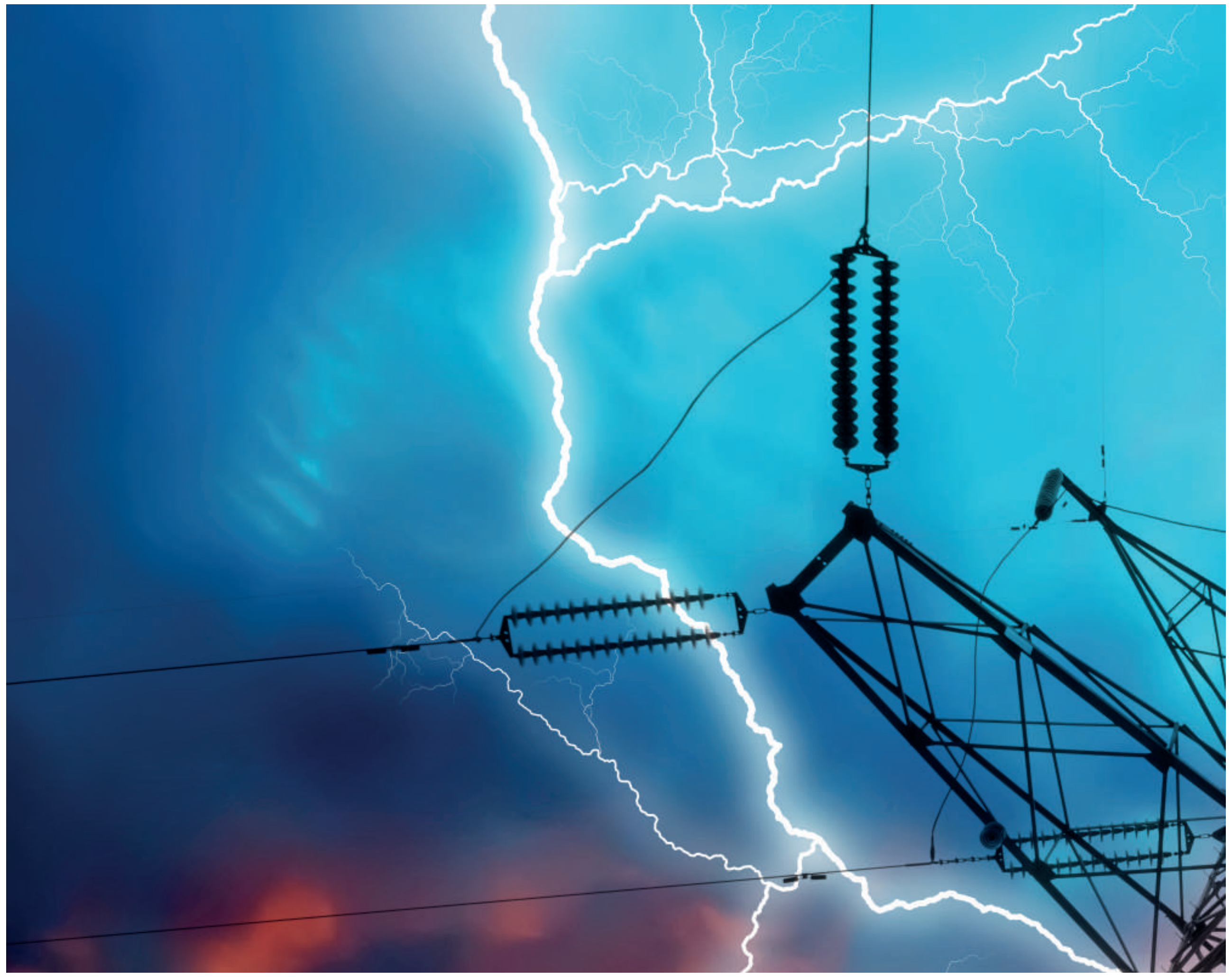


SUEZ

For almost a century, Suez has used electric trucks to collect certain household waste. The current generation, consisting of 25 vehicles, is for example up and running in Neuilly-sur-Seine, Créteil and Issy-les-Moulineaux. These household waste collection trucks operate urban rounds at approximately 40 km per hour on 7-hour rounds. The performance of these electrical vehicles is comparable to their diesel equivalents. Batteries are recharged at night over an 8-hour period. Slow charging maintains the length of service of batteries. A possible constraint is the installation of recharging infrastructure which can be quite voluminous, depending on the number of vehicles to be charged.

On the strength of this long experience, Suez is pleased to collaborate with a national manufacturer as a new, more competitive industrial solution emerges. SUEZ undertakes to promote a range of waste collection vehicles that are even more eco-friendly, with a total absence of emissions of local polluting agents and considerably reducing noise. Extended use of the electric waste collection truck in France will also enable Suez and its customers to appreciably reduce their carbon footprint.





TOTAL

Total, as a major player in the responsible energy market, is positioned as a lead operator in electromobility and other alternative sources of energy. As such, Total is building an integrated model, partly relying on a network of service stations, in a changing environment. Our aim is to supply energy for mobility, through varied distribution networks, while providing the quality of service expected by Total customers.

Through recent acquisitions (Pitpoint, Direct Énergie and G2mobility), Total has the capacity to deploy solutions adapted to electromobility in the European perimeter (France, Belgium, Luxembourg, Netherlands, Germany) and in a multitude of public and private spaces. Depending on the country, the offer includes the supply of electricity, the introduction of recharging infrastructure, the operational management of a network of terminals and services offering easy access to a vast web to allow long-distance journeys and transport. One of the strategic objectives consists in operating, by 2025, 150,000 recharging points on public and private car parks (up to 22 kW), as well as 1,000 superchargers in 300 service stations (175 kW).

The market however will have very different needs, depending on the uses and motivations of customers. To reach an acceptable level of maturity and TCO, technological breakthroughs are still needed. Today, there are very few industrial electric vehicles on the road: the offer will adapt to take into account the emergence and development of this type of vehicle. We will provide technical solutions for appropriate recharging, a reassuring network and a facilitated customer experience.

TRANSDEV

For around ten years, Transdev has been operating and owns near to 600 electric buses of the 40,000 vehicles circulating worldwide (including ferries, cars, bikes, trains, trams, underground trains). These electric vehicles cover between 100 and 400 km per day on average.

There are several techniques used to recharge these vehicles, i.e.: slow charging using a socket, supercharging using a pantograph and continuous supply by cable for trolleybuses.

The powertrain is easier to maintain than a combustion-powered vehicle. However, the batteries require specific monitoring and lifting infrastructure to replace them as well as conditioning infrastructure for their storage and transport.

The main advantages compared to diesel are obviously to have “local zero-emission” vehicles which are also silent. However the range of these electric buses is still low compared to diesel, biodiesel, CNG/bioCNG, bioethanol or xTL vehicles. Although it is possible to imagine easy operation of the current range of electric buses on conventional lines, it is necessary to take into account the impact of thermal comfort auxiliaries on the vehicle’s range when transferring to an electric line.

Transdev is specialised in the operation and commissioning of mass transit systems with electric buses but this technology is still optional for customers and transport management authorities in tenders in France.

Moreover, Transdev’s own field teams increasingly use electric intervention vehicles (light vehicles).

CHAPTER 9

10 PROPOSALS FOR SUCCESSFUL TRANSITION OF THE GOODS HAULAGE SECTOR TOWARDS ELECTRIC VEHICLES

98 % of industrial vehicles sold to date in France are diesel. Also, to make this transition a success, it is necessary to apply the 10 recommendations made by the sector to support haulage contractors and operators in all the components of electric mobility: purchasing, recharging, operation and best practices.

For some purposes, the use of liquid fuel cannot be avoided. There are already solutions, still at the demo level, for certain captive fleets (HVO100, B100, ED95, etc.)

Other solutions are currently being developed to complete the range (BTL, E-fuel, etc.).

PROPOSAL NO. 1

STRENGTHEN SUPPORT OF INVESTMENT IN BUSINESSES CONVERTING THEIR FLEETS THROUGH THE EXTRA DEPRECIATION OF HEAVY GOODS VEHICLES USING ELECTRIC ENERGY

“Heavy goods vehicle” extra depreciation:

The 2019 Finance Act extended to 100% electric vehicles fitted with a battery or hydrogen cell, CNG/bioCNG, the exceptional tax deduction already applied to 3.5-tonne vehicles running on natural gas, biomethane or using ED95 fuel.

This scheme should be adapted to take into account the extra cost of purchasing industrial electric vehicles. Despite large reductions in the cost of electric technology, these vehicles are currently 2 to 2.5 times more expensive than their diesel equivalent. Such a gap in investment cost is obstructing the switch to electric and distracts from the use costs of this technology which are actually very competitive (fuel, maintenance). Due to this, it is important to reinforce and sustain extra depreciation specifically for industrial electric vehicles (trucks, buses and coaches) over a transitory period to put the cost of ownership at the same level as diesel. The following criteria need to be applied:

- 40% of the value of these vehicles if their maximum allowable total mass is higher than or equal to 2.6 tonnes and lower than 3.5 tonnes.
- 60 % of their value if their maximum allowable total mass is higher than or equal to 3.5 tonnes.

Moreover, more generally, it is advisable to have stable, clear and predictable taxation.

PROPOSAL NO. 2

SETTING UP SUPPORT FOR INVESTEMNT IN THE DEVELOPMENT OF RECHARGING INFRASTRUCTURE FOR INDUSTRIAL ELECTRIC VEHICLES

The conversion of fleets to industrial electric vehicles means having a robust network (in number and spread) of standardised recharging infrastructure that is sufficiently fast (initially Combo CCS 80 to 350 k) to recharge battery-powered electric vehicles.

Logistics centres and depots in which these vehicles are parked are preferred recharging locations and must be equipped in priority. These fuelling points require very high investment which needs to be supported financially.

This proposal is very important as the user experience will be facilitated by it. If not, users will turn away from the electric solution.

PROPOSAL NO. 3

EXTENDING INVESTMENT SUPPORT MECHANISMS TO COLLECTIVE AUTHORITIES AND INDIVIDUAL ENTREPRENEURS.

Investment support mechanisms (refundable advances, bonus/penalty mechanisms, etc.) could be set up for those not benefiting from an extra depreciation scheme, such as local authorities or individual entrepreneurs: retailers, artisans, etc.

Such subsidies could be calculated on the basis of the CO_2 emissions avoided. Within this context, the CEE Moebus programme is an example to follow and strengthen by opening it up to all types of industrial electric vehicles.

PROPOSAL NO. 4

SETTING UP OF A GUARANTEE FUND FOR 5 YEARS TO GUARANTEE THE RESIDUAL VALUE OF ELECTRIC VEHICLES

The future resale value of the industrial vehicle is a crucial factor in the choice of alternative energy. This finding is particularly relevant in the market launch phase, characterised by stakeholders' strong aversion to risk. In this context, reducing uncertainty associated with the evolution of this resale value could speed up the penetration of electric vehicles on the goods haulage market and of coaches. Such a system over the market launch phase could strongly boost the transition towards electric fleets.

PROPOSAL NO. 5

ADAPTING REGULATIONS ON THE TOTAL AUTHORISED WEIGHT OF INDUSTRIAL ELECTRIC VEHICLES

The adoption of the European regulation establishing performance standards in terms of CO_2 for new industrial vehicles and amending regulations (EC) no. 595/2009 and (EU) 2018/956 and directive 96/53/CE of May 2019 is a key step in the transition of industrial vehicles. It sets the emissions reduction targets that manufacturers must meet. This will lead to an increase in the number of electric solutions.

To ensure the success of these solutions and take into account the additional impact that can be attributed to technology, the regulation increases the authorised maximum weight of vehicles to 2 tonnes.

So as not to disadvantage future 3-axle industrial electric vehicles which will weigh up to 2 tonnes more than their thermal equivalents, it is necessary to ensure the transposition of this provision into national law.

It is in fact important to maintain the weight exemption of 1 tonne applicable to N1 and N2 category vehicles.

PROPOSAL NO. 6

EASING THE CIRCULATION AND PARKING OF INDUSTRIAL ELECTRIC VEHICLES IN URBAN ZONES

Given their advantages in terms of polluting and noise emissions, it is advisable that urban authorities (city councils and metropolitan districts) set up incentive schemes for the deployment of industrial electric vehicles:

- Reduction of parking prices,
- Access to reserved lanes,
- Access to dedicated delivery spaces,
- Extended delivery times.

We need to foster the concerted deployment of low-emission and zero--emission zones, taking into account the constraints of the relevant stakeholders (mass transit, delivery, artisans, interventions, etc.).

We could set up monetary or non-monetary incentives for the use of electric vehicles given their advantages with respect to diesel and gas combustion engine vehicles in terms of noise, mobility and polluting emissions (free parking, reserved lanes and parking spaces, extended delivery times).

It is in fact essential to standardise and harmonise the use of recharges for professionals:

- Right to recharging points,
- Right to electric supply adapted to professionals,
- Payment conditions,
- Real-time information on the state of installed power points,
- Possibility of reserving their use,
- Etc.

PROPOSAL NO. 7

PROMOTING THE TESTING OF ROAD ELECTRIFICATION

Dynamic electric recharging is an encouraging solution to cut carbon emissions in road haulage.

It is indispensable to support testing in order to validate technological choices.

PROPOSAL NO. 8

SUPPORT LONG-DISTANCE RECHARGING PROJECTS

To allow the development of electric transport on long-distance routes (> 300 km), infrastructure needs to be built next to the major roads to link up existing networks or around large metropolitan districts.

Equipping major roads requires the implementation of appropriate subsidies to support the funding of connection costs and the deployment of specific infrastructure. Coordinated national planning is also fundamental.

PROPOSAL NO. 9

CONTINUE AND EXPAND TESTING TO OPTIMISE URBAN ELECTRIC DELIVERY.

To reduce urban congestion and optimise flows linked to last kilometre deliveries, it is essential to support local testing in the pooling of these logistics. Financial support of the first local deployments is essential. It may be organised in conjunction with ADEME calls for tenders for Energy economy certification (CEE), funding facilities, reinforcement and generalisation of regional initiatives.

Moreover, a national platform for logistics could be set up grouping together players in the ecosystem (city, developer, shipper, haulage contractor, logistics centres, etc.) to study current logistics flows and make optimisation recommendations to improve the competitiveness of stakeholders. This approach must cover all logistics issues: Optimisation of traffic and occupation of the urban area, minimisation of break bulk, etc.

PROPOSAL NO. 10

DEVELOP SKILLS AND TRAINING ON ELECTRIC MOBILITY AND TECHNOLOGY SET UP.

The electric conversion of private and professional vehicle fleets is the greatest revolution in the transport industry since the invention of the internal combustion engine. The sector recommends support from the State, the OPCO Mobilité and regional bodies to give professionals good technical knowledge of this new technology, a good hold of long-term economic issues for businesses as well as appropriate understanding of subsidy schemes for the conversion of their fleets.

For that, several actions need to be set up:

- Creation of exchange and dialogue platforms between industrialists and training players to adapt training courses to new technology, the creation or adjustment of professional qualification certificates (CQP).
- Acting as close as possible to employment areas with local stakeholders (Direccte, Pôle Emploi - job centres-, branches, competitiveness clusters, etc.) to support businesses (especially small and medium sized) in their skills management and career plan projects for employees.
- Creation of skillsets and qualified labour needed to ensure the competitiveness of manufacturers and OEMs on the international scene.
- Supporting operators in the upstream and downstream sectors in adapting their profession to all the life cycle stages: production, maintenance, recycling.

White Paper – Industrial Electric vehicles

CHAPTER 10

APPENDICES

INDUSTRIAL ELECTRIC VEHICLES LIGHT UTILITY VEHICLES AND HEAVY GOODS VEHICLES

MAN

BRAND MANUFACTURER	MAN	MAN
VEHICLE TRADE NAME	eTGE	eTGM
MAXIMUM ALLOWABLE TOTAL MASS	3500 kg	26000 kg
TYPE OF ENERGY	Full electric	Full electric
EXAMPLES OF TYPES OF BODYWORK	11M3³ van	Van, refrigerated box
VEHICLE LENGTH		
MIN.		
MAX.	5986 mm	7660 mm
PAYLOAD		
MIN.		
MAX.	1000 kg	15279 kg
USES AND APPLICATIONS	Last km logistics, urban deliveries	Urban and suburban deliveries
VEHICLE USE CYCLE(S)	no recommendation	no recommendation
POSITION OF BATTERY PACKS	Under the floor, in the wheelbase	Under the cabin, in the wheelbase
EMBEDDED BATTERIES		
ENERGY (KW)	36	185
WEIGHT	Nc	Nc
BATTERY RECHARGING		
POWER	7.2kW (Wallbox) / 40kW (CCS)	44kW (Type 2) / 150kW (CCS)
LENGTH	5h20 @7,2kW / 80% in 40 min @40kW (CCS)	4h10 @44 kW / 1h15 @150kW
VEHICLE PERFORMANCE		
MAX. POWER	100kW	264 kW
ENGINE TORQUE	290Nm	3100 Nm
VEHICLE RANGE (KM)		
MIN.		
MAX.	173 km	180 km
BATTERY TECHNOLOGY	Li-Ion	Li-Ion
BATTERY LIFE	Nc	Nc
FEATURES		

INDUSTRIAL ELECTRIC VEHICLES LIGHT UTILITY VEHICLES AND HEAVY GOODS VEHICLES

MERCEDES		
BRAND MANUFACTURER	FUSO	Mercedes-Benz
VEHICLE TRADE NAME	eCanter	eActros
MAXIMUM ALLOWABLE TOTAL MASS	7490kg	18 tonnes (2 axles) and 25 tonnes (3 axles)
TYPE OF ENERGY	100% electric	Full electric
EXAMPLES OF TYPES OF BODYWORK	Dry cargo box / deck / Autonomous refrigerated box	Body
VEHICLE LENGTH		
MIN.	5935 mm	
MAX.	6995 mm	12 m
PAYLOAD		
MIN.	3000 kg	
MAX.	4290 kg	
USES AND APPLICATIONS	urban logistics	Distribution
VEHICLE USE CYCLE(S)	Dry cargo box / vehicle limited to 80 km per hour to maintain battery autonomy as much as possible.	
POSITION OF BATTERY PACKS	on the exterior of the chassis side sills	Under the cabin, interior and exterior side sills
EMBEDDED BATTERIES		
ENERGY (KW)	82kWh (6x13.8kWh)	
WEIGHT	Unknown	
BATTERY RECHARGING		
POWER	200V (domestic current) / 500V (fast charging with recharging terminal)	Between 20 and 150 kW
LENGTH	9 hrs / 1.45 hrs	Between 2 and 11 hours
VEHICLE PERFORMANCE		
MAX. POWER	129kWh	126 kW
ENGINE TORQUE	390 Nm	2 x 485 Nm
VEHICLE RANGE (KM)		
MIN.	100km	0
MAX.	125 km	200
BATTERY TECHNOLOGY	Deutsche ACCUmotive HV	lithium-ion
BATTERY LIFE	10 years	
FEATURES		

White Paper – Industrial Electric vehicles

INDUSTRIAL ELECTRIC VEHICLES LIGHT UTILITY VEHICLES AND HEAVY GOODS VEHICLES

MERCEDES		
BRAND MANUFACTURER	Daimler AG	Daimler AG
VEHICLE TRADE NAME	eVito van	eSprinter van
MAXIMUM ALLOWABLE TOTAL MASS	3t200	3t500
TYPE OF ENERGY	100% electric	100% electric
EXAMPLES OF TYPES OF BODYWORK	Vito Long and Extra-long	Sprinter van 37S
VEHICLE LENGTH		
MIN.	Long: 5,140 mm	5,926 mm
MAX.	Extra-long 5,370 mm	5,926 mm
PAYLOAD		
MIN.	1,048 kg	~ 900 kg (4 batteries)
MAX.	1 073 kg	~1,040 kg (3 batteries)
USES AND APPLICATIONS	Urban and suburban	Urban and suburban
VEHICLE USE CYCLE(S)		
POSITION OF BATTERY PACKS	Floor	Floor
EMBEDDED BATTERIES		
ENERGY (KW)	41.4 kW	3 batteries: 41.4 kW / 4 batteries: 55.2 kW
WEIGHT	~ 340 kg	~ 340 kg / ~ 450 kg
BATTERY RECHARGING		
POWER	AC: 7.2 kW	AC: 7.2 kW / DC: > 80 kW
LENGTH	100% of the battery: 6 hrs	100% of the battery with 3 batteries: AC: 6 hrs / DC: 25 min 100% of the battery with 4 batteries:AC: 8 hrs / DC: 30 mn
VEHICLE PERFORMANCE		
MAX. POWER		
ENGINE TORQUE		
VEHICLE RANGE (KM)		
MIN.	115 hp	115 hp
MAX.	300 Nm	300 Nm
BATTERY TECHNOLOGY		
BATTERY LIFE	150 km in WLTP 149 (mini) at 189 (maxi) in NEDC	~115 km with 3 batteries ~150 km with 4 batteries
FEATURES	- Lithium-ion - No max. battery life - Mercedes battery guarantee certificate: 8 years/100 000 km - Cold batteries that may immedia-tely be recharged after a journey	- Lithium-ion - No max. battery life - Mercedes battery guarantee certificate: 8 years/100 000 km - Cold batteries that may immedia-tely be recharged after a journey

INDUSTRIAL ELECTRIC VEHICLES LIGHT UTILITY VEHICLES AND HEAVY GOODS VEHICLES

RENAULT SAS

BRAND MANUFACTURER	RENAULT SAS
VEHICLE TRADE NAME	MASTER Z.E.
MAXIMUM ALLOWABLE TOTAL MASS	3.1 T /3.5T
TYPE OF ENERGY	Full electric
EXAMPLES OF TYPES OF BODYWORK	Van: L1H1, L1H2,L2H2 & L3H2 - Flatbed: L2H1 & L3H1
VEHICLE LENGTH	
MIN.	5048mm (van) 5530mm (flatbed)
MAX.	6198mm (van) 6180 mm (flatbed)
PAYLOAD	
MIN.	975 kg (van) 1355 kg (incomplete flatbed)
MAX.	1128 kg (van) 1377kg (incomplete flatbed)
USES AND APPLICATIONS	parcel transport and delivery, refrigerator, etc.
VEHICLE USE CYCLE(S)	Range in excess of 80 km including in the case of the most difficult uses (heavy load, driving in city centre with frequent stops, winter conditions). The consumption in actual use also depends on equipment, the driving style and topography.
POSITION OF BATTERY PACKS	under the body between side sills
EMBEDDED BATTERIES	
ENERGY (KW)	LG 33KWh
WEIGHT	280 kg
BATTERY RECHARGING	
POWER	7KW AC
LENGTH	6 hours - from 0% to 80% in 4 hours
VEHICLE PERFORMANCE	
MAX. POWER	57 KW
ENGINE TORQUE	225N/m
VEHICLE RANGE (KM)	
MIN.	90 km
MAX.	160 km
BATTERY TECHNOLOGY	Lithium Ion
BATTERY LIFE	> 8 years
FEATURES	air-cooled

INDUSTRIAL ELECTRIC VEHICLES LIGHT UTILITY VEHICLES AND HEAVY GOODS VEHICLES

RENAULT TRUCKS

BRAND MANUFACTURER	RENAULT TRUCKS	RENAULT TRUCKS	RENAULT TRUCKS
VEHICLE TRADE NAME	MASTER Z.E.	D 16 t Z.E.	D 26 t Z.E.
MAXIMUM ALLOWABLE TOTAL MASS	3.1 t / 3.5 t (2020)	16 t	26 t
TYPE OF ENERGY	100% electric	100% electric	100% electric
EXAMPLES OF TYPES OF BODYWORK	Van (8 to 13 m³) or flatbed with dry cargo box or refrigerated box. 6 available versions.	Dry cargo box or refrigerated box for urban distribution	Household waste collection vehicle, dry cargo box, refrigerated box, etc.
VEHICLE LENGTH			
MIN.	5075 mm	to be specified	to be specified
MAX.	6225 mm	to be specified	to be specified
PAYLOAD			
MIN.	975 kg	4t	10t
MAX.	1,331 kg (flatbed excluding bodywork)	8t	14t
USES AND APPLICATIONS	Last kilometre delivery, parcel delivery, refrigerated, etc.	Urban distribution: Depending on the battery and bodywork capacity	BOM and urban distribution depend on bodywork
VEHICLE USE CYCLE(S)	Range in excess of 80 km including for the toughest uses	NA	NA
POSITION OF BATTERY PACKS	Under the cabin	In the wheelbase	In the wheelbase
EMBEDDED BATTERIES			
ENERGY (KW)	33 kWh	200 or 300 kWh	200 kWh
WEIGHT	255 kg	2t or 3t	2t
BATTERY RECHARGING			
POWER	74 kW recommended	22 kW in AC (cable or terminal) / up to 150 KW in DC	22 kW in AC (cable or terminal) / up to 150 kW in DC
LENGTH	Completely recharged in 6 hrs (7.4 KW)	8 hrs (200 kWh) or 12 hrs (300 kWh) / <2 hours fast charging	8 hrs / <2 fast charging
VEHICLE PERFORMANCE			
MAX. POWER	57 kW	185 kW	370 kW
ENGINE TORQUE	225 Nm	425 Nm	850 Nm
VEHICLE RANGE (KM)			
MIN.	-	-	-
MAX.	160 km depending on use. Actual average range of 120 km	Up to 300 km (excluding bodywork and auxiliary)	Up to 200 km (excluding bodywork and auxiliary)
BATTERY TECHNOLOGY	Lithium-ion	Lithium-ion	Lithium-ion
BATTERY LIFE	Between 5 and 8 years depending on use	8 to 10 years on average (depending on applications and uses)	8 to 10 years on average (depending on applications and uses)
FEATURES	Available in the network	Industrial production starting early 2020	Industrial production starting early 2020

INDUSTRIAL ELECTRIC VEHICLES LIGHT UTILITY VEHICLES AND HEAVY GOODS VEHICLES

SCANIA					
BRAND MANUFACTURER	SCANIA	SCANIA	SCANIA	SCANIA	SCANIA
VEHICLE TRADE NAME					
MAXIMUM ALLOWABLE TOTAL MASS	19 t	26 t	19 t	26 t	19 t
TYPE OF ENERGY	Hybrid (HEV)	Hybrid (HEV)	Hybrid (HEV)	Hybrid (HEV)	Batteries (BEV)
	Plug-in hybrid (PHEV)	Plug-in hybrid (PHEV)	Plug-in hybrid (PHEV)	Plug-in hybrid (PHEV)	
EXAMPLES OF TYPES OF BODYWORK					
VEHICLE LENGTH					
MIN.					
MAX.					
PAYLOAD					
MIN.					
MAX.					
USES AND APPLICATIONS					
VEHICLE USE CYCLE(S)					
POSITION OF BATTERY PACKS					
EMBEDDED BATTERIES					
ENERGY (KW)	7.4 KWh	7.4 KWh	7.4 KWh	7.4 KWh	150kWh
WEIGHT					
BATTERY RECHARGING					
POWER	22 kW	22 kW	22 kW	22 kW	
LENGTH	20'	20'	20'	20'	
VEHICLE PERFORMANCE					
MAX. POWER	130 kW	130 kW	130 kW	130 kW	220 kW
ENGINE TORQUE	1050 Nm	1050 Nm	1050 Nm	1050 Nm	1300 Nm
VEHICLE RANGE (KM)					
MIN.					
MAX.					
BATTERY TECHNOLOGY	LITHIUM/ION	LITHIUM/ION	LITHIUM/ION	LITHIUM/ION	LITHIUM/ION
BATTERY LIFE					
FEATURES					

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SUMMARY OF THE WHITE PAPER

ELECTRICITY FOR THE INDUSTRIAL VEHICLE SECTOR

What is the offer and what are the conditions for success?

The road sector makes up for 31% of greenhouse gas emissions [1]and 1 to 6% of polluting agents[2] of the air in France. Road haulage represents 6% of these greenhouse gas emissions and is therefore a major lever to be activated to achieve the objectives of fighting greenhouse gases and improving the quality of air in France. These objectives are expressed in the different French and European regulations that control the development of emissions caused by the use of vehicles sold.

Compliance of the sector with these environmental demands should not reduce competitiveness in Europe amidst a very dynamic global competitive context and a global vehicle supply.

Manufacturers, haulage contractors and operators unanimously agree to green-up their footprint and reduce their impact on the environment and protect a viable economic balance. It is in fact an increasingly pressing demand, and even a choice criterion, for consumers and their customers committed to corporate social responsibility (CSR). The replacement of a combustion-powered vehicle by a 100% electric engine is a solution to these concerns: An electric engine produces no emissions.

Today, battery-powered electric vehicles offer ranges of up to 300 km, which offers a competitive alternative, especially for uses in urban and suburban zones. The subsequent development of vehicles fitted with “hydrogen fuel cells” could extend that radius of action and better use the vehicle’s payload.

For serial development of these electrification possibilities, the decisive factor is the reduction of the cost of electric powertrains, batteries and recharging infrastructure which are currently expensive for the purchase and use of electric vehicles.

For light vehicles, the total cost of ownership of an electric vehicle through subsidies is now approaching that of a conventional combustion-powered vehicle. Constant progress is observed in terms of improving the range of private vehicles and of their price (range of around 400 km). Electric heavy goods vehicles, coaches and buses will follow the same trend if given the right support.

The major manufacturers are already marketing the first truck models for urban and suburban distribution whereas electric buses are already broadly deployed in China and are operating in European cities.

The electric conversion of industrial vehicles (trucks and buses) has already started in the world and Europe and the French industrial fabric of manufacturers and OEMs is ready to gear up this momentum at the national level.

The success of this transition will require setting up 10 recommendations made by the sector to support haulage contractors and operators in all the components of electric mobility: purchasing, recharging, operation and best practices.

[1] National Transport Accounts, 2019

[2] Diesel heavy goods vehicles only