Global EV Outlook 2021

Accelerating ambitions despite the pandemic

ELECTRIC VEHICLES INITIATIVE
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

CLEAN ENERGY MINISTERIAL
Accelerating the Transition to Clean Energy Technologies

INTERNATIONAL ENERGY AGENCY

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Abstract

The Global EV Outlook is an annual publication that identifies and discusses recent developments in electric mobility across the globe. It is developed with the support of the members of the Electric Vehicles Initiative (EVI).

Combining historical analysis with projections to 2030, the report examines key areas of interest such as electric vehicle (EV) and charging infrastructure deployment, energy use, CO_2 emissions and battery demand. The report includes policy recommendations that incorporate learning from frontrunner markets to inform policy makers and stakeholders that consider policy frameworks and market systems for electric vehicle adoption.

This edition also features an update of the electric heavy-duty vehicle models coming onto commercial markets and slotted for release in the coming few years, and on the status of development of megachargers. It compares the electric vehicle supply equipment per EV with the recommended AFID targets. It also analyses the impact of EV uptake on governments' revenue from fuel taxation. Finally, it makes available for the first time two online tools: the Global EV Data Explorer and Global EV Policy Explorer, which allow users to interactively explore EV statistics and projections, and policy measures worldwide.

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Executive summary

Strong momentum in electric vehicle markets despite the pandemic

There were 10 million electric cars on the world's roads at the end of 2020, following a decade of rapid growth. Electric car registrations increased by 41% in 2020, despite the pandemic-related worldwide downturn in car sales in which global car sales dropped 6%. Around 3 million electric cars were sold globally (a 4.6% sales share), and Europe overtook the People's Republic of China ("China") as the world's largest electric vehicle (EV) market for the first time. Electric bus and truck registrations also expanded in major markets, reaching global stocks of 600 000 and 31 000 respectively.

The resilience of EV sales in the face of the pandemic rests on three main pillars:

- *Supportive regulatory frameworks*: even before the pandemic many countries were strengthening key policies such as CO_2 emissions standards and zero-emission vehicle (ZEV) mandates. By the end of 2020, more than 20 countries had announced bans on the sales of conventional cars or mandated all new sales to be ZEVs.
- *Additional incentives* to safeguard EV sales from the economic downturn: some European countries increased their purchase incentives and China delayed the phase-out of its subsidy scheme.
- The number of EV models expanded and battery cost continued to fall.

Vehicle manufacturers announced increasingly ambitious electrification plans. Out of the world's top 20 vehicle manufacturers, which represented around 90% of new car registrations in 2020, 18 have stated plans to widen their portfolio of models and to rapidly scale up the production of light-duty electric vehicles. The model availability of electric heavy-duty vehicles is also broadening, with four major truck manufacturers indicating an all-electric future.

Consumer spending on electric car purchases increased to USD 120 billion in 2020. In parallel, governments across the world spent USD 14 billion to support electric car sales, up 25% from 2019, mostly from stronger incentives in Europe. Nonetheless, the share of government incentives in total spending on electric cars has decreased over the past five years, suggesting that EVs are becoming increasingly attractive to consumers.

The near-term outlook for EV sales is bright. In the first-quarter of 2021, global electric car sales rose by around 140% compared to the same period in 2020, driven by sales in China of around 500 000 vehicles and in Europe of around 450 000. US sales more than doubled relative to the first-quarter of 2020, albeit from a much lower base.

EVs are set to be a more common sight on the world's roads in the 2020s

Existing policies around the world suggest healthy growth over this decade: in the Stated Policies Scenario, the EV stock across all modes (except two/three-wheelers) reaches 145 million in 2030, accounting for 7% of the road vehicle fleet.

EV markets could be significantly larger if governments accelerate efforts to reach climate goals. In the Sustainable Development Scenario, the global EV fleet reaches 230 million vehicles in 2030 (excluding two/three-wheelers), a stock share of 12%.

The expanding fleet of EVs will continue to reduce well-to-wheel GHG emissions, with the net savings relative to internal combustion engine (ICE) vehicles increasing over time depending on the pace at which electricity generation decarbonises. In 2030, in the Stated Policies Scenario, the global EV fleet reduces GHG emissions by more than one-third compared to an equivalent ICE vehicle fleet; in the Sustainable Development Scenario, the level rises to two-thirds.

Policies need to leverage momentum to further accelerate electrification

Even with the recent success of EV deployment, reaching a trajectory consistent with climate goals is a formidable challenge. It requires stronger ambition and action from all countries. Advances in battery technology and mass manufacturing will continue to drive down the cost of EVs.

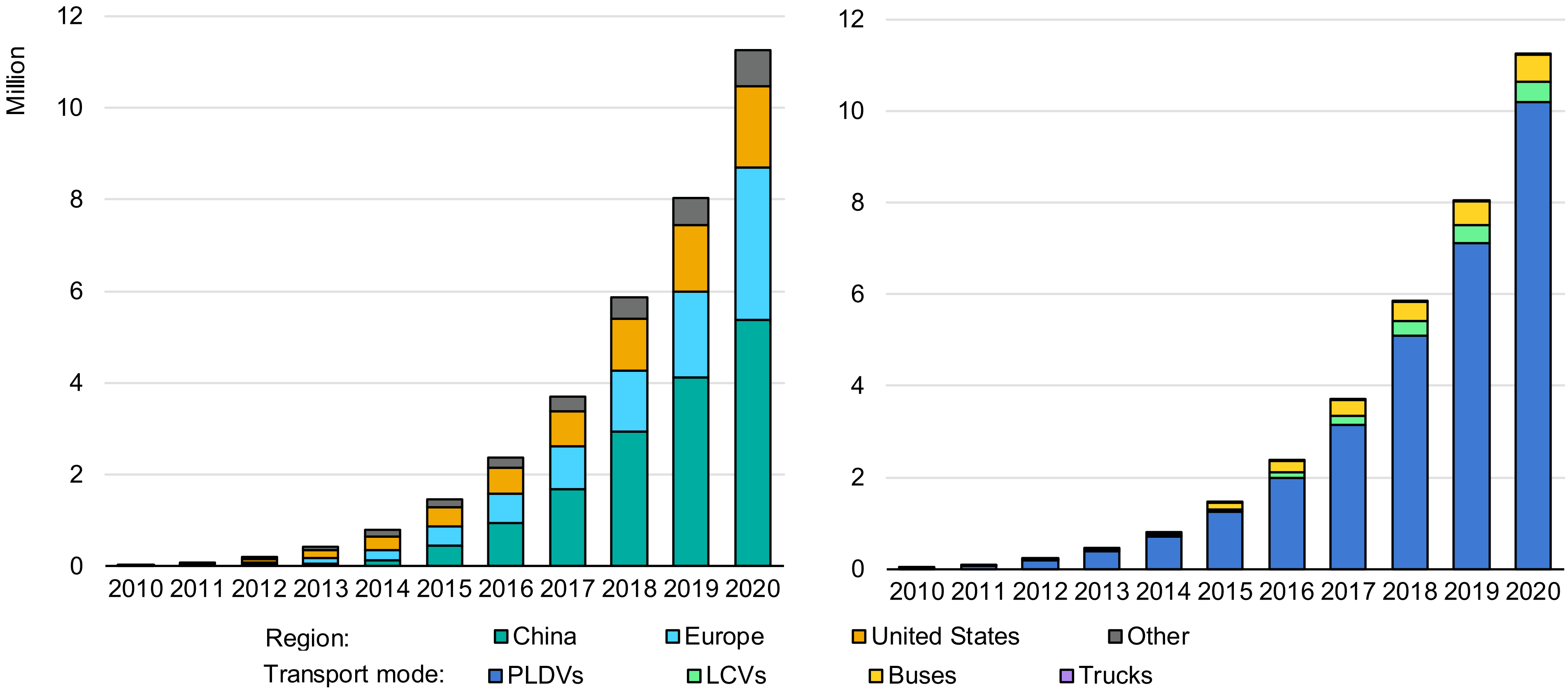
But the 2020s will need to see more than just the mass adoption of electric light-duty vehicles to meet climate goals. Governments will also need to put in place policies to promote the roll-out of zero-emission vehicles in the medium- and heavy-duty vehicle segments and the correponding fast-charging infrastructure.

In the short term, countries can continue to implement, enforce and tighten measures such as CO_2 and fuel economy standards and EV mandates.Taxing gasoline and diesel at rates that reflect their environmental and human health impacts can provide government revenue, reduce their negative impacts and hasten the transition to electric mobility. Differentiated taxation of vehicles and fuels that reflect their environmental performance can further align markets with the climate benefits of EVs.

In order for electric vehicles to attain their full potential to mitigate carbon emissions, critical progress is required to decarbonise electricity generation, to integrate electric vehicles in power systems, to build charging infrastructure and to advance sustainable battery manufacturing and their recycling.

Electric vehicles across all transport modes had steady growth over the last decade

Global electric vehicle stock by region (left) and transport mode (right), 2010-2020



Notes: PLDVs = passenger light-duty vehicles, LCVs = light-commercial vehicles. Electric vehicles include battery electric and plug-in hybrid electric vehicles. Europe includes EU27, Norway, Iceland, Switzerland and United Kingdom. Other includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand.

Sources: IEA analysis based on country submissions, complemented by ACEA (2021); CAAM (2021); EAFO (2021); EV Volumes (2021) and Marklines (2021).

Introduction

Overview

Vehicle manufacturers and policy makers are boosting their attention and actions related to electric vehicles (EVs). EV technologies such as full battery electric and plug-in hybrid electric models are attactive options to help reach environmental, societal and health objectives.

In addition to being two- to four-times more efficient than conventional internal combustion engine models, EVs can reduce reliance on oil-based fuels and, if running on low-carbon power, can deliver significant reductions in greenhouse gas emissions. Plus, with zero tailpipe emissions, EVs are well suited to help solve air pollution issues. Moreover, EVs are driving advances in battery technology – a key issue for industrial competitiveness in the transition to clean energy.

EV fleets are expanding at a fast pace in several of the world's largest vehicle markets. The costs of batteries and EVs are dropping. Charging infrastructure is expanding. This progress promotes electrification of transport modes such as two/three-wheelers, light-duty vehicles (LDVs) (cars and vans), taxis and shared vehicles, buses and heavy-duty vehicles with short range requirements such as urban deliveries. Manufacturers are continuing to expand the number of EV models available to customers.

Effective policies still needed to address upfront investment costs, promote EV charging infrastructure and ensure a smooth integration of charging demand in power systems. With foundations being laid for widespread adoption of EVs in several large economies, there are strong prospects that the 2020s will be the decade in which electric mobility significantly expands.

The *Global EV Outlook 2021* – the flagship annual publication of the Electric Vehicles Initiative – analyses the worldwide status of electric mobility. It considers the factors that have influenced recent developments, technological prospects and the outlook for EV deployment in the period to 2030. The analysis is presented in three chapters:

Chapter 1 discusses trends in electric mobility with historical data on EV registrations and stock, and availability of charging infrastructure to the end of 2020. It explores the main factors driving electrification of road transport, including roll-out plans from the private sector and other developments to April 2021.

Chapter 2 provides an overview of the current policy framework relevant to both light-duty and heavy-duty EVs to April 2021. It highlights measures undertaken by governments to shield the EV market from the impact of the Covid-19 panademic.

Chapter 3 presents the outlook for EVs and chargers to 2030. It assesses their impacts on energy use, greenhouse gas emissions, battery production volumes and revenue from taxes.

Electric Vehicles Initiative

Electric Vehicles Initiative aims to accelerate EV deployment

The Electric Vehicles Initiative (EVI) is a multi-governmental policy forum established in 2010 under the Clean Energy Ministerial (CEM). Recognising the opportunities offered by EVs, the EVI is dedicated to accelerating the adoption of EVs worldwide.To do so, it strives to better understand the policy challenges related to electric mobility, help governments address them and to serve as a platform for knowledge sharing.

The EVI facilitates exchanges between government policy makers that are committed to supporting EV development and a variety of partners, bringing them together twice a year. Its multilateral nature, openness to various stakeholders and engagement at different levels of governance (from country to city-level) offer fruitful opportunities to exchange information and to learn from experiences developed by a range of actors in the transition to electric mobility.

The International Energy Agency (IEA) serves as the co-ordinator to support the EVI member governments in this activity. Governments that have been active in the EVI in the 2020-21 period include Canada, Chile, People's Republic of China (hereafter "China"), Finland, France, Germany, India, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, Sweden and United Kingdom. Canada and China co-lead the initiative. Greece and Ghana are observers.

The EVI also helps to raise the ambition levels for electric mobitlity worldwide through the linked CEM campaigns of EV30@30 and Global Commercial Vehicle Drive to Zero Campaign, each endorsed by different members.

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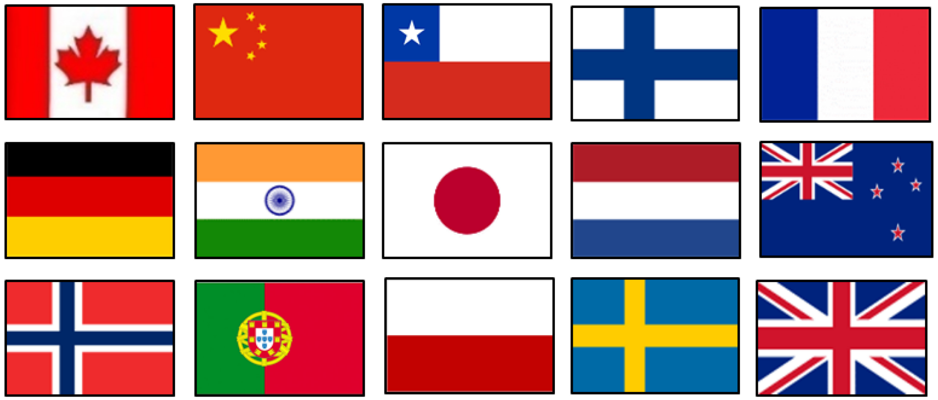


Electric Vehicles Initiative campaigns

EV30@30 and the Drive to Zero campaigns support EV deployment

EV30@30 Campaign

The EV30@30 Campaign was launched at the CEM meeting in 2017 to spur the deployment of EVs. It sets a collective aspirational goal for EVs (excluding two/three-wheelers) to reach 30% sales share by 2030 across all signatory countries. This is the benchmark against which progress is to be measured for the EVI members. Fourteen countries endorsed the campaign: Canada; Chile; China; Finland; France; Germany; India; Japan; Mexico; Netherlands; Norway; Portugal; Sweden and United Kingdom. In addition, 30 companies and organisations support the campaign, including: C40; FIA Foundation; Global Fuel Economy Initiative; Hewlett Foundation; Natural Resources Defence Council; REN21; SLoCaT; The Climate Group; UN Environment Programme; UN Habitat; World Resources Institute; ZEV Alliance; ChargePoint; Energias de Portugal; Enel X; E.ON; Fortum; Iberdrola; Renault-Nissan-Mitsubishi Alliance; Schneider Electric; TEPCO; Vattenfall and ChargeUp Europe.

Coordinated by the IEA, the campaign includes five implementing actions to help achieve the goal in accordance with the priorities and programmes of each EVI member country.

These include:

- Support and track the deployment of EV chargers.
- Galvanise public and private sector commitments to incorporate EVs in company and supplier fleets.
- Scale up policy research and information exchanges.
- Support governments through training and capacity building.
- Establish the Global EV Pilot City Programme to achieve 100 EV-Friendly Cities over five years.

Drive to Zero Campaign

The Global Commercial Vehicle Drive to Zero Campaign was launched at the 2020 CEM meeting and operates as part of the EVI. The campaign, administered by CALSTART, a clean transport non-profit organisation, aims to bring governments and leading industry stakeholders together to collaboratively develop policies, programmes and actions that can support the rapid manufacture and deployment of zero-emission commercial vehicles. Drive to Zero counts more than 100 pledge partners, including nine national governments (as of April 2020) and leading state, provincial and regional governments and agencies from across the world.

Implementing actions of the EV30@30 campaign

GEF-7 Global Programme on electromobility

The GEF-7 Global Electric Mobility Programme, funded by the Global Environment Facility (GEF), will be launched in the second-half of 2021 to help low and middle-income countries shift to electromobility. The programme plans to implement one global project and 27 country projects over a five-year period. The IEA together with the UN Environment Programme (UNEP) will lead the global project, which aims to expand and complement the work of the EVI. Under the global project, the IEA and UNEP along with working groups (focusing on LDVs, two/three-wheelers, heavy-duty vehicles and system integration and batteries) will develop knowledge products to help inform the country projects, with knowledge transfers supported by regional platforms (Africa, Asia, Europe and Latin America/Caribbean). In addition, the data tracking framework used for the annual *Global EV Outlook* reports will be extended to the countries participating in the programme. In part, programme activities will be implemented in collaboration with the European Commission SOLUTIONSPlus Project – an initiative funded by the European Union Horizon 2020 which is focused on EV deployment in urban areas.

EVI Global EV Pilot City Programme

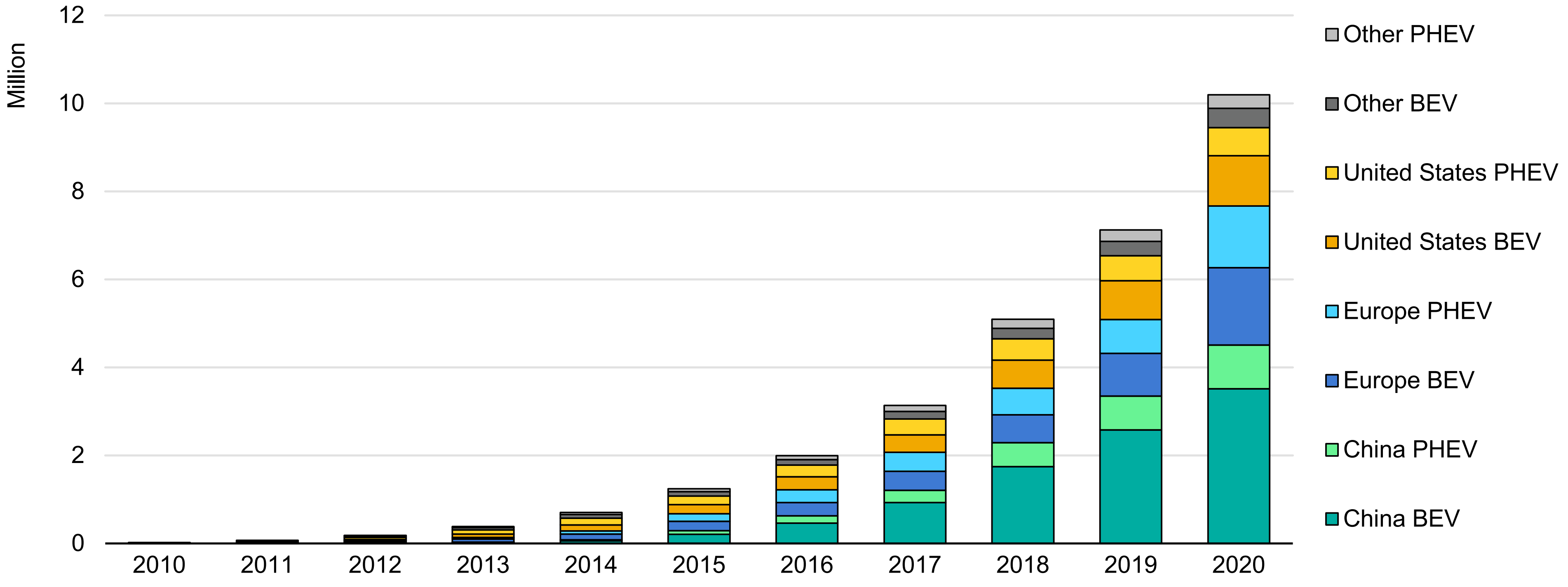
The EVI Global EV Pilot City Programme was launched in May 2018 at the 9th CEM as an initiative of the EV30@30 campaign. It aims to build a network of at least 100 cities over an initial period of five years to work together on the promotion of electric mobility. Its central pillars are to facilitate information exchanges between cities and to encourage best practices, for example through webinars and workshops. Another important element is to develop analytical outputs and reports to help cities and other stakeholders learn from previous experiences of member cities. In March 2021, the EVI Pilot City Programme and the Hybrid and Electric Vehicle Technology Collaboration Programme (HEV TCP) jointly released the third EV Cities Casebook and Policy Guide. It aims to inspire a move towards mass electric mobility by showcasing cities building better and cleaner mobility with EVs. The casebook looks at global case studies of EV innovation, issues policy guidance, and provides analysis of common challenges and lessons learned in order to foster global uptake of electric vehicles in urban areas. The IEA and the Shanghai International Automobile City serve as the joint secretariat of the EVI Global EV Pilot City Programme.

Trends and developments in electric vehicle markets

Trends and developments in electric light-duty vehicles

More than 10 million electric cars were on the world's roads in 2020 with battery electric models driving the expansion

Global electric car stock, 2010-2020

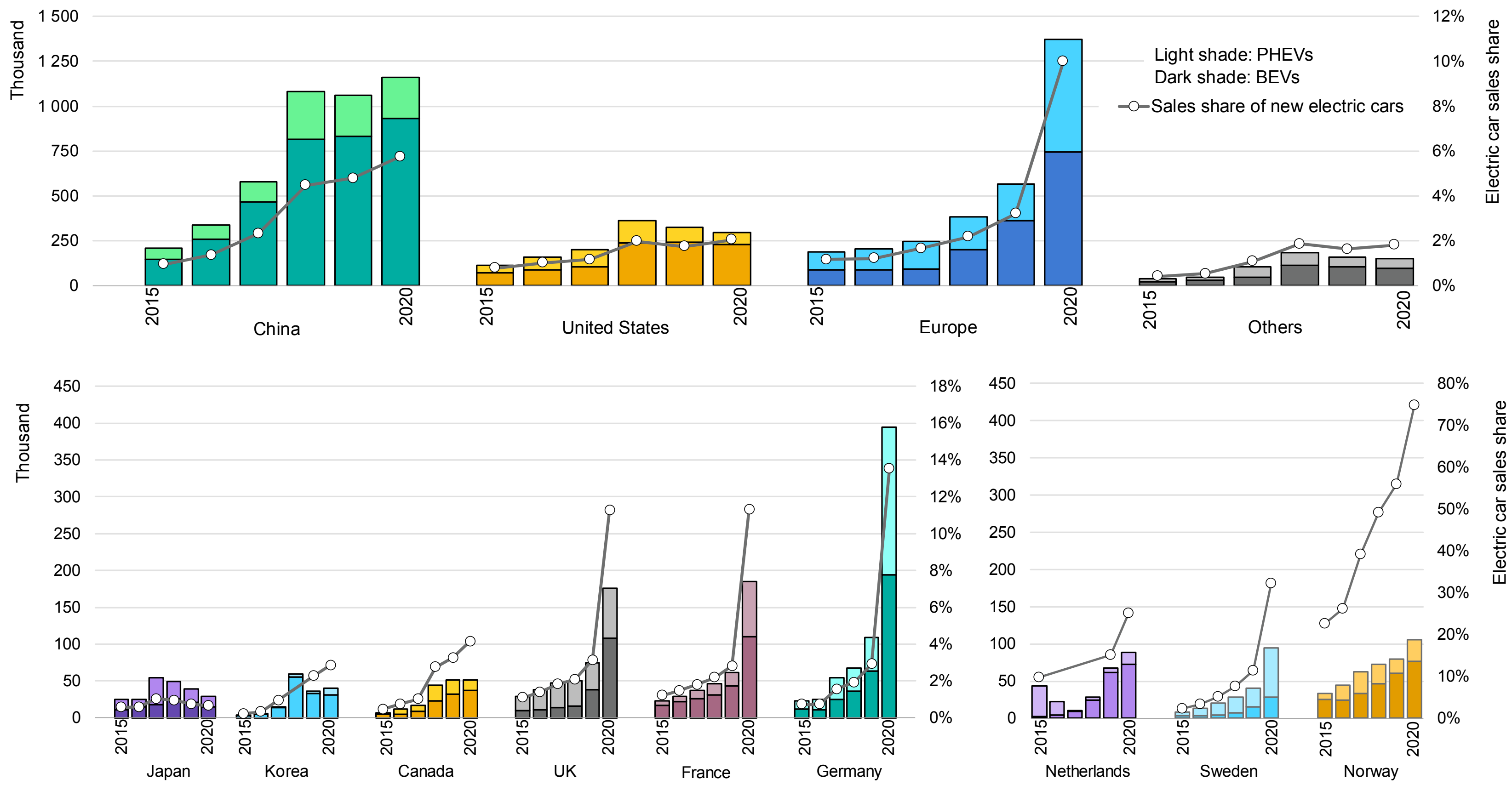


Notes: Electric vehicles include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs). This report focuses on BEVs and PHEVs, i.e. EVs that are fuelled with electricity from the grid. All figures and discussion exclude FCEVs unless otherwise stated. Other includes Australia, Brazil, Canada, Chile, India, Japan, Korea, Malaysia, Mexico, New Zealand, South Africa and Thailand. Europe includes the EU27, Norway, Iceland, Switzerland and United Kingdom. Regional EV stock data can be interactively explored via the Global EV Data Explorer.

Sources: IEA analysis based on country submissions, complemented by ACEA (2021); CAAM (2021); EAFO (2021); EV Volumes (2021) and Marklines (2021).

Electric car registrations increased in major markets in 2020 despite the Covid pandemic

Electric car registrations and sales share in selected countries and regions, 2015-2020



Notes: PHEV = plug-in hybrid electric vehicle; BEV = battery electric vehicle. The selected countries and regions are the largest EV markets and are ordered by size of the total car market in the upper half of the figure and by sales share of electric cars in the lower half. Regional EV registration data can be interactively explored via the Global EV Data Explorer.

Sources: IEA analysis based on country submissions, complemented by ACEA (2021); CAAM (2020); EAFO (2021); EV Volumes (2021) and Marklines (2021).

Electric cars had a record year in 2020, with Europe overtaking China as the biggest market

Global

After a decade of rapid growth, in 2020 the global electric car stock hit the 10 million mark, a 43% increase over 2019, and representing a 1% stock share. Battery electric vehicles (BEVs) accounted for two-thirds of new electric car registrations and two-thirds of the stock in 2020. China, with 4.5 million electric cars, has the largest fleet, though in 2020 Europe had the largest annual increase to reach 3.2 million.

Overall the global market for all types of cars was significantly affected by the economic repercussions of the Covid-19 pandemic. The first part of 2020 saw new car registrations drop about one-third from the preceding year. This was partially offset by stronger activity in the second-half, resulting in a 16% drop overall year-on-year. Notably, with conventional and overall new car registrations falling, global electric car sales share rose 70% to a record 4.6% in 2020.

About 3 million new electric cars were registered in 2020. For the first time, Europe led with 1.4 million new registrations. China followed with 1.2 million registrations and the United States registered 295 000 new electric cars.

Numerous factors contributed to increased electric car registrations in 2020. Notably, electric cars are gradually becoming more competitive in some countries on a total cost of ownership basis. Several governments provided or extended fiscal incentives that buffered electric car purchases from the downturn in car markets.

Europe

Overall Europe's car market contracted 22% in 2020. Yet, new electric car registrations more than doubled to 1.4 million representing a sales share of 10%. In the large markets, Germany registered 395 000 new electric cars and France registered 185 000. The United Kingdom more than doubled registrations to reach 176 000. Electric cars in Norway reached a record high sales share of 75%, up about one-third from 2019. Sales shares of electric cars exceeded 50% in Iceland, 30% in Sweden and reached 25% in the Netherlands.

This surge in electric car registrations in Europe despite the economic slump reflect two policy measures. First, 2020 was the target year for the European Union's CO_2 emissions standards that limit the average carbon dioxide (CO_2) emissions per kilometre driven for new cars. Second, many European governments increased subsidy schemes for EVs as part of stimulus packages to counter the effects of the pandemic.

In European countries, BEV registrations accounted for 54% of electric car registrations in 2020, continuing to exceed those of plug-in hybrid electric vehicles (PHEVs). However, the BEV registration level doubled from the previous year while the PHEV level thripled. The share of BEVs was particularly high in the Netherlands (82% of all electric car registrations), Norway (73%), United Kingdom (62%) and France (60%).

China

The overall car market in China was impacted by the panademic less than other regions. Total new car registrations were down about 9%.

Registration of new electric cars was lower than the overall car market in the first-half of 2020. This trend reversed in the second-half as China constrained the panademic. The result was a sales share of 5.7%, up from 4.8% in 2019. BEVs were about 80% of new electric cars registered.

Key policy actions muted the incentives for the electric car market in China. Purchase subsidies were initially due to expire at the end of 2020, but following signals that they would be phased out more gradually prior to the pandemic, by April 2020 and in the midst of the pandemic, they were instead cut by 10% and exended through 2022. Reflecting economic concerns related to the pandemic, several cities relaxed car licence policies, allowing for more internal combustion engines vehicles to be registered to support local car industries.

United States

The US car market declined 23% in 2020, though electric car registrations fell less than the overall market. In 2020, 295 000 new electric cars were registered, of which about 78% were BEVs, down from 327 000 in 2019. Their sales share nudged up to 2%. Federal incentives decreased in 2020 due to the federal tax credits for Tesla and General Motors, which account for the majority of electric car registrations, reaching their limit.

Other countries

Electric car markets in other countries were resilent in 2020. For example, in Canada the new car market shrunk 21% while new electric car registrations were broadly unchanged from the previous year at 51 000.

New Zealand is a notable exception. In spite of its strong pandemic response, it saw a decline of 22% in new electric car registrations in 2020, in line with a car market decline of 21%. The decline seems to be largely related to exceptionally low EV registrations in April 2020 when New Zealand was in lockdown.

Another exception is Japan, where the overall new car market contracted 11% from the 2019 level while electric car registrations declined 25% in 2020. The electric car market in Japan has fallen in absolute and relative terms every year since 2017, when it peaked at 54 000 registrations and a 1% sales share. In 2020, there were 29 000 registrations and a 0.6% sales share.

Consumer spending on EVs continues to rise, while government support stabilises

Consumer spending

Consumers spent USD 120 billion on electric car purchases in 2020, a 50% increase from 2019, which breaks down to a 41% increase in sales and a 6% rise in average prices. The rise in average prices reflects that Europe, where prices are higher on average than in Asia, accounted for a bigger proportion of new electric car registrations. In 2020, the global average BEV price was around USD 40 000 and around USD 50 000 for a PHEV.

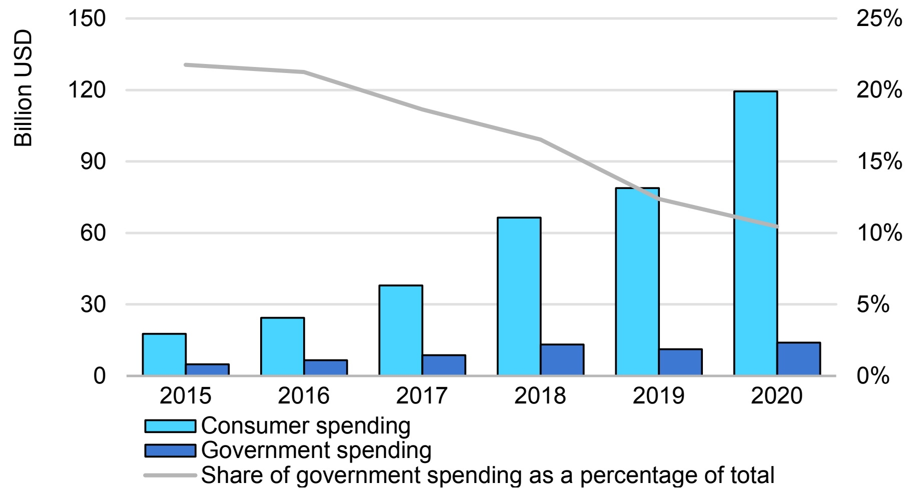
Government spending

Governments across the world spent USD 14 billion on direct purchase incentives and tax deductions for electric cars in 2020, a 25% rise year-on-year. Despite this, the share of government incentives in total spending on EVs has been on a downward slide from roughly 20% in 2015 to 10% in 2020.

All the increase in government spending was in Europe, where many countries responded to the pandemic-induced economic downturn with incentive schemes that boosted electric car sales. In China, government spending decreased as the eligibility requirements for incentive programmes tightened.

An important novelty in subsidy schemes was the introduction of price caps in Europe and China, i.e. no subsidy given for vehicles with prices above a certain threshold. This might be responsible for average electric car price falling in Europe and China: BEV cars sold in China were 3% cheaper in 2020 than in 2019, while PHEV cars in Europe were 8% cheaper.

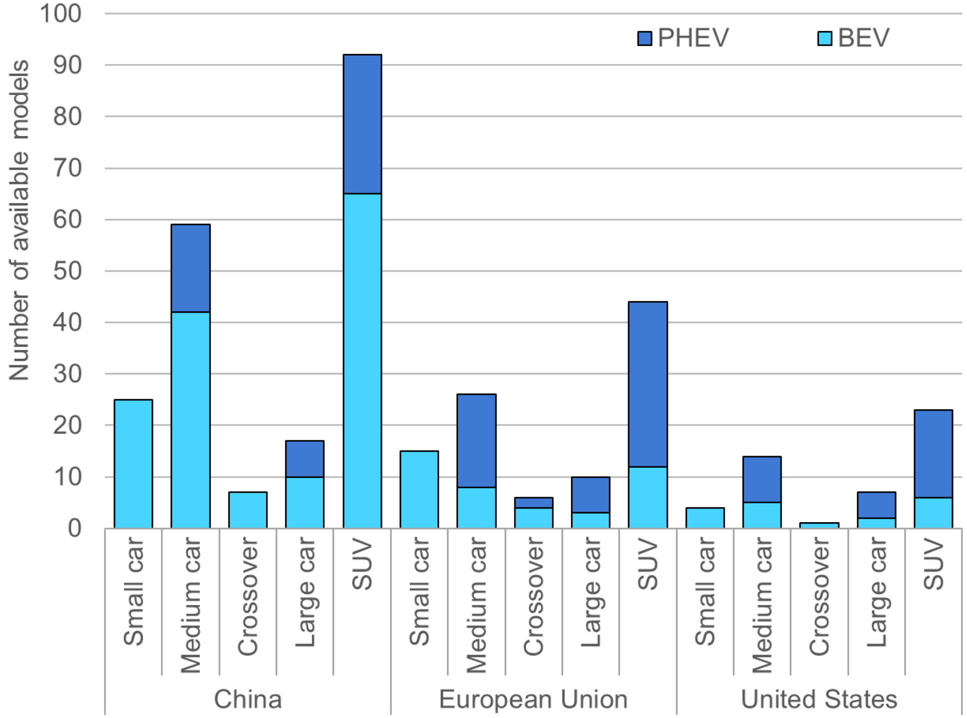
Consumer and government spending on electric cars, 2015-2020



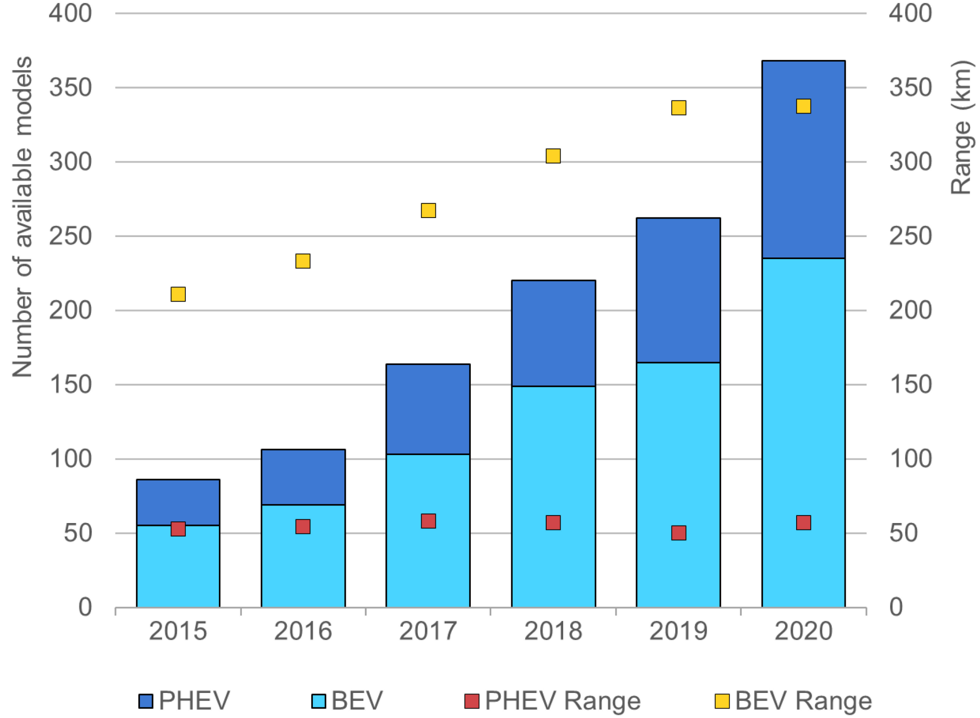
Notes: Government incentives are the sum of direct government spending through purchase incentives and foregone revenue due to taxes waived specifically for electric cars. Only national government purchase support policies for electric cars are taken into account. Consumer spending is the total expenditure based on model price, minus government spending.
Sources: IEA analysis based on EV Volumes (2021) and Climate Policy Initiative (2021).

More electric car models are available; ranges start to plateau

Electric car models available by region, 2020



Electric car models available globally and average range, 2015-2020



Notes: BEV = battery electric vehicle; PHEV = plug-in hybrid vehicle; crossover = a type of sport utility vehicle built on a passenger car platform rather than on a pickup truck platform; SUV = sport utility vehicle. Vehicle models do not include the various trim-levels. Range is normalised to Worldwide Harmonized Light Vehicle Test Procedure (WLTP) for all regions. Range for PHEVs refers to the electric drive range.

Sources: IEA analysis based on EV Volumes (2021) and Marklines (2021).

Automakers entice customers with a wide menu including electric SUV models

Worldwide about 370 electric car models were available in 2020, a 40% increase from 2019. China has the widest offering, reflecting its less consolidated automotive sector and that it is the world's largest EV market. But in 2020 the biggest increase in number of models was in Europe where it more than doubled.

BEV models are offered in most vehicle segments in all regions; PHEVs are skewed towards larger vehicle segments. Sport utility vehicle (SUV) models account for half of the available electric car models in all markets. China has nearly twice as many electric car models available as the European Union, which has more than twice as many electric models as the United States. This difference can partially be explained by the comparatively lower maturity of the US EV market, reflecting its weaker regulations and incentives at the national level.

The average driving range of new BEVs has been steadily increasing. In 2020, the weighted average range for a new battery electric car was about 350 kilometres (km), up from 200 km in 2015.The weighted average range of electric cars in the United States tends to be higher than in China because of a bigger share of small urban electric cars in China.The average electric range of PHEVs has remained relatively constant about 50 km over the past few years.

The widest variety of models and the biggest expansion in 2020 was in the SUV segment. More than 55% of announced models worldwide are SUVs and pick-ups. Original equipment manufacturers (OEMs) may be moving to electrify this segment for the following reasons:

- SUVs are the fastest growing market segment in Europe and China, and by far the largest market share in the United States.
- SUVs command higher prices and generally offer higher profit margins than smaller vehicles. This means OEMs find it easier to bear the extra costs of electrification for SUVs since the powertrain accounts for a smaller share of the total cost compared with a small car.
- Electrifying the heaviest and most fuel consuming vehicles goes further toward meeting emissions targets than electrifying a small car.
- In Europe, the ZLEV credit scheme in the most recent CO_2 emissions standards offers strong incentives for selling electric SUVs from 2025, as it relaxes emissions standards in proportion to their potential to reduce specific CO_2 emissions. In fact, in Europe, the share of electric SUV models is higher than for the overall market.

China leads in electric LCV sales with Europe not far behind and Korea entering the market

Global electric light-commercial vehicle (LCV) stock numbers about 435 000 units. About a third of these are in Europe where new electric LCV registrations in 2020 were only 5% below those in China, which is the world leader.

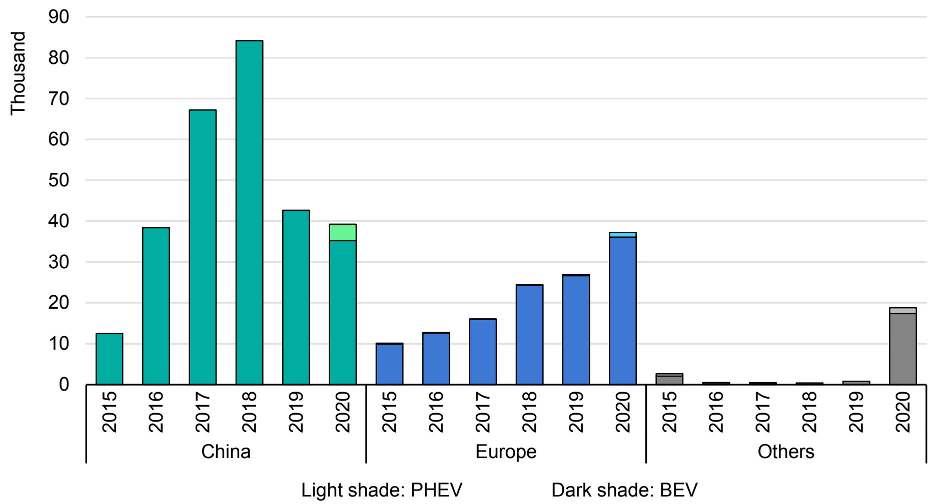
Electric LCV registrations in China in 2020 were 3 400 units below the previous year and slightly less than half of the peak in 2018. The bulk of the electric LCV registrations are BEVs, with PHEVs accounting for less than 10%.

In Europe, electric LCV registrations jumped almost 40% in 2020 from the prior year to exceed 37 000 units. Though that was less impressive than the more than doubling of electric car registrations. New EV registrations in Europe are being driven by economic stimulus packages and by CO_2 standards that limit emissions per kilometre driven. However, current standards for LCVs are not stringent enough to warrant large-scale electrification, as they do for passenger cars.

Registration of electric LCVs in 2020 in the rest of the world were about 19 000 units. Most of these were in Korea, reflecting the launch of two new BEV LCV models, but Canada also added to the stock of electric LCVs. Other markets around the world have yet to see much uptake of electric LCVs.

The explosion of home deliveries during the Covid-19 pandemic further boosted the electric LCV expansion in some countries. Increased deliveries raised concerns about air pollution, particularly in urban areas. In response, a number of companies announced plans to electrify delivery fleets.

Electric LCVs registrations by region, 2015-2020



Notes: PHEV = plug-in hybrid vehicle; BEV = battery electric vehicle. Regional electric LCV registrations and stock data can be interactively explored via the Global EV Data Explorer.
Sources: IEA analysis based on country submissions, complemented by ACEA (2021); EAFO (2021) and EV Volumes (2021).

18 of the 20 largest OEMs have committed to increase the offer and sales of EVs

Original equipment manufacturer announcements related to electric light-duty vehicles

Original equipment manufacturer	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BMW Group			25		15-25%					10
BAIC Group	2				1.3					50%
Changan Automobile (Group)					33					
Daimler		10			25%					50%
Dongfeng Motor Co	1	30%	1		1				1	1
FAW					40%					60%
Ford		40				100%*				
GM Group			22		30	1				1
Honda										40%T
Hyundai-Kia					1					
					29					
Mazda		1								5%
Renault-Nissan		20								
		20%								
Maruti Suzuki	1									1.5
SAIC					30%					30
Stellantis					38%*					70%*
					31%**					35%**
Toyota Group	1				15					>1
Volkswagen					20%					70%*
			1		3				26	50%**
					75					
Volvo (Geely Group)	1	1	1	1	50%					100%*

% of sales electric
Annual sales (million)
New EV models (number)
Cumulative sales (million)

* European market only
** Chinese and US markets only
T Includes both EVs and FCEVs

Notes: This table is based on the authors' understanding of OEM announcements and may not be complete. It includes only announcements related to electric light-duty vehicles (PHEVs and BEVs) and it excludes announcements related to hybrid vehicles and those that do not provide a clear indication of the EV share.

Sources: BMW (2021); BJEV-BAIC (2021); BYD (2021); Chery (2021); Changan Automobile (2021); Daimler (2021); Dongfeng (2021); FAW (2021); Ford (2021); GAC; General Motors; Honda (2021); Hyundai (2020); Mazda (2021); Renault-Nissan (2019); Maruti Suzuki (2019); SAIC (2021); Stellantis (2021); Toyota (2021); Volkswagen (2021).

Manufacturers' electrification targets align with the IEA's Sustainable Development Scenario

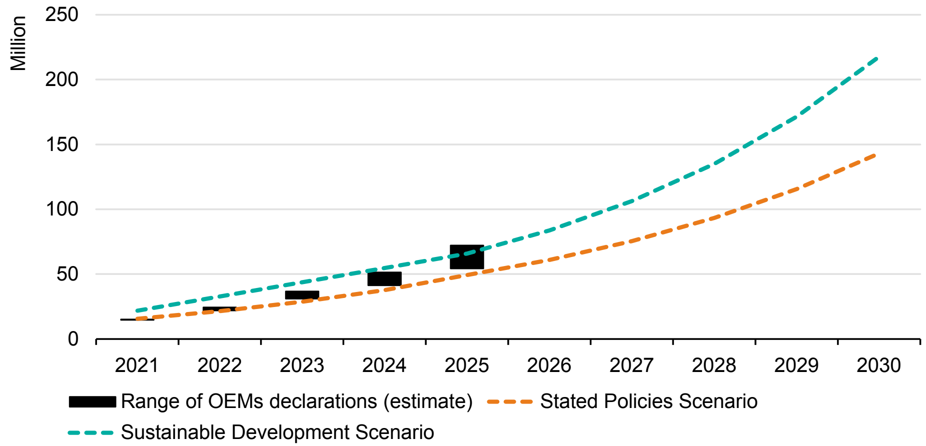
OEMs are expected to embrace electric mobility more widely in the 2020s. Notably 18 of the 20 largest OEMs (in terms of vehicles sold in 2020), which combined accounted for almost 90% of all worldwide new car registrations in 2020, have announced intentions to increase the number of available models and boost production of electric light-duty vehicles (LDVs).

A number of manufacturers have raised the bar to go beyond previous announcements related to EVs with an outlook beyond 2025. More than ten of the largest OEMs worldwide have declared electrification targets for 2030 and beyond..

Significantly, some OEMs plan to reconfigure their product lines to produce only electric vehicles. In the first-trimester of 2021 these announcements included: Volvo will only sell electric cars from 2030; Ford will only electric car sales in Europe from 2030; General Motors plans to offer only electric LDVs by 2035; Volkswagen aims for 70% electric car sales in Europe, and 50% in China and the United States by 2030; and Stellantis aims for 70% electric cars sales in Europe and 35% in the United States.

Overall, the announcements by the OEMs translate to estimated cumulative sales of electric LDVs of 55-73 million by 2025. In the short term (2021-2022), the estimated cumulative sales align closely with the electric LDV projections in the IEA's Stated Policies Scenario. By 2025, the estimated cumulative sales based on the OEMs announcements are aligned with the trajectories of IEA Sustainable Development Scenario.

OEMs announcements compared to electric LDVs stock projections in two IEA scenarios, 2021-2025



Notes: Cumulative sales are based on current OEM announcements and interpolated between current sales and the OEM targets. This assessment has been developed estimating first a number of EVs deployed by OEMs in a target year and then extrapolating these values for the following years using a range of assumptions. The number of EVs sold by each OEM in the target year is calculated taking into account three possible inputs: i) an absolute target value of EV sales; ii) a target value expressed in terms of models deployed in a given year; or iii) a targeted percentage of the OEM sales in a given year.
Sources: IEA analysis developed with the Mobility Model and based on the OEM announcements included in the table above.

Trends and developments in electric heavy-duty vehicles

Electric bus and truck registrations expanded in major markets in 2020

Electric bus and electric heavy-duty truck (HDT) registrations increased in 2020 in China, Europe and North America. The global electric bus stock was 600 000 in 2020 and the electric HDT stock was 31 000.

Bus registrations

China continues to dominate the electric bus market, with registration of 78 000 new vehicles in 2020, up 9% on the year to reach a sales share of 27%. Local policies to curb air pollution are the driving force.

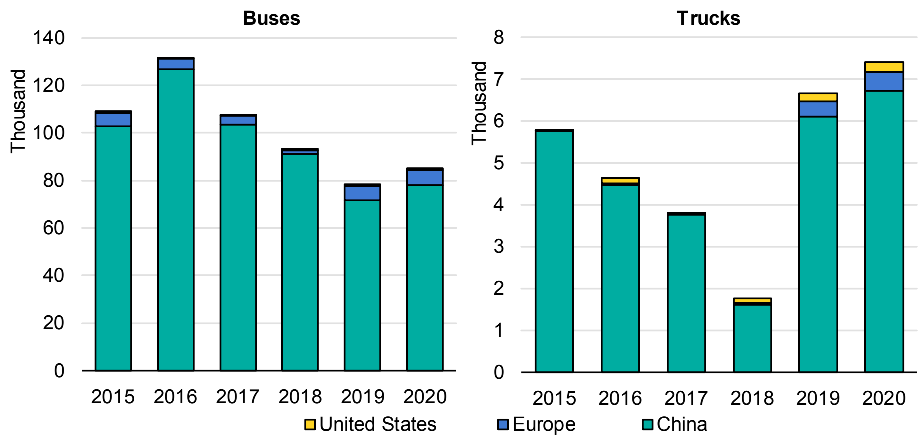
Electric bus registrations in Europe were 2 100, an increase of around 7%, well below the doubling in registrations seen in 2019. Electric buses now make up 4% of all new bus registrations in Europe. It is too early to see the effect of the non-binding European Clean Bus Deployment Initiative and demand may be still largely driven by muncipal level policies.

In North America, there were 580 new electric bus registrations in 2020, down almost 15% from the prior year. In the United States, electric bus deployment primarily reflects polices in California, which is the location of most of the current e-bus stock. In South America, Chile leads the way registering 400 electric buses in 2020 for a total stock of more than 800. India increased electric bus registrations 34% to 600 in 2020.

Heavy-duty truck registrations

Global electric HDT registrations were 7 400 in 2020, up 10% on the previous year. The global stock of electric HDTs numbers 31 000. China continues to dominate the category, with 6 700 new registrations in 2020, up 10% though much lower than the fourfold increase in 2019. Electric HDT registrations in Europe rose 23% to about 450 vehicles and in the United States increased to 240 vehicles. Electric trucks are still below 1% of sales in both.

Electric bus and truck registrations by region, 2015-2020



Note: Electric bus and truck registrations and stock data can be interactively explored via the Global EV Data Explorer.
Sources: IEA analysis based on country submissions, complemented by ACEA (2021); EAFO (2021) and EV Volumes (2021).

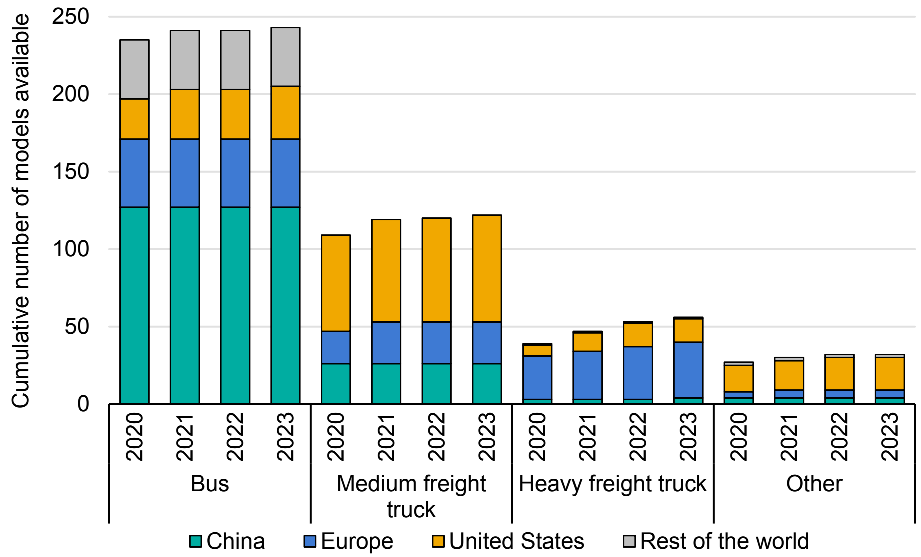
Electric heavy-duty vehicle models are broadening

The availability of electric heavy-duty vehicles (HDVs) models is expanding in leading global markets.[1] Buses were the earliest and most successful case of electrification in the HDV market, but the growing demand for electric trucks is pushing manufacturers to broaden product lines. Nevertheless, model availability is not the only indicator of a healthy market – fewer total models may reflect the reliability and broad applicability of existing designs, whereas more diversity of models may reflect the need to tailor products for specific needs and operations.

The growth in electric model availability from 2020 to 2023 across segments – bus, medium freight truck (MFT), heavy freight truck (HFT) and others – demonstrates manufacturers' commitments to electrification. Truck makers such as Daimler, MAN, Renault, Scania and Volvo have indicated they see an all-electric future. The broadening range of available zero-emission HDVs, particularly in the HFT segment, demonstrates the commitment to provide fleets the flexibility to meet operational needs.

The HDV segment includes a wide variety of vehicle types, e.g. from long-haul freight to garbage collection trucks. China has the most variety in available electric bus models. The availablity of MFT models is broadest in the United States. For HFTs – the segment where the EV model offer is expected to the grow the most – Europe offers the widest selection of models.

Number of announced electric HDV models available by segment, 2020-2023

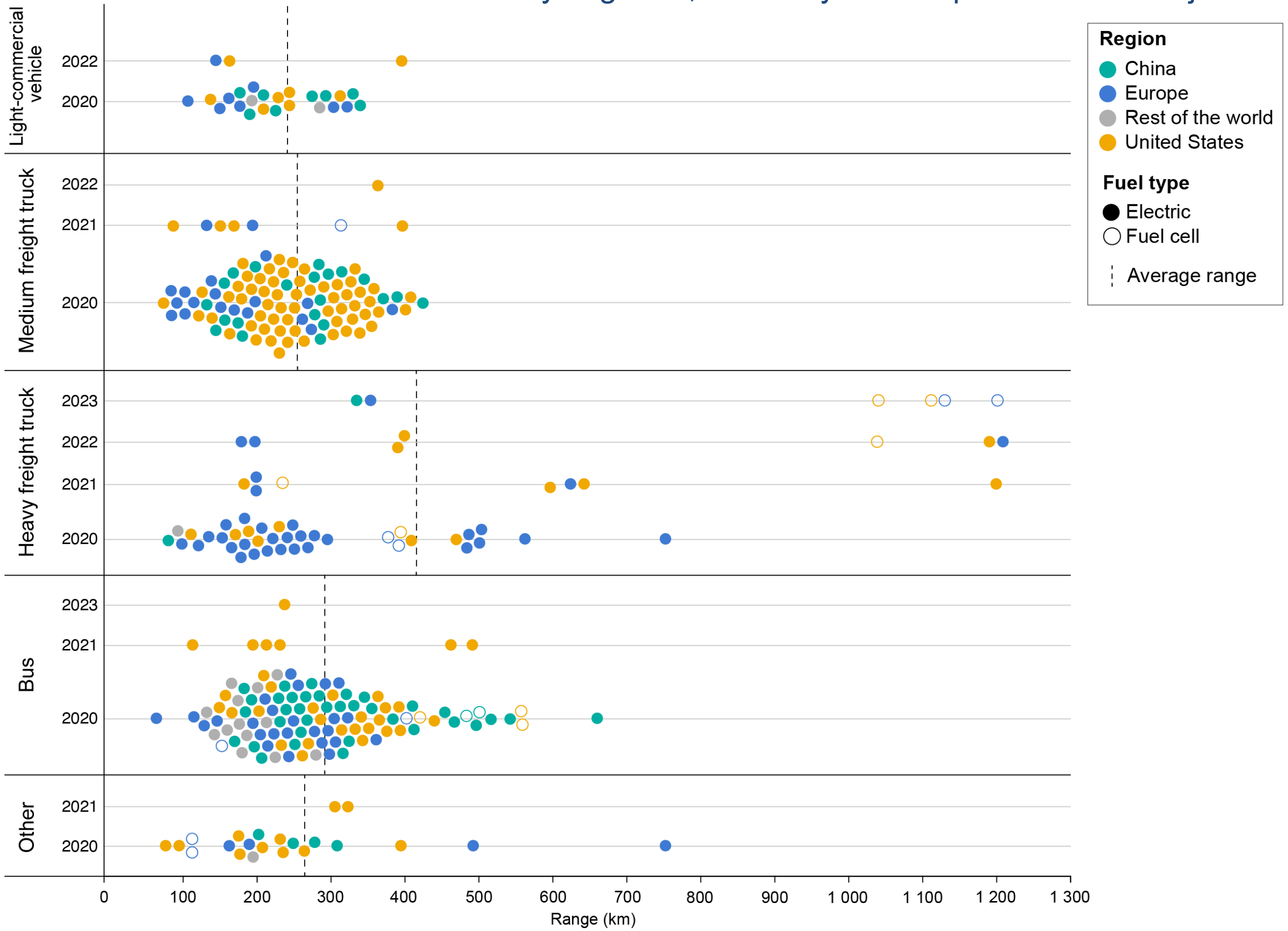


Notes: Other includes garbage, bucket, concrete mixer, mobile commercial and street sweeper trucks. Rest of the world includes India and South America.
Source: IEA analysis based on Global Drive to Zero ZETI tool.

[1] Electric HDVs data are derived from the Global Drive to Zero's Zero Emission Technology Inventory (ZETI) which is a regularly updated tool that offers a detailed glimpse of announced OEM production model timelines. ZETI data are meant to support fleet operators and policy makers and should not be construed as representative of the entire vehicle market.

Types of zero-emission HDVs expand, and driving range lengthens

Current and announced zero-emission HDV models by segment, release year and powertrain in major markets, 2020-2023



Notes: Data are derived from CALSTART's Zero-Emission Technology Inventory. Although the inventory is continuously updated, this snapshot may be not fully comprehensive due to new model announcements and small manufacturers not yet captured in the inventory. The term zero-emission vehicle includes BEVs, PHEVs and FCEVs. Other includes garbage, bucket, concrete mixer, mobile commercial and street sweeper trucks. Years after 2021 include announced models.

Source: IEA analysis based on the Global Drive to Zero ZETI tool.

Private sector commitment and other electrification trends

Private sector demand for zero-emission commercial vehicles amplifies market signals for OEMs to develop EVs

Private sector declarations related to electric commercial vehicles

Company	Operating area	Announced	Target / actions
Amazon	Global	2020	Orders 100 000 BEV light-commercial vehicles from start-up company Rivian. Amazon aims to be net-zero emissions by 2040.
Anheuser-Busch	United States	2019	Orders up to 800 hydrogen fuel cell Nikola heavy-duty trucks.
DHL Group	Global	2019	Delivery of mail and parcels by EVs in the medium term and net-zero emissions logistics by 2050.
FedEx	Global	2018	Transition to an all zero-emission vehicle fleet and carbon neutral operations by 2040.
H_2 Mobility Association	Switzerland	2019	19 of Switzerland's largest retailers invest in Hyundai hydrogen trucking services that will deploy up to 1 600 heavy-duty zero-emission trucks.
Ingka Group (IKEA)	Global	2018	Zero-emission deliveries in leading cities by 2020 and in all cities by 2025.
Japan Post	Japan	2019	Electrify 1 200 mail and parcel delivery vans by 2021 and net-zero emissions logistics by 2050.
JD	China	2017	Replace entire vehicle fleet (> 10 000) with New Energy Vehicles by 2022.
SF Express	China	2018	Launch nearly 10 000 BEV logistics vehicles.
Suning	China	2018	Independent retailer's Qingcheng Plan will deploy 5 000 new energy logistics vehicles.
UPS	North America	2019	Order 10 000 BEV light-commercial vehicles with potential for a second order.
Various companies	Multinational	2018	Walmart, Pepsi, Anheuser-Busch, FedEx, Sysco and other large multinational corporations pre-order 2 000 Tesla Semi models within six months of truck's debut.
Walmart	United States	2020	Electrify the whole vehicle fleet by 2040.

Notes: Based on authors understanding of private sector announcements and may not be comprehensive.

Sources: Amazon (2020); Anheuser-Busch (2019); DHL Group (2019); FedEx (2021); H2 Mobility Association (2019); Ingka Group (2018); Japan Post (2019); JD (2017); SF Express (2018); Suning (2018); UPS (2019); Various companies (2017) (2020) and Walmart (2020).

Climate Group's EV100 Initiative update on private sector commitments

Despite a turbulent year, major companies around the world are accelerating the transition to electric mobility by shifting fleets to electric vehicles and installing charging stations.

The Climate Group's EV100 Initiative brings together over 100 companies in 80 markets committed to making electric transport the new normal by 2030. This equates to 4.8 million vehicles switched to EVs and chargers installed in 6 500 locations by 2030.

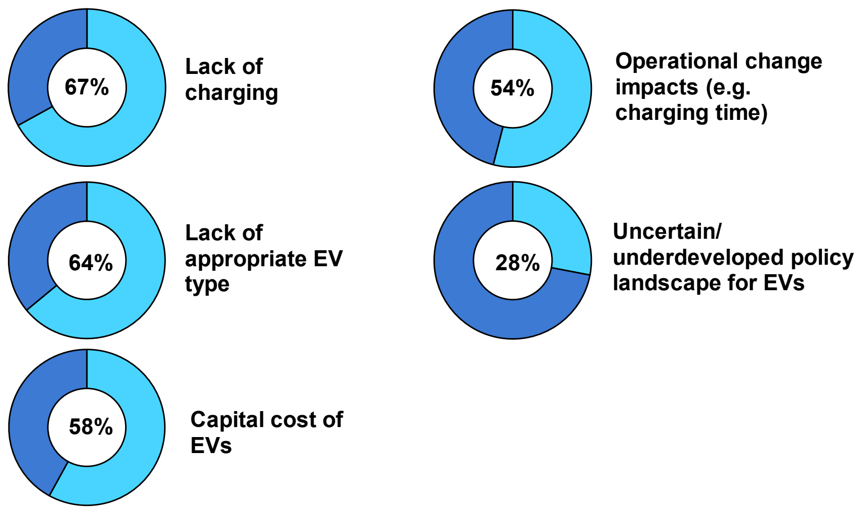
Collectively, by 2020 EV100 members had already deployed 169 000 zero-emission vehicles, double the previous year. Even though companies identify commercial vans and heavy-duty vehicles as the most difficult EVs to find, the number of commercial electric vehicles rose 23% in 2020, including a threefold increase in electric trucks.

EV100 members are also expanding the availability of charging infrastructure for staff and customers, with 16 900 charging points installed at 2 100 locations worldwide. Over half of EV100 members are using renewables to power all their charging operations.

Significant barriers to EV adoption remain. EV100 members reported the lack of charging infrastructure as the top barrier (especially in the United States and United Kingdom). Lack of availability of appropriate vehicle types was also highlighted by the companies as a persistant obstacle. The purchase price of EVs remains an important hurdle despite many companies acknowledge the significant cost savings over the lifetime of a vehicle due to lower fuel and maintenance costs.

To help overcome these barriers, 71% of EV100 members support more favourable EV procurement tax benefits and 70% favour more supportive policies at state, regional and city government levels. Sixty percent of the member companies support government targets to phase out petrol and diesel vehicles.

Top five barriers to EV adoption reported by EV100 members



Note: Percentages reflect the ranking of the barriers as significant or very significant by EV 100 member respondents.
Source: The Climate Group (2021).

Battery demand lagged EV sales in 2020; Europe sees highest rise in demand

Automotive lithium-ion (Li-Ion) battery production was 160 gigawatt-hours (GWh) in 2020, up 33% from 2019. The increase reflects a 41% increase in electric car registrations and a constant average battery capacity of 55 kilowatt-hours (kWh) for BEVs and 14 kWh for PHEVs. Battery demand for other transport modes increased 10%. Battery production continues to be dominated by China, which accounts for over 70% of global battery cell production capacity.

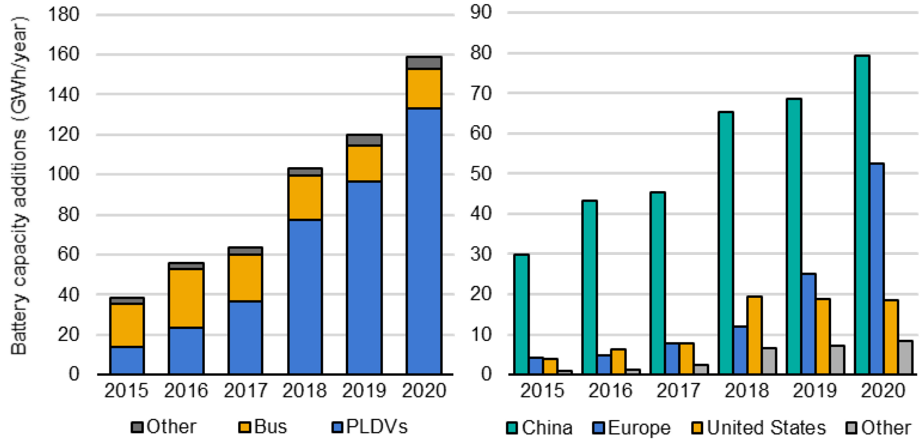
China accounted for the largest share of battery demand at almost 80 GWh in 2020, while Europe had the largest percentage increase at 110% to reach 52 GWh. Demand in the United States was stable at 19 GWh.

Nickel-manganese-cobalt continues to be the dominant chemistry for Li-ion batteries, with around 71% sales share and nickel-cobalt-aluminium accounting for most of the rest. Lithium-iron-phosphate battery chemistry has regained sales share but is still under 4% for the electric car market.

According to the BNEF's yearly survey of battery prices, the weighted average cost of automotive batteries declined 13% in 2020 from 2019, reaching USD 137/kWh at a pack level. Lower prices are offered for high volume purchases, confirmed by teardown analysis of a VW ID3 showing an estimated cost of USD 100/kWh for its battery cells.

In Europe, demand for batteries in 2020 exceeded domestic production capacity. Today Europe's main battery factories are located in Poland and Hungary. Production capacity is roughly 35 GWh per year, but announced capacity could yield up to 400 GWh by 2025. Momentum was evident in 2020 in Europe with many new battery plants announced or under construction with support from the European Investment Bank. In the United States, both Korean and domestic battery manufacturers have signalled large investments in a market currently dominated by a Tesla-Panasonic joint venture.

Automotive battery demand by mode and region, 2015-2020



Notes: Other = light-commercial vehicles, heavy-duty trucks and two/three-wheelers; PLDVs = passenger light-duty vehicles.
Source: IEA analysis developed with EV Volumes (2021) data.

Pandemic spreads popularity of electric micromobility

Electric micromobility surged in the second-half of 2020, one of the consumer trends that accelerated during the Covid-19 pandemic, further boosted by the construction of bike lanes and other measures to promote mobility. Sales of private e-bikes in the United States more than doubled in 2020, outpacing sales of all bikes which were up an already healthy 65%.

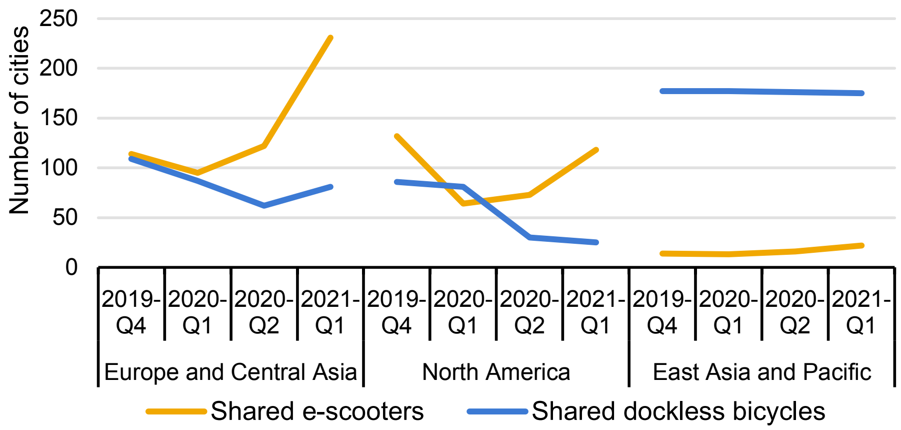
Many shared micromobility operators reduced or suspended services during the height of the second-quarter 2020 Covid-19 lockdowns. But as confinements were eased, services rebounded strongly, with 270 cities worldwide relaunching operations. As of February 2021, around 650 cities have shared micromobility services. In Europe, e-scooter services have increased rapidly, with more than 100 cities adding operations since July 2020.

Preliminary data from operators indicate average trip distances on e-scooters have increased by around 25% relative to before the pandemic. Operators are increasingly offering more powerful e-bikes with plans to expand into electric mopeds, which could further displace longer trips currently completed by car or public transit.

Several major operators are introducing swappable batteries to improve operational efficiency and reduce emissions. Although the use of swappable batteries increases the number of total batteries needed to support a fleet, it can significantly reduce operational emissions and enable longer lifetime of vehicles.

Privately owned electric two/three-wheelers (which include motorised vehicles such as motorcycles and mopeds but exclude micromobility solutions) are concentrated in Asia, with China accounting for 99% of registrations. The global stock of electric two/three-wheelers is now around 290 million. Electric two/three-wheelers account for one-third of all two/three-wheeler sales. While current sales are dominated by Asia, the market is growing rapidly in Europe, rising by 30% in 2020, benefitting from wider model availability and continued incentives.

Availability of dockless shared micromobility services, 2019-2021



Source: NUMO New Mobility Atlas (2021).

Korea takes a lead in deploying fuel cell electric vehicles

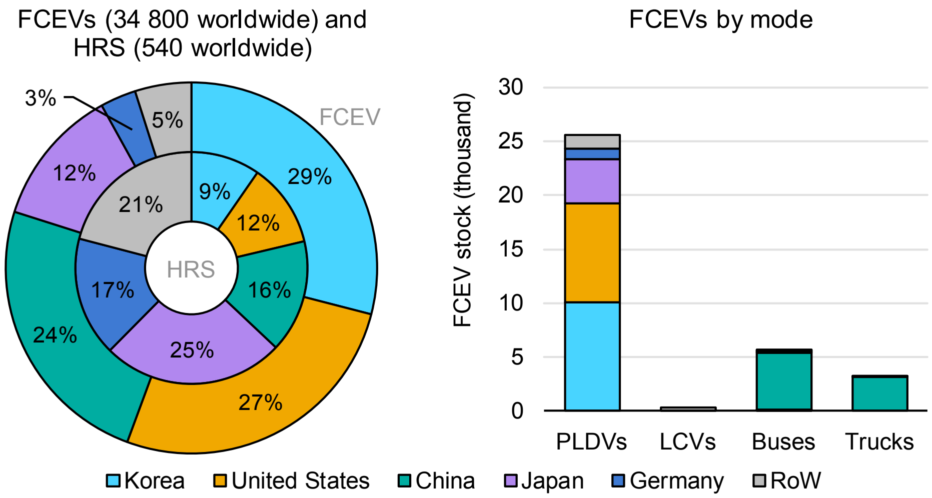
Fuel cell electric vehicles (FCEVs) are zero-emission vehicles that convert hydrogen stored on-board using a fuel cell to power an electric motor. FCEV cars became commercially available in 2014, though registrations remain three orders of magnitude lower than EVs as hydrogen refuelling stations (HRS) are not widely available and unlike EVs cannot be charged at home. Few commercial FCEV models are available and with high fuel cost and purchase prices result in a higher total cost of ownership than EVs.

To address the chicken-and-egg problem for FCEVs a number of goverments have funded the construction of HRS and have deployed public buses and trucks, such as garbage trucks, to provide a certain level of station utilisation. Today, there are approximately 540 HRS globally that provide fuel for almost 35 000 FCEVs. Approximately three-quarters of the FCEVs are LDVs, 15% are buses and 10% are trucks.

In 2020, Korea took the lead in FCEVs, surpassing the United States and China, to reach more than 10 000 vehicles. To support these FCEVs, the number of HRS in Korea increased by 50%, with 18 new stations in 2020. FCEVs in China are almost exclusively buses and trucks, unlike most other countries where cars are dominant. China accounts for 94% of global fuel cell buses and 99% of fuel cell trucks.

In 2020, the global FCEV stock increased 40%, with Korea contributing half and doubling its total FCEV stock. Japan and China increased the number of HRS, each opening about 25 stations in 2020. Worldwide the number of HRS increased 15%.

Fuel cell electric vehicle stock and hydrogen refuelling stations by region, 2020



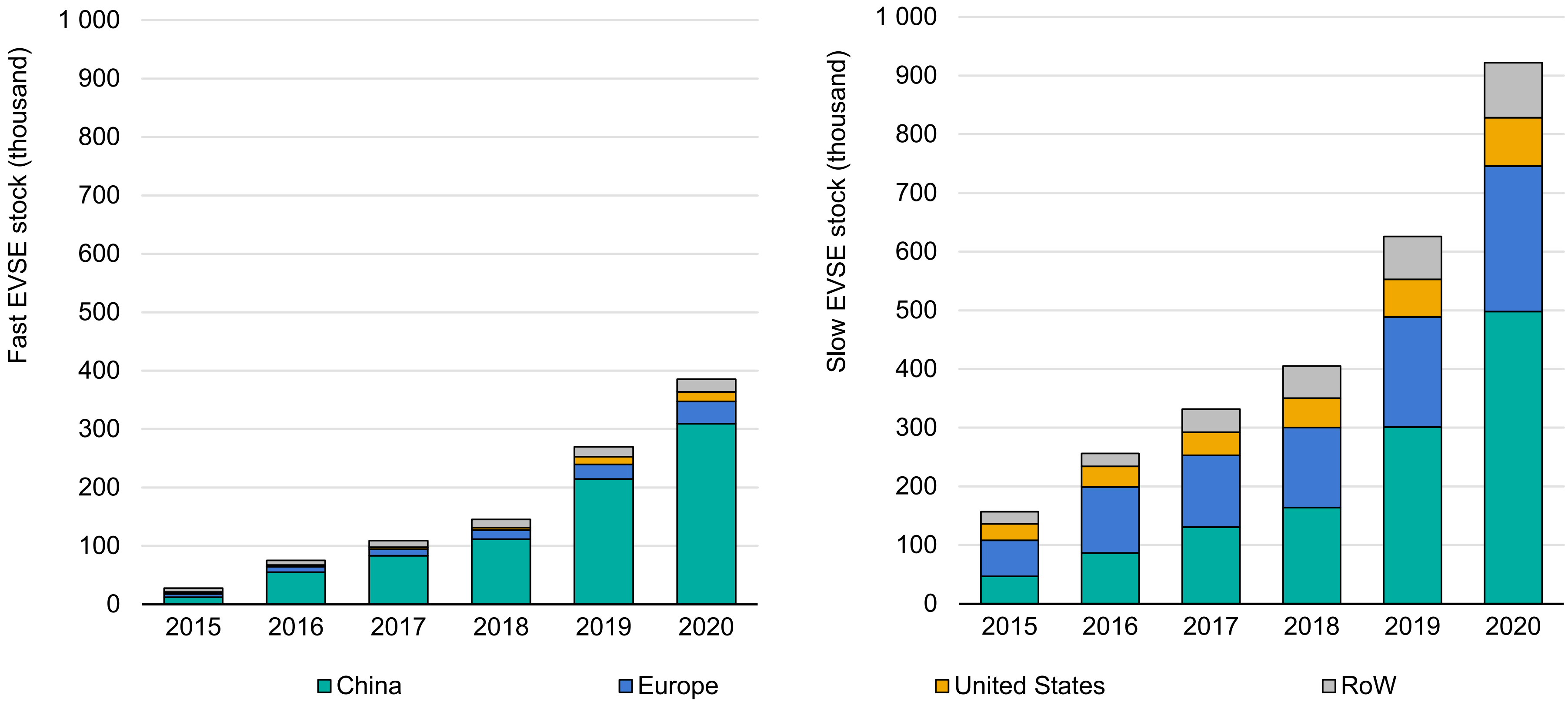
Notes: FCEV = fuel cell electric vehicle (shown in the outer circle); HRS = hydrogen refuelling station (shown in inner circle); PLDVs = passenger light-duty vehicles; LCVs = light-commercial vehicles; RoW = rest of the world.

Sources: All fuel cell vehicle data reported in this figure and section are based on the annual data submission of the Advanced Fuel Cell Technology Collaboration Program (AFC TCP) to the IEA secretariat.

Deployment of electric vehicle-charging infrastructure

Publicly accessible slow and fast chargers increased to 1.3 million in 2020

Stock of fast and slow publicly accessible chargers for electric light-duty vehicles, 2015-2020



Notes: EVSE = electric vehicle supply equipment. RoW = rest of the world. Slow chargers have a charging power below 22 kW, while fast chargers provide more than 22 kW. For additional details about charger classification by rated power refer to Global EV Outlook 2019. Regional slow and fast publicly accessible charger data can be interactively explored via the Global EV Data Explorer.

Sources: IEA analysis based on country submissions, complemented by AFDC (2021) and EAFO (2021).

Installation of publicly accessible chargers expanded sevenfold in the last five years; Covid-19 muted the pace in 2020 while China still leads

While most charging of EVs is done at home and work, roll-out of publicly accessible charging will be critical as countries leading in EV deployment enter a stage where simpler and improved autonomy will be demanded by EV owners. Publicly accessible chargers reached 1.3 million units in 2020, of which 30% are fast chargers. Installation of publicly accessible chargers was up 45%, a slower pace than the 85% in 2019, likely because work was interrupted in key markets due to the pandemic. China leads the world in availability of both slow and fast publicly accessible chargers.

Slow chargers

The pace of slow charger (charging power below 22 kW) installations in China in 2020 increased by 65% to about 500 000 publicly accessible slow chargers. This represents more than half of the world's stock of slow chargers.

Europe is second with around 250 000 slow chargers, with installtions increasing one-third in 2020. The Netherlands leads in Europe with more than 63 000 slow chargers. Sweden, Finland and Iceland doubled their stock of slow chargers in 2020.

Installation of slow chargers in the United States increased 28% in 2020 from the prior year to total 82 000. The number of slow chargers installed in Korea rose 45% in 2020 to 54 000, putting it in second place.

Fast chargers

The pace of fast charger (charging power more than 22 kW) installations in China in 2020 increased by 44% to almost 310 000 fast chargers, slower than the 93% pace of annual growth in 2019. The relatively high number of publically available fast chargers in China is to compensate for a paucity of private charging options and to facilitate achievement of goals for rapid EV deployment.

In Europe, fast chargers are being rolled out at a higher rate than slow ones. There are now more than 38 000 public fast chargers, up 55% in 2020, including nearly 7 500 in Germany, 6 200 in the United Kingdom, 4 000 in France and 2 000 in the Netherlands. The United States counts 17 000 fast chargers, of which nearly 60% are Tesla superchargers. Korea has 9 800 fast chargers.

Publicly accessible fast chargers facilitate longer journeys. As they are increasingly deployed, they will enable longer trips and encourage late adopters without access to private charging to purchase an electric vehicle.

Most countries in Europe did not achieve 2020 AFID targets for publicly accessible chargers

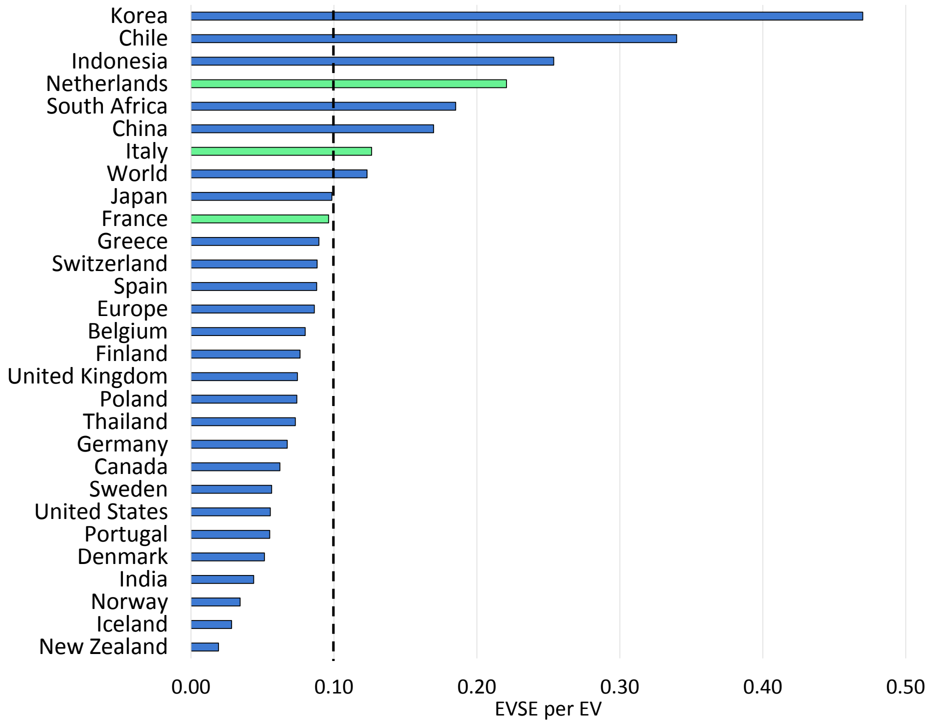
European countries for the most part failed to meet the recommended electric vehicle supply equipment (EVSE) per EV 2020 targets for publicly accessible chargers set by the Alternative Fuel Infrastructure Directive (AFID). However, there are wide disparities between countries.

AFID, the key policy regulating the deployment of public electric EVSE in the European Union, recommended that member states aim for 1 public charger per 10 EVs, a ratio of 0.1 in 2020.

In the European Union, the average public EVSE per EV ratio was 0.09 at the end of 2020. But that is not the whole story. The Netherlands and Italy are above the target at 0.22 and 0.13 respectively, with almost all being slow chargers, though fast chargers are 3% of the installations in the Netherlands and 9% in Italy.

Countries with the highest EV penetration tend to have the lowest EVSE per EV ratios, such as Norway (0.03), Iceland (0.03) and Denmark (0.05). In these sparsely populated countries with many detached houses and private parking spaces, most EV owners can largely use private home charging. To a lesser extent, it also refects that the Nordic countries have a higher proportion of fast chargers, with shares of 40% in Iceland, 31% in Norway and 17% in Denmark.

Ratio of public chargers per EV stock by country, 2020



Notes: Green colour represents the European Union countries fulfilling the AFID target. Vertical dotted line denotes the AFID target ratio. EVSE
Sources: IEA analysis based on country submissions, complemented by EAFO (2021) and EV Volumes (2021).

Planning needs to start now for megachargers to enable long-distance trucking

The roll-out of public charging infrastructure has so far mostly focused on serving electric light-duty vehicles. The electrification of heavy freight trucks (HFTs) is a longer term endeavour, with less than 40 electric HFTs on the road in 2020.

HFTs require batteries with high capacity to meet their needs for heavy-duty cycles and long-range operations, and consequently they require high power charging. So far charging options for HFTs have tended to be early stage demonstrations, proof-of-concept activities and efforts to faciliate standardisation.

Megachargers of 1 megawatt (MW) or more would be capable of charging trucks operating over long distances reasonably quickly. Long-term planning for megacharger infastructure is needed now to avoid negative impacts on the electrical grid. Some impact to grids is inevitable given the high power requirements of megachargers. Significant investment may be needed for grid reinforcements, modernisation, storage and integration with power systems. Planning and co-ordination among electricity generators, distribution system operators and megacharging operations are needed.

Some efforts are underway to develop standards for megachargers. Working jointly, the CHAdeMO association and the China Electricity Council have developed an ultra-high power charging standard (up to 900 kW), called ChaoJi. A version up to 1.8 MW, called Ultra ChaoJi, is under development. In parallel, the CharIN initiative established a task force called the Megawatt Charging System Taskforce which aims to develop a new high power standard above 1 MW by 2023 for charging heavy-duty trucks, based on the combined charging system (CCS) standard. Prototype testing started in September 2020. Tesla announced in late 2020 that it is working with third-parties to develop a standard for megachargers that can be provided to Semi truck owners. Tesla is one of five to have submitted a design to CharIN.

Industry experts addressing international standardisation are evaluating avenues to harmonise megacharger standards for mutual compatibility, in order to facilitate the roll-out of electric HFTs.

There are also regional efforts to develop megacharging infrastructure. Underpinned with stimulus funding, Iberdrola, a Spanish multinational electric utility, has expressed interest in installing megacharger infrastructure in heavy-duty freight truck corridors in Spain by 2025. ElaadNL (EV knowledge centre of Dutch grid operators), along with local and national government entities, in September 2021 launched an open-access test centre for companies and academia that offers test facilities for megachargers. In the United States, the West Coast Clean Transit Corridor Initiative aims to install charging sites capable of charging HDTs at 2 MW along key transit corridors from Mexico to the boder with Canada by 2030.

Policies to promote electric vehicle deployment

Are we entering the era of the electric vehicle?

Ten million electric cars were on the world's roads in 2020. It was a pivotal year for the electrification of mass market transportation. Sales of electric cars were 4.6% of total car sales around the world. The availability of electric vehicle models expanded. New initiatives for critical battery technology were launched. And, this progress advanced in the midst of the Covid-19 pandemic and its related economic downturn and lockdowns.

Over the last decade a variety of support policies for electric vehicles (EVs) were instituted in key markets which helped stimulate a major expansion of electric car models.

But the challenge remains enormous. Reaching a trajectory consistent with the IEA Sustainable Development Scenario will require putting 230 million EVs on the world's roads by 2030.

For EVs to unleash their full potential to combat climate change, the 2020s will need to be the decade of mass adoption of electric light-duty vehicles. In addition, specific policy support and model expansion for the medium- and heavy-duty vehicle segments will be crucial to mitigate emissions and make progress toward climate goals.

Main policy drivers of EV adoption to date

Significant fiscal incentives spurred the initial uptake of electric light-duty vehicles (LDVs) and underpinned the scale up in EV manufacturing and battery industries. The measures – primarily purchase subsidies, and/or vehicle purchase and registration tax rebates – were designed to reduce the price gap with conventional vehicles. Such measures were implemented as early as the 1990s in Norway,[2] in the United States in 2008 and in China in 2014.

Gradual tightening of fuel economy and tailpipe CO_2 standards has augmented the role of EVs to meet the standards. Today, over 85% of car sales worldwide are subject to such standards. CO_2 emissions standards in the European Union played a significant role in promoting electric car sales, which in 2020 had the largest annual increase to reach 2.1 million. Some jurisdictions are employing mandatory targets for EV sales, for example for decades in California[3] and in China since 2017.

Convenient and affordable publicly accessible chargers will be increasingly important as EVs scale up. To help address this, governments have provided support for EV charging infrastructure through measures such as direct investment to install publicly accessible chargers or incentives for EV owners to install charging

[2] In Norway, battery-electric cars have been exempt from registration tax since 1990 and from value added tax since 2001. Such taxes in Norway can be up to half or as much as the full initial (pre-tax) vehicle purchase price.

[3] A number of other US states follow the California ZEV mandate (Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, Vermont and Washington). Canadian provinces Québec and British Columbia adopted the mandate in 2020.

points at home. In some places building codes may require new construction or substantial remodels to include charging points, for example in apartment blocks and retail establishments.

Efforts by cities to offer enhanced value for EVs has encouraged sales even outside of urban areas. Such measures include strategic deployment of charging infrastructure, and putting in place preferential/prohibited circulation or access schemes such as low- and zero-emission zones or differentiated circulation fees. Such measures have had a major impact on EV sales in Oslo and a number of cities in China.

Broader and more ambitious policy portfolios to accelerate the transition

Making the 2020s the decade of transition to EVs requires more ambition and action among both market leaders and followers. In markets that demonstrated significant progress in the 2010s, a primary direction in 2021 and beyond should be to continue to implement and tighten, as well as to broaden, regulatory instruments. Examples include the European Union CO_2 emissions regulation for cars and vans, China's New Energy Vehicles (NEV) mandate or California's Zero-Emission Vehicle (ZEV) mandate.

Near-term efforts must focus on continuing to make EVs competitive and gradually phasing out purchase subsidies as sales expand. This can be done via differentiated taxation of vehicles and fuels, based on their environmental performance, and by reinforcing regulatory measures that will enable the clean vehicle industry to thrive.

In the long term, realising the full potential for EVs to contribute to cut vehicle emissions requires integration of EVs in power systems, decarbonisation of electricity generation, deployment of recharging infrastructure and manufacturing of sustainable batteries.

Countries that currently deploy limited numbers of electric cars can profit from the lessons learned and advances already made in automotive and battery technology to support the production and uptake of EVs. Product innovation and the expertise developed in the charging services industry will also be beneficial for emerging economies. But they will also need to significantly tighten fuel economy and emissions standards. Emerging economies with large markets for second-hand imported cars can use policy levers to take advantage of electric car models at attractive prices, though they will need to place particular emphasis on implications for electricity grids.[4,5]

To date, more than 20 countries have announced the full phase-out of internal combustion engine (ICE) car sales over the next

[4] For example, Sri Lanka applies significantly differentiated import taxes for conventional versus electric and hybrid second-hand vehicles. As a result, it is recognised for its high number of hybrid and electric vehicles. Mauritius is taking a similar approach.

[5] In Africa, 60% of LDVs in circulation are imported second-hand vehicles, primarily from EU countries, Japan and United States.

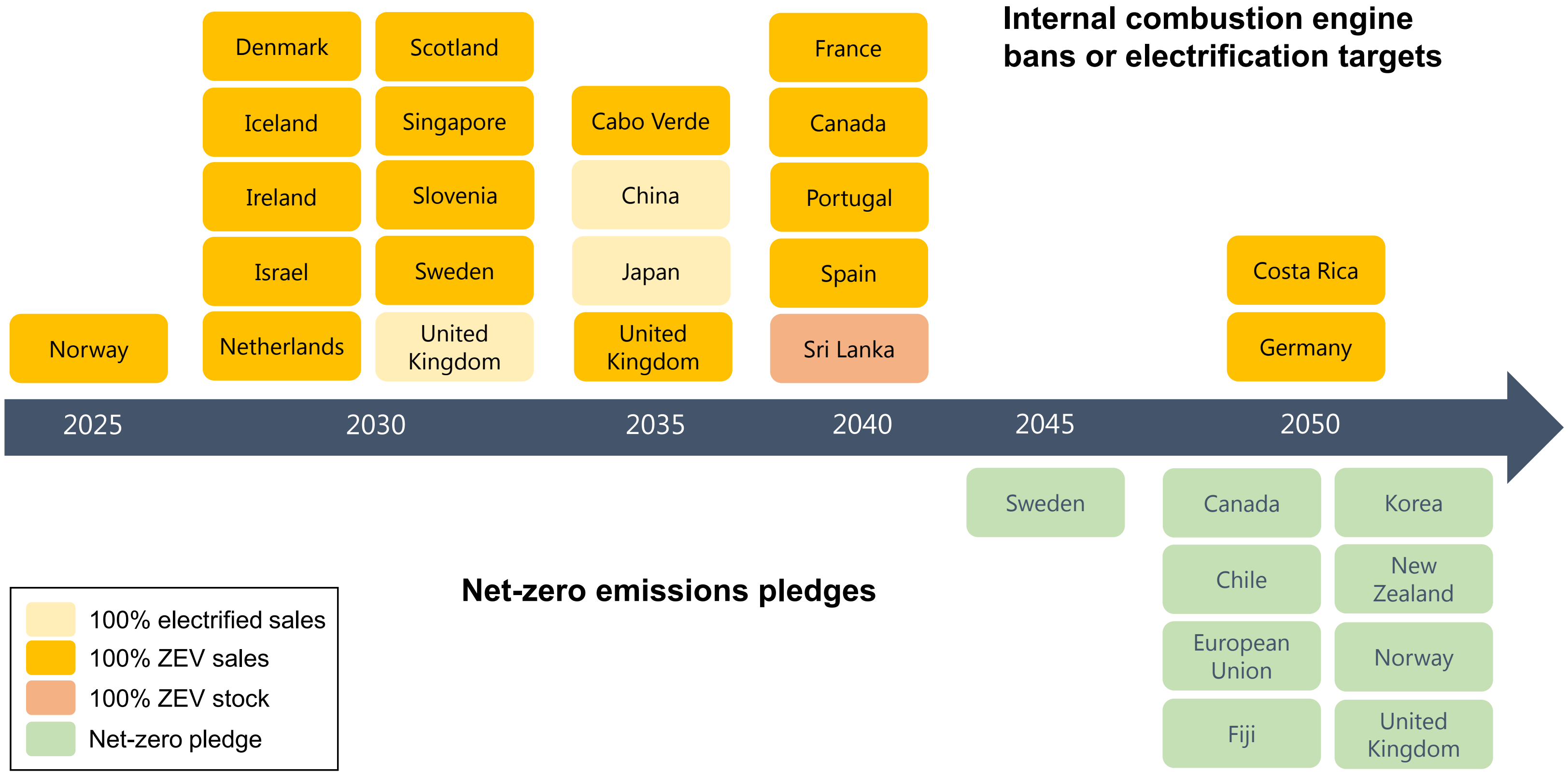
10‑30 years, including emerging economies such as Cabo Verde, Costa Rica and Sri Lanka. Moreover, more than 120 countries (accounting for around 85% of the global road vehicle fleet, excluding two/three-wheelers) have announced economy-wide net-zero emissions pledges that aim to reach net zero in the coming few decades.

Policy attention and actions need to broaden to other transport modes, in particular commercial vehicles – light-commercial vehicles, medium- and heavy-duty trucks, and buses – as they have an increasing and disproportionate impact on energy use, air pollution and CO_2 emissions. Medium- and heavy-duty vehicles represent 5% of all four-wheeled road vehicles in circulation but almost 30% of CO_2 emissions. Progress in batteries has led to rapid commercialisation in the past few years of more and more models in ever heavier weight segments and with increasing ranges.

In 2020, California was the first to propose a ZEV sales requirement for heavy-duty trucks. The Advanced Clean Truck Regulation is due to take effect from 2024. The Netherlands and a number of other countries are implementing zero-emission commercial vehicle zones and pioneering deployment efforts. Although this is a "hard-to-abate" sector and there are competing decarbonisation pathways (including hydrogen and biofuels), the electrification of medium- and heavy-duty vehicles is increasingly recognised as a promising pathway to reduce both local pollutant and CO_2 emissions. Electrification of HDVs requires policy support and commercial deployment similar to that which passenger cars enjoyed in the 2010s. Electric buses are already making a dent in key cities around the world, supported by national and local policies that target air pollution. Policy measures to promote electric buses are diverse; they may include competitive tenders, green public procurement programmes, purchase subsidies and direct support to charging infrastructure deployment, as well as effective pollutant emissions standards.

Given their enormous number and populartity, electrifying two/three-wheelers in emerging economies is central to decarbonising transport in the near term. China is taking a lead with a ban of ICE versions of two/three-wheelers in a number of cities.

More than 20 countries have electrification targets or ICE bans for cars, and 8 countries plus the European Union have announced net-zero pledges



Notes: Only countries that have either an ICE ban or electrification target or with net-zero emissions in law or proposed legislation have been included. Those with net-zero emissions policy documents only, e.g. Japan and China, have not been included. European Union refers to the collective pledge of the 27 member states. Some individual countries also have net-zero emissions pledges either in law or proposed legislation (Denmark, France, Germany, Hungary, Ireland, Luxembourg, Slovenia, Spain, Sweden and the Netherlands). The targets reflect the status as of 20 April 2021. Electrified vehicles include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell electric vehicles (FCEVs) and hybrid electric vehicles (HEVs). ZEV = zero-emission vehicle (BEVs, PHEVs and FCEVs)

Sources: See list of sources.

Policies affecting the electric light-duty vehicle market

Policies buoyed electric car sales in 2020 despite the Covid-19 pandemic

Electric car sales broke all records in 2020. They were up over 40% from 2019. This is particurlary notable as sales of all types of cars contracted 16% in 2020 reflecting pandemic-related conditions.

Existing EV strategies bolstered the electric car market in the first-half of 2020

Electric car sales were underpinned with existing policy support and augmented with Covid-related stimulus measures. Prior to the pandemic, many countries were already developing and strengthening e-mobility strategies with key policy measures such as fiscal incentives and making vehicle CO_2 emission standards more strigent. Purchase incentives increased in early 2020, notably in Germany, France and Italy. As a result, electric car sales in Europe were 55% higher during the first-half of 2020 relative to the same period in 2019.

In the rest of the world, electric car sales were hurt by the economic crisis, with sales falling from 2019 levels though not as steeply as conventional cars.

Stimulus measures boosted electric cars sales in the second-half of 2020

Additional Covid-19-related stimulus measures from mid-2020 further boosted electric car sales. Sales between July and December surpassed the 2019 levels in each month in all large markets, despite second waves of the pandemic.[6]

These stimulus measures differed in important ways from those enacted during the 2008‑09 financial crisis. First, there was a specific focus on boosting the uptake of electric and hybrid vehicles. Second, a number of countries adopted a more integrated approach for the transport sector by supporting charging infrastructure, public transport and non‑motorised mobility. EV stimulus measures primarily took the form of increased purchase incentives (or delaying the phase-out of subsidies) and EV-specific cash-for-clunker approaches. Noteably, Germany did not provide any subsidies to conventional cars in its support package to the automotive sector.

The approaches were more integrated to the broader context of commitments to clean energy transitions and EV deployment than those that were made prior to the Covid-19 crisis. In a number of

[6] Including China, European Union, India, Korea, United Kingdom and United States.

countries they were confirmed in 2020 via new commitments to achieve net-zero emissions by mid-century.

In addition, ongoing declines in battery costs, wider availability of electric car models, uptake of EVs by fleet operators and enthusiasm of electric car buyers provided fertile ground for the EV market in 2020. These factors, supplemented by local policy measures, likely played an influential role in the uptick in electric car sales shares in the United States despite few incentives at the federal level.

Maintaining momentum in 2021 and beyond is vital

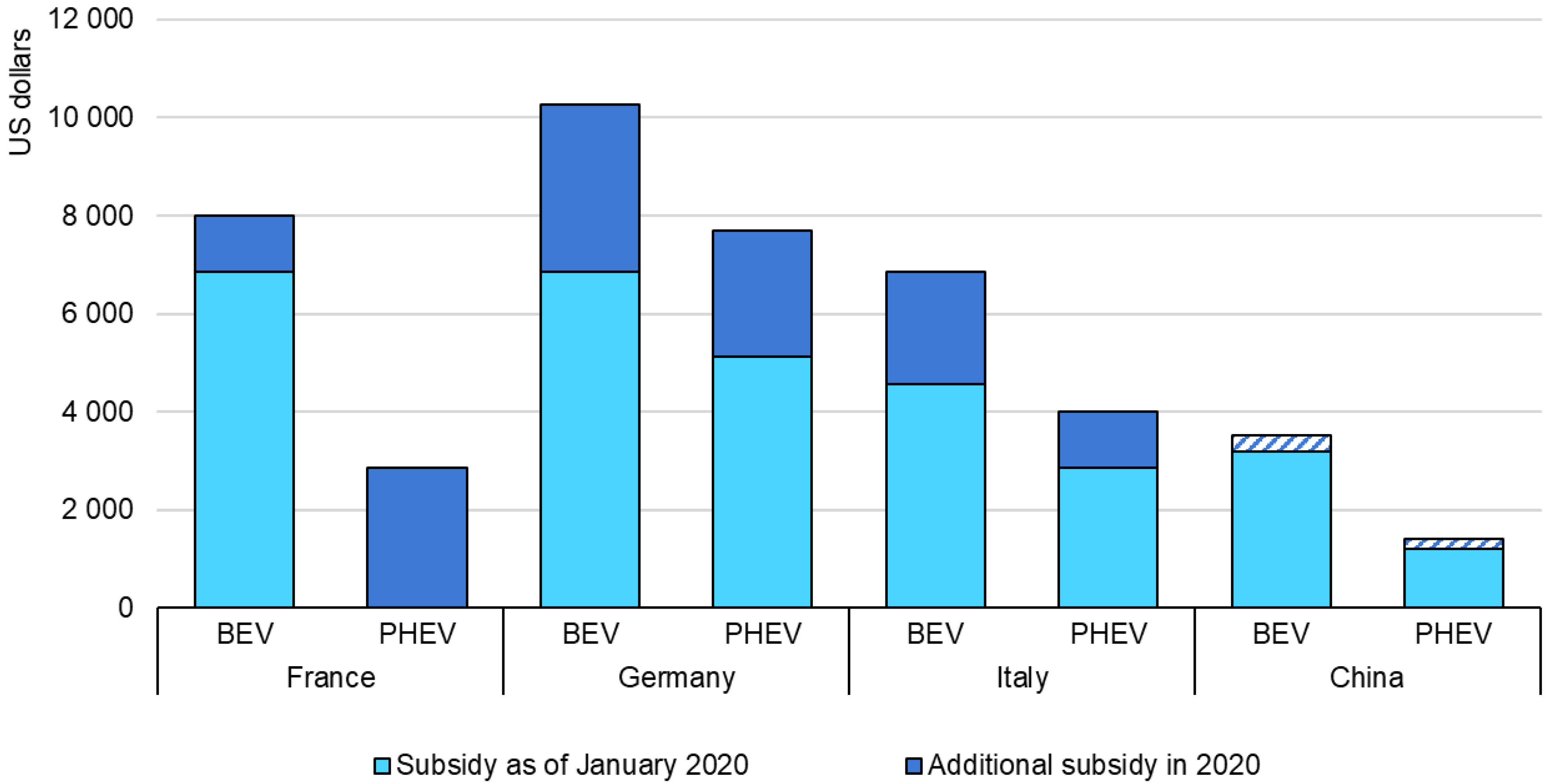
Many of the automotive-related stimulus measures implemented in 2020 were planned to be phased out by the end of the year. In some cases, the maximum quotas were reached in just a few weeks, e.g. France's enhanced cash-for-clunker scheme. The targeted stimulus measures provided impetus to the EV market, but do not guarantee persistent sales growth over time.

Acknowledging the success of the short-term measures, in the second-half of 2020 some countries extended their EV support packages by several months or even years, although in some cases with stricter access to subsidies, e.g. tightened vehicle price caps, higher income conditions, gradual reduction of subsidies and tax reductions.

Recovery packages that have a continued focus on electric mobility offer an opportunity to accelerate the pace of the transition. At the start of this decade, policy measures should encompass a broad set of considerations including social and environmental lessons learned from the pandemic. These include: equity, such as applying revenue conditions or vehicle retail price-conditions, or providing zero-interest loans; environmental performance standards, such as allocating incentives proportional to each model's emission reductions; and long-term viability with a view to reaching revenue neutrality, such as differentiated taxation and bonus-malus systems. Regulatory instruments should continue to encourage sustainable and low-emissions technology investment (considering the full lifecycle of a product), while supporting and prioritising industry reskilling to low-carbon economic activities with high employment multipliers, including non-motorised transport infrastructure and battery manufacturing.

Subsidies have been instrumental in boosting EV sales during the pandemic

National subsidies for EV purchase before and after economic stimulus measures in selected countries, 2020



Notes: Only direct purchase subsidies are included. The hashed lines for China indicate that over the course of 2020, EV subsides have been reduced. In China, the complete phase-out of the subsidy programme originally planned for the end of 2020 was postponed to 2022.

Current zero-emission light-duty vehicle policies and incentives in selected countries

		Canada	China	European Union	India	Japan	United States
Regulations vehicles	ZEV mandate	**British Columbia**: 10% ZEV sales by 2025, 30% by 2030 and 100% by 2040. **Québec**: 9.5% EV credits in 2020, 22% in 2025.	**New Energy Vehicle dual credit system**: 10-12% EV credits in 2019-2020 and 14-18% in 2021-2023.				**California:** 22% EV credits by 2025. **Other states:** Varied between ten states.
	Fuel economy standards (most recent for cars)	114 g CO_2/km or 5.4 L/100 km*** (2021, CAFE)	117 g CO_2/km or 5.0 L/100 km (2020, NEDC)	95 g CO_2/km or 4.1 L/100 km (2021, petrol, NEDC)	134 g CO_2/km or 5.2 L/100 km (2022, NEDC)	132 g CO_2/km or 5.7 L/100 km (2020, WLTP Japan)	114 g CO_2/km or 5.4 L/100 km*** (2021, CAFE)
Incentives vehicles	Fiscal incentives	✓	✓	✓	✓	✓	✓
Regulations chargers**	Hardware standards.	✓	✓	✓	✓	✓	✓
	Building regulations.	✓ *	✓ *	✓	✓		✓ *
Incentives chargers	Fiscal incentives	✓	✓	✓	✓	✓	✓ *

* Indicates that it is only implemented at state/provincial/local level. ** All countries/regions in the table have developed basic standards for electric vehicle supply equipment (EVSE). China, European Union and India mandate specific minimum standards, while Canada, Japan and United States do not. *** Historically, Canada and the United States have aligned emission standards for on-road light-duty vehicles. In April 2020 the United States adopted a final rule to reduce the annual stringency conditions for the 2021-2026 model years. Soon after, Canada finalised its mid-term evaluation of the Passenger Automobile and Light Truck GHG Emissions regulation, indicating a potential separation from the US ruling, pending further consultation. ✓ Indicates that the policy is set at national level.

Notes: g CO_2 /km = grammes of carbon dioxide per kilometre; L/100 km = litres per 100 kilometres; CAFE= Corporate Average Fuel Economy test cycle used in the United States and Canada fuel economy and GHG emissions tests; NEDC = New European Driving Cycle; WLTP= Worldwide Harmonized Light Vehicle Test Procedure; WLTP Japan = WLTP adjusted for slower driving conditions in Japan. Building regulations imply an obligation to install chargers in new construction and renovations. Charger incentives include direct investment and purchase incentives for public and private charging.

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Strong policies underpin major electric car markets

The Covid-19 pandemic spurred governments to enact stimulus measures, many of which singled out EV development both as a way to create jobs and to push for a cleaner tomorrow.

China

In order not to further hinder the car market in the depressed context of the pandemic, the planned end-2020 elimination of the New Electric Vehicle (NEV) subsidy programme was postponed to 2022 albeit with gradual reductions in subsidies over that period. The programme, which drove EV technology improvements over time, favoured models with longer driving ranges, better fuel economy and high density batteries. In 2020, a vehicle price cap and a NEV sales limit of 2 million per year were added to the subsidy programme. Plus in early 2021, fuel consumption limits for passenger light-duty vehicles (PLDVs) were set at 4.0 L/100 km (NEDC) by 2025.

The NEV credit mandate, introduced in 2017, has been a powerful driver of EV sales. It sets annual ZEV credit targets for manufacturers as a percentage of their annual vehicle sales. In 2020, the programme and its targets were extended to 2023, by which the target will be 18% (16% in 2022, 14% in 2021). Each EV can receive between 1 and 3.4 credits depending on its characteristics. Each OEM can achieve the target in several ways, mainly by selling BEVs, PHEVs and FCEVs in various proportions, and by trading credits with other manufacturers. In addition, since June 2020, "fuel-efficient passenger vehicle" bonuses can count towards the calculation of corporate NEV credits; conventional vehicles with fuel consumption below defined thresholds account for only a fraction of a conventional vehicle sold by the OEM. This provides an additional compliance pathway towards annual NEV credit targets.[7]

Other ZEV policies and programmes that deal with charging infrastructure, battery reuse and recycling and FCEV deployment were rolled out in 2020. To cushion the impacts of the pandemic on the automotive sector, some cities in China eased access restrictions in the second-quarter of 2020 to encourage all types of car sales. But many local governments included measures specifically aimed at supporting ZEV sales such as offering time-limited purchase subsidies, charging rebates to new ZEV adopters and expanding traffic restriction waivers for ZEVs.

China does not have specific ZEV policies in place beyond 2023, when the NEV credit expires, but has announced clear commitments. The New Energy Automobile Industry Plan (2021-2035) targets 20% of vehicle sales to be ZEVs by 2025,[8] to achieve international competitiveness for China's ZEV industry. The China Society of Automotive Engineers set a goal of over 50% EV sales by 2035. These goals fit in the context of China's announcing economy-wide carbon neutrality ambitions before 2060.

[7] In 2021, a fuel-efficient passenger vehicle counts for only half of a conventional vehicle sold, easing compliance to meet the NEV credit target for the OEM. This 0.5 factor tightens in 2022 and 2023.

[8] This target was confirmed in October 2020 and updates the previous target of 15-20%, though a proposal for an update to 25% by 2025 did not make it to the final version.

China's major cities have implemented a broad array of EV promotion policies

Local EV promotion policies in 20 cities in China with the largest car sales, 2020

City	Car plate restrictions and ZEV direct access	Traffic restrictions and ZEV waivers	Lower cost or free parking	Subsidies for the use of charging infrastructure	Direct ZEV purchase subsidies	Public bus fleet electrification
Shanghai	✓	✓		✓ 2020		✓ 2025
Beijing	✓	✓				✓ 2020*
Chengdu		✓	First two hours			✓**
Guangzhou	✓		First hour		✓ 2020/21	✓ 2020
Zhengzhou			50% off		✓ 2020	
Chongqing		✓	100% off	✓	✓ 2020	
Shenzhen	✓		First two hours		✓ 2020/21	
Suzhou			First hour			✓ 2020*
Hangzhou	✓	✓				✓ 2022
Dongguan						✓ 2020
Xi'an		✓	First two hours			✓ 2019
Wuhan		✓	First hour and then 50% off			
Tianjin	✓	✓		✓ 2020		✓ 2020*
Changsha						✓ 2020
Foshan						✓ 2019
Ningbo						✓ 2022
Nanjing			First hour			✓ 2021
Kunming			First two hours			✓**
Jinan		✓	First two hours and then 50% off (BEV)	✓ 2020/21		✓**
Shijiazhuang		✓			✓ Dec 2020	✓ 2020*

* Indicates the full fleet electrification target applies to the city's urban area.

** Indicates that the electrification requirement applies only to new or replacement vehicles.

Notes: ZEV = zero-emissions vehicle. All restrictions refer to privately owned LDVs. Various other restrictions apply to commercial vehicles. The cities are ranked by size of the car fleet in 2019. For the categories *subsidies for the use of charging infrastructure* and *direct ZEV purchase subsidies* the numbers indicate the years for which the policy is active. For the category *public bus fleet electrification*, the numbers specify the year by which the total stock is expected to be electrified.

Sources: See list of sources.

European Union

As part of its pandemic-related response, the European Union accelerated the roll-out of electric mobility through its commitment to decarbonisation in the EU Green Deal[9] and the subsequent Next Generation EU and Recovery Plan. In December 2020, the EU Sustainable and Smart Mobility Strategy and Action Plan bolstered these plans for the transport sector with ambitious ZEV deployment goals.

A number of EU directives and regulations are under review to adapt them to achieve stated ambitions. These include: CO_2 emissions performance standards for cars and vans; Alternative Fuels Infrastructure Directive; European Energy Performance of Buildings Directive (which supports the deployment of charging infrastructure); Batteries Directive of 2006 which is being complemented by a proposed Batteries Regulation announced in December 2020 and the EURO pollutants emissions standard.

Corporate fleet average tailpipe emissions are targeted to go below 95 grammes of carbon dioxide per kilometre (g CO_2/km)[10] in 2021 under the CO_2 emissions standards. EVs are increasingly important to meet the targets and a driving factor explaining why EV sales rose in 2020 despite Covid-19 and the automotive sector's overall downturn. The next targets push emissions to fall 15% in 2025 and 37.5% by 2030 from 2021 levels.These targets are being revised with a view to better support the EU Green Deal ambitions. Revisions are likely to include lower emissions targets, modifications in the role of zero and low emission vehicles (ZLEVs) (emissions under 50 g CO_2) and possibly a well-to-wheel approach rather than the current tailpipe (tank-to-wheel) approach.

In early 2021, nine EU countries urged the European Commission to accelerate an EU-wide phase out of petrol and diesel cars. This could create legislation allowing member states to enforce national ICE bans.

In addition to EU policies and directives, many countries in Europe are continuing EV subsidy and incentive measures. In some, pandemic relief stimulus measures have favoured alternative powertrains with supplemental purchase subsidies and cash-for-clunker schemes.

United States

At the federal level, the United States took a less supportive approach to EVs than China and Europe in 2020. The Corporate Average Fuel Economy (CAFE) standard was revised and rebranded as the Safer, Affordable Fuel-Efficient (SAFE) vehicle standard with significantly weaker energy efficiency targets for model years 2021-2026 than

[9] Which includes a commitment for climate neutrality by 2050.

[10] Applicable to 95% of registered new cars in 2020 and 100% in 2021.

those established under the CAFE standards.[11] In 2020, a federal tax credit of up to USD 7 500 for the purchase of an electric car was still available, with the exception of General Motors and Tesla which had reached the 200 000 sales limit per automaker in 2018, but this credit was not renewed.

It was at the state level where policies pushed for stronger EV deployment. The number of states following the California Low Emissions Vehicles pollutant and GHG emissions regulations now represent about a third of US car sales. The governor of California issued an Executive Order requiring that by 2035 all new car and passenger light truck sales be zero-emission vehicles. New York, New Jersey, and Massachusetts are considering similar bans on internal combustion engines.

Other state level policies such as the Low Carbon Fuel Standard are supporting EV adoption, especially in the heavy-duty vehicle sector. In addition, the majority of US states have specific policies in place to offer tax credits or purchase incentives for EVs as well as financial and technical assistance for installing charging infrastructure.

Total car sales dropped 23% in the United States in 2020, but sales shares of electric cars held up. This may be reflective of state intiatives partly compensating for diluted federal incentives as well as the expanding menu of available EV models including very popular SUV models. Only 30% of electric cars sold in the United States in 2020 benefitted from federal tax credits. In early 2021, the new US administration announced intentions to encourage ZEVs. So changes to the SAFE and federal tax credit programmes may be forthcoming and may be likely to to be structured to benefit domestic manufacturers and middle-class consumers.

India

India's efforts to control pollutant emissions from vehicles moved into high gear in April 2020 when it imposed Bharat Stage VI (BS-VI) standards, (which are largely aligned with Euro 6 standards), on new sales of motorcycles, light-duty and heavy-duty vehicles. The jump directly from BS-IV to BS-VI forces manufacturers to make significant changes to vehicle designs in a short period. Investment by some Indian OEMs focus on ICE models meeting BS-VI standards, thereby delaying investment in BEV deployment. These OEMs have indicated that they are facing losses due to slumps in auto sales from reduced demand during the pandemic.

Faster Adoption and Manufacturing of Electric Vehicles (FAME II) scheme is India's key national policy relevant for EVs. It allocates USD 1.4 billion over three years from 2019 for 1.6 million hybrid and electric vehicles (including two/three-wheelers, buses and cars)[12] and includes measures to promote domestic manufacturing of EVs

[11] SAFE weakens the annual improvement in fuel-economy standards from 4.7% under CAFE to 1.5% for model years 2021-2026.

[12] The largest share of the incentives is dedicated to buses (41%), followed by three-wheelers (29%) and two-wheelers (23%).

and their parts. However, more than halfway to the April 2022 end-date only 3% of the allocated funds have been used for a total of just 30 000 vehicles. Significant acceleration will be required to reach both the programme targets and national targets of 30% EV sales by 2030. Some critics blame the lack of supply-side policy instruments such as ZEV sales requirements or ICE phase-out targets to hasten EV adoption, while others have indicated the limited availability of EV models for average consumers.

State and urban governments have also started efforts to fast track road vehicle electrification. In February 2021, the chief minister of New Delhi announced the Switch Delhi awareness campaign to highlight its ambitious EV policy introduced in August 2020. The policy targets 25% electrification of vehicle sales in 2024 and 50% of all new buses to be battery electric. Other cities such as Kolkata, Pune, Nagpur and Bangalore continue to transform their fleets.

Japan

Japan declared an intention to be cabon neutral by 2050 in a statement from the prime minister in October 2020. In December the Ministry of Economy, Trade and Industry (METI) released the Green Growth Strategy with action plans for 14 sectors to achieve that goal. For transport, it will focus on increased electrification and fuel cell use, as well as next generation batteries, by using a mix of grants (for research, development and demonstration projects), regulatory reforms related to hydrogen refuelling and EV charging infrastructure and tax incentives for capital investment and R&D.

METI announced that by the mid-2030s Japan aims to have all new passenger cars electrified.[13] To reach this goal, it proposed to revisit fuel efficiency regulations, public procurement of EVs, expansion of charging infrastructure and large-scale investment in EV supply chains. A decision on options is to be made in mid-2021. Speculation is that the fuel efficiency standards for LDVs may be strengthened to meet the more ambitious mid-2030 and carbon neutrality targets.

In 2020, Japan was one of the few markets where EV sales dropped more than overall car sales. Sales are expected to recover after Japan doubled its subsidies for passenger ZEVs registered from the end of 2020. Other measures such as tax exemptions on BEVs, PHEVs and FCEVs have been extended for two years. In January 2021, electric cars sales increased around 35% relative to January 2020.

Canada

Canada continued to support key infrastructure and ZEV incentives in 2020 in light of its recently increased climate ambitions to reach net-zero emissions by 2050. Canada has ZEV targets of 10% of LDV sales by 2025, 30% by 2030 and 100% by 2040. Québec supports

[13] Electrified vehicles include HEVs, BEVs, PHEVs and FCEVs.

even faster adoption and has aligned with mandates in California and 14 other US states. British Columbia also has a ZEV mandate and together with Québec is leading the country in ZEV uptake.

A federal invesment of CDN 1.5 billion (USD 1.2 billion) in the low carbon and zero emissions fuels fund was announced in 2020 to increase production and use of low-carbon fuels, while major infrastructure and ZEV deployment programmes and federal purchase incentives received additional funding.

Chile

Chile's energy roadmap 2018-2022 targets a ten-fold increase in the number of electric cars in 2022 compared with 2017. The National Electromobility Strategy aims for a 40% penetration rate of electric cars in the private stock by 2050 (and 100% of public transport by 2040).

A new energy efficiency law aims to reduce energy intensity by at least 10% by 2030 (from 2019). It will establish energy efficiency standards for imported vehicles (with BEVs and PHEVs given supercredits) for LDVs and heavy-duty trucks. The government offers subsidies for electric taxis and home charging points.

New Zealand

New Zealand has a target of net-zero emissions by 2050, which is an important accelerator for policy developments in a variety of sectors. In 2020, the government and the private sector co-financed 45 new low-emissions transport projects, including charging infrastructure and BEV trucks. Legislation is expected to be adopted in 2021 for a clean car import standard which would progressively phase in more stringent targets, setting limits of up to 105 g CO_2/km average emissions in 2025. A February 2021 draft advice package from New Zealand's Climate Change Commission recommended a number of policies to accelerate the uptake of electric LDVs, including banning the import, manufacturing or assembling of light-duty ICE vehicles from 2030. The government's response to the Climate Change Commission's advice is due by the end of 2021.

Governments roll-out plans for interconnected charging infrastructure networks

The rapid evolution of EVSE infrastructure continued in 2020 and early 2021. Efforts are underway in some countries to strategically plan and install large-scale interconnected EV charging stations along main transport routes. Key considerations in the planning include digitalisation, interoperability and roadmaps for developing charging networks. Stimulus packages are augmenting the funding for EV infrastructure in some cases.

In the **Europe Union**, the Alternative Fuel Infrastructure Directive (AFID) is the main measure guiding the roll-out of publicly accessible EV charging stations. EU members are required to set deployment targets for publicly accessible EV chargers for the decade to 2030, with an indicative ratio of 1 charger per 10 electric cars. The EU Green Deal raised the bar with a target of 1 million publicly accessible chargers installed by 2025 and set out a roadmap of key actions to achieve it. This includes revisions to the AFID in 2021. Some proponents call for it to be converted to an enforced regulation which would allow the establishment of binding targets for member states, to revise the 1 charger per 10 electric cars ratio, to give EU citizens the right to request the installation of charging points ("right to plug") regardless of location and to include provisions for HDVs.

The AFID also sets targets for the deployment of chargers along the Trans-European Transport Network (TEN-T) core network, which will be reviewed in 2021. To inform the review three large industry associations signed a joint letter that proposes to formalise charging point targets to 2029 and an ultra-fast charging network along the TEN-T. Others have stated the importance of these revisions to ramp up charging infrastructure to meet increasingly ambitious OEM targets and the variety of availible EV models.

EU member states are implementing the revised European Energy Performance of Buildings Directive (EPBD III), which sets requirements for residential and non-residential buildings to improve access to charging points. The Recovery and Resilience Facility, a EUR 672.5 billion fund, includes support for charging stations.

An interconnected European EV charging network also depends on the ambitions of individual countries. Leading countries such as Germany, France, Netherlands, Sweden and Italy have national policies and targets to encourage development that range from grants and fiscal incentives for installation of public and private chargers to free public charging in urban areas.

Similar to large-scale investments in Europe, **China** announced a USD 1.4 trillion digital infrastructure public spending programme that includes funding for EV charging stations. This has trickled down to the local level, with more than ten cities announcing targets to install about 1.2 million chargers by 2025.[14] The province of Henan modified its approach from subsidising capital expenses for public charging stations to a tariff subsidy mechanism for fast charging stations. It also provides financial rewards to local governments that meet targets for new household chargers.

In the **United States** an infrastructure plan proposed in early 2021 would establish grant and incentive programmes to install 500 000 chargers, adding to about 100 000 existing charging points. Leading states such as California and New York offer subsidies and tax incentives, and collaborate with electric utilities to promote EV deployment.

In **Canada**, the Zero Emission Vehicle Infrastructure programme (iZEV) received additional funding of CAD 150 million) (USD 112 million). Its focus is on level 2 chargers at multi-unit residential buildings and workplaces, and fleet and high power charging infrastructure. The Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative (EVAFIDI) supports the installation of a national network of fast chargers.

In **Chile**, the new Energy Efficiency Law aims to ensure the interoperability of the EV charging system to facilitate the access and connection of EV users to the charging network.

Under **India**'s FAME II programme, USD 133 million is budgeted for charging infrastructure, though so far the funds have been under utilised. In October 2020, the Ministry of Heavy Industries released an expression of interest welcoming investors to benefit from the scheme and install a minimum of 1 charging station every 25 km along key highways and every 100 km to accommodate HDVs. Critics compare it to a similar initiative in 2019 in which there were many applicants but grants were only awarded to public companies.

[14] Includes cities/provinces of Beijing, Tianjin, Shanghai, Sichuan, Henan,Guangdong, Shandong, Jiangxi, Hunan and Hainan.

Markets for EV battery supply heat up

The rapid deployment of electric mobility and the automotive industry adoption of batteries to power EVs are drastically changing the battery industry. The scale of lithium-ion (Li-ion) battery material sourcing and manufacturing is set to grow substantially. Recent years have witnessed consolidation of small producers and rapid growth in installed and planned factory size.

Much of the existing legislation regulating batteries and their waste was not designed for automotive Li-ion batteries. Public authorities are only at the start of providing policy frameworks for the large-scale transformation of the automotive battery industry in terms of material sourcing, design, product quality requirements and traceability from inception to disposal. Effective policy frameworks are increasingly important for issues related to industrial competitiveness, know-how, employment and the environment.

In 2020, policy developments related to EV batteries focused on increasing competitiveness to strategically position countries to take a larger market share throughout the entire EV supply chain and to reduce reliance on imports of EV components.

In **China,** subsidies and regulations for battery suppliers favour large production facilities (at least 8 gigawatt-hours [GWh]) of Li-ion batteries and encourage consolidation and cost competitiveness. Though not official, China appears to be setting minimum production capacities for battery manufacturers (aiming for 3-5 GWh/year) in an attempt to consolidate small players and reduce battery costs. China established key measures in 2018 to push battery producers to establish collection and recycling activities. Guidelines encourage the standardisation of battery design, production and verification, as well as repairing and repackaging for second life utilisation.

To promote expansion of the ZEV industry, in 2018 the goverment banned investment in new enterprises for ICE car manufacturing that did not meet energy performance-related requirements. Also in 2018, new requirements were set for ZEV investments and limitations on foreign investment were eased to attract large foreign manufacturers.

In response to increased pressure from China, **Japan** continues to focus on competitiveness and high performance batteries. Its recently released Green Growth Strategy targets reducing the cost of batteries (cutting costs to USD 100 per kWh by 2030) and aims to achieve net-zero emissions of a vehicle through its entire lifecycle by 2050. Next generation batteries, such as solid state, are viewed as a key strategic pillar for the evolution of Japan’s automotive industry and to achieve the aims of the Green Growth Strategy. The government and automotive sector are collaborating on the collection and testing of used batteries to maximise the value of the embedded materials and to avoid waste.

The **European Union** aims to build a competitive EU-based automotive battery industry and to establish global standards for environmentally and socially responsible batteries. The EU 2006 Battery Directive is being revised with a new Batteries Regulation proposed in December 2020 for mandatory collection and recycling of automotive EV batteries.[15] It calls for a carbon footprint declaration for batteries sold in Europe starting in 2024. It proposes enhanced transparency and traceability along the full lifecycle via labelling and a digital "battery passport".

The European Battery Alliance serves to promote local competitive and innovative manufacturing. In early 2021 the European Commission approved a EUR 2.9 billion support package for a pan-European research and innovation project along the entire battery value chain – in particular related to raw and advanced materials, battery cells and systems, recycling and sustainability. Named European Battery Innovation, the project will provide support to 12 countries through 2028. Poland is positioning itself as a central EV manufacturing hub for Europe: in early 2020 the European Investment Bank supported the construction of a LG Chem Li-ion battery cells-to-packs manufacturing gigafactory in Poland.

In the **United States**, California eastablished the Lithium-ion Car Battery Recycling Advisory Group and tasked it with proposing policies for the end-of-life reuse and recycle of batteries. Their recommendations are due for release in 2022.

In **Canada**, the federal government and the province of Ontario each provided CAD 295 million (USD 220 million) to the Ford Motor Company Canada to support production of EVs, making it the largest Ford EV factory in North America. The federal and Québec governments are providing CAD 100 million (USD 75 million) to Lion Electric to support a battery pack assembly plant project.

In **India**, the Performance Linked Incentives scheme was extended in November 2020 to include INR 18 billion (USD 243 million) over five years for the advanced chemistry cell battery sector along with USD 7.8 billion for the automotive sector. Serving the "make in India" goal it provides incentives for the domestic production of EVs and to reduce reliance on imported components.

[15] The 2006 EU Battery Directive targets a 50% recycling efficiency of batteries by weight. The new Battery Regulation proposal envisions a 70% recycling efficiency for Li-ion batteries by 2030, plus specific recovery rates of 95% for cobalt, nickel and copper and 70% for lithium.

Policies affecting the electric heavy-duty vehicle market

Current zero-emission heavy-duty vehicle policies and incentives in selected countries

Policy Category	Policy	Canada	China	European Union	India	Japan	United States
Regulations vehicles	ZEV sales requirements			Voluntary to earn credits economy standards under fuel. Municipal vehicle purchase requirements.			**California:** new bus sales 100% ZEV by 2029. **California and New Jersey:** new truck sales up to 75% by 2035.
	Fuel economy standards	✓	✓	✓	✓	✓	✓
	Weight exemptions			2 tonnes over class.			**California:** 2 000 pounds over class.
Incentives vehicles	Direct incentives	✓*	✓*	✓*	✓	✓	✓*
Incentives fuels	Low-carbon fuel standards	✓*					✓*
Incentives EVSE	Direct investment	✓			✓	✓	✓*
	Utility investment						✓*

* Indicates implementation only at state/local level.

Notes: ZEV = zero-emission vehicle, which includes BEV, PHEV and FCEV; EVSE = electric vehicle supply equipment. Weight exemptions support freight operators by allowing ZEV trucks to exceed strict weight restrictions by a set amount. Because batteries weigh more than diesel fuel combustion technologies, ZEV truck operators may need to reduce their cargo to meet weight restrictions, resulting in lower profits and inefficient freight delivery. Utility investment: electric utilities tend to be large companies with business interests in EV charging, but they may be unwilling or unable to invest in charging infrastructure. Leading provinces and states have enabled or directed utilities to develop plans and deploy HDV charging infrastructure.

Sources: See list of sources.

Public policies prepare for expected surge in electric heavy-duty vehicles

Electric heavy-duty vehicles (HDVs) have faced slower adoption compared with LDVs due to high energy demands, large battery capacity requirements and limited availability of vehicle models. Now, the landscape is changing with advances in battery technology, bigger variety of models available and policies to support ZEV uptake in the HDV segment. Demand is expected to surge in this decade..

Asia

China is the leader in deploying zero-emission HDVs drawing from early and continuing actions over the last decade. The government bolstered the zero-emission HDV market with generous direct subsidies, initially for public buses and municipally owned vocational trucks, to offset higher vehicle costs (compared to ICE vehicles). Fuel economy standards further supported the development of electrified components.

Government subsidies for electric HDVs that were due to be phased out in 2019 were extended in 2020 through the Notice on improving the promotion and application of financial subsidy policies for New Energy Vehicles.

Current subsidies are calculated as a purchase price reduction valued per kilowatt-hour (kWh of battery capacity and modified for bus length and truck weight, with a cap set at about CNY 200 000 [USD 30 000]). Local governments often augment the subsidy with a cap set at 50% of new vehicle costs.

Japan's HDV decarbonisation strategy takes a different direction by focusing on hydrogen. Its 2017 Basic Hydrogen Strategy aims to rapidly expand hydrogen production and make the fuel more abundant and affordable. Its hydrogen strategy sets targets for FCEV deployment, including 1 200 transit buses by 2030. Japan plans to showcase the FCEV bus technology during the 2021 Tokyo Summer Olympics.

In **India**, through the FAME-II programme, the government is targeting electrification of buses. About 86% of the programme's budget is earmarked for direct vehicle subsidies, which is expected to generate demand for 7 000 BEV buses. Under the programme, the national government recently approved the addition of 5 595 new electric buses in various states.

Europe

The **European Union** has supported commercial ZEV adoption with a variety of regulations and incentives. Its 2019 HDV CO_2 standards reward participating ZEV manufacturers for up to twice the credit allocation of a diesel-fuelled truck through 2024. This "super-credit" system will be replaced in 2025 with a benchmarking system that reduces the calculation of the manufacturer's average specific CO_2 emissions once their ZEV sales share exceeds 2%. ZEV adoption is also supported by the Clean Vehicles Directive, which aggregates municipal vehicle purchases to national levels and establishes ZEV procurement targets for each member state in 2025 and 2030. The European Union also allows electric heavy trucks to exceed class limits by 2 tonnes.

EU member states are using policy measures to promote deployment of electric HDVs. Germany, Spain, Italy and France have provided incentives for commercial ZEV purchases with amounts ranging from EUR 9 000 to EUR 50 000 in some case since 2017. The Netherlands will implement zero-emission zones in 2025 for up to 40 of its largest cities, which will likely encourage the use of electric commercial vehicles in urban areas. The Netherlands and Norway have announced targets to electrify buses and trucks.

Switzerland has encouraged FCEV truck growth through its road tax on diesel truck operations, making alternative fuels more attractive for large Swiss retail associations.

United States

At the federal level, the United States lacks meaningful policy to support electric HDVs. Fuel economy standards allow ZEVs as eligible technologies but no other incentives are in place. At the subnational level, however, innovative policies have been adopted. For example,15 states and the District of Columbia have targeted 2050 for all new commercial HDVs to be ZEVs, with an interim target of 30% by 2030.

California leads state efforts:

- Launched by the California Air Resources Board in 2009, the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) makes clean vehicles more affordable for fleets through point-of-purchase price reductions. It is a first-come first-served incentive that reduces the incremental cost of commercial vehicles. Incentives may be up to USD 150 000 for eligible ZEV technologies. HVIP has disbursed more than USD 120 million for the uptake of ZEV buses and trucks. The programme was replicated in New York and is planned for adoption in Massachusetts and New Jersey.
- Developed in 2009, the Low Carbon Fuel Standard rewards clean fuel generators and ZEV owners with credits that can be sold to non-compliant fuel providers. The programme is expected to particularly encourage zero-emission HDVs as the fleets are more likely to accrue large-scale savings for using low-carbon fuels and to secure those savings. The standard was replicated in Oregon.
- Adopted the Innovative Clean Transit Rule in 2018, which requires all bus sales to be ZEVs by 2029, and the Advanced Clean Truck Rule in 2020, which uses the LDV ZEV programme design to require zero-emission truck sales as a percentage of total vehicle sales for each truck manufacturer. New Jersey has become the first of several states to adopt the rule; 13 other states plus the District of Columbia have announced their interest in following suit.

- Adopted legislation that compels large investor-owned utilities to submit proposals for electrified transportation, including programmes specific to HDVs. Southern California Edison has proposed to spend more than USD 300 million to install truck and bus charging stations in its service territory in the next five years. Pacific Gas & Electric has developed a plan that replaces costly charges for commercial ZEVs with a subscription service.
- Allows a 1 metric tonne exemption for alternative fuel freight vehicles to exceed weight class limits.

Canada

In October 2020, the government announced the Infrastructure Growth Plan and pledged CAD 1.5 billion (USD 1.1 billion) to procure 5 000 zero-emission public buses, with an additional CAD 2.75 billion (USD 2 billion) over the next five years to electrify transit and school buses across the country.

Canadian provinces also have programmes to advance zero-emission HDV adoption. Québec has subsidised electric trucks since 2017 and offers commercial freight vehicle operators 50% off the incremental price of a new electric truck up to CAD 75 000 (USD 56 000). British Columbia recently increased incentives in two Clean BC programmes that enable commercial ZEV purchase price reductions up to 33% with a cap of CAD 100 000 (USD 75 000). British Columbia also manages a low-carbon fuel standard that was implemented in 2010 and was updated in 2020 to require fuel suppliers to reduce carbon intensity annually to reach a total reduction of 20% relative to 2010. At the national level, the Clean Fuel Standard adopts design features of British Columbia's low-carbon fuel standard, putting in place a policy to reduce the carbon intensity starting in 2022 by 13% by 2030, relative to a 2016 baseline.

Other regions

In early 2021, the **New Zealand** government established a requirement that only zero-emission public transit may be purchased from 2025, with the target of decarbonising the public transport bus fleet by 2035. Government support to regional councils for this objective is a NZD 50 million (USD 35 million) fund over four years.

In South America, **Chile** and **Colombia** each established national targets in 2019 to electrify their bus fleets by 2040 and 2035 respectively.

Government investment in charging infrastructure for HDVs is slowly picking up

Leading governments around the world are developing programmes and strategies to roll-out high power fast charging networks. Several large-scale national or regional investments have also expanded commercial charging that has indirectly supported HDVs.

China has prioritised public fast charging infrastructure, which today supports its expanding commerical electric vehicle fleet, including HDVs. While subsidies from the central government have not been particularly large, additional subsidies from local sources have supported installation of large-scale charging infrastrucure by China's largest electric utilities.

In **India,** the FAME II programme supports investment in EVSE for electric buses with funding up to USD 135 million. This is expected to cover the costs of one low power charger per bus and one fast charger for every ten buses.

In **Japan,** the government supports the ZEV deployment plan with infrastructure targets and financial support. Through its Basic Hydrogen Strategy, plans are to install 320 hydrogen stations by 2025.

The **European Union** Alternative Fuels Infrastructure Directive requires each member state to establish a plan that defines charging needs. It does not explicitly set guidelines or targets for the charging infrastructure to support electric HDVs.

The **Netherlands** released a roadmap for logistics charging infrastructure, including HDVs and inland shipping in 2021.

The **United Kingdom** government will provide GBP 500 million (USD 640 million) to support public charging installations to 2025, including funding for the Rapid Charge network that will place high power chargers (150-350 kW) along strategic transport corridors. It aims to install 2 500 high power charging stations by 2030 and 6 000 by 2035.

California and some other US states are supporting infrastructure developments for electric HDVs through direct investment. The California Energy Commission (CEC) has funded the largest hydrogen refuelling network in North America with more than USD 125 million since 2009 for 62 public stations as part of the state goal to install 200 stations by 2025. Until 2020, investments have focused on LDV refuelling infrastructure. In December 2020, a plan was approved to provide up to an additional USD 115 million for hydrogen refuelling infrastructure, including fuelling for medium and heavy-duty vehicles.

The **Canada** Infrastructure Bank will invest CAD 1.5 billion (USD 1.1 billion) in electric buses and associated charging infrastructure.

Links to sources for figures and tables in Chapter 2

More than 20 countries have electrification targets or ICE bans for cars and 8 countries plus the European Union have announced net-zero pledges

Carbon Neutrality Coalition (2020), Energy & Climate Intelligence Unit (2020), Government of Cabo Verde (2019), Government of Canada (2019), Government of Costa Rica (2018), Government of Denmark (2019), Government of France (2019), Government of Iceland (2018), Government of Israel (2018), Government of Japan (2020), Government of Netherlands (2019), Government of Norway (2016), Government of Portugal (2019), Government of Scotland (2018), Government of Slovenia (2017), Government of Spain (2019), Government of Sweden (2018), Government of the United Kingdom (2020), ICCT (2020), McKinsey (2019), UNFCC (2020).

Current zero-emission light-duty vehicle policies and incentives in selected countries

ACEA (2020), Alternative Fuels Data Centre (2020), California Air Resources Board (2020), Centre for Science and Environment (2017), China Briefing (2020), Colombia University (2019), U.S. Department of Energy (2021), Department of Heavy Industry India (2020), European Commission (2019), European Commission (2018), Environmental Protection Agency (2020), Global Fuel Economy Initiative (2017), Global EV Outlook (2019), Government of British Colombia (2019), Government of India (2017), Government of India (2019), Government of Japan (2020), Government of the United States (2020), Government of Québec (2017), ICCT (2021), ICCT (2020), ICCT (2019), Ministry of Environment Japan (2020a), Ministry of Environment (2020b), Plug In BC (2021), State of Colorado (2019), State of Conneticut (2020), State of Maryland (2020), State of Massacheusetts (2016), State of New Jersey (2020), State of Vermont (2020), State of New York (2017), State of Oregon (2017), Transport Canada (2021), Transport & Environment (2020), TransportPolicy.net (2020), TransportPolicy.net Japan (2020).

China's major cities have implemented a broad array of EV promotion policies

Shanghai Government (2020), Shanghai Government (2021), Government of Sichuan (2020), Government of Guangzhou (2020a), Guangzhou Development and Reform Commission (2020), Government of Guangzhou (2017), NewQQ(2021), Government of Chongqing (2020), Shezhen Development and Reform Commission (2020), Government of Suzhou (2020), Suzhou Daily Newspaper Group (2018), Zhejiang Provinicial Development and Reform Comission (2020a), Sohu (2019), Chutian Metropolis Daily (2019), Wuhan Traffic management Bureau (2016), Government of Tiannjin (2020), Dongguan (2020), CAAM (2020a), Government of Hunan (2017), Zhejiang Provinicial Development and Reform Comission (2020b), Xinhuanet (2017), Government of Jinan (2020), Government of Kunming (2020), Bendibao (2020), CAAM (2020b).

Current zero-emission heavy-duty vehicle policies and incentives in selected countries

British Columbia Laws (2020), California Air Resource Board (2019), California Air Resource Board (2020), California Air Resource Board (2021), California Energy Commission (2020), California HVIP (2021), California Legislative Information (2018), California Public Utilities Commission (2018), Commonwealth of Massachusetts.(2021), European Commission (2019a), European Comission (2019b), European Union (2019), Government of Canada (2021a), Government of Canada (2021b), Government of India (2019), ICCT (2019), IEA (2019), METI (2017), METI (2019), NYSERDA (2021), NJEDA (2021), State of Oregon (2017), Transport Québec (2020), ZEV Alliance (2020).

Prospects for electric vehicle deployment

Outlook for electric mobility

This outlook explores two pathways for road transport electrification in the pivotal decade to 2030. It assesses the projected uptake of electric vehicles (EVs) across transport modes and regions. Then, it explores the implications of electric mobility for charging infrastructure, battery demand, energy demand, GHG emissions and revenue from road transport fuel taxation. This outlook for electric mobility takes a scenario-based approach which build on the latest market data, policy drivers and technology perspectives: the Stated Policies and Sustainable Development scenarios.

Stated Policies Scenario

The Stated Policies Scenario (STEPS) is the baseline scenario of the IEA flagship reports the *World Energy Outlook* and *Energy Technology Perspectives.* This scenario reflects all existing policies, policy ambitions and targets that have been legislated for or announced by governments around the world. It includes current EV-related policies and regulations, as well as the expected effects of announced deployments and plans from industry stakeholders. STEPS aims to hold up a mirror to the plans of policy makers and illustrate their consequences.

Sustainable Development Scenario

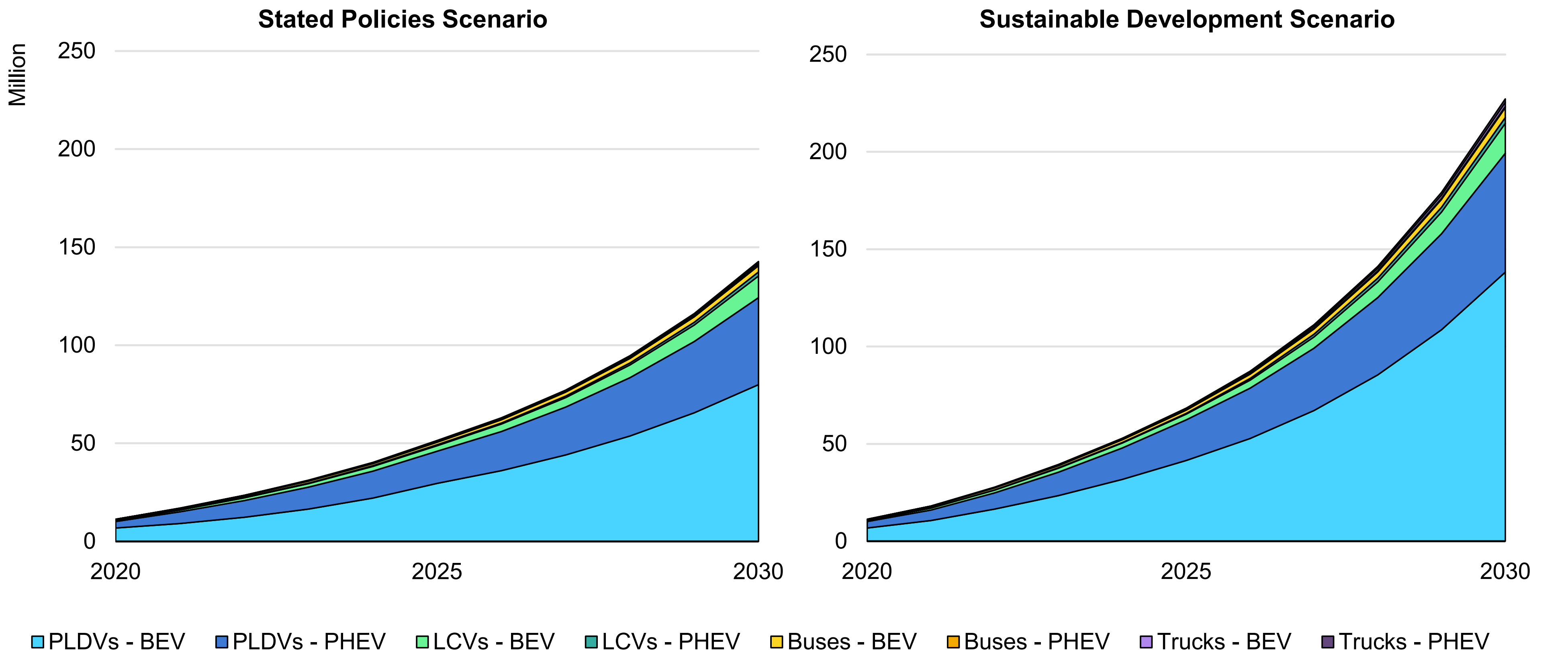
The Sustainable Development Scenario (SDS) rests on three pillars: ensure universal energy access for all by 2030; bring about sharp reductions in emissions of air pollutants; and meet global climate goals in line with the Paris Agreement. The SDS reaches net-zero emissions by 2070 and global temperature rise stays below 1.7-1.8 °C with a 66% probability, in line with the higher end of temperature ambition of the Paris Agreement.[16] To achieve this goal, the scenario requires a rapid reduction of carbon intensity of electricity generation, changes in driving behaviour and utilisation of public transport or non-motorised modes (resulting in reduced annual vehicle kilometres travelled and vehicle stock).

The SDS assumes that all EV-related targets and ambitions are met, even if current policy measures are not deemed sufficient to stimulate such adoption rates. In this scenario, the collective target of the EV30@30 signatories to achieve 30% sales share in 2030 for light-duty vehicles, buses and trucks is surpassed at the global level (reaching almost 35%), which reflects increasing ambitions for widespread EV deployment.

[16] To achieve net-zero emissions by 2050 and limit the global temperature rise to 1.5 °C (with a 50% probability), further acceleration of EV adoption would be required.

Passenger cars drive the growth of electric vehicles to 2030

Global EV stock by mode and scenario, 2020-2030



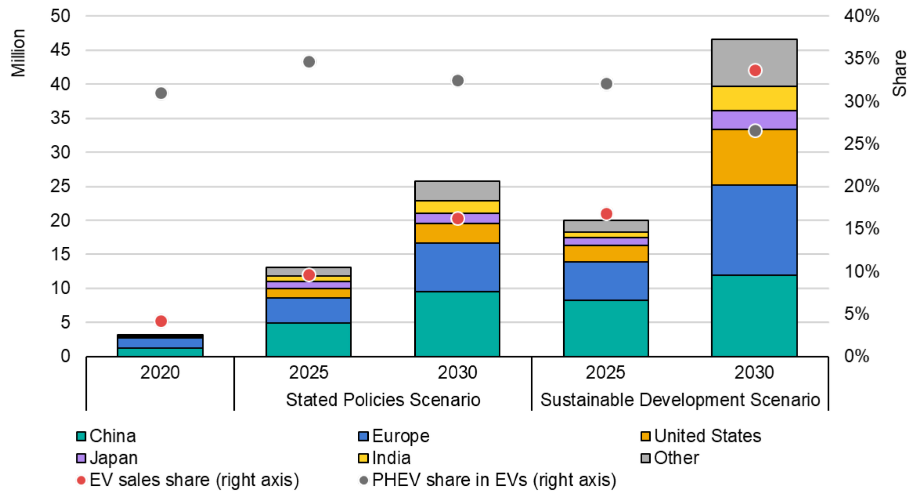
Notes: PLDVs = passenger light-duty vehicles; BEV = battery electric vehicle; LCVs = light-commercial vehicles; PHEV = plug-in hybrid electric vehicle. The figure does not include electric two/three-wheelers. For reference, total road EV stock (excluding two/three-wheelers) in 2030 is 2 billion in the Stated Policies Scenario and 1.9 billion in the Sustainable Development Scenario. Projected EV stock data by region can be interactively explored via the Global EV Data Explorer.

Source: IEA analysis developed with the Mobility Model.

EVs penetrate all road transport modes in the short term

In the Stated Policies Scenario, the global EV stock across all transport modes (excluding two/three-wheelers) expands from over 11 million in 2020 to almost 145 million vehicles by 2030, an annual average growth rate of nearly 30%. In this scenario, EVs account for about 7% of the road vehicle fleet by 2030. EV sales reach almost 15 million in 2025 and over 25 million vehicles in 2030, representing respectively 10% and 15% of all road vehicle sales.

Global EV sales by scenario, 2020- 2030



Notes: PHEV = plug-in hybrid electric vehicle. EV sales share = share of EVs (BEV+PHEV) out of total vehicles sales. PHEV share in EVs = share of PHEV sales out of EV (BEV+PHEV) sales. The regional breakdown of these figures by vehicle type can be interactively explored via the IEA's Global EV Data Explorer. Source: IEA analysis developed with the Mobility Model.

In the Sustainable Development Scenario, the global EV stock reaches almost 70 million vehicles in 2025 and 230 million vehicles in 2030 (excluding two/three-wheelers). EV stock share in 2030 reaches 12%.

Two/three-wheelers

Two/three-wheelers are easy to electrify because their light weight and short driving distances require relatively small batteries, which also raises fewer issues related to charging from power systems. On a total cost of ownership basis, electrification already makes economic sense in some regions. At more than 20%, two/three-wheelers are the most electrified road transport segment today.

Electric two/three-wheelers are projected to continue being the largest EV fleet among all transport modes. Growth is mainly in Asia where two/three-wheelers are prevalent. The global stock of electric two/three-wheelers in the Stated Policies Scenario increases from over 290 million in 2020 to more than 385 million in 2030, to account for a third of the total stock in 2030. Sales of electric two/three-wheelers increase from almost 25 million in 2020 to 50 million in 2030, when they account for more than half of all sales.

In the Sustainable Development Scenario, the global stock of electric two/three-wheelers reaches over 490 million in 2030, around 40% of the total stock for two/three-wheelers. This corresponds to sales of over 60 million in 2030, accounting for almost 75% of all sales, a 25% increase relative to the Stated Policies Scenario.

Light-duty vehicles

In the Stated Policies Scenario, the electric LDV stock rises from about 10 million in 2020 to around 50 million vehicles in 2025 and almost 140 million vehicles in 2030. Globally, the stock share of electric LDVs increases from less than 1% today to 8% in 2030. Sales of electric LDVs rise from 3 million in 2020 to 13 million in 2025 (sales share of 10%) and 25 million in 2030 (17% sales share). In the Sustainable Development Scenario, almost 220 million electric LDVs are projected to be circulating worldwide by 2030 (of which only 20 million are light-commercial vehicles), corresponding to an almost 15% stock share. Sales of electric LDVs are projected to reach 45 million in 2030 (35% sales share), an 80% increase relative to the Stated Policies Scenario. Governments and the private sector have announced several policies and targets regarding LDV electrification, which impact the scenario results.

Buses

The global electric bus fleet increases from 600 000 in 2020 to 1.6 million in 2025 and 3.6 million in 2030 in the Stated Policies Scenario, hitting 5% and 10% stock shares respectively. Most of the electrification is limited to urban buses, driven by efforts to reduce air pollution. There is less electrification of intercity buses, which have longer routes and require longer charging time. Overall, in the Stated Policy Scenario, the bus segment is expected to electrify faster than LDVs, reflecting government commitments to convert public transport fleets.

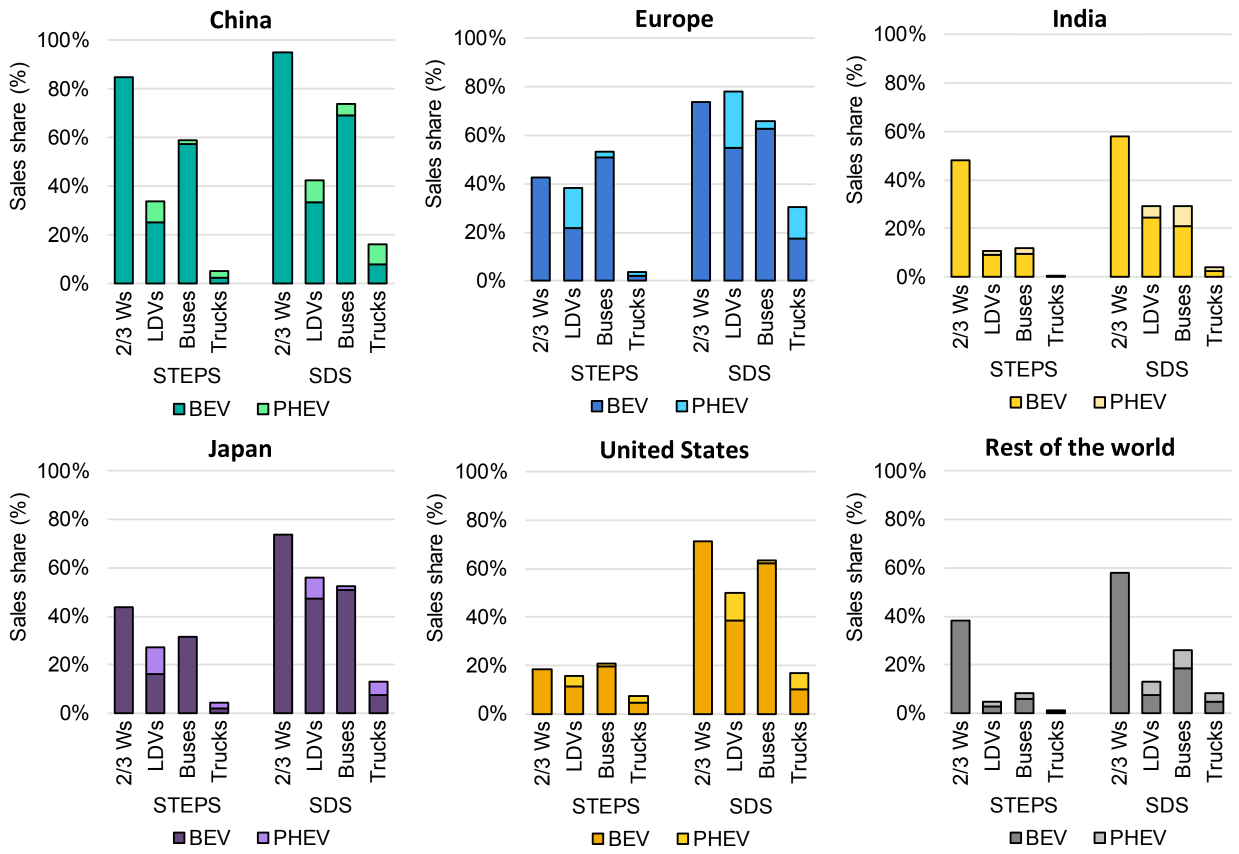
In the Sustainable Development Scenario, the deployment of electric buses accelerates, reaching over 5.5 million in 2030, corresponding to over 15% of the stock, primarily in urban buses.

Medium- and heavy-duty trucks

The electric truck fleet reaches 1.8 million in 2030 in the Stated Policies Scenario and 3.9 million in the Sustainable Development Scenario, hitting 1% and 3% of the total truck stock respectively. The share of global sales of electric trucks rises from neglible in 2020 to 3% over the projection period (10% in the Sustainable Development Scenario). Electric trucks are particularly used for deliveries in urban areas, where driving distances are shorter and overnight charging is possible. The electrification rate of trucks is the lowest of all vehicle segments, at least for the near term, in part because long-haul trucking requires advanced technologies for high power charging and/or large batteries. Reflecting the relative difficulty of electrifying the trucking sector, fuel economy standards are not stringent enough to require electrification for compliance and other policy or regulatory measures, such as ZEV mandates, tend to be less ambitious than for their light-duty vehicle counterparts.

Europe and China continue to lead global EV markets

EV share of vehicle sales by mode and scenario in selected regions, 2030



Notes: STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; 2/3 Ws = two/three-wheelers; LDVs = light-duty vehicles; BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle. Europe includes the countries of the European Union plus Iceland, Norway and United Kingdom. Regional projected EV sales and sales shares data can be interactively explored via the Global EV Data Explorer.

Source: IEA analysis developed with the Mobility Model.

Electrification of road transport accelerates, but at varying speeds

China

With nearly 60% of two/three-wheelers sold in 2020 being electric, China continues to lead in the electrification of this transport segment in both scenarios. China also continues to have the biggest electric bus sales share in both scenarios, reaching almost 60% in the Stated Policies Scenario and 75% in the Sustainable Development Scenario in 2030. This is no surprise given the country's leadership in electric bus manufacturing and the high number of bus models available in China.

For LDVs, China is expected to reach 35% EV sales in 2030 in the Stated Policies Scenario. It achieves 43% EV sales in the Sustainable Development Scenario, hitting the government's 2030 target and on track to achieve the China Society of Automotive Engineers goal of over 50% EV sales by 2035. In both electric LDVs and trucks, China's sales shares are lower than those in Europe in 2030 in the Stated Policies Scenario, mainly a reflection of the less stringent fuel economy standards and overall regulatory landscape for EVs. The electric truck sales share in 2030 reaches 5% in the Stated Policies Scenario and over 15% in the Sustainable Development Scenario.

In China, EV sales share across all modes (excluding two/three-wheelers) is just over 30% in 2030 in the Stated Policies Scenario and exceeds 40% in the Sustainable Development Scenario.

Europe

Stimulus measures to soften the economic effects of the Covid pandemic and CO_2 fuel economy standards underpin EV sales and are expected to maintain Europe as one of the most advanced EV markets in the coming years. Original equipment manufacturers are backing these goals, with several recently announcing their intention to only sell EVs in Europe from 2030. Europe is expected to lead the global electrification of LDVs in both scenarios. While the EV sales share is similar to that of China in the Stated Policies Scenario in 2030, Europe's overall clean energy ambitions as reflected in the Sustainable Development Scenario require higher electrification efforts to 2030. This is due in part to the European Union net zero 2050 target, EV deployment targets in a number of European countries and the United Kingdom advancing its ban on ICE vehicles to 2035. By 2030, electric LDV sales shares reach almost 40% in the Stated Policies Scenario and 80% in the Sustainable Development Scenario.

To support the European Union Sustainable and Smart Mobility Strategy, Europe must make significant efforts in the electrification of trucks, reflected in a sales share of 30% in 2030 in the Sustainable Development Scenario (compared to about 5% in the Stated Policies Scenario). Europe, along with North America, currently has the most electric heavy-duty truck models available as manufacturers are positioning themselves in view of the European Union net-zero emissions target in 2050. Its heavy-duty CO_2 emissions standards also incentivise zero-emission trucks.

Electric two/three-wheelers in Europe start from a low level compared with Asia but reach more than 40% sales share in 2030 in the Stated Policies Scenario. Electric buses attain over 50% sales share in the Stated Policies Scenario and over 65% in the Sustainable Development Scenario, spurred by the European Union Clean Vehicle Directive, which targets EV sales shares ranging from 33% to 65% by 2030 for publicly procured vehicles.

In Europe, EV sales share across all modes is about 35% by 2030 in the Stated Policies Scenario. In the Sustainable Development Scenario, by 2030, Europe has a combined EV sales share (for electric LDVs, buses and trucks) of just over 70%.

India

EV sales share across all modes (including two/three-wheelers) in India is above 30% in 2030 in the Stated Policies Scenario. Reflecting the intentions of FAME II, EV deployment in India is mainly achieved through the electrification of two/three-wheelers, which reach a sales share of almost 50%. The rate of electrification of buses and LDVs is lower, below 15% sales share in 2030.

In the Sustainable Development Scenario, EV sales shares in India scale up to almost 50% in 2030 across all road vehicle modes (30% excluding two/three-wheelers). By 2030 almost 60% of all two/three-wheelers sold are electric, as are about 30% of LDVs and buses.

Japan

In the Stated Policies Scenario, Japan reaches almost 30% electric LDV sales share, driven by the country's current fuel economy standards. In the Sustainable Development Scenario, electrification of LDVs increases more rapidly, reaching 55% in 2030, in anticipation of the announced ICE vehicle ban in the mid-2030s and the 2050 net zero pledge. Although EV and automotive battery manufacturing is very advanced in Japan, in the Stated Policies Scenario it has lower domestic EV sales shares than Europe and China. This reflects Japan's EV incentive schemes and fuel economy standards that do not include specific provisions for EVs.

In the Stated Policies Scenario, by 2030 EV sales share in Japan across all modes (excluding two/three-wheelers) reach 25%. In the Sustainable Development Scenario, EV sales shares are almost 55% across all modes (except two/three-wheelers), the same as for electric LDV sales shares.

United States

The outlook for EVs has improved with the United States announcing plans to strengthen fuel economy standards, subsidise EVs and charging infrastructure and reach net-zero emissions by 2050. In addition, several states intend to implement zero-emission truck sales requirements. As a result, the United States has the highest sales shares of electric heavy-duty trucks in the Stated Policies Scenario, reflecting the relatively large number (about 70) of electric truck models currently available in North America.

In the Stated Policies Scenario, the 2030 EV sales shares reach about 15% for LDVs, 20% for buses and 7% for trucks. The resulting EV sales share across all modes (excluding two/three-wheelers) is 15%. If additional measures are announced by the new administration, these EV shares may be boosted further. In the Sustainable Development Scenario, the 2030 EV sales shares reach about 50% for LDVs, 65% for buses and over 15% for trucks, resulting in an EV sales share of about 50% across modes.

Other regions

Many countries around the world have not yet developed a clear vision or set targets for electric mobility. A lack of fiscal incentives for EVs, lack of charging infrastructure and higher purchase price hurdles contribute to lower EV sales shares in a number of countries and in the other regions category overall.

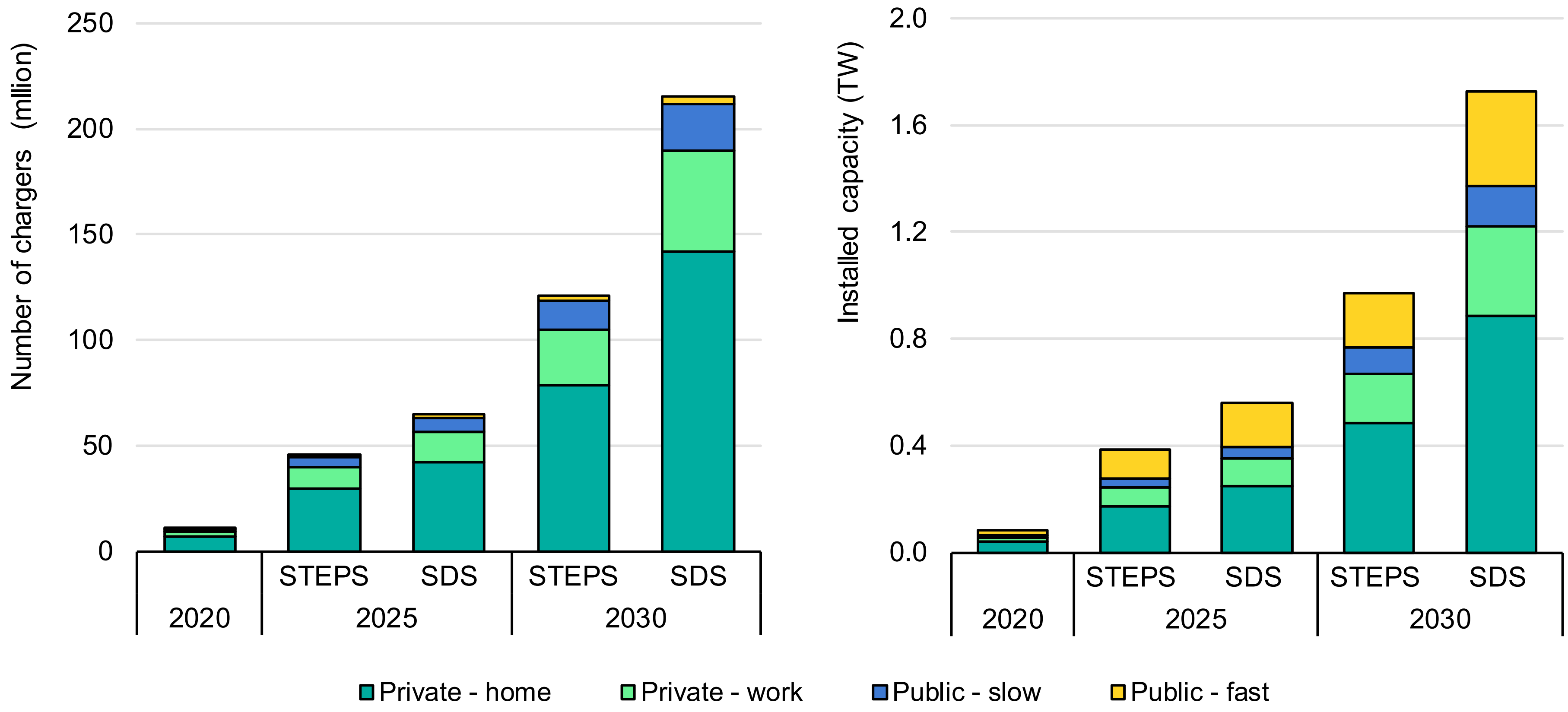
For the other regions category in the Stated Policies Scenario, EV sales shares average 5% for LDVs, 8% for buses and 1% for trucks in 2030. The Sustainable Development Scenario assumes higher electrification across the world, though still lagging behind the more advanced markets. In the Sustainable Development Scenario, the other regions category average EV shales shares of almost 15% for LDVs, over 25% for buses and 8% for trucks.

Some of these countries (e.g., Canada, Chile, Colombia, Israel, Korea, Pakistan, New Zealand) have adopted policies and other measures to support vehicle electrification and have net-zero emission pledges, thus have significantly higher sales shares than the averages listed above. For example, Canada's EV sales share across modes (excluding two/three-wheelers) is 25% in the Stated Policies Scenario and 40% in the Sustainable Development Scenario. Similarly, Korea averages an EV sales share of 25% across modes in the Stated Policies Scenario and 60% in the Sustainable Development Scenario.

Charging infrastructure

Private charging for electric light-duty vehicles will dominate in numbers and capacity

Electric LDV chargers and cumulative installed charging power capacity by scenario, 2020-2030



Notes: STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; TW = terawatt. Regional projected electric vehicle supply equipment (EVSE) stock data can be interactively explored via the Global EV Data Explorer.
Source: IEA analysis developed with the Mobility Model.

Charging points for LDVs expand to over 200 million and supply 550 TWh in the Sustainable Development Scenario

EVs require access to charging points, but the type and location of chargers are not exclusively the choice of EV owners. Technological change, government policy, city planning and power utilities all play a role in EV charging infrastructure. The location, distribution and types of electric vehicle supply equipment (EVSE) depend on EV stocks, travel patterns, transport modes and urbanisation trends. These and other factors vary across regions and time.

- Home charging is most readily available for EV owners residing in detached or semi-detached housing, or with access to a garage or a parking structure.
- Workplaces can partially accommodate the demand for EV charging. Its availability depends on a combination of employer-based initiatives and regional or national policies.
- Publicly accessible chargers are needed where home and workplace charging are unavailable or insufficient to meet needs (such as for long-distance travel). The split between fast and slow charging points is determined by a variety of factors that are interconnected and dynamic, such as charging behaviour, battery capacity, population and housing densities, and national and local government policies.

The assumptions and inputs used to develop the EVSE projections in this outlook follow three key metrics that vary by region and scenario: EVSE-to-EV ratio for each EVSE type; type-specific EVSE charging rates; and share of total number of charging sessions by EVSE type (utilisation).

EVSE classifications are based on access (publicly accessible or private) and charging power. Three types are considered for LDVs: slow private (home or work), slow public and fast/ultra-fast public.[17]

Private chargers

The estimated number of private LDV chargers in 2020 is 9.5 million, of which 7 million are at residences and the remainder at workplaces. This represents 40 gigawatts (GW) of installed capacity at residences and over 15 GW of installed capacity at workplaces.

Private chargers for electric LDVs rise to 105 million by 2030 in the Stated Policies Scenario, with 80 million chargers at residences and

[17] Slow chargers have a power rate below 22 kilowatts (kW); fast chargers have a power rate above 22 kW; ultra-fast chargers have a power rate above 150 kW.

25 million at workplaces. This accounts for 670 GW in total installled charging capacity and provides 235 terawatt-hours (TWh) of electricity in 2030.

In the Sustainable Development Scenario, the number of home chargers is more than 140 million (80% higher than in the Stated Policies Scenario) and those at workplace number almost 50 million in 2030. Combined, the installed capacity is 1.2 TW, over 80% higher than in the Stated Policies Scenario, and provides 400 TWh of electricity in 2030.

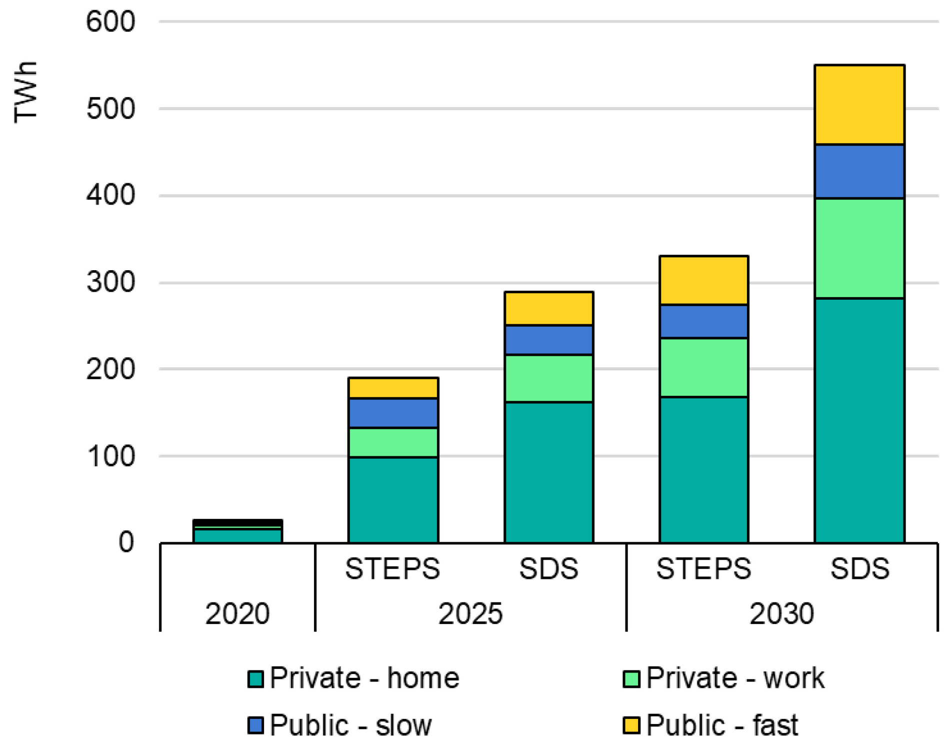
Private chargers account for 90% of all chargers in both scenarios in 2030, but for only 70% of installed capacity due to the lower power rating (or charging rate) compared to fast chargers. Private chargers meet about 70% of the energy demand in both scenarios, reflecting the lower power rating.

Publicly accessible chargers

There are 14 million slow public chargers and 2.3 million public fast chargers by 2030 in the Stated Policies Scenario. This accounts for 100 GW of public slow charging installed capacity and over 205 GW of public fast installed capacity. Publicly accessible chargers provide 95 TWh of electricity in 2030.

In the Sustainable Development Scenario, there are more than 20 million public slow chargers and almost 4 million public fast chargers installed by 2030 corresponding to installed capacities of 150 GW and 360 GW respectively. These provide 155 TWh of electricity in 2030.

Electricity demand by LDV charger type and scenario, 2020-2030



Notes: STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario.
Source: IEA analysis developed with the [Mobility Model.]

Implications of electric mobility

Annual battery demand grows twenty-fold in the Sustainable Development Scenario

Global lithium-ion automotive battery manufacturing capacity in 2020 was roughly 300 GWh per year, while the production was around 160 GWh. Battery demand is set to increase significantly over the coming decade, reaching 1.6 TWh in the Stated Policies Scenario and 3.2 TWh in the Sustainable Development Scenario.

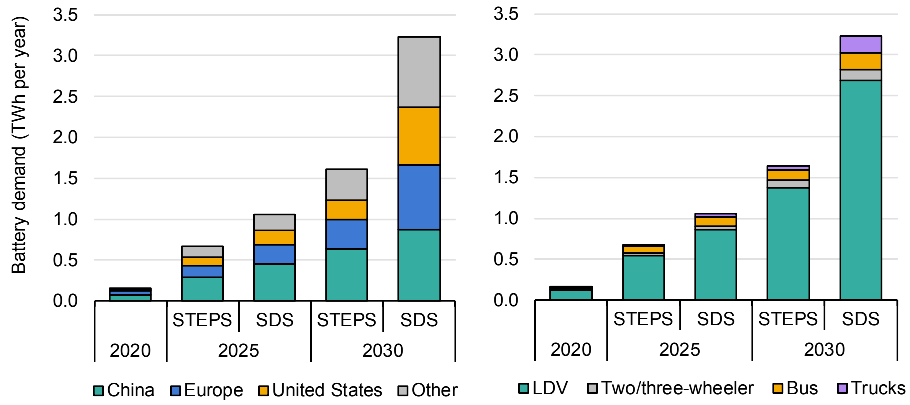
Today the largest demand for EV batteries is in China. It is expected to remain the biggest market in this decade in both scenarios. China is followed by Europe and the United States.

Electric LDVs are expected to continue driving total battery demand for EVs, accounting for about 85% of demand in both scenarios. Battery demand is projected to reach 120 GWh for buses and 100 GWh for two/three-wheelers in 2030. Battery demand for heavy trucks only increases in the Sustainable Development Scenario, exceeding 200 GWh of demand in 2030. In the Stated Policies Scenario, market penetration for electric trucks is limited by the absence of more stringent policies. Battery demand growth is also driven by increases in average battery size, which is expected to rise to enable longer driving ranges and to electrify heavier vehicles such as sport utility vehicles.

A thorough assessment of the implications of EV battery demand on raw materials will be available in a forthcoming IEA report, *The role of critical minerals in clean energy transitions.*

Announced planned production capacity for EV batteries equates to roughly 3.2 TWh by 2030. This capacity is sufficient to satisfy the battery needs of the Sustainable Development Scenario targets if all battery manufacturing plants are operated at full capacity (currently they operate at about 50% capacity). At least five years are needed from breaking ground for a new battery factory to producing at full capacity. Therefore, for the Sustainable Development Scenario targets to be met, efforts must be made to ensure that all the announced production capacity is built on time and that factories rapidly increase their capacity factors.

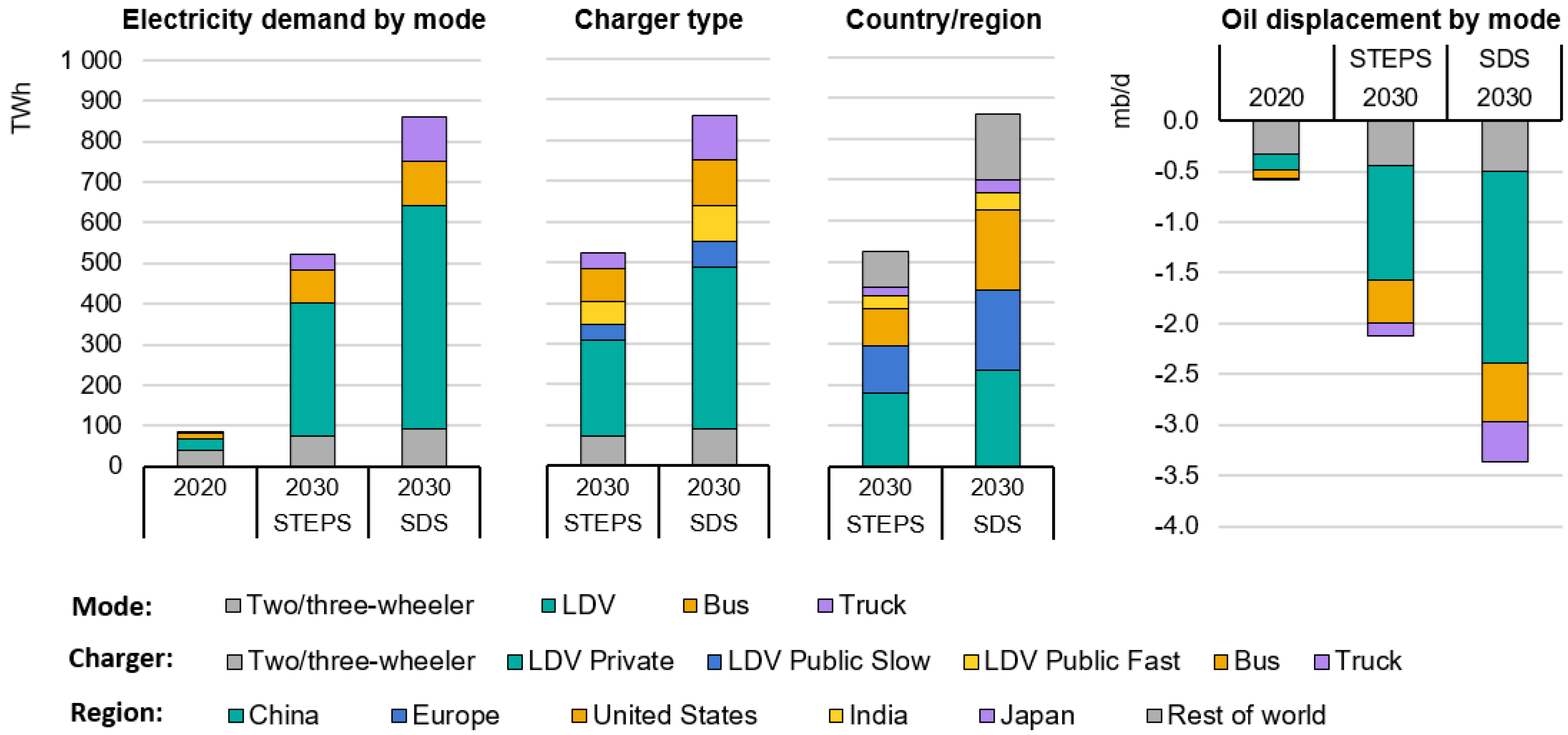
Annual EV battery demand projections by region (left), mode and scenario (right), 2020-2030



Notes: LDV = light-duty vehicle. Only considers lithium-ion batteries.
Source: IEA analysis developed with the Mobility Model.

Electric vehicles diversify the transport energy mix

Electricity demand from the global EV fleet and oil displacement by scenario, 2020 and 2030



Notes: mb/d = million barrels per day; STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario; LDV = light-duty vehicle. The analysis is carried out for each region in the Mobility Model separately and then aggregated for global results. Regional data can be interactively explored via the Global EV Data Explorer.

Source: IEA analysis developed with the Mobility Model.

EVs account for a minor share of global electricity consumption in 2030

The global EV fleet in 2020 consumed over 80 TWh of electricity (mainly for electric two/three-wheelers in China), which equates to today's total electricity demand in Belgium. Electricity demand from EVs accounts for only about 1% of current electricity total final consumption worldwide.

Electricity demand for EVs is projected to reach 525 TWh in the Stated Policies Scenario and 860 TWh in the Sustainable Development Scenario in 2030. LDVs account for about two-thirds of demand in both scenarios. By 2030, electricity demand for EVs will account for at least 2% of global electricity total final consumption in both scenarios.

The EV fleet is expected to become increasingly significant for power systems in both scenarios, possibly driving increments in peak power generation and transmission capacity. Smart charging is of crucial importance to ensure that EV uptake is not constrained by grid capacity. More than half of EV electricity demand in 2030 in both scenarios is via slow chargers, whose timing can be more easily managed to ensure the smooth operation and security of power systems.

China remains the largest consumer of electricity for EVs in 2030, although its share in global EV electricity demand more than halves (from 80% in 2020 to around 35% or less than 30% in the Stated Policies Scenario and Sustainable Development Scenario, respectively). This reflects the spread of electric mobility more widely across the world in the 2020s.

Expanding EV stock also enhances energy security by reducing oil use which today accounts for around 90% of total final consumption in the transport sector. Globally, the projected EV fleet in 2030 displaces over 2 million barrels per day (mb/d) of diesel and gasoline in the Stated Policies Scenario and about 3.5 mb/d in the Sustainable Development Scenario, up from about 0.5 mb/d in 2020. For context, Germany consumed around 2 mb/d of oil products across all sectors in 2018.

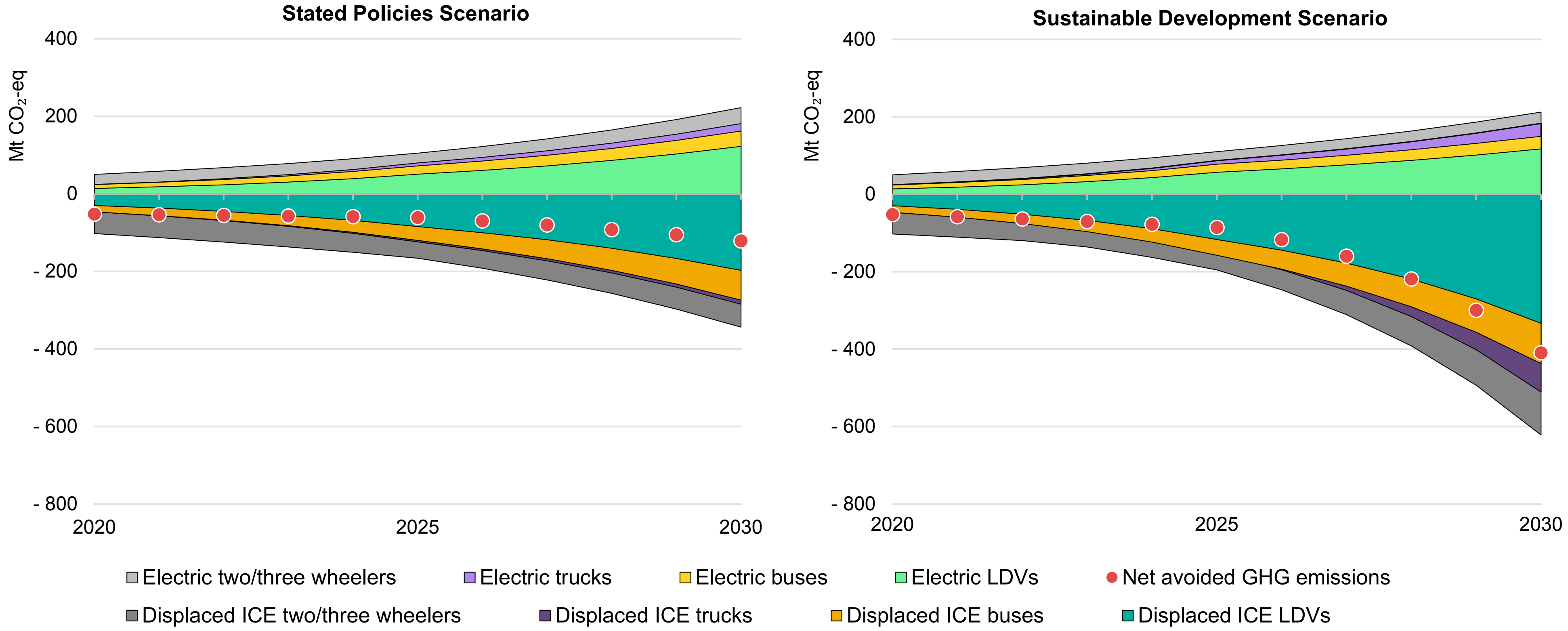
Share of electricity consumption attributable to EVs relative to final electricity demand by region and scenario, 2020 and 2030

Country/region	2020	Stated Policies Scenario 2030	Sustainable Development Scenario 2030
China	1.0%	2%	3%
Europe	0.3%	3%	5%
India	0.0%	2%	2%
Japan	0.1%	2%	3%
United States	0.2%	2%	5%

Sources: Electricity demand from EVs was evaluated with the Mobility Model; total final electricity consumption from IEA (2021).

Net reduction of GHG emissions from EVs increases over time

Net and avoided well-to-wheel GHG emissions from the global EV fleet by scenario, 2020-2030



Notes: Mt CO_2-eq = million tonnes of carbon-dioxide equivalent; LDVs = light-duty vehicles; ICE = internal combustion engine. Well-to-wheel emissions include those from fuel production and vehicle use, but not vehicle manufacturing. Positive emissions are from the global EV fleet (BEVs and PHEVs). Negative emissions are those that would have been emitted by an equivalent ICE vehicle fleet. The red dots denote net GHG emissions savings from EVs in comparison with an equivalent ICE fleet. Regional well-to-wheel GHG emissions data can be interactively explored via the Global EV Data Explorer.

Sources: IEA analysis developed with the Mobility Model using the carbon intensity values from Energy Technology Perspectives 2020 for both scenarios.

GHG emission benefits from EVs multiply as electricity generation decarbonises

In 2020, EVs saved more than 50 Mt CO_2-eq of GHG emissions globally, equivalent to the entire energy sector emissions in Hungary in 2019. These savings were mainly achieved from the electric two/ three-wheeler fleet in China.

The outlook for the decade is that the expanding fleet of EVs will continue to reduce well-to-wheel (WTW) GHG emissions relative to continued reliance on ICE vehicles powered by liquid and gaseous fuels with the percent net reduction increasing over time. That is because the carbon intensity of electricity generation is expected to decrease at a faster pace than that of liquid and gaseous fuel blends. However, in order to harness the maximum GHG emissions mitigation potential, EV deployment needs to be accompanied by decarbonisation of electricity generation.

In the projections, the WTW GHG emissions from the EV stock are determined for each country/region based on the amount of electricity consumed by EVs and the average carbon intensity of power generation. The assumption is that the average carbon intensity of generation is cut by 20% in the Stated Policies Scenario and 55% in the Sustainable Development Scenario by 2030. The avoided GHG emissions are those that would have been emitted if the projected EV fleet were instead powered by ICE vehicles.

In 2030, the global EV fleet reduces GHG emissions by more than one-third compared to an equivalent ICE vehicle fleet in the Stated Policies Scenario and by two-thirds in the Sustainable Development Scenario.

In the Stated Policies Scenario, the global EV fleet is projected to emit 230 Mt CO_2-eq in 2030, but if that fleet was powered by ICE vehicles emissions would be 350 Mt CO_2eq, delivering 120 Mt CO_2-eq of net savings. In the Sustainable Development Scenario, the WTW GHG emissions from the EV fleet in 2030 are expected to be lower than in the Stated Policies Scenario (210 Mt CO_2-eq) reflecting that the increase in the number of EVs is counterbalanced by less carbon-intense power generation. The Sustainable Development Scenario delivers 410 tonnes CO_2-eq in net savings.

A recent IEA analysis shows that from a lifecycle perspective (which includes emissions related to vehicle manufacturing, use and end-of-life) BEVs today provide lifecycle GHG emissions reductions of around 20-30% relative to conventional ICE vehicles on a global average. These benefits are more pronounced in countries where the power generation mix is rapidly decarbonising, such as the European Union, where BEV lifecycle emissions are around 45-55% lower. Moreover, the analysis shows that decarbonising the fuel consumed by a vehicle should be the priority to reduce its lifecycle emissions for all powertrains.

Measures are needed to balance reduced revenue from fuel taxes associated with EV uptake

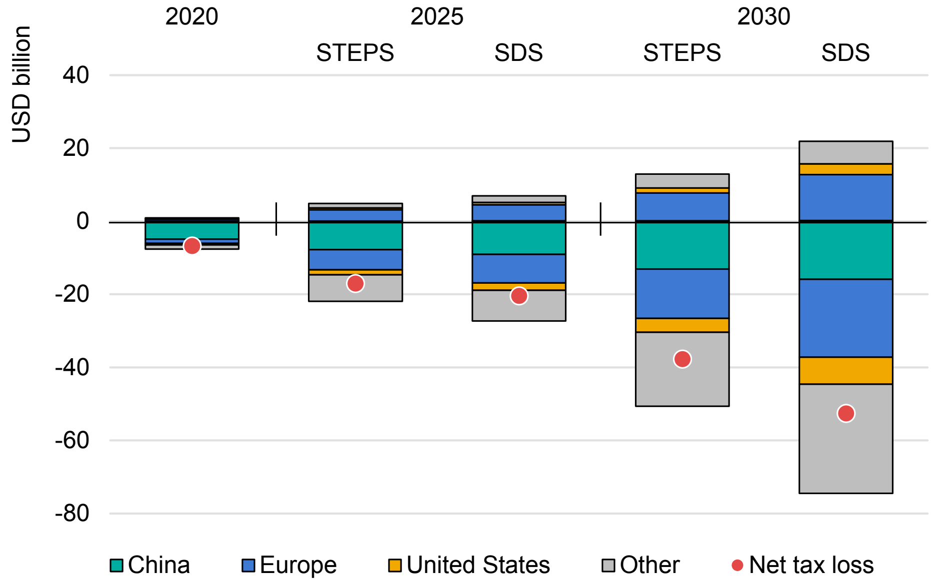
By reducing the consumption of oil products, EV uptake lessens the amount of revenue that governments derive from fossil fuel taxes, which is not fully compensated by levies on the increased electricity use. The net tax loss is mainly due to lower overall energy consumption (EVs are two-to-four times more efficient than comparable ICE vehicles) rather than different taxation levels of electricity and oil products.

While this effect on government tax take is limited today, by 2030 the global EV fleet might imply a net fuel tax loss of around USD 40 billion in the Stated Policies Scenario and USD 55 billion in the Sustainable Development Scenario. Governments should anticipate this trend and design mechanisms that enable continued support for EV deployment while limiting the revenue impact.

In the short term, existing taxation schemes should flexibly adapt to changes in the fuel market. For instance, taxes on oil products should adapt to maintain the overall revenue from fuel taxation, despite a net decline in use. However, these short-term measures cannot be protracted in time, as they risk creating distortions and raising equity issues.

In the longer term, the stabilisation of tax revenue – important to support investment in roads and other transport infrastructure – is likely to require deeper reforms in tax schemes. These could include coupling higher taxes on carbon-intensive fuels with distance-based charges. However, it is also important to note that widespread EV adoption will reduce air pollution, offsetting lost tax revenue by reducing health damages and their associated costs.

Additional tax revenue from electricity and tax loss from displaced oil products by region and scenario, 2020-2030



Notes: STEPS = Stated Policies Scenario; SDS = Sustainable Development Scenario. Fuel tax rates are assumed to remain constant after 2020.
Source: IEA analysis developed with the Mobility Model using taxes from IEA Energy Prices.

Annex

Abbreviations and acronyms

AFC TCP	Advanced Fuel Cell Technology Collaboration Partnership
AFID	Alternative Fuel Infrastructure Directive
BS-IV	Bharat Stage 4 Emission Standards
BS-VI	Bharat Stage 6 Emission Standards
BEV	battery electric vehicle
BNEF	Bloomberg New Energy Finance
CAD	Canadian dollar
CAFE	Corporate Average Fuel Economy
CCS	combined charging system
CEC	California Energy Commission
CEM	Clean Energy Ministerial
CO_2	carbon dioxide
e-bus	electric bus
e-scooter	electric scooter
EPBD	Energy Performance of Buildings Directive
EU	European Union
EUR	Euro
EV	electric vehicle
EVAFIDI	Electric Vehicle and Alternative Fuel Infrastructure Deployment Initiative
EV100	The Climate Group's EV100 Initiative
EVI	Electric Vehicle Initiative
EVSE	electric vehicle supply equipment
FAME II	Faster Adoption and Manufacturing of Electric Vehicles
FCEV	fuel cell electric vehicle
GBP	United Kingdom pound
GHG	greenhouse gases
GM	General Motors
HDT	heavy-duty truck
HDV	heavy-duty vehicle
HEV	hybrid electric vehicle
HFT	heavy freight truck
HRS	hydrogen refuelling station
HVIP	Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (California)
ICE	internal combustion engine
IEA	International Energy Agency
INR	Indian rupee
iZEV	Zero-Emission Vehicle Infrastructure programme
LCV	light-commercial vehicle
LDV	light-duty vehicle
LFP	Lithium-iron-phosphate
Li-ion	lithium-ion
MAN	Maschinenfabrik Augsburg-Nürnberg
METI	Ministry of Economy, Trade and Industry (Japan)
MFT	medium freight truck
MHDV	medium- and heavy-duty vehicles

NCA	nickel-cobalt-aluminium
NEDC	New European Driving Cycle
NEV	new energy vehicle
NMC	nickel-manganese-cobalt
NZD	New Zealand dollar
OEM	original equipment manufacturer
PHEV	plug-in hybrid electric vehicle
PLDV	passenger light-duty vehicle
PLI	performance linked incentives
SAFE	Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule (United States)
SDS	Sustainable Development Scenario
STEPS	Stated Policies Scenario
SUV	sport utility vehicle
TEN-T	Trans-European Transport Network
TFC	Total final consumption
USD	United States dollar
VW	Volkswagen
WLTP	Worldwide Harmonized Light Vehicle Test Procedure
WTW	well-to-wheel
ZETI	Zero-Emission Technology Inventory
ZEV	zero-emission vehicle
ZLEV	zero- or low-emission vehicle

Units of measure

°C	degree Celsius
g CO_2	grammes of carbon dioxide
g CO_2/km	grammes of carbon dioxide per kilometre
GWh	gigawatt-hour
km	kilometre
km/lge	kilometre per litre of gasoline equivalent
kW	kilowatt
KWh	kilowatt-hours
L/100km	litres per 100 kilometres
lbs	pounds
mb/d	million barrels per day
Mt CO_2-eq	million tonnes of carbon-dioxide equivalent
MW	megawatt
t CO_2	tonne of carbon dioxide
t CO_2-eq	tonne of carbon-dioxide equivalent
TW	terawatt
TWh	terawatt-hour

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AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

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