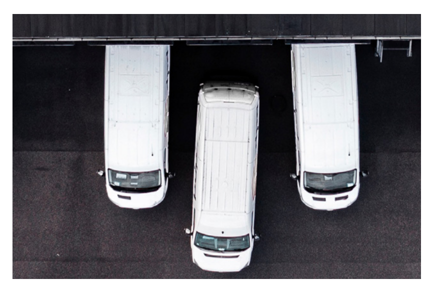
International Transport Forum

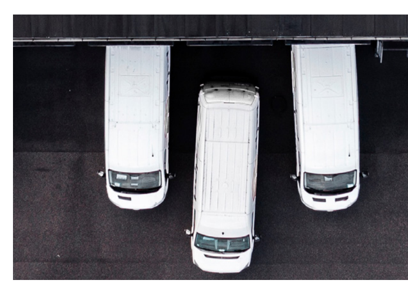
How Urban Delivery Vehicles can Boost Electric Mobility



Decarbonising Transport

Decarbonising Transport Initiative

How Urban Delivery Vehicles can Boost Electric Mobility



Decarbonising Transport

The International Transport Forum

The International Transport Forum is an intergovernmental organisation with 62 member countries. It acts as a think tank for transport policy and organises the Annual Summit of transport ministers. ITF is the only global body that covers all transport modes. The ITF is politically autonomous and administratively integrated with the OECD.

The ITF works for transport policies that improve peoples' lives. Our mission is to foster a deeper understanding of the role of transport in economic growth, environmental sustainability and social inclusion and to raise the public profile of transport policy.

The ITF organises global dialogue for better transport. We act as a platform for discussion and pre-negotiation of policy issues across all transport modes. We analyse trends, share knowledge and promote exchange among transport decision-makers and civil society. The ITF's Annual Summit is the world's largest gathering of transport ministers and the leading global platform for dialogue on transport policy.

The Members of the Forum are: Albania, Armenia, Argentina, Australia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Canada, Chile, China (People's Republic of), Croatia, Czech Republic, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kazakhstan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Mexico, Republic of Moldova, Mongolia, Montenegro, Morocco, the Netherlands, New Zealand, North Macedonia, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, the United Arab Emirates, the United Kingdom, the United States and Uzbekistan.

International Transport Forum
2 rue André Pascal
F-75775 Paris Cedex 16
contact@itf-oecd.org
www.itf-oecd.org

Case-Specific Policy Analysis Reports

Cite this work as: ITF (2020), "How Urban Delivery Vehicles can Boost Electric Mobility", *International Transport Forum Policy Papers*, No. 81, OECD Publishing, Paris.

Acknowledgements

The authors of this report are Till Bunsen and Pierpaolo Cazzola. Till Bunsen is the main author of the chapters on the market status of electric road vehicles and lessons from electrification projects for light commercial vehicles. Pierpaolo Cazzola is the main author of the chapters on costs and environmental performance of electric light commercial vehicles and policies to accelerate electrification of light commercial vehicles.

The authors thanks the following individuals for their contributions and insightful comments during the review process: Daniel Barber (New Zealand government), Esteban Bermúdez Forn (UN Environment Programme), Tomoko Blech (CHAdeMO Association Europe), Richard Clarke (FIA Foundation), Nick Clay (Arrival), Richard Colley (Arrival), Alain Costa (ChargePoint), François Cuenot (United Nations), Akshima Ghate (RMI India), David Gohlke (Argonne National Laboratory, ANL), Isabel Gomez Bernal (Iberdrola), Sita Holtslag (The Netherlands), Aakansha Jain (UC Davis), Ivan Jaques (Worldbank), Oliver Lah (Wuppertal Institute), Francisco Laveron Simavilla (Iberdrola), Alan Lewis (Smart Freight Centre), William Lilley (Aramco Overseas Company), Jian Liu (The People's Republic of China), Maurizio Maggiore (European Commission), Mark Major (SLOCAT Partnership), Cristina Miclea (C40), Sonja Munnix (The Netherlands government), Matteo Muratori (NREL), Andi Novianto (Indonesian government), Fabricio Pietrobelli (UN Environment Programme), Sophie Punte (Smart Freight Centre), Sharif Qamar (TERI), Felipe Rodríguez (ICCT), Sandra Roling (Climate Group), Guido Sacchetto (European Commission), Sacha Scheffer (The Netherlands government), Colin Smith (Smart Freight Center), Jon Steel (Arrival), Christelle Verstraeten (ChargePoint), Michael Wang (ANL), Martina Wikstrom (Swedish government), Choi You Jun (KATECH), Yan (Joann) Zhou (ANL).

At the International Transport Forum, credits go to Jari Kauppila for reviewing of the document, and special thanks go to Matteo Craglia for the help provided in the finalisation of the draft and his review contributions.

This work is part of the ITF Decarbonising Transport (DT) initiative, a key instrument developed by the ITF to help governments and industry to translate climate ambitions into actions. The initiative (https://www.itf-oecd.org/decarbonising-transport) brings together a partnership that extends far beyond the ITF's member countries. It includes work streams aiming to:

- track progress to evaluate how current mitigation measures contribute to reaching objectives for reducing greenhouse gas (GHG) emissions from transport
- develop in-depth sectoral and focus studies to identify effective policies in specific modes (e.g. road transport) and thematic areas (e.g. cities)
- bring policies together in a catalogue of effective measures, to support countries to develop their GHG emission mitigation strategy in transport
- support the policy dialogue, leveraging on extensive engagement with the United Nations Framework Convention on Climate Change (UNFCCC), including the ITF's designation as focal point for transport of the Marrakech Partnership for Global Climate Action (MP-GCA).

Funding for this work has been provided by a voluntary contribution by the Korea Automotive Technology Institute (KATECH).

Table of contents

Figures

Tables

Boxes

List of acronyms

BEV	battery electric vehicle
EV	electric vehicle
GHG	greenhouse gas
GVW	gross-vehicle weight
ICE	internal combustion engine
LCA	life-cycle assessment
LDV	light duty vehicle
LEZ	low emission zone
NEV	new energy vehicle
OBD	on-board diagnostics
OEM	original equipment manufacture
PEMS	Portable Emission Measurement System
PHEV	plug-in hybrid electric vehicle
TCO	total cost of ownership
TTW	tank-to-wheel
UAR	urban access restriction
WLTP	Worldwide harmonized Light vehicles Test Procedure
WTT	well-to-tank
WTW	well-to-wheel
ZEZ	zero emission zone

Executive summary

What we did

This study explores how fleet operators, vehicle manufacturers and policy makers can scale up the electrification of light commercial vehicles (LCVs). The research focuses on challenges such as the limited number of available models, the small production scale, the current levels of battery costs and availability of charging infrastructure. It also compares life-cycle environmental impacts and total cost of ownership of alternative technology options for LCVs.

What we found

The market for electric LCVs has grown in recent years. This is especially relevant for vans, which are frequently used for last-mile delivery. Several global logistics operators have introduced large numbers of electric LCVs for last-mile delivery in urban areas. In the passenger vehicle sector, electric vehicles are already a mass-market technology, while their uptake in the commercial vehicle sector is trailing behind, despite their viable application for fleet operators.

The electric LCVs available have high list prices. Yet they are well positioned to realise net savings through low-fuel and maintenance costs due to higher average annual travel than cars and several shared parts for their construction. Increasing vehicle production will reduce prices, as was the case for electric passenger cars.

With current battery costs, the total cost of ownership of electric LCVs is at par with diesel vans in regions where diesel is expensive, provided that EVs can be produced at scale. LCVs have a higher mileage than cars, which maximises fuel cost savings once electrified. At the same time, their range requirements keeps battery pack size, and hence costs, small. With battery costs projected to fall, the cost-competitiveness of electric vehicles will improve. This will have an impact notably in countries with low fuel taxes. It will also make LCVs more attractive for users that require above-average ranges from LCVs.

Switching to EVs reduces the energy use per vehicle-kilometre and eliminates tailpipe emissions. Their low energy use comes with lower greenhouse gas emissions (GHG) from fuel use, notably where fleets use renewable electricity. LCV's reduced GHG emissions during operation more than compensates for their GHG footprint from battery manufacturing. The declining carbon intensity of electricity generation in most markets will reinforce the emission savings from electric vehicles. Policy support and falling cost for renewable energy drive this development.

Plug-in hybrid electric vehicles (PHEVs) can deliver similar environmental benefits as battery electric vehicles (BEVs), as long as the share of electric driving exceeds 90%. This is only possible with pro-active monitoring by corporate actors, public policies to enforce it, good availability of charging infrastructure and high durability of PHEV batteries or periodic battery replacements for PHEVs.

The recent growth of the passenger EV market has been driven by incentives for early adopters, combined with improved availability of charging infrastructure. Tightened fuel economy standards also played an important role to promote EVs and other efficient vehicle technologies. A number of regulations now specify fuel economy targets for LCVs or similar vehicle classes. Some already mandate LCVs to be zero-emission in the future or include targeted incentives that go in this direction.

Low-emission zones or zero-emission zones in cities are new policy measures that promote the electrification of last-mile delivery vehicle fleets. Several cities plan to regulate access for vehicles with combustion engines, sending a strong signal to operators to adopt cleaner technologies.

What we recommend

Prioritise electrification of vehicles with high mileage and regular daily activity, including LCVs in last-mile delivery

Using electric vans for urban last-mile delivery can boost electric mobility deployment in the commercial sector. Electrification of light commercial vehicles with high annual mileage reduces air pollution, energy consumption and GHG emissions from the road transport sector more than that of vehicles with lower activity levels. Yet existing electrification programmes tend to focus on passenger cars. Prioritising vehicle types with high annual mileage and regular daily activity maximises fuel cost reductions and total cost of ownership savings.

Promote electric light commercial vehicles in cities and tightly regulate combustion-engine vehicles

Cities offer the best operational conditions for electric LCVs. They also suffer most from air pollution from vehicles with combustion engines. Vehicle access regulations that favour electric vehicles, such as low- or zero-emission zones, send a strong signal to operators to electrify fleets. Such regulations can bring to bear the economic and environmental benefits of electric LCVs and improve liveability of cities. They can also stimulate demand for second-hand electric vehicles by LCV users with lower mileage and slow down depreciation of electric vehicles, which increases their value proposition.

Strengthen fuel economy standards, zero-emission mandates and economic incentives for light commercial vehicles

Fuel economy standards and mandates for zero tailpipe emission vehicles promote the transition of the vehicle market to more efficient propulsion technologies. They also incentivise vehicle manufacturers to expand their offer of electric models. Where such standards and mandates have been adopted for passenger cars, they have tightened driven fuel economy improvements of new vehicles and stimulated the market for electric models. The commercial vehicles market is trailing, however, that of passenger cars. Extending fuel economy standards to vans can accelerate the transition here, too. Integrating temporary economic incentives with fuel economy standards is a way forward where electrification offers net benefits but vehicle prices or financing costs prevents operators from switching. Financial incentives are also important to help smaller fleet operators to overcome higher upfront costs. Incentives work best as the market scales up and the upfront cost gaps are largest.

Define regulatory requirements and clarify costs for upgrades to the electricity grid needed for electric vehicles

Installing chargers at depots for large EV fleets is likely to rely on grid upgrades, which can delay electrification projects. Governments should streamline regulatory requirements for grid upgrades to avoid delays in deploying charging infrastructure. Public authorities need to clarify costs coverage for grid reinforcements. Without this, costs for local grid reinforcements could fall entirely on the first requester. Regulators can opt to share financial responsibility for grid reinforcements over all network users, as they can open opportunities for other end-use developments as well.

Use vehicle design and components of electric passenger cars to unlock price reductions of electric light commercial vehicles

Prices for electric passenger vehicles have notably declined in recent years and their price gap with conventional cars narrows. Meanwhile, the price tag of available LCVs remains much higher than for versions with conventional powertrains. Expanding the production scale of electric LCVs may achieve the cost reductions seen for electric passenger cars. Profit margins in the logistics sector are low and these cost reductions are necessary to accelerate deployment. Production volumes of LCVs are inherently lower than for passenger cars because of their smaller market size. Manufacturers can increase these capacities through horizontal integration between passenger car and LCV production or through collaborations between manufacturers. Vehicle demand will also increase production scales, which can justify targeted incentive policies at early market stage. Increasing EV production also accelerates price declines and technological progress of vehicle batteries.

Strengthen co-operation among stakeholders to reduce investments risks for the manufacturing of electric light commercial vehicles

Increased co-operation between the main players in the automotive and logistics industries can grow the market and production scale for EVs. Market growth increases customer choice and large scale production reduces production costs. Closer co-operation between manufacturers and fleet managers will therefore make electric LCVs increasingly cost competitive. Public authorities and multinational customers of logistics companies could require the use of EVs to fulfil logistics contracts and so help to reduce the risk of investing into EV production.

Introduction

The market for electric vehicles (EVs) has grown considerably since the 2010s. Declining costs for vehicle batteries and comprehensive support programmes by governments have been important drivers of this. Yet uptake in the commercial vehicle sector is trailing behind that of the passenger vehicle section, despite their viable application for fleet operators.

Supported by the right policies, large scale deployment of light commercial vehicles (LCVs) can achieve economic and environmental benefits and boost the transition to electric mobility, especially in countries that currently apply higher taxation rates on fossil fuels. EVs have no tailpipe emissions, consume less energy than vehicles with internal combustion engine (ICE), and in most cases, emit less life-cycle greenhouse gases (GHGs) than comparable ICE vehicles. The decreasing costs of EVs make them increasingly competitive with ICE vehicles. Car and truck manufacturers in many countries have introduced electric models and announced deployment targets to seize increasing opportunities from EVs.[1, 2]

LCVs account for approximately 70% of all road freight vehicles and for one-fifth of this segment's energy use. LCV fleets servicing last-mile urban delivery have characteristics that make them highly suitable for electrification. The predictable daily mileage of vehicles that operate in fleets allows battery size and charger installations to be optimised. Electrification brings higher energy efficiency and lower maintenance to vehicles. The high mileage of LCVs will help them to achieve net savings once electrified and can result in lower operational costs than for ICEs.

This report analyses the opportunities for last-mile urban delivery vehicles to transition from ICE to electric powertrains. These vehicles can play an important role in the scale-up of road transport electrification, despite a number of existing challenges.

The report is structured in the following four sections:

- The current status of passenger vehicle electrification, before analysing in greater detail the light commercial vehicle (LCV) segment and its fleets used for urban delivery of goods.
- The performance of LCVs used for the urban delivery of goods with respect to costs, energy use and GHG emission performances. This comparison considers different technology options with electric and ICE powertrains.
- Current electric model availability and early cases of electric LCV fleets for urban deliveries. These demonstrate the growing interest among operators for a technology transition. This section builds on these existing experiences to identify opportunities, remaining challenges and ways to overcome them.
- Existing policies that promote the electrification of LCV fleets and those that can help overcome remaining challenges, focusing on the near-term but also touching upon long-term issues.

There are significant differences in the international classification of LCVs (UNECE, 2005, 2017). This report primarily covers vehicles with a gross vehicle mass of no more than 3.5 t that are intended for the carriage of goods.[3]

Electric vehicle in this report refers to either a battery electric vehicle (BEV) or a plug-in hybrid electric vehicle (PHEV) in the light-duty vehicle segment. It does not include hybrid electric vehicles (HEV) that cannot be plugged-in.

Market status of electric road vehicles

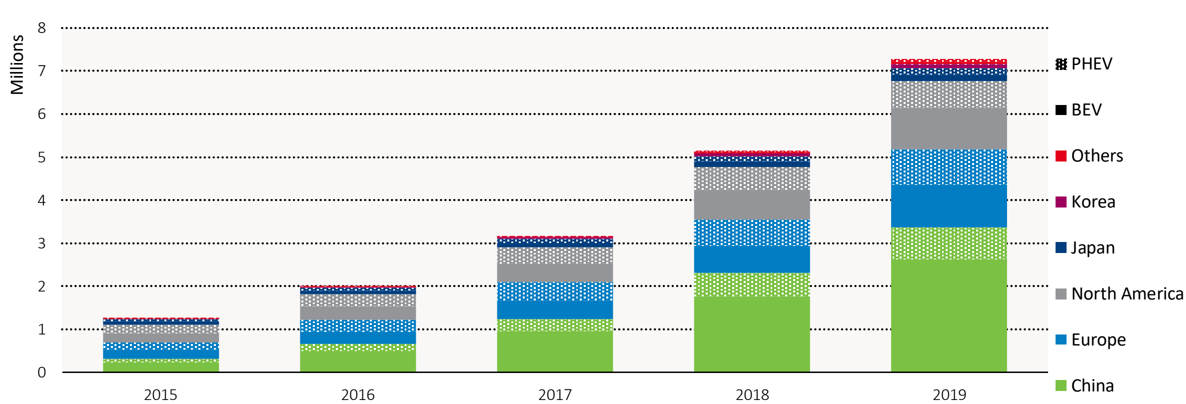
The market adoption of electric vehicles is growing globally. This is due to the overall decrease of battery costs and at the same time many governments are introducing supportive policies as EVs are recognised as the most market-ready technology to decarbonise road transport.

Electrification status of passenger road vehicles

The number of electric passenger cars on the road has increased on average by more than 50% each year in the 2015-19 period. By 2019 there were more than 7 million vehicles (IEA, 2020a). Registrations of new electric vehicles in 2019 were highest in the car markets of China (1 million), the United States (0.3 million) and Europe (0.6 million) and exceeded 2 million worldwide.

In early 2020, sales for electric passenger vehicles was more resilient to the impacts of the Covid-19 economic downturn than for internal combustion engine (ICE) vehicles. In this same time period, monthly sales of passenger cars collapsed in China (by 80%), Italy (by 85%), France (by more than 70%), Spain (almost 70%), United Kingdom (by 44%), Germany and the United States (both 38%) in a year-on-year comparison. In Europe, new registrations of electric passenger cars grew despite the collapsing car market (ITF, 2020a). In China, sales of New Energy Vehicles (NEV) contracted stronger than for all cars from January to September 2020 with an 18% decrease for NEV compared to 7% decrease for all cars, year on year. However, the market is recovering by end of this period with faster rebound for NEVs. For the month of September 2020, NEV sales had increased by 67%, compared to a 12% increases for all cars, year on year (Government of China, 2020). Economic impacts of Covid-19 have not halted the dynamic electric mobility development and stimulus packages that offer opportunities to further promote this technology.

Figure 1. Global electric passenger car stock, 2015–2019



Notes: PHEV = plug-in hybrid electric vehicle, BEV = battery-electric vehicle

Sources: IEA (2020a).

Government policies on EVs have influenced the current market size and make electric passenger cars a mass-market technology in some regions. Purchase incentives narrow the price difference between EVs and ICE cars and stimulate their sales. In the major EV markets included in Table 1, purchase incentives for BEVs are available up to USD 3 200 in China, USD 3 700 in Japan, USD 6 800 in Europe and USD 6 700 in Korea, while tax credits up to USD 7 500 per vehicle apply to EV sales in the United States (IEA, 2020a). Purchase incentives differ according to EV technologies, vehicle price, and sometimes electric range or battery energy-density. Similar incentives exist for vehicle chargers. Waivers for taxes and fees (e.g. parking fees or vehicle registration tax) are other instruments to incentivise electric passenger cars.

Table 1. Policies that support vehicle electrification in major electric vehicle markets

	European Union	China	United States
Vehicle regulations	The EU directive 2019/631 revised the existing fleet-based average fuel economy standards for 2020-30 with the aim to reduce energy use of new cars by 37.5% and by 31% for new LCVs in this period.	In 2020, China revised its fuel economy standards, aiming to reach a fleet-based average fuel economy of 4 litres of gasoline equivalent (Lge) /100 km for new vehicles by 2025. Average fuel economy is calculated using a credit system, in which EVs receive extra credits.	In 2020 the United States revised its fuel economy standards to lower ambition of annual efficiency improvements of new light duty vehicles from previously 4.7% to approximately 1.5% between 2021 and 2026.
Vehicle incentives	Several member states offer purchase incentives for electric vehicles of up to USD 6 800 per vehicle.	The New Energy Vehicle (NEV) Subsidy Programme allocates incentives to producers of EVs. Incentives depend on electric range, fuel economy and battery energy density. The highest incentive of USD 3 200 per vehicle is offered for BEVs with electric range over 400 km.	The federal government offers tax credits up to USD 7 500 per vehicle to buyers of BEVs or PHEVs. Individual states offer further incentives.
Vehicle targets	The EU aims to have 13 million zero- and low emission vehicles by 2025. Several member states have announced phase out dates for ICE vehicle sales, ranging between 2025 (Norway) and 2050 (Germany).	Aim to reach 25% market share for New Energy Vehicles (BEV, PHEV, and FCEV) by 2025.	In 2020, California issued an executive order to phase out sales of new ICE cars by 2035.
Charger incentives	Local incentives exist for private home charging and public charging, often set by local stakeholders (e.g. local government, local utility).	Local incentives exist for private home charging and public charging often set by local stakeholders (e.g. local government, local utility).	Over half of all states offer incentives to deploy charging infrastructure.
Charger targets	Member states aim for at least a 1:10 ratio of public chargers to electric vehicles under Directive 2014/94/EU. In 2019 the European Commission set the target of 1 million charging points by 2025 and announced a revision of Directive 2014/94/EU.	Aim to provide 500 000 publicly accessible chargers by 2020.	California has the largest target set of 250 000 charging points by 2025.

Source: IEA (2019; 2020a); CARB (2020); Tesla (2020); EC (2019a).

As EVs have matured technologically, several regulators have integrated support mechanisms for them into general vehicle regulations. For instance, zero-emission vehicle (ZEV) mandates actually phase out ICE vehicles. Fuel economy standards or emission performance standards also incentivise original equipment manufacturers (OEMs) to sell electric vehicles, as they generally emit less than ICE. Table 1 summarises important measures developed in the main vehicle markets of Europe, China and the United States to promote electric vehicles and their chargers. These regions have also adopted EV ambition targets for the 2025-50 period. These range from reaching a high market share for vehicle sales to arriving at agreed upon fleet size (IEA, 2020a).

Electric buses have also seen a significant deployment in the past years, with close to 100 000 units newly registered in 2018 and 2019. Recent market growth has largely concentrated in China, where 98% of today's more than 0.5 million electric buses operate (IEA, 2020a). Other markets with strong growth (despite a smaller initial base) include Europe, India and Latin America.

Key reasons for the success of electric buses includes their regular and predictable daily usage patterns through slow city traffic. This makes it possible to operate them during the day with a single charge (e.g. with a battery size of 325 kWh for a 12 m electric urban bus). Furthermore, buses have limited travel during the night when they park at central depots, which allows for overnight charging. Together with high-annual mileage, these factors offer significant benefits in terms of reduced-energy costs for bus operations. Light commercial vehicles for urban deliveries share many of the same factors that led to the success of electric buses.

Electrification status of light commercial vehicles

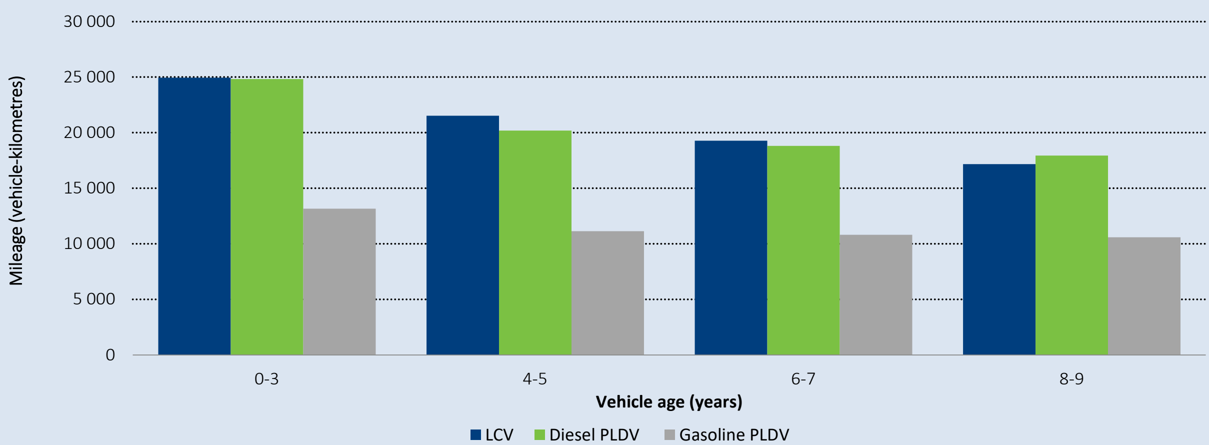
LCVs make up the majority of road freight vehicles globally. They operate in cities as postal delivery vehicles, general delivery vehicles, trade, and service vehicles of craftsperson, telecommunications companies, or utilities etc. The majority of LCVs are operated by small businesses. A survey among LCV owners in the Netherlands found that small companies with less than ten employees own almost 70% of the country's LCVs (Connekt, 2017). In the European Union more than half of companies with LCVs operate less than ten vehicles on average. Large fleet operators that operate 100 or more vehicles represent only 5% of all vehicle owners in the EU (Arval Mobilty Observatory, 2020). However, LCV fleets can still be large. For instance, UPS operates 10 000 last-mile delivery vehicles in Europe, while Amazon's global last-mile fleet reaches 30 000 units (Coppola, 2019; Gibbs 2020).

LCV mileage is greater, on average, than for passenger cars and differs across different owner groups. For example there is higher annual travel for large fleets and lower distances for smaller companies. Vehicle replacement patterns are also different, with faster rates in large companies and fleets. This means that operators of large fleets represent an important buyer group for new vehicles (Box 1).

Box 1. Usage and turnover patterns for light commercial vehicles

Light commercial vehicles (LCVs) drive many more kilometres than cars, especially in the first years of vehicle lifetime. A dip in activity follows this period of intense use of LCVs, while the mileage of privately owned cars is more stable over vehicle lifetime. Diesel cars often have a similar activity profile to LCVs in that they are the preferred technology option for high kilometre use (e.g. fleet vehicles or company cars), particularly in regions were taxes on diesel are lower than on gasoline. Figure 2 is based on data collected in vehicle inspections in Germany and compares the average mileage of cars (gasoline and diesel) with LCVs in several vehicle age cohorts.

Figure 2. Mileage by vehicle age of different light-duty vehicle types



Notes: LCV= Light-commercial vehicle; PLDV= Passenger light duty vehicles (cars)

Source: Government of Germany (2020).

The observed vehicle mileage of LCVs and diesel cars is significantly higher than for gasoline cars and their mileage drops by 14% after three years of vehicle use. At this point in vehicle lifetime, fleet operators often sell vehicles (e.g. company cars or transport vans) to the second-hand market. This means that first-owner mileage of LCVs is significantly higher than their average mileage during entire lifetime.

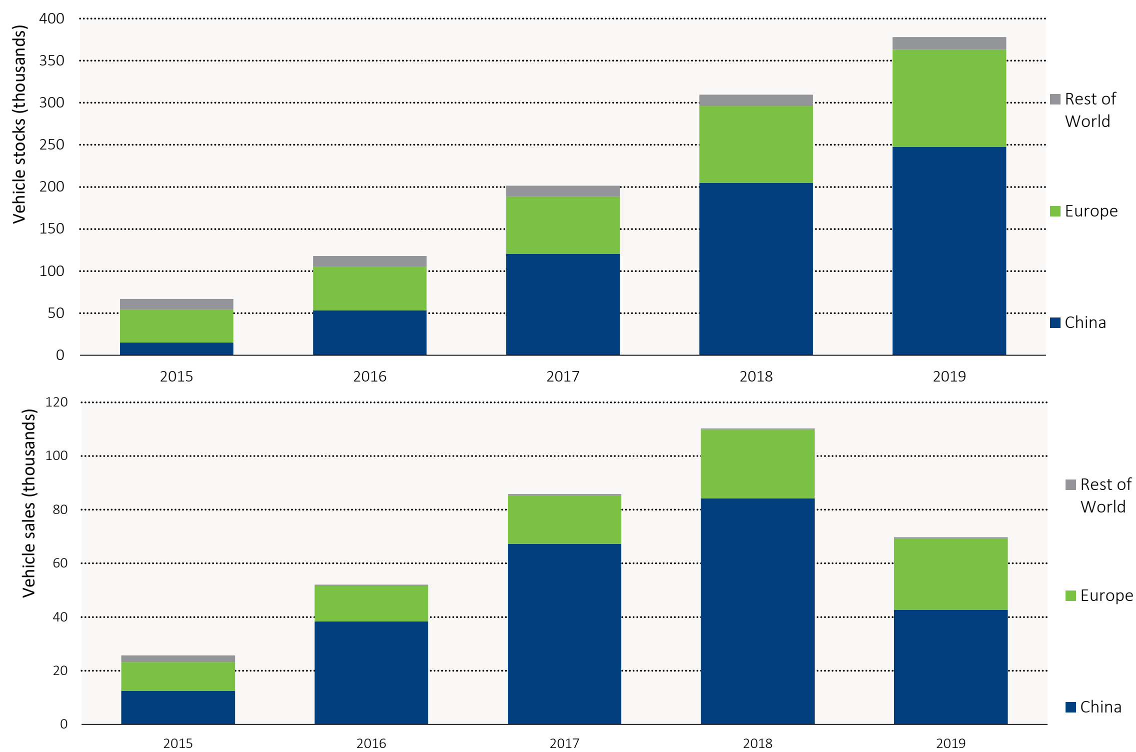
Young vehicles with high mileage typically operate with large companies, who are more likely to operate large fleets. In the Netherlands, companies with more than 100 employees report an average annual mileage of 24 000 km per vehicle and an average vehicle age of six years, compared to less than 20 000 km and about ten years in companies with no more than one employee (Connekt, 2017).

Looking at the specific user group of last-mile operators, a study on the mission profile of LCVs in German cities found that average annual mileages of last-mile delivery vehicles is about 22 000 km. This suggests that the overall average identified for all LCVs is similar to the case of LCVs used for urban deliveries. According to this assessment, the average daily mileage of urban delivery vehicles is 70-100 km, with 70 km representing most vehicles. This corresponds to nine hours of operation for six days a week. This analysis indicates that urban delivery vehicles stop 50-100 times per day. Their average payload is 875 kg. Most of these LCVs park at a central depot overnight, a feature that would enable centralised overnight charging for electric vehicles (ADAC, 2019).

Vehicle mileage not only differs by users but also across regions. At similar income levels, regions with low fuel taxation and urban sprawl tend to have higher vehicle mileages than regions where fuel taxes are high and cities dense. For instance, average lifetime mileage per year of LCVs in the United States reaches 20 000 km while it is only 9 000 km in Japan, a country with higher fuel taxation and urbanisation rates. In the European Union, average lifetime mileage per year of LCVs is 18 000 km (IEA, 2017). While these values represent all user groups of LCVs, one can expect similar regional mileage differences for last-mile operations.

In 2019, approximately 70 000 electric LCVs were sold and global stock in use counted as 380 000 vehicles, of which 65% were in China and 31% in Europe (IEA, 2020a). Sales were also concentrated in China and Europe, with China being the largest market with 61% of global sales in 2019. The technology share of electric vehicles is insignificant in the LCV segment, which is estimated at a stock size of 150 million and over 10 million sales in 2019 (IEA, 2020b).The light-duty vehicle (LDV) segment is comprised of both LCVs and passenger cars. Of all electric light-duty vehicle sales, less than 5% are LCVs, roughly half of their share when looking at all technologies.

Figure 3. Stocks and sales of electric light commercial vehicles in selected regions



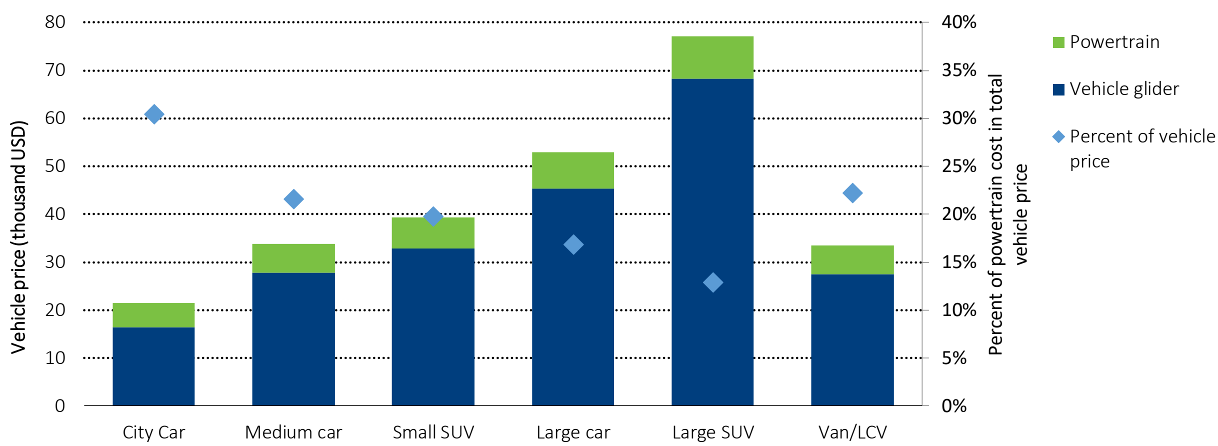
Source: IEA (2020a)

The underrepresentation of LCVs within electric LDV sales can be explained by two main factors.

First, policy instruments still have a greater focus on passenger cars concerning electrification. Incentives that policy makers have deployed to promote EVs passenger cars include purchase subsidies for vehicles, programmes to support roll-out of charging infrastructure, reductions on vehicle tax, specific road charges or parking fees for EVs, tax incentives for electric company cars, and privileged access to zero-emission zones or high-occupancy lanes.

Second, there is greater scope to attract EV customers in the premium passenger car market, which supported market growth of electric vehicles early on. The difference in vehicle prices between EVs and conventional technologies is determined by the high costs for electric powertrains and batteries. However, the share of these costs in vehicle prices is smaller in the premium segment (i.e. large cars or SUVs) than for smaller cars and LCVs (Figure 4). Vehicle models offered by a number of OEMs mirrored this, as the first electric models would often be in the premium segment. Vehicle battery costs have since declined[4] and OEMs now also offer smaller electric cars that target a broad customer group. In 2019, OEMs had 279 electric passenger car models on offer. The progression of the electric car market is evidenced by an additional 197 models announced until 2025 (IEA, 2020a). LCVs are not included in current electrification programmes to the same extent as passenger cars. The comparably high share of powertrain costs in vehicle prices, together with high costs for vehicle batteries, may have held back electrification of LCVs longer than of passenger cars.

Figure 4. Share of powertrain costs in internal combustion engine vehicle price for different vehicle segments



Notes: Vehicle glider includes all vehicle components but the power train.

Sources: ITF analysis based on IEA and ICCT (2019). Powertrain base costs derived from Miller (2020) and Fries et al. (2017). Estimates for costs of additional engine power (ca. USD 26 per kW) derived from Edwards et al. (2011).

The under-representation of electric LCVs in the global light vehicle stock and sales observed to date may change in coming years. This is due to their benefits relating to operating costs and environmental performance and mission profiles that, in case of urban deliveries, can offer important advantages to optimise battery capacity and reduce costs. This topic is discussed in the following chapter.

Costs and environmental performance of electric light commercial vehicles

Switching to electric LCVs can propose economic benefits to vehicle owners and reduce the environmental impact of fleets. Electric powertrains strongly reduce GHG emissions from fuel use and can even eliminate these when using electricity from renewable resources. The high mileage of LCVs maximises savings from the low operation costs of electric vehicles, which can turn into net-savings especially for vehicles with above-average mileage in countries with high diesel taxation. This chapter reviews the performance of urban delivery light commercial vehicles with respect to costs, energy use and GHG emission performances. It compares electric LCVs with the benchmark of the most established technology, diesel powered vehicles. To do so, it relies on two key instruments:

A life cycle assessment (LCA) – a calculation method that evaluates energy use and environmental impacts of any given vehicle. It can consider all contributions to their life cycle including manufacturing, fuel production and vehicle and fuel use. As a result, it outlines the characteristics of different LCV powertrain technologies and fuels. While LCA can account for a wide range of possible flows and impacts, this analysis focuses on energy impacts and GHG emissions, measured per vehicle kilometre (vkm).

The total cost of ownership (TCO) – a calculation method that determines the overall cost of owning and using a vehicle – for the same LCV powertrain technologies and fuels.

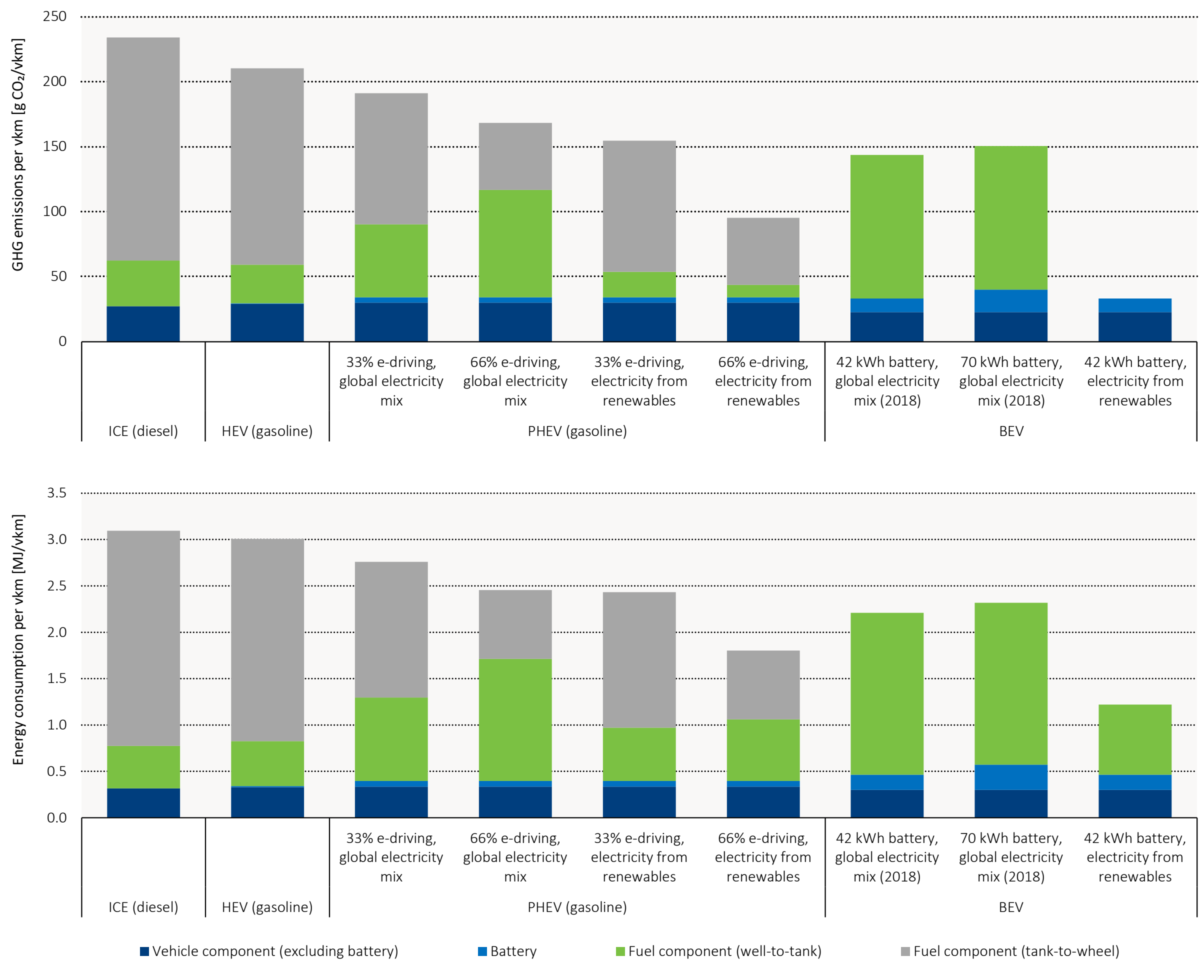
The analysis developed here includes considerations on the way LCA impacts and TCO are affected by variations in vehicle mileages, battery sizes and fuel costs. Additional considerations concern the influence of battery weight on available payloads and impacts of different market volumes on vehicle costs.

Life cycle impacts of alternative technology options for light-commercial vehicles

The life-cycle energy and GHG emissions of current (diesel powered) LCVs are heavily influenced by the fuel used. This is due to their high lifetime mileage and their reliance on fossil oil as the main form of energy used for fuel production and use. Energy requirements and emissions decline with the progressive introduction of powertrain electrification (Figure 5). An electric LCV with specifications and usage profile consistent with parameters that have been observed for urban operations[5] uses less energy and causes less GHG emissions than a diesel van, especially when it runs on low-carbon electricity. This is applicable to both PHEVs and BEVs, and maximised, for PHEVs, in cases with high fractions of all-electric driving. Energy savings of almost 70% and more than 80% for GHG emissions per lifetime vkm are possible for BEVs that have a full reliance on renewable energy as a primary resource for energy consumption.

The low energy use of electric vehicles is the most important enabler of their small energy and GHG emission impact. Results in Figure 5 consider a fuel use of 0.2 kWh/km (0.72 MJ/km) for battery electric LCVs (equivalent to about 2 litres of gasoline per 100 km). This amount is a quarter of that used by ICE-powered vehicles.[6] This energy efficiency gap may even be higher in cases (not included in the characterisation of the inputs to Figure 5) of mission profiles requiring frequent stops – indeed likely for urban delivery vehicles. This additional saving potential stems from opportunities offered by electrification to limit the sensitivity of energy use to congested traffic and the challenges faced by combustion engines to operate at high energy efficiency in the same conditions.[7]

Figure 5. Lifecycle greenhouse gas emissions and energy use of different light commercial vehicle powertrains and energy types

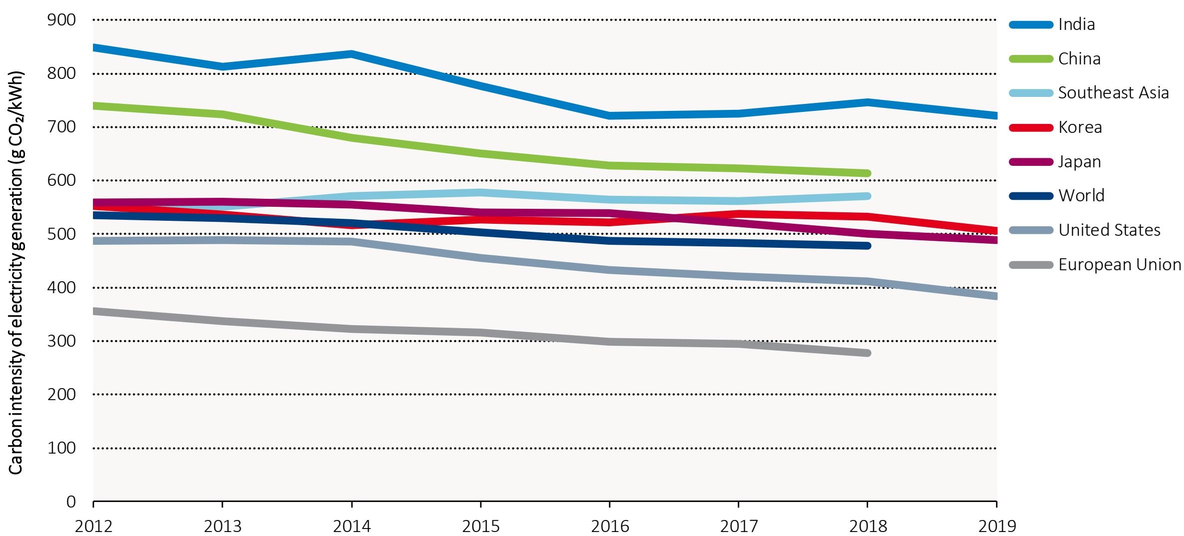


Notes: ICE = internal combustion engine vehicle; HEV = hybrid electric vehicle; PHEV = plug-in hybrid electric vehicle; BEV = battery electric vehicle.
ICEs are assumed to be powered by diesel, HEVs and PHEVs by gasoline. Vehicle assumptions: battery pack size 42 kWh for BEVs, 16 kWh for PHEVs and 3 kWh for HEVs. Battery chemistry: NMC111 for all but BEVs, which uses NMC 622 (note that this has little impacts on GHG emissions and energy use per vkm). GHG emission intensities of battery manufacturing: 75 kg CO2-eq/kWh (in line with production in North America). Annual mileage: 20 000 km. Vehicle lifetime: fifteen years. Fuel economy (WLTP values): ICE - 6.9 litres of gasoline equivalent per 100 kilometres (Lge/100 km); HEV – 6.5 Lge/100 km; BEV 0.2 kWh/km. PHEV use a combination of HEV and BEV fuel economies. The fuel economy of BEVs and PHEVs includes a 5% penalty for charging losses. Power supply CO_2 intensity in 2018: in the fuel cycle is 553 g CO2-eq/kWh (includes combustion and fugitive emission and accounts for transport, distribution and charger losses). Energy use is expressed in primary energy terms, accounting for conversion efficiencies of 29% for oil fuelled electricity plants, 50% for natural gas, 38% for coal, 33% for nuclear, 35% for biomass combustion and 100% for hydro, solar and wind.

Sources: ITF analysis, based on the application to LCVs of an assessment tool developed for ITF (2020b), relying on the GREET model of the Argonne National Laboratory.

Recently there has been a decline in carbon intensities for electricity generation in most of the major global economies (Figure 6), along with expectations of declining costs of renewable electricity and energy storage (IRENA, 2020; IEA, 2020c; BNEF, 2020; IRENA, 2019; NREL, 2020). This suggests that the lifecycle energy use and GHG emissions of electric vehicles will further decrease in the future; extending their lead over diesel-powered vans, unless the carbon content of diesel fuel can be effectively reduced. The achievement of energy efficiency improvements and GHG emission cuts can also be strengthened by voluntary actions. One example is the choice made by operators with large electric LCV fleets to use renewable electricity to charge their vehicles (Deutsche Post DHL Group, 2020a; Climate Group, 2020a; Climate Group, 2020b).

Figure 6. Carbon intensity of electricity generation



Source: IEA (2020d)

Battery manufacturing for vehicles with high annual mileage can have a low impact in terms of energy use and GHG emissions/vkm (Figure 5). This is the case even when large battery packs are needed, and/or in cases where a battery replacement is necessary to ensure that all lifetime travel (300 000 km) is completed.[8] The relative importance of energy and GHG emissions due to the vehicle component increases once electricity decarbonises. This stems from mineral mining and refining processes, battery production, and differences in the carbon intensity of virgin or recycled materials.[9] Its reduction depends on energy efficiency gains in manufacturing plants (e.g. thanks to process improvements, increases in production capacity and the rate of use of available capacities) or from the use of low-carbon electricity for processes with high-energy consumption (especially important in the case of aluminium production).

Further gains may be possible from material recycling (generally associated with lower energy and carbon intensities than virgin materials). Energy savings and emission reductions are also possible from new battery chemistries, as they enable increases in the energy content of batteries per unit weight and substitute less energy dense batteries, provided that this happens without a shift to materials requiring more energy and GHG intensive material extraction and refining processes.

PHEVs can lead to energy and GHG emissions impacts that are comparable with BEVs, but only if a high compliance with all-electric driving can be met. Recent evidence however, shows that drivers are not commonly choosing this available feature for passenger cars.[10] To be possible, it would require long-lasting battery technologies because smaller batteries are subject to a higher cycle frequency (and therefore higher durability challenges) than larger batteries. It would also require sufficient awareness, leadership and buy-in from fleet managers and users and/or policies requiring and enforcing all-electric driving in cities. Last, it would require ease of access to charging infrastructure. In addition to their potential low energy use and emission impacts, PHEVs can offer important advantages in terms of resource efficiency, given that they are less material intensive (smaller battery size) than BEVs. These outcomes will also rely heavily on drivers making use of the all-electric features when driving.[11]

The BEV results in Figure 5 show that larger battery packs (larger range and lower cycle life requirements) have higher life-cycle impacts on the energy and GHG emissions due to manufacturing. One exception being if smaller packs require a replacement. Therefore, if batteries are durable enough to not require replacement, optimizing the battery capacity to range needs can help limiting energy and GHG impacts as well as resource extraction constraints and vehicle costs.

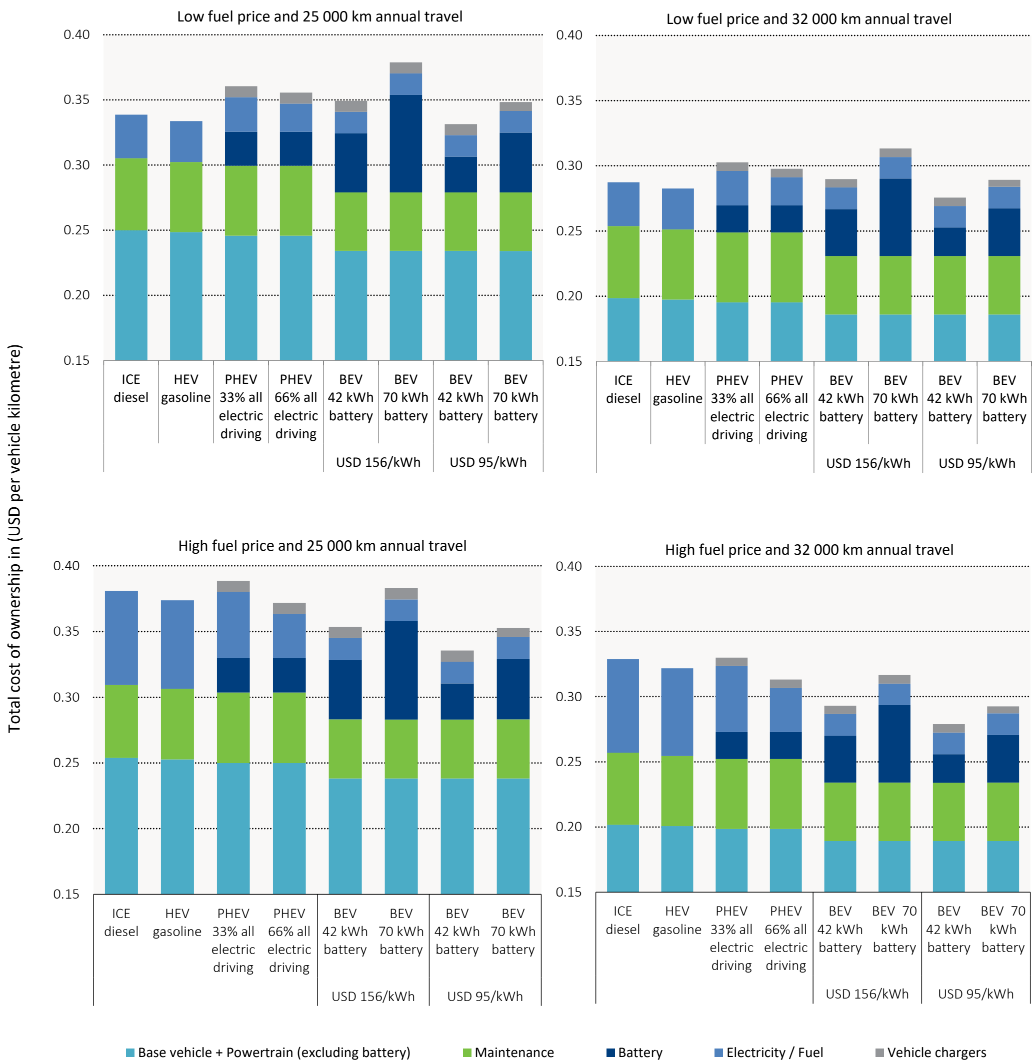
A final consideration, not illustrated in Figure 5 and applying to all powertrain and energy technologies, is that all impacts per vehicle kilometre decrease with increasing lifetime mileage (due to a decreases from the vehicle cycle, while the fuel cycle remains constant). Beyond energy and GHG emissions, it is also important to recall that vehicles driving electric in urban areas are well suited to reduce air pollutants from tailpipe emissions where they can be especially harmful due to high exposure rates.

Total cost of ownership

Vehicle electrification in the LCV segment presents opportunities to accelerate efforts to decarbonise the road transport sector, especially in cities or urban environments. However, the high upfront costs of electric vehicles can hold back operators' purchase decisions. Electric vehicles play out their cost advantage only during operation, when the lower costs for fuel and maintenance make them cheaper to operate than conventional LCVs. These savings often outweigh higher vehicle prices over the time a vehicle remains in the fleet. The amount of savings is case specific, with strongest impact from vehicle costs, annual mileage and fuel prices.

A total cost of ownership (TCO) analysis provides comparative, case-specific information on the cost of alternative vehicle options per vkm. This calculation method determines the overall cost of owning and using a vehicle across its useful life, in a single indicator, in essence the cost borne by the vehicle owner per vkm. Key parameters included in the TCO assessment for this study include purchase price, vehicle depreciation – and therefore residual value of the vehicle once it is sold, fuel costs use, maintenance and insurance costs. The TCO calculation also takes into account interest rates that discount future expenditures and it is well suited to integrate costs due to new energy distribution infrastructures, where they are relevant. Other studies may also choose to include vehicle taxes (e.g. circulation and/or registration), licensing and tolls. The TCO approach considers that carriers/operators do not usually keep their vans over an entire lifetime. It is able to detect this by accounting for depreciation and to factor in residual reselling values of vehicles. By addressing this, the TCO assessment highlights what benefits are tangible for the first owner of a vehicle.

Figure 7. Total cost of ownership for first owners of light commercial vehicles with different powertrains and fuels, including effects of annual travel and fossil fuel price changes



Notes: ICE = internal combustion engine vehicle; HEV = hybrid electric vehicle; PHEV = plug-in hybrid electric vehicle; BEV = battery electric vehicle.

Fuel economies are the same as for Figure 6. Engine, exhaust after treatment costs and fuel tanks costs are assumed to be USD 50/kW for ICE diesel and USD 44/kW for gasoline hybrids. Costs for electric motors and inverters are USD 27/kW. These values are informed by Edwards et al. (2011) and aim to reflect cases with strict (Euro 6) pollutant emission standards. All LCVs are assumed to have a power rating of 100 kW. All-electric power for PHEVs is set at 60 kW. HEV electric motors at 42 kW. ICEs for HEV and PHEV at 80 kW. Low fuel costs correspond to USD 0.7/litre of gasoline equivalent (Lge). High fuel cost to USD 1.5/Lge. Electricity prices are set at USD 0.12/kWh. PHEV battery costs per kWh are 50% larger than the USD 156/kWh used for BEV battery costs – consistent with the values discussed in IEA (2019) and reported by Bloomberg NEF (2019); HEV battery cost per kWh are 70% larger. This is consistent with the considerations discussed in IEA, (2018a). Battery capacities are 3 kWh for hybrids and 16 kWh for PHEVs. The LCV first owner lifetime is set at 5.5 years. Depreciation rates decline from 22% to 11% a year from year 1 to year 5 and are set uniformly for all powertrains. Maintenance costs are set at USD 0.065/km for BEVs and USD 0.08/km for PHEVs, HEVs and ICE vehicles (Bernd, Redelbach, Santini, & Friedrich, 2012). Electric LCVs are fully reliant on a single private slow charger (up to 22 kW) per vehicle, installed at vehicle depots, with a lifetime of 15 years. Charger costs are set at USD 1 100 for the charger and USD 500 for its installation, complemented by USD 250 of annual charges. The discount rate is 10%.

Figure 7 compares the TCO of diesel ICE, hybrid, plug-in hybrid and battery electric LCVs. Results are based on a technical assessment of LCV purchase prices reflecting powertrain cost differentials once they are all deployed on a large scale, comparable to what is currently observed for passenger cars. The analysis excludes purchase subsidies. Figure 7 is therefore focused on a context where policy support has been successful in bringing upfront vehicle purchase costs down from an initial condition where the market volume for electric LCVs are still small. This clarification is important, since differences in market volumes are one of the elements that explains why current selling prices are higher than is the focus of this analysis. For instance, the sticker prices for the electric LCV models Mercedes e-Sprinter and VW e-Crafter (Table 1) are about 80% higher than their conventional versions with diesel powertrain.

Figure 7 does not consider economic penalties due to lower range and payload of electric LCV compared to ICE models. The choice related with range is due to a focus on vehicles that have mission profiles allowing for daily recharges, thanks to urban operations (which limit daily ranges, due to time and speed constraints). The choice on payloads is based on the consideration that, while battery weight penalty can reduce payload of electric LCV by over 500 kg compared to ICE Models, OEMs already produce electric vehicle with increased gross vehicle weight to compensate for this. Further, regulators in some countries have lifted the vehicle weight limit for standard driving licenses (applicable for electric vehicles only) (Box 4) (Tsakalidis, et al., 2020).[12]

The results shown in Figure 7 also focus on first-owner economics and the first 5.5 years of ownership. This amount of time is compatible with vehicle replacement practices in use by fleet managers today. For this reason, annual travel is assumed larger than the average across the whole LCV life considered in the LCA results presented in Figure 6. The 42 kWh battery capacity for BEVs shown in Figure 7 allows for an all-electric range of 175 km (accounting for a 20% buffer to ensure better durability). This range covers the typical daily driving distance of urban delivery vehicles, but may be tight (due to variability in daily travel needs) for cases characterised by 32 000 km of annual travel. Similar to Figure 6, Figure 7 also includes an assessment of an LCV that uses a 70 kWh battery. Electric LCV models currently available (see Table 3) have battery capacities that are in this range.[13]

Electric LCVs produced at scale can have a competitive TCO, already at today's battery costs per kWh, if compared with ICE diesel versions. This occurs across a wide variety of cases. Figure 7 shows that a reduction in battery costs would strengthen this finding and:

- With current battery costs, plug-in hybrid and battery electric LCVs produced at scale do not yet have comparable TCOs with ICE and hybrid LCVs at low fuel prices (0.7 USD/Lge).
- BEVs and PHEVs can have a lower TCO than hybrids and ICE LCVs if fuels are priced at USD 1.5/Lge.
- PHEVs with high shares of all-electric driving and BEVs using smaller battery packs are the cases that have the best cost competitiveness with ICE diesel and HEVs. Yet, their use in missions with high daily travel is subject to greater challenges, due to greater range limitations for BEVs and all-electric driving constraints for PHEVs.
- The cost competitiveness of PHEVs and BEVs is better at higher annual travel distances.
- Battery cost reductions enable BEVs to become cost competitive with ICE diesel vehicle and HEVs also at lower fuel costs, if paired with smaller battery packs.

Figure 7 excludes revenues that could be available from the provision of grid services. An example are solutions that ease issues faced by the electricity grid, such as variations of electricity demand and its rate of change across different times of the day and constraints in power capacity at the local level. Further, Figure 7 does not take into account variations in the electricity price. This is set at USD 0.12/kWh, but could be higher or lower, depending on the region, the time of the day and the conditions offered by utilities and charging service providers. Operators that charge at night may benefit from low off-peak electricity rates.[14]

PHEVs emerge as an interesting option, with advantages for energy efficiency, resource efficiency and resilience, but they need to be highly reliant on electricity to be cost competitive.

Ensuring that batteries are durable and sized correctly for the intended application are important requirements for plug-in LCVs, since a battery replacement during the vehicle life adds significant costs. Battery durability issues are unlikely to be a major hurdle for fleet owners operating new vehicles only for a few years (5.5 years in the calculations shown). Some degree of battery degradation is also compatible with lower average travel for vehicles purchased in the second-hand market, and therefore not associated, in this analysis, to accelerated depreciation.

Nevertheless, poor durability may indeed lead to faster depreciation, with negative implications for the economic competitiveness of electric models. On the other hand, local policies restricting access to vehicles that cannot travel in zero-emission mode in cities may help slowing down the EV depreciation rate, in comparison with other powertrain technologies. This could have important positive implications for the cost competitiveness of EVs.

Charger costs shown in Figure 7 focus entirely on depot charging, with relatively low barriers for the installation of one charger per vehicle (e.g. a wallbox). This is compatible with fleets that charge overnight (using for instance level 2 AC chargers with no more than 22 kW charging capacity per charger) after each day of operation, to ensure that their batteries store sufficient energy to cover their daily travel needs. The cost per charger is assumed to total up to USD 1 600 (hardware and installation) for 15 years of useful life and USD 250/year of annual charges. The assumption of 15 years lifetime for a charger is longer than the 5.5 years assumption of vehicle use by first owners and relies on older EVs being replaced by new EVs. In these conditions, charging infrastructure costs are less than USD 0.01 per km.

These costs do not consider technologies that enable use of vehicle-to-grid, given that fleet managers can already save costs from simpler types of participating in the power market, for instance demand management solutions like delayed charging. This excludes any infrastructure costs before the metre, which are typically borne by the network operator and are shared across many electricity end-uses.

Charger installation costs depend on the specific circumstances. In particular, LCVs requiring on-street charging may need more expensive publicly available (and possibly higher power) chargers. In such a case, ensuring that charger costs remain comparable with the results in Figure 7 requires high occupancy factors. Conversely, the high utilisation rate of depot-based chargers and independence from more expensive (public) fast chargers can keep charging costs low. Using slow chargers with comparably small capacity also avoids high costs from demand charges, which are calculated based on peak-demand events from users (e.g. the 15-minute interval of a given month in which electricity use was highest).

In conclusion, LCVs emerge as a market segment where electrification can be cost-competitive. Two important precursors are fossil fuels being subjected to higher taxation and the market scaling up for new electric versions. This is particularly relevant for these vehicles used in urban delivery fleets. Depending on the vehicle user type, penalties due to reduced payloads of electric vehicles can be a market barrier. However, policies to lift the vehicle weight restrictions of basic driving licenses can address this. Avoiding excess battery capacity can also reduce battery costs per vkm.

Prioritising high-mileage vehicles for electrification clearly comes with net benefits to reduce demand for fossil fuels, diversifying the transport energy mix and reducing GHG emissions. Future declines of battery pack prices (a likelihood with the current surge in battery production) can further enhance the economic benefits already available, making electric vehicles a competitive option for users with lower annual travel and in countries where fuel taxes are lower. These cost declines may also increase the battery capacity at which the TCO of electric powertrains break even with combustion engines, thus making electric vehicles with larger batteries a competitive option for users that need to cover higher daily distances in all-electric driving mode.

Lessons from electrification projects for light commercial vehicles

There is growing interest in a transition towards the electrification of LCVs, especially in cities. Electrification projects that have shown energy, environmental and economic advantages can stimulate the electrification of urban delivery vehicles. This chapter reviews some of these projects, building on insights related to the life-cycle energy and GHG emissions of electrified and fully-electric LCVs and their cost. It presents what models are available today, examines forward-looking, existing projects for insight into future market developments for electric LCVs and explores opportunities and remaining challenges.

Model availability and options are increasing

Overall, the market offer for electric LCVs is limited; the amount of models on offer for electric LCVs is still trailing that of passenger cars. One possible reason for this is that the initial offer of EVs focused first on the most remunerative market segments, where powertrain costs have a relatively small importance for the formation of the vehicle price. Table 2 includes a list of electric LCVs that are commercially available today, focusing on vans. The limited diversity of models in Table 2 is also consistent with considerations brought forward in Chapter 2, acknowledging that the TCO results where electric LCVs are cost competitive require production at a large scale.

Table 2 also shows that OEMs are starting to offer vehicles with different configurations in terms of battery capacity, with a range varying between 31-79 kWh and therefore larger versions with a range that exceeds the typical daily requirements for urban deliveries.

Table 2. Commercially available electric vans

Model name	Battery capacity (kWh)	Electric range (km)	Gross vehicle mass (kg)	Payload (kg)	Load volume (m^3)
BAIC Weiwang 407 EV	43.5	190	2 410	880	4.5
BYD T3	48	215	2 420	810	3.5
Changsha Sunda 4.5m Battery Electric Logistics Van	49	290	2 495	840	-
Chery Karry YOYO	40	220	2 000	990	-
DaeChang Motors DANIGO VAN	42	250	1 930	500	3.5
Dongfeng Fengon Xiaokang EC36	41	260	-	-	-
FAW JIABAO V80LEV	40	315	2 350	730	4.9
Fiat E-Ducato	47 79	129 to 146 210 to 238	3 500	985 to 1 160 690 to 845	10 to 17
Ford Transit Custom PHEV	14	50	3 500	1 000	6
Iveco Blue Power Electric	56	130	3 500	-	7.3 to 19.6

Model name	Battery capacity (kWh)	Electric range (km)	Gross vehicle mass (kg)	Payload (kg)	Load volume (m^3)
	84	200			
Joylong EW5	74	280	-	1 650	9.6
LEVC VN5	31	98	2 900	830	5.5
Mahindra e Supro	14	115	1 920	600	2
Mercedes eSprinter	35 47	119 157	3 500	1 045 891	11
Mercedes eVito	35	150	3 300	1 030	6
Nissan e-NV200	40	200	2 220	705	4.2
PEUGOT e-Partner L1	22.5	150	2 180	1 000	4.4
PEUGEOT e-Boxer/ Citroën ë-Jumper	37 70	200 340	-	Up to 1 890	8-17
Renault Kangoo Z.E.	33	230	2 180	557	3.5
Renault Master Z.E.	33	185	3 500	1 413	11.7
SAIC EV80 Maxus	56	200	3 500	995	10.2
Sokon Richi EC35	41	200	2 510	840	4.8
Streetscooter Box Work L	40	160	2 600	905	8
Toyota Proace Electric/ Citroën ë-Jumpy/ Peugeot e-Expert/ Opel Vivaro-e	50 75	230 330	- -	1 000 1 275	4.6
VW e-crafter/ MAN eTGE	35.8	150	3 500	970	10.7
VW e-Transporter	37.3	138	3 200	1 100	6.7

Notes: This table focuses on N1 class vehicles and provides examples of available models. Chinese manufacturers offer the largest range of models, a compressive list (including passenger cars) is available from wattEV2buy (2020i). The IVECO Blue Power Electric is offered in larger sizes up to 5 tons GVW. The Fiat E-Ducato model is offered in a larger version with 4250 kg GVW with 47 kWh and 79 kWh battery configuration, which increases the payload by over 700 kg compared to the version included in the table. The Toyota Proace Electric and three electric models of the PSA Group (Citroën ë-Jumpy, Peugeot e-Expert and Opel Vivaro-e) have the same specifications and come to market in late 2020. The PSA Group announced the PEUGEOT e-Boxer and Citroën ë-Jumper for late 2020, both have identical specifications (Schaal, 2020a; Schaal, 2020b). VW e-crafter and MAN eTGE have identical specifications. LEVC VN5 will start production in 2021 and has a gasoline powered range extender, which extends range to 482 km (LEVC, 2020). Ford Transit Custom PHEV is a PHEV. Listed electric driving ranges represent values according to the Worldwide harmonized Light vehicles Test Procedure (WLTP), either as provided by literature or converted from New European Driving Cycle (NEDC) values with a 0.86 pure electric range ratio, as suggested by Tsiakmakis et al. (2017).

Sources: Nissan (2020); Daimler (2020a); Mercedes Benz (2020a); Volkswagen Nutzfahrzeuge (2019; 2020); Groupe Renault (2020a; 2020b); Chanje (2020); Fiat (2020a; 2020b); Streetscooter (2019); SAIC (2020); Greis (2019); Changsha Sunda (2020); LEVC (2020), IVECO (2020a; 2020b); Toyota (2020); Mahindra (2020); wattEV2buy (2020a; 2020b; 2020c); wattEV2buy (2020d; 2020e; 2020f); wattEV2buy (2020g; 2020h); EFAHRER (2019); Ford (2020a); Peugot (2019); Mitsubishi (2011); Danigo (2020).

As the offer for electric passenger cars is extending into a broader range of market segments – including small city cars and SUVs (IEA, 2020a) – the model availability for electric LCVs is also starting to gain momentum. Currently available electric LCV models are BEVs, with few exceptions.

LCVs share several components with cars (including batteries) and many of the cost reductions from the growth of the electric car market can be applied to LCVs. In turn, improvements in battery density and lower costs will help widen the spectrum of use cases enabling electric LCV users to find net benefits in a shift to PHEVs and/or BEVs, encouraging OEMs to diversify their electric LCV offer.

Several OEMs have recently announced plans for the next two years:

- Ford announced that it will launch an electric version of its Transit model in 2022 (Ford, 2020b)
- General Motors is reported to plan a launch of electric LCV model(s) in 2021 (O'Kane, 2020)
- The start-ups Rivian and Arrival are expected to deliver their first large EV van orders in 2021 and 2020, respectively. Rivian has 100 000 confirmed orders from Amazon while Arrival will deliver 10 000 vans to UPS (Arrival, 2020; Lambert, 2020).

At the time of writing, the specifications of these vehicles were yet to be released. Nevertheless, the focus on delivery vans in these announcements indicates that incumbent LCV manufacturers and new market entrants have indeed identified commercial vehicles used for urban deliveries as a market that bears good potential for an increase in EV demand for commercial vehicles.

Early adopters

Early adopters of electric LCVs include logistics companies and major groups that rely on logistic service providers for the distribution of their products. Table 3 lists examples for existing electric LCV fleets. It focuses on fleets deployed for last-mile delivery that charge at central depots, primarily at night outside of operation hours.

The French postal service operator, La Poste, was one of the first that placed a large order of 10 000 vehicles as part of a government-supported initiative to promote EVs (Post&Parcel, 2011). The vehicle model is Renault Kangoo Z.E.. It has a gross vehicle mass just over 2 t and was available as early as 2011. Table 3 lists this case and others including Deutsche Post DHL, another early adopter that, when faced with limited market offer, started with 150 electric LCVs produced by its subsidiary Streetscooter in 2014 and currently has 10 000 in operation (Deutsche Post DHL Group, 2020a). Recent projects include large operators that have turned to incumbent OEMs, such as Amazon for its order of 1 800 electric LCVs from Mercedes Benz, following the acquisition of ten electric LCVs from Mercedes Benz for a Munich depot in early 2020, together with 40 vehicles from Streetscooter (Daimler, 2020b; Amazon, 2020a; Deutsche Post DHL Group, 2020b)

Of the operators listed in Table 3, Deutsche Post DHL, Austrian Post, Swiss Post and Ingka Group are members of the EV100 campaign of the Climate Group (Climate Group, 2020b). Under this initiative, they have pledged to electrify their last-mile operations by 2030 the latest.

Table 3. Selected examples of vehicle electrification projects by large market players in logistics

Implementer	Details
Amazon	In 2019 announced to purchase 100 000 electric vans from Rivian. Vehicle delivery will start in 2021, reach 10 000 in 2022 and complete in 2030. In 2020 announced purchase of 1 200 eSprinter and 600 eVito electric vans from Mercedes Benz for operation in Europe. Vehicles delivery will start in 2020. By time of announcement, Amazon already operates 10 eSprinter in Munich, Germany. By 2020, 150 electric vans operate with delivery partners operating for Amazon at a depot in Essen, Germany. This depot also is equipped with 340 vehicle chargers.
Austrian Post	In 2019, the Austrian operator acquired 249 electric LCV (Renault Kangoo Z.E.), increasing its number of electric vehicles to 972 (including scooters and cars, excluding bikes).
Chinese operators	China today is the largest market for electric LCVs. Several logistics and e-commerce companies are part of the transition and have electrified their delivery fleets, which typically include both two-wheelers and LCVs. For instance, JD Logistics has pledged to electrify its fleet by 2020 and vehicles of its delivery partners by 2022. The company had reached this goal for its Beijing operations already by 2017 and already converted 5 000 vehicles in its fleet to electric vehicles. Suning Logistics will electrify operations in 100 Chinese cities and operate 5 000 electric vehicles. SF Express by end of 2018 aimed at operating almost 10 000 electric vehicles in over 30 Chinese cities. China Post has pledged to only introduce electric vehicles to its delivery fleet from 2020 onwards.
Deutsche Post DHL	By 2020 the German operator Deutsche Post DLH Group deploys 10 000 electric LCVs from 700 depots in Germany, equipped with 13 500 chargers for overnight charging. The group's subsidiary Streetscooter produced these vehicles. In 2020, the group announced to cease production at Streetscooter and to only continue maintenance of existing vehicles. In 2019, the group had looked for a buyer for its subsidiary, citing its high losses and that owning a vehicle manufacturer was incompatible with its long-term strategy.
FedEx	In 2018 announced it would take 1 000 electric trucks (from Chinese OEM Chanje) into operation and in 2020 started to equip 42 California sites with chargers.
Ingka Group	Ingka Group is the franchisee of IKEA stores in 30 countries and by 2025 will only use electric vehicles for its last-mile delivery. External logistics partners operate the approximately 10 000 vehicles (including ICE vehicles) used today. In 2019, Shanghai operations were the first to reach full electrification (and later Guangzhou and Tianjin) with logistics partner DST. This logistics provider specialises in electric vehicles and operates large vans (SAIC MAXUS EV80, Nanjing IVECO EV 42) as well as small trucks (SAIC Yuejin, Geely Yuancheng E200). In 2020, prototype testing of custom-built box-body trucks from MAN and Renault took place in Berlin and Paris. These vehicles have a loading capacity of 20 m^3 and according to Ingka Group are more suitable to transport furniture than the current regular model offer by OEMs.
Le Groupe La Poste	By 2019 La Poste operated 7 280 electric LCVs, most of these Renaults Kangoo. These vehicles charge overnight at depots. In 2019, 400 electric LCV (Nissan E NV200) make up almost all of Chronopost's Paris fleet alongside 40 natural gas vehicles. DPD UK, a subsidiary of La Poste, operates 450 electric LCV (Nissan E NV200) and aimed to increase fleet size to 500 during 2020, representing a 10% share of all vehicles. DPD will reach green delivery in 250 European cities by 2025, deploying 7 000 low-emission vehicles (including cargo bikes, natural gas vehicles and electric vans).
Swiss Post	By 2020, the Swiss operator deploys 30 electric LCVs and aims to increase the fleet size up to 400 vehicles by 2023. Swiss Post also operates 6 000 electric three-wheelers and retired its last gasoline scooter in 2017.
UPS	In 2020 confirmed orders for 10 000 electric vans from Arrival with the option for another 10 000. Vehicles will start operation between 2020 and 2024 in Europe and North America. In 2018 installed a charging management system at a depot to support the electrification of its entire London fleet. This system avoids requirements to reinforce the distribution grid for increasing the number of electric vehicles to 170 from then 52 (retrofitted diesel vehicles).

Notes: The Chanje truck of FedEx exceed a GVW of 3.5 t, the threshold of UN vehicle classification N1. Table 3 provides examples of electric LCV fleets used in last-mile delivery of postal operators. This excludes electric LCV fleets in other sectors as well as large commercial car fleets. For instance, the EV100 campaign of Climate Group reports that its members by 2020 deploy over 12 000 electric EVs (Climate Group, 2020b).

Sources: Amazon (2020b; 2020a); Lambert (2020); Hodgson (2018); Government of UK (2018); Gibory (2019); Manthey (2019); Le Groupe la Poste (2019); DPD Group (2020a; 2020b); Deutsche Post DHL Group (2020a); Schaal (2020c); FedEx (2018); Hampel (2020); Die Post (2020a; 2020b); Österreichische Post AG (2020a; 2020b);Climate Group (2020a), DST (2020), Ingka Group (2020a; 2020b); Fehrenbacher (2020); Fenglianyun (2019); CGTN (2019).

In addition to these large-scale adoption and early deployment cases, a number of smaller scale electrification programmes are helping companies to start gaining experience of the switch to e-mobility. A recent UPS project with Tevva has interesting features. It retrofits conventional vehicles with a battery electric powertrain and range extenders. Vehicles then rely on geofencing technology to automatically switch to fully electric mode when reaching a predetermined boundary, such as entering a clean air zone (Government of UK, 2017; Tevva, 2019; UPS, 2019).

Box 2. Electrifying small electric vehicles in last-mile operations

In 2018 Korea Post announced the arrival of 10 000 small electric cars in its fleet to replace ICE motorbikes. These vehicles have a lower TCO than motorbikes and their larger capacity makes it possible to deliver more in a single trip, reducing both driving distances and time spent per delivery zone (ITF, 2020c). Swiss Post has replaced its entire motorbike fleet with electric three-wheelers as of 2016. This fleet is 6 000 units strong and vehicle have a payload up to 270 kg (Swiss Post, 2020). Japan Post has started trials with electric motorbikes (Honda, 2017). This operator also deploys 1 200 small electric vehicles in Tokyo metropolitan area (Japan Post Group, 2019). Amazon has started to roll out electric rickshaws (three-wheelers) for its last-mile delivery in India and aims to operate 10 000 locally produced electric vehicles (including three-wheelers and four-wheelers) in the country by 2025 (Amazon, 2020c). Indian e-commerce company Flipkart pledged to fully electrify its delivery fleet by 2030 under the EV100 campaign of the Climate Group (Flipkart, 2020). In China, logistics operators commonly deploy small vehicles for urban deliveries, and several operators have pledged to electrify fleets (see Table 3).

In Europe, postal operators have introduced electrified cargo-bikes in city centres. Some of these operate from small, distributed depots that are shared between different operators. These include Post NL, which is part of a collaboration to make last-mile delivery emission-free in 30-40 Dutch cities as well as the operators DHL, UPS, Hermes, DPD and GLS in a pilot project in Berlin (DPD Group, 2019; PostNL, 2019). Partners of the Berlin project report that operating cargo bikes can be just as efficient as LCVs in areas with small distances between delivery points. Whether cargo bikes (payload up to 125 kg, in case of DHL) are suitable on a given route also depends on the typical number, volume, and weight of parcels (Deutsche Post DHL Group, 2017). For instance, a van may be more appropriate on routes with many commercial clients that receive many and large parcels.

Besides avoiding ICE emissions, a key advantage of small electric vehicles is that they are not only more resilient to congestion compared to LCVs, but can also prevent increasing traffic from delivery vehicles themselves. These vehicles use less curb space than vans and may be able to navigate urban traffic faster. Replacing gasoline motorbikes with electric ones requires little more operational adjustment than planning for overnight charging of batteries. Systemic transitions, such as from LCVs to electrified bikes operating from distributed depots, require more operational adjustments that may be not feasible in all cases.

The electrification programmes of light vehicles used for freight transport is not limited to LCVs. Several companies have already rolled out small electric vehicles, including electrified bicycles, electric two- and three-wheelers, as well as small electric cars. The size and speed of these vehicles make them mostly suitable to operate in cities. Box 2 discusses examples, looking at experiences recently developed in Europe, India, Japan and Korea on this topic.

Main motivations for early adopters

Reduced environmental impacts drive motivation to electrify fleets. For instance, Amazon presents its fleet acquisition of electric vehicles to be part of its *The Climate Pledge* initiative, under which the company aims to reach net-zero carbon for its shipments by 2040 and a 50% reduction by 2030 (Amazon, 2020d). Similarly, the EV100 campaign of Climate Group, endorsed by nearly 90 global companies, including four of the operators listed in Table 3, emphasises opportunities to cut GHG emissions and to curb local air pollution through accelerating the transition to electric vehicles. In a survey among its members, alleviating impacts of climate change was found to be the strongest driver for fleet electrification, followed by reducing air pollution on the second place (Climate Group, 2020b).

Box 3. Assisting fleet managers to make technology choices

Important reasons for fleet operators to deploy electric vehicles include their potential to save costs and to reduce environmental impacts. The extent to which electric vehicles can achieve benefits is context specific and depends for instance on vehicle mileage, energy prices and carbon intensity of fuels. Tailored information on the performance of alternative technologies can assist the technology choices of individual fleet operators.

One example for this is the online TCO calculator of Californian utility Pacific Gas and Electric (PG&E). This tool lets fleet operators calculate potential fuel cost savings of electric vehicles based on their specific vehicle type, fleet size, driving profile, type of chargers and typical charging times. PG&E also provides information on emission savings from switching from petroleum fuels to electricity (PG&E, 2020). Another online tool is the eCost Calculator from Mercedes Benz that lets interested buyers compare operation costs of their current vehicles with those of Mercedes' electric vans (Mercedes-Benz, 2020b).

Worldwide harmonised Light vehicles Test Procedure (WLTP) results on vehicle performance do not reflect well-to-tank emissions of fuel production. These upstream emissions are especially relevant for electric vehicles, as the carbon footprint of electricity depends on the power mix. The Total Emissions of Ownership (TEO) concept, developed by the Smart Freight Centre, addresses this information gap of existing vehicle testing cycles through encouraging fleet operators to consider well-to-tank emissions in their technology choices. This approach accounts for differences in energy efficiency across different technologies, and also encourages changes in emission intensity of electricity, acknowledging that the performance of existing electric vehicles will improve if the power sector decarbonises (Smart Freight Centre, 2020). To reflect entirely life-cycle impacts of powertrain technology shifts, the TEO needs to be complemented by an assessment of the emissions imputable to vehicle manufacturing (including batteries).

EVs are attractive for corporate social responsibility goals, as they reduce environmental impacts of fleets. Another motivation are the opportunities for TCO reductions from electrification. While existing operators usually do not release information on the cost structure of their electric fleets, expectations for cost savings are confirmed by important players like the Ingka Group. This operator emphasises that, while reducing externalities are an important driver for its electrification programme, a switch to EVs would not be viable if EVs were not cost competitive (Ingka Group, 2020a). Large recent orders (e.g. from Amazon and UPS) demonstrate that fleet managers are indeed expecting cost savings from electric vehicles. There are a number of tools and concepts available that assist fleet managers to explore which vehicle technologies offers benefits, some of which are listed in Box 3.

The arrival of policies regulating vehicle access to city centres or applying pricing schemes with differentiated conditions for electric vehicles, along with pledges to set up zero-emission zones are also driving motivation to electrify. The implementation of these often includes bans for diesel vehicles in part of the metropolitan area and all vehicles with internal combustion engines at a later stage. Key examples are given by cities that have joined the C40 Green and Healthy Streets Declaration pledge to set up zero-emission zones by 2030 in their metropolitan areas (C40, 2020).

Overcoming remaining challenges for electrification of light commercial vehicles

Increase model availability and production scales of electric light commercial vehicles

The limited model availability for electric commercial vehicles remains a limiting factor for electrification programmes. In a survey among EV100 members, respondents identify limited model availability as the largest barrier to their electrification plans (Climate Group, 2020b). In Europe, a group of freight fleet operators including Nestle, Unilever and ABInBev petitioned the European Commission to introduce binding sales targets for zero-emission vans and regional trucks to address the limited vehicle supply in the European market (Transport & Environment, 2019).

The availability of electric vehicle models is increasing, but it is occurring at a different pace across different freight vehicle segments. Lighter vehicles such as those listed in Table 2 are subject to the most dynamic developments in terms of EV model availability growth, yet operators that need larger vehicles still face a model shortage at regular vehicle markets and may need to opt for customised vehicles, including retrofitted diesel trucks. Due to high costs for ad-hoc solutions that are not mass marketed, these options are inherently associated with high upfront costs.[15]

Reaching vehicle production levels sufficient to deliver large economies of scale remains a challenge at the current market stage. This hinders the potential of commercial vehicles, including LCVs in urban delivery, to electrify faster than other vehicle segments. The challenges posed by scale are well represented by the sticker price of electric LCVs available on the market today, which are still well above the estimates – reflecting large scale production volumes – discussed in Chapter 2.

Scaling up deployment where electric LCVs face least technological limitations, such as in last-mile delivery, and compete best with diesel vehicles on TCOs, can accelerate electrification efforts in the broader commercial vehicles sector. Collaboration between large fleet operators and OEMs can drive model development and scale-up of production, and ultimately help to make electric LCVs more cost competitive. This is because increasing market demand and direct involvement from large fleet operators can be an important driver for model development and it is consistent with the need to ensure large scale deployment to enable cost reductions. In this context, it is worth flagging that Amazon and UPS actually invested in their designated suppliers, Rivian and Arrival (Arrival, 2020; Hawkins 2019).[16] A closer co-operation between OEMs and large fleet managers can therefore be instrumental to help make EVs an increasingly cost competitive technology, which eventually benefits all user groups. For instance operators with smaller fleets (e.g. dozens, not hundreds of vehicles) or lower mileage, who currently face higher TCOs for EVs than for diesel vans.

OEMs already partner to share components across brands to reduce production costs. Production lines of LCVs are usually smaller than for passenger cars because of their smaller market and so benefit from this arrangement. For instance, the models Citroën Jumper, Fiat Ducato and Peugeot Boxer use the same vehicle platform while Renault Master, Nissan NV400 and Opel Movano share another (Utilitaire Magazine, 2018). A similar approach can also be taken for BEVs, as show already by the shared platform used for the Toyota Proace Electric, Citroën ë-Jumpy, Peugeot e-Expert and Opel Vivaro-e. In addition, these platforms can be redesigned to ensure that they can be used not only for ICEs, but also for HEVs, PHEVs and BEVs.

Innovative solutions in vehicle manufacturing will also help to solve the scale problem. Architectural design should take advantage of the compact dimensions of electric motors, capitalise on the presence of much fewer moving parts in EVs than in ICE vehicles and the possibility to exploit greater design flexibility (e.g. in skateboard configurations) for upper body design and construction. These should eventually also be applicable for different vehicle configurations – e.g. in cars and LCVs at once. They can also result from innovations in the design of the EV production facilities. For example, Arrival suggests that cost cuts could be available also at smaller production scales thanks to the combination of streamlined production methods, the use of “micro-factories” that can start by building on a small scale in areas of demand and other improvements derived from greater reliance on digital technologies (Designboom, 2020).

Economies of scale can also be derived from increasing the size of battery production plants, as already demonstrated by the rapid deployment of new large scale battery production facilities in Asia, Europe and North America. Further cost reductions can come from progress in battery chemistries, thanks to greater energy density and improved manufacturing techniques.

Deploy charging infrastructure to promote electrification of light commercial vehicle fleets

Installing charging infrastructure can be another barrier preventing operators from electrifying fleets. Charging a large number of vehicles can require changes to the floor plan of the depot and a large number of electric LCVs may be needed to justify costs for construction works. Depending on the charging system and existing local grid infrastructure, chargers for a large fleet are likely to require upgrades to the local distribution grid and onsite to-the-meter components. To-the-meter upgrades can increase project barriers if fleet owners must pay for these, depending on network regulations. This holds especially if operators who request incremental capacity increase have to bear costs for infrastructure that will benefit a larger number of users later on. Inversely, sharing costs for grid reinforcements for connecting electric fleet depots over all network users may increase network charges for all users.

The deployment status of an adequate charger network can also have an impact on the rate of vehicle depreciation. This is an important consideration for TCO assessments for fleet vehicles that are replaced after a few years of use. In particular, depreciation rates may risk acceleration if second hand vehicle purchases are hampered by a limited availability of chargers, due to limitations in the size of the second hand vehicle market. This could be the case if a large number of potential second hand vehicle buyers (e.g. private individual or a small companies) have limited opportunities to install a private slow charger and if publicly accessible chargers are also not available. This can be addressed through targeted roll-out of public charging infrastructure, such as in Paris where needs of commercial vehicles were a key consideration for planning a network of chargers (CHAdeMO, 2020).

Fleet operators have a central role in the mobilisation of the investments needed for the deployment of private chargers for electric LCVs. Their role can be complemented by co-operative arrangements with electricity providers, for example with the use of utility tariffs that shift upfront financing for EVs and their charging infrastructure from the fleet manager to the electricity provider or the grid operator.

To minimise charger costs, fleet managers can ensure that the features of the chargers used for private fleets are optimised to take account of the needs dictated by the vehicle use profile, i.e. calibrated primarily on daily usage cycles. They can also co-operate with other partners to share charging facilities, especially in cases where there are complementarities with respect to their time of use (e.g. during daytime for a retailer receiving clients, and at night for the recharge of its delivery vehicles or those of a nearby depot) and/or make joint investments.

Savings on charger costs can also be made by relying on slow charging and/or allow for grid services in the case of urban deliveries. Chargers may feature charging management systems – such as load shifting during the period of time while vehicles are not in use, and parked at the depot. For example, UPS introduced a charging management system at its central London depot that increased the number of chargers the existing infrastructure can support from 63 to 170 (Government of UK, 2018). Further, some utilities in some countries have introduced specialised programmes for electric fleet operators to plan infrastructure operations.

Policies to accelerate electrification of light commercial vehicles

Electric LCVs are becoming a cost-competitive alternative to diesel vans especially in urban transport and if operated in fleets. Several models are available and announced fleet purchases alone will strongly increase the global stock of electric LCVs, helping to mitigate some of the remaining challenges for the electrification of this vehicle market segment.

A range of government policies recognise the important role that clean LCVs play for improved air quality and reduced climate impacts from road transport. They also support their potential for advancing the transition to electric light-duty vehicles in a cost efficient manner. Government support for the electrification of urban freight deliveries has taken different forms, including:

- Prioritising low- and zero-emission vehicles in public procurement programmes tailored for commercial vehicles, for instance from government-owned postal operators
- Giving preferential access to electric vehicles for freight deliveries in portions of urban areas or applying preferential access charges. These are called trough Urban Access Regulations (UARs) and can include low-emission zones (LEZ) or zero-emission zones (ZEZ).
- Applying regulations on fuel economy and GHG emissions per kilometre of commercial vehicles. Limits on local pollutant emissions are tightened, integrated and/or complemented by incentives or mandates for low- and zero-emission vehicles.
- Introducing economic incentives, such as differentiated registration or circulation taxes (and/or rebates) based on the environmental performance of the commercial vehicles.

These measures will be further discussed in detail in the next sections of this report. They follow interventions aiming to build experience at an early stage of adoption (such as funding for small scale pilot projects that help operators[17]) and add to policy interventions aiming to ensure that electric LCVs are not subject to drawbacks due to weight limitations in load capacity, briefly recalled in Box 4.

Box 4. Addressing the payload limitation of electric light commercial vehicles

The weight of batteries makes electric LCVs heavier than ICE vehicles, resulting in a payload capacity reduction of sometimes over 500 kg (Tsakalidis, et al., 2020). This tends to not affect last-mile delivery operators, for which the volume capacity is usually the limiting vehicle specification factor. However, it may impact the attractiveness of electric LCVs to users with larger weight requirements as well as their resale value in second-hand markets.

To address this, some OEMs offer electric LCV models with an increased gross-vehicle-weight (GVW) that avoids payload reductions. For example, the Fiat e Ducato is offered as a large version with 4.25 tonne GVW, exceeding the usual weight threshold of LCVs by 750 kg (Fiat, 2020b). Regulatory revisions in several countries (including Austria, Germany and the United Kingdom) promote use of these vehicles, in which the GVW threshold of standard class B driving licenses was lifted from 3.5 tonnes to 4.25 tonnes for electric vehicles (Tsakalidis, et al., 2020).

In addition to the government measures listed above, there is a broader range of actions needed to stimulate electric mobility, steer industrial development and ensure that both develop in a way that is environmentally sound. These are listed in Box 5.

Box 5. Policies that support vehicle electrification without a specific focus on commercial vehicles

Existing measures that promote vehicle electrification without a specific focus on urban delivery fleets apply to other road vehicles (e.g. cars and buses). They include public procurement schemes, pollutant and GHG emission regulations and/or economic incentives as well as LEZ and ZEZ in cities. Other measures that support vehicle electrification without a specific focus on commercial vehicles include a range of complementary instruments, such as:

- technical regulations and standards on vehicle safety and charging[18]
- programmes supporting the roll out of publicly accessible vehicle chargers, suitable for all light vehicles (passenger and freight)
- more accurate measurement procedures for both GHG and pollutant emissions – in particular the Worldwide harmonized Light vehicles Test Procedure (WLTP) and the use of portable emission measurement systems (PEMS) for real-world measurements of local pollutant emissions
- regulations, carbon pricing mechanisms and hybrid solutions ensure that the carbon content of the electricity used by transport vehicles declines over time. Regulations include; renewable electricity quotas and priority dispatching for renewable electricity; carbon pricing mechanisms include carbon taxes on road fuels and/or emission trading schemes; and hybrid solutions include low carbon fuel standards.
- regulations and incentives aiming to promote reductions in the carbon content of key components of electric vehicles (in particular batteries), foster eco-design and material recycling and address the sustainable sourcing of materials
- industrial policies enabling scale increases and a reduction in costs for key enabling technologies, in particular automotive batteries
- regulatory reforms enabling the effective participation of aggregators of electricity demand loads and/or electricity storage capacity (including from transport vehicles) in the electricity market.

The following sections will concentrate primarily on policies that have a specific relevance for LCVs, namely: green procurement and removing barriers to charging infrastructure. It closes by examining longer-term policy challenges, such as the stability of government revenues and the need to manage structural changes in the demand for new materials in the automotive and energy sectors.

Green procurement policies for vehicle fleets

Public procurement of large electric vehicle fleets can demonstrate the chosen technology of the procurement programme and enable fleet managers to build experience and to optimise vehicle use. An example where LCV fleet operators benefited from the adoption of early green procurement by a public entity in is France. In 2011, the French government commissioned 25 000 electric vehicles for private and public operators. La Poste ordered 10 000 Renault Kangoo Z.E. electric vehicles through this programme (Post&Parcel, 2011; AFP, 2011). Other government-owned postal operators that have procured electric fleets (albeit smaller than La Poste) are Swiss post (included in Table 3) as well as Royal Mail in the United Kingdom, which operates about 300 electric vehicles from Peugeot and Mercedes (Royal Mail, 2020a; Royal Mail, 2020b). Another recent, large public procurement of electric vehicles is the one of Korea Post, the national postal service of Korea, which announced a plan in 2018 to introduce 10 000 EVs in postal services in Korea by 2020 (ITF, 2020c).

Public procurement programmes are crucial for large scale deployment/market adoption. If scaled up and applied as minimum thresholds for publicly owned low- and zero-emission vehicles, these programmes allow the industry realise economies of scale. If governments were to seek alignment with (multinational) companies that are freight buyers/customers, then the demand for electric LCVs could be amplified even further.

The Clean Vehicles Directive in the European Union is one such procurement policy that promotes EV deployment on a larger scale. It includes specific requirements or incentive mechanisms for vehicles with low or zero tailpipe emissions (IEA, 2016; EC, 2019b). The procurement of LCV programmes can, in itself, stimulate further market deployment of these electric vehicles, especially if applied to large fleets with high vehicle numbers.

The application scope of green procurement programmes should expand on criteria for goods and services that are delivered to public authorities (e.g. municipalities) and publicly owned agencies. An example of this is the BuyZet project in Copenhagen. The city identified opportunities and barriers for the greater consolidation of goods deliveries to its buildings and engaged in a dialogue with relevant market actors to discuss the necessary steps to achieve emissions-free procurement deliveries (BuyZet, 2020).

Low- and zero-emission zones

Cities have been at the forefront of electric mobility support since the market entrance of electric passenger cars. A global group of 35 cities have pledged to make a major areas zero emissions by 2030 under the C40 Green and Healthy Streets Declaration (C40, 2020). Several European municipalities and local administrations have enforced or announced access restrictions for vehicles with poor environmental performance for certain areas. In other cases (London in particular), access to the city centre is subject to differentiated charges, again taking into account of environmental performances of vehicles.[19] Chinese cities (e.g. Beijing, Chengdu, X'ian and Shenzhen) also have vehicle registration limits. Some cities in the United States also have toll waivers or differentiated access fees: for example, the ports of Los Angeles and Long Beach for zero tailpipe emission vehicles (CALSTART, 2020).

Decisions regarding the nature of low-emission zones (LEZ) or zero-emission zones (ZEZ) and the vehicles targeted are often not uniform across different cities, despite some attempt to rationalise actions across national territories (e.g. in France, with the development of the Crit'Air window sticker). Restrictions also vary in terms of timelines and range from banning old cars with high pollutant emissions, to banning diesel vehicles, until banning all vehicles with internal combustion engines.

These policies range from cases that have a main focus on passenger cars to formulations that apply exclusively to freight delivery vehicles. A selection of measures adopted in cities that do apply to (or are designed exclusively for) urban delivery vans are is included in Table 4. Accessing city centres is crucial for vehicles used in last-mile delivery operations and existing experiences show that the prospect of access restrictions sends a strong signal to operators to electrify. The Chinese cities with the largest existing electric LCV fleets – Shenzhen, Chengdu, X'ian – are among those that already have such access restrictions in place.

Table 4. Selected city policies regulating access for commercial vehicles with internal combustion engines

Country	Policies
China	Beijing: the Beijing New Energy Logistics and Distribution Vehicle Priority Implementation Plan requires that by the end of 2020, all freight delivery vehicles under 4.5 t active at daytime within the Fifth Ring Road are BEVs. Chengdu: Electric freight vehicles are exempt from road access restrictions and do not need to apply for city access permits. Diesel vehicles need to obtain city access permits whose number is limited, and no additional permits will be granted for non-zero emission vehicles from 2020 onwards. Shenzhen: Electric freight vehicles are exempt from road access restrictions while diesel vehicles have access based on odd-even license plate and are banned from ten green logistic zones.
France	Paris will ban all ICE vehicles by 2030 and diesel vehicles by 2024. The 2019 law requires all cities having more than 100 000 inhabitants to analyse the feasibility of a low-emissions zone (LEZ). In this context, 15 urban agglomerations committed to establish an LEZ by the end of 2020.
India	In Delhi, entry of diesel commercial vehicles is restricted to certain hours of night. The restriction is stricter during the winter season, when air pollution deteriorates. Diesel LCVs are banned from getting registered in Delhi.
The Netherlands	Dutch cities together with private stakeholders adopted the Green Deal Zero Emission City, under which logistics vans will be emission free in central areas of 30-40 cities by 2025.
United Kingdom	London: battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs) are exempt from the city's congestion charge that prices vehicle access from 7:00 to 22:00 and its ultra low-emission zone (ULEZ). London will expand its ULEZ to a larger area in 2021 and also aims to implement a central London ZEZ by 2025. Local ZEZs from 2020, with two of them, run by London boroughs, already in place.

Sources: CNEVI (2020), C40 (2020); WRI (2020); Transport for London (2020); L'internaute (2020); Vie publique (2019); Rijksoverheid (2020) and Supreme Court of India (2015).

Low- and zero- emission zones play an important role to accelerate technology transitions, starting from areas where air pollution and congestion from road vehicles are most pronounced. They are well suited to increase the value proposition of electric LCVs for two reasons:

- they offer enhanced access to important operation areas of delivery vehicles (i.e. city centres)
- they can have important impacts on depreciation rates for different vehicle technologies, slowing them for low- and zero-emission vehicles and accelerating them for vehicles using conventional powertrains.

Including LCVs in the scope of application of LEZ and ZEZ, starting from the LCVs with high lifetime mileage and frequent use in cities – like vehicles used for urban freight deliveries, would therefore be beneficial for the cost competitiveness of versions equipped with low- and zero-emission powertrains and would help to stimulate their market uptake.

Greater harmonisation of the criteria adopted by local administrations to define which vehicles are affected by differentiated charges and/or access restrictions would save costs. It would provide a focus point for manufacturers to clarify technological solutions that have the greatest resilience to tightened policy requirements on air quality and GHG emissions. Early announcements of LEZ and ZEZ establishment are also important, as they enable OEMs to plan their product line up and ensure that production capacity can ramp up fast enough to respond to changes in market demand.

Road charges or access restrictions that differentiate between electric and non-electric driving could also be significantly enhanced by systems that can automatically detect the driving mode. These would be especially important to ensure that all-electric driving on PHEVs can be effectively maximised. Geofencing technologies offer advantages in this respect, provided that privacy concerns can be addressed. They also require an international regulatory framework that does not yet exist (ITF, 2020d).

Fuel economy standards and environmental regulations

Fuel economy, emissions performance regulations, have been in place in different jurisdictions for a number of years. They include technical and policy-setting regulations.

Technical regulations focus on aspects such as the measurement procedures and tests for tailpipe pollutant and GHG emissions/ and energy consumption. They have been subject to important revisions in recent years due to the need to ensure better representativeness of on-road driving conditions. They also integrate provisions of on-board diagnostics (OBD) and, since OBD has not proven to be an efficient tool for limiting tampering of vehicles, real-world emission tests. The latter require portable emissions measurement systems (PEMS).

Policy-setting regulations define overall limit values for technical parameters and timelines for their development. They cover two main subjects: tailpipe emissions of local air pollutants and of GHGs. The latter are strictly related with energy efficiency, and therefore also identified as fuel economy standards.

Regulations that set limit values and timelines on tailpipe pollutants are commonly known as Tier 1, Tier 2 and Tier 3 (in the United States), Euro 1 to 6 (for cars and LCVs, in Europe) or Euro I to VI (for trucks, in Europe).[20] They encourage adoption of EVs due to the increasing requirements on after-treatment systems imposed for ICE vehicles.

Fuel economy standards and other environmental regulations also play a crucial role in incentivising OEMs to increase their sales share of electric vehicles. They require progressive reductions of GHG emissions from vehicle tailpipes, something on which EVs have a major advantage. Fuel economy standards were first applied to passenger cars, but they are currently also covering LCVs and other commercial vehicles, such as heavy duty trucks. Box 6 provides an overview of regulatory instruments whose scope of application includes urban LCVs. A broader overview of pollutant emissions, GHG and other regulations (including enabling technical regulations on measurement procedures and tests, as well as other regulatory instruments for EVs and hydrogen vehicles) are available in ITF (2020d).

Some fuel economy standards are paired with mandates or incentives for the deployment of low and zero tailpipe emission vehicles. Examples include: California's Zero Emission Vehicle mandate, China's New Energy Vehicle (NEV) credit mandate and the integration of incentives in the European regulations requiring reductions in GHG emissions per km. These are leading the way for EVs to be included in corporate average emission calculations across all major vehicle markets.

A growing number of countries have set goals within a targeted year for all new cars and LCVs sold to have zero tailpipe emissions. Target years range from 2025 for Norway, to years between 2030 and 2050 for countries including Denmark, France, Germany, Iceland, Ireland, Japan, the Netherlands, Portugal, Slovenia, Spain, Sri Lanka, Sweden and the United Kingdom (IEA, 2020a).

Box 6. Emission regulations that have specific relevance for urban delivery vehicles

The European Commission applies CO_2 standards for new passenger cars and LCVs sold in the European Union. The regulation requires vehicle manufacturers to meet binding emissions targets or face financial penalties. The average CO_2 emissions of new passenger cars is currently required to be 95 gCO2/km by 2021 and light commercial vehicles must meet 147 g CO_2/km by 2020 (EC, 2014). The European Commission introduced additional targets as part of the latest round of updates in 2018; CO_2 emissions from passenger cars must drop by 15% in 2025 and 37.5% in 2030 with respect to 2021 levels. Emissions from light commercial vehicles are required to drop by 15% in 2025 and 31% in 2030 (EC, 2020a). The Commission also intends to revisit and strengthen the 2030 targets, by June 2021 (EC, 2020b).

Similar policies apply in Japan, where the limit for the average fuel economy of passenger cars and light commercial vehicles below 3.5 t is set at 25.4 km/l (91 g CO_2/km) by 2030, with ambitions for electric vehicles to account for 20-30% of new car sales (ICCT, 2019).

In Canada, the average fuel economy of passenger cars and light trucks are required to fall by approximately 5% annually between 2021 and 2025 (Government of Canada, 2014).

Recent changes to fuel economy standards in the United States have lowered the ambition of federal targets and now require annual efficiency improvements of approximately 1.5% between 2021 and 2026 (US EPA, 2020). However, a number of states will maintain previous levels of ambition of 4.7% annual improvements (IEA, 2020a). Additional regulations passed recently in California and 14 other states in the United States, require all light-duty vehicles and drayage trucks to be zero-emission vehicles by 2035, with similar goals for last-mile delivery trucks and vans by 2040 and all medium and heavy duty trucks by 2045 (CARB, 2020).

Additional targeted regulatory requirements for zero tailpipe emission vehicles could be considered for LCVs that have the highest lifetime travel profiles. This is similar to the case of ridesourcing and taxis in the passenger car market. The California's Clean Miles Standard could be an interesting instrument in this context. Currently, this is applicable to passenger vehicles used in ridesourcing services. It sets annual requirements for zero-emissions vehicle travel, taking into account the average travel-distance-weighted performance of ridesourcing, in order to account for the uneven distribution of high- versus low-distance drivers. Extending this approach to freight delivery vehicles, as a complement to CO_2 and/or zero-emission vehicle standards for LCVs, could help addressing equity concerns (in particular the case of drivers that have lower than average annual travel on LCVs) by targeting large, well-managed and GPS-tracked fleets for an earlier and accelerated transition to EVs.

Regulatory requirements on all-electric driving in cities can also be instrumental to maximise all-electric driving on PHEVs. To be effectively implemented, they may need technologies that enable automatic detection of the driving mode, along with geo-fencing requirements or the application of location-specific regulatory provisions. This is a complex development, and one that is unlikely to be developed for LCVs alone.

There are priorities for future developments of fuel economy standards and environmental regulations. Regulations that tighten the threshold for air pollutants, GHG emissions and energy use of vehicles promote investments in cleaner technologies, including ZEVs. This is why setting targets gives clear signals on the future market orientation and can accelerate electrification in the commercial vehicle sector in the coming years.

LCVs have, on average, a higher lifetime travel profile than passenger cars. Therefore, regulatory requirements on emissions regulations or fuel economy standards for LCVs can be set up with a higher ambitions. The reason for this is that, at current battery costs and in countries with high fuel prices, LCV electrification is already offering concrete opportunities for a cost-effective payback of higher upfront costs, leading to net savings across the vehicle lifetime. Similar considerations apply for "zero emission" vehicle mandates.

Pollutant emission regulations for LCVs are likely to make most sense if they are fully aligned with those of passenger cars, given the large technology sharing/overlap between cars and LCVs. Taking this approach would be beneficial also to avoid potential issues due to the possibility for type approving LCVs either with test procedures for light or heavy vehicles. This is the case in Europe and therefore also in the regulatory framework that transposed into the vehicle regulations of the United Nations, and applied more broadly Its current type approval certification framework for LCVs requires both pollutant emission and CO_2 testing if it is completed following the light vehicle requirements, but it is only limited to pollutant emission testing when it follows heavy vehicle requirements.

In addition to tailpipe emission regulations, it is also important to ensure that electricity is fully integrated into regulatory policies on low-carbon fuels and that the environmental performance of vehicle batteries is fully addressed, as outlined in ITF (2020d). Minimum performance requirements on battery durability (calendar life and cyclic ageing) that are tested with in-service verification methods are important to minimise risks of faster depreciation for EVs, preventing substandard products from entering the market. Other aspects related with battery design, second life and end-of-life of batteries, and in particular those that can contribute to maximise the residual value of batteries used on vehicles that reach their end-of-life, can also have positive impacts for reduced depreciation rates.

International co-operation, harmonised technical regulations and standards and a good alignment of regulatory policy goals in different global regions is also important to support the achievement of scales that justify major OEM investments for a technology transition. This is especially important in the case of freight delivery vans, given that their volume of sales is only about one-tenth of the global car market. These considerations on market scale and international alignment and co-operation are especially relevant for countries whose vehicle registration account for a limited portion of the overall global market and that are major vehicle exporters.

Economic incentives

Economic incentives schemes for EVs can complement regulatory requirements on tailpipe CO_2 emissions, fuel economy standards and/or ZEV mandates. To date, these schemes have been primarily targeting passenger cars and mainly consist of differentiated tax rates for vehicle acquisition and/or circulation taxes, eventually deployed as revenue neutral mechanisms that apply penalties to vehicles with high fuel consumption and transfers them towards vehicles with low or zero tailpipe emissions. Several countries in Europe already vary taxation for LCVs based on GHG emissions per kilometre (Table 5) and some local administrations (e.g. city authorities in the Netherlands) also provide economic incentives.

Table 5. European Union countries with light-commercial vehicle taxation based on CO_2 per km

Country	Description
Belgium	Tax rate variable with g CO_2/km
Cyprus*	Tax rate variable with g CO_2/km
Finland	Tax rate variable with g CO_2/km
France	Bonus for LCVs emitting less than 20 g CO_2/km, lower for vehicles price above EUR 45 000 and zeroed out above EUR 60 000
Luxembourg	Different bonuses for BEVs and PHEVs
Norway	Different bonuses for vehicles emitting less than 50 and 87 g CO_2/km, maluses for vehicles above 118 g CO_2/km, plus a weight tax capped at a constant limit of heavy vehicles
Portugal	Tax rate variable with g CO_2/km, exemption for BEVs
Slovenia	Bonuses for BEVs and PHEVs

Note: A CO2-based excise duty (already in place for passenger cars) is due to be introduced for LCVs in the United Kingdom, but not earlier than April 2021.

* Note by Turkey The information in this document with reference to “Cyprus” relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the “Cyprus issue”.

Note by all the European Union Member States of the OECD and the European Union The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Source: (ACEA, 2020).

For passenger cars, incentives and differentiated taxation have also been supplemented by exemptions of the value added tax (VAT) and exemptions from company car taxes for EVs. This is not applicable to LCVs used for professional services, as they are generally exempt from VAT.

There are priorities for future developments of economic incentives. Economic incentives that reduce the upfront investment gap between ICEVs and EVs are amongst the most direct methods of promoting EV adoption. Their application is important to stimulate market demand for LCVs, as for all other vehicles.

The continuing cost reductions in battery technologies and EVs mean that economic and financial incentives for electric LCVs are likely to be required only in the market scale up phase, when upfront cost gaps are largest. In addition, due to the concrete opportunities for net saving in terms of TCO for high mileage vehicles used for urban deliveries, the use of public finances for economic incentives deserves careful considerations to really target cases where meeting regulatory requirements would have unfair negative impacts, such as net cost increases. The focus of incentives should therefore be really on the reduction of investment risks needed to ensure that scale is achieved. Returns are long lasting benefits from cost reductions for clean and sustainable energy technologies for transport vehicles.

Due to rapid technology cost developments and impacts on government budgets it is important that economic incentive programs are designed in a way that is ready to adapt over time. Especially if economic incentives take the form of subsidies, rather than differentiated taxation. Flexibility to adapt to cost and market development is especially relevant for LCVs. When produced at scale and subject to high annual travel profiles it can bring net savings for their owners.

Policies must ensure that regulatory requirements are equitable. The higher upfront costs of low- and zero-emission vehicles, along with limited opportunities to negotiate prices via large purchase orders, means that operators with small fleets or low mileage are more likely to face difficulties achieving TCO savings from a switch towards EVs. Smaller operators are also more often subject to greater constraints on the availability of capital and access to low interest loans. To address this aspect, policies can focus on reductions in the cost of capital for clean vehicles (e.g. with low interest loans and/or better financial conditions for lease), in addition to broader mechanisms that aim to reduce upfront cost gaps.

Supporting the deployment of charging infrastructure

Supporting mechanisms to reduce the costs for the installation of private chargers should not prioritise cases where usage profiles and technical characteristics of vehicles enable net savings in terms of TCO. Even if there is scope for economic support in the initial market deployment phase. When TCO for EVs come with net savings, government are likely better placed as regulators.

Private, depot-based slow chargers with charging capacity up to 22 kW appear to be the most suitable option for electric LCV fleets. Charging can take place while vehicles are not in use during the night, which is cheaper than using fast chargers during operation hours due to their lower technology costs. Slow chargers are also easier to integrate in the electricity system than fast chargers and operators may benefits from low electricity rates during off-peak hours at night.

Ensuring that depot charging is available for large fleets requires grid upgrades/reinforcements in the proximity of depots. To avoid delays in depot charging deployment, governments should streamline regulatory requirements for grid upgrades. In addition, public authorities should clarify which economic actors should take responsibility to cover the costs of grid reinforcements. Without this clarification, costs for local grid reinforcement risk to fall entirely on the first company requesting it, even if electricity demand is shared across a wide variety of uses. This is currently the case if these grid improvements open up opportunities for other end-use developments (e.g. on other transport vehicles or electricity end-uses) and/or strengthen demand response mechanisms, with net benefits in other parts of the electricity system (e.g. the more effective integration of variable renewable energy).

The allocation of public funding to support the deployment of a core network of publicly accessible chargers shared with passenger cars deserves consideration. This is true especially where this is not already in place and despite the bulk of LCV charging taking place through private outlets. The justification for this lies in the higher investment risks faced for public charging deployment in comparison with private chargers, due to higher installation cost and contextual requirement of high frequencies of use (a feature that is not easily available, especially in an initial phase of EV deployment).

The strategy adopted for public slow charger deployment for passenger cars in Dutch cities, may be interesting for the early adoption phase for small LCV fleets to have easy access to parking/charging at depots (AUAS, 2018). This involves zoning actions via a demand-based approach. It is due to an inherent capacity of demand-based charger installations to maximise usage rates (and therefore minimise costs) and well aligned with the importance (for public authorities and stakeholders in the electricity sector) to gain insights on the geographical locations where publicly accessible EV chargers will be most needed. Strategic rollouts, based on the assessment of locations likely to be subject to higher demand (and therefore higher charger utilisation rates), are likely better suited as the share of electric cars and LCVs grows, and the more the market matures, the more data on the best charger locations become available.

Depending on the market regulation in a given country, obligations for charging point operators can be used to ensure that they make publicly accessible chargers broadly available. Under such regulation, chargers with high utilisation rates would cross-subsidise those that are less frequented. Norway already subjects charging point operators to public service obligations that promote coverage of publicly accessible chargers (IEA, 2018b).

Regulations can also require that parking spaces in new or refurbished buildings are EV-ready, i.e. including the necessary elements such as conduits to facilitate a grid connection. A key example in this respect is the case of the European Directive on the energy performance of buildings and related implementing legislation, in EU member countries. This is relevant for electric LCVs (including those used for urban deliveries), since the availability of charging infrastructure and/or the possibility to limit installation costs can play an important role to ensure that there is sufficient market demand in the second-hand vehicle market, reducing the likelihood of an accelerated depreciation pattern.

Longer-term policy challenges

Without changes to transport-related taxation schemes, the increasing uptake of electric vehicles has the potential to change the tax revenue base derived from vehicle and fuel taxes (IEA, 2019; OECD, 2019). This important issue is relevant for electric LCVs because revenue from transport charges and taxation ensure continued availability of funding for the development and maintenance of transport infrastructure, among other goals. Increasing taxes on carbon-intensive fuels, combined with the use of location-specific distance-based charges to recover infrastructure costs and to reflect the costs of pollution and congestion (something that requires the variation of distance-based charges depending on the extent of the pollution and congestion levels) can support the long-term transition to zero-emissions mobility while maintaining revenue from transport taxes. Location-specific distance-based charges are also well suited to manage the impacts of disruptive technologies in road transport, including those related to electrification, automation and shared mobility services (OECD, 2019 and IEA, 2019).

The related battery production requirements for increased EV uptake, along with a transition towards renewable energy technologies, imply bigger demand for new materials in the automotive and energy sectors. The potential environmental impacts of resource extraction as well as material supply risks require increased attention to raw materials supply. Examples for existing initiatives include the work already developed in Europe on the subject of battery supply chains and the circular economy by the European Battery Alliance (EC, 2020c), the recent announcement on the launch of the European Raw Material Alliance (EC, 2020d) and a cooperative effort on the same subject of the Office for Energy Efficiency and Renewable Energy of the United States Department of Energy and the United States Geological Survey (DOE, 2020).

Notes

1 Road vehicles are the largest contributor to transport energy demand globally, and their high reliance on petroleum-based fuels makes them a large GHG emitter. More than 90% of fuel use by light-duty vehicles (including cars and LCV) are gasoline and diesel. These vehicles are responsible for the emission of local pollutants (such as CO, NOX and particular matter) in high exposure areas like urban roads and emit directly (i.e. from their tailpipes) over 0.6 Mt CO2 GHG emissions a year. Biofuels have gained a foothold in the transport fuel mix, but their success has been limited, to date, due to challenges in achieving production costs that re capable to compete with fossil alternatives. Biofuel’s capacity to abate GHG emission on a life-cycle basis is also strongly dependent on the production pathway selected. Waste-based options offer the best performances, but face limitations in terms of volumes. Other challenges include competition for land use with agriculture and forests and potential risks of transferring impacts of the variability of energy prices into food products. Despite interesting prospects for cost reduction, other alternatives – in particular electro fuels – are currently hampered by high production costs. In the longer term, their large scale adoption also faces challenges due to limited thermodynamic efficiencies in their production and use, leading to very large requirements of low cost and low carbon electricity production. These factors, combined with the size of the existing road vehicle fleet, means that there is a high level of locked-in emissions unless existing ICE vehicles phase out prior their natural end of lifetime.

2 Coupling decarbonisation efforts in the transport and power sectors can also help overcome challenges that power systems face from increasing shares of intermittent renewable generation capacity. One challenge is the mismatch between the generation peaks of renewables (during midday for PV and during night for wind turbines) and the demand peak of household electricity use during morning and evening hours. A growing EV fleet can support the integration of renewables if it can effectively contribute to increased flexibility in power systems. Key ways to help in this direction include the provision of ultra-short-term demand response (e.g. frequency control) and the possibility to shift electricity demand across time periods (load shifting). This is well suited for slow charging EVs, also feasible in case of fast charging (if stationary storage is deployed) and it may also include bidirectional charging, in cases where EVs feed electricity back to the grid during peak demand hours. EVs can also help contain costs associated with the local adaptation of the grid to increased electrification by providing grid balancing services.

3 These are classified as N1 vehicles in the European Union and other countries adopting the classification of the United Nations (UNECE, 2005). To the extent to which they are relevant for urban deliveries and they do share technologies with cars, vehicles falling in the N2 category of the UN classification (i.e. with a gross vehicle mass greater than 3.5 t and below 12 t) are also within the scope of this work

4 The average costs of vehicle battery packs have decreased from more than USD 1,100 per kilowatt-hour (kWh) in 2010 to USD 156 per kWh in 2019 (BNEF, 2019). Vehicles battery costs determine the price premium of electric vehicles compared to ICE technology. Decreasing battery costs, induced by policy support and technology progress, are crucial to reduce costs and ensure that the EV value proposition becomes increasingly valuable for a broader range of customers and usage profiles. This is the case not just for electric passenger cars, but also commercial vehicles and buses.

5 Details are specified in the note to Figure 5.

6 This is informed by a very limited variability of energy use per km to changes in weight, footprint and engine power, for BEVs and energy use data available from test results (IEA & ICCT, 2019).

7 On the other hand, the gap between driving in real world conditions and analysis results may be lower in cases where electric LCVs require the frequent use of heating in the driver compartment and/or refrigeration of loads.

8 The assumptions used here for the 70 kWh pack reflect either a larger battery capacity or a 42 kWh battery replacement (without accounting for changes in embedded energy and carbon due to the time lag required by the replacement). Whether or not a replacement is necessary depends on the characteristics of the batteries in terms of durability and the battery size. A 4235 kWh battery and a 0.2 kWh/km energy use would require more than 1700 cycles to cover 300 000 km (assuming a full recharge capped at 80% of the total capacity).. The number of cycles falls to less than 900 for a 70 kWh battery.

9 Additional differences relate with the energy required in the end-of-life treatment of the batteries. This depends on the technical characteristics and the scale of the processes needed for end-of-life treatment and how they relate with competing options (e.g. landfilling and use of virgin materials). End-of-life processes are not within the system boundaries of the life

cycle analysis considered here. On the other hand, this analysis accounts for differences in energy and carbon intensities from the production of virgin and/or recycled materials.

10 Recent research shows that the real-world share of electric driving for PHEVs, on average and in current conditions,, is about half the share considered in the type-approval values, and typically ranging between 20% and 50% (Plötz, Moll, Li,, Bieker, & Mock, 2020).

11 An average travel of 20 000 km/year would be consistent with 83 km/day if vehicles are operated 5 days a week and 48 weeks a year. If the energy use per km is 0.2 kWh and if daily distances do not vary significantly, a battery of 16.5 kWh could be sufficient to cover almost 80% of the travel needs in all electric mode.

12 In the specific case of the United Kingdom, Germany and Austria these limits have been lifted from 3.5t to 4.25 t for a type B driving license (Tsakalidis, et al., 2020).

13 A battery smaller than 42 kWh would still provide the range needed and it is in use in some of the models that are currently commercially available. However, customizing battery size is only feasible at pack level, which allows OEMs to realize economies of scale through using battery models in both their electric cars and LCV model series. One example for this is the Renault Zoe and Kangoo Z.E., which use the same battery.

14 This is a likely event for electric LCV that operate during daytime and are stored in depots at night.

15 A recent example for this is Ingka Groups deployment of customized box-type vehicles in Paris and Berlin with 20 m3 load volume, about 30% more than what available vehicles typically offer (Ingka Group, 2020b).

16 Prior to UPS' order of 10 000 vehicles from Arrival in 2020, the companies have collaborated in prototype development since 2016 and announced commissioning of a pilot fleet with 35 vehicles in 2018 (UPS, 2018).

17 Pilot projects with government support enable operators to test electrification concepts and can initiate larger conversion programmes. These projects are most relevant for operators taking a small first batch of electric vehicles in operation and can provide important insights for later fleet conversions of entire depots. For example, the ZUKUFT.DE project of the Government of Germany brings together vehicle manufactures, electricity network operators, last mile operators and research institutes. Started in 2018, this program aims at rolling out over 500 electric LCVs in several cities for last-mile operation (NOW, 2020). Another example is the UK government's support for UPS' implementation of a novel charging management system at its London depot that made possible to deploy additional vehicles without network upgrades (Table 3).

18 Further information on regulatory measures listed in the first four items in this last set of measures are the focus of a recently released report on Regulations and standards for clean trucks and buses (ITF, 2020d).

19 Several European cities also enforce Urban Access Regulations that already embed provisions that are differentiated according to noise, weight and freight loading/unloading dimension..

20 European regulations are transposed in international and other national regulations and also relevant for other major markets, such as China and India.

References

ACEA (2020), *ACEA Tax Guide.* Retrieved from European Automobile Manufacturers' Association: https://acea.be/uploads/news_documents/ACEA_Tax_Guide_2020.pdf.

ADAC (2019), *VW e-Crafter: Erste Testfahrt mit dem neuen Elektro-Transporter (VW e-Crafter: First test ride with the new electric van)*. Retrieved October 30, 2020, from ADAC: www.adac.de/rund-ums-fahrzeug/autokatalog/marken-modelle/vw/vw-e-crafter/.

AFP (2011), *La Poste: les véhicules électriques lancés (La Poste launched electric vehicles)*. Retrieved October 30, 2020, from Le Figaro: www.lefigaro.fr/flash-eco/2011/12/13/97002-20111213FILWWW00511-la-poste-les-vehicules-electriques-lances.php.

Amazon (2020a), *Mercedes-Benz Joins The Climate Pledge and Delivers More Than 1,800 Electric Vehicles to Amazon's Delivery Fleet in Europe*. Retrieved October 30, 2020, from About Amazon: https://blog.aboutamazon.eu/company-news/mercedes-benz-joins-the-climate-pledge-and-delivers-more-than-1-800-electric-vehicles-to-amazons-delivery-fleet-in-europe.

Amazon (2020b), *Our biggest commitment to electromobility in Germany to date: The last mile is green in Essen*. Retrieved October 30, 2020, from About Amazon: https://blog.aboutamazon.eu/sustainability/our-biggest-commitment-to-electromobility-in-germany-to-date-the-last-mile-is-green-in-essen.

Amazon (2020c), *10,000 Electric Vehicles in our delivery fleet by 2025*. Retrieved October 30, 2020, from About Amazon: https://blog.aboutamazon.in/operations/10-000-electric-vehicles-in-our-delivery-fleet-by-2025.

Amazon (2020d), *The Climate Pledge*. Retrieved October 30, 2020, from Amazon: https://sustainability.aboutamazon.com/about/the-climate-pledge.

Arrival (2020), *UPS invests in Arrival and orders 10,000 Generation 2 Electric Vehicles*. Retrieved October 30, 2020, from Arrival: https://arrival.com/news/ups-invests-in-arrival-and-orders-10000-generation-2-electric-vehicles.

Arval Mobilty Observatory (2020), *2020 Fleet Barometer.* Retrieved from Arval Mobilty Observatory: https://cms-static.arval.com/sites/default/files/32/2020/06/Arval%20Mobility%20Observatory%20Barometer%202020%20-%20Global.pdf.

AUAS (2018), *Study reveals optimal charging infrastructure rollout strategy*. Retrieved October 30, 2020, from Amsterdam University of Applied Sciences: www.amsterdamuas.com/content/news/news/2018/07/study-reveals-optimal-charging-infrastructure-rollout-strategy-for-electric-vehicles.html.

Bernd, P. et al. (2012), *Cost analysis of Plug-in Hybrid Electric Vehicles including Maintenance & Repair Costs and Resale Values.* Retrieved from https://elib.dlr.de/75697/1/EVS26_Propfe_final.pdf.

BNEF (2019), *Battery Pack Prices Fall As Market Ramps Up With Market Average At $156/kWh In 2019*. Retrieved October 30, 2020, from Bloomberg New Energy Finance: https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/.

BNEF(2020), *Energy Storage Investments Boom As Battery Costs Halve in the Next Decade*. Retrieved October 30, 2020, from Bloomberg New Energy Finance: https://about.bnef.com/blog/energy-storage-investments-boom-battery-costs-halve-next-decade/.

BuyZet (2020), *Supply logistics.* Retrieved October 30, 2020, from BuyZet: www.buyzet.eu/supply-logistics/.

C40 (2020), *Fossil Fuel Free Streets Declaration*. Retrieved from C40: www.c40.org/other/green-and-healthy-streets.

CALSTART (2020), *The beachhead model.* Retrieved from https://globaldrivetozero.org/public/The_Beachhead_Model.pdf.

CARB (2020), *Governor Newsom announces California will phase out gasoline-powered cars & drastically reduce demand for fossil fuel in California's fight against climate change*. Retrieved October 30, 2020, from California Air Resources Board: https://ww2.arb.ca.gov/news/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce.

CGTN (2019), *Beijing Dongsi Post Office greens its business through sustainable vehicles and packaging*. Retrieved October 30, 2020, from China Global Television Network: https://news.cgtn.com /news/3d3d414f3349444e34457a6333566d54/index.html.

CHAdeMO (2020), *Paris inaugurates a network of 60 multi-standard chargers*. Retrieved October 30, 2020, from CHAdeMO: www.chademo.com/paris-inaugurates-a-network-of-60-multi-standard-chargers/

Changsha Sunda. (2020). *4.5m Battery Electric Logistics Van*. Retrieved October 30, 2020, from Changsha Sunda: www.sundaev.com/electric-vehicle/electric-van/cdk5021xxybev1-battery-electric-logistics-van.html.

Chanje. (2020). *Vehicles*. Retrieved October 30, 2020, from Chanje: https://chanje.com/vehicles/.

Climate Group (2020a), *EV100 members*. Retrieved October 30, 2020, from The Climate Group: www.theclimategroup.org/ev100-members.

Climate Group (2020b), *Annnual Report.* Retrieved from EV100: www.theclimategroup.org/sites/default/files/downloads/ev100_annual_progress_and_insights_report_2020.pdf.

CNEVI (2020), ***北京公共**车辆电动化政策加码，轻型物流配送年底基本为电动车 (Beijing's public vehicle electrification policy has been increased, and light-duty logistics and distribution will basically be electric vehicles by the end of the year).* Retrieved October 30, 2020, from http://www.cnevi.com/archives/6887.html.

Connekt (2017), *Users and deployment of delivery.* Retrieved from Topsector Logistiek: https://topsectorlogistiek.nl/wptop/wp-content/uploads/2017/04/20170516-Users-and-deployment-of-delivery-vans-bericht-42-ENG.pdf.

Coppola, G. (2019), *Amazon's Van-Buying Spree Delivers a Gift to Auto Industry*. Retrieved October 30, 2020, from Bloomberg: www.bloomberg.com/news/articles/2019-12-19/amazon-van-buying-supports-banner-year-for-auto-fleet-business.

Daimler (2020a), *eSprinter: Systematic electrification of commercial fleets: from 2019 the eSprinter will add to the drive portfolio*. Retrieved October 30, 2020, from Global Media Site: https://media.daimler.com/marsMediaSite/ko/en/39957895.

Daimler (2020b), *Reliable deliveries: Locally emission-free Mercedes-Benz eVito vehicles on the road for Amazon in Munich*. Retrieved October 30, 2020, from Daimler Global Media Site: https://media.daimler.com/marsMediaSite/en/instance/ko.xhtml?rs=0&ls=L2RlL2luc3RhbmNlL2tvLnhod

G1sP29pZD00ODM2MjU4JnJlbElkPTYwODI5JmZyb21PaWQ9NDgzNjI1OCZib3JkZXJzPXRydWUmcmVzdWx0SW5mb1R5cGVJZD00MDYyNiZ2aWV3VHlwZT10aHVtYnM!&oid=45397226.

Danigo (2020), *Danigo EV Van*. Retrieved October 30, 2020, from Danigo: www.dacmotors.co.kr/product/%ED%99%94%EB%AC%BC%EC%A0%84%EA%B8%B0%EC%B0%A8.

Designboom (2020), *EV manufacturer 'arrival' turns the typical white van into a clean, green machine*. Retrieved October 30, 2020, from Designboom: www.designboom.com/technology/ev-manufacturer-arrival-electric-white-van-green-10-02-2019/.

Deutsche Post DHL Group (2017), *DHL expands green urban delivery with City Hub for cargo bicycles*. Retrieved October 30, 2020, from Deutsche Post DHL Group: www.dpdhl.com/en/media-relations/press-releases/2017/dhl-expands-green-urban-delivery-city-hub-cargo-bicycles.html.

Deutsche Post DHL Group (2020a), *Press kit on StreetScooter / E-Mobility*. Retrieved October 30, 2020, from Deutsche Post DHL Group: www.dpdhl.com/en/media-relations/specials/electro-mobility.html.

Deutsche Post DHL Group (2020b), *StreetScooter provides electric vans and charging infrastructure for Amazon*. Retrieved October 30, 2020, from Deutsche Post DHL Group: www.dpdhl.com/en/media-relations/press-releases/2020/streetscooter-provides-electric-vans-and-charging-infrastructure-for-amazon.html.

Die Post (2020a), *Pakete kommen im E-Lieferwagen (The parcels come by electric delivery van)*. Retrieved October 30, 2020, from Die Post: https://geschaeftsbericht.post.ch/19/ar/de/e-fahrzeuge/.

Die Post (2020b), *Unterwegs mit dem Elektroroller (On the road with electric scooters)*. Retrieved October 30, 2020, from Die Post: www.post.ch/de/ueber-uns/verantwortung/unsere-schwerpunkte/zustellung-per-elektroroller.

DOE (2020), *USGS and EERE: Collaborating to Strengthen America's Energy and Resource Independence.* Retrieved October 30, 2020, from U.S. Department of Energy: www.energy.gov/eere/articles/usgs-and-eere-collaborating-strengthen-america-s-energy-and-resource-independence.

DPD Group (2019), *Paketauslieferung per Lastenrad erfolgreich erprobt (Successful trail for parcel delivery with cargobikes)*. Retrieved October 30, 2020, from DPD Group: www.dpd.com/de/de/2019/05/24/komodo-paketauslieferung-per-lastenrad-erfolgreich-erprobt/.

DPD Group (2020a), *DPD UK takes delivery of 300 Nissan e-NV200 vans to create UK's largest electric vehicles parcel delivery fleet*. Retrieved October 30, 2020, from DPD Group: www.dpd.com/group/en/2020/01/30/dpd-uk-takes-delivery-of-300-nissan-e-nv200-vans-to-create-uks-largest-electric-vehicles-parcel-delivery-fleet/.

DPD Group (2020b), *Green delivery in 225 European cities by 2025*. Retrieved October 30, 2020, from DPD Group: www.dpd.com/group/en/2020/10/06/green-delivery-in-225-european-cities-by-2025/.

DST (2020), *Webinar presentation by Mr Leo Liu, Data Analyst Head for DST Car Rental Ltd*. Retrieved October 30, 2020, from Zero Emission Zones for Freight: Lessons from Shenzhen and Shanghai: www.c40knowledgehub.org/s/article/Zero-Emission-Zones-for-Freight-Lessons-from-Shenzhen-and-Shanghai?language=en_US.

EC (2014), *Regulation (EU) No 333/2014 of the European Parliament and of the Council*. Retrieved October 30, 2020, from European Commission: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.103.01.0015.01.ENG.

EC (2019a), *The European Green Deal.* Retrieved October 30, 2020, from European Commission: https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf.

EC (2019b), *Directive (EU) 2019/1161 of the European Parliament and of the Council of 20 June 2019 amending Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles*. Retrieved October 30, 2020, from European Commission: https://eur-lex.europa.eu/eli/dir/2019/1161/oj

EC (2020a), *CO2 emission performance standards for cars and vans (2020 onwards)*. Retrieved October 30, 2020, from European Commission: https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en.

EC (2020b), *Stepping up Europe's 2030 climate ambition.* Retrieved from European Commission: https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/com_2030_ctp_en.pdf.

EC (2020c), *Sustainability requirements for rechargeable batteries - Presentation at Mapping standards for low- and zero-emission electric heavy duty vehicles EXPERT WORKSHOP.* Retrieved October 30, 2020, from European Commission: www.itf-oecd.org/sites/default/files/docs/sustainability-requirements-rechargeable-batteries-eu-legislation-santos.pdf.

EC (2020d), *Commission announces actions to make Europe's raw materials supply more secure and sustainable.* Retrieved October 30, 2020, from European Commission: https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1542.

Edwards, R. et al. (2011), Well-to-wheels analysis of future automotive fuels and powertrains in the European context TTW Appendix 1. JRC Scientific and Technical Reports. (88). Retrieved from https://doi.org/10.2788/79018.

EFAHRER (2019), *Ford Transit Custom PHEV im Test: Transport-Urgestein mit Stecker (Testing the Ford Transit Custom PHEV: A classic with plug)*. Retrieved October 30, 2020, from EFAHRER: https://efahrer.chip.de/elektroautos/ford-transit-custom-plug-in-hybrid_20336.

FedEx (2018), *FedEx Acquires 1,000 Chanje Electric Vehicles*. Retrieved October 30, 2020, from FedEx: https://newsroom.fedex.com/newsroom/fedex-acquires-1000-chanje-electric-vehicles/.

Fehrenbacher, K. (2020), *How IKEA plans to deliver its goods via electric trucks and vans*. Retrieved October 30, 2020, from GreenBiz: www.greenbiz.com/article/how-ikea-plans-deliver-its-goods-electric-trucks-and-vans.

Fenglianyun (2019), *菜鸟、京东、苏宁等布局新能源物流车 (Cainiao, JD.com, Suning and others deploy new energy logistics vehicles)*. Retrieved October 2020, 2020, from Fenglian Cloud Public Service Platform: www.ssccs.net/f/view-c707f0e20c7742a683bd7d750f9f3cc8-ca9c4e66c0ef4f038c24ad4fcd3757d6.html?type=hotspot&source=.

Fiat (2020a), *E-Ducato.* Retrieved from Fiat Profeassional: www.fiatprofessional.com/content/dam/fiatprofessional/cross/modale-brochure/E-Ducato-electric.pdf.

Fiat (2020b), *Price list E Ducato*. Retrieved from Fiat Professional: www.media.fcaemea.com/uploads/uk/attachment/fiateducatotechspecandpricing200820-5f3d1ecd1f02f.pdf.

Flipkart (2020), *100% electric mobilty by 2030 - Flipkart drives towards sustainabilty with EV100*. Retrieved October 30, 2020, from Flipkart: https://stories.flipkart.com/100-electric-mobility-by-2030-flipkart-drives-towards-sustainability-with-ev100/.

Ford (2020a), *Ford Transit Custom Plug-In Hybrid (PHEV)*. Retrieved October 30, 2020, from Ford: www.ford.de/service/ihre-mobilitaet/ask-ford/nutz-und-flottenfahrzeuge/nutzfahrzeuge-allgemein/ford-transit-custom-plug-in-hybrid-phev.

Ford (2020b), *2022 All Electric Transit.* Retrieved October 30, 2020, from Ford: www.ford.com/commercial-trucks/all-electric-transit/2022/.

Fries, M. et al. (2017), *An Overview of Costs for Vehicle Components, Fuels, Greenhouse Gas Emissions and Total Cost of Ownership.* Retrieved from UC Davis: https://steps.ucdavis.edu/wp-content/uploads/2018/02/FRIES-MICHAEL-An-Overview-of-Costs-for-Vehicle-Components-Fuels-Greenhouse-Gas-Emissions-and-Total-Cost-of-Ownership-Update-2017-.pdf.

Gibbs, N. (2020), *How UPS aims to energize market for low-CO2 vans*. Retrieved October 30, 2020, from Automotive News Europe: https://europe.autonews.com/automakers/how-ups-aims-energize-market-low-co2-vans.

Gibory, P. E. (2019), *La Poste, numéro un mondial des flottes « branchées » (La Poste, the world leader for plugged fleets)*. Retrieved October 30, 2020, from Le Monde: www.lemonde.fr/economie/article/2019/04/08/la-poste-numero-un-mondial-des-flottes-branchees_5447176_3234.html.

Government of Canada (2014), *Regulations Amending the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations*. Retrieved October 30, 2020, from Government of Canada: www.gazette.gc.ca/rp-pr/p2/2014/2014-10-08/html/sor-dors207-eng.html.

Government of China (2020), *2020年9月汽车工业经济运行情况 (Economic operation of the auto industry in September 2020).* Retrieved October 30, 2020, from Ministry of Industry and Information Technology: www.miit.gov.cn/n1146312/n1146904/n1648362/n1648363/c8114568/content.html.

Government of Germany (2020), *Verkehr in Kilometern (VK) (traffic in kilometres)*. Retrieved 30 October, 2020, from Kraftfahrt Bundesamt: www.kba.de/DE/Statistik/Produktkatalog/produkte/Kraftverkehr/vk_uebersicht.html?nn=1146130.

Government of the Netherlands (2020), *Kamerbrief over afspraken zero-emissie stadslogistiek (Letter to parliament about agreements on zero-emission city logistics).* Retrieved October 30, 2020, from Rijksoverheid: www.rijksoverheid.nl/documenten/kamerstukken/2020/10/05/afspraken-zero-emissie-stadslogistiek.

Government of UK (2017), *Result of Competition: OLEV Low Emission Freight Demonstration - Stream 1.* Retrieved from Innovate UK: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/641549/OLEV_Low_Emission_Freight_Demonstration_-_Stream_1_-_Competition_Results....pdf.

Government of UK (2018), *Smart Electric Urban Logistics.* Retrieved from World Sustainable Business Council: https://wbcsdtools.org/goev/wp-content/uploads/2020/06/UPS-Electric-Vehicles-Case-Study.pdf.

Greis, F. (2019), *Der chinesische E-Transporter zum Kampfpreis (The Chinese e-van at a competetive price)*. Retrieved October 30, 2020, from Golem: www.golem.de/news/probefahrt-mit-maxus-ev80-der-chinesische-e-transporter-zum-kampfpreis-1907-142495.html.

Groupe Renault (2020a), *Master Z.E.* Retrieved from Groupe Renault: https://cdn.group.renault.com/ren/be/transversal-assets/brochures/vn/fr/Master_ZE.pdf.asset.pdf/1555580524405.pdf.

Groupe Renault (2020b), *Renault KANGOO Z.E.* Retrieved from Renault Nutzfahrzeuge: https://cdn.group.renault.com/ren/at/renaultat/downloadcenter/kangoo-ze/kangoo-ze-preisliste.pdf.

Hampel, C. (2020), *FedEx and Chanje roll out DC charging infrastructure*. Retrieved October 30, 2020, from Electrive: www.electrive.com/2020/03/01/fedex-and-changje-roll-out-dc-charging-infrastructure/.

Hawkins, A. J. (2019), *Amazon will order 100,000 electric delivery vans from EV startup Rivian, Jeff Bezos says*. Retrieved October 30, 2020, from The Verge: www.theverge.com/2019/9/19/20873947/amazon-electric-delivery-van-rivian-jeff-bezos-order.

Hodgson, C. (2018), *UPS moves to using only electric vehicles in London*. Retrieved October 30, 2020, from Financial Times: www.ft.com/content/fe262594-2904-11e8-b27e-cc62a39d57a0.

Honda (2017), *Japan Post and Honda Enter Discussions on Collaboration Toward the Establishment of Social Infrastructure*. Retrieved October 30, 2020, from Honda: https://global.honda/newsroom/news/2017/c170323eng.html.

ICCT (2019), *Japan 2030 fuel economy standards*. Retrieved from International Council on Clean Transportation: https://theicct.org/sites/default/files/publications/Japan_2030_fuel_standard_update_20191007.pdf.

IEA & ICCT (2019), *Fuel economy in major car markets: Technology and policy drivers 2005-2017 Working paper 19.* Retrieved from Global Fuel Economy Initiative: www.globalfueleconomy.org/media/708177/gfei-wp19.pdf.

IEA (2016), *Major countries commit to increase the share of electric vehicles in government fleets*. Retrieved October 30, 2020, from International Energy Agency: www.iea.org/news/major-countries-commit-to-increase-the-share-of-electric-vehicles-in-government-fleets.

IEA (2017), *The Future of Trucks.* Retrieved from International Energy Agency: www.iea.org/reports/the-future-of-trucks.

IEA (2018a), *Global EV Outlook 2018.* Retrieved from International Energy Agency: https://webstore.iea.org/global-ev-outlook-2018.

IEA (2018b), *Nordic EV Outlook 2018.* Retrieved from International Energy Agency: https://webstore.iea.org/nordic-ev-outlook-2018.

IEA (2019), *Global EV Outlook 2019.* Retrieved from International Energy Agency: https://webstore.iea.org/download/direct/2807?fileName=Global_EV_Outlook_2019.pdf.

IEA (2020a), *Global EV Outlook 2020.* Retrieved from International Energy Agency: www.iea.org/reports/global-ev-outlook-2020.

IEA (2020b), *IEA Mobilty Model.* Retrieved October 30, 2030, from International Energy Agency: www.iea.org/areas-of-work/programmes-and-partnerships/the-iea-mobility-model.

IEA (2020c), *Renewables 2019.* Retrieved from International Energy Agency: www.iea.org/reports/renewables-2019.

IEA (2020d), *Emission factors*. Retrieved October 30, 2020, from International Energy Agency: www.iea.org/subscribe-to-data-services/co2-emissions-statistics.

Ingka Group (2020a), *Webinar presentation by Ms Angela Hultberg, Global Head of Sustainable Mobility for Ingka Group*. Retrieved October 30, 2020, from Zero Emission Zones for Freight: Lessons from Shenzhen and Shanghai: www.c40knowledgehub.org/s/article/Zero-Emission-Zones-for-Freight-Lessons-from-Shenzhen-and-Shanghai?language=en_US.

Ingka Group (2020b), *IKEA tests new electric vehicle prototypes*. Retrieved October 30, 2020, from Ingka: www.ingka.com/news/ikea-tests-new-electric-vehicle-prototypes/.

IRENA (2019), *Utility-scale batteries.* Retrieved October 30, 2020, from International Renewable Energy Agency: www.irena.org/publications/2019/Sep/Utility-scale-batteries.

IRENA (2020), *Renewable Power Generation Costs in 2019.* Retrieved October 30, 2020, from International Renewable Energy Agency: www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019.

ITF (2020a), *Electric Mobility: Taking the Pulse in Times of Coronavirus*. Retrieved from International Transport Forum: www.itf-oecd.org/sites/default/files/electric-vehicles-covid-19.pdf.

ITF (2020b), *Good to Go? Assessing the Environmental Performance of New Mobility.* Retrieved from International Transport Forum: www.itf-oecd.org/sites/default/files/docs/environmental-performance-new-mobility.pdf.

ITF (2020c), *Electrifying postal delivery vehciles in Korea.* Retrieved from International Transport Forum: www.itf-oecd.org/sites/default/files/docs/electrifying-postal-delivery-vehicles-korea_0.pdf.

ITF, (2020d), *Regulations and Standards for Clean Trucks and Buses*. Retrieved from International Transport Forum: www.itf-oecd.org/regulations-and-standards-clean-trucks-and-buses.

IVECO (2020a), *Daily Electric*. Retrieved October 30, 2020, from IVECO: www.iveco.com/germany/neufahrzeuge/pages/daily-blue-power-electric.aspx#form-bottom.

IVECO (2020b), *New Daily.* Retrieved October 30, 2020, from IVECO: https://cdn.ipaper.io/iPaper/Files/889e16e9-f75f-452a-a8fe-668e75c4d222.pdf?Policy=eyJTdGF0ZW1lbnQiOlt7IlJlc291cmNlIjoiaHR0cHM6Ly9jZG4uaXBhcGVyLmlvL2lQYXBlci9GaWxlcy8qIiwiQ29uZGl0aW9uIjp7IkRhdGVMZXNzVGhhbiI6eyJBV1M6RXBvY2hUaW1lIjoxNjMzMDA1NzU4fX19XX0_&Sig.

Japan Post Group (2019), *Annual Report*. Retrieved October 30, 2020, from Japan Post Group: www.japanpost.jp/en/ir/library/disclosure/2019/pdf/all.pdf.

Lambert, F. (2020), *Closer look at Rivian's electric delivery van for Amazon*. Retrieved October 30, 2020, from Electrek: https://electrek.co/2020/02/06/rivian-amazon-electric-delivery-van-closer-look/.

Le Groupe La Poste (2019), *Chronopost : livraison 100% propre et lancement de ChronoCity à Paris*. Retrieved October 30, 2020, from Le Groupe La Poste: www.groupelaposte.com/fr/article/chronopost-livraison-100-propre-et-lancement-de-chronocity-a-paris.

LEVC (2020), *VN5 features*. Retrieved October 30, 2020, from LEVC: www.levc.com/vn5-features/.

L'internaute (2020), *Zones à faibles émissions (ZFE) : quelles villes concernées ? Les dates (Low emission zones: Which cities are concerned?).* Retrieved October 30, 2020, from www.linternaute.fr/auto/guide-pratique-auto/2227989-zones-a-faibles-emissions-zfe-quelles-villes-concernees-les-dates/.

Mahindra (2020), *e Supro*. Retrieved October 30, 2020, from Mahindra: www.mahindrasupro.com/esupro/discover-the-new-verito.aspx.

Manthey, N. (2019), *Chronopost expands electric van fleet in France*. Retrieved October 30, 2020, from Electrive: www.electrive.com/2019/10/10/chronopost-expands-electric-van-fleet-in-france/.

Mercedes-Benz (2020a), *Unter der Haube: Die technischen Daten, Maße und Gewicht des eVito Kastenwagen. (Under the hood: Technology specifiations, dimension and weight of the eVito van)*. Retrieved October 30, 2020, from Mercedes Benz: www.mercedes-benz.de/vans/de/vito/e-vito-panel-van/technical-data.

Mercedes-Benz (2020b), *eCost Calculator*. Retrieved October 30, 2020, from Mercedes-Benz: www.mercedes-benz.de/vans/de/mercedes-benz-vans/evan-ecosystem/ecost-calculator.

Miller, J. (2020), *Electric car costs to remain higher than traditional engines*. Retrieved October 30, 2020, from Financial Times: www.ft.com/content/a7e58ce7-4fab-424a-b1fa-f833ce948cb7.

Mitsubishi (2011), *Minicab MiEV*. Retrieved October 30, 2020, from Mitsubishi Motors Corporation: www.mitsubishi-motors.com/en/discoveries/motorshow/2011/tms2011/lineup/minicab-miev.html.

Nissan (2020), *Nissan E-NV200 Prices and Specifications.* Retrieved from Nissan: www-europe.nissan-cdn.net/content/dam/Nissan/gb/brochures/Vehicles/Nissan_e-NV200_van_UK.pdf.

NOW (2020), *ZUKUNFT.DE*. Retrieved October 30, 2020, from NOW GmbH Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie: www.now-gmbh.de/de/bundesfoerderung-elektromobilitaet-vor-ort/projektfinder/elektromobilitaet-vor-ort/zukunft-de.

NREL (2020), *Declining Renewable Costs Drive Focus on Energy Storage*. Retrieved October 30, 2020, from National Renewable Energy Laboratory: www.nrel.gov/news/features/2020/declining-renewable-costs-drive-focus-on-energy-storage.html.

OECD (2019), *Tax Revenue Implications of Decarbonising Road Transport.* Retrieved from Organisation for Economic Co-operation and Development: www.oecd-ilibrary.org/taxation/tax-revenue-implications-of-decarbonising-road-transport-scenarios-for-slovenia_87b39a2f-en.

O'Kane, S. (2020), *General Motors is reportedly working on an electric delivery van*. Retrieved October 30, 2020, from The Verge: www.theverge.com/2020/6/4/21280862/gm-bv1-electric-van-delivery-ultium-amazon-ford-transit.

Österreichische Post AG (2020a), *Sustainability Report 2019.* Retrieved from https://assets.post.at/-/media/Dokumente/En/Ueber-Uns/Investor-Relations/Geschaefts--und-Nachhaltigkeitsberichte/Austrian-Post-Sustainability-Report-2019.pdf?rev=1b0284f7-ee3c-4f47-b471-6a1148f1f5e3.

Österreichische Post AG (2020b), *Annual Report 2019.* Retrieved from Österreichische Post AG: https://assets.post.at/-/media/Dokumente/En/Ueber-Uns/Investor-Relations/Geschaefts--und-Nachhaltigkeitsberichte/Austrian-Post-Annual-Report-2019.pdf?rev=3e037224-68af-4e04-bfc2-3448ca314b59.

Peugot (2019), *Peugot Partner.* Retrieved October 30, 2020, from Peugot: https://media.peugeot.de/file/09/6/katalog-peugeot-partner-dezember-2019.621096.pdf#_ga=2.241745154.1693824045.1603455186-114459261.1603455186.

PG&E (2020), *Fuel savings calculator*. Retrieved October 30, 2020, from Pacific Gas and Electric Company: https://fleets.pge.com/fuel-savings.

Plötz, P. et al. (2020), *Real-world usage of plug-in hybrid electric vehicles: Fuel consumption, electric driving, and CO2 emissions.* Retrieved from https://theicct.org/publications/phev-real-world-usage-sept2020.

Post&Parcel (2011), *La Poste orders 10,000 electric vehicles from Renault*. Retrieved October 30, 2020, from Post&Parcel: https://postandparcel.info/43283/news/la-poste-orders-10000-electric-vehicles-from-renault/.

PostNL (2019), *Sustainable city logistics on the rise at PostNL*. Retrieved October 30, 2020, from PostNL: www.postnl.nl/en/about-postnl/press-news/news/2019/sustainable-city-logistics-on-the-rise-at-postnl.html.

Royal Mail (2020a), *Royal Mail introduces more electric vehicles in London*. Retrieved October 30, 2020, from Royal Mail: www.royalmailgroup.com/en/press-centre/press-releases/royal-mail/royal-mail-introduces-more-electric-vehicles-in-london/.

Royal Mail (2020b), *Annual report and financial statement 2019-20.* Retrieved October 30, 2020, from Royal Mail: www.royalmailgroup.com/media/11212/royal-mail-plc-annual-report-and-accounts-2019-20.pdf.

SAIC (2020), *Maxus EV 80*. Retrieved October 30, 2020, from SAIC: www.maxusev80.com/.

Schaal, S. (2020a), *Citroën ë-Jumper kommt noch dieses Jahr (Citroën ë-Jumper to be launched this year)*. Retrieved October 30, 2020, from electrive.net: www.electrive.net/2020/09/07/citroen-e-jumper-kommt-noch-dieses-jahr/.

Schaal, S. (2020b). *Peugeot e-Expert: Das Nutzfahrzeug-Trio von PSA ist komplett (Peugot e-Expert: PSA's commercial vehicle trio is complete)*. Retrieved October 30, 2020, from electrive.net: www.electrive.net/2020/05/14/peugeot-e-expert-das-nutzfahrzeug-trio-von-psa-ist-komplett/.

Schaal, S. (2020c), *Verkauf geplatzt: Post will StreetScooter-Fertigung einstellen (No deal: Post will cease StreetScooter production)*. Retrieved October 30, 2020, from Electrive: www.electrive.net/2020/02/28/deutsche-post-will-streetscooter-fertigung-noch-2020-einstellen/.

Smart Freight Centre (2020), *Low Emission Fuels and Vehicles for Road Freight: introductory guide to support the transition to zero emissions*. Retrieved October 30, 2020, from Smart Freight Centre: www.smartfreightcentre.org/en/news/low-emission-fuels-and-vehicles-for-road-freight-introductory-guide-to-support-transition-to-zero-emission/34785/.

Streetscooter (2019), *Streetscooter tools on wheels.* Retrieved from Streetscooter: www.streetscooter.com/wp-content/uploads/2019/01/StreetScooter-Brochure-EN-Web.pdf.

Supreme Court of India (2015), *Order.* Retrieved from https://www.epca.org.in/court_orders/SC_order16-12-2015.pdf.

Swiss Post (2020), *On the road with an electric scooter*. Retrieved October 30, 2020, from Swiss Post: www.post.ch/en/about-us/responsibility/our-priorities/delivery-by-electric-scooter.

Tesla (2020), *Electric Vehicle & Solar Incentives*. Retrieved October 30, 2020, from Tesla: www.tesla.com/support/incentives.

Tevva (2019), *Tevva partners with UPS to provide range extended electric vehicles in Birmingham and Southampton*. Retrieved October 30, 2020, from Tevva: https://tevva.com/tevva-partners-with-ups/.

Toyota (2020), *Toyota Proace Electric: 100% elektrisch zonder compromissen (Toyota Proace Electric: 100% electric without compromises)*. Retrieved October 30, 2020, from Toyota: www.toyota.nl/over-toyota/toyota-world/Toyota-PROACE-elektric-modellen.json.

Transport & Environment (2019), *Leading industry brands call for zero-emission trucks sales targets.* Retrieved from Transport & Environment: https://www.transportenvironment.org/sites/te/files/publications/2019_11_European_Green_Deal_trucks_vans_letter_final.pdf.

Transport for London (2020), *Congestion Charge*. Retrieved October 30, 2020, from Transport for London: https://tfl.gov.uk/modes/driving/electric-vehicles-and-rapid-charging.

Tsakalidis, A. et al. (2020), Electric light commercial vehicles: Are they the sleeping giant of electromobility? *Transportation Research Part D: Transport and Environment, 86*. Retrieved from https://doi.org/10.1016/j.trd.2020.102421.

Tsiakmakis, S. et al. (2017), *From NEDC to WLTP: effect on the type-approval CO2 emissions of light-duty vehicles.* Retrieved from European Commission Joint Research Centre: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC107662/kjna28724enn.pdf.

UNECE (2005), *Special resolution No. 1 Concerning the common definitions of vehicle categories, masses and dimensions.* Retrieved from UN Economic Commission for Europe: www.unece.org/fileadmin/DAM/trans/doc/2005/wp29/TRANS-WP29-1045e.pdf.

UNECE (2017), *Consolidated Resolution on the Construction of Vehicles.* Retrieved from UN Economic Commission for Europe: www.unece.org/fileadmin/DAM/trans/main/wp29/wp29resolutions/ECE-TRANS-WP.29-78r6e.pdf.

UPS (2018), *UPS To Deploy New, State-Of-The-Art Electric Vehicles In London And Paris*. Retrieved October 30, 2020, from UPS Pressroom: www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1525867012405-924.

UPS (2019), *UPS's Investment In Breakthrough Lower-Emissions Tech Zaps The E-Vehicle Range Challenge In The UK*. Retrieved October 30, 2030, from UPS: www.pressroom.ups.com/pressroom/ContentDetailsViewer.page?ConceptType=PressReleases&id=1567522217503-928.

US EPA (2020), *The safer affordable fuel efficient (SAFE) vehicles proposed rule for model years 2021-2026*. Retrieved October 30, 2020, from United States Environmental Protection Agency: www.epa.gov/regulations-emissions-vehicles-and-engines/safer-affordable-fuel-efficient-safe-vehicles-proposed.

Utilitaire Magazine (2018), *Guide grand fourgon ou grande camionnette (Guide large van or large light truck)*. Retrieved October 30, 2020, from Utilitaire Magazine: www.utilitairemagazine.com/fourgon-camionnette/guide-grand-fourgon-ou-grande-camionnette/.

Vie publique (2019), *Loi du 24 décembre 2019 d'orientation des mobilités (Mobillity strategy law of 24 December 2019).* Retrieved October 30, 2020, from www.vie-publique.fr/loi/20809-loi-du-24-decembre-2019-dorientation-des-mobilites-lom.

Volkswagen Nutzfahrzeuge (2019), *Der e-Crafter. Kataloge und Preislisten (The e-Crafter. Brochures and pricelists*. Retrieved from Volkswagen Nutzfahrzeuge: www.volkswagen-nutzfahrzeuge.de/idhub/content/dam/onehub_nfz/importers/de/download/kataloge/Volkswagen-Nutzfahrzeuge-Der-e-Crafter-Katalog.pdf.

Volkswagen Nutzfahrzeuge (2020), *Der neue ABT e-Transporter 6.1 (The new ABT e-Transporter)*. Retrieved October 30, 2020, from Volkswagen Nutzfahrzeuge: www.volkswagen-nutzfahrzeuge.de/de/elektromobilitaet/modelle/abt-e-transporter-6-1.html.

wattEV2buy (2020a), *BAIC Weiwang 407 EV*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/electric-vehicles/baic/baic-407-ev-ldv-specs-range-battery-price-sales/.

wattEV2buy (2020b), *BYD T3*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/electric-vehicles/byd-electric-vehicles/byd-t3-ev-ldv-specs-range-charge-cost-price-charge-time/.

wattEV2buy (2020c), *FAW JIABAO V80LEV*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/faw-jiabao-v80l-ev-review-compare/.

wattEV2buy (2020d), *Changhe EC100*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/electric-vehicles/changhe-ev-models/changhe-suzuki-big-dipper-e-mpv-ev-specs-range-battery-price/.

wattEV2buy (2020e), *Karry YoYo*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/electric-vehicles/chery-auto/chery-karry-yoyo-em-3-ev-mpv-specs-range-battery-price/.

wattEV2buy (2020f), *Fengon Xiaokang EC36*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/dongfeng-xiaokang-ec36/page/4/?et_blog.

wattEV2buy (2020g), *Ruichi EC35*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/electric-vehicles/chongqing-jinkang-electric-vehicles/sokon-ruichi-ec35-ldv-electric-vehicle-specs-range-charging-time/.

wattEV2buy (2020h), *Joylong EW5*. Retrieved October 30, 2020, from wattEV2buy: https://wattev2buy.com/joylong-ew5-ev-lcv/.

wattEV2buy (2020i), *Chinese Electric Vehicles*. Retrieved October 30, 2030, from wattEV2buy: https://wattev2buy.com/list-chinese-electric-cars-list-chinese-ev-car-brands/.

WRI (2020), *Zero Emission Zones for Freight: Lessons from Beijing - Webinar presentation from Lulu Xue, Urban Mobility Manager at WRI-China*. Retrieved October 30, 2020, from C40 Knowledge Hub: www.c40knowledgehub.org/s/article/Zero-Emission-Zones-for-Freight-Lessons-from-Beijing?language=en_US

International Transport Forum

How Urban Delivery Vehicles can Boost Electric Mobility

This report presents policies and private sector initiatives for the electrification of urban delivery vehicles. Electric vehicles have low operational costs and the high mileage of delivery vehicles maximises net savings from converting a fleet. Insights on the total cost of ownership and the environmental footprint of electric fleets highlight broader benefits of electrification programmes for commercial vehicles.

International Transport Forum
2 rue André Pascal
F-75775 Paris Cedex 16
+33 (0)1 73 31 25 00
contact@itf-oecd.org
www.itf-oecd.org

OECD

Published: 12/2020 | Photo credit: Valdis Skudre | Shutterstock