Global EV Outlook 2021

Accelerating ambitions despite the pandemic

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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 16%. 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.

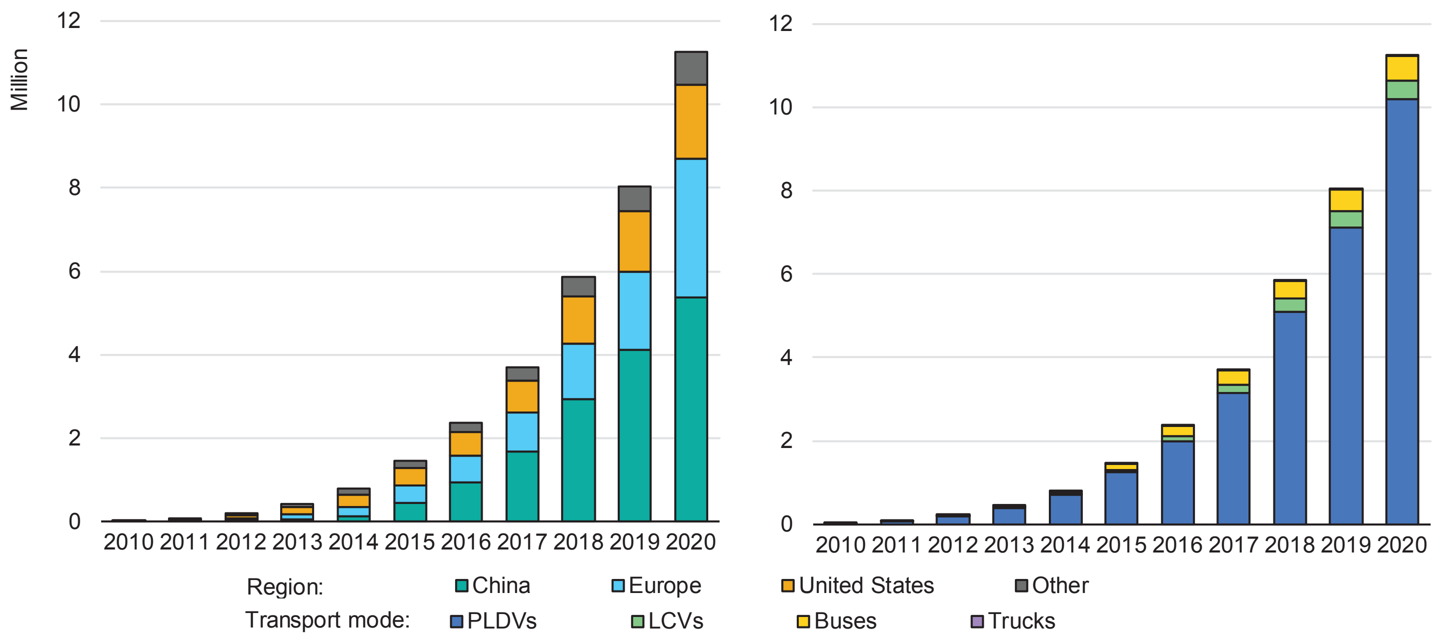
But the 2020s will need to see more than just the mass adoption of electric light-duty vehicles to meet climate goals. Governments will also need to put in place policies to promote the roll-out of zero-emission vehicles in the medium- and heavy-duty vehicle segments and the correponding fast-charging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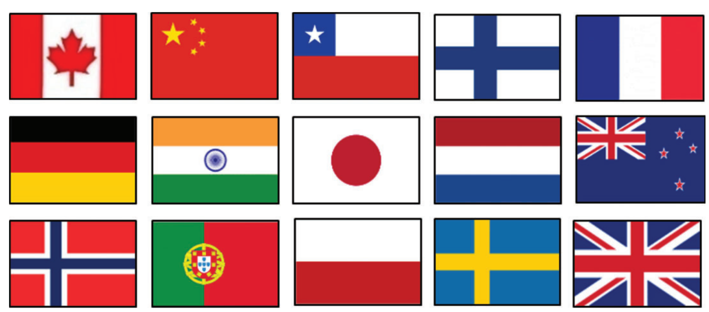


Electric Vehicles Initiative campaigns

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

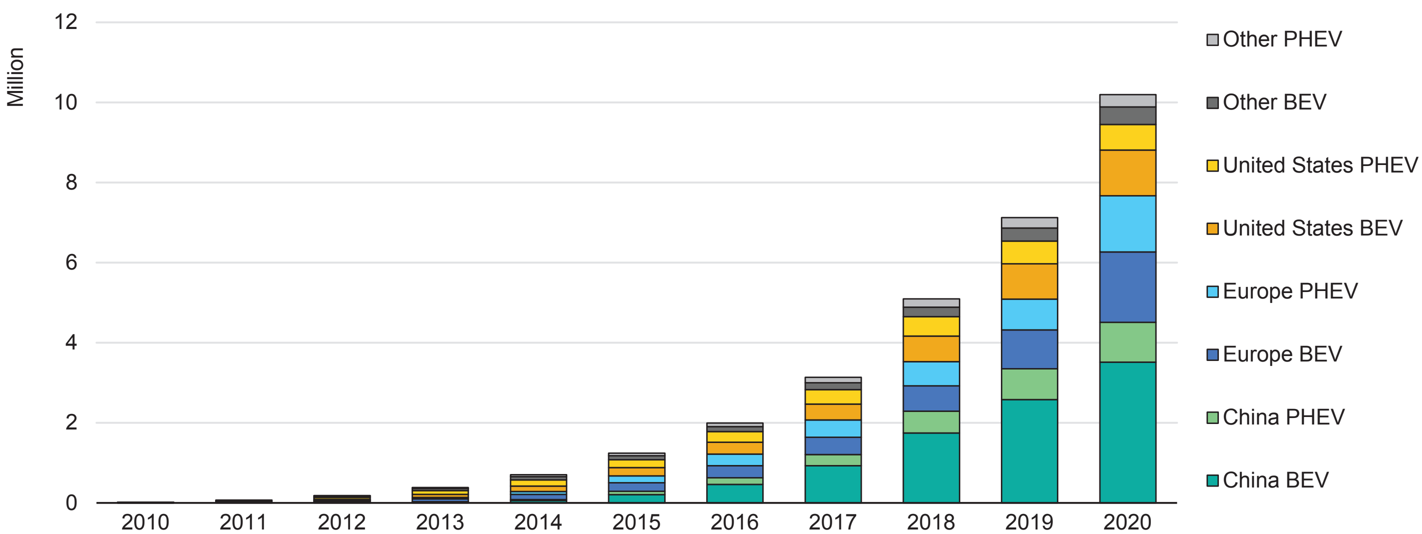
The EVI Global EV Pilot City Programme was launched in May 2018 at the 9th CEM as an initiative of the EV30@30 campaign. It aims to build a network of at least 100 cities over an initial period of five years to work together on the promotion of electric mobility. Its central pillars are to facilitate 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

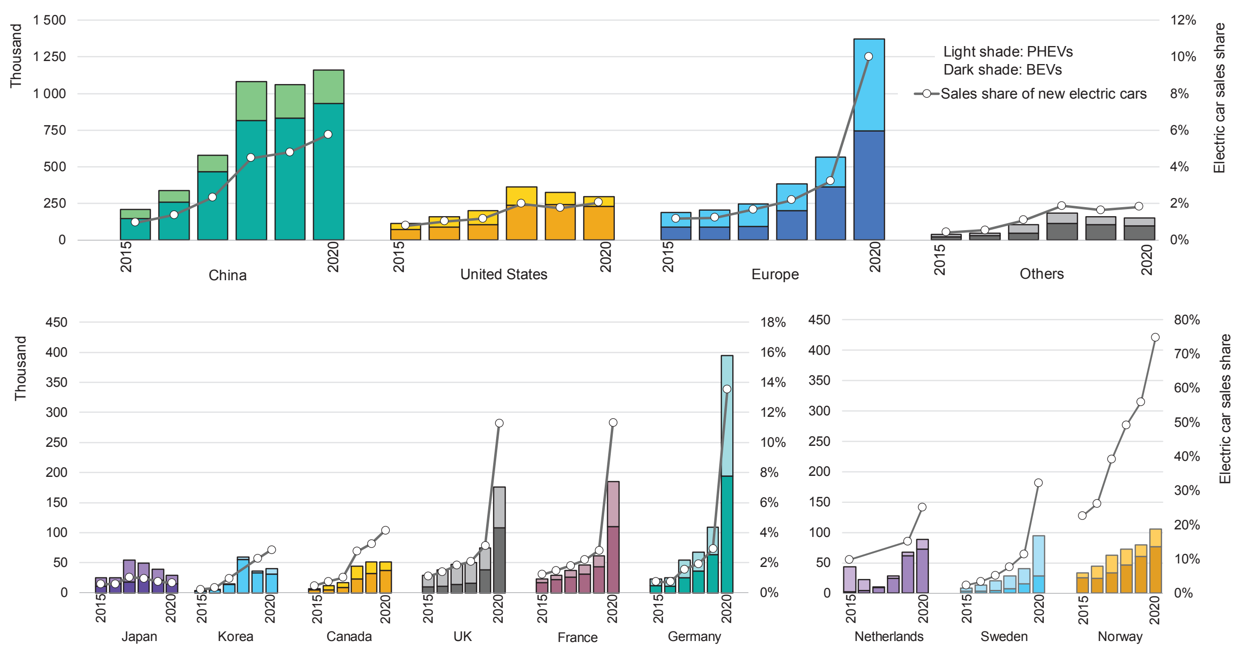


Notes: Electric vehicles include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs). This report focuses on BEVs and PHEVs, i.e. EVs that are fuelled with electricity from the grid. All figures and discussion exclude FCEVs unless otherwise 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.

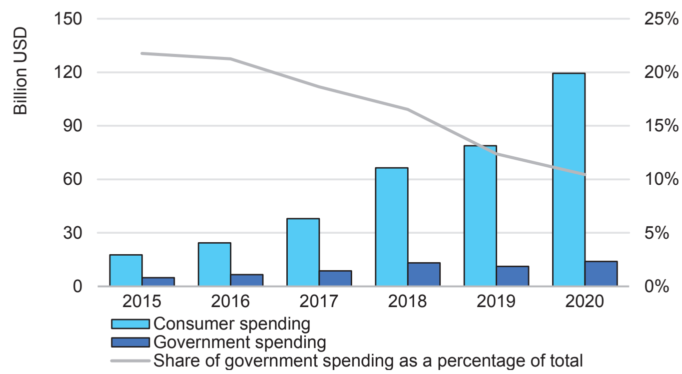
Government spending

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.

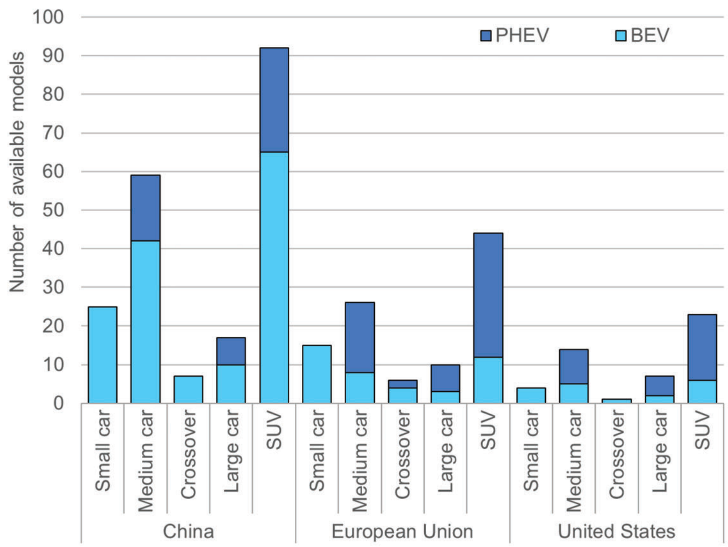
Consumer and government spending on electric cars, 2015-2020



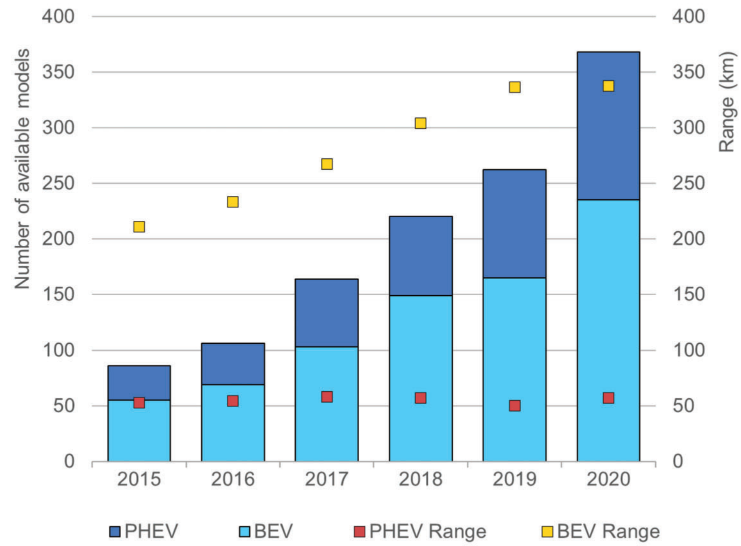
Notes: Government incentives are the sum of direct government spending through purchase incentives and foregone revenue due to taxes waived specifically for electric cars. Only national government purchase support policies for electric cars are taken into account. Consumer spending is the total expenditure 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.

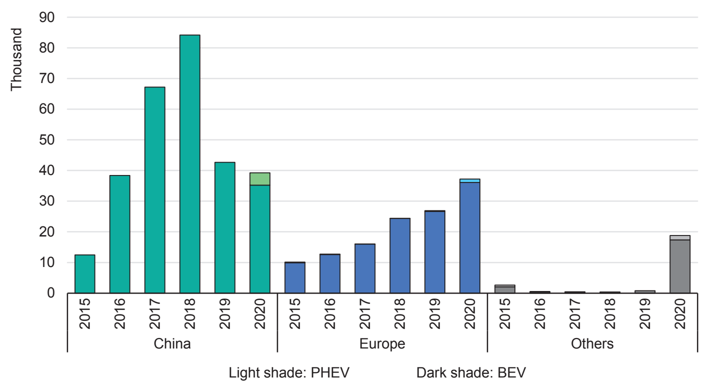
Electric LCV registrations in China in 2020 were 3 400 units below the previous year and slightly less than half of the peak in 2018. The bulk of the electric LCV registrations are BEVs, with PHEVs accounting for less than 10%.

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

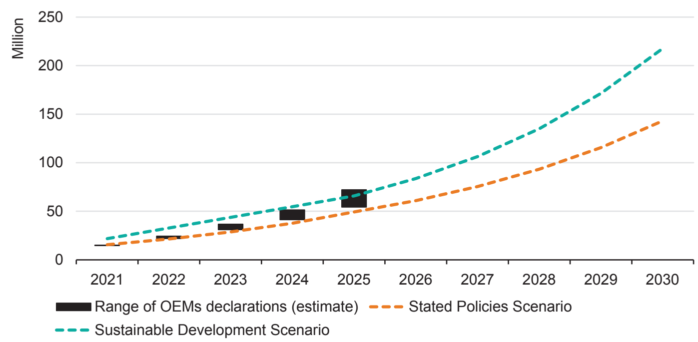
OEMs are expected to embrace electric mobility more widely in the 2020s. Notably 18 of the 20 largest OEMs (in terms of vehicles sold in 2020), which combined accounted for almost 90% of all worldwide new car registrations in 2020, have announced intentions to increase the number of available models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

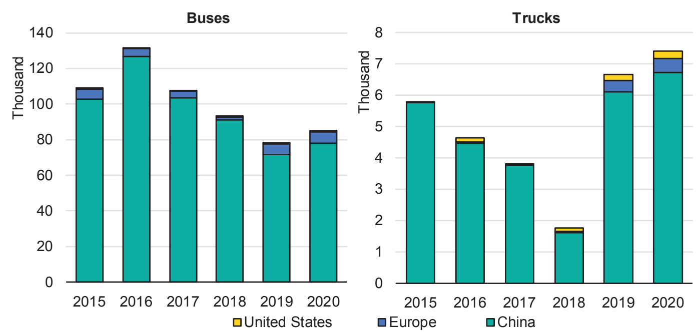
Electric bus registrations in Europe were 2 100, an increase of around 7%, well below the doubling in registrations seen in 2019. Electric buses now make up 4% of all new bus registrations in Europe. It is too early to see the effect of the non-binding European Clean Bus Deployment Initiative and demand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

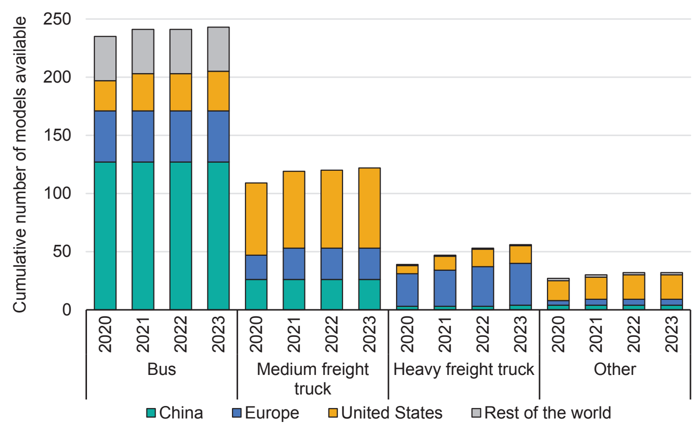
Electric heavy-duty vehicle models are broadening

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

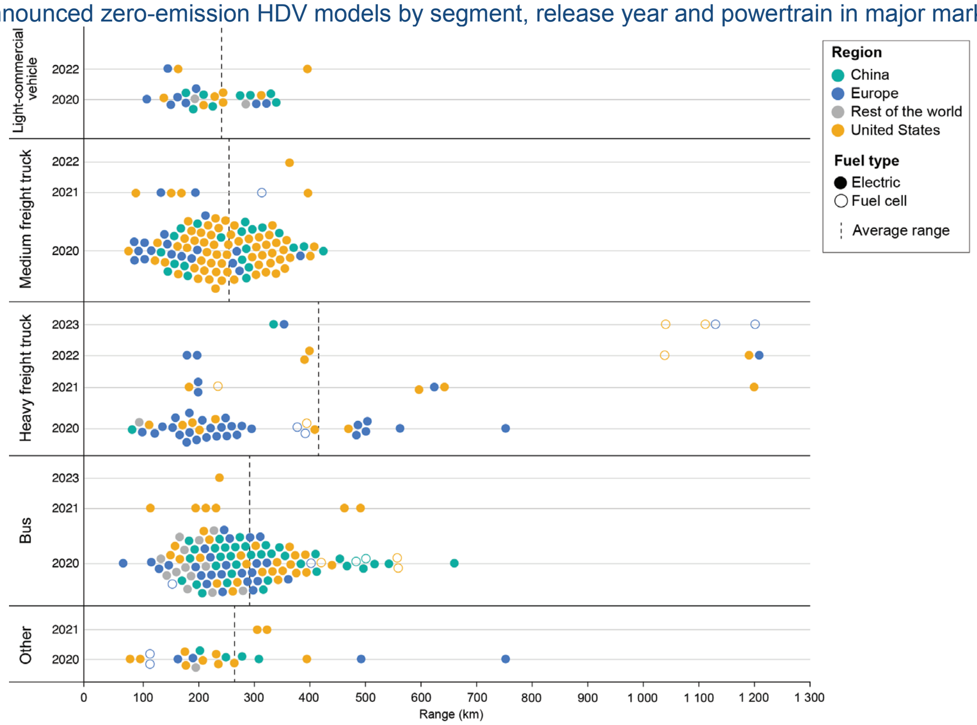


Notes: Other includes garbage, bucket, concrete mixer, mobile commercial and street sweeper trucks. Rest of the world includes India and South America.
Source: IEA analysis based on Global Drive to Zero ZETI tool.

[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.

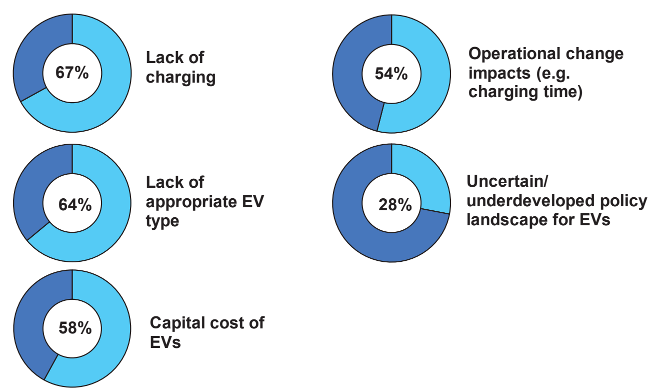
Collectively, by 2020 EV100 members had already deployed 169 000 zero-emission vehicles, double the previous year. Even though companies identify commercial vans and heavy-duty vehicles as the most difficult EVs to find, the number of commercial electric vehicles rose 23% in 2020, including a threefold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

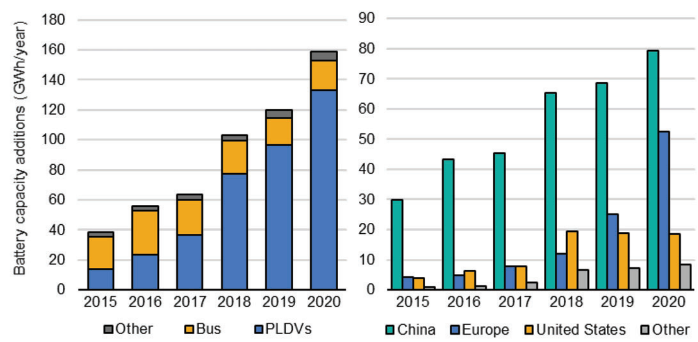
China accounted for the largest share of battery demand at almost 80 GWh in 2020, while Europe had the largest percentage increase at 110% to reach 52 GWh. Demand in the United States was stable at 19 GWh.

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%.

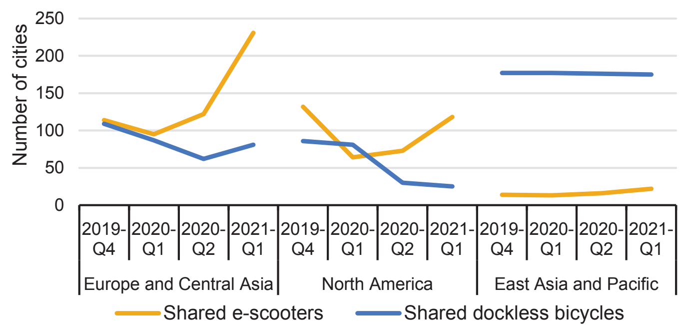
Many shared micromobility operators reduced or suspended services during the height of the second-quarter 2020 Covid-19 lockdowns. But as confinements were eased, services rebounded strongly, with 270 cities worldwide relaunching operations. As of February 2021, around 650 cities have shared micromobility 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

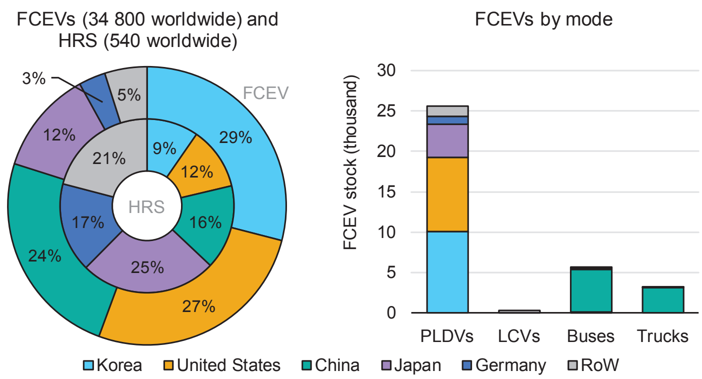
Fuel cell electric vehicles (FCEVs) are zero-emission vehicles that convert hydrogen stored on-board using a fuel cell to power an electric motor. FCEV cars became commercially available in 2014, though registrations remain three orders of magnitude lower than EVs as hydrogen refuelling stations (HRS) 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



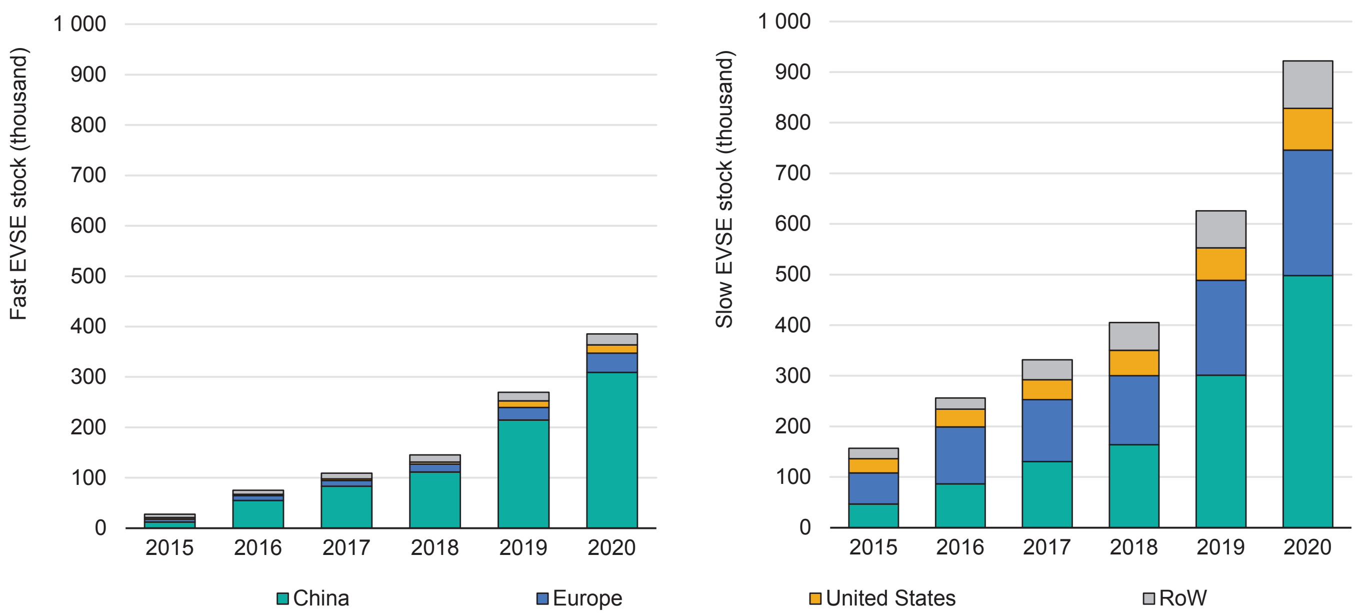
Notes: FCEV = fuel cell electric vehicle (shown in the outer circle); HRS = hydrogen refuelling station (shown in inner circle); PLDVs = passenger light-duty vehicles; LCVs = light-commercial vehicles; RoW = rest of the world.

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

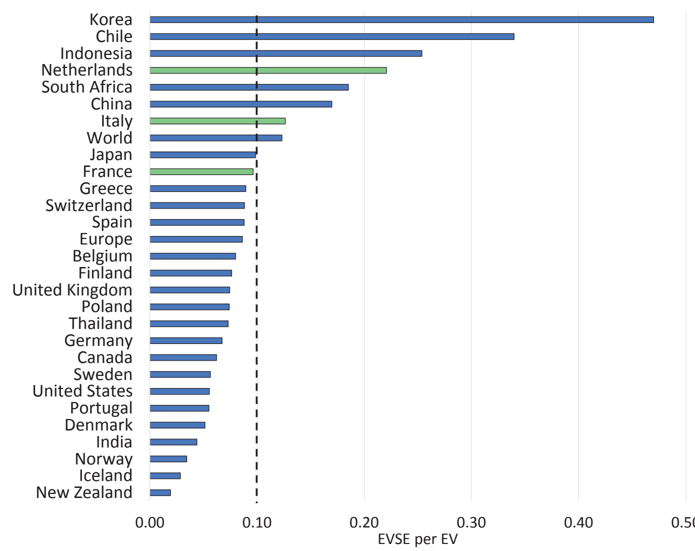
European countries for the most part failed to meet the recommended electric vehicle supply equipment (EVSE) per EV 2020 targets for publicly accessible chargers set by the Alternative Fuel Infrastructure Directive (AFID). However, there are wide disparities between countries.

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 infrastructure 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.

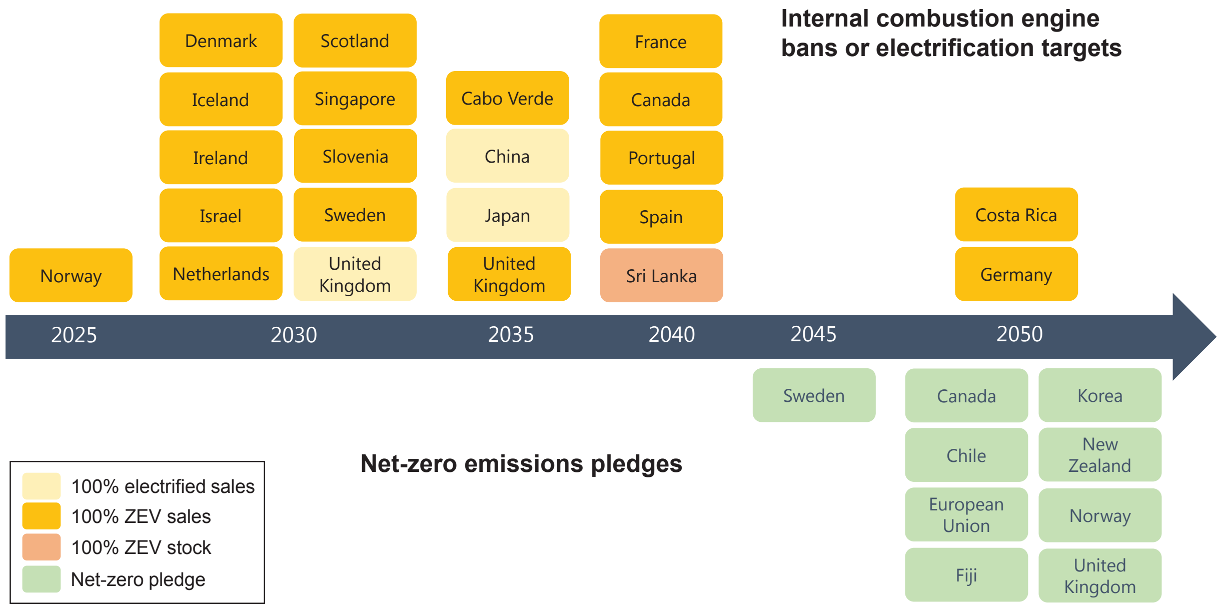
10‑30 years, including emerging economies such as Cabo Verde, Costa Rica and Sri Lanka. Moreover, more than 120 countries (accounting for around 85% of the global road vehicle fleet, excluding two/three-wheelers) have announced economy-wide net-zero emissions pledges that aim to reach net zero in the 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 here include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell electric vehicles (FCEVs) and hybrid electric vehicles (HEVs), depending on the definitions of each country. 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

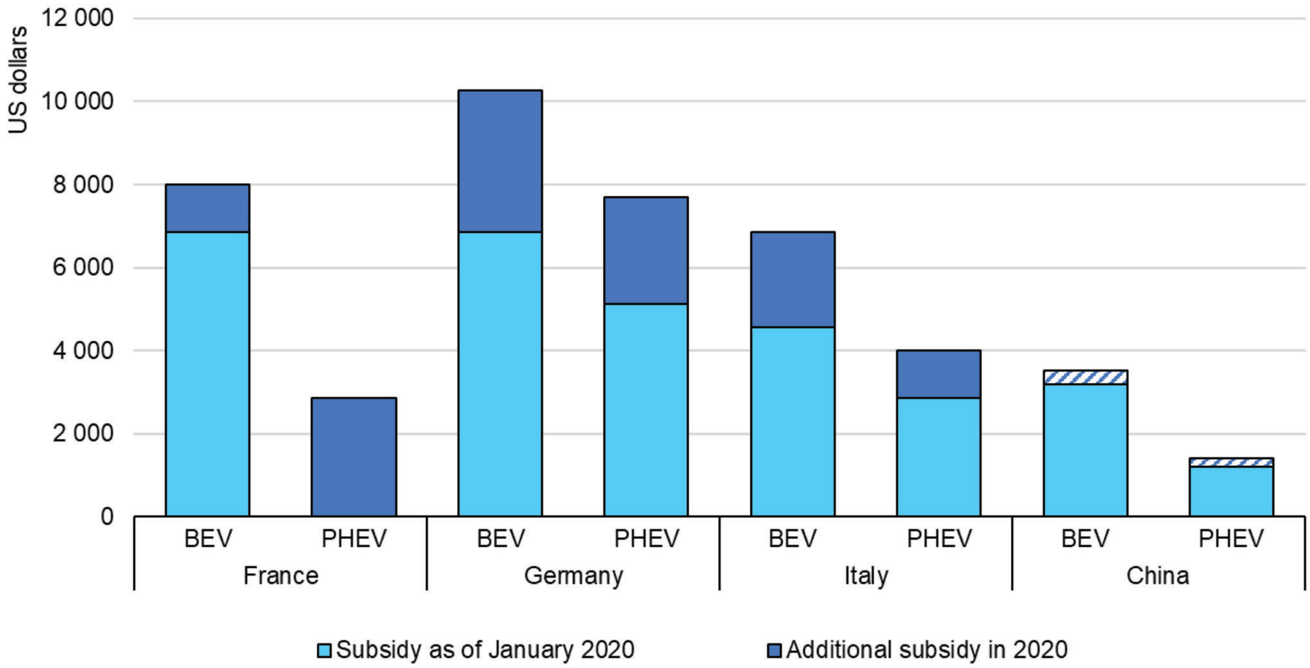
Many of the automotive-related stimulus measures implemented in 2020 were planned to be phased out by the end of the year. In some cases, the maximum quotas were reached in just a few weeks, e.g. France's enhanced cash-for-clunker scheme. The targeted stimulus measures provided impetus to the EV market, 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.

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

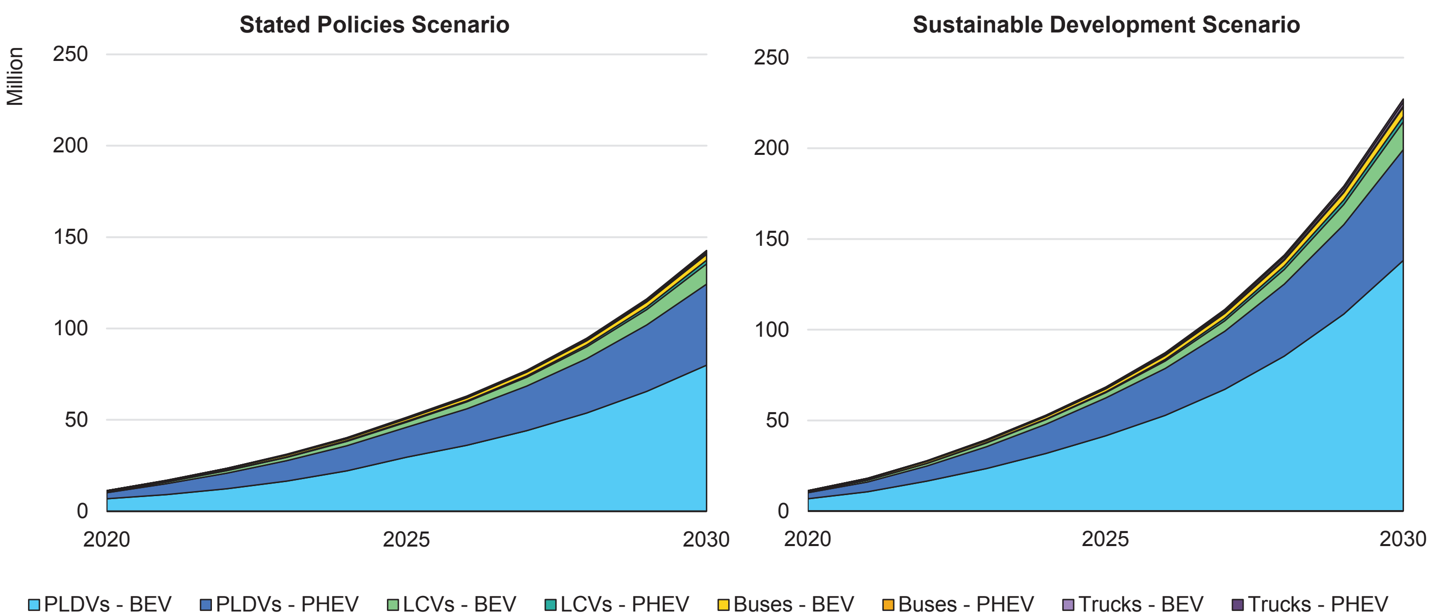
The Sustainable Development Scenario (SDS) rests on three pillars: ensure universal energy access for all by 2030; bring about sharp reductions in emissions of air pollutants; and meet global climate goals in line with the Paris Agreement. The SDS reaches net-zero emissions by 2070 and global temperature 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



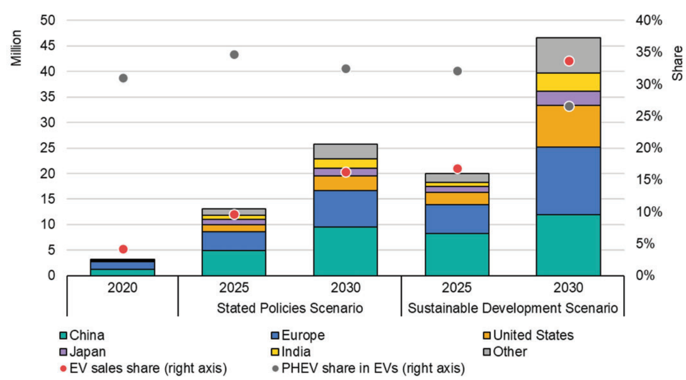
Notes: PLDVs = passenger light-duty vehicles; BEV = battery electric vehicle; LCVs = light-commercial vehicles; PHEV = plug-in hybrid electric vehicle. The figure does not include electric two/three-wheelers. For reference, total road EV stock (excluding two/three-wheelers) in 2030 is 2 billion in the 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.

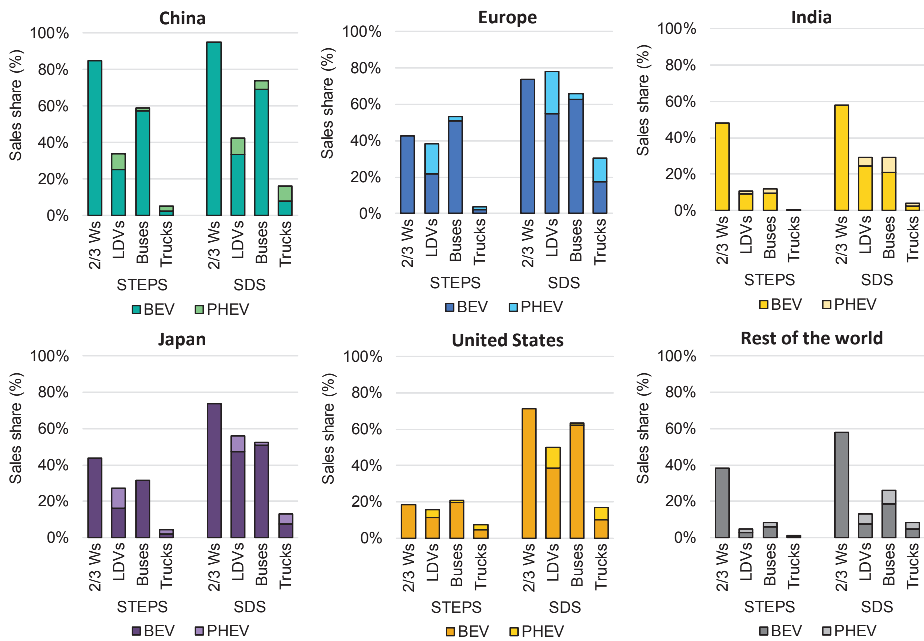
In the Sustainable Development Scenario, the deployment of electric buses accelerates, reaching over 5.5 million in 2030, corresponding to over 15% of the stock, primarily in urban buses.

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.

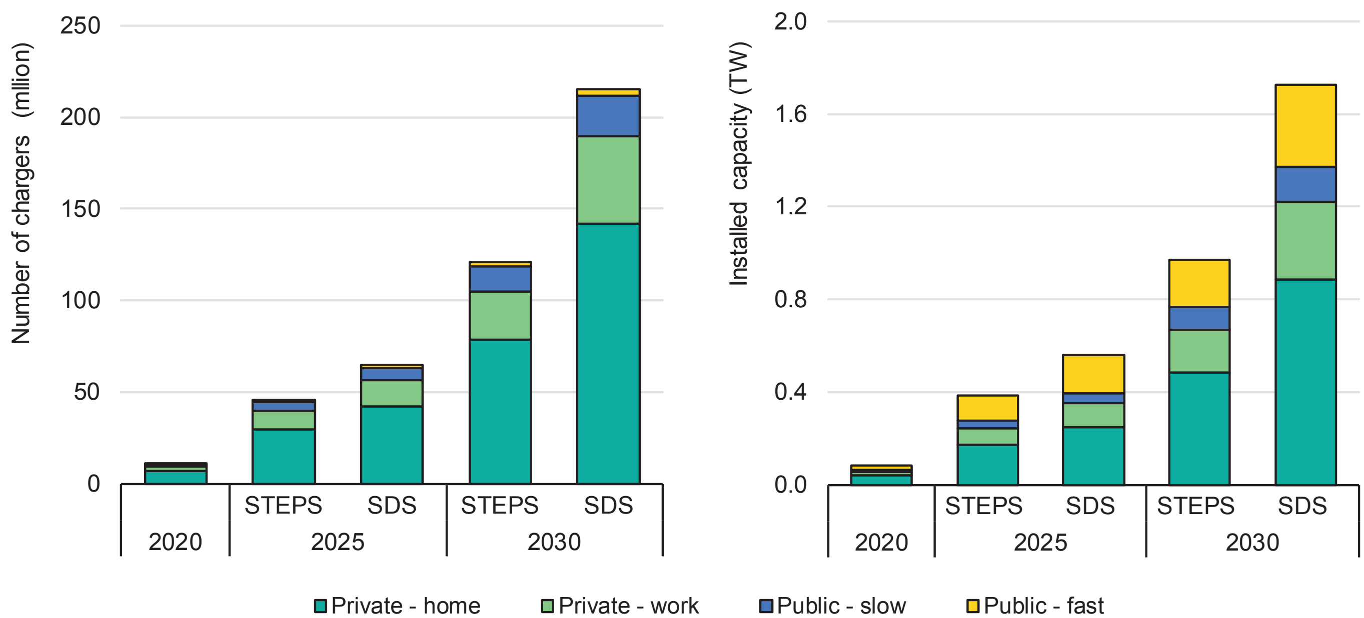
For the other regions category in the Stated Policies Scenario, EV sales shares average 5% for LDVs, 8% for buses and 1% for trucks in 2030. The Sustainable Development Scenario assumes higher electrification across the world, though still lagging behind the more advanced markets. In the Sustainable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

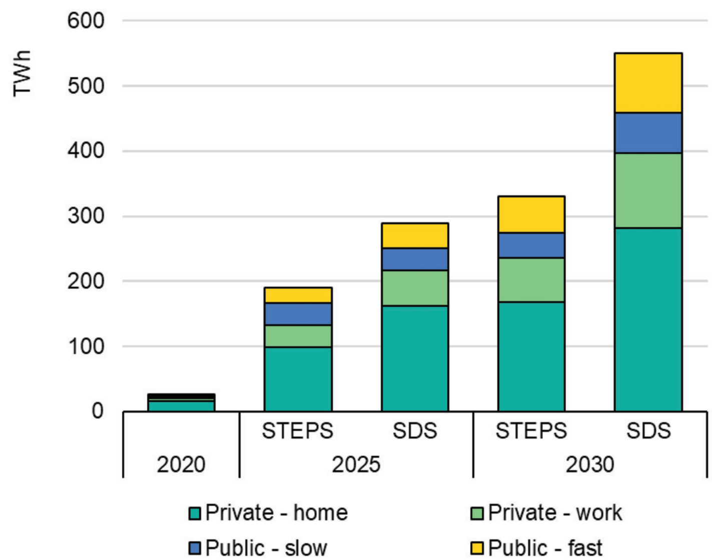
Private chargers account for 90% of all chargers in both scenarios in 2030, but for only 70% of installed capacity due to the lower power rating (or charging rate) compared to fast chargers. Private chargers meet about 70% of the energy demand in both scenarios, reflecting the lower power rating.

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.

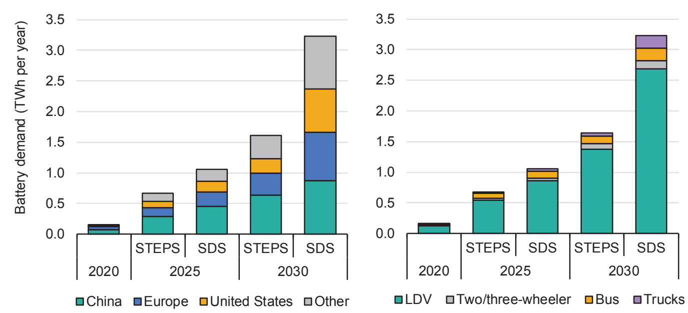
Today the largest demand for EV batteries is in China. It is expected to remain the biggest market in this decade in both scenarios. China is followed by Europe and the United States.

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.

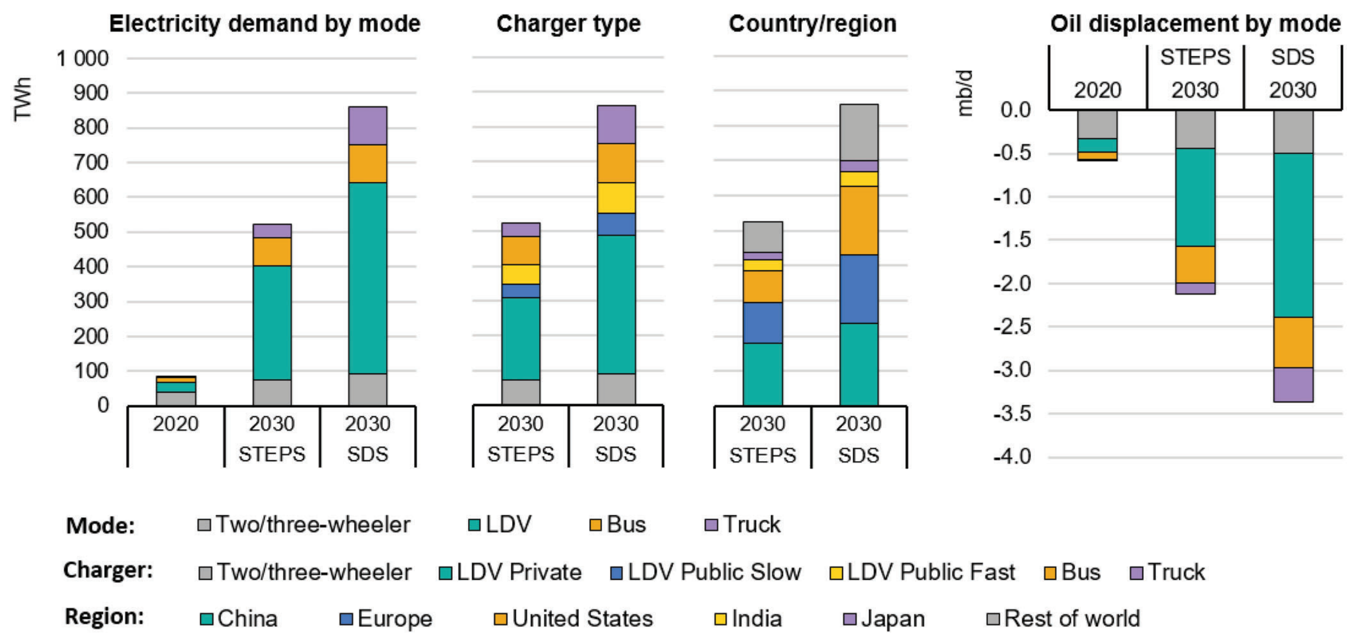
Annual EV battery demand projections by region (left), mode and scenario (right), 2020-2030



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.

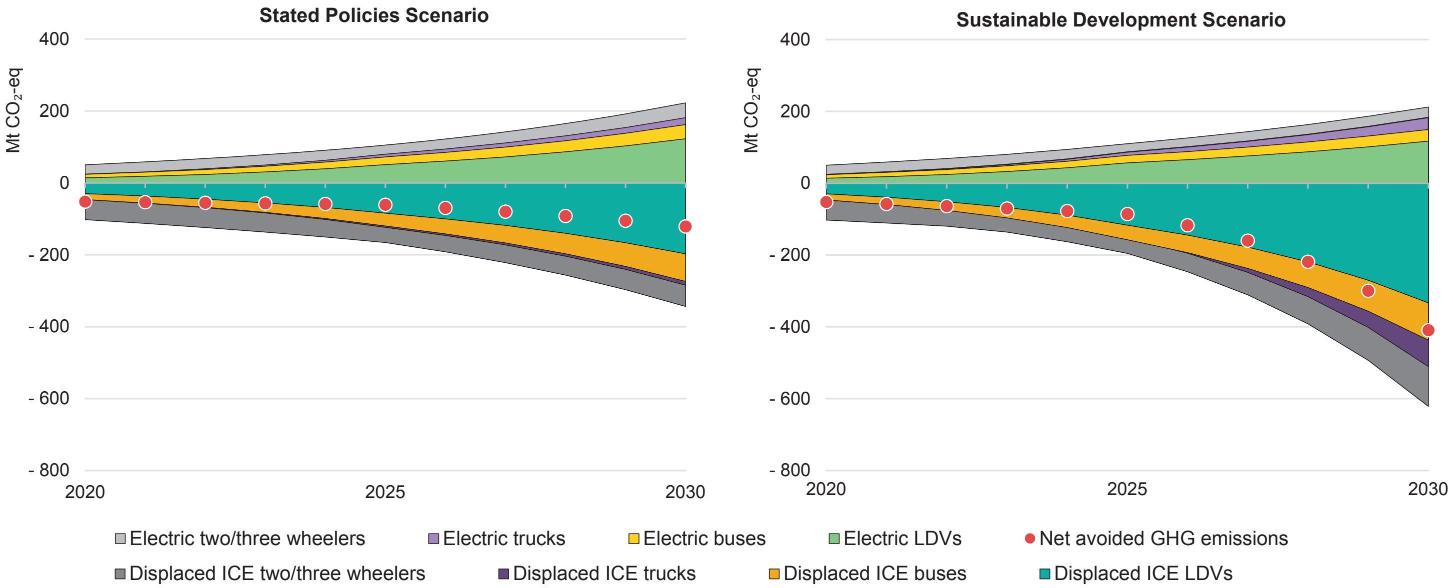
Share of electricity consumption attributable to EVs relative to final electricity demand by region and scenario, 2020 and 2030

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

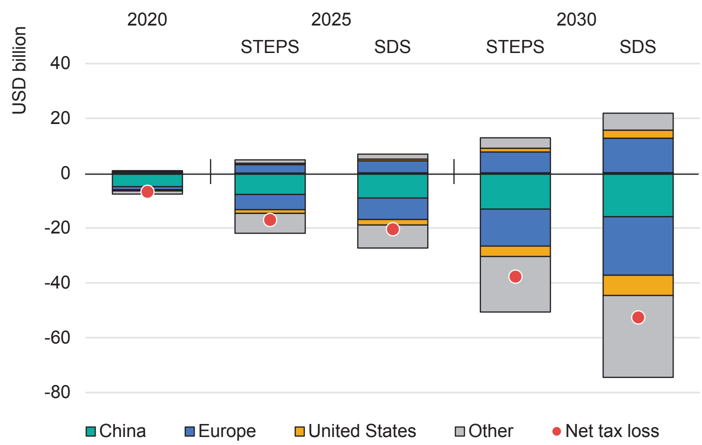
By reducing the consumption of oil products, EV uptake lessens the amount of revenue that governments derive from fossil fuel taxes, which is not fully compensated by levies on the increased electricity use. The net tax loss is mainly due to lower overall energy consumption (EVs are two-to-four times 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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Electric Bus

Global Electric Vehicle (EV) Battery Market 2021-2025

March 2021 | 120 pages | ID: 5749188 | Format: PDF | Infiniti Research Limited

Summary

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Global Electric vehicle (EV) battery market 2021-2025
The analyst has been monitoring the electric vehicle (EV) battery market and it is poised to grow by $ 37.69 bn during 2021-2025 progressing at a CAGR of 18% during the forecast period. Our reports on electric vehicle (EV) battery market provides a holistic analysis, market size and forecast, trends, growth drivers, and challenges, as well as vendor analysis covering around 25 vendors.
The report offers an up-to-date analysis regarding the current global market scenario, latest trends and drivers, and the overall market environment. The market is driven by the advances in EV battery and associated technologies, shift of automotive industry toward EVs, and decline in EV lithium-ion battery cost. In addition, advances in EV battery and associated technologies is anticipated to boost the growth of the market as well.
The electric vehicle (EV) battery market analysis includes type segment and geographical landscapes.

The electric vehicle (EV) battery market is segmented as below:
By Type
• Lithium-ion battery
• Lead-acid battery
• Others

By Geographical Landscapes
• APAC
• North America
• Europe
• MEA
• South America

This study identifies the EV charging with v2g technology as one of the prime reasons driving the electric vehicle (EV) battery market growth during the next few years. Also, revision in safety standards of lithium-ion batteries, and developments regarding EV charging infrastructure will lead to sizable demand in the market.

The analyst presents a detailed picture of the market by the way of study, synthesis, and

summation of data from multiple sources by an analysis of key parameters. Our report on electric vehicle (EV) battery market covers the following areas:
• Electric vehicle (EV) battery market sizing
• Electric vehicle (EV) battery market forecast
• Electric vehicle (EV) battery market industry analysis

This robust vendor analysis is designed to help clients improve their market position, and in line with this, this report provides a detailed analysis of several leading electric vehicle (EV) battery market vendors that include A123 Systems LLC, Ballard Power Systems Inc., BYD Company Ltd., Cummins Inc., EnerSys, Exide Technologies, GS Yuasa International Ltd., LG Chem Ltd., Panasonic Corp., and Samsung SDI Co. Ltd.. Also, the electric vehicle (EV) battery market analysis report includes information on upcoming trends and challenges that will influence market growth. This is to help companies strategize and leverage on all forthcoming growth opportunities.
The study was conducted using an objective combination of primary and secondary information including inputs from key participants in the industry. The report contains a comprehensive market and vendor landscape in addition to an analysis of the key vendors.

The analyst presents a detailed picture of the market by the way of study, synthesis, and summation of data from multiple sources by an analysis of key parameters such as profit, pricing, competition, and promotions. It presents various market facets by identifying the key industry influencers. The data presented is comprehensive, reliable, and a result of extensive research - both primary and secondary. Technavio’s market research reports provide a complete competitive landscape and an in-depth vendor selection methodology and analysis using qualitative and quantitative research to forecast an accurate market growth.

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Global EV Outlook 2021

Accelerating ambitions despite the pandemic

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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 16%. 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.

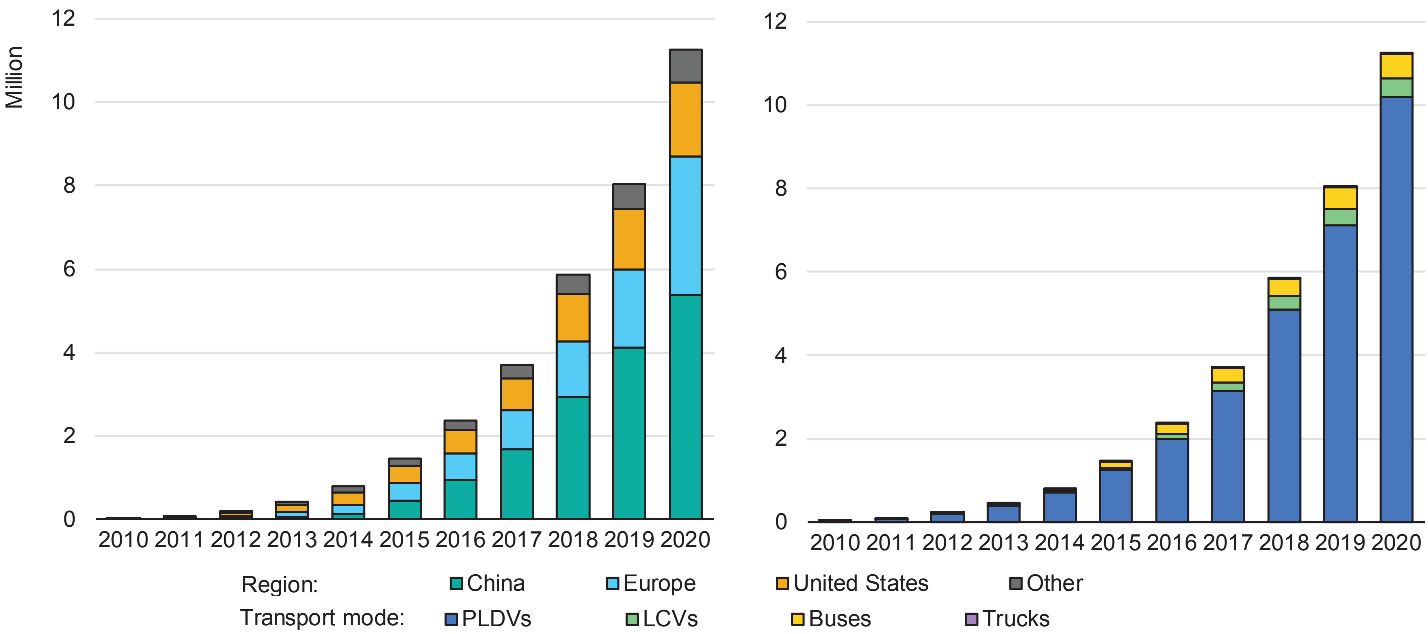
But the 2020s will need to see more than just the mass adoption of electric light-duty vehicles to meet climate goals. Governments will also need to put in place policies to promote the roll-out of zero-emission vehicles in the medium- and heavy-duty vehicle segments and the correponding fast-charging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

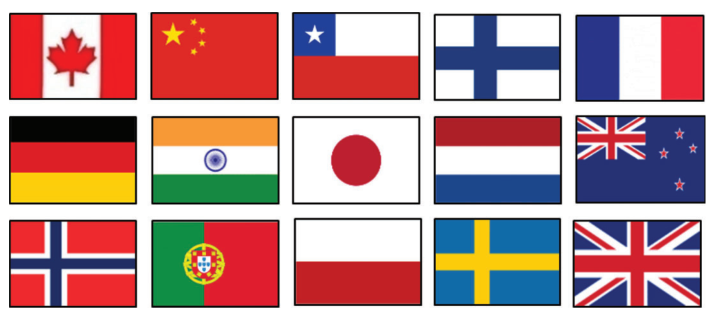
The International Energy Agency (IEA) serves as the co-ordinator to support the EVI member governments in this activity. Governments that have been active in the EVI in the 2020-21 period include Canada, Chile, People's Republic of China (hereafter "China"), Finland, France, Germany, India, Japan, Netherlands, 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.

ELECTRIC VEHICLES INITIATIVE

AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

EVI co-lead EVI co-lead



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

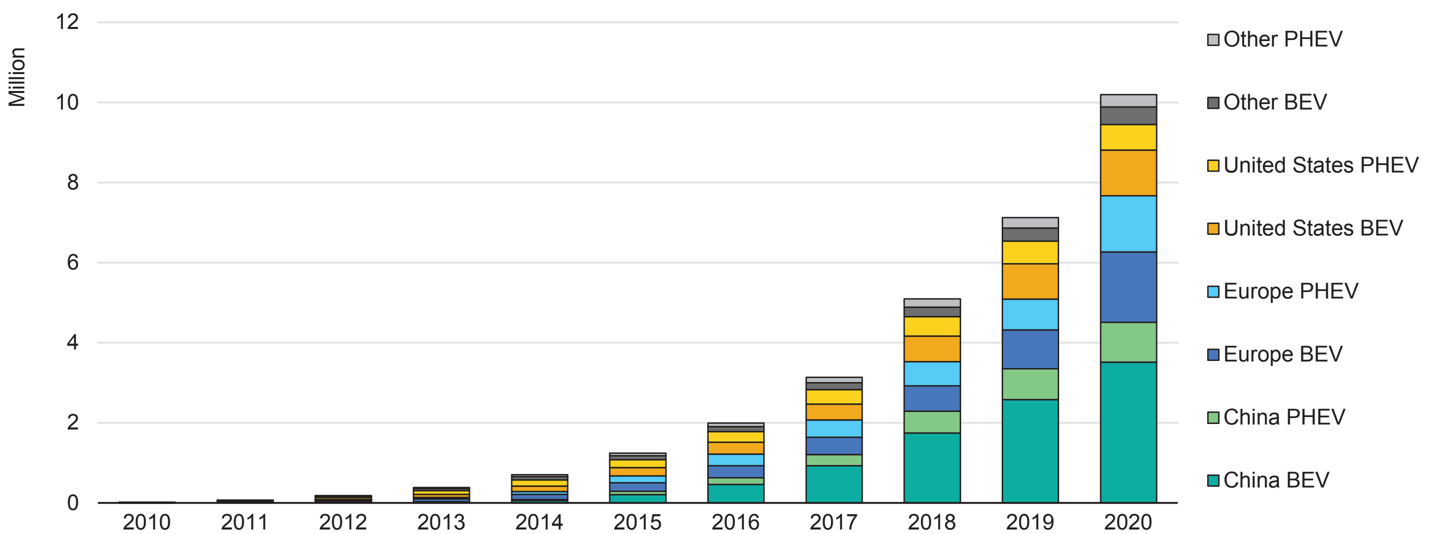
The EVI Global EV Pilot City Programme was launched in May 2018 at the 9th CEM as an initiative of the EV30@30 campaign. It aims to build a network of at least 100 cities over an initial period of five years to work together on the promotion of electric mobility. Its central pillars are to facilitate 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

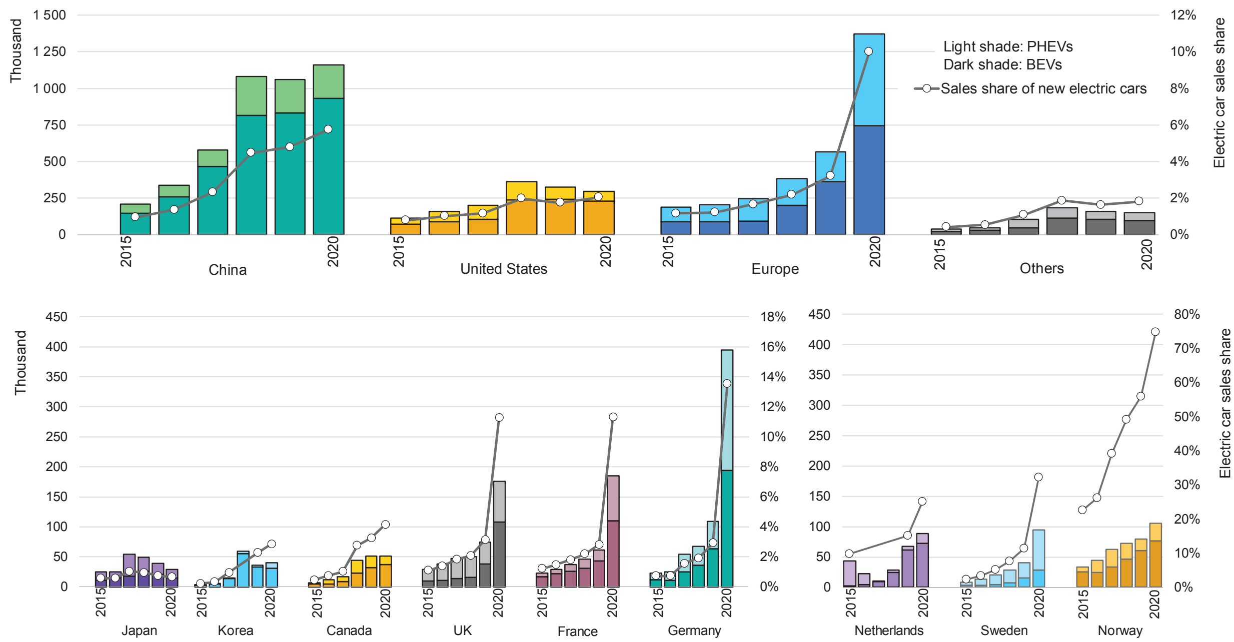


Notes: Electric vehicles include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs). This report focuses on BEVs and PHEVs, i.e. EVs that are fuelled with electricity from the grid. All figures and discussion exclude FCEVs unless otherwise 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.

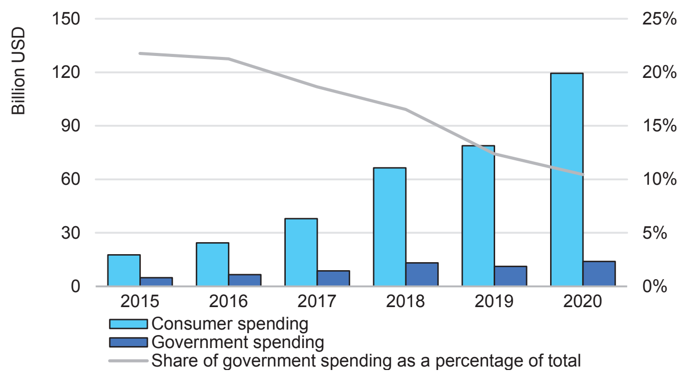
Government spending

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.

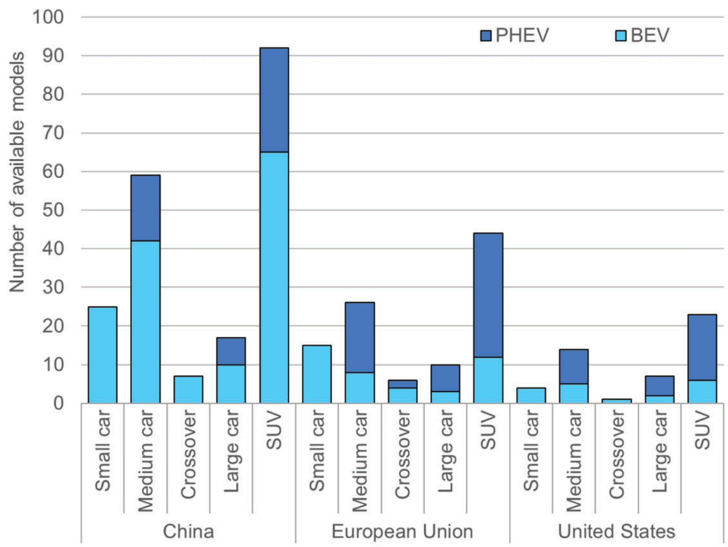
Consumer and government spending on electric cars, 2015-2020



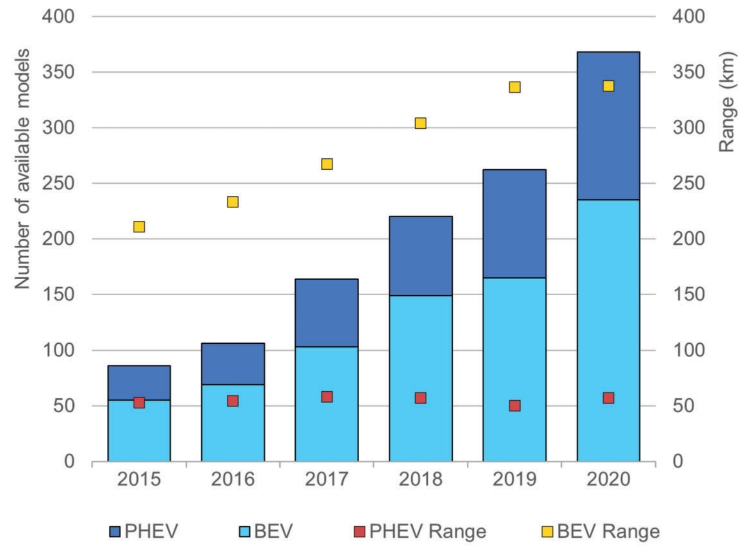
Notes: Government incentives are the sum of direct government spending through purchase incentives and foregone revenue due to taxes waived specifically for electric cars. Only national government purchase support policies for electric cars are taken into account. Consumer spending is the total expenditure 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.

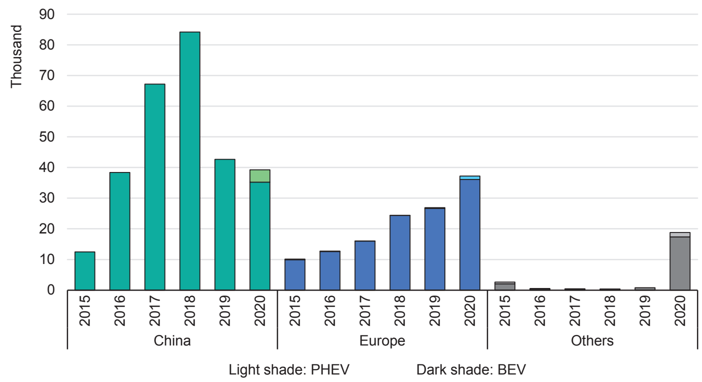
Electric LCV registrations in China in 2020 were 3 400 units below the previous year and slightly less than half of the peak in 2018. The bulk of the electric LCV registrations are BEVs, with PHEVs accounting for less than 10%.

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

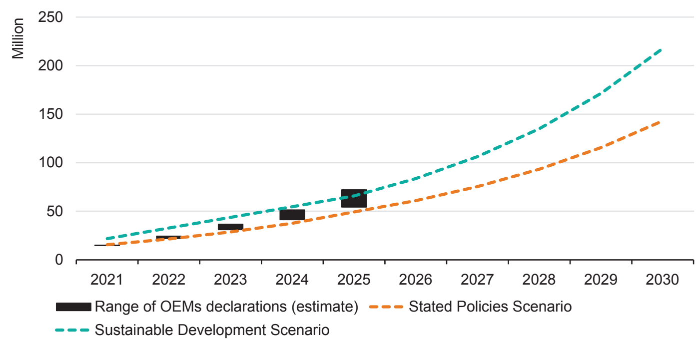
OEMs are expected to embrace electric mobility more widely in the 2020s. Notably 18 of the 20 largest OEMs (in terms of vehicles sold in 2020), which combined accounted for almost 90% of all worldwide new car registrations in 2020, have announced intentions to increase the number of available models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

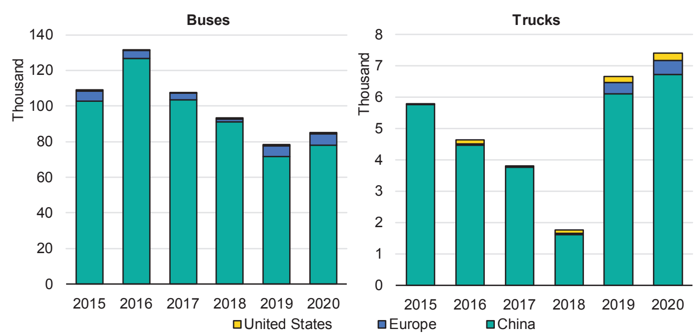
Electric bus registrations in Europe were 2 100, an increase of around 7%, well below the doubling in registrations seen in 2019. Electric buses now make up 4% of all new bus registrations in Europe. It is too early to see the effect of the non-binding European Clean Bus Deployment Initiative and demand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

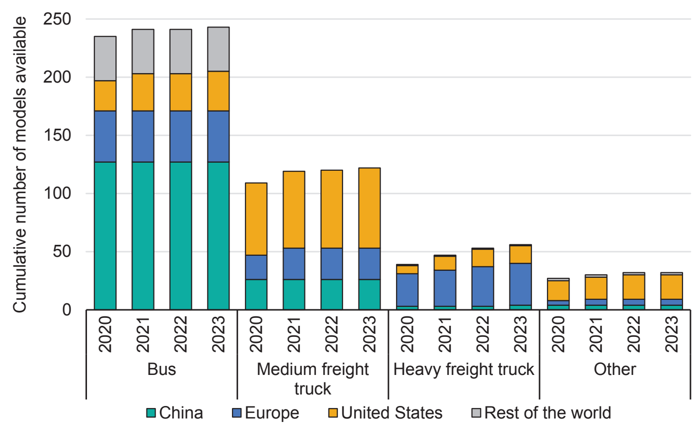
Electric heavy-duty vehicle models are broadening

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

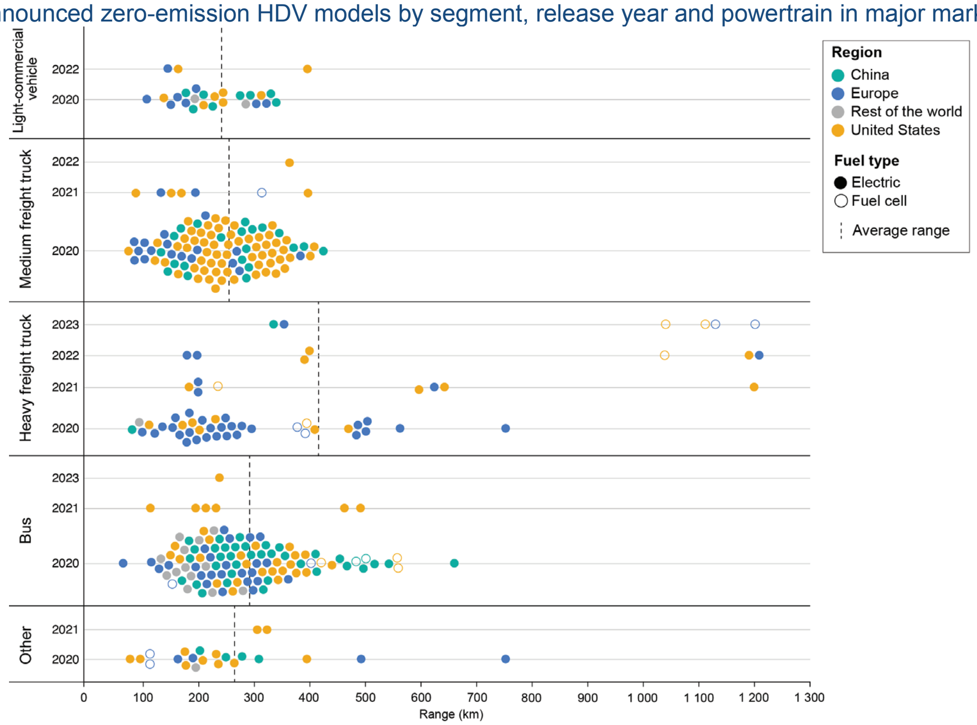


Notes: Other includes garbage, bucket, concrete mixer, mobile commercial and street sweeper trucks. Rest of the world includes India and South America.
Source: IEA analysis based on Global Drive to Zero ZETI tool.

[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.

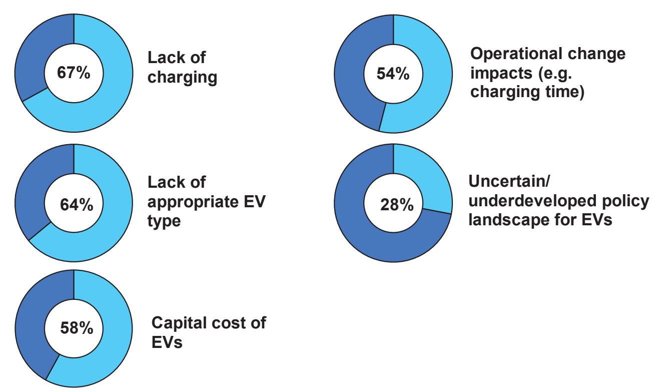
Collectively, by 2020 EV100 members had already deployed 169 000 zero-emission vehicles, double the previous year. Even though companies identify commercial vans and heavy-duty vehicles as the most difficult EVs to find, the number of commercial electric vehicles rose 23% in 2020, including a threefold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

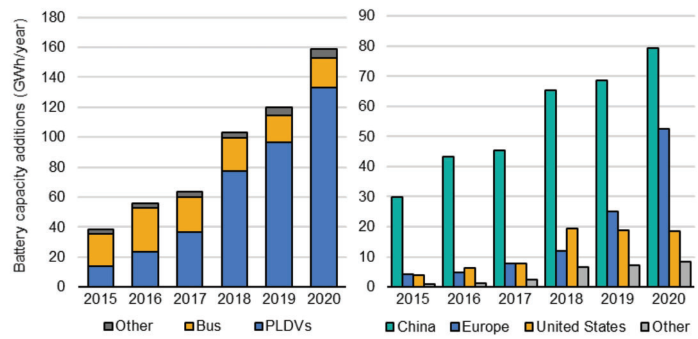
China accounted for the largest share of battery demand at almost 80 GWh in 2020, while Europe had the largest percentage increase at 110% to reach 52 GWh. Demand in the United States was stable at 19 GWh.

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%.

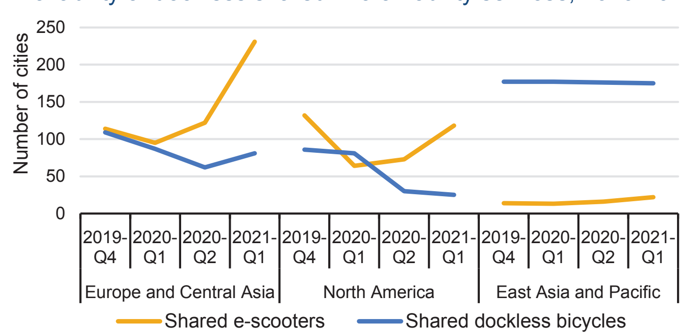
Many shared micromobility operators reduced or suspended services during the height of the second-quarter 2020 Covid-19 lockdowns. But as confinements were eased, services rebounded strongly, with 270 cities worldwide relaunching operations. As of February 2021, around 650 cities have shared micromobility 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

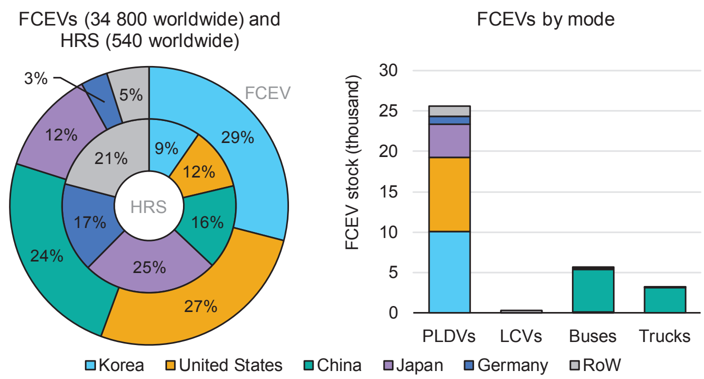
Fuel cell electric vehicles (FCEVs) are zero-emission vehicles that convert hydrogen stored on-board using a fuel cell to power an electric motor. FCEV cars became commercially available in 2014, though registrations remain three orders of magnitude lower than EVs as hydrogen refuelling stations (HRS) 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



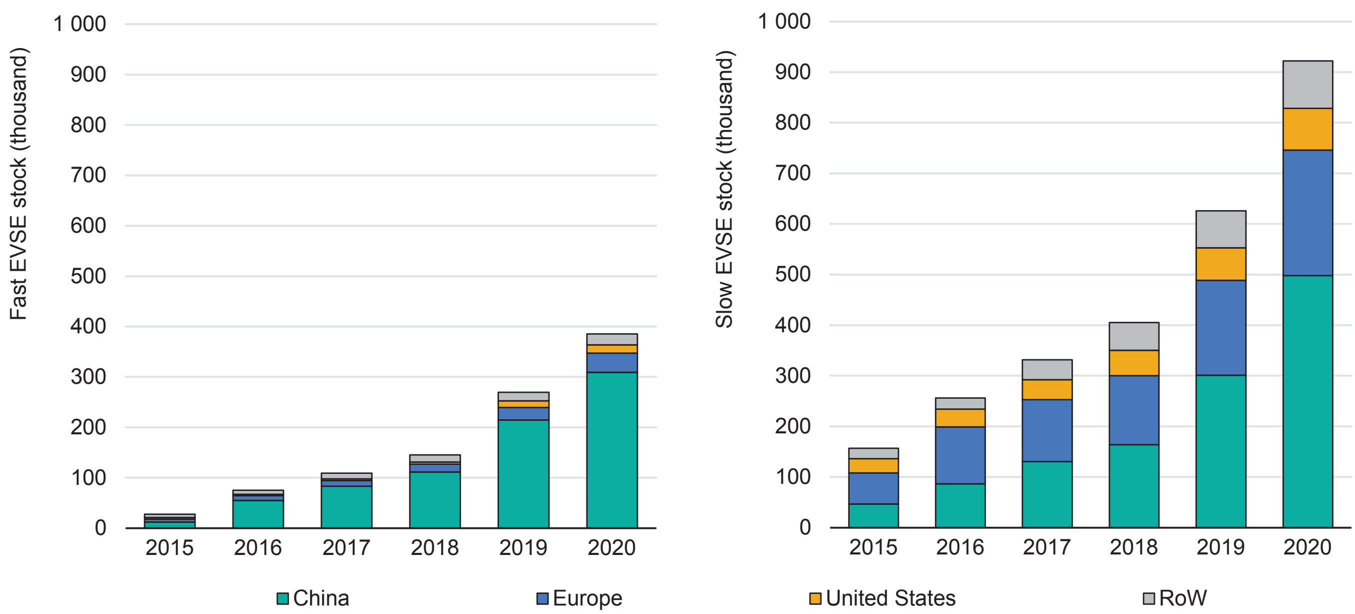
Notes: FCEV = fuel cell electric vehicle (shown in the outer circle); HRS = hydrogen refuelling station (shown in inner circle); PLDVs = passenger light-duty vehicles; LCVs = light-commercial vehicles; RoW = rest of the world.

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

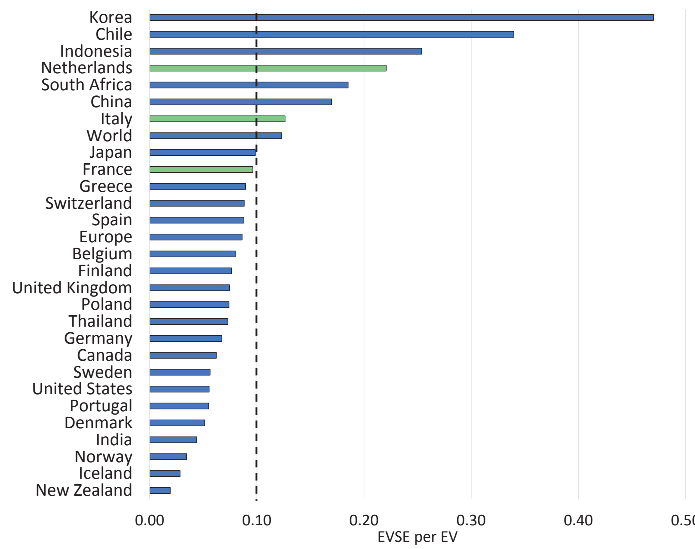
European countries for the most part failed to meet the recommended electric vehicle supply equipment (EVSE) per EV 2020 targets for publicly accessible chargers set by the Alternative Fuel Infrastructure Directive (AFID). However, there are wide disparities between countries.

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 infrastructure 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.

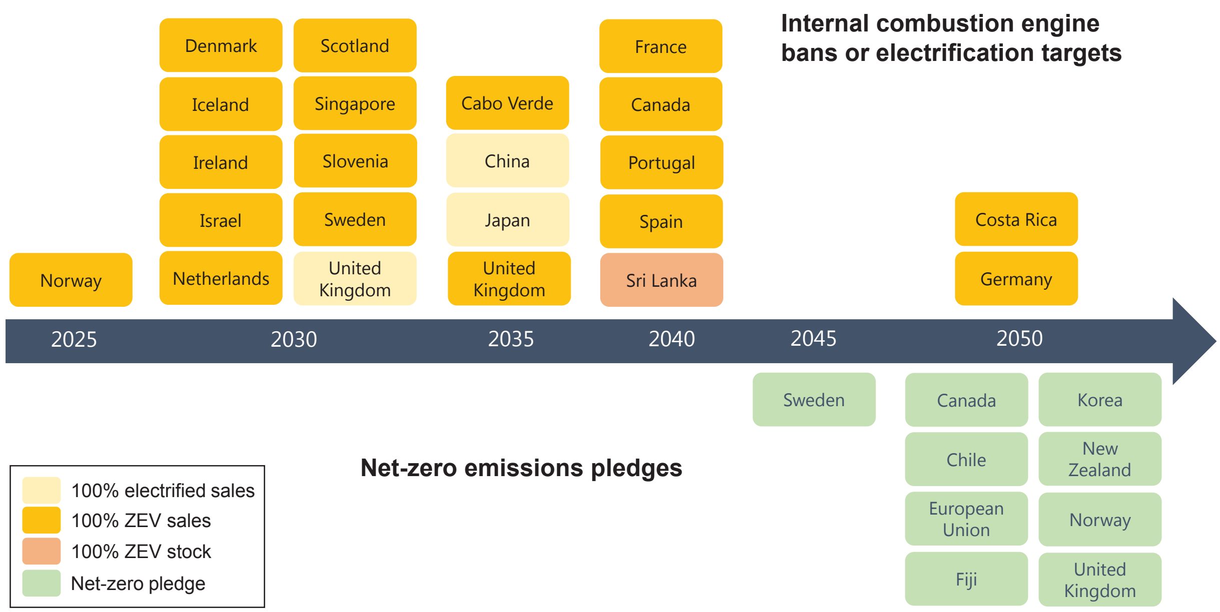
10‑30 years, including emerging economies such as Cabo Verde, Costa Rica and Sri Lanka. Moreover, more than 120 countries (accounting for around 85% of the global road vehicle fleet, excluding two/three-wheelers) have announced economy-wide net-zero emissions pledges that aim to reach net zero in the 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 here include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), fuel cell electric vehicles (FCEVs) and hybrid electric vehicles (HEVs), depending on the definitions of each country. 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

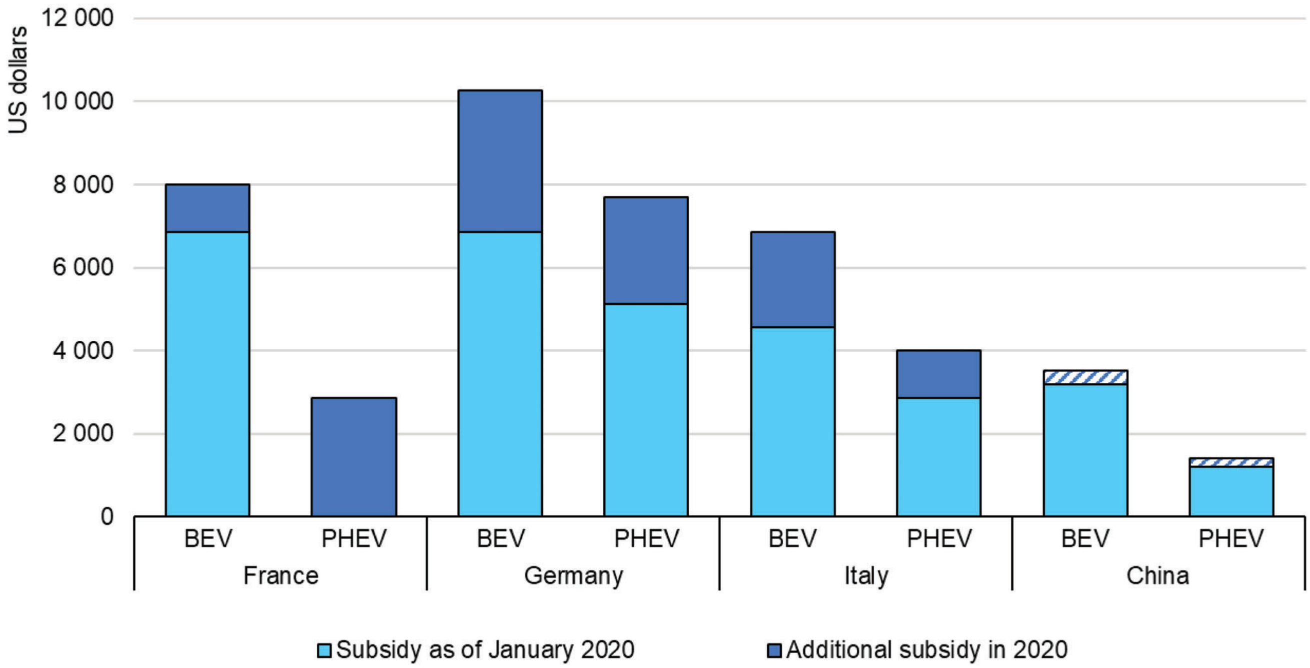
Many of the automotive-related stimulus measures implemented in 2020 were planned to be phased out by the end of the year. In some cases, the maximum quotas were reached in just a few weeks, e.g. France's enhanced cash-for-clunker scheme. The targeted stimulus measures provided impetus to the EV market, 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.

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

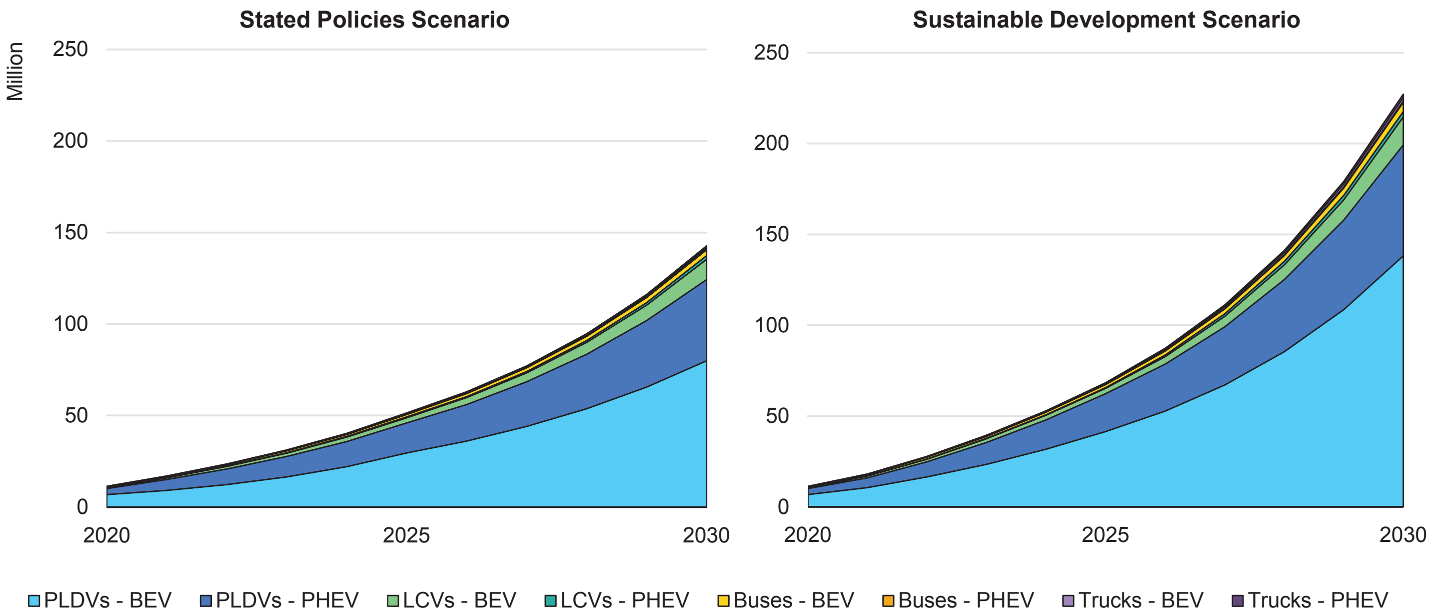
The Sustainable Development Scenario (SDS) rests on three pillars: ensure universal energy access for all by 2030; bring about sharp reductions in emissions of air pollutants; and meet global climate goals in line with the Paris Agreement. The SDS reaches net-zero emissions by 2070 and global temperature 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



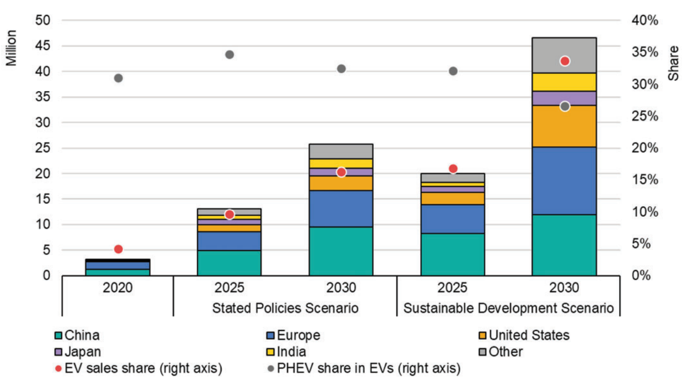
Notes: PLDVs = passenger light-duty vehicles; BEV = battery electric vehicle; LCVs = light-commercial vehicles; PHEV = plug-in hybrid electric vehicle. The figure does not include electric two/three-wheelers. For reference, total road EV stock (excluding two/three-wheelers) in 2030 is 2 billion in the 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.

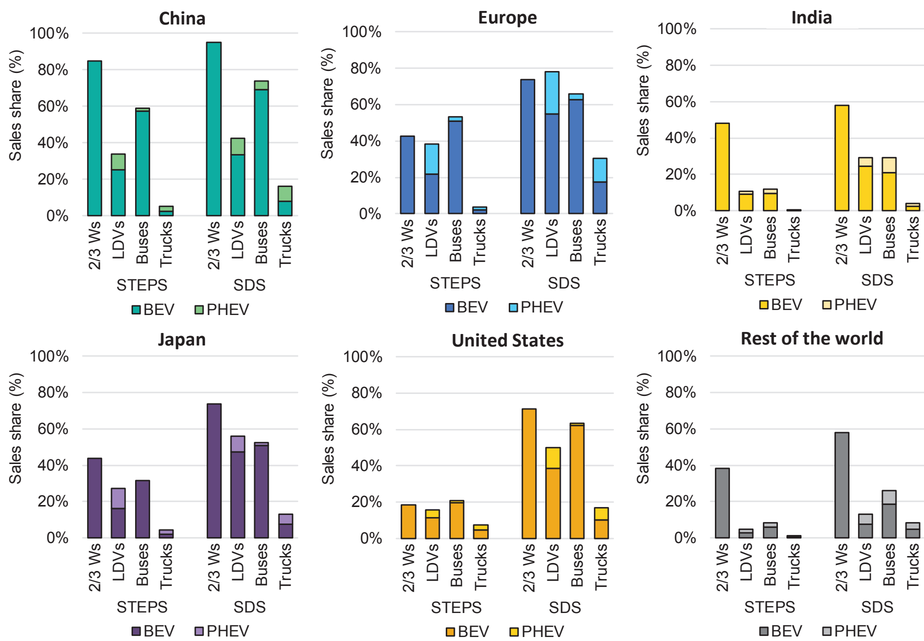
In the Sustainable Development Scenario, the deployment of electric buses accelerates, reaching over 5.5 million in 2030, corresponding to over 15% of the stock, primarily in urban buses.

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.

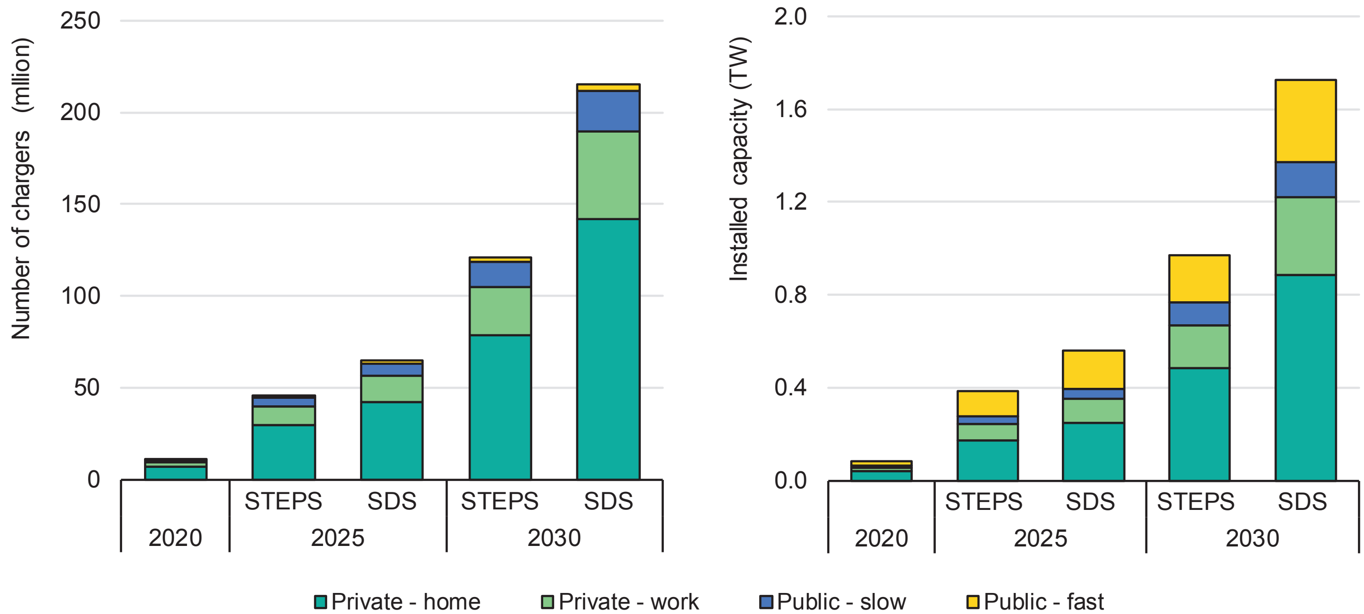
For the other regions category in the Stated Policies Scenario, EV sales shares average 5% for LDVs, 8% for buses and 1% for trucks in 2030. The Sustainable Development Scenario assumes higher electrification across the world, though still lagging behind the more advanced markets. In the Sustainable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

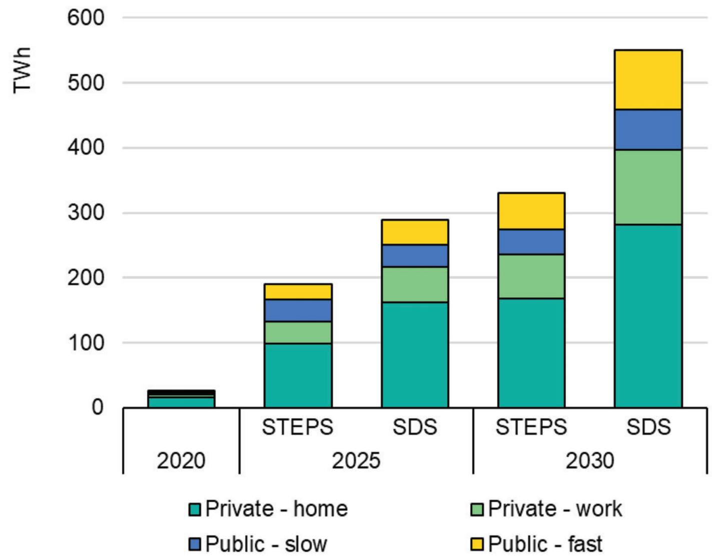
Private chargers account for 90% of all chargers in both scenarios in 2030, but for only 70% of installed capacity due to the lower power rating (or charging rate) compared to fast chargers. Private chargers meet about 70% of the energy demand in both scenarios, reflecting the lower power rating.

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.

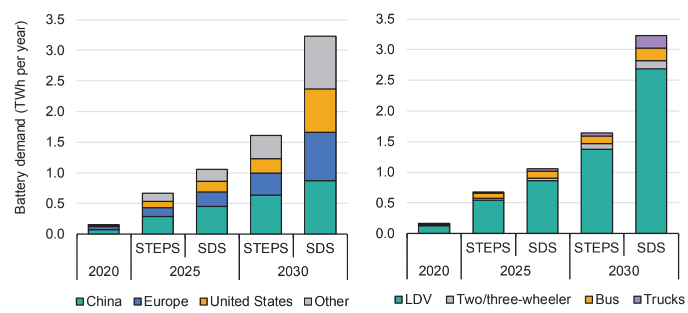
Today the largest demand for EV batteries is in China. It is expected to remain the biggest market in this decade in both scenarios. China is followed by Europe and the United States.

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.

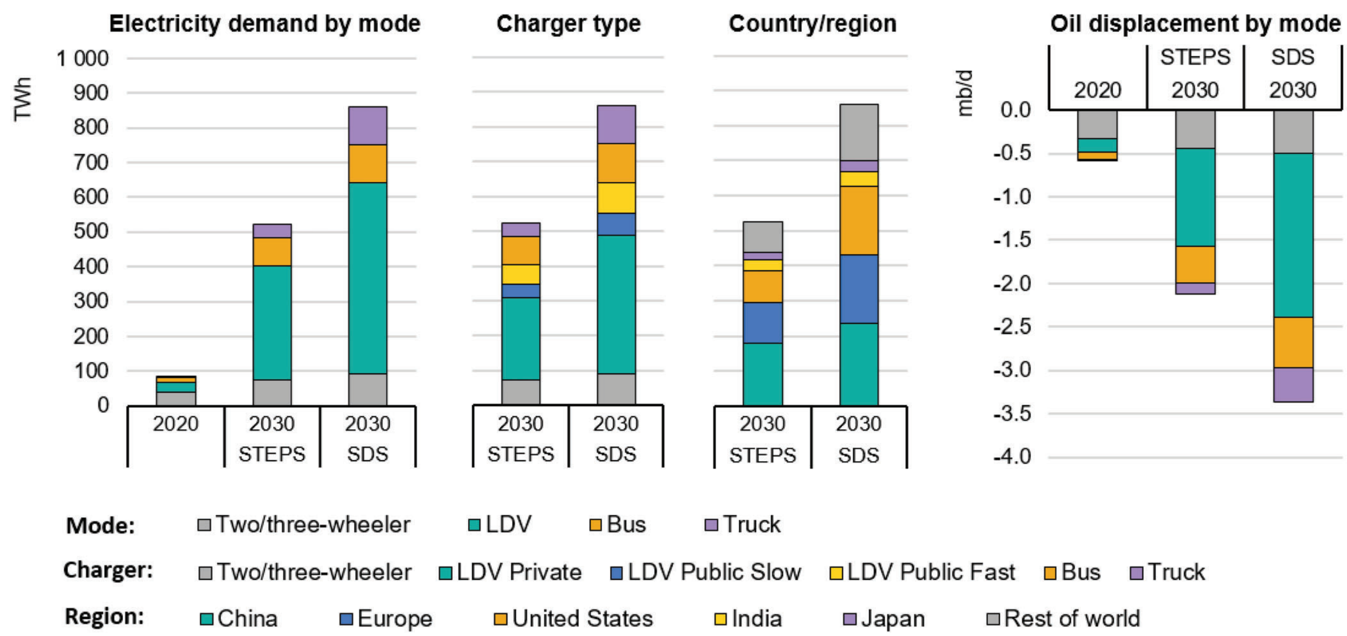
Annual EV battery demand projections by region (left), mode and scenario (right), 2020-2030



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.

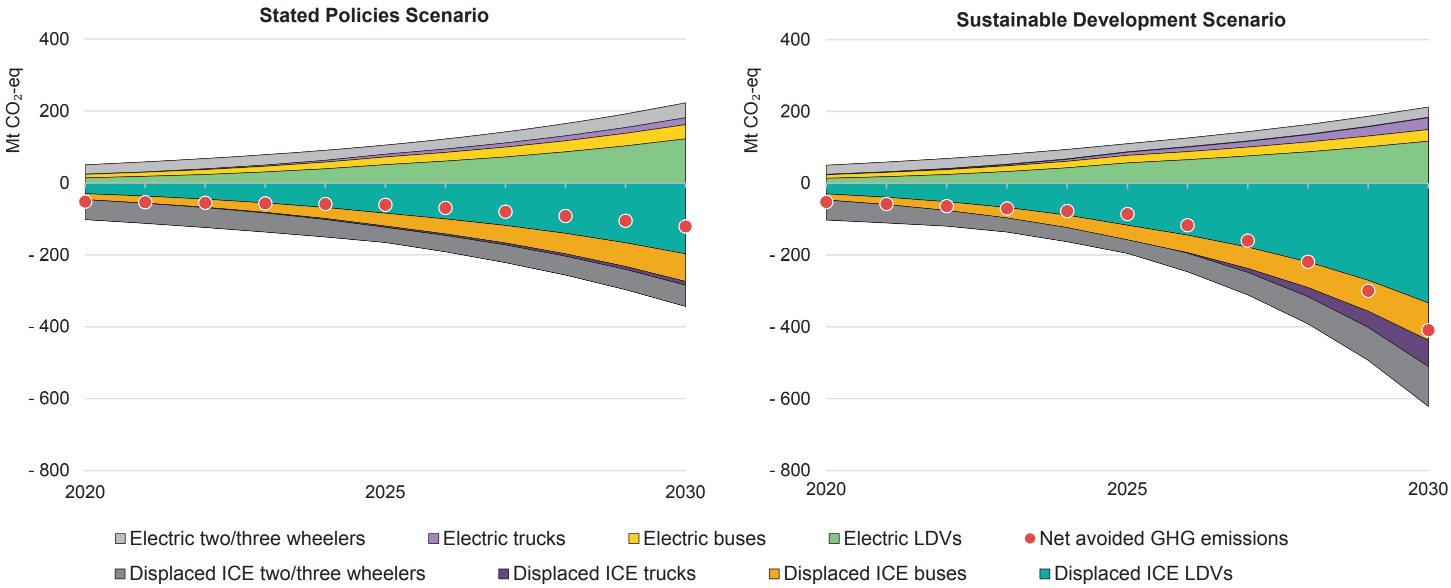
Share of electricity consumption attributable to EVs relative to final electricity demand by region and scenario, 2020 and 2030

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

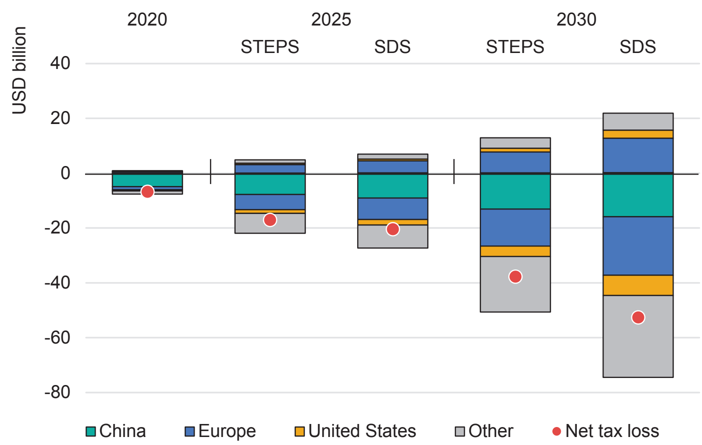
By reducing the consumption of oil products, EV uptake lessens the amount of revenue that governments derive from fossil fuel taxes, which is not fully compensated by levies on the increased electricity use. The net tax loss is mainly due to lower overall energy consumption (EVs are two-to-four times 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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Electric Bus

BRIEFING ROOM

FACT SHEET: The American Jobs Plan

MARCH 31, 2021 • STATEMENTS AND RELEASES

While the American Rescue Plan is changing the course of the pandemic and delivering relief for working families, this is no time to build back to the way things were. This is the moment to reimagine and rebuild a new economy. The American Jobs Plan is an investment in America that will create millions of good jobs, rebuild our country's infrastructure, and position the United States to out-compete China. Public domestic investment as a share of the economy has fallen by more than 40 percent since the 1960s. The American Jobs Plan will invest in America in a way we have not invested since we built the interstate highways and won the Space Race.

The United States of America is the wealthiest country in the world, yet we rank 13th when it comes to the overall quality of our infrastructure. After decades of disinvestment, our roads, bridges, and water systems are crumbling. Our electric grid is vulnerable to catastrophic outages. Too many lack access to affordable, high-speed Internet and to quality housing. The past year has led to job losses and threatened economic security, eroding more than 30 years of progress in women's labor force participation. It has unmasked the fragility of our caregiving infrastructure. And, our nation is falling behind its biggest competitors on research and development (R&D), manufacturing, and training. It has never been more important for us to invest in strengthening our infrastructure and competitiveness, and in creating the good-paying, union jobs of the future.

Like great projects of the past, the President's plan will unify and mobilize the country to meet the great challenges of our time: the climate crisis and the ambitions of an autocratic China. It will invest in Americans and deliver the jobs and opportunities they deserve. But unlike past major investments, the plan prioritizes addressing long-standing and persistent racial injustice. The plan targets 40 percent of the benefits of climate and clean infrastructure investments to disadvantaged communities. And, the plan invests in rural communities and communities impacted by the market-based transition to clean energy. Specifically, President Biden's plan will:

Fix highways, rebuild bridges, upgrade ports, airports and transit systems. The President's plan will modernize 20,000 miles of highways, roads, and main-streets. It will fix the ten most economically significant bridges in the country in need of reconstruction. It also will repair the worst 10,000 smaller bridges, providing critical linkages to communities. And, it will replace thousands of buses and rail cars, repair hundreds of stations, renew airports, and expand transit and rail into new communities.

Deliver clean drinking water, a renewed electric grid, and high-speed broadband to all Americans. President Biden's plan will eliminate all lead pipes and service lines in our drinking water systems, improving the health of our country's children and communities of color. It will put hundreds of thousands of people to work laying thousands of miles of transmission lines and capping hundreds of thousands of orphan oil and gas wells and abandoned mines. And, it will bring affordable, reliable, high-speed broadband to every American, including the more than 35 percent of rural Americans who lack access to broadband at minimally acceptable speeds.

Build, preserve, and retrofit more than two million homes and commercial buildings, modernize our nation's schools and child care facilities, and upgrade veterans' hospitals and federal buildings. President Biden's plan will create good jobs building, rehabilitating, and retrofitting affordable, accessible, energy efficient, and resilient housing, commercial buildings, schools, and child care facilities all over the country, while also vastly improving our nation's federal facilities, especially those that serve veterans.

Solidify the infrastructure of our care economy by creating jobs and raising wages and benefits for essential home care workers. These workers – the majority of whom are women of color – have been underpaid and undervalued for too long. The President's plan makes substantial investments in the infrastructure of our care economy, starting by creating new and better jobs for caregiving workers. His plan will provide home and community-based care for individuals who otherwise would need to wait as many as five years to get the services they badly need.

Revitalize manufacturing, secure U.S. supply chains, invest in R&D, and train Americans for the jobs of the future. President Biden's plan will ensure that the best, diverse minds in America are put to work creating the innovations of the future while creating hundreds of thousands of quality jobs today. Our workers will build and make things in every part of America, and they will be trained for well-paying, middle-class jobs.

Create good-quality jobs that pay prevailing wages in safe and healthy workplaces while ensuring workers have a free and fair choice to organize, join a union, and bargain collectively with their employers. By ensuring that American taxpayers' dollars benefit working families and their communities, and not multinational corporations or foreign governments, the plan will require that goods and materials are made in America and shipped on U.S.-flag, U.S.-crewed vessels. The plan also will ensure that Americans who have endured systemic discrimination and exclusion for generations finally have a fair shot at obtaining good paying jobs and being part of a union.

Alongside his American Jobs Plan, President Biden is releasing a Made in America Tax Plan to make sure corporations pay their fair share in taxes and encourage job creation at home. A recent study found that 91 Fortune 500 companies paid $0 in federal taxes on U.S. income in 2018. Another study found that the average corporation paid just 8 percent in taxes. President Biden believes that profitable corporations should not be able to get away with paying little or no tax by shifting jobs and profits overseas. President Biden's plan will reward investment at home, stop profit shifting, and ensure other nations won't gain a competitive edge by becoming tax havens.

The President's American Jobs Plan is a historic public investment – consisting principally of one-time capital investments in our nation's productivity and long-term growth. It will invest about 1 percent of GDP per year over eight years to upgrade our nation's infrastructure, revitalize manufacturing, invest in basic research and science, shore up supply chains, and solidify our care infrastructure. These are investments that leading economists agree will give Americans good jobs now and will pay off for future generations by leaving the country more competitive and our communities stronger. In total, the plan will invest about $2 trillion this decade. If passed alongside President Biden's Made in America corporate tax plan, it will be fully paid for within the next 15 years and reduce deficits in the years after.

BUILD WORLD-CLASS TRANSPORTATION INFRASTRUCTURE: FIX HIGHWAYS, REBUILD BRIDGES, AND UPGRADE PORTS, AIRPORTS AND TRANSIT SYSTEMS

President Biden is calling on Congress to make a historic and overdue investment in our roads, bridges, rail, ports, airports, and transit systems. The President's plan will ensure that these investments produce good-quality jobs with strong labor standards, prevailing wages, and a free and fair choice to join a union and bargain collectively. These investments will advance racial equity by providing better jobs and better transportation options to underserved communities. These investments also will extend opportunities to small businesses to participate in the design, construction, and manufacturing of new infrastructure and component parts. President Biden's plan will deliver infrastructure Americans can trust, because it will be resilient to floods, fires, storms, and other threats, and not fragile in the face of these increasing risks. President Biden is calling on Congress to:

Transform our crumbling transportation infrastructure:

Decades of declining public investment has left our roads, bridges, rail, and transit systems in poor condition, with a trillion-dollar backlog of needed repairs. More than 35,000 people die in traffic crashes on U.S. roads each year, and millions more are seriously and often permanently injured. The United States has one of the highest traffic fatality rates in the industrialized world, double the rate in Canada and quadruple that in Europe. Across cities, suburbs, and rural areas, President Biden's plan will help parents get to work reliably and affordably, reduce the impacts of climate change for our kids, and make sure fewer families mourn the loss of a loved one to road crashes. His investments will use more sustainable and innovative materials, including cleaner steel and cement, and component parts Made in America and shipped on U.S.-flag vessels with American crews under U.S. laws. And, his infrastructure investments will mitigate socio-economic disparities, advance racial equity, and promote affordable access to opportunity.

The President's plan invests an additional $621 billion in transportation infrastructure and resilience. It will:

- **Repair American roads and bridges**. One in five miles, or 173,000 total miles, of our highways and major roads are in poor condition, as well as 45,000 bridges. Delays caused by traffic congestion alone cost over $160 billion per year, and motorists are forced to pay over $1,000 every year in wasted time and fuel. The President is proposing a total increase of $115 billion to modernize the bridges, highways, roads, and main streets that are in most critical need of repair. This includes funding to improve air quality, limit greenhouse gas emissions, and reduce congestion. His plan will modernize 20,000 miles of highways, roads, and main streets, not only "fixing them first" but "fixing them right," with safety, resilience, and all users in mind. It will fix the most economically significant large bridges in the country in need of reconstruction, and it will repair the worst 10,000 smaller bridges, including bridges that provide critical connections to rural and tribal communities. The plan includes $20 billion to improve road safety for all users, including increases to existing safety programs and a new Safe Streets for All program to fund state and local "vision zero" plans and other improvements to reduce crashes and fatalities, especially for cyclists and pedestrians.
- **Modernize public transit**. Households that take public transportation to work have twice the commute time, and households of color are twice as likely to take public transportation. Our current transit infrastructure is inadequate – the Department of Transportation estimates a repair backlog of over $105 billion, representing more than 24,000 buses, 5,000 rail cars, 200 stations, and thousands of miles of track, signals, and power systems in need of replacement. This translates to service delays and disruptions that leave riders stranded and discourage transit use. President Biden is calling on Congress to invest $85 billion to modernize existing transit and help agencies expand their systems to meet rider demand. This investment will double federal funding for public transit, spend down the repair backlog, and bring bus, bus rapid transit, and rail service to communities and neighborhoods across the country. It will ultimately reduce traffic congestion for everyone.

- **Invest in reliable passenger and freight rail service**. The nation's rail networks have the potential to offer safe, reliable, efficient, and climate-friendly alternatives for moving people and freight. However, unlike highways and transit, rail lacks a multi-year funding stream to address deferred maintenance, enhance existing corridors, and build new lines in high-potential locations. There are currently projects just waiting to be funded that will give millions more Americans reliable and fast inter-city train service. President Biden is calling on Congress to invest $80 billion to address Amtrak's repair backlog; modernize the high traffic Northeast Corridor; improve existing corridors and connect new city pairs; and enhance grant and loan programs that support passenger and freight rail safety, efficiency, and electrification.

- **Create good jobs electrifying vehicles**. U.S. market share of plug-in electric vehicle (EV) sales is only one-third the size of the Chinese EV market. The President believes that must change. He is proposing a $174 billion investment to win the EV market. His plan will enable automakers to spur domestic supply chains from raw materials to parts, retool factories to compete globally, and support American workers to make batteries and EVs. It will give consumers point of sale rebates and tax incentives to buy American-made EVs, while ensuring that these vehicles are affordable for all families and manufactured by workers with good jobs. It will establish grant and incentive programs for state and local governments and the private sector to build a national network of 500,000 EV chargers by 2030, while promoting strong labor, training, and installation standards. His plan also will replace 50,000 diesel transit vehicles and electrify at least 20 percent of our yellow school bus fleet through a new Clean Buses for Kids Program at the Environmental Protection Agency, with support from the Department of Energy. These investments will set us on a path to 100 percent clean buses, while ensuring that the American workforce is trained to operate and maintain this 21st century infrastructure. Finally, it will utilize the vast tools of federal procurement to electrify the federal fleet, including the United States Postal Service.

- **Improve ports, waterways, and airports.** The United States built modern aviation, but our airports lag far behind our competitors. According to some rankings, no U.S. airports rank in the top 25 of airports worldwide. Our ports and waterways need repair and reimagination too. President Biden is calling on Congress to invest $25 billion in our airports, including funding for the Airport Improvement Program, upgrades to FAA assets that ensure safe and efficient air travel, and a new program to support terminal renovations and multimodal connections for affordable, convenient, car-free access to air travel. President Biden is calling on Congress to invest an additional $17 billion in inland waterways, coastal ports, land ports of entry, and ferries, which are all essential to our nation's freight. This includes a Healthy Ports program to mitigate the cumulative impacts of air pollution on neighborhoods near ports, often communities of color. These investments will position the United States as a global leader in clean freight and aviation.

- **Redress historic inequities and build the future of transportation infrastructure.** The President's plan for transportation is not just ambitious in scale, it is designed with equity in mind and to set up America for the future. Too often, past transportation investments divided communities – like the Claiborne Expressway in New Orleans or I-81 in Syracuse – or it left out the people most in need of affordable transportation options. The President's plan includes $20 billion for a new program that will reconnect neighborhoods cut off by historic investments and ensure new projects increase opportunity, advance racial equity and environmental justice, and promote affordable access. The President's plan will inspire basic research, like advanced pavements that recycle carbon dioxide, and "future proof" investments that will last decades to leave coming generations with a safe, equitable, and sustainable transportation system. And, the President's plan will accelerate transformative investments, from pre-development through construction, turning "shovel worthy" ideas into "shovel ready" projects. This includes $25 billion for a dedicated fund to support ambitious projects that have tangible benefits to the regional or national economy but are too large or complex for existing funding programs.

- **Invest resources wisely to deliver infrastructure projects that produce real results.** America lags its peers – including Canada, the U.K., and Australia – in the on-time and on-budget delivery of infrastructure, and is falling behind countries like China on overall investment. Delivering this historic investment will require partnership across government, unions, and industry, to produce meaningful outcomes for the American people – reliable transportation, safe water, affordable housing, healthy schools, clean electricity, and broadband for all. When President Biden managed the implementation of the Recovery Act, he insisted on the strongest possible accountability and transparency measures to ensure public dollars were invested efficiently and effectively. When Congress enacts the American Jobs Plan, the President will bring the best practices from the Recovery Act and models from around the world to break down barriers and drive implementation of infrastructure investments across all levels of government to realize the President's vision of safe, reliable, and resilient infrastructure. Critically, in order to achieve the best outcomes on cost and performance for the American people, the Administration will support the state, local, and tribal governments delivering these projects through world-class training, technical assistance, and procurement best practices. In addition, the President's plan will use smart, coordinated infrastructure permitting to expedite federal decisions while prioritizing stakeholder engagement, community consultation, and maximizing equity, health, and environmental benefits.

Make our infrastructure more resilient:

Millions of Americans feel the effects of climate change each year when their roads wash out, airport power goes down, or schools get flooded. Last year alone, the United States faced 22 extreme weather and climate-related disaster events with losses exceeding $1 billion each – a cumulative price tag of nearly $100 billion. Chronic underinvestment in resilience has harmed American transportation infrastructure, disrupting service, making travel conditions unsafe, causing severe damage, and increasing maintenance and operating costs.

In 2020, the United States endured 22 separate billion-dollar weather and climate disasters, costing $95 billion in damages to homes, businesses, and public infrastructure. In Louisiana, Hurricane Laura caused $19 billion of damage, resulting in broken water systems and a severely damaged electrical grid that impeded a quick recovery. Building back better requires that the investments in this historic plan make our infrastructure more resilient in the face of increasingly severe floods, wildfires, hurricanes, and other risks. Every dollar spent on rebuilding our infrastructure during the Biden administration will be used to prevent, reduce, and withstand the impacts of the climate crisis. Additionally, the President is calling for $50 billion in dedicated investments to improve infrastructure resilience and:

- **Safeguard critical infrastructure and services, and defend vulnerable communities.** People of color and low-income people are more likely to live in areas most vulnerable to flooding and other climate change-related weather events. They also are less likely to have the funds to prepare for and recover from extreme weather events. In the wake of Hurricane Harvey, Black and Hispanic residents were twice as likely as white residents to report experiencing an income shock with no recovery support. President Biden's plan increases resilience in the most essential services, including the electric grid; food systems; urban infrastructure; community health and hospitals; and our roads, rail, and other transportation assets. His plan also targets investments to support infrastructure in those communities most vulnerable physically and financially to climate-driven disasters and to build back above existing codes and standards. The President's plan will invest in vulnerable communities through a range of programs, including FEMA's Building Resilient Infrastructure and Communities program, HUD's Community Development Block Grant program, new initiatives at the Department of Transportation, a bipartisan tax credit to provide incentives to low- and middle-income families and to small businesses to invest in disaster resilience, and transition and relocation assistance to support community-led transitions for the most vulnerable tribal communities.

- **Maximize the resilience of land and water resources to protect communities and the environment.** President Biden's plan will protect and, where necessary, restore nature-based infrastructure – our lands, forests, wetlands, watersheds, and coastal and ocean resources. Families and businesses throughout the United States rely on this infrastructure for their lives and livelihoods. President Biden is calling on Congress to invest in protection from extreme wildfires, coastal resilience to sea-level rise and hurricanes, support for agricultural resources management and climate-smart technologies, and the protection and restoration of major land and water resources like Florida's Everglades and the Great Lakes. Additionally, the President's plan provides funding for the western drought crisis by investing in water efficiency and recycling programs, Tribal Water Settlements, and dam safety. President Biden's plan will empower local leaders to shape these restoration and resilience project funds in line with the Outdoor Restoration Force Act.

REBUILD CLEAN DRINKING WATER INFRASTRUCTURE, A RENEWED ELECTRIC GRID, AND HIGH-SPEED BROADBAND TO ALL AMERICANS

Too many American families drink polluted water, lack access to affordable, high-speed internet, or experience power outages too often – all while paying more for those services. President Biden's plan invests in the infrastructure necessary to finally deliver the water, broadband, and electricity service that Americans deserve. Specifically, his plan will:

Ensure clean, safe drinking water is a right in all communities:

Across the country, pipes and treatment plants are aging and polluted drinking water is endangering public health. An estimated six to ten million homes still receive drinking water through lead pipes and service lines. The President's investments in improving water infrastructure and replacing lead service lines will create good jobs, including union and prevailing wage jobs. President Biden's plan invests $111 billion to:

- **Replace 100 percent of the nation's lead pipes and service lines.** According to the CDC, there is no safe level of lead exposure for children. Lead can slow development and cause learning, behavior, and hearing problems in children, as well as lasting kidney and brain damage. President Biden believes that no American family should still be receiving drinking water through lead pipes and service lines. To eliminate all lead pipes and service lines in the country, he is calling on Congress to invest $45 billion in the Environmental Protection Agency's Drinking Water State Revolving Fund and in Water Infrastructure Improvements for the Nation Act (WIIN) grants. In addition to reducing lead exposure in homes, this investment also will reduce lead exposure in 400,000 schools and childcare facilities.
- **Upgrade and modernize America's drinking water, wastewater, and stormwater systems, tackle new contaminants, and support clean water infrastructure across rural America.** Aging water systems threaten public health in thousands of communities nationwide. President Biden will modernize these systems by scaling up existing, successful programs, including by providing $56 billion in grants and low-cost flexible loans to states, Tribes, territories, and disadvantaged communities across the country. President Biden's plan also provides $10 billion in funding to monitor and remediate PFAS (per- and polyfluoroalkyl substances) in drinking water and to invest in

rural small water systems and household well and wastewater systems, including drainage fields.

Revitalize America's digital infrastructure:

Generations ago, the federal government recognized that without affordable access to electricity, Americans couldn't fully participate in modern society and the modern economy. With the 1936 Rural Electrification Act, the federal government made a historic investment in bringing electricity to nearly every home and farm in America, and millions of families and our economy reaped the benefits. Broadband internet is the new electricity. It is necessary for Americans to do their jobs, to participate equally in school learning, health care, and to stay connected. Yet, by one definition, more than 30 million Americans live in areas where there is no broadband infrastructure that provides minimally acceptable speeds. Americans in rural areas and on tribal lands particularly lack adequate access. And, in part because the United States has some of the highest broadband prices among OECD countries, millions of Americans can't use broadband internet even if the infrastructure exists where they live. In urban areas as well, there is a stark digital divide: a much higher percentage of White families use home broadband internet than Black or Latino families. The last year made painfully clear the cost of these disparities, particularly for students who struggled to connect while learning remotely, compounding learning loss and social isolation for those students.
The President believes we can bring affordable, reliable, high-speed broadband to every American through a historic investment of $100 billion. That investment will:

- **Build high-speed broadband infrastructure to reach 100 percent coverage.** The President's plan prioritizes building "future proof" broadband infrastructure in unserved and underserved areas so that we finally reach 100 percent high-speed broadband coverage. It also prioritizes support for broadband networks owned, operated by, or affiliated with local governments, non-profits, and co-operatives—providers with less pressure to turn profits and with a commitment to serving entire communities. Moreover, it ensures funds are set aside for infrastructure on tribal lands and that tribal nations are consulted in program administration. Along the way, it will create good-paying jobs with labor protections and the right to organize and bargain collectively.

- **Promote transparency and competition.** President Biden's plan will promote price transparency and competition among internet providers, including by lifting barriers that prevent municipally-owned or affiliated providers and rural electric co-ops from competing on an even playing field with private providers, and requiring internet providers to clearly disclose the prices they charge.

- **Reduce the cost of broadband internet service and promote more widespread adoption.** President Biden believes that building out broadband infrastructure isn't enough. We also must ensure that every American who wants to can afford high-quality and reliable broadband internet. While the President recognizes that individual subsidies to cover internet costs may be needed in the short term, he believes continually providing subsidies to cover the cost of overpriced internet service is not the right long-term solution for consumers or taxpayers. Americans pay too much for the internet – much more than people in many other countries – and the President is committed to working with Congress to find a solution to reduce internet prices for all Americans, increase adoption in both rural and urban areas, hold providers accountable, and save taxpayer money.

Reenergize America's power infrastructure:

As the recent Texas power outages demonstrated, our aging electric grid needs urgent modernization. A Department of Energy study found that power outages cost the U.S. economy up to $70 billion annually. The President's plan will create a more resilient grid, lower energy bills for middle class Americans, improve air quality and public health outcomes, and create good jobs, with a choice to join a union, on the path to achieving 100 percent carbon-free electricity by 2035. President Biden is calling on Congress to invest $100 billion to:

- **Build a more resilient electric transmission system.** Through investments in the grid, we can move cheaper, cleaner electricity to where it is needed most. This starts with the creation of a targeted investment tax credit that incentivizes the buildout of at least 20 gigawatts of high-voltage capacity power lines and mobilizes tens of billions in private capital off the sidelines – right away. In addition, President Biden's plan will establish a new Grid Deployment Authority at the Department of Energy that allows for better leverage of existing rights-of-way – along roads and railways – and supports creative financing tools to spur additional high priority, high-voltage transmission lines. These efforts will create good-paying jobs for union laborers, line workers, and electricians, in addition to creating demand for American-made building materials and parts.
- **Spur jobs modernizing power generation and delivering clean electricity.** President Biden is proposing a ten-year extension and phase down of an expanded direct-pay investment tax credit and production tax credit for clean energy generation and storage. These credits will be paired with strong labor standards to ensure the jobs created are good-quality jobs with a free and fair choice to join a union and bargain collectively. President Biden's plan will mobilize private investment to modernize our power sector. It also will support state, local, and tribal governments choosing to accelerate this modernization through complementary policies – like clean energy block grants that can be used to support clean energy, worker empowerment, and

environmental justice. And, it will use the federal government's incredible purchasing power to drive clean energy deployment across the market by purchasing 24/7 clean power for federal buildings. To ensure that we fully take advantage of the opportunity that modernizing our power sector presents, President Biden will establish an Energy Efficiency and Clean Electricity Standard (EECES) aimed at cutting electricity bills and electricity pollution, increasing competition in the market, incentivizing more efficient use of existing infrastructure, and continuing to leverage the carbon pollution-free energy provided by existing sources like nuclear and hydropower. All of this will be done while ensuring those facilities meet robust and rigorous standards for worker, public, and environmental safety as well as environmental justice – and all while moving toward 100 percent carbon-pollution free power by 2035.

- **Put the energy industry to work plugging orphan oil and gas wells and cleaning up abandoned mines.** Hundreds of thousands of former orphan oil and gas wells and abandoned mines pose serious safety hazards, while also causing ongoing air, water, and other environmental damage. Many of these old wells and mines are located in rural communities that have suffered from years of disinvestment. President Biden's plan includes an immediate up-front investment of $16 billion that will put hundreds of thousands to work in union jobs plugging oil and gas wells and restoring and reclaiming abandoned coal, hardrock, and uranium mines. In addition to creating good jobs in hard-hit communities, this investment will reduce the methane and brine that leaks from these wells, just as we invest in reducing leaks from other sources like aging pipes and distribution systems.
- **Remediate and redevelop idle real property, and spur the buildout of critical physical, social, and civic infrastructure in distressed and disadvantaged communities.** In thousands of rural and urban communities around the country, hundreds of thousands of former industrial and energy sites are now idle – sources of blight and pollution. Through a $5 billion investment in the remediation and redevelopment of these Brownfield and Superfund sites, as well as related economic and workforce development, President Biden's plan will turn this idle real property into new hubs of economic growth and job creation. But it's not enough to redevelop old infrastructure. President Biden's plan also will bring these communities new critical physical, social, and civic infrastructure. This means investing in the Economic Development Agency's Public Works program (while lifting the cap of $3 million on projects) and in "Main Street" revitalization efforts through HUD and USDA. President Biden's plan also will spur targeted sustainable, economic development efforts through the Appalachian Regional Commission's POWER grant program, Department of Energy retooling grants for idled factories (through the Section 132 program), and dedicated funding to support community-driven environmental justice efforts – such as capacity and project grants to address legacy pollution and the cumulative impacts experienced by frontline and fenceline communities.

- **Build next generation industries in distressed communities.** President Biden believes that the market-based shift toward clean energy presents enormous opportunities for the development of new markets and new industries. For example, by pairing an investment in 15 decarbonized hydrogen demonstration projects in distressed communities with a new production tax credit, we can spur capital-project retrofits and installations that bolster and decarbonize our industry. The President's plan also will establish ten pioneer facilities that demonstrate carbon capture retrofits for large steel, cement, and chemical production facilities, all while ensuring that overburdened communities are protected from increases in cumulative pollution. In addition, in line with the bipartisan SCALE Act, his plan will support large-scale sequestration efforts that leverage the best science and prioritize community engagement. And to accelerate responsible carbon capture deployment and ensure permanent storage, President Biden's plan reforms and expands the bipartisan Section 45Q tax credit, making it direct pay and easier to use for hard-to-decarbonize industrial applications, direct air capture, and retrofits of existing power plants.
- **Mobilize the next generation of conservation and resilience workers.** This $10 billion investment will put a new, diverse generation of Americans to work conserving our public lands and waters, bolstering community resilience, and advancing environmental justice through a new Civilian Climate Corps, all while placing good-paying union jobs within reach for more Americans.

BUILD, PRESERVE, AND RETROFIT MORE THAN TWO MILLION HOMES AND COMMERCIAL BUILDINGS; MODERNIZE OUR NATION'S SCHOOLS, COMMUNITY COLLEGES, AND EARLY LEARNING FACILITIES; AND UPGRADE VETERANS' HOSPITALS AND FEDERAL BUILDINGS

There is a severe shortage of affordable housing options in America, and the American Society of Civil Engineers gives our school infrastructure a "D+." President Biden believes we must invest in building and upgrading modern, resilient, and energy-efficient homes and buildings, including our nation's schools, early learning facilities, veterans' hospitals and other federal buildings, and in the process, employ American workers in jobs with good wages and benefits. President Biden's plan will:

Build, preserve, and retrofit more than two million homes and commercial buildings to address the affordable housing crisis:

There is a severe shortage of affordable housing options in America. Millions of families pay more than half their income on rent, and home energy costs are a significant concern for American renters as well. And, across the country, people are struggling to purchase their first home.

The President's plan invests $213 billion to produce, preserve, and retrofit more than two million affordable and sustainable places to live. It pairs this investment with an innovative new approach to eliminate state and local exclusionary zoning laws, which drive up the cost of construction and keep families from moving to neighborhoods with more opportunities for them and their kids. The President's plan will help address the growing cost of rent and create jobs that pay prevailing wages, including through project labor agreements with a free and fair choice to join a union and bargain collectively.

President Biden is calling on Congress to:

- **Produce, preserve, and retrofit more than a million affordable, resilient, accessible, energy efficient, and electrified housing units.** Through targeted tax credits, formula funding, grants, and project-based rental assistance, President Biden's plan will extend affordable housing rental opportunities to underserved communities nationwide, including rural and tribal areas.
- **Build and rehabilitate more than 500,000 homes for low- and middle-income homebuyers.** President Biden is calling on Congress to take immediate steps to spur the construction and rehabilitation of homes for underserved communities. Specifically, he is calling on Congress to pass the innovative, bipartisan Neighborhood Homes Investment Act (NHIA). Offering $20 billion worth of NHIA tax credits over the next five years will result in approximately 500,000 homes built or rehabilitated, creating a pathway for more families to buy a home and start building wealth.
- **Eliminate exclusionary zoning and harmful land use policies.** For decades, exclusionary zoning laws – like minimum lot sizes, mandatory parking requirements, and prohibitions on multifamily housing – have inflated housing and construction costs and locked families out of areas with more opportunities. President Biden is calling on Congress to enact an innovative, new competitive grant program that awards flexible and attractive funding to jurisdictions that take concrete steps to eliminate such needless barriers to producing affordable housing.
- **Address longstanding public housing capital needs.** Years of disinvestment have left our public housing in disrepair. President Biden is calling on Congress to invest $40 billion to improve the infrastructure of the public housing system in America. This funding will address critical life-safety concerns, mitigate imminent hazards to residents, and undertake energy efficiency measures which will significantly reduce ongoing operating expenses. These improvements will disproportionately benefit women, people of color, and people with disabilities.
- **Put union building trade workers to work upgrading homes and businesses to save families money.** President Biden's plan will upgrade homes through block grant programs, the Weatherization Assistance Program, and by extending and expanding

home and commercial efficiency tax credits. President Biden's plan also will establish a $27 billion Clean Energy and Sustainability Accelerator to mobilize private investment into distributed energy resources; retrofits of residential, commercial and municipal buildings; and clean transportation. These investments have a particular focus on disadvantaged communities that have not yet benefited from clean energy investments.

Modernize our nation's schools and early learning facilities:

Too many students attend schools and child care centers that are run-down, unsafe, and pose health risks. These conditions are dangerous for our kids and exist disproportionately in schools with a high percentage of low-income students and students of color. And even before COVID-19, 43 percent of parents reported struggling to find an adequate child care facility for their children. President Biden is calling on Congress to:

- **Modernize our public schools.** President Biden believes we can't close the opportunity gap if low-income kids go to schools in buildings that undermine health and safety, while wealthier students get access to safe buildings with labs and technology that prepare them for the jobs of the future. The President's plan invests $100 billion to upgrade and build new public schools, through $50 billion in direct grants and an additional $50 billion leveraged through bonds. These funds will first go toward making sure our schools are safe and healthy places of learning for our kids and work for teachers and other education professionals, for example by improving indoor air quality and ventilation. As we make our schools safer, we also will invest in cutting-edge, energy-efficient and electrified, resilient, and innovative school buildings with technology and labs that will help our educators prepare students to be productive workers and valued students. Under the President's plan, better operating school facilities will reduce their greenhouse gas emissions and also will become environments of community resilience with green space, clean air, and safe places to gather, especially during emergencies. Funds also will be provided to improve our school kitchens, so they can be used to better prepare nutritious meals for our students and go green by reducing or eliminating the use of paper plates and other disposable materials.
- **Investing in community college infrastructure**. Investing in community college facilities and technology helps protect the health and safety of students and faculty, address education deserts (particularly for rural communities), grow local economies, improve energy efficiency and resilience, and narrow funding inequities in the short-term, as we rebuild our higher education finance system for the long-run. President Biden is calling on Congress to invest $12 billion to address these needs. States will be responsible for using the dollars to address both existing physical and technological infrastructure needs at community colleges and identifying strategies to address access to community college in education deserts.

- **Upgrade child care facilities and build new supply in high need areas.** Lack of access to child care makes it harder for parents, especially mothers, to fully participate in the workforce. In areas with the greatest shortage of child care slots, women's labor force participation is about three percentage points less than in areas with a high capacity of child care slots, hurting families and hindering U.S. growth and competitiveness. President Biden is calling on Congress to provide $25 billion to help upgrade child care facilities and increase the supply of child care in areas that need it most. Funding would be provided through a Child Care Growth and Innovation Fund for states to build a supply of infant and toddler care in high-need areas. President Biden also is calling for an expanded tax credit to encourage businesses to build child care facilities at places of work. Employers will receive 50 percent of the first $1 million of construction costs per facility so that employees can enjoy the peace of mind and convenience that comes with on-site child care. These investments will provide safe, accessible, energy efficient, high-quality learning environments for providers to teach and care for children. Public investments in schools and childcare improves children's outcomes—the foundation for future productivity gains. In classrooms with poor ventilation, for example, student absences are 10 to 20 percent higher.

Upgrade VA hospitals and federal buildings:

The federal government operates office buildings, courthouses, and other facilities in every state, where millions of workers serve the public from outdated, inefficient, and sometimes unsafe working conditions. While the median age of U.S. private sector hospitals is roughly 11 years, the Veterans Affairs' hospital portfolio has a median age of 58. The President believes our veterans deserve state-of-the-art hospitals and care. President Biden's plan provides $18 billion for the modernization of Veterans Affairs hospitals and clinics. President Biden's plan also invests $10 billion in the modernization, sustainability, and resilience of federal buildings, including through a bipartisan Federal Capital Revolving Fund to support investment in a major purchase, construction or renovation of Federal facilities. And, President Biden's plan utilizes the vast tools of federal procurement to purchase low carbon materials for construction and clean power for these newly constructed VA hospitals and federal buildings.

SOLIDIFY THE INFRASTRUCTURE OF OUR CARE ECONOMY BY CREATING JOBS AND RAISING WAGES AND BENEFITS FOR ESSENTIAL HOME CARE WORKERS

Even before COVID-19, our country was in the midst of a caregiving crisis. In addition to caring for children, families feel the financial burden of caring for aging relatives and family members with disabilities, and there is a financial strain for people with disabilities living independently to ensure that they are getting care in their homes. At the same time, hundreds of thousands of people who need better care are unable to access it, even though they qualify under Medicaid. In fact, it can take years for these individuals to get the services they badly need. Aging relatives and people with disabilities deserve better. They deserve high-quality services and support that meet their unique needs and personal choices.

Caregivers – who are disproportionally women of color – have been underpaid and undervalued for far too long. Wages for essential home care workers are approximately $12 per hour, putting them among the lowest paid workers in our economy. In fact, one in six workers in this sector live in poverty. President Biden is calling on Congress to make substantial investments in the infrastructure of care in our country. Specifically, he is calling on Congress to put $400 billion toward expanding access to quality, affordable home- or community-based care for aging relatives and people with disabilities. These investments will help hundreds of thousands of Americans finally obtain the long-term services and support they need, while creating new jobs and offering caregiving workers a long-overdue raise, stronger benefits, and an opportunity to organize or join a union and collectively bargain. Research shows that increasing the pay of direct care workers greatly enhances workers' financial security, improves productivity, and increases the quality of care offered. Another study showed that increased pay for care workers prevented deaths, reduced the number of health violations, and lowered the cost of preventative care.

President Biden's plan will:

- **Expand access to long-term care services under Medicaid.** President Biden believes more people should have the opportunity to receive care at home, in a supportive community, or from a loved one. President Biden's plan will expand access to home and community-based services (HCBS) and extend the longstanding Money Follows the Person program that supports innovations in the delivery of long-term care.
- **Put in place an infrastructure to create good middle-class jobs with a free and fair choice to join a union.** The HCBS expansion under Medicaid can support well-paying caregiving jobs that include benefits and the ability to collectively bargain, building state infrastructure to improve the quality of services and to support workers. This will improve wages and quality of life for essential home health workers and yield significant economic benefits for low-income communities and communities of color.

INVEST IN R&D, REVITALIZE MANUFACTURING AND SMALL BUSINESSES, AND TRAIN AMERICANS FOR THE JOBS OF THE FUTURE

Half the jobs in our high growth, high wage sectors are concentrated in just 41 counties, locking millions of Americans out of a shot at a middle-class job. President Biden believes that, even in the face of automation and globalization, America can and must retain well-paid union jobs and create more of them all across the country. U.S. manufacturing was the Arsenal of Democracy in World War II and must be part of the Arsenal of American Prosperity today, helping fuel an economic recovery for working families. From the invention of the semiconductor to the creation of the Internet, new engines of economic growth have emerged due to public investments that support research, commercialization, and strong supply chains. President Biden is calling on Congress to make smart investments in research and development, manufacturing and regional economic development, and in workforce development to give our workers and companies the tools and training they need to compete on the global stage. Specifically, President Biden is calling on Congress to:

Invest in R&D and the technologies of the future:

Public investments in R&D lay the foundation for the future breakthroughs that over time yield new businesses, new jobs, and more exports. However, we need more investment if we want to maintain our economic edge in today's global economy. We are one of the few major economies whose public investments in research and development have declined as a percent of GDP in the past 25 years. Countries like China are investing aggressively in R&D, and China now ranks number two in the world in R&D expenditures. In addition, barriers to careers in high-innovation sectors remain significant. We must do more to improve access to the higher wage sectors of our economy. In order to win the 21st century economy, President Biden believes America must get back to investing in the researchers, laboratories, and universities across our nation. But this time, we must do so with a commitment to lifting up workers and regions who were left out of past investments. He is calling on Congress to make an $180 billion investment that will:

- **Advance U.S. leadership in critical technologies and upgrade America's research infrastructure.** U.S. leadership in new technologies—from artificial intelligence to biotechnology to computing—is critical to both our future economic competitiveness and our national security. Based on bipartisan proposals, President Biden is calling on Congress to invest $50 billion in the National Science Foundation (NSF), creating a technology directorate that will collaborate with and build on existing programs across the government. It will focus on fields like semiconductors and advanced computing, advanced communications technology, advanced energy technologies, and biotechnology. He also is calling on Congress to provide $30 billion in additional funding for R&D that spurs innovation and job creation, including in rural areas. His plan also will invest $40 billion in upgrading research infrastructure in laboratories across the country, including brick-and-mortar facilities and computing capabilities and networks. These funds would be allocated across the federal R&D agencies, including at the Department of Energy. Half of those funds will be reserved for Historically Black College and Universities (HBCUs) and other Minority Serving Institutions, including the creation of a new national lab focused on climate that will be affiliated with an HBCU.
- **Establish the United States as a leader in climate science, innovation, and R&D**. The President is calling on Congress to invest $35 billion in the full range of solutions needed to achieve technology breakthroughs that address the climate crisis and position America as the global leader in clean energy technology and clean energy jobs.

This includes launching ARPA-C to develop new methods for reducing emissions and building climate resilience, as well as expanding across-the-board funding for climate research. In addition to a $5 billion increase in funding for other climate-focused research, his plan will invest $15 billion in demonstration projects for climate R&D priorities, including utility-scale energy storage, carbon capture and storage, hydrogen, advanced nuclear, rare earth element separations, floating offshore wind, biofuel/bioproducts, quantum computing, and electric vehicles, as well as strengthening U.S. technological leadership in these areas in global markets.

- **Eliminate racial and gender inequities in research and development and science, technology, engineering, and math.** Discrimination leads to less innovation : one study found that innovation in the United States will quadruple if women, people of color, and children from low-income families invented at the rate of groups who are not held back by discrimination and structural barriers. Persistent inequities in access to R&D dollars and to careers in innovation industries prevents the U.S. economy from reaching its full potential. President Biden is calling on Congress to make a $10 billion R&D investment at HBCUs and other MSIs. He also is calling on Congress to invest $15 billion in creating up to 200 centers of excellence that serve as research incubators at HBCUs and other MSIs to provide graduate fellowships and other opportunities for underserved populations, including through pre-college programs.

Retool and revitalize American manufacturers and small businesses:
The U.S. manufacturing sector accounts for 70 percent of business R&D expenditure, 30 percent of productivity growth, and 60 percent of exports. Manufacturing is a critical node that helps convert research and innovation into sustained economic growth. Workers on the factory floor work hand-in-hand with engineers and scientists to sharpen and maintain our competitive edge. While manufacturing jobs have been a ladder to middle-class life, we have let our industrial heartland be hollowed out, with quality jobs moving abroad or to regions with lower wages and fewer protections for workers. President Biden is calling on Congress to invest $300 billion in order to:

- **Strengthen manufacturing supply chains for critical goods.** President Biden believes we must produce, here at home, the technologies and goods that meet today's challenges and seize tomorrow's opportunities. President Biden is calling on Congress to invest $50 billion to create a new office at the Department of Commerce dedicated to monitoring domestic industrial capacity and funding investments to support production of critical goods. The President also is calling on Congress to invest $50 billion in semiconductor manufacturing and research, as called for in the bipartisan CHIPS Act.
- **Protect Americans from future pandemics.** This funding provides $30 billion over 4 years to create U.S. jobs and prevent the severe job losses caused by pandemics through major new investments in medical countermeasures manufacturing; research and

development; and related biopreparedness and biosecurity. This includes investments to shore up our nation's strategic national stockpile; accelerate the timeline to research, develop and field tests and therapeutics for emerging and future outbreaks; accelerate response time by developing prototype vaccines through Phase I and II trials, test technologies for the rapid scaling of vaccine production, and ensure sufficient production capacity in an emergency; enhance U.S. infrastructure for biopreparedness and investments in biosafety and biosecurity; train personnel for epidemic and pandemic response; and onshore active pharmaceutical ingredients. COVID-19 has claimed over 500,000 American lives and cost trillions of dollars, demonstrating the devastating and increasing risk of pandemics and other biological threats. Over the past two decades, outbreaks of SARS, Ebola, influenza, Zika and others have cost billions in lost productivity. The risk of catastrophic biological threats is increasing due to our interconnected world, heightened risk of spillover from animals to humans, ease of making and modifying pandemic agents, and an eroding norm against the development and use of biological weapons. The American Rescue Plan serves as an initial investment of $10 billion. With this new major investment in preventing future pandemics, the United States will build on the momentum from the American Rescue Plan, bolster scientific leadership, create jobs, markedly decrease the time from discovering a new threat to putting shots in arms, and prevent future biological catastrophes.

- **Jumpstart clean energy manufacturing through federal procurement.** The federal government spends more than a half-a-trillion dollars buying goods and services each year. As a result, it has the ability to be a first-mover in markets. This incredible purchasing power can be used to drive innovation and clean energy production, as well as to support high quality jobs. To meet the President's goals of achieving net-zero emissions by 2050, the United States will need more electric vehicles, charging ports, and electric heat pumps for residential heating and commercial buildings. The President is calling on Congress to enable the manufacture of those cars, ports, pumps, and clean materials, as well as critical technologies like advanced nuclear reactors and fuel, here at home through a $46 billion investment in federal buying power, creating good-paying jobs and reinvigorating local economies, especially in rural areas.
- **Make it in ALL of America.** The President believes we must build social infrastructure to support innovation and productivity across the country. He is calling on Congress to invest $20 billion in regional innovation hubs and a Community Revitalization Fund. At least ten regional innovation hubs will leverage private investment to fuel technology development, link urban and rural economies, and create new businesses in regions beyond the current handful of high-growth centers. The Community Revitalization Fund will support innovative, community-led redevelopment projects that can spark new economic activity, provide services and amenities, build community wealth, and close the current gaps in access to the innovation economy for communities of color

and rural communities that have suffered from years of disinvestment. And, President Biden is calling on Congress to invest $14 billion in NIST to bring together industry, academia, and government to advance technologies and capabilities critical to future competitiveness. He is calling on Congress to quadruple support for the Manufacturing Extensions Partnership —increasing the involvement of minority-owned and rurally-located small- and-medium-sized enterprises in technological advancement.

- **Increase access to capital for domestic manufacturers.** America's manufacturing industry needs to innovate, adapt, and scale to win the industries of the future. President Biden is calling on Congress to invest more than $52 billion in domestic manufacturers. The President is calling on Congress to invest in existing capital access programs with a proven track record of success, with a focus on supporting rural manufacturing and clean energy. The President's plan also includes specific supports for modernizing supply chains, including in the auto sector, like extending the 48C tax credit program. He also will call for the creation of a new financing program to support debt and equity investments for manufacturing to strengthen the resilience of America's supply chains.
- **Create a national network of small business incubators and innovation hubs**. Almost all manufacturers (98 percent) are small- and medium-sized firms. Furthermore, small business ownership is a cornerstone of job creation and wealth building. However, even before the pandemic, many entrepreneurs struggled to compete in a system that is so often tilted in favor of large corporations and wealthy individuals. President Biden is calling on Congress to invest $31 billion in programs that give small businesses access to credit, venture capital, and R&D dollars. The proposal includes funding for community-based small business incubators and innovation hubs to support the growth of entrepreneurship in communities of color and underserved communities.
- **Partner with rural and Tribal communities to create jobs and economic growth in rural America.** Today, despite the fact that rural and Tribal communities across the country are asset-rich, more than 8 in 10 persistent poverty counties fall outside of a metropolitan area. President Biden's plan invests in rural and Tribal communities, including by providing 100 percent broadband coverage, rebuilding crumbling infrastructure like roads, bridges, and water systems, providing research and development funding to land grant universities, and positioning the U.S. agricultural sector to lead the shift to net-zero emissions while providing new economic opportunities for farmers. President Biden also is proposing to transform the way the federal government partners with rural and Tribal communities to create jobs and spur inclusive economic growth. Rural communities often don't have the same budget as big cities to hire staff needed to navigate and access federal programs. On top of that, they have to navigate a myriad of programs all with different purposes and requirements. As part of his plan to ensure that all communities recover – regardless of geography –

President Biden is proposing a $5 billion for a new Rural Partnership Program to help rural regions, including Tribal Nations, build on their unique assets and realize their vision for inclusive community and economic development. This program will empower rural regions by supporting locally-led planning and capacity building efforts, and providing flexible funding to meet critical needs.

Invest in Workforce Development:

As more Americans rejoin the workforce or seek out new opportunities in a changing economy, there is a greater need for skills development opportunities for workers of all kind. In order to ensure workers have ready access to the skills they will need to succeed, and to improve racial and gender equity, President Biden is calling on Congress to invest $100 billion in proven workforce development programs targeted at underserved groups and getting our students on paths to careers before they graduate from high school. His plan will:

- **Pair job creation efforts with next generation training programs.** President Biden is calling on Congress to invest in evidence-based approaches to supporting workers. This includes wraparound services, income supports, counseling, and case management, paired with high-quality training and effective partnerships between educational institutions, unions, and employers. Specifically, he is calling for a $40 billion investment in a new Dislocated Workers Program and sector-based training. This funding will ensure comprehensive services for workers, who have lost jobs through no fault of their own, to gain new skills and to get career services they need with in-demand jobs. Sector-based training programs will be focused on growing, high demand sectors such as clean energy, manufacturing, and caregiving, helping workers of all kinds to find good-quality jobs in an ever-changing economy.
- **Target workforce development opportunities in underserved communities**. Structural racism and persistent economic inequities have undermined opportunity for millions of workers. All of the investments in workforce training will prioritize underserved communities and communities hit hard by a transforming economy. President Biden also will call upon Congress to ensure that new jobs created in clean energy, manufacturing, and infrastructure are open and accessible to women and people of color. President Biden is calling on Congress to also specifically target funding to workers facing some of the greatest challenges, with a $12 billion investment. This includes $5 billion over eight years in support of evidence-based community violence prevention programs. He is calling on Congress to invest in job training for formerly incarcerated individuals and justice-involved youth and in improving public safety. He also is calling on Congress to tackle long-term unemployment and underemployment through a new subsidized jobs program. And, he is calling on Congress to eliminate sub-minimum wage provisions in section 14(c) of the Fair Labor Standards Act and

expand access to competitive, integrated employment opportunities and fair wages for workers with disabilities.

- **Build the capacity of the existing workforce development and worker protection systems**. The United States has underinvested in the workforce development system for decades. In fact, we currently spend just one-fifth of the average that other advanced economies spend on workforce and labor market programs. This lack of investment impacts all of us: better educated workers create spillover effects for other workers and lack of employment has negative social impacts on communities. President Biden is calling on Congress to invest a combined $48 billion in American workforce development infrastructure and worker protection. This includes registered apprenticeships and pre-apprenticeships, creating one to two million new registered apprenticeships slots, and strengthening the pipeline for more women and people of color to access these opportunities through successful pre-apprenticeship programs such as the Women in Apprenticeships in Non-Traditional Occupations. This will ensure these underserved groups have greater access to new infrastructure jobs. These investments include the creation of career pathway programs in middle and high schools, prioritizing increased access to computer science and high-quality career and technical programs that connect underrepresented students to STEM and in-demand sectors through partnerships with both institutions of higher education and employers. The President's plan also will support community college partnerships that build capacity to deliver job training programs based on in-demand skills. His plan will better tailor services to workers' job seeking and career development needs through investments in Expanded Career Services and the Title II adult literacy program. The President's plan includes funding to strengthen the capacity of our labor enforcement agencies to protect against discrimination, protect wages and benefits, enforce health and safety safeguards, strengthen health care and pensions plans, and promote union organizing and collective bargaining.

CREATE GOOD-QUALITY JOBS THAT PAY PREVAILING WAGES IN SAFE AND HEALTHY WORKPLACES WHILE ENSURING WORKERS HAVE A FREE AND FAIR CHOICE TO ORGANIZE, JOIN A UNION, AND BARGAIN COLLECTIVELY WITH THEIR EMPLOYERS

As America works to recover from the devastating challenges of a deadly pandemic, an economic crisis, and a reckoning on race that reveals deep disparities, we need to summon a new wave of worker power to create an economy that works for everyone. We owe it not only to those who have put in a lifetime of work, but to the next generation of workers who have only known an America of rising inequality and shrinking opportunity. This is especially important for workers of color and for women, who have endured discrimination and systematic exclusion from economic opportunities for generations. All of us deserve to enjoy America's promise in full — and our nation's leaders have a responsibility to overcome racial, gender, and other inequalities to make it happen. To that end, the President is calling on Congress to create new, good-quality union jobs for American workers by leveraging their grit and ingenuity to address the climate crisis and build a sustainable infrastructure. Increased unionization can also impact our economic growth overall by improving productivity. President Biden's plan will:

- **Empower Workers**. President Biden is calling on Congress to update the social contract that provides workers with a fair shot to get ahead, overcome racial and other inequalities that have been barriers for too many Americans, expand the middle class, and strengthen communities. He is calling on Congress to ensure all workers have a free and fair choice to join a union by passing the Protecting the Right to Organize (PRO) Act, and guarantee union and bargaining rights for public service workers. His plan also ensures domestic workers receive the legal benefits and protections they deserve and tackles pay inequities based on gender.
- **Create good jobs**. The President's plan demands that employers benefitting from these investments follow strong labor standards and remain neutral when their employees seek to organize a union and bargain collectively. He is asking Congress to tie federal investments in clean energy and infrastructure to prevailing wages and require transportation investments to meet existing transit labor protections. He also is calling for investments tied to Project Labor, Community Workforce, local hire, and registered apprenticeships and other labor or labor-management training programs so that federal investments support good jobs and pathways to the middle class. Finally, he is asking Congress to include a commitment to increasing American jobs through Buy America and Ship American provisions.
- **Protect workers**. President Biden is calling on Congress to provide the federal government with the tools it needs to ensure employers are providing workers with good jobs – including jobs with fair and equal pay, safe and healthy workplaces, and workplaces free from racial, gender, and other forms of discrimination and harassment. In addition to a $10 billion investment in enforcement as part of the plan's workforce proposals, the President is calling for increased penalties when employers violate workplace safety and health rules.

THE MADE IN AMERICA TAX PLAN

Alongside the American Jobs Plan, the President is proposing to fix the corporate tax code so that it incentivizes job creation and investment here in the United States, stops unfair and wasteful profit shifting to tax havens, and ensures that large corporations are paying their fair share.

The 2017 tax law only made an unfair system worse. A recent independent study found that

91 Fortune 500 companies paid $0 in federal corporate taxes on U.S. income in 2018. In fact, according to recent analysis by the Joint Committee on Taxation, the 2017 tax bill cut the average rate that corporations paid in half from 16 percent to less than 8 percent in 2018. A number of the provisions in the 2017 law also created new incentives to shift profits and jobs overseas. President Biden's reform will reverse this damage and fundamentally reform the way the tax code treats the largest corporations.

President Biden's reform will also make the United States a leader again in the world and help bring an end to the race-to-the-bottom on corporate tax rates that allows countries to gain a competitive advantage by becoming tax havens. This is a generational opportunity to fundamentally shift how countries around the world tax corporations so that big corporations can't escape or eliminate the taxes they owe by offshoring jobs and profits from the United States.
Together these corporate tax changes will raise over $2 trillion over the next 15 years and more than pay for the mostly one-time investments in the American Jobs Plan and then reduce deficits on a permanent basis:

- **Set the Corporate Tax Rate at 28 percent.** The President's tax plan will ensure that corporations pay their fair share of taxes by increasing the corporate tax rate to 28 percent. His plan will return corporate tax revenue as a share of the economy to around its 21st century average from before the 2017 tax law and well below where it stood before the 1980s. This will help fund critical investments in infrastructure, clean energy, R&D, and more to maintain the competitiveness of the United States and grow the economy.

- **Discourage Offshoring by Strengthening the Global Minimum Tax for U.S. Multinational Corporations.** Right now, the tax code rewards U.S. multinational corporations that shift profits and jobs overseas with a tax exemption for the first ten percent return on foreign assets, and the rest is taxed at half the domestic tax rate. Moreover, the 2017 tax law allows companies to use the taxes they pay in high-tax countries to shield profits in tax havens, encouraging offshoring of jobs. The President's tax reform proposal will increase the minimum tax on U.S. corporations to 21 percent and calculate it on a country-by-country basis so it hits profits in tax havens. It will also eliminate the rule that allows U.S. companies to pay zero taxes on the first 10 percent of return when they locate investments in foreign countries. By creating incentives for investment here in the United States, we can reward companies that help to grow the U.S. economy and create a more level playing field between domestic companies and multinationals.

- **End the Race to the Bottom Around the World.** The United States can lead the world to end the race to the bottom on corporate tax rates. A minimum tax on U.S. corporations alone is insufficient. That can still allow foreign corporations to strip profits out of the United States, and U.S. corporations can potentially escape U.S. tax by inverting and switching their headquarters to foreign countries. This practice must end. President Biden is also proposing to encourage other countries to adopt strong minimum taxes on corporations, just like the United States, so that foreign corporations aren't advantaged and foreign countries can't try to get a competitive edge by serving as tax havens. This plan also denies deductions to foreign corporations on payments that could allow them to strip profits out of the United States if they are based in a country that does not adopt a strong minimum tax. It further replaces an ineffective provision in the 2017 tax law that tried to stop foreign corporations from stripping profits out of the United States. The United States is now seeking a global agreement on a strong minimum tax through multilateral negotiations. This provision makes our commitment to a global minimum tax clear. The time has come to level the playing field and no longer allow countries to gain a competitive edge by slashing corporate tax rates.

- **Prevent U.S. Corporations from inverting or claiming tax havens as their residence.** Under current law, U.S. corporations can acquire or merge with a foreign company to avoid U.S. taxes by claiming to be a foreign company, even though their place of management and operations are in the United States. President Biden is proposing to make it harder for U.S. corporations to invert. This will backstop the other reforms which should address the incentive to do so in the first place.
- **Deny Companies Expense Deductions for Offshoring Jobs and Credit Expenses for Onshoring.** President Biden's reform proposal will also make sure that companies can no longer write off expenses that come from offshoring jobs. This is a matter of fairness. U.S. taxpayers shouldn't subsidize companies shipping jobs abroad. Instead, President Biden is also proposing to provide a tax credit to support onshoring jobs.
- **Eliminate a Loophole for Intellectual Property that Encourages Offshoring Jobs and Invest in Effective R&D Incentives.** The President's ambitious reform of the tax code also includes reforming the way it promotes research and development. This starts with a complete elimination of the tax incentives in the Trump tax law for "Foreign Derived Intangible Income" (FDII), which gave corporations a tax break for shifting assets abroad and is ineffective at encouraging corporations to invest in R&D. All of the revenue from repealing the FDII deduction will be used to expand more effective R&D investment incentives.
- **Enact A Minimum Tax on Large Corporations' Book Income.** The President's tax reform will also ensure that large, profitable corporations cannot exploit loopholes in the tax code to get by without paying U.S. corporate taxes. A 15 percent minimum tax on the income corporations use to report their profits to investors—known as "book income"—will backstop the tax plan's other ambitious reforms and apply only to the very largest corporations.

- **Eliminate Tax Preferences for Fossil Fuels and Make Sure Polluting Industries Pay for Environmental Clean Up**. The current tax code includes billions of dollars in subsidies, loopholes, and special foreign tax credits for the fossil fuel industry. As part of the President's commitment to put the country on a path to net-zero emissions by 2050, his tax reform proposal will eliminate all these special preferences. The President is also proposing to restore payments from polluters into the Superfund Trust Fund so that polluting industries help fairly cover the cost of cleanups.

- **Ramping Up Enforcement Against Corporations.** All of these measures will make it much harder for the largest corporations to avoid or evade taxes by eliminating parts of the tax code that are too easily abused. This will be paired with an investment in enforcement to make sure corporations pay their fair share. Typical workers' wages are reported to the IRS and their employer withholds, so they pay all the taxes they owe. By contrast, large corporations have at their disposal loopholes they exploit to avoid or evade tax liabilities, and an army of high-paid tax advisors and accountants who help them get away with this. At the same time, an under-funded IRS lacks the capacity to scrutinize these suspect tax maneuvers: A decade ago, essentially all large corporations were audited annually by the IRS; today, audit rates are less than 50 percent. This plan will reverse these trends, and make sure that the Internal Revenue Service has the resources it needs to effectively enforce the tax laws against corporations. This will be paired with a broader enforcement initiative to be announced in the coming weeks that will address tax evasion among corporations and high-income Americans.

These are key steps toward a fairer tax code that encourages investment in the United States, stops shifting of jobs and profits abroad, and makes sure that corporations pay their fair share. The President looks forward to working with Congress, and will be putting forward additional ideas in the coming weeks for reforming our tax code so that it rewards work and not wealth, and makes sure the highest income individuals pay their fair share.

###

Climate change: China aims for 'carbon neutrality by 2060'

By Matt McGrath
Environment correspondent

22 September 2020

COP26

EPA

China's President Xi Jinping addressing the UN via video link

China will aim to hit peak emissions before 2030 and for carbon neutrality by 2060, President Xi Jinping has announced.

Mr Xi outlined the steps when speaking via videolink to the UN General Assembly in New York.

The announcement is being seen as a significant step in the fight against climate change.

China is the world's biggest source of carbon dioxide, responsible for around 28% of global emissions.

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With global climate negotiations stalled and this year's conference of the parties (**COP26**) postponed until 2021, there had been little expectation of progress on the issue at the UN General Assembly.

However China's president surprised the UN gathering by making a bold statement about his country's plans for tackling emissions.

He called on all countries to achieve a green recovery for the world economy in the wake of the coronavirus pandemic.

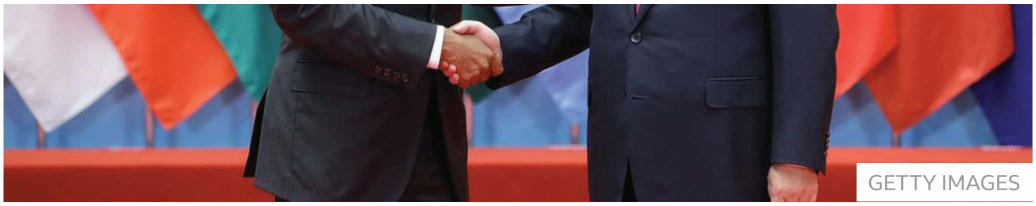
According to the official translation, Mr Xi went on to say:

"We aim to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060."

Until now China has said it would peak its emissions by 2030 at the latest, but it has avoided committing to a long-term goal.

Emissions from China continued to rise in 2018 and 2019 even as much of the world began to shift away from fossil fuels.

While the Covid-19 crisis this spring saw the country's emissions plunge by 25%, by June they had bounced back again as coal-fired plants, cement and other heavy industries went back to work.



In 2014 the US and China reached a surprise agreement on climate change

Observers believe that in making this statement at this time, the Chinese leader is taking advantage of US reluctance to address the climate question.

"Xi Jinping's climate pledge at the UN, minutes after President Donald Trump's speech, is clearly a bold and well calculated move," said Li Shuo, an expert on Chinese climate policy from Greenpeace Asia.

"It demonstrates Xi's consistent interest in leveraging the climate agenda for geopolitical purposes."

Back in 2014 Mr Xi and then US-President Barack Obama came to a surprise agreement on climate change, which became a key building block of **the Paris agreement signed in December 2015**.

Mr Xi has again delivered a surprise according to Li Shuo.

"By playing the climate card a little differently, Xi has not only injected much needed momentum to global climate politics, but presented an intriguing geopolitical question in front of the world: on a global common issue, China has moved ahead regardless of the US. Will Washington follow?"

There are many questions about the announcement that remain unanswered, including what is meant exactly by carbon neutrality and what actions the country will take to get there.

"Today's announcement by President Xi Jinping that China intends to reach carbon neutrality before 2060 is big and important news - the closer to 2050 the better," said former US climate envoy Todd Stern.

"His announcement that China will start down this road right away by adopting more vigorous policies is also welcome. Simply peaking emissions 'before 2030' won't be enough to put China on the rapid path needed for carbon neutrality, but overall this is a very encouraging step."


GETTY IMAGES

This week has seen the second lowest Arctic sea ice minimum on record

Most observers agreed that the announcement from China was a significant step, not least because of the country's role in financing fossil fuel development around the world.

"China isn't just the world's biggest emitter but the biggest energy financier and biggest market, so its decisions play a major role in shaping how the rest of the world progresses with its transition away from the fossil fuels that cause climate change," said Richard Black, director of the Energy and Climate Intelligence Unit (ECIU), a UK-based think tank.

"The announcement today is also a major fillip for the European Union, whose leaders recently urged President Xi to take exactly this step as part of a joint push on lowering emissions, showing that international moves to curb climate change remain alive despite the best efforts of Donald Trump and [Brazil's president] Jair Bolsonaro in the run-up to next year's COP26 in Glasgow."

Follow Matt on Twitter @mattmcgrathbbc

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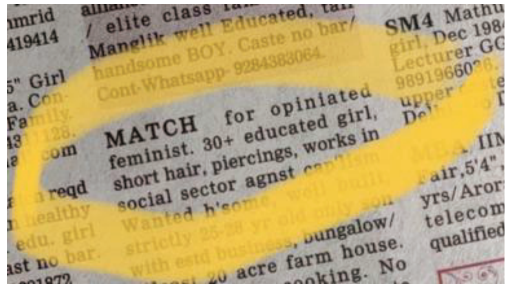

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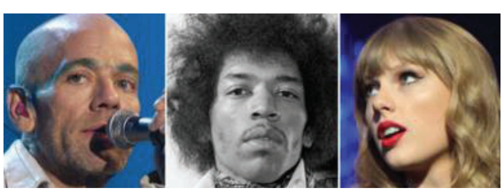

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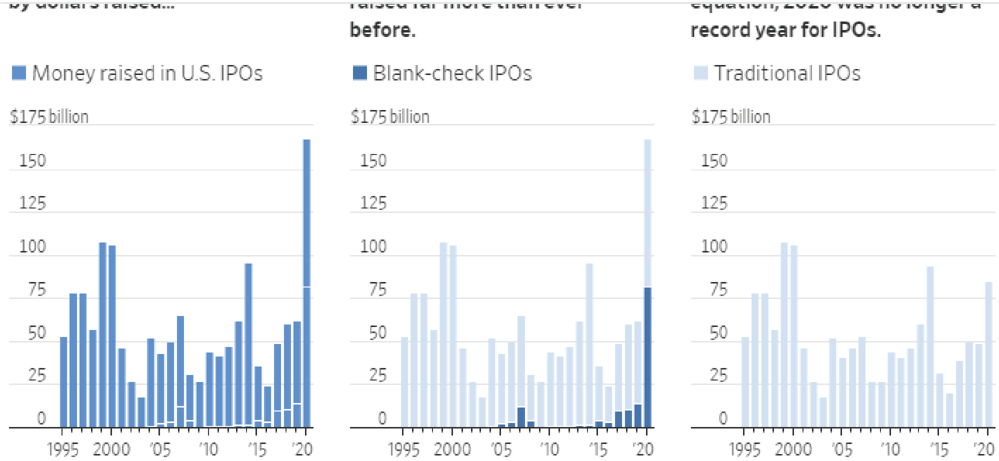
Baris Guzel

2020 was the year of EV SPACs and here are the 4 factors fueling the boom

Baris Guzel Jan 4 · 6 min read ★

2020 was the year where we saw the proliferation of SPACs (Special Purpose Acquisition Companies aka "blank-check companies"). As shown in the chart from the WallStreetJournal below, SPACs ended up raising far more money in 2020 than ever before. As of the date of this post, there are 220 SPACs with $70B+ in trust seeking acquisitions…



Note: 2020 data as of Dec. 24
Source: Dealogic

SPAC sponsors targeted companies in high growth industries, and some of these deals, especially in the EV (Electric Vehicles[1]) space, have been particularly successful. According to our own deal tracker, 20+ startups in EV space raised more than $10B via SPAC deals (incl. PIPEs) in 2020.

Mobility-related SPAC Deals

This list is maintained by Baris Guzel (baris@bmwiventures.com). Please feel free to drop a note if you have any suggestions.

										Select Investors			
SPAC	Target	Vertical	Revenues CY19 ($M)	Announced	Target Eq. Rollover ($M)	Proforma Enterpr. Value ($M)	Based on	SPAC Size ($M)	PIPE/ Round Size ($M)	Target	PIPE/ Round	Stock Price as of Jan 03	SPAC Performance (since inception)
VTIQ	**Nikola**	EV	-	Mar-3	$3,207	$3,324	1.0x of 2024E Revenues	$237	$525	CNH, ValueAct, NEL, Wabco	Fidelity, ValueAct and P. Schoenfeld	$15.26	53%
SHLL	**Hyliion**	EV	-	Jun-19	$1,000	$1,097	1.1x of 2023E Revenues/ (	$235	$325	Dana, Sensata Technologies, Axioma Ventures, New Era Capital Partners		$16.48	65%
GRAF	**Velodyne**	Lidar	$106	Jul-2	$1,472	$1,566	3.80x of 2023E Revenues/	$117	$150	Ford, Baidu, Inc., Nikon Corporation and Hyundai Mobis		$22.82	128%
SPAQ	**Fisker**	EV	-	Jul-13	$1,750	$1,900	0.6x of 2023E Revenues	$569	$500	Caterpillar Ventures, Golden Sand C	Moore Strategic Ventures, AllianceBe	$14.65	47%
DPHC	**Lordstown**	EV	-	Aug-3	$790	$965	0.3x of 2023E Revenues/ (	$280	$500	Workhorse Group	GM, Fidelity, Wellington, Federated H	$20.06	101%
HCAC	**Canoo**	EV	-	Aug-18	$1,750	$1,841	0.8x of 2025E Revenues	$309	$323	TPK Holdings and Yapeo	BlackRock, among other institutional	$13.80	38%
GMHI	**Luminar**	Lidar	-	Aug-24	$2,718	$2,900	3.5x of 2025E Revenues	$400	$170	Canvas Ventures, 1517 Fund, Peter	Alec Gores, Van Tuyl Companies, Pe	$34.00	240%
KCAC	**QuantumScape**	Battery	-	Sep-3	$3,688	$3,321	1.0x of 2027E Revenues	$230	$500	VW, Kleiner Perkins, Breakthrough E	Fidelity and Janus Henderson Invest	$84.45	745%
PIC	**XL Fleet**	EV	$7	Sep-18	$1,000	$1,087	1.5x of 2023E Revenues/ (	$232	$150	Constellation Technology Ventures, Oil and Gas Climate Initiative, IKEA G		$23.73	137%
SBE	**Chargepoint***	EV Infra	$147	Sep-24	$2,450	$2,401	1.7x of 2025E Revenues/ '	$317	$225	Braemar, Kleiner Perkins, Linse Cap	Baillie Gifford and Neuberger Berma	$40.08	301%
RMG	**RomeoPower**	Battery	-	Oct-5	$897	$993	1.3x of 2023E Revenues/ (	$234	$150	OpenDoor VC, BorgWarner, HG Ven	The Heritage Group and Republic Se	$22.49	125%
AMCI	**Advent Tech**	Battery	-	Oct-13	$250	$358	6.0x of 2023E Revenues/ 2	$153	$25	Dolphin Capital, ILPRA, Motivian, Systems Sunlight, Velti, Piraeus		$14.93	49%
IPV	**Aeva**	Lidar	-	Nov-2	$1,700	$1,803	2.0x of 2025E Revenues	$243	$120	Lux, Canaan, Silver Lake, Audi, Pors	Adage Capital and Porsche SE	$14.54	45%
CIIC	**Arrival**	EV	-	Nov-18	$5,338	$5,392	1.1x of 2023E Revenues/ (	$260	$400	Kinetik, Hyundai, Kia, UPS Ventures	Fidelity, Wellington, BNP Paribas, an	$28.12	181%
NGA	**The Lion Electric**	EV	-	Nov-30	$1,350	$1,500	0.4x of 2024E Revenues/ 2	$319	$200	BDC Capital, XPND Capital, Power (	Power Sustainable Capital (a wholly	$17.78	78%
CGRO	**Innoviz**	Lidar	-	Dec-10	$975	$1,033	1.8x of 2025E Revenues	$150	$200	China Merchants Capital, Softbank, /	Antara Capital, Magna International,	$14.29	43%
TPGY	**EVBox**	EV Infra	$73	Dec-10	$607	$969	6.7x of 2021E Revenues	$350	$325	ENGIE	BlackRock, Inclusive Capital Partner	$25.87	159%
GIK	**Lightning eMotors**	EV	-	Dec-11	$539	$651	0.56x of 2024E Revenues/	$202	$125	BP Ventures, Factor[e] Ventures, Ca	BP Technology Ventures	$13.18	32%
FIII	**Electric Last Mile S**	EV	-	Dec-11	$808	$1,196	1.0x of 2023E Revenues/ (	$250	$155	Sokon, Seres/ SF Motors	BNP Paribas Asset Management En	$13.54	35%
EXPC	**Blade**	eVTOL	$33	Dec-15	$356	$450	1.1x of 2024E Revenues	$275	$125	Colony Capital, Lerer Hippeau, Baro	KSL Capital Partners, Hedosophia, H	$11.08	11%
CLA	**Ouster**	Lidar	-	Dec-2	$1,500	$1,570	1.9x of 2024E Revenues/ '	$200	$100	Cox Automotive, Tao Capital, KilmaH	Cox Enterprises, Fontinalis Partners,	$13.50	35%
				Median	**$1,350**	**$1,500**		**$243**	**$200**				65%

* BiV portfolio company

Please find the link to the most up-to-date version of this tracker below.

Guzel (baris@bmwiventures.com). Please feel free to...

docs.google.com

All of these have been so far positively performing[2] (compared to the SPAC IPO price) with Quantumscape highest at $84.45 per share, representing a whopping 745% return above the SPAC initial offering price. First principles thinking would require all of us to ask the following question: why was 2020 the year of EV SPACs? As an ex-investment banker that helped advise companies on IPO and M&A transactions and as a VC investor with portfolio companies going through SPAC and IPO routes, here is my attempt to answer it. I believe that 2020 created a perfect storm for EV SPACs for a few reasons:

1. High volatility creating an environment hostile to the traditional IPO process

Volatility is a key topic for every startup that is contemplating an IPO. Good ECM (Equity Capital Markets) bankers would tell you that you would need a certain period of low volatility (less than ~20) for good pricing.

Source: Google Finance

In a traditional IPO process, a company goes through a 6+ month-long process and the price of the offering is decided during the final night before the IPO, which is affected by volatility. As seen above, the volatility has gone up sharply in 2020, which created a

Yes, these are billions of dollars left on the table. Essentially, 2020 made it more visible how broken the traditional IPO process is.

In comparison, a company gets the price at the beginning of a SPAC process after negotiating with SPAC sponsors. This provides more clarity and execution certainty. The SPAC process also allows tapping into larger funding pools thanks to PIPEs. In a nutshell… SPAC = growth round + IPO. These are all happening a fraction of the time needed for a traditional IPO. If you would like to learn more about the SPAC process (and compare it to the IPO process), please see another post I've put together earlier for some of our portfolio companies below:

A Primer for Going Public Via SPAC

With $4B raised, the largest Special Purpose Acquisition Company (SPAC) ever, Pershing Square Tontine Holdings Ltd…

medium.com

Also, I would highly recommend this excellent post by Bill Gurley:
https://abovethecrowd.com/2020/08/23/going-public-circa-2020-door-3-the-spac/

2. Historically low interest rate environment increasing risk appetite and making growth stocks more attractive

Given the unprecedented measures taken by the Federal Reserve, we are living in a historically low interest rate environment. As of the writing of this post, 10-year treasury bond yield is around 0.9%.

Source: Cnbc

Imagine, you are an investment professional at CalPERS or any other large institutional investor. In order to stay solvent, you would probably need to return at least a few percentages per year. Back in the day, you could do this by lending money to the US govt, which is assumed to be theoretically risk-free. During the early 1980s, this rate was above 10%! Now, the returns are much lower (the same applies for other fixed income investments), and you see a new asset class rising with SPACs, where early SPAC investors can gain substantial returns (again see the chart), what would you do? In a nutshell, historically low interest rate environments help increase the risk appetite for investors and attract everyone to high growth/tech stocks, which is the topic of the next factor.

3. Tesla's soaring stock price increasing interest in e-mobility

In 2020, Tesla's stock price had a meteoric rise of 696% YoY and made the company the largest auto manufacturer in the world by the market cap. Below is how Tesla's stock price increase compares to the tech's famous FAANG stocks, namely Facebook (FB), Amazon (AMZN), Apple (AAPL), Netflix (NFLX); and Alphabet (GOOG).

Source: Google Finance

made it clear that ESG would be a key priority going forward and a transformation is due. All in all, this helped fuel the excitement around EV startups and yes, Tesla was used as a comparable in these presentations to illustrate valuation multiples and growth projections.

4. Forward-looking projections making it easier to tell the story

As growth is the top-of-mind for investors, forward looking projections play a key role. During a traditional IPO process, there are many rules in place that limits the timing and dissemination of the disclosures and forward looking statements during an IPO (Ask your lawyers about "gun-jumping" and quiet periods). On the other hand, during a SPAC process, a target startup and SPAC sponsor can start promoting as soon as the reverse merger deal is announced and CNBC could turn into a video roadshow venue the next morning. These efforts and forward looking projections, typically showing substantial growth figures, are making it easier to tell the story and promote. Below is a slide from Quantumscape's deck illustrating sizable revenue projections down the road.

Source: Quantumscape Investor Deck

Unless there are any substantial changes in these factors, I would expect the SPAC boom to continue in 2021. Having said that, there are a few cautions we should

- Many of these companies are pre-revenue. As a result, the return profile of these investments will look more like a VC-style "power law" returns, where a small number of these will likely make a big chunk of the returns.
- Due to substantial economics, SPACs are attracting unusual sponsors with limited investment experience, such as celebrities and politicians, which could create an "ICO like" environment and hurt the reputation of SPACs as a class.
- Fundamentally, it comes down to the reputation and capabilities of the SPAC sponsors. Assessing a target company with very limited cash flow, operating history or revenues is no easy feat. Private Equity and, especially, Venture Capital investors are paid to do such analyses on a regular basis.

1. Please note that we're including Lidar startups in this bucket, as well.
2. Please note that we are excluding the warrants in our return calculations for simplicity purposes.
3. ESG (Environmental, Social and Governance) that is also known as "sustainable investing."

Baris is an engineer with work experiences in top-tier investment banking and venture capital. At BMW i Ventures, Baris has played a key role in the firm's investments in AutoFi (led Series B), Zūm (led Series C), Tekion (co-led Series B), Mapillary (led Series B, acquired by Facebook), Xometry (led Series B) and Vera (acquired by HelpSystems). Baris has also supported existing portfolio companies, including Life360 (ASX:360), Strivr and Moovit (acquired by Intel for ~$1B). Baris holds a Master of Engineering and Technology Management from Duke along with an MBA (Dean's Fellow & Full Tuition Waiver) from UNC Kenan-Flagler Business School, where he led VCIC, the world's largest venture capital competition. Please feel free to reach out on baris@bmwiventures.com or @BarisGSF over Twitter.

IPO Blank Check Startup Electric Vehicles Mobility

Status of COVID-19 Vaccines within WHO EUL/PQ evaluation process (20 January 2021)

er	Name of Vaccine	NRA of Record	Platform	EOI accepted	Pre-submission meeting held	Dossier accepted for review*	Status of assessment**
	BNT162b2/COMIRNATY (INN tozinameran)	EMA	Nucleoside modified mNRA	✓	✓	✓	Finalized
	Recombinant Novel Coronavirus Vaccine (CHO Cell)	NMPA	Recombinant protein subunit	Not accepted Product in Phase I/II			
	SARS-CoV-2 Vaccine, Inactivated (Vero Cell)	NMPA	Inactivated	Not accepted, still under development			
	AZD1222	Core – EMA Non-COVAX	recombinant replication defective chimpanzee adenovirus expressing the SARS-CoV-2 S surface glycoprotein	✓	✓	✓	In progress Core data Non-Covax. Covax data to be reviewed as EMA pos approval change
	AZD1222	MFDS KOREA	=	✓	✓	Tentative 18 and 29 Jan 2021 (CMC for SK Bio)	Core data (non-Covax in progress
es	Ad26.COV2.S	EMA	recombinant, replication-incompetent adenovirus type 26 (Ad26) vectored vaccine encoding the (SARS-CoV-2) Spike (S) protein	✓	✓	Rolling data to EMA: Dec, Feb, **Apr (critical data),** May ✓	Not yet started. Use abridged procedure relying on EMA
2	SARS-CoV-2 Vaccine (Vero Cell), Inactivated (InCoV)	NMPA	Inactivated, produced in Vero cells	✓	✓	End of Dec 2020	In progress
	SARS-CoV-2 Vaccine (Vero Cell), Inactivated	NMPA	Inactivated, produced in Vero cells	✓	✓	13Jan2021 (under screening)	
	Sputnik V	Russian NRA	Human Adenovirus Vector-based Covid-19 vaccine	Additional information submitted – under assessment	✓	22Jan2021 discussion on content and format	
Centre of ogy	EpiVacCorona	Russian NRA	Peptide antigen	Letter received not EOI			
	Ad5-nCoV		Recombinant Novel Coronavirus Vaccine (Adenovirus Type 5 Vector)	Additional information requested	26Jan 2021		
	mRNA-1273	EMA	mNRA-based vaccine encapsulated in lipid nanoparticle (LNP)	Expected in Feb 2021			
	Covishield (ChAdOx1_nCoV-19)	DCGI	recombinant ChAdOx1 adenoviral vector encoding the Spike protein antigen of the SARS-CoV-2	✓	08Jan 2021	13 Jan (Under screening)	
		NMPA	No pre-submission meeting yet				
		EMA	No pre-submission meeting yet				

re than one date is possible because of the rolling submission. Dossier is accepted for submission after screening of received submission
r screening; 2. Under assessment; 3. Waiting responses from the applicant. 4. Risk-benefit decision 5. Final decision made
is only an estimate because it depends on when all the data is submitted under rolling submission and when all the responses to the assessors' questions are submitted.
oducts Co Ltd
l Products Co-Ltd

Global and China Biomedicine Market 2012-2020: Market Size, Structure, Trends, Analysis and Forecast

Product Code: RP-ID-10085635

Published Date: 24 Feb 2020

Region: Global

Pages: 118

Category: Healthcare & Pharmaceuticals

Publisher: Pub-ID-26

Impact Analysis on the Growth of Market

Activating Probable Propositions Amidst COVID-19 Crisis

With things going haywire, we analyze key points to make sure that the businesses around the globe are completely prepared to tackle potential implications caused by COVID-19. Be it protecting employees, customers or the overall business operations, we ensure that the employers take the right decisions, make strategic investments and maintain a healthy work culture along with taking probable measures to minimize the financial loss.

The annual growth rate of

The annual growth rate of
world biomedicine market has been outpacing that of the overall pharmaceutical market in recent years and this trend will continue in the coming years with a steady 10.4% growth per annum by 2020. In particular, China's biomedicine market is expected to grow at an even higher rate (15% annually) over the forecast 2015-2020 period, driven by increasing and aging population, government initiatives and favorable policies, improving level of biotech and innovation, and increasing urbanization as well as household income in China.

Global and China Biomedicine Market 2012-2020: Market Size, Structure, Trends, Analysis and Forecast reviews the worldwide market of biological medicines and reagents with Chinese biomedicine market examined in detail specifically. With global economic, demographic, and healthcare profiles reviewed as market environments, this report provides market trend of world biomedicines for 2012-2020, market structure of product segments (Therapeutic Protein, Antibody, Vaccines, Blood Products, and Diagnostic Reagent), dynamics of biosimilar segment, geographic spread (North America, Europe, Asia Pacific region, Latin America and the rest of world), development highlights in global biomedicines market, and 20 profiled leading biomedicine manufacturers in the world.

Qualitative market analyses for Chinese biomedicine market include market growth drivers, restraints and challenges, emerging market opportunities, and competitive landscape. Based on biomedicine type, China's biomedicine market is segmented into Therapeutic Protein, Antibody, Vaccines, Blood Products, and Diagnostic Reagent, with the fast-growing generic biomedicines highlighted in particular. The nation's market is also analyzed by marketing channel and by region. The historic performance and benchmarked outlook for China's biomedicine imports, exports, and manufacturing industry are also provided with data available for 2010-2020 period. The major biological bases and clusters in China are revealed and 32 Chinese key biomedicine producers are profiled.

Key Players:

Pfizer, Inc.

Novartis International AG

Novartis International AG

Merck & Co., Inc.

F. Hoffmann-La Roche AG

Sanofi S.A.

Eli Lilly and Company

Selected Chinese companies:

Beijing Tiantan Biological Products Co., Ltd.

Shanghai Kehua Bio-engineering Co., Ltd

Staidson (Beijing) Biopharmaceuticals Co., Ltd.

Biotech Pharmaceutical Co., Ltd. (BPL)

Innovent Biologics, Inc.

Zhuhai Livzon MAB Biological Technology Company Ltd.

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Data Page | Published: 09 February 2021

DATA PAGE

Financing breaks all records in 2020

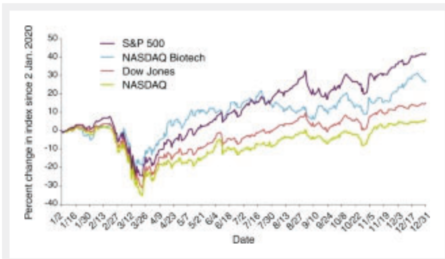
Laura DeFrancesco

Nature Biotechnology **39**, 133–134 (2021)

2020 stands out as one of the best years ever for biotech financing across the globe. Stock indices remained up through December. Initial public offerings (IPOs) had a banner year, with >73 life science firms raising collectively >$22 billion. Thirty-three biotech-related special purpose acquisition companies (SPACs) — shell companies making an IPO that present private biotechs with an alternative to going public without a costly traditional flotation — raised a whopping $6.3 billion. Private fundraising also mushroomed, with a 37% increase in funds flooding in compared to the previous year, and private equity firms like Blackstone Life Sciences continued to expand into venture financing. Only mergers were off compared to previous years, as pharma showed a greater interest in partnerships. Chinese biotechs continued to flex their muscles, with seven of the top ten IPOs originating in Asia (last year, the region accounted for only four), and three of the ten biggest venture rounds last year also included Chinese biotechs LianBio, Everest Medicines and Mabwell Biotechnology.

Stock market performance

Biotech stocks were up over 20% on the year.



Global biotech initial public offerings

All regions had nearly triple IPO funding.

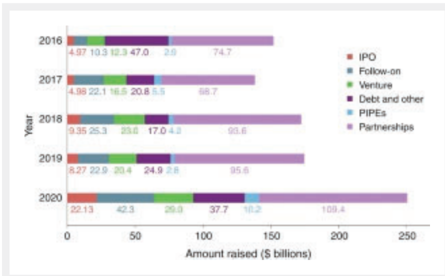
Number of IPOs

	2016	2017	2018	2019	2020
Asia-Pacific	18	13	28	40	44
Europe	23	26	16	8	14
Americas	25	33	56	46	73

1. Source: BCIQ BioCentury Online Intelligence

Global biotech financing

Money flowed into the sector from all avenues — none as great, though, as partnerships.



PIPE, private investment in public equity. Source: BCIQ BioCentury Online Intelligence.

Global biotech venture capital investment

All regions brought risk capital.

Number of rounds

	2016	2017	2018	2019	2020
Asia-Pacific	70	82	104	109	112
Europe	195	182	171	176	178
Americas	428	492	501	411	442

1. Source: BCIQ BioCentury Online Intelligence

IPOs

Company (principal underwriters)	Amount raised ($ millions)	Date completed	Country	Change in stock price (as of 1/12/2021
SK Biopharmaceuticals (NH Investment & Securities, Citigroup Global Markets)	799	2 July	South Korea	+21
AbCellera Biologics (Credit Suisse, Stifel, Nicolaus, Berenberg Bank, SVB Leerink, BMO Capital Markets)	555	15 December	Canada	–32
RemeGen (Morgan Stanley, Huatai Securities, J.P. Morgan Securities, UBS, BOCI Asia, BOCOM International, Haitong International, Zhongtai Financial International)	514	9 November	China	+ 60
Legend Biotech (Morgan Stanley, J.P. Morgan, Jefferies)	487	5 June	China	–21
Relay Therapeutics (Goldman Sachs, Cowen)	460	15 July	United States	+14
Everest Medicines (Goldman Sachs, Bank of America, Citibank, CICC, Credit Suisse, Nomura, Brocade River)	451	8 October	United States	+9.5
Akeso (Morgan Stanley)	383	23 April	China	+100
Genor Biopharma (Goldman Sachs, Jefferies, J.P. Morgan Securities, CMB International Capital, China Renaissance, Haitong International, Macquarie Capital)	371	6 October	China	Not available
Gan & Lee Pharmaceuticals (Qiming Venture Partners)	360	28 June	China	+46
Antengene (Goldman Sachs, J.P. Morgan, Citibank, CICC, CMB International Capital)	359	19 Nov	China	–5

1. Source: BCIQ BioCentury Online Intelligence

Licensing/collaboration

Researcher	Partner	Up-front cash ($ millions)	Description
Genmab	AbbVie	750	Genmab grants AbbVie rights to co-develop and commercialize bispecific antibody products outside of the United States and Japan

Researcher	Partner	Up-front cash ($ millions)	Description
Blueprint Medicines	Roche	1,702	Blueprint Medicines grants Roche exclusive rights to pralsetinib to treat non-small-cell lung cancer, thyroid cancers and solid tumors outside the United States, excluding Greater China
Seattle Genetics	Merck	600	Seattle Genetics partners with Merck to develop and commercialize cancer drugs ladiratuzumab vedotin and Tukysa (tucatinib)
Denali	Biogen	560	Denali partners with Biogen to develop and commercialize LRRK2 program for Parkinson's disease and certain TV platform–enabled programs for neurodegenerative diseases
Dragonfly Therapeutics	Bristol Myers Squibb	475	Dragonfly Therapeutics grants Bristol Myers Squibb exclusive, worldwide rights to develop and commercialize Dragonfly's IL-12 investigational immunotherapy program
uniQure	CSL Behring	450	uniQure grants CSL Behring exclusive, worldwide rights to develop and commercialize etranacogene dezaparvovec to treat hemophilia
Assertio Therapeutics	Collegium Pharmaceutical	375	Assertio Therapeutics grants Collegium Pharmaceutical US rights to Assertio's Nucynta (tapentadol) franchise for pain
Atea Pharmaceuticals	Roche	350	Atea Pharmaceuticals partners with Roche to develop and distribute AT-527 for COVID-19
Takeda	Arrowhead	300	Takeda and Arrowhead collaborate to co-develop and co-commercialize ARO-AAT for α1-antitrypsin-associated liver disease
Translate Bio	Sanofi	300	Sanofi partners with Translate Bio to develop COVID-19 mRNA vaccine and for other infectious disease indications for up to $1.9 billion
Apellis Pharmaceuticals	Orphan Biovitrum	250	Apellis Pharmaceuticals grants Swedish Orphan Biovitrum (Sobi) global co-development and exclusive ex-US commercialization rights to systemic pegcetacoplan (APL-2)

1. Source: BCIQ BioCentury Online Intelligence

Venture capital

Company (lead investors)	Amount raised ($ millions)	Round number	Country	Date completed

Company (lead investors)	Amount raised ($ millions)	Round number	Country	Date completed
Sana Biotechnology (Flagship Pioneering, Canada Pension Plan Investment Board, Baillie Gifford, F-Prime Capital Partners, Alaska Permanent Fund, GV, Bezos Expeditions, Omega Funds, Altitude Life Science Ventures)	700	Not disclosed	United States	23 June
Lyell Immunopharma (not disclosed)	493	C	United States	5 March
Grail (Flagship Pioneering, Canada Pension Plan Investment Board, Baillie Gifford, F-Prime Capital Partners, Alaska Permanent Fund, GV, Bezos Expeditions, Omega Funds, Altitude Life Science Ventures)	390	D	United States	6 May
CureVac (KfW)	337	Not disclosed	Germany	15 June
LianBio (BlackRock, Vida Ventures, Perceptive Advisors, Konstantin Poukalov, Venrock Healthcare Capital Partners, T. Rowe Price, Pfizer, Viking Global Investors, Wellington Management, RA Capital Management, Tybourne Capital Management)	310	Not disclosed	China	29 June
Mabwell Biotechnology (Shiyu Capital, Loyal Valley Capital, Ganzhou Development Investment Holding Group, Golden China Fund, Ningbo Gaoling Fund, Suzhou Ruihua, Nanshan National Fund)	279	A	China	29 April
Freeome (Perceptive Advisors, Janus Henderson Investors, Soleus Capital, Roche Venture Fund, Kaiser Permanente Ventures, Section 32, RA Capital Management, GV, EcoR1 Capital, Andreessen Horowitz, Cormorant Asset Management and others)	270	C	United States	28 August
Everest Medicines (Janchor Partners, RA Capital Management, Hillhouse Capital, Decheng Capital, Janus Henderson Investors, Rock Springs Capital, Octagon Capital, Guoxin Guotong Fund, CBC Group, Cormorant Capital, Pavilion Capital, HBM Healthcare Investments, existing investors)	260	C	United States	4 June
Thrive Earlier Detection (Section 32, Exact Sciences, Janus Henderson Investors, T. Rowe Price, Perceptive Advisors, Third Rock Ventures, Brown Advisory, Rock Springs Capital, Camden Partners, Invus, Lux Capital)	257	B	United States	29 July

Company (lead investors)	Amount raised ($ millions)	Round number	Country	Date completed
Recursion Pharmaceuticals (Leaps by Bayer, Data Collective, Epic Ventures, Catalio Capital Management, Casdin Capital, Obvious Ventures, Samsara BioCapital, Intermountain Ventures, Lux Capital, Two Sigma Ventures, Advantage Capital, Mubadala Capital Ventures US, Felicis Ventures)	239	D	United States	9 September

1. Source: BCIQ BioCentury Online Intelligence

Mergers and acquisitions

Target	Acquirer	Value ($ millions)	Date announced
Immunomedics	Gilead Sciences	21,000	13 September
MyoKardia	Bristol Myers Squibb	13,100	5 October
Qiagen	Thermo Fisher Scientific	11,500	3 March
Momenta Pharmaceuticals	Johnson & Johnson	6,500	19 August
Forty Seven	Gilead Sciences	4,900	2 March
Principia Biopharma	Sanofi	3,680	17 August
VelosBio	Merck	2,750	5 November
Aimmune Therapeutics	Nestlé	2,600	13 August
Asklepios BioPharmaceutical	Bayer	2,000	26 October
Portola Pharmaceuticals	Alexion	1,176	5 May

1. Source: BCIQ BioCentury Online Intelligence

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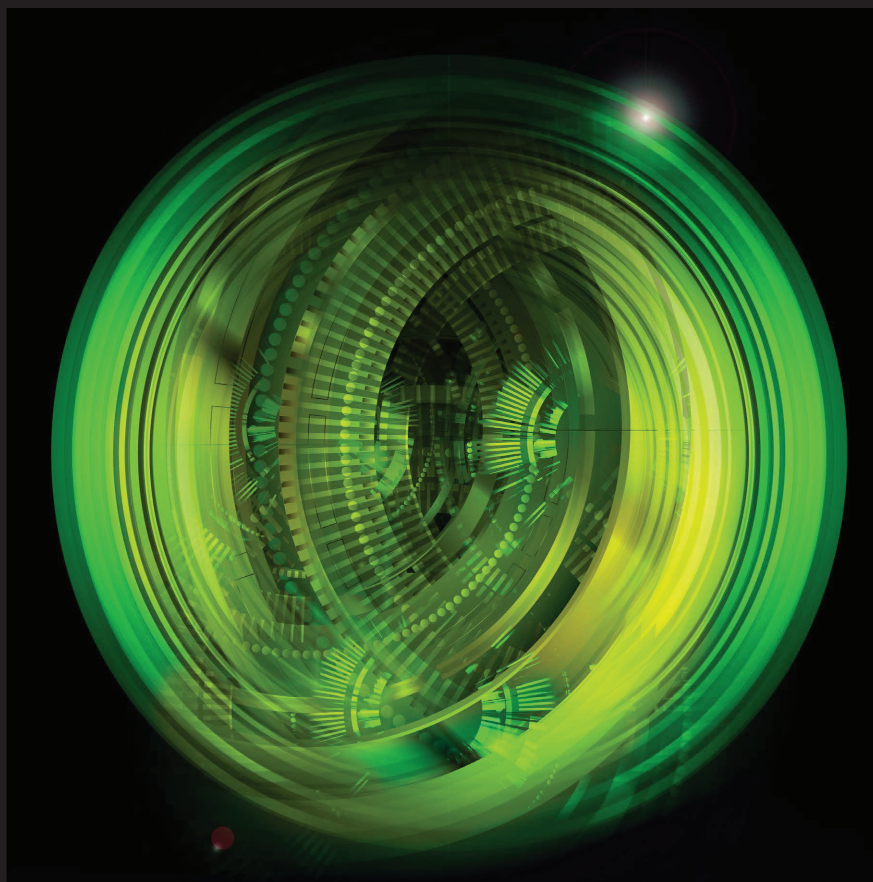


2021 outlook for the US telecommunications, media, and entertainment industry

Deloitte Center *for*
Technology, Media &
Telecommunications

Interview with Kevin Westcott

Heading into 2021, the COVID-19 pandemic will continue to shape business strategies throughout the telecommunications, media, and entertainment sector.

In media and entertainment, the pandemic has accelerated many trends that were already underway. For example, with theaters closed or allowing only limited attendance, major studios increasingly are making first-run movies available direct-to-consumer via streaming services. In addition, as consumption of streaming content rises, we've seen growth not just in the number of subscription services, but also in ad-supported models designed to satisfy increasingly cost-conscious consumers. What's more, customer retention (versus acquisition) has become top of mind—making it important that providers offer a broad range of content: video, music, games, and even podcasts. This new reality places a premium on understanding consumer behavior patterns and developing a more nuanced approach to engaging with customers. As consumers experiment with their entertainment options, we strongly encourage providers to adopt new strategies and agile approaches for content development, aggregation, and delivery.

We expect that telecommunications companies will continue to provide the bedrock for other industries to recover and thrive in 2021. Telecom providers have an opportunity to shape a new future for businesses and consumers on the strength of advanced wireless technologies such as 5G. We believe that the move to next-generation networking has the potential to transform how industries operate—creating competitive advantage and unlocking new opportunities for innovation. Telecommunications providers should help their customers envision what is possible through new 5G-enabled use cases that can truly disrupt their industries. They should shift their conversations from focusing on technical capabilities to what types of specific outcomes and benefits they can help enable for others with 5G. As enterprise 5G adoption grows and edge computing advances, this is likely going to require telecommunication companies to bring lots of different capabilities and partners together to address the opportunity. We look forward to seeing how this unfolds in the coming year.

Kevin Westcott
Vice chairman, US Tech, Media & Telecom leader
Deloitte LLP

Key takeaways
In 2021, telecommunications, media, and entertainment organizations should consider three key strategic opportunities both to recover from the COVID-19 crisis and to boldly position themselves to thrive in the future:

- **Renewing** the focus on customers' needs by taking a more nuanced approach to customer engagement.
- **Converging and remixing entertainment experiences** through new service offerings and entertainment bundles—and by adopting new strategies that can enable business agility.
- **Repositioning to monetize advanced wireless networks** through new products, services, and business models.

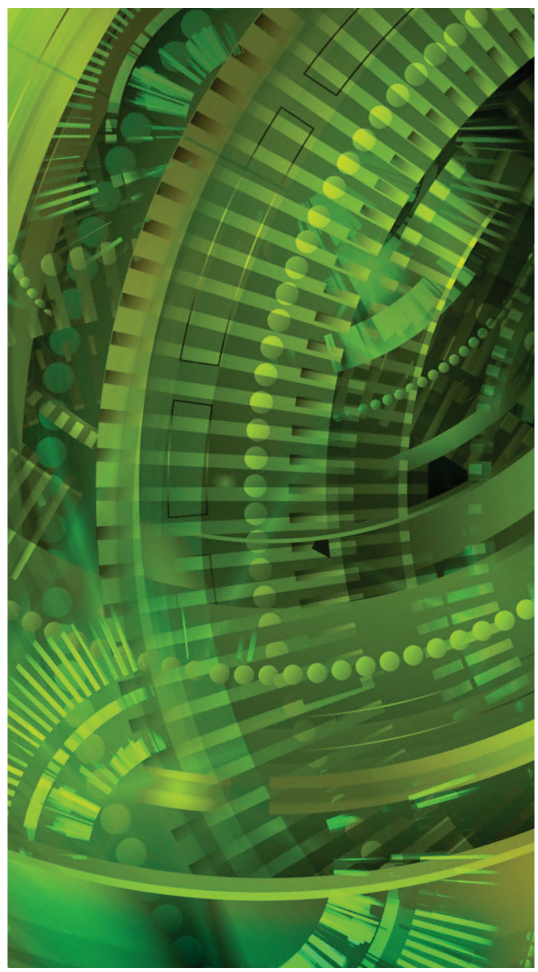
About the series
Deloitte's 2021 outlooks for the US technology, media, and telecommunications (TMT) industry seek to identify the strategic issues that TMT organizations should consider in the coming year, including their impacts, key actions to take, and critical questions to ask. The goal is to equip US TMT organizations with the information needed to position themselves for a strong, resilient future.

Three critical issues for the telecommunications, media, and entertainment industry to consider in 2021

1. **Renewing the focus on customers' needs**
   Streaming providers should move past simply focusing on cost and content by becoming more nuanced in their customer engagement. To improve retention, they should address customers' challenges and preferences though content windowing, tiered pricing, tailored services, and social experiences.

2. **Converging and remixing entertainment experiences**
   The COVID-19 pandemic has accelerated consumers' willingness to experiment with their entertainment options. The hard lines that used to exist between content and distribution channels are increasingly blurring. The coevolution of entertainment and technology is helping fuel new service offerings and entertainment bundles for consumers—necessitating new strategies and agile approaches for companies and creators.

3. **Repositioning to monetize advanced wireless networks**
   Although consumer and enterprise adoption of advanced wireless technologies like 5G is still nascent, the shift to next-generation networking is undeniably underway. The key for telecom providers is determining how they can leverage these new technologies to create new products, services, and business models that drive revenue growth.



1. Renewing the focus on customers' needs

It is important for M&E companies to understand consumer needs and behavior patterns in order to develop services that both attract and retain customers.

They should understand the economic needs of consumers. The COVID-19 pandemic has imposed severe economic constraints on millions of consumers: 39% of respondents to Deloitte's COVID-19 *Digital media trends survey* reported a decrease in their household income since the pandemic began. Consumers who lost income during the pandemic were more than twice as likely to cancel a streaming service because of cost compared with those whose income was unchanged.[1]

They also should understand consumer needs around content. As we enter 2021, original content will almost certainly remain the No. 1 factor driving consumer adoption and cancellation of streaming services.[2] The challenge then becomes how to retain those customers before they seek other streaming options. As a result, the next level of focus should be on consumer experience: How do I attract you with original content, but then retain you by knowing more about you as a customer?

The churn rate among OTT services in the United States rose from 35% in Q1 2019 to 41% in Q1 2020.[3]

The implications for M&E companies are clear: Customers want tailored options in terms of content and pricing. Therefore, while the availability of original content is typically critical for attracting customers, a broad content library and tiered pricing (including free, ad-supported offerings) are increasingly essential for retaining them.

Key opportunities for growth

To achieve success in 2021 and beyond, streaming providers should meet their customers where they are, both financially and with highly desirable content. This may mean that having great original content won't be enough in the long term and they should offer a broader array of other entertainment services as well.

To address US consumers' concerns about the cost of streaming services, providers are increasingly offering ad-supported video streaming services (AVOD) as an alternative to paid subscriptions. According to Deloitte's *Digital media trends survey*, 47% of American consumers are watching at least one free ad-supported streaming video service, such as Pluto TV, Tubi, and the Roku Channel (18% growth since the pandemic began).[4]

Sixty-five percent of respondents to Deloitte's *Digital media trends survey* say they're comfortable watching ads to eliminate or reduce subscription costs and that, given a choice, they prefer ad-supported options for watching streaming video services.[5] In addition, 37% say they appreciate the broad range of shows and movies available on free services.[6]

AVOD delivers three other key benefits:

- It can help streaming video services appeal to a wide range of viewers. Free ad-supported video appeals to thrifty baby boomers and matures, who prefer free streaming options by 58% and 65%, respectively, over subscription-based options.[7] Free or discounted AVOD services may also appeal to women, who are facing more financial hardship than men during the COVID-19 pandemic.[8]
- Ad-supported tiers can help fund pricey content. Given the escalating cost of producing original TV series (up to $25 million per episode) and exclusive streaming rights for sports leagues, streaming services may need to combine subscriptions and ads for "ultra-premium" content to make the numbers work.[9]
- It can deliver better data points for targeting consumers.[10] Ad experts and Wall Street analysts believe that the industry is in the middle of a strategic shift from linear to streaming buys.[11]

Increasingly, customer retention will depend upon having a single platform capable of satisfying a wide range of entertainment desires. So, rather than focusing solely on streaming video, providers should explore potentially adding games, music, and podcasts to their suite of offerings or partnering with other providers:

- Since the COVID-19 pandemic began, 48% of US consumers have participated in some form of video gaming activity. In addition, 29% of US consumers say they are more likely to use their free time to play a video game than to watch a video.[12] In 2020, the global video game market was expected to reach $159 billion.[13]
- US paid subscription-based music streaming revenues grew from $1.2 billion in 2015 to $5.9 billion in 2019, a compound annual growth rate of 49%.[14] Deloitte's *Digital media trends survey* revealed that 12% of US consumers added a paid music streaming service during the early stages of the pandemic.[15]
- Podcast-based advertising spending was estimated to rise from $678.7 million in 2019 to $863.4 million in 2020.[16] By helping to satisfy consumers' demand for original content, podcasts now reach more than 100 million Americans every month—an audience that is becoming increasingly diverse.[17]

Key challenges to overcome

To continue to attract, delight, and retain customers in 2021 and beyond, M&E companies will likely need to surmount several challenges, beginning with ensuring a steady stream of high-quality content. Of course, amid the pandemic, this means finding innovative ways to quickly and safely return to the production of that content.[18]

It's also imperative that M&E companies continue to build their capabilities to harness customer data to deliver highly relevant content recommendations and targeted advertising. This should happen whether customers are using a subscription-based service or a free ad-supported offering. Thanks to dynamic advertising technologies, brands can serve each customer with individualized ads based on their data and profile.

Armed with better and more actionable customer data, M&E companies can offer personalized video content, music, games, and podcasts as well. When a consumer gets a relevant recommendation for a song or game, and they get value from the interaction, they are more likely to stick around. To provide a high level of value, M&E companies should work toward strong integration and a seamless user experience among all the content and services they provide.

Although the flow of new entrants may be waning, competitive pressures will likely only increase in the coming year. Media providers are challenged to meet consumer demand for original content, a broad array of other content options, and a mix of subscription and free ad-supported services. For many M&E companies, this may require significant investments in in both technology and content, including potential mergers and acquisitions.

Ultimately, success will likely come down to providing the best overall customer experience possible—one that is built on a strong foundation of compelling content and tailored recommendations, advertising, and services. This approach can help create customer relationships that last years, not weeks.

Actions companies should take now

- Explore new business models and technologies that foster a deeper understanding of consumer behavior and better consumer engagement.
- Lead with original content: 45% of US subscribers say that they paid for a specific streaming video service to watch new original content not available anywhere else.[19]
- Meet customers where they are by offering a broad set of options (video, music, games, podcasts, and more), available via a mix of subscription and free ad-supported services.
- Redefine relationships with advertisers to target consumers with more highly tailored content and advertising.

Strategic questions to consider

- How can studios and publishers enable faster experimentation with content and delivery? How can they quickly test new behaviors and segments with minimal risk?
- How will consumers adapt to lost income and lower pay if the economic recovery is slow? Will they cut paid services and move to free options?
- How will ad-supported models evolve as consumers demand more pricing options?

2. Converging and remixing entertainment experiences

Convergence isn't just for streaming video providers. All M&E companies should think about moving beyond stand-alone products and embrace aggregation of content through both subscription and ad-based services. But to take the next step, they may also need to reimagine what shows, movies, games, and concerts actually look like. These lines are already blurring, and there's likely more to come in the near future.

As the coevolution of entertainment and technology continues, it will likely demand new strategies and agile approaches for companies and creators. This is especially true when it comes to 5G, which promises to drive even greater convergence among video, games, and music thanks to its faster speeds and lower latency. When combined with advances in artificial intelligence, augmented and virtual reality, and location-based services, 5G has the potential to redefine entertainment and accelerate remixing.

One innovative example of a remixed entertainment experience can be seen in how musicians have pioneered a new channel for releasing music: video games. Rapper Travis Scott staged a virtual concert within the video game *Fortnite* that attracted 27.7 million unique players, making it Epic Games' most successful in-game event ever and helping to launch the rapper's newest single, "The Scotts," to No. 1 on the Billboard Hot 100. Meanwhile, in Block by Blockwest, a virtual music festival inside the *Minecraft* video game, nearly 30 bands performed across three stages (servers) during an event streamed by 134,000 users.[20]

Key opportunities for growth

While the convergence of content and distribution channels has been apparent for some time, the COVID-19 pandemic sent this trend into overdrive. One of the prime examples is the decision by several studios to release first-run movies directly to streaming video services. Box-office revenues have been declining for years as consumers watch more films from home on streaming video services. With COVID-19 closing theaters, some studios released movies directly to consumers. In the short term, this approach helps studios to counter the closure of theaters due to the pandemic. It could also serve a more strategic purpose: providing a powerful hook for acquiring and retaining customers on subscription-based video streaming platforms.

Of course, no one knows how the coming months will further shift viewers' actions and preferences. And newly established digital movie-viewing trends (and success stories) have raised new questions around movie releases, particularly with studios experimenting with releasing films exclusively to certain direct-to-consumer streaming services. Will premium video on demand (PVOD) become a viable alternative release method for all or just some cinematic productions? Is there a balance to be struck that supports theater owners and studios? Will PVOD have long-term consequences for the economics of film production? The COVID-19 pandemic and its impact on the movie industry has challenged the typical notions around theatrical launches. In the future, studios will probably take a portfolio approach to movie distribution rather than a one-size-fits-all strategy.

The pandemic also helped boost the popularity of esports on social media. In addition, early in the pandemic, esports helped fill the void created by the disappearance of traditional sports on television. One event, the eNASCAR iRacing Pro Invitational Series on Fox Sports 1, attracted 1.6 million unique viewers—certainly respectable for Sunday afternoon cable TV programming.[21] Other examples include broadcasts of *Madden NFL 2020* on Fox Sports 1, *NBA 2K* on ESPN, and *League of Legends* Spring Split Playoffs on ESPN.[22] Esports delivers several key benefits to television networks, including the ability to attract younger audiences (19% of millennials watch virtual sports[23]), establish a foothold in the online world versus alternatives like Twitch and YouTube, and evolve as providers of interactive live content.[24]

Another trending remix opportunity is the online "watch party"—groups of people viewing movies and other video content together on their favorite social media platforms. By late June 2020, almost one-fifth of US adults aged 18 and older had participated in a watch party, according to market research firm Maru/Matchbox. Nearly two-thirds of those who had hosted watch parties said they'd had one within the past month.[25]

Key challenges to overcome

M&E companies will face difficulties expanding and converging their content and service offerings and building new entertainment remixes on top of that. Some companies will already have all the pieces available. They should focus on developing user environments that feel like one seamless ecosystem. For companies accustomed to developing and marketing stand-alone offerings, this new approach may represent a challenge. For companies that don't have all the pieces, they should acquire what they need or find partners who can provide it.

For new, recent behaviors, like watch parties, technology developers and M&E companies should ascertain whether emerging trends are likely to continue after the pandemic wanes and people start spending fewer evenings at home.

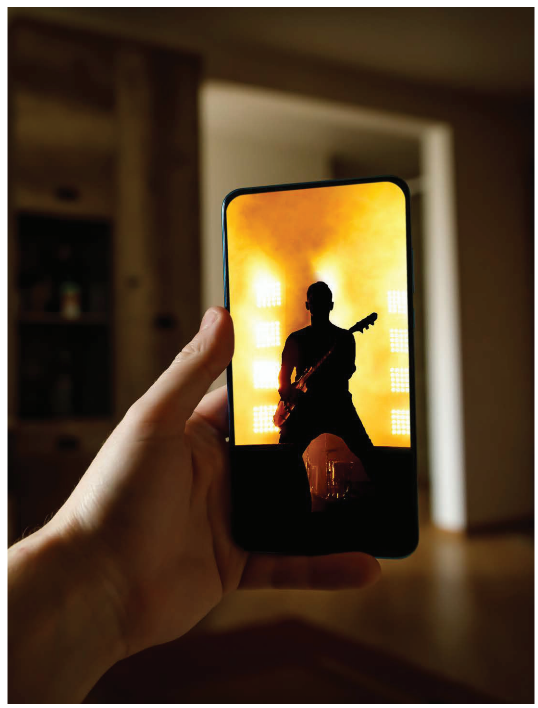
And, while video games present exciting possibilities for musicians, few video game platforms currently support video concerts. In addition, to make virtual concerts accessible to everyone, technical issues such as latency should be addressed. One potential solution is software that enables remote recording in a studio. Similar software could be adopted within video game platforms for livestreaming audio.[26]

Actions companies should take now

- Prepare for new consumer behaviors that may become permanent.
- In particular, explore opportunities in the areas of direct-to-consumer offerings like PVOD, as well as crossover services such as watch parties, music within video games, and esports on broadcast TV.
- Seek ways to make more relevant content easier to discover and access.
- Anticipate where consumers want a new experience, not just a better version of what they have today.

Strategic questions to consider

- How can M&E companies use multichannel, social, and other platforms to create more intimate live experiences? What kinds of new storytelling might these tools enable?
- How could livestreaming expand access to audiences (and revenues) for events while building in options to respond more effectively to disruptions? Are there contractual provisions that allow for multiple distribution scenarios?
- How can content providers offers seamless experiences as customers move among video content, games, podcasts, music services, social channels, and more?



3. Repositioning to monetize advanced wireless networks

US telecommunications networks did an excellent job of adapting to (and driving) changes to how people live, work, learn, and play since the COVID-19 pandemic. By enabling these new modes of communication, telecommunications providers will likely serve as the bedrock of companies' ability to recover and thrive in 2021 and beyond—across industries.

In the coming year, however, telecommunications companies should have an even larger role to play as 5G wireless technology begins to gain traction among enterprises and consumers alike. In particular, 5G promises to provide enterprises with unprecedented, real-time visibility, insights, and control over their assets, products, and services. It can also provide new opportunities to radically transform how they operate and deliver new products and services.

In many ways, this represents a major shift for telecommunications companies. While the telecom playbook for upgrading consumers to next-generation wireless technologies is already proven, providers now should develop a business model for addressing enterprise markets, which stand to benefit from advanced wireless technologies like 5G. This will likely involve exploring and developing new operating and business models that require greater collaboration with third-party partners to deliver end-to-end enterprise applications that meet the disparate needs of specific industries.

Because 5G will likely trigger innovative business models that gain large-scale adoption, telecom providers should strive to help enterprise customers gain first-mover advantages in defining and developing the innovative business models that can disrupt their industries.

The good news for telecom providers and technology companies is that most businesses already understand the importance of harnessing advanced wireless network technologies to spur future growth. In Deloitte's recent study of advanced wireless adoption, "Enterprises building their future with 5G and Wi-Fi 6," those that are using and testing 5G and/or Wi-Fi 6 see the immense potential—86% of surveyed networking execs believe that advanced wireless will transform their organization within three years, and 79% say the same about their industry.[27]

More than nine in 10 of these networking executives regard advanced wireless technologies as "very" or "critically" important to their business success today.[28]

The market opportunity is vast: The GSMA estimates that 5G will generate $700 billion in economic value,[29] with enterprises representing 68% of the market, led by retail, government, and finance applications.[30]

Key opportunities for growth

5G capabilities have the potential to revolutionize every industry, from manufacturing to health care to government. To enable the full promise of advanced wireless technologies like 5G, telecom providers should do more than simply deliver the communications network—it's essential that they bring together all of the required capabilities as well. This often involves integrating edge computing capabilities with a variety of Internet of Things (IoT) devices, such as sensors.

5G connectivity and edge computing go hand in hand: 5G networks migrate computer processing (typically hosted in the cloud) closer to the edge where data is generated, analyzed, and acted upon. The edge can be located anywhere, including on-premises at an enterprise location. Together, 5G connectivity, compact computing power, and AI combine to create the intelligent edge, a versatile foundation for unlocking the full potential of IoT and Industry 4.0.[31]

In the retail industry, the intelligent edge can enable powerful use cases such as smart shelves, cashierless shopping, digital signage, dynamic pricing, and contactless shopping. In addition to enhanced retail experiences, the intelligent edge is expected to fuel use cases such as smart warehouses and virtual medicine.

According to ABI Research, syncing of edge servers with telecommunications infrastructure represents a $54 billion opportunity by 2024.[32] In addition, IDC predicts that in two years, 45% of IoT-generated data will be stored, processed, analyzed, and acted upon close to or at the edge of networks. By enabling data aggregation and processing at the edge, companies can achieve bandwidth savings while also reducing latency and improving reliability.[33]

Key challenges to overcome

On the enterprise side, telecommunications providers should resolve a dilemma in terms of the intelligent edge. While some providers believe that they can generate more revenue by partnering with internet giants, others worry that their role would be limited to that of connectivity partner—in effect, acting merely as a stepping-stone for hyperscalers and cloud giants. Providers realize that they should act fast by either integrating vertically or by leveraging horizontal capabilities. One of their challenges is determining how to build upon their current business structure so that they're in the driver's seat.[34] Telecom providers also face increased competition from industrial solution providers like Bosch and Siemens, both of which are developing their own edge services.[35]

Another challenge is dealing with the significant costs of making 5G operational. Many providers are concerned not only about the steep up-front investment to build the 5G network, but also about the time horizon required to realize the return on their investments.[36] With governments demanding higher prices for 5G spectrum, service providers could be left with no option but to let consumers pay for all or a major part of it.[37]

Networking executives' biggest concern with regard to adoption of advanced wireless technologies is security.[38] High bandwidth and increased speed provide hackers with even more opportunities to manipulate the network.[39] Devices using 5G technology can potentially bypass the cybersecurity platforms operational for 4G technology, giving cybercriminals a platform to launch cyberattacks.[40]

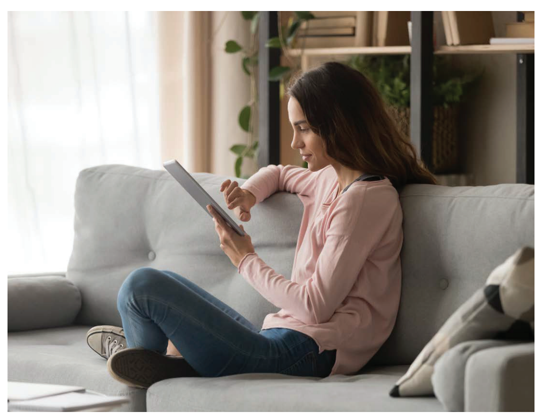
Finally, due to decreased in-store traffic due to the pandemic, online interfaces have become an integral part of consumer buying journey for telecom providers. It is therefore essential that telecommunications companies offer as many touchpoints as possible to improve the customer experience and satisfaction.[41] In terms of the in-store experience, telecommunications providers should explore how technologies that enable greater safety (such as "contactless" environments) can tie into rewards programs, consumer engagement opportunities, and exclusive experiences.

Actions companies should take now

- Focus on the benefits and outcomes of adopting advanced wireless technologies like 5G rather than on the technology itself.
- Leverage advanced wireless technologies such as 5G to develop enterprise applications that are truly industry-specific.
- Develop a better understanding of customers' usage patterns, with an eye toward strengthening the value proposition.
- Reassess all of the ways that customers transact with the business, with a focus on both the channel mix and the ability to meet customer needs (for example, by offering "contactless" inventory and checkout).

Strategic questions to consider

- Should we capitalize on the enterprise customer's current emphasis on secure, high-quality connectivity to accelerate the introduction of new products and services, such as 5G, Wi-Fi 6, and edge computing?
- Do we have the proper capabilities to manage a significant customer shift to digital-first customer service and support models?
- Is there an opportunity to strengthen and promote lower-cost, self-service online sales and service channels to customers? How do we encourage our customers to turn first to lower-cost digital channels?
- Which forms of connectivity and what types of data and applications are customers using? Can we use this information to understand network constraints and allocate future investments accordingly?



Looking boldly to the future

In spring 2020, a couple of months into the COVID-19 pandemic, we stated that the pandemic had exacerbated structural challenges and trends that media and entertainment companies have faced for a long time. We added that leaders have a rare opportunity to rebuild the industry to create a new future in which M&E companies can grow and thrive.

On the telecommunications side, we pointed out that service providers have an opportunity to play a key role in the recovery from COVID-19; that in a world of social distancing, network connectivity may prove to be the bedrock underpinning our society, mitigating the pandemic's negative impact by allowing us to stay in touch with our communities.

Heading into 2021, it is critical for M&E companies to understand consumer behavior patterns and develop a more nuanced approach to engaging with customers. As consumers experiment with their entertainment options, providers should continually adopt new strategies and agile approaches for content development and delivery.

At the same time, telecom providers can shape a new future for businesses and consumers on the strength of advanced wireless technologies such as 5G. This shift to next-generation networking has the potential to transform how industries operate.

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Relevant insights

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Networks, Technologies & Spectrum Snapshot

March 2021

LTE and 5G Market Statistics

Network Types

153 operators with launched commercial 5G networks, in 64 countries/territories

As of mid-March 2021 GSA's data showed:

- There are **807** operators with commercially launched LTE networks (offering broadband fixed wireless access and or mobile services) Within this, GSA has identified:
  - **421** operators that have launched LTE fixed wireless access services (excludes those offering MiFi/dongle services only).
  - **744** operators that offer fully mobile LTE services.
- **245** operators hold licences to use spectrum for TD-LTE services, **167** of which are known to be actively using the spectrum (either deploying networks or have launched services).
- **360** operators are investing in one or more LTE-Advanced technologies.
- **212** operators are investing in LTE-Advanced Pro technologies.
- **428** operators in **132** countries/territories are investing in 5G networks in the form of tests, trials, pilots, planned and actual deployments.
- Of those, **153** operators in **64** countries/territories have launched commercial 3GPP-compatible 5G services (either mobile or FWA).
- **68** operators are identified as investing in 5G standalone (including those evaluating/testing, piloting, planning, deploying as well as those that have launched 5G SA networks).

Figure 1: Countries/territories with operators known to be investing in 5G

Network Features

111 operators have deployed/launched VoLTE networks worldwide

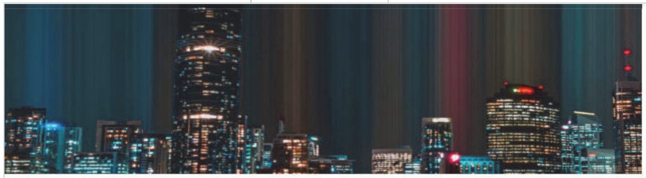
The NTS database tracks various LTE network technologies:

- **4x4 MIMO** – 151 operators identified as investing, of which 94 have deployed/launched the technology within their commercial networks.
- **8T8R MIMO and Massive MIMO** – 92 operators identified as investing in these technologies; at least 41 deployed/launched.
- **256 QAM in the DL** – 124 operators identified as investing, of which 79 are known to have deployed/launched the technology within their commercial networks.

And numerous key LTE service features:

- 36 operators investing in **LAA** (9 with deployed/launched networks); 12 operators investing in **LTE-U** (3 with deployed/launched networks); 3 operators investing in **LWA** (one launch so far).
- 280 operators investing in VoLTE, and 228 operators with launched **VoLTE** services.
- 160 companies investing in **NB-IoT**, 111 of which have launched services.
- 71 deployed/launched networks **LTE-M** networks 51 of which have deployed/launched services.

GSA



Networks, Technologies & Spectrum Snapshot

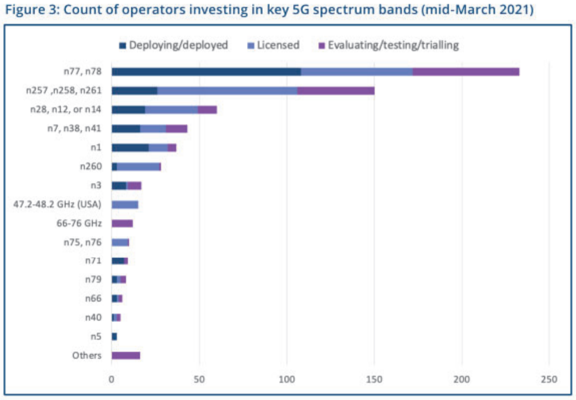
March 2021

Spectrum bands

Band 3 most deployed for LTE, Bands n77/n78 most deployed for 5G

Figure 2: Count of operators investing in key LTE spectrum bands (mid-March 2021)

Figure 3: Count of operators investing in key 5G spectrum bands (mid-March 2021)



GSA

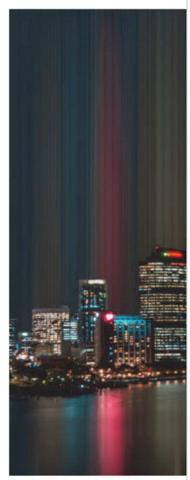
Networks, Technologies & Spectrum Snapshot

March 2021

Definitions

GSA uses the following definitions for technologies and services:

- **Licensed to test/trial**: in live public networks, or using specific spectrum bands, but tests have not started yet.
- **Evaluation/testing/trialling**: Work to evaluate possible investments, early tests and trials including demonstrations, lab tests, and field trials where the technology might be subsequently removed. Also includes testing/trialling of an unspecified type.
- **Planned**: the operator has announced an intention to launch but has not yet started deploying the network/service and does not have a licence (if one is needed).
- **Licensed**: means the operator has a licence to use the spectrum band for commercial services. Variations include licensed for mobile broadband, licensed – technology neutral, licensed for LTE, licensed for 5G, or licensed for 2G or 3G.
- **Deploying**: the operator has started actual construction/installation/deployment; and may be piloting the network in selected locations.
- **Running field trials/pilot projects**: Later stage testing, typically using the equipment intended to be deployed or in process of wider deployment within the network.
- **Deployed in network**: 5G has been installed and activated in parts of the network, even if not used for commercial service yet, but is intended to stay in the network and is ultimately expected to be used for commercial services.
- **Soft launch**: a 5G launch has been announced, but services are not widely available for customers to use – they are either restricted to a few pilot customers, or 5G devices are not generally available, (or where they are available, they cannot yet access the 5G network).
- **Launched**: commercial services are generally available to customers, over a live 5G network, with access to devices and subscriptions offering access to the 5G network.
- **Testbed/incubator services**: services accessible by third-party partners (such as enterprises and public sector or government organisations) for developing 5G applications and solutions, including those funded by the government/public sector. Excludes testbeds to test the 5G network technology itself.
- **5G FWA/home broadband**: services designed to provide home or enterprise broadband using fixed wireless access terminals or 5G-enabled home routers; nomadic mobility only.
- **5G mobile:** full mobility 5G data services within the network coverage area.



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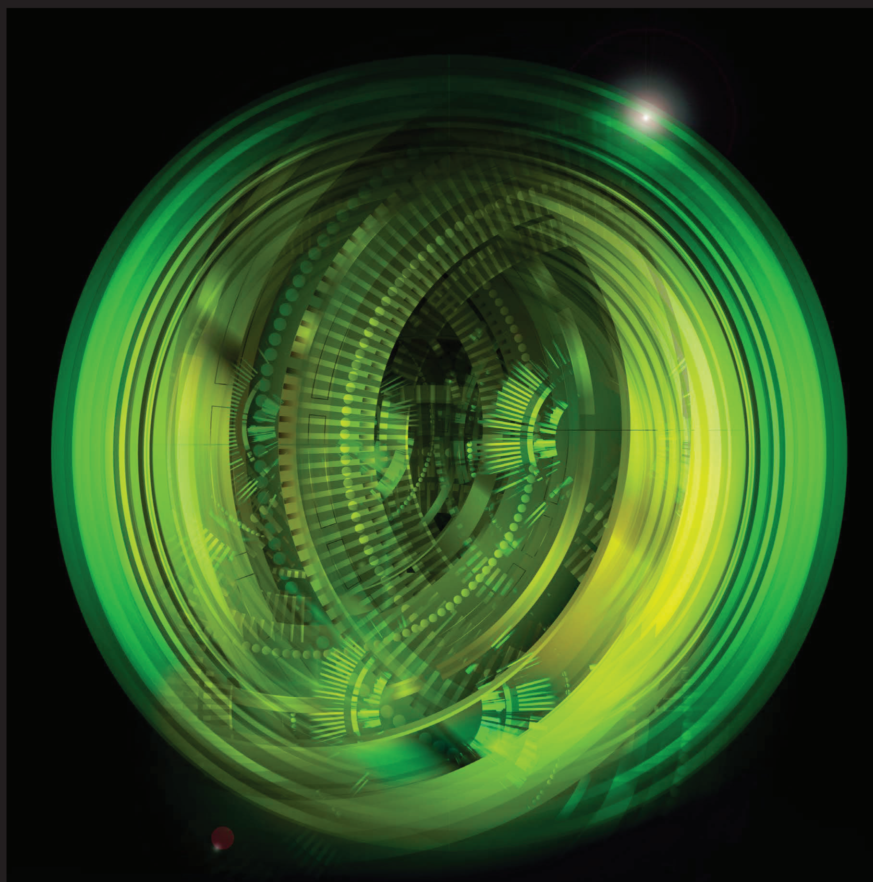


2021 outlook for the US telecommunications, media, and entertainment industry

Deloitte Center *for*
Technology, Media &
Telecommunications

Interview with Kevin Westcott

Heading into 2021, the COVID-19 pandemic will continue to shape business strategies throughout the telecommunications, media, and entertainment sector.

In media and entertainment, the pandemic has accelerated many trends that were already underway. For example, with theaters closed or allowing only limited attendance, major studios increasingly are making first-run movies available direct-to-consumer via streaming services. In addition, as consumption of streaming content rises, we've seen growth not just in the number of subscription services, but also in ad-supported models designed to satisfy increasingly cost-conscious consumers. What's more, customer retention (versus acquisition) has become top of mind—making it important that providers offer a broad range of content: video, music, games, and even podcasts. This new reality places a premium on understanding consumer behavior patterns and developing a more nuanced approach to engaging with customers. As consumers experiment with their entertainment options, we strongly encourage providers to adopt new strategies and agile approaches for content development, aggregation, and delivery.

We expect that telecommunications companies will continue to provide the bedrock for other industries to recover and thrive in 2021. Telecom providers have an opportunity to shape a new future for businesses and consumers on the strength of advanced wireless technologies such as 5G. We believe that the move to next-generation networking has the potential to transform how industries operate—creating competitive advantage and unlocking new opportunities for innovation. Telecommunications providers should help their customers envision what is possible through new 5G-enabled use cases that can truly disrupt their industries. They should shift their conversations from focusing on technical capabilities to what types of specific outcomes and benefits they can help enable for others with 5G. As enterprise 5G adoption grows and edge computing advances, this is likely going to require telecommunication companies to bring lots of different capabilities and partners together to address the opportunity. We look forward to seeing how this unfolds in the coming year.

Kevin Westcott
Vice chairman, US Tech, Media & Telecom leader
Deloitte LLP

Key takeaways
In 2021, telecommunications, media, and entertainment organizations should consider three key strategic opportunities both to recover from the COVID-19 crisis and to boldly position themselves to thrive in the future:

- **Renewing** the focus on customers' needs by taking a more nuanced approach to customer engagement.
- **Converging and remixing entertainment experiences** through new service offerings and entertainment bundles—and by adopting new strategies that can enable business agility.
- **Repositioning to monetize advanced wireless networks** through new products, services, and business models.

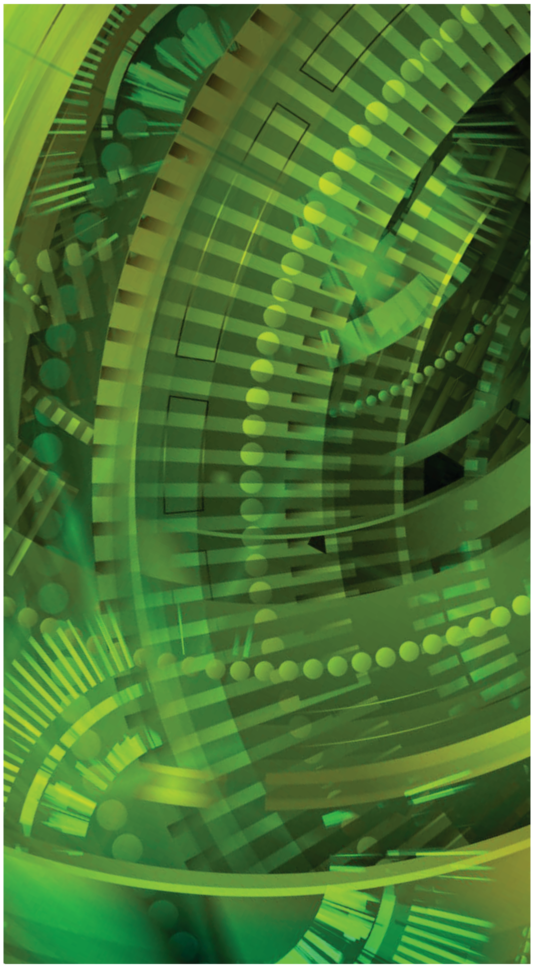
About the series
Deloitte's 2021 outlooks for the US technology, media, and telecommunications (TMT) industry seek to identify the strategic issues that TMT organizations should consider in the coming year, including their impacts, key actions to take, and critical questions to ask. The goal is to equip US TMT organizations with the information needed to position themselves for a strong, resilient future.

Three critical issues for the telecommunications, media, and entertainment industry to consider in 2021

1. **Renewing the focus on customers' needs**
   Streaming providers should move past simply focusing on cost and content by becoming more nuanced in their customer engagement. To improve retention, they should address customers' challenges and preferences though content windowing, tiered pricing, tailored services, and social experiences.

2. **Converging and remixing entertainment experiences**
   The COVID-19 pandemic has accelerated consumers' willingness to experiment with their entertainment options. The hard lines that used to exist between content and distribution channels are increasingly blurring. The coevolution of entertainment and technology is helping fuel new service offerings and entertainment bundles for consumers—necessitating new strategies and agile approaches for companies and creators.

3. **Repositioning to monetize advanced wireless networks**
   Although consumer and enterprise adoption of advanced wireless technologies like 5G is still nascent, the shift to next-generation networking is undeniably underway. The key for telecom providers is determining how they can leverage these new technologies to create new products, services, and business models that drive revenue growth.



1. Renewing the focus on customers' needs

It is important for M&E companies to understand consumer needs and behavior patterns in order to develop services that both attract and retain customers.

They should understand the economic needs of consumers. The COVID-19 pandemic has imposed severe economic constraints on millions of consumers: 39% of respondents to Deloitte's COVID-19 *Digital media trends survey* reported a decrease in their household income since the pandemic began. Consumers who lost income during the pandemic were more than twice as likely to cancel a streaming service because of cost compared with those whose income was unchanged.[1]

They also should understand consumer needs around content. As we enter 2021, original content will almost certainly remain the No. 1 factor driving consumer adoption and cancellation of streaming services.[2] The challenge then becomes how to retain those customers before they seek other streaming options. As a result, the next level of focus should be on consumer experience: How do I attract you with original content, but then retain you by knowing more about you as a customer?

The churn rate among OTT services in the United States rose from 35% in Q1 2019 to 41% in Q1 2020.[3]

The implications for M&E companies are clear: Customers want tailored options in terms of content and pricing. Therefore, while the availability of original content is typically critical for attracting customers, a broad content library and tiered pricing (including free, ad-supported offerings) are increasingly essential for retaining them.

Key opportunities for growth

To achieve success in 2021 and beyond, streaming providers should meet their customers where they are, both financially and with highly desirable content. This may mean that having great original content won't be enough in the long term and they should offer a broader array of other entertainment services as well.

To address US consumers' concerns about the cost of streaming services, providers are increasingly offering ad-supported video streaming services (AVOD) as an alternative to paid subscriptions. According to Deloitte's *Digital media trends survey*, 47% of American consumers are watching at least one free ad-supported streaming video service, such as Pluto TV, Tubi, and the Roku Channel (18% growth since the pandemic began).[4]

Sixty-five percent of respondents to Deloitte's *Digital media trends survey* say they're comfortable watching ads to eliminate or reduce subscription costs and that, given a choice, they prefer ad-supported options for watching streaming video services.[5] In addition, 37% say they appreciate the broad range of shows and movies available on free services.[6]

AVOD delivers three other key benefits:

- It can help streaming video services appeal to a wide range of viewers. Free ad-supported video appeals to thrifty baby boomers and matures, who prefer free streaming options by 58% and 65%, respectively, over subscription-based options.[7] Free or discounted AVOD services may also appeal to women, who are facing more financial hardship than men during the COVID-19 pandemic.[8]
- Ad-supported tiers can help fund pricey content. Given the escalating cost of producing original TV series (up to $25 million per episode) and exclusive streaming rights for sports leagues, streaming services may need to combine subscriptions and ads for "ultra-premium" content to make the numbers work.[9]
- It can deliver better data points for targeting consumers.[10] Ad experts and Wall Street analysts believe that the industry is in the middle of a strategic shift from linear to streaming buys.[11]

Increasingly, customer retention will depend upon having a single platform capable of satisfying a wide range of entertainment desires. So, rather than focusing solely on streaming video, providers should explore potentially adding games, music, and podcasts to their suite of offerings or partnering with other providers:

- Since the COVID-19 pandemic began, 48% of US consumers have participated in some form of video gaming activity. In addition, 29% of US consumers say they are more likely to use their free time to play a video game than to watch a video.[12] In 2020, the global video game market was expected to reach $159 billion.[13]
- US paid subscription-based music streaming revenues grew from $1.2 billion in 2015 to $5.9 billion in 2019, a compound annual growth rate of 49%.[14] Deloitte's *Digital media trends survey* revealed that 12% of US consumers added a paid music streaming service during the early stages of the pandemic.[15]
- Podcast-based advertising spending was estimated to rise from $678.7 million in 2019 to $863.4 million in 2020.[16] By helping to satisfy consumers' demand for original content, podcasts now reach more than 100 million Americans every month—an audience that is becoming increasingly diverse.[17]

Key challenges to overcome

To continue to attract, delight, and retain customers in 2021 and beyond, M&E companies will likely need to surmount several challenges, beginning with ensuring a steady stream of high-quality content. Of course, amid the pandemic, this means finding innovative ways to quickly and safely return to the production of that content.[18]

It's also imperative that M&E companies continue to build their capabilities to harness customer data to deliver highly relevant content recommendations and targeted advertising. This should happen whether customers are using a subscription-based service or a free ad-supported offering. Thanks to dynamic advertising technologies, brands can serve each customer with individualized ads based on their data and profile.

Armed with better and more actionable customer data, M&E companies can offer personalized video content, music, games, and podcasts as well. When a consumer gets a relevant recommendation for a song or game, and they get value from the interaction, they are more likely to stick around. To provide a high level of value, M&E companies should work toward strong integration and a seamless user experience among all the content and services they provide.

Although the flow of new entrants may be waning, competitive pressures will likely only increase in the coming year. Media providers are challenged to meet consumer demand for original content, a broad array of other content options, and a mix of subscription and free ad-supported services. For many M&E companies, this may require significant investments in in both technology and content, including potential mergers and acquisitions.

Ultimately, success will likely come down to providing the best overall customer experience possible—one that is built on a strong foundation of compelling content and tailored recommendations, advertising, and services. This approach can help create customer relationships that last years, not weeks.

Actions companies should take now

- Explore new business models and technologies that foster a deeper understanding of consumer behavior and better consumer engagement.
- Lead with original content: 45% of US subscribers say that they paid for a specific streaming video service to watch new original content not available anywhere else.[19]
- Meet customers where they are by offering a broad set of options (video, music, games, podcasts, and more), available via a mix of subscription and free ad-supported services.
- Redefine relationships with advertisers to target consumers with more highly tailored content and advertising.

Strategic questions to consider

- How can studios and publishers enable faster experimentation with content and delivery? How can they quickly test new behaviors and segments with minimal risk?
- How will consumers adapt to lost income and lower pay if the economic recovery is slow? Will they cut paid services and move to free options?
- How will ad-supported models evolve as consumers demand more pricing options?

2. Converging and remixing entertainment experiences

Convergence isn't just for streaming video providers. All M&E companies should think about moving beyond stand-alone products and embrace aggregation of content through both subscription and ad-based services. But to take the next step, they may also need to reimagine what shows, movies, games, and concerts actually look like. These lines are already blurring, and there's likely more to come in the near future.

As the coevolution of entertainment and technology continues, it will likely demand new strategies and agile approaches for companies and creators. This is especially true when it comes to 5G, which promises to drive even greater convergence among video, games, and music thanks to its faster speeds and lower latency. When combined with advances in artificial intelligence, augmented and virtual reality, and location-based services, 5G has the potential to redefine entertainment and accelerate remixing.

One innovative example of a remixed entertainment experience can be seen in how musicians have pioneered a new channel for releasing music: video games. Rapper Travis Scott staged a virtual concert within the video game *Fortnite* that attracted 27.7 million unique players, making it Epic Games' most successful in-game event ever and helping to launch the rapper's newest single, "The Scotts," to No. 1 on the Billboard Hot 100. Meanwhile, in Block by Blockwest, a virtual music festival inside the *Minecraft* video game, nearly 30 bands performed across three stages (servers) during an event streamed by 134,000 users.[20]

Key opportunities for growth

While the convergence of content and distribution channels has been apparent for some time, the COVID-19 pandemic sent this trend into overdrive. One of the prime examples is the decision by several studios to release first-run movies directly to streaming video services. Box-office revenues have been declining for years as consumers watch more films from home on streaming video services. With COVID-19 closing theaters, some studios released movies directly to consumers. In the short term, this approach helps studios to counter the closure of theaters due to the pandemic. It could also serve a more strategic purpose: providing a powerful hook for acquiring and retaining customers on subscription-based video streaming platforms.

Of course, no one knows how the coming months will further shift viewers' actions and preferences. And newly established digital movie-viewing trends (and success stories) have raised new questions around movie releases, particularly with studios experimenting with releasing films exclusively to certain direct-to-consumer streaming services. Will premium video on demand (PVOD) become a viable alternative release method for all or just some cinematic productions? Is there a balance to be struck that supports theater owners and studios? Will PVOD have long-term consequences for the economics of film production? The COVID-19 pandemic and its impact on the movie industry has challenged the typical notions around theatrical launches. In the future, studios will probably take a portfolio approach to movie distribution rather than a one-size-fits-all strategy.

The pandemic also helped boost the popularity of esports on social media. In addition, early in the pandemic, esports helped fill the void created by the disappearance of traditional sports on television. One event, the eNASCAR iRacing Pro Invitational Series on Fox Sports 1, attracted 1.6 million unique viewers—certainly respectable for Sunday afternoon cable TV programming.[21] Other examples include broadcasts of *Madden NFL 2020* on Fox Sports 1, *NBA 2K* on ESPN, and *League of Legends* Spring Split Playoffs on ESPN.[22] Esports delivers several key benefits to television networks, including the ability to attract younger audiences (19% of millennials watch virtual sports[23]), establish a foothold in the online world versus alternatives like Twitch and YouTube, and evolve as providers of interactive live content.[24]

Another trending remix opportunity is the online "watch party"—groups of people viewing movies and other video content together on their favorite social media platforms. By late June 2020, almost one-fifth of US adults aged 18 and older had participated in a watch party, according to market research firm Maru/Matchbox. Nearly two-thirds of those who had hosted watch parties said they'd had one within the past month.[25]

Key challenges to overcome

M&E companies will face difficulties expanding and converging their content and service offerings and building new entertainment remixes on top of that. Some companies will already have all the pieces available. They should focus on developing user environments that feel like one seamless ecosystem. For companies accustomed to developing and marketing stand-alone offerings, this new approach may represent a challenge. For companies that don't have all the pieces, they should acquire what they need or find partners who can provide it.

For new, recent behaviors, like watch parties, technology developers and M&E companies should ascertain whether emerging trends are likely to continue after the pandemic wanes and people start spending fewer evenings at home.

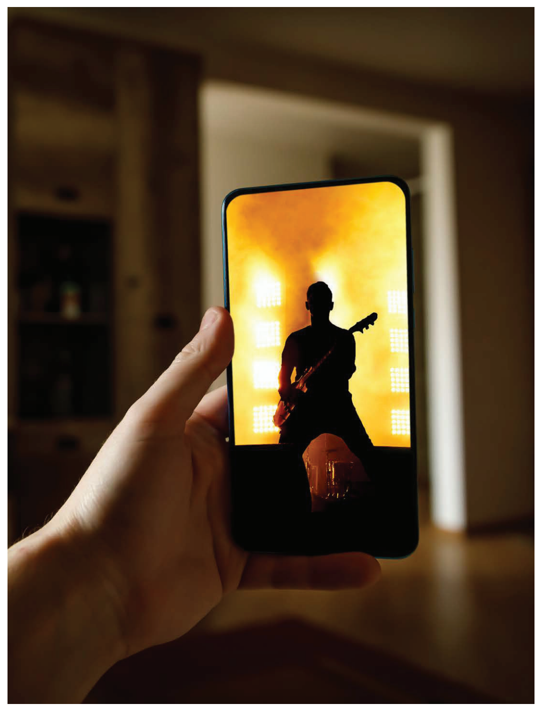
And, while video games present exciting possibilities for musicians, few video game platforms currently support video concerts. In addition, to make virtual concerts accessible to everyone, technical issues such as latency should be addressed. One potential solution is software that enables remote recording in a studio. Similar software could be adopted within video game platforms for livestreaming audio.[26]

Actions companies should take now

- Prepare for new consumer behaviors that may become permanent.
- In particular, explore opportunities in the areas of direct-to-consumer offerings like PVOD, as well as crossover services such as watch parties, music within video games, and esports on broadcast TV.
- Seek ways to make more relevant content easier to discover and access.
- Anticipate where consumers want a new experience, not just a better version of what they have today.

Strategic questions to consider

- How can M&E companies use multichannel, social, and other platforms to create more intimate live experiences? What kinds of new storytelling might these tools enable?
- How could livestreaming expand access to audiences (and revenues) for events while building in options to respond more effectively to disruptions? Are there contractual provisions that allow for multiple distribution scenarios?
- How can content providers offers seamless experiences as customers move among video content, games, podcasts, music services, social channels, and more?



3. Repositioning to monetize advanced wireless networks

US telecommunications networks did an excellent job of adapting to (and driving) changes to how people live, work, learn, and play since the COVID-19 pandemic. By enabling these new modes of communication, telecommunications providers will likely serve as the bedrock of companies' ability to recover and thrive in 2021 and beyond—across industries.

In the coming year, however, telecommunications companies should have an even larger role to play as 5G wireless technology begins to gain traction among enterprises and consumers alike. In particular, 5G promises to provide enterprises with unprecedented, real-time visibility, insights, and control over their assets, products, and services. It can also provide new opportunities to radically transform how they operate and deliver new products and services.

In many ways, this represents a major shift for telecommunications companies. While the telecom playbook for upgrading consumers to next-generation wireless technologies is already proven, providers now should develop a business model for addressing enterprise markets, which stand to benefit from advanced wireless technologies like 5G. This will likely involve exploring and developing new operating and business models that require greater collaboration with third-party partners to deliver end-to-end enterprise applications that meet the disparate needs of specific industries.

Because 5G will likely trigger innovative business models that gain large-scale adoption, telecom providers should strive to help enterprise customers gain first-mover advantages in defining and developing the innovative business models that can disrupt their industries.

The good news for telecom providers and technology companies is that most businesses already understand the importance of harnessing advanced wireless network technologies to spur future growth. In Deloitte's recent study of advanced wireless adoption, "Enterprises building their future with 5G and Wi-Fi 6," those that are using and testing 5G and/or Wi-Fi 6 see the immense potential—86% of surveyed networking execs believe that advanced wireless will transform their organization within three years, and 79% say the same about their industry.[27]

More than nine in 10 of these networking executives regard advanced wireless technologies as "very" or "critically" important to their business success today.[28]

The market opportunity is vast: The GSMA estimates that 5G will generate $700 billion in economic value,[29] with enterprises representing 68% of the market, led by retail, government, and finance applications.[30]

Key opportunities for growth

5G capabilities have the potential to revolutionize every industry, from manufacturing to health care to government. To enable the full promise of advanced wireless technologies like 5G, telecom providers should do more than simply deliver the communications network—it's essential that they bring together all of the required capabilities as well. This often involves integrating edge computing capabilities with a variety of Internet of Things (IoT) devices, such as sensors.

5G connectivity and edge computing go hand in hand: 5G networks migrate computer processing (typically hosted in the cloud) closer to the edge where data is generated, analyzed, and acted upon. The edge can be located anywhere, including on-premises at an enterprise location. Together, 5G connectivity, compact computing power, and AI combine to create the intelligent edge, a versatile foundation for unlocking the full potential of IoT and Industry 4.0.[31]

In the retail industry, the intelligent edge can enable powerful use cases such as smart shelves, cashierless shopping, digital signage, dynamic pricing, and contactless shopping. In addition to enhanced retail experiences, the intelligent edge is expected to fuel use cases such as smart warehouses and virtual medicine.

According to ABI Research, syncing of edge servers with telecommunications infrastructure represents a $54 billion opportunity by 2024.[32] In addition, IDC predicts that in two years, 45% of IoT-generated data will be stored, processed, analyzed, and acted upon close to or at the edge of networks. By enabling data aggregation and processing at the edge, companies can achieve bandwidth savings while also reducing latency and improving reliability.[33]

Key challenges to overcome

On the enterprise side, telecommunications providers should resolve a dilemma in terms of the intelligent edge. While some providers believe that they can generate more revenue by partnering with internet giants, others worry that their role would be limited to that of connectivity partner—in effect, acting merely as a stepping-stone for hyperscalers and cloud giants. Providers realize that they should act fast by either integrating vertically or by leveraging horizontal capabilities. One of their challenges is determining how to build upon their current business structure so that they're in the driver's seat.[34] Telecom providers also face increased competition from industrial solution providers like Bosch and Siemens, both of which are developing their own edge services.[35]

Another challenge is dealing with the significant costs of making 5G operational. Many providers are concerned not only about the steep up-front investment to build the 5G network, but also about the time horizon required to realize the return on their investments.[36] With governments demanding higher prices for 5G spectrum, service providers could be left with no option but to let consumers pay for all or a major part of it.[37]

Networking executives' biggest concern with regard to adoption of advanced wireless technologies is security.[38] High bandwidth and increased speed provide hackers with even more opportunities to manipulate the network.[39] Devices using 5G technology can potentially bypass the cybersecurity platforms operational for 4G technology, giving cybercriminals a platform to launch cyberattacks.[40]

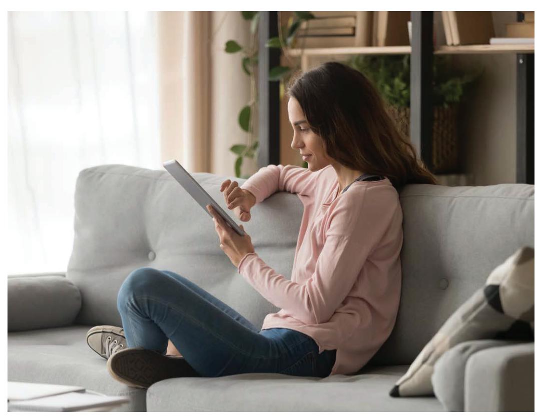
Finally, due to decreased in-store traffic due to the pandemic, online interfaces have become an integral part of consumer buying journey for telecom providers. It is therefore essential that telecommunications companies offer as many touchpoints as possible to improve the customer experience and satisfaction.[41] In terms of the in-store experience, telecommunications providers should explore how technologies that enable greater safety (such as "contactless" environments) can tie into rewards programs, consumer engagement opportunities, and exclusive experiences.

Actions companies should take now

- Focus on the benefits and outcomes of adopting advanced wireless technologies like 5G rather than on the technology itself.
- Leverage advanced wireless technologies such as 5G to develop enterprise applications that are truly industry-specific.
- Develop a better understanding of customers' usage patterns, with an eye toward strengthening the value proposition.
- Reassess all of the ways that customers transact with the business, with a focus on both the channel mix and the ability to meet customer needs (for example, by offering "contactless" inventory and checkout).

Strategic questions to consider

- Should we capitalize on the enterprise customer's current emphasis on secure, high-quality connectivity to accelerate the introduction of new products and services, such as 5G, Wi-Fi 6, and edge computing?
- Do we have the proper capabilities to manage a significant customer shift to digital-first customer service and support models?
- Is there an opportunity to strengthen and promote lower-cost, self-service online sales and service channels to customers? How do we encourage our customers to turn first to lower-cost digital channels?
- Which forms of connectivity and what types of data and applications are customers using? Can we use this information to understand network constraints and allocate future investments accordingly?



Looking boldly to the future

In spring 2020, a couple of months into the COVID-19 pandemic, we stated that the pandemic had exacerbated structural challenges and trends that media and entertainment companies have faced for a long time. We added that leaders have a rare opportunity to rebuild the industry to create a new future in which M&E companies can grow and thrive.

On the telecommunications side, we pointed out that service providers have an opportunity to play a key role in the recovery from COVID-19; that in a world of social distancing, network connectivity may prove to be the bedrock underpinning our society, mitigating the pandemic's negative impact by allowing us to stay in touch with our communities.

Heading into 2021, it is critical for M&E companies to understand consumer behavior patterns and develop a more nuanced approach to engaging with customers. As consumers experiment with their entertainment options, providers should continually adopt new strategies and agile approaches for content development and delivery.

At the same time, telecom providers can shape a new future for businesses and consumers on the strength of advanced wireless technologies such as 5G. This shift to next-generation networking has the potential to transform how industries operate.

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Relevant insights

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Networks, Technologies & Spectrum Snapshot

March 2021

LTE and 5G Market Statistics

Network Types

153 operators with launched commercial 5G networks, in 64 countries/territories

As of mid-March 2021 GSA's data showed:

- There are **807** operators with commercially launched LTE networks (offering broadband fixed wireless access and or mobile services) Within this, GSA has identified:
  - **421** operators that have launched LTE fixed wireless access services (excludes those offering MiFi/dongle services only).
  - **744** operators that offer fully mobile LTE services.
- **245** operators hold licences to use spectrum for TD-LTE services, **167** of which are known to be actively using the spectrum (either deploying networks or have launched services).
- **360** operators are investing in one or more LTE-Advanced technologies.
- **212** operators are investing in LTE-Advanced Pro technologies.
- **428** operators in **132** countries/territories are investing in 5G networks in the form of tests, trials, pilots, planned and actual deployments.
- Of those, **153** operators in **64** countries/territories have launched commercial 3GPP-compatible 5G services (either mobile or FWA).
- **68** operators are identified as investing in 5G standalone (including those evaluating/testing, piloting, planning, deploying as well as those that have launched 5G SA networks).

Figure 1: Countries/territories with operators known to be investing in 5G

Network Features

111 operators have deployed/launched VoLTE networks worldwide

The NTS database tracks various LTE network technologies:

- **4x4 MIMO** – 151 operators identified as investing, of which 94 have deployed/launched the technology within their commercial networks.
- **8T8R MIMO and Massive MIMO** – 92 operators identified as investing in these technologies; at least 41 deployed/launched.
- **256 QAM in the DL** – 124 operators identified as investing, of which 79 are known to have deployed/launched the technology within their commercial networks.

And numerous key LTE service features:

- 36 operators investing in **LAA** (9 with deployed/launched networks); 12 operators investing in **LTE-U** (3 with deployed/launched networks); 3 operators investing in **LWA** (one launch so far).
- 280 operators investing in VoLTE, and 228 operators with launched **VoLTE** services.
- 160 companies investing in **NB-IoT**, 111 of which have launched services.
- 71 deployed/launched networks **LTE-M** networks 51 of which have deployed/launched services.

Networks, Technologies & Spectrum Snapshot

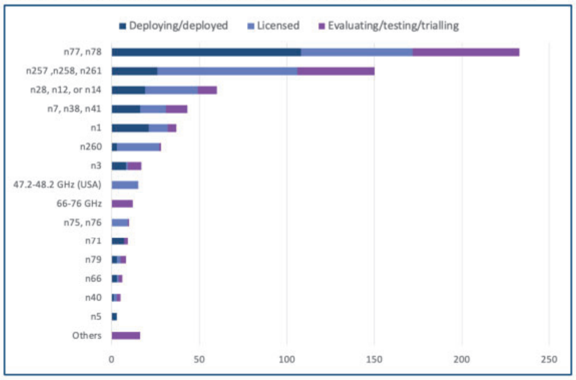
March 2021

Spectrum bands

Band 3 most deployed for LTE, Bands n77/n78 most deployed for 5G

Figure 2: Count of operators investing in key LTE spectrum bands (mid-March 2021)

Figure 3: Count of operators investing in key 5G spectrum bands (mid-March 2021)



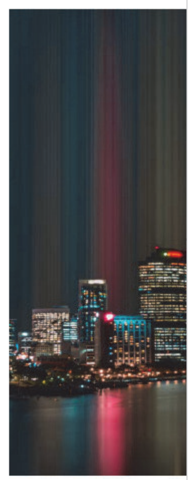
Networks, Technologies & Spectrum Snapshot

March 2021

Definitions

GSA uses the following definitions for technologies and services:

- **Licensed to test/trial**: in live public networks, or using specific spectrum bands, but tests have not started yet.
- **Evaluation/testing/trialling**: Work to evaluate possible investments, early tests and trials including demonstrations, lab tests, and field trials where the technology might be subsequently removed. Also includes testing/trialling of an unspecified type.
- **Planned**: the operator has announced an intention to launch but has not yet started deploying the network/service and does not have a licence (if one is needed).
- **Licensed**: means the operator has a licence to use the spectrum band for commercial services. Variations include licensed for mobile broadband, licensed – technology neutral, licensed for LTE, licensed for 5G, or licensed for 2G or 3G.
- **Deploying**: the operator has started actual construction/installation/deployment; and may be piloting the network in selected locations.
- **Running field trials/pilot projects**: Later stage testing, typically using the equipment intended to be deployed or in process of wider deployment within the network.
- **Deployed in network**: 5G has been installed and activated in parts of the network, even if not used for commercial service yet, but is intended to stay in the network and is ultimately expected to be used for commercial services.
- **Soft launch**: a 5G launch has been announced, but services are not widely available for customers to use – they are either restricted to a few pilot customers, or 5G devices are not generally available, (or where they are available, they cannot yet access the 5G network).
- **Launched**: commercial services are generally available to customers, over a live 5G network, with access to devices and subscriptions offering access to the 5G network.
- **Testbed/incubator services**: services accessible by third-party partners (such as enterprises and public sector or government organisations) for developing 5G applications and solutions, including those funded by the government/public sector. Excludes testbeds to test the 5G network technology itself.
- **5G FWA/home broadband**: services designed to provide home or enterprise broadband using fixed wireless access terminals or 5G-enabled home routers; nomadic mobility only.
- **5G mobile:** full mobility 5G data services within the network coverage area.



5G Services

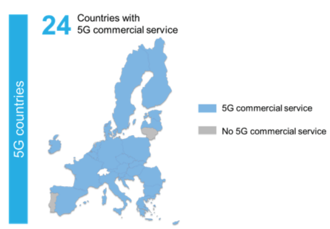
…icements of …rcial launches

Global 5G race is heating up. The number of live 5G networks increased significantly in Europe and outside Europe since the beginning of 2019. Only Lithuania, Malta and Portugal have not launched 5G services in the EU as at the end of March 2021.

1. Europe

At the end of March 2021, 5G commercial services had been deployed in 24 EU-27 countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain and Sweden.

EU-27 countries with 5G commercial service – March 2021



Source: IDATE Digiworld

Austria

T-Mobile

T-Mobile announced in March 2019 a commercial launch with friendly customers using the 3.6 GHz band. The operator announced it had deployed 25 base stations for this launch in rural areas. The first 5G smartphones were available at the end of 2019.

The rebranded operator Magenta announced in July 2020 that its 5G network was active at 600 locations across the country, covering 25% of Austrian homes and

ABOUT (HTTPS://5GOBSERVATORY.EU/ABOUT/)
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DEPLOYMENTS (HTTPS://5GOBSERVATORY.EU/INFO-DEPLOYMENTS/)

businesses. By the end of 2020, the player reached 1,200 locations, representing almost 40% [illegible] d businesses. The company noted [illegible] lementing Dynamic Spectrum [illegible] nology.

[illegible] 2020, T-Mobile Austria paid 87 million EUR for 2×20 MHz of 700 MHz spectrum, 20 MHz in the 1500 MHz band and 2×15 MHz of 2.1 GHz spectrum in the second 5G auction in the country.

Three

Three Austria announced a 5G pre-launch after activating its 5G network in the city of Linz in June 2019. The operator activated, in September 2019, more 5G base stations in Worgl and Vienna and started offering 5G tariffs and devices. In December 2019, the company revealed that around 100 5G locations were going to be live across the country by the end of 2019. The operator has worked with Chinese vendor ZTE in its commercial 5G deployment.

A1 Telekom

A1 launched its 5G network in January 2020 using the 3.5 GHz band. The “A1 5Giganetwork” covers 350 locations across 129 municipalities in Austria. A1 had previously signed a commercial contract with Finnish vendor Nokia for the deployment of its 5G network across the country. The contract includes both Nokia’s 5G radio access and cloud-native 5G core technology.

Belgium

Proximus

Proximus launched Belgium’s first commercial 5G services on April 1, 2020, using spectrum in its existing spectrum holdings (2.1 GHz) and within current EMF norms. Coverage was available in about 30 cities and towns. In June 2020, the operator expanded the network coverage to an additional 26 locations in Flanders, including the municipalities of Ghent and Antwerp. The network was not deployed in the Brussels region due to its strict radiation standards. By the end of 2020, the network covered more than 100 sites in 62 cities and ...s, mainly in Flanders.

In September 2020, Vivacom launched the first Bulgaria 5G network in all 27 district centers of the country. The operator gave free of charge 30 GB per month to its customers to test the new technology until the end of 2020. Vivacom is using Dynamic Spectrum Sharing (DSS) in the 1800 MHz and 2.1 GHz bands.

A1

A1 Bulgaria switched on its 3.6 GHz 5G network in the capital city of Sofia in November 2020. The operator said that the network supports coverage of Sofia's main residential and business districts and can deliver 1 Gbps download speeds.

Croatia

Hrvatski Telekom

Hrvatski Telekom (HT) switched on Croatia's first commercial 5G network in late October 2020 in parts of six major cities: Zagreb, Rijeka, Split, Osijek, Samobor and Sveta Nedelja. At launch, 18% of the Croatian population was covered with the 5G network. In December 2020, the operator announced its 5G network covered one million people in 14 cities, reaching 25% of the country's population. Customers on selected tariffs and with a 5G-capable device can access 5G services at no extra charge until June 2021.

The Hrvatski Telekom's 5G network is based on Dynamic Spectrum Sharing (DSS) technology, which enables the current use of existing frequencies for 5G. Hrvatski Telekom has launched on 2100MHz bands while awaiting the upcoming 3.5 GHz auction rescheduled for 2021.

Cyprus

-Vodafone

2021, Cypriot mobile operator Cyta services capable of providing Gbps. The company advertised a footprint of 70% at launch, with plans to extend the coverage to 98% of the population within twelve months.

Czech Republic

Telefonica

O2 (Telefonica) Czech Republic launched 5G services in July 2020 in selected parts of Prague. The network is also available in the city of Koline. In December 2020, the operator announced its network was available in two more cities: Pilsen and Bilina. O2 plans to cover at least three more cities in early 2021.

Vodafone

Vodafone Czech Republic announced in early October 2020 the launch of its NSA 5G network in the cities of Prague, Brno, Usti nad Labem, Jesenik, and Karlovy Vary, using Dynamic Spectrum Sharing technology. In February 2021, the operator communicated that ist 5G network was available in more than 130 cities and smaller municipalities, covering approximately two million people, more than 20% of the population.

T-Mobile

T-Mobile launched 5G commercial services in November 2020 in the cities of Prague and Brno. The operator said that by the end of 2020, more than a quarter of the population in both cities will be covered by its 5G network, targeting having around 360 base transceiver stations online. In December 2020, TMobile announced its 5G network covered one million people in 14 cities.

Operators count on the coming 5G auction for a truly nationwide expansion of the network.

Denmark

TDC ...hed commercial 5G services in the ...d in Copenhagen, Odense, Aarhus ...r in early September 2020. The ...med that by December 2020, 3,800 ... had been equipped with Ericsson's 5G technology throughout Denmark, with a footprint of 90% of the population.

The company is offering two 5G plans: the "Professional" with 30 GB of data allowance costs 399 DKK (54 EUR) per month and the "Premium" with 100 GB of data allowance costs 499 DKK (67 EUR) per month. These two 5G price plans complete 4G cheaper plans with lower data allowances (3 GB at 199 DKK/month or 27 EUR and 10 GB at 299 DKK/month or 40 EUR).

Telenor ***Denmark***

Telenor Denmark activated its 5G network in November 2020 using the 3.5 GHz band, covering around 600,000 potential customers in Copenhagen and Aalborg. Cities of Aarhus and Odense are next in line for rollouts.

Telia Denmark

The operator launched commercial 5G services in November 2020 using the 3.5 GHz band. By January 2021, 30% of the population was covered by its 5G network.

Hi3G Access

Danish mobile network operator Hi3G Access announced the official switch-on of its new 5G network in Copenhagen and Roskilde in mid-December 2020. The operator launched 5G using frequencies in the 700 MHz and 1800 MHz. In March 2021 it is expected that the Danish Energy Agency will hold an auction to award spectrum in the 3.5 GHz band. That additional spectrum and further 5G development will enable speeds of around 1 Gbps, 3 Denmark said. The operator announced that it expects to cover one-third of its network by mid-2021 and to complete its nationwide network by mid- 2022.

Estonia

...witched on Estonia's first ...5G network in November 2020 in ...f the country's three largest cities, ... and Pärnu. The network uses Ericsson Spectrum Sharing technology, enabling Telia to utilise its existing frequencies since the government has not yet auctioned off 3.5 GHz licences for 5G.

Finland

Elisa

Elisa reported its 5G network carried a 5G phone call on 27 June 2018 between the Estonian minister of Economy and her Finnish colleague in Finland. Tests performed showed data speeds of 2.2 Gbps. That said, the first 5G licences were made available in the 3.6 GHz band frequencies in autumn 2018. The operator started offering 5G mobile devices and plans in June 2019 in Tampere, Jyväskylä, Turku and Helsinki.

Elisa revealed in June 2020 that its 5G network had been switched on in a total of 30 cities and towns across the country, with more than one million people within its service area. In January 2021, Elisa confirmed that its network covered some two million Finns and about 34% of the population, while 5G subscriptions had risen to close to 200,000 by the end of 2020.

Telia

Telia Finland launched 5G services in seven cities at the end of 2019 using its 3.5 GHz spectrum. The operator also promotes Fixed Wireless Access for homes, besides normal mobile subscriptions. In November 2020, the operator stated that its 5G network was covering 42 cities, reaching approximately 1.4 million people or 25% of the population.

DNA

DNA started selling mobile 5G subscriptions in January 2020 using its 3.5 GHz band, having previously launched its 'DNA Home 5G' offering in December 2019. In November 2020, the network was available in 76 municipalities, ...re than 1.5 million people and 27% of the population.

Orange

Orange France launched its commercial 5G mobile network on 3 December 2020 in 15 municipalities including Nice, Marseille, Le Mans, Angers, and Clermont Ferrand. By the end of 2020, more than 160 municipalities will be covered with the 3.5 GHz 5G network, providing data speeds up to three-to-four times faster than 4G LTE. According to Orange, each municipality will be added to the official coverage list when its 5G outdoor population coverage rate reaches 80% or more.

Bouygues Telecom

Bouygues Telecom switched on its 5G network in 20 major cities the 1st of December 2020. The network was available in Lyon, Nice, Montpellier, Reims, Le Havre, Toulon, Dijon, Villeurbanne, Le Mans, Aix-en-Provence, Boulogne-Billancourt, Metz, Saint-Denis, Argenteuil, Rouen, Versailles, Montreuil, Nancy, Avignon, and Cannes. In January 2021, Bouygues announced its 5G rollout reached over 1,000 municipalities across the country via 2,407 base stations. The French operator has also confirmed the goal of achieving nationwide coverage by the end of 2021. The current roll-out phase will rely on the 3.5 GHz and 2.1 GHz bands.

SFR

SFR announced in late November 2020 the launch of its 5G service using the 2.6 GHz and 3.5 GHz in the city of Nice. 50% of the population of the city was covered by 5G, and within several weeks, 80% was planned to be covered. The company confirmed plans to extend its coverage to more than 120 municipalities throughout December 2020. The rollouts will take place at selected locations in (https://5gobservatory.eu) the agglomerations of Bordeaux, Marseille-Aix-en-Provence, Montpellier, Nantes, Nice, and ... rance.

European 5G Observatory

... became in December 2020 the ... operator to launch commercial 5G services. At launch, for the same data volume, consumers had to pay more than three times at Orange or at SFR.

The 5G network covered about 40% of the population and had good indoor reception thanks to the 5,255 active 700 MHz cell sites. Free Mobile also activated 220 cell sites equipped with 3.6 GHz frequencies to offer ultra-fast speeds in selected locations. By February 2021, the operator had activated 6,274 base stations.

France's spectrum agency ANFR said that the number of cell sites authorized for 5G services amounted to 18,039 as of January 7, 2021.

Germany

Deutsche Telekom

Deutsche Telekom switched on its 5G network in September, 2019, in five German cities: Berlin, Bonn, Cologne, Darmstadt, and Munich. Hamburg, Frankfurt, and Leipzig followed.

In July 2020, the operator announced that its 5G network covered 40 million Germans, representing half of the population. Services were available in over 3,000 towns and municipalities after a further 18,000 antennas were upgraded for 5G and integrated into the live network. The company announced that it plans to cover 80% of the population by the end of 2021.

Telekom uses spectrum in the 2.1 GHz band to provide customers with 5G coverage in less ... is being used in large cities. Dynamic Spectrum Sharing is also being deployed. ...

Vodafone Germany

Vodafone Germany started its 5G network in … February 2021, the operator … that it switched on a further 2,200 … at around 800 locations across … total, more than 7,000 5G antennas were active at almost 2,500 locations, providing coverage to more than 20 million Germans, with this set to rise to 30 million by the end of 2021.

Vodafone is using the 1800 MHz band to provide 5G in densely populated cities with speeds of more than 500 Mbps, while the 700 MHz range is being deployed in rural areas to offer data rates of up to 200 Mbps and the 3500 MHz band is being rolled out in high traffic areas such as stadiums and train stations, where it is able to support speeds of 1 Gbps.

Telefonica

Telefonica became Germany's third mobile network operator to introduce 5G services in October 2020, when the network was activated in ten cities: Berlin, Hamburg, Munich, Frankfurt, Cologne, Dusseldorf, Stuttgart, Essen and Potsdam. Telefonica's 5G network in the 3.6 GHz band will have grown from 450 antennas to over 6,000 to cover more than 30% of the population by the end of 2021. The operator expects to reach around 50% by the end of 2022 and the whole country by 2025. In rural areas, the company will use Dynamic Spectrum Sharing.

Greece

Wind Hellas

Greek mobile operator Wind Hellas announced in December 2020 that it switched on its 5G mobile network a few days after winning frequencies in the country's multi-band 5G spectrum auction. The network was initially covering Athens and Thessaloniki, while coverage of other major cities is expected in 2021. The operator said that 5G population coverage is expected to exceed 60% within three years.

Cosmote

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5G SPECTRUM (HTTPS://5GOBSERVATORY.EU/5G-SPECTRUM/)

LINKS (HTTPS://5GOBSERVATORY.EU/LINKS/)

(https://5gobservatory.eu) European 5G Observatory

Cosmote launched its commercial 5G services in December 2020 in Athens, Thessaloniki and … cities, with speeds exceeding 1 … ain areas. In March 2021, the … anded its 5G network to cover 17 … ng 90% of the population of the … largest cities, Athens and Thessaloniki. The company is aiming to increase coverage to over 50% of the population by the end of 2021. *Vodafone Greece*

In January 2021, Vodafone Greece became the country's third mobile operator to switch on its 5G network. The services were available in parts of Athens and Thessaloniki, with 40% of the population expected to be covered by March 2022.

Hungary

Vodafone Hungary

In October 2019, Vodafone Hungary launched a commercial 5G service limited to Budapest, using its existing 3.5 GHz spectrum and ahead of Hungary's March 2020 licence auction where it won additional 3.5 GHz frequencies plus a 700 MHz licence. In March 2021, the operator announced that its 5G network was available 'in most of Budapest'.

In late June 2020, the operator announced plans to roll out 5G services in six cities, focusing on the busiest parts of inner cities and around universities. The rollouts will increase the number of Vodafone 5G base stations to about 300.

Magyar Telekom

The operator launched commercial 5G mobile network services in April 2020 in partnership with Ericsson. The network was available in limited areas of Budapest and Puskas Ferenc stadium. By September 2020, the network was available in parts 18 cities and towns including Zalaegerszeg, Szombathely, Debrecen, Szeged and Kecskemét.

Ireland

Vodafone

European Commission

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DEPLOYMENTS (HTTPS://5GOBSERVATORY.EU/INFO-DEPLOYMENTS/)

Vodafone Ireland launched 5G services in August 2019 in selected areas of five Irish cities, ...blin and Waterford using the 3.5 ...n May 2020, the operator ...d that the 5G network was live in ... Galway, Limerick and Waterford.

Eir

In early December 2019, Eir launched its 5G service in 10 towns and cities using the 3.5 GHz band. By January 2020, 5G services were available in 20 towns and cities. In February 2021, Eir confirmed that its 5G network covered 55% of the population, with infrastructure available in 239 towns and cities via more than 800 base stations.

Three Ireland

In late September 2020, Three Ireland started offering 5G commercial services with Ericsson's equipment in a total of 315 sites across Ireland, reaching 35% of population coverage using the 3.7 GHz band. The operator expects to add a further 500 5G-capable sites in 2021. Ericsson announced that the 5G network is powered by the vendor's fully virtualised 5G Core and the latest products and solutions from its Radio System portfolio.

Italy

Vodafone

Vodafone Italy launched its commercial 5G services in 5 cities on 6 June 2019 (Milan, Rome, Turin, Bologna and Naples). In Turin, the Vodafone network covered 80% of the city with 120 cell sites. The number of cities with 5G availability is meant to increase up to 100 by the end of 2021. The operator inked a network sharing 5G deal with Telecom Italia in early 2019.

Telecom Italia

TIM launched its 5G services on June 24th, 2019 in parts of Rome and Turin, Naples followed in July 2019. ... were available in Bologna, Brescia, Florence, Genoa, Milan, Naples, Turin, and Rome. In (https://5gobservatory.eu)August 2020, the network was available in a total of ten cities. The company announced plans to ...ies by the end of 2021.

...unched its 5G network in around ten ...tals in October 2020. The operator announced in January 2021 it had rolled out 5G networks in 59 Italian provinces and eight additional provincial capitals, covering around 73.7% of the population.

Iliad Italia

Iliad Italia switched on its 5G network in 27 Italian cities in December 2020. The operator launched what it could be a highly disruptive offer in Italia, a 5G called Flash 70 for under 10 EUR for a limited period only, until January 21, 2021. The operator did not say what the price will be after the offer period.

Latvia

LMT

Latvian Mobile Telephone launched 5G network in July 2019, with limited availability. In January 2020, commercial 5G services were extended to the cities of Jelgava and Daugavpils.

Tele2

Tele2 Latvia commercially launched 5G services in Daugavpils and Jelgava in January 2020. The operator said any customer with a compatible device could use the 5G network. By September 2020, the network was available in Riga, Jurmala, and Valmiera. In January 2021, the operator announced plans to expand its 5G network with the deployment of base stations in 13 more cities over the course of 2021.

Luxembourg

Orange

The operator confirmed the network was activated in November 2020 covering Luxembourg City and surrounding areas such as Bertrange, Strassen, Kirchberg and the airport.

Orange subscribers can access 5G services at no extra charge as part of their existing mobile

mobile network operator Tango services in November 2020. The 5G network was initially available in Luxembourg City before being deployed in other larger towns from early 2021. All customers can benefit from the new 5G network with their current mobile subscription, reaching speeds of up to 1 Gbps.

Netherlands

VodafoneZiggo

The operator activated its 5G network in late April 2020 across more than half of the Netherlands. VodafoneZiggo announced plans to cover all of the Netherlands by late 2020. In partnership with Ericsson, the operator implemented 5G services via its existing antennas and Dynamic Spectrum Sharing technology which allows operators to dynamically allocate some of their existing 4G LTE spectrum to 5G. More specifically, the company is using 800/1800/2100/2600 MHz bands.

The company notes that the mobile data download speeds that 5G can offer using its existing spectrum reach a maximum of 1 Gbps, although it adds that in practice the 5G data rates experienced by initial customers will be on average 10% higher than the 4G speeds (maximum of 350 Mbps) they were previously getting.

T-Mobile

In late July 2020, T-Mobile Netherlands launched its 5G mobile network in The Hague and 'most of the Netherlands'. The operator confirmed that its initial 5G network is based on its new 700 MHz spectrum, with

Unlimited Plus subscriptions

5G suitable

devices. The company announced in January 2021 that it reached 90% 5G population

N

... 5G services the same ... bile, in late July 2020 using its 700 ... band. The network covered over 90% of the top five Dutch cities, Amsterdam, Rotterdam, The Hague, Utrecht,

and Eindhoven, reaching approximately half of the Netherlands' population. The operator plans to offer nationwide 5G coverage by the end of 2021. KPN announced that B2B customers will be able to purchase special 5G-only services including coverage-on-demand, application priority and guaranteed bandwidth.

Poland

Polkomtel (Plus)

Polish operator launched the country's first commercial 5G mobile network in May 2020. The network used 100 base stations in the 2.6 GHz band, providing 5G services in seven cities and to about 900 000 people: Warsaw, Gdansk, Katowice, Lodz, Poznan, Szczecin and Wroclaw. Polkomtel communicated there were 5.2 million people covered by its 5G networks at the end of November 2020. The company is planning to have coverage of eleven million Poles in 150 cities and towns with 1,700 base stations by the end of 2021.

Orange Poland

The operator launched 5G services via 1,600 base stations, using the 2.1 GHz band and covering up to six million people in July 2020. T-Mobile aimed to cover by the end of June 2020, Warsaw, Lodz, Krakow, Poznan, Wroclaw, Plock, Opole, Czestochowa, Rzeszow, Bielsko-Biala and Kielce. The network uses the 2.1 GHz band.

Play

The operator announced the launch of its commercial 5G services in June 2020 over 50 base stations in 16 cities using the 2.1 GHz band.

Romania

…unched 5G services in Romania on … in areas of three cities. Customers … two 5G plans: The Red Infinity 17 …d 5G data at EUR 17 per month and Red Infinity 25 with unlimited 5G data and more services at EUR 25 per month.

Digi

RCS&RDS (Digi) announced its first 5G commercial service in June 2019, in areas of six cities. The company offered two 5G compatible smartphones: the Xiaomi Mi Mix 3 5G and the Huawei Mate 20x 5G.

Orange

In November 2019, Orange Romania launched 5G in Bucharest, Cluj-Napoca and Iasi. The operator announced in January 2020 the expansion of its 5G network to Brasov and Poiana Brasov.

In late August 2020, Orange Romania announced its 5G network in Bucharest had been expanded to cover the entire city, enabling 100% of its population to access download speeds of up to 1.2 Gbps. The network was also expanded to Mamaia and Timisoara.

Slovakia

Slovak Telekom

Slovak Telekom became the country's first operator to launch commercial 5G services in December 2020. Services were available in eight districts of Bratislava. ST announced that customers can expect download speeds of between 300 Mbps and 600 Mbps, and between 60 Mbps and 80 Mbps for upload. The operator is utilizing 15 MHz of frequencies in the 2.1 GHz band, in combination with LTE spectrum.

Slovenia

Telekom Slovenije

(https://5gobservatory.eu)Telekom Slovenije launched the first commercial 5G network in Slovenia in July 2020. The mobile ... raded 150 4G base stations to ... and announced that it provided ... approximately 25% of the ... By the end of 2020, Telekom ... expected to surpass 33% coverage.

Ericsson announced that Telekom Slovenije is using its Radio Access Network (RAN) and Cloud Core solutions for its 5G commercial rollout. Ericsson also assisted with a software installation to existing Ericsson Radio System and packet core equipment, which enables spectrum sharing between 4G and 5G on 2.6 GHz FDD spectrum.

Spain

Vodafone

Vodafone Spain launched its commercial 5G services at 3.7 GHz in 15 cities in June 2019 with initial speeds of up to 1 Gbps. At launch, the service was reaching approximately 50% coverage in each of the 15 cities.

Vodafone Spain activated in June 2020 its 5G network in a total of 21 cities. The company had previously said that it was working with Huawei and Ericsson in the deployment of the 5G network.

Telefonica

Telefonica announced in September 2020 the switched on of its 5G network in unspecified Spanish locations. The network utilises 3.5 GHz spectrum, alongside re-farmed 1800 MHz and 2.1 GHz frequencies. Telefonica announced it awarded Finnish vendor Nokia the contract to increase 5G coverage up to 75% of the Spanish population by year-end 2020. Nokia is the only vendor to supply 5G radio technology to all of Telefonica's 5G operations across Europe.

Orange

In September 2020, Orange Spain launched 5G mobile services using the 3.5 GHz band in selected parts of five cities, namely: Madrid, Barcelona, Valencia, Seville and Malaga,

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(https://5gobservatory.eu) predominantly in central areas. Orange covered around 30% of each city. The operator … March 2021 that its 5G network … municipalities across 38 provinces, … population coverage of 23%. The … its 5G service to reach more than … the end of 2021, providing coverage of over 51% of the population. In 2022, coverage is expected to reach 90%, via a combination of NSA 5G architecture and Dynamic Spectrum Sharing technology.

The Ericsson Radio System, delivering Massive MIMO, powers the 3.6 GHz 5G network in Madrid and Barcelona. Ericsson also supplies Orange Spain with a 5G Evolved Packet Core to support the 5G New Radio non-standalone 5G network.

MASMOVIL

In September 2020, Grupo MASMOVIL became the fourth Spanish operator to launch 5G services, after switching on connectivity in 15 cities. The carrier said that the 5G service is being offered via a combination of its own infrastructure and an agreement with rival operator Orange.

Sweden

Tele2

Tele2 switched on 5G networks in Stockholm, Gothenburg and Malmo on May 24, using 80 MHz of the 3.6 GHz spectrum band. The operator communicated in November 2020 that it expanded its 5G network to 30 new locations. The firm said that speeds of up to 1 Gbps are available at most 5Genabled locations.

Telia Sweden

Telia Sweden announced in May 2020 that its 5G network was active through 15 base stations in Stockholm, using its existing 700 MHz spectrum, boosted by LTE and New Radio carrier aggregation. In December 2020, the … available in 20 cities. The company is working with … Ericsson … confirmed it is providing radio access network products and

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(https://5gobservatory.eu) solutions. Certified by the Swedish Society for Nature Conservation, the 5G network is 100 % renewable energy.

European 5G Observatory

2020, Tre Sweden announced the launch of 5G services in Malmo, Lund, Uppsala, Helsingborg, Vasteras and large parts of Stockholm. The operator activated 385 5G base stations, 200 of which are in Stockholm, and expected to cover most of the centre of the capital by the end of August.

Telenor

Telenor Sweden launched commercial 5G services in central Stockholm in October 2020, becoming the fourth 5G network in the country. The operator said its network will provide internet access at 1 Gbps to customers with a compatible handset and a Telenor 5G-ready 30 GB, 75 GB, or unlimited subscription. 5G network coverage is available in at least half of the city centre. The operator intends to widen its footprint in the capital while also adding connectivity in Malmo and Gothenburg before expanding the rollout to towns with a population of over 50,000. Telenor also said that it expects its 5G network to cover 99% of Sweden's population by 2023.

2. Rest of Europe

Norway

Telenor Norge began offering a commercial 5G service in March 2020, becoming the first operator in the country to do so. The 5G network initially available in nine locations across the country: Kongsberg, Elverum, Bodo, Askvoll, Fornebu, Kvitfjell, Spikersuppa, Oslo and Trondheim. In November 2020, Telenor launched an FWA 5G service.

In May 2020, Telia launched 5G for customers in Lillestrom and parts of Groruddalen in Oslo, with plans to expand to other areas during 2020.

service.

Switzerland

In Switzerland, *Sunrise* announced partial 5G commercial launch in March 2019 and full ...ptember 2019. *Swisscom* launched in ... At launch, Swisscom's network ... 100 sites in 50 cities and villages. ...erator was targeting more than 90 ... ulation coverage by the end of 2019.

United Kingdom

EE

EE launched 5G services in May 2019 across six cities, including some areas of London, Edinburgh, Cardiff, Belfast, Birmingham, and Manchester. The network had targeted to bring 5G connectivity in 45 cities and large towns by the end of 2019.

As of June 2020, EE's 5G service was live in 80 towns and cities across the country, announced the UK carrier. The company is using a Non-standalone 5G New Radio deployment focused on using the combined power of 4G and 5G technologies. In a second phase from 2022, it will introduce the full 5G core network, enhanced device chipset capabilities, and increased availability of 5G-ready spectrum. A third phase, beginning in 2023, will introduce Ultra-Reliable Low Latency Communications (URLLC), network slicing and multi-gigabit-per-second speeds.

In January 2021, EE announced that it was offering 5G connectivity in a total of 125 towns and cities across the country.

Three UK (FWA)

Three UK launched its 5G network for smartphone users in February 2020 in 65 locations, including parts of London, Cardiff, Glasgow, Manchester, Birmingham, Coventry and Nottingham. The 5G network went live earlier in August 2019. It was available in central London and to Three Broadband service users only.

In March 2021, Three UK issued a network update ... operation across 193 towns and cities, up from around 1,000 at the end of 2020. Further, it (https://5gobservatory.eu) expects 'hundreds of more sites' to come online before the end of 2021 and notes that its 5G ...band services now cover 1.6 million

European 5G Observatory

...nched 5G services in the UK in July 2019 in seven cities. It planned to offer 5G services in twelve additional UK cities by ear-end 2019. Vodafone UK confirmed in July 2020 that its 5G network footprint at that date covered a total of 44 locations, while it also claimed to have 'massively expanded' coverage in launch cities.

Telefonica (O2)

Telefonica (O2) became in October 2019, the latest mobile operator to switch on its 5G network in the UK. Services were available in six cities and towns: Cardiff, Belfast, Edinburgh, Leeds, London, and Slough. As of June 2020, the 5G network was live across parts of 60 towns and cities in the country, up from 20 at the start of 2020.

The company revealed in January 2021 that it was offering 5G services in in over 150 towns and cities nationwide. Telefonica also noted that it has increased its 5G coverage footprint 'significantly' in bigger cities such as London, Birmingham, Glasgow, Bristol, Liverpool, and Manchester.

3. South Korea

SK Telecom, LGU+ and KT launched 5G services in December 2018 for business customers and in April 2019 for residential users.

MNOs announced in July 2018 their intention to jointly launch 5G in March 2019. This intention arrived one year after a first agreement signed in April 2018 on a shared 5G deployment and network. This first agreement's intention aimed at avoiding a costly marketing campaign when 4G came to reality back in 2011 and generating heavy cost savings of nearly 1 billion USD over the next ten years.

The Korean government announced that operators had deployed in early 2020 a total of ... base stations across the country.

... 2021 with 12.87 ... subscribers, according to data from ... of Science and ICT. South Korean telcos are expecting a big surge in 5G adoption in 2021, according to local press, with top wireless carrier SK Telecom aiming to have 9 million 5G users by the end of 2021, and smaller rival LG Uplus targeting 4 million.

At the end of January 2021, total mobile subscriptions in the Asian nation stood at 70.69 million, with 4G subscriptions at 51.9 million, down 660,000 compared to December 2020. As of early 2021, South Korean telecom operators provide 5G services via NSA 5G networks and are mostly in large cities. The companies are preparing to commercialize new technology, such as Standalone versions of the 5G networks and millimeter-wave 5G.

4. Australia

Telstra Australia

The operator launched its 5G service on the 3.6 GHz band at the end of May 2019 as it had switched on over 200 5G sites since August 2018. The 5G service was available in over 10 cities, twenty-five additional cities were expected to be covered before end-June 2020. The operator announced it was ahead of its target and 5G services were available in 47 cities across the country by summer 2020.

Telstra and Swedish vendor Ericsson announced collaboration agreements to provide 5G equipment and upgrade Telstra's network.

In September 2020, the operator announced that it had more than 1,500 5G sites in operation across selected areas of 53 cities and towns covering around ten million people.

In January 2021, the Australian operator announced that its 5G network covered 50% of the country's population and that it plans to increase coverage to 75% before the end of June 2021.

...ously acquired spectrum in the 3.6 ... AUD 386 million (EUR 240 ... ng it 60 MHz of contiguous 5G ... ll major capital cities and between 50 MHz and 80 MHz in regional areas.

Optus

Rival mobile network operator *Optus* announced the commercial launch of 5G mobile and 5G residential fixed broadband services covering selected areas in November 2019. 290 5G base stations went live in Sydney, Canberra, Adelaide, Brisbane, Melbourne, Perth and other locations in New South Wales, Victoria and Queensland, noting that 1,200 sites were planned by March 2020. The telco failed to achieve that target and announced in January 2021 it had 1,000 active 5G base stations.

Optus is using equipment from both Ericsson and Nokia in its rollout of 5G. The company secured spectrum in the 3.6 GHz spectrum auction for AUD 185 million (EUR 110 million) in late 2018.

Vodafone Australia

The telco switched on, in March 2020, its first 5G sites in Parramatta and confirmed plans to expands its network in Sydney, Melbourne, Brisbane, Adelaide, Canberra and Perth in summer 2020.

5. Japan

NTT DOCOMO

NTT DOCOMO launched Japan's first 5G smartphone service on March 25, 2020. The network was live in 150 areas in the country covering 29 of Japan's 47 prefectures. By March 2021, more than 500 cities are expected to have access to the next-generation network. The operator expects to reach 10,000 5G sites by June 2021 and 20,000 by March 2022.

KDDI

KDDI launched 5G mobile services in 15 of Japan's 47 prefectures on March 26, 2020. The ... it aimed to install 10,000 base stations by March 2021 and another ... by the end of March 2022. By 2025, ... plans to cover 93% of the ... areas of the country, as well as install 30,107 base stations in the 3.7 GHz and 4.5 GHz spectrum bands and 12,756 base stations in the 28 GHz band.

SoftBank

SoftBank turned on its 5G network on March 27, 2020. 5G mobile services were available in selected areas in seven prefectures across Japan. The operator aims to install over 10,000 5G base stations by the end of March 2023. By 2025, the company plans to expand its network to roughly 64% of the populated areas of the country and install 7,355 base stations in the 3.7 GHz and 4.5 GHz spectrum bands and 3,855 base stations in the 28 GHz band.

SoftBank and KDDI teamed together to speed up 5G rollout in rural areas. To this end, they announced on April 1st, 2020 the setup of a joint venture, 5G JAPAN. The joint venture's goal is to promote infrastructure sharing based on the mutual use of base station assets held by the two companies. The initial capital of the joint venture will be 500 million JPY (4.24 million EUR) and each operator will own 50% of the stakes.

Rakuten

Greenfield operator Rakuten launched commercial 5G services in late September 2020 in certain areas across six prefectures of the country. The service initially offered via Non-Stand Alone (NSA) 5G architecture, was available in parts of Tokyo, Kanagawa, Saitama, Hokkaido, Osaka and Hyogo. Rakuten Mobile's President Yoshihisa Yamada said that the operator is expecting the 5G to be available in Japan's all 47 prefectures by end-March 2021. Rakuten claims to have launched the world's first fully virtualized mobile network that uses lower-cost and more up-to-date cloud and software (https://5gobservatory.eu) technologies. The operator expects to launch a Stand Alone 5G network in the second quarter

...of Internal Affairs and ...ions planned to start allowing ...equencies to be converted to 5G this summer, which would let providers use existing base stations to power 5G networks.

6. China

In December 2018, China issued test licences to players for national 5G trials until June 2020 (China Telecom: 3.4-3.5 GHz, China Unicom: 3.5-3.6 GHz, 260 MHz on 2515-2675 MHz and 4800-4900 MHz). The country awarded four 5G licences to China Mobile, China Unicom, China Telecom and China Broadcasting Network, earlier in June 2019, faster than anticipated.

China Mobile, *China Telecom* and *China Unicom* launched 5G services on November 1st, 2019. Each player activated their network in 50 cities at launch, including Beijing, Shanghai, Guangzhou, Shenzhen, Hangzhou, Nanjing, Tianjin, Wuhan, Jinan, and Zhengzhou. In early October 2019, the three major mobile operators had already registered almost 9 million 5G users before the official launch. China Mobile announced 5.32 million subscribers, China Telecom hit 1.76 million subs, and China Unicom was right in line with 1.75 million users.

China Mobile announced it ended November 2020 with a total of 147.4 million 5G subscribers, compared to 6.7 million 5G customers in January 2020. Rival operator China Telecom added 7.6 million subscribers in November 2020 to take its total 5G subscribers base to 79.5 million. China Unicom has not revealed its 5G numbers. Not all "5G package subscribers" announced by the players are in possession of a 5G-capable handset. This "exceeds" the actual 5G user numbers.

(https://5gobservatory.eu/) The Ministry of Industry and Information Technology announced that by April 2020, ... cations companies had built more ... 5G base stations across the ... September 2020, the number of base ... was 500,000.

The tech hub, often referred to as China's answer to Silicon Valley, was home to about 46,000 5G cell sites as of September 2020.

In early 2021, China Mobile announced it ended the first month of the year with a total of 168.97 million 5G subscribers, compared to 6.7 million 5G customers in January 2020. The carrier have deployed over 385,000 5G base stations nationwide, according to local press reports. Rival operator China Telecom added 10.67 million 5G subscribers in January 2021 to take its total 5G subscribers base to 97.17 million. China Unicom has not revealed its 5G subscribers numbers.

China's vice-minister of industry and information technology communicated in early 2021 that a total of 718,000 5G base stations were built in China in 2020, accounting for 'nearly 70% of the world's total 5G sites'. About 100,000 5G base stations were built in 2019. In 2021, local carriers are expected to deploy approximately 600,000 5G base stations, according to recent reports.

Local operators said that they already provide 5G coverage in all Chinese cities at prefecture level and above. The Chinese government has been encouraging 5G partnerships to boost efficiency and accelerate network rollouts.

In September 2019, China Telecom and China Unicom agreed to share their 5G SA infrastructure. The deal could save about 9 billion EUR in construction investment by preliminary estimate. In May 2020, China Mobile signed a 5G network sharing agreement with China Broadcasting Network, which jointly fund and deploy a network over the 700MHz frequency.

7. USA

Verizon

… 5G Home service was launched in … 8 in limited areas of four US cities … cramento, Indianapolis, Los … e telco noted that the platform can … speeds of up to 1 Gbps, although users could expect ‘typical’ speeds of around 300 Mbps. In early October 2020, the service was also available in Chicago, Detroit, Saint Paul and Minneapolis and by the end of 2020, the technology was available in ten cities nationwide.

The operator launched its 5G mobile services in selected areas of Chicago and Minneapolis in April 2019 using millimetre-wave spectrum. As of September 2020, the 5G mobile network was available in about 35 cities across the country and in December 2020 in 61. In October 2020, the company switched on its 5G network utilizing Dynamic Spectrum Sharing (DSS) technology, which allows 5G to run simultaneously on the same spectrum band as 4G. Verizon total footprint increased to 230 million people and covered 2,700 towns and cities.

AT&T

The company launched its ‘5G E’ mobile services in certain parts of selected cities in December 2018, using the 39 GHz frequency range. In April 2020, the company had rollout out its 5G network in the 850 MHz band in over 190 markets, covering about 120 million people. AT&T’s faster mm-wave network branded ‘5G+’ was launched for consumer access in March 2020, offering coverage in parts of 35 cities.

In late July 2020, AT&T announced that its 5G network using the 850 MHz band was available to 205 million consumers across the country. By November 2020, AT&T’s 5G network reached more than 225 million people in about ‘14,000 cities and towns across the US’.

(https://5gobservatory.eu/) In July 2019, T-Mobile USA pre-launched its 5G services in selected parts of six US cities (...veland, New York City, Los Angeles, ...as Vegas) using the 28 GHz band. ... 2019 T-Mobile switched on its 5G ...g the 600 MHz frequency band. The deployment covered more than 200 million people and more than 5 000 cities and towns across the country. In January 2021, the operator announced its 5G network covered 280 million people, equivalent to more than 84% of the population. It should however be noted that data rates available with the 600 MHz spectrum alone is lower than the data rates provided by 4G services.

In late September 2020, T-Mobile US covered a total of 210 towns and cities using its 2.5 GHz band, the former Sprint spectrum. In November 2020, the operator communicated it had nearly double the number of locations with access to 2.5 GHz 5G connectivity, about 400, and that it planned to cover 100 million people by the end of 2020.

T-Mobile partnered with Cisco and Nokia to build its 5G core and Ericsson and Nokia for its 5G radio infrastructure.

T-Mobile USA and Sprint Merger

Sprint and T-Mobile officially merged into one company in April 2020. T-Mobile started to expand its network with spectrum re-farmed from Sprint in the 2.5 GHz band and opened nationwide 5G access for Sprint customers in the 600 MHz and mm-wave bands.

Sprint

Sprint had launched 5G services in May 2019 in three cities (Atlanta, Dallass Fort Worth and Kansas City). In July 2019, it extended services to Chicago and in September 2019 to selected parts of Los Angeles, New York City, Phoenix and Washington DC. The Sprint 5G Non-Standalone network in the 2.5 GHz band was using massive 128-antenna MIMO equipment to be able to operate 4G at the same time.

8. Other countries

STC ... that they had ... services in June 2019. Batelco ... October 2020 that its 5G network now covers 95% of the Kingdom's population across all four governorates. In January 2020, STC's 5G network was expanded to cover 50% of Bahrain's territory.

Brazil

Telefonica

In July 2020, Telefonica launched its 5G network in selected parts of eight state capitals, namely: Sao Paulo, Salvador, Brasilia, Rio de Janeiro, Porto Alegre, Goiania, Curitiba, and Belo Horizonte. Rival Claro also launched 5G services in selected zones of in Sao Paulo and Rio de Janeiro in July 2020.

Claro

Claro launched its 5G network in July 2020 using a combination of 700 MHz, 1800 MHz and 2.5 GHz spectrum in areas in Sao Paulo and Rio de Janeiro. The operator announced plans to expand its 5G service in 12 additional cities before the end of 2020.

Canada

Rogers Communications

The operator started offering 5G services in March 2020 in parts of Vancouver, Toronto, Ottawa, and Montreal using equipment from Ericsson. In October 2020, the company announced the expansion of its 5G network to a total of 130 towns and cities. Rogers also disclosed that it added 600 MHz and AWS (1700 MHz) band frequencies to its original 2.5 GHz 5G commercial spectrum, having switched on Dynamic Spectrum Sharing (DSS) technology in a number of its new and existing 5G locations. In December 2020 Rogers announced that it was starting to roll out Canada's first 5G standalone (SA) core network, in partnership with Ericsson, (https://5gobservatory.eu) ...nually to serve Montreal, Ottawa, Toronto and Vancouver, aiming to support future devices and ...ey become available.

...he construction of its 5G network ...2020, using equipment from Finnish vendor Nokia. The carrier also selected Ericsson 5G Radio Access Network (RAN) technology to support its nationwide 5G mobile and fixed wireless access deployment. The operator launched commercial 5G services in Montreal, The Greater Toronto Area, Calgary, Edmonton, and Vancouver. In February 2021, the operator reported that the 5G network was available in more than 150 centres (cities and smaller communities) covering 24% of the Canadian population. Bell is targeting 5G population coverage of roughly 50% by end-2021.

Telus

The third largest operator by mobile subscribers, *Telus*, announced in June 2020, the selection of European vendors Ericsson and Nokia to build its 5G network. In June 2020, the operator announced the roll-out of its 5G network in Vancouver, Montreal, Calgary, Edmonton, and the Greater Toronto Area. The company planned to continue to expand to an additional 26 markets across Canada throughout the remainder of 2020. As of February 2021, Telus' 5G presence reached over 50 towns and cities across the country. The mobile operator also revealed that it selected South Korea's Samsung as a network infrastructure partner to provide 'transformational 5G mobile services'.

Hong Kong

HKT, *Hutchison 3* and *China Mobile Hong Kong* (CMHK) launched 5G services on April 1, 2020. CMHK announced its 5G network covers over 90% of the main areas of Hong Kong Island. ... in 11 of the territory's 18 districts.

India

The Indian government is strongly backing 5G deployment, but 5G is still in the early stages of ... The Department of Telecom (DoT) is ... spectrum in the 3.3-3.6 GHz and ... ds, along with the 71-76 GHz, the ... nd the 57-64 GHz frequency ranges ... late bands. A reasonable target for 5G launch is 2022.

Israel

Pelephone announced the launch of its commercial 5G services in 150 locations in October 2020, including Tel Aviv, Haifa, Ra'anana, Dimona and Kiryat Shmona.

Kuwait

All the three MNOs in Kuwait launched 5G services in July 2019.

New Zealand

Vodafone New Zealand launched 5G services in parts of Auckland, Wellington, Christchurch, and Queenstown in December 2019. In March 2021, Vodafone New Zealand announced 5G mobile and broadband services were available in parts of Tauranga.

Spark launched 5G service in July 2020 in Palmerston North and promised four more locations will be added before the end of the year. By March 2021, 5G services were available in six cities.

Oman

Omantel launched 5G home services in December 2019. The network covered parts of about 17 cities and towns. The operator launched 5G mobile services in February 2021 in parts of over 7 locations. *Ooredoo* followed and launch 5G services in May 2020 in over 6 cities and towns.

Philippines

Globe Telecom launched 5G FWA services in June 2019 in parts of Pulacan, Cavite City, and Rizal. *PLDT* launched its 5G mobile network in (https://5gobservatory.eu) the main business districts of Metropolitan Manila in late July 2020. *Smart Communications* ... 5G network in September 2020.

European 5G Observatory

...tar claimed in May 2018 to be the first world player to launch 5G nationally with 50 sites registered late in July 2018. Ooredoo seemed to be providing 5G wTTH (wireless To The Home) services in the 3.5 GHz spectrum range domestically with very few compatible devices available. In July 2019, the operator launched its 5G mobile network and by September 2020 the coverage reached 'more than 90% of populated areas in Qatar.

Vodafone Qatar launched 5G services in August 2019.

Saudi Arabia

The SA Kingdom set up a national 5G task force to prepare the foundations for a large-scale 5G rollout before the end of 2019.

Zain and *STC* launched 5G services in June 2019. By February 2021, Zain's 5G network covered 44 cities across the country and STC 5G services were available in 22 cities.

Singapore

M1 announced that it switched on its 5G non-standalone network in Singapore in September 2020. Coverage was available in Singapore's central business district, and other selected areas. The operator announced plans to extend coverage to the rest of the country's key urban areas/towns by the end-2020.

South Africa

In May 2020, *Vodacom* turned on 5G in Johannesburg, Pretoria, and Cape Town. Wider coverage is expected throughout the year. *MTN* rolled out 5G services in areas of Bloemfontein, ... Queenstown, Port Elizabeth, Port Alfred in July ...

(https://5gobservatory.eu) 2020. *Rain* launched 5G services in areas of Cape Town, Johannesburg & Tshwane in July

...20, *Advanced Info Service* (AIS) launched 5G services on the 2.6 GHz range it acquired from auction concluded the same month. By February 2021, the network covered 200 locations and had 5,400 base stations.

True launched commercial 5G services were launched in March 2020 via 400 BTS in the 2.6 GHz band, while the 700 MHz band was enabled in January 2021 and 5G in the 26 GHz range was added in February 2021. By March 2021, True offered 5G connectivity in 355 locations in all 77 provinces.

DTAC commenced commercial 5G services in the 700 MHz band in December 2020. As of February 2021, 5G is offered in six provinces.

Taiwan

Taiwan Mobile launched 5G services in July 2020 in major cities via 2,000 base stations. *Taiwan Star* launched its commercial 5G services in August 2020. 5G coverage in Taiwan's major metropolitan areas has reached 50% and is expected to top 80% by the end of 2020. *APT* launch 5G commercial services in October 2020 in 'parts of densely populated areas.

UAE

Du announced the rollout in 2018 of a limited 5G network. In June 2019, its 5G services using the 3.5 GHz and 2.6 GHz bands were launched and by February 2021, it had 200 base stations in main urban areas. Etisalat's planned to roll out 5G commercial fixed devices in September 2018.

In May 2019, 5G mobile services were available and by February 2021, the network was available

Uruguay

5G TRIALS (HTTPS://5GOBSERVATORY.EU/5G-TRIAL/)
(https://5gobservatory.eu/)*Itália* launched a commercial 5G network in April 2019, in Manantiales, though limited in

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LATEST NEWS IN EUROPE

(https://5gobservatory.eu/slovenian-operators-pay-164-million-eur-for-new-mobile-spectrum/)

Slovenian operators pay 164 million EUR for new mobile spectrum

Slovenia's Agency for Communications Networks and Services (Akos) announced the completion of the multiband auction, which raised 164.2 million EUR.

(https://5gobservatory.eu/a1-vivacom-andtelenor-secured-5g-spectrum-in-3-6-ghz-band/)

A1, Vivacom andTelenor secured 5G spectrum in 3.6 GHz band

All bids were above the initial reserve price set at 4 million BGN (2 million EUR)

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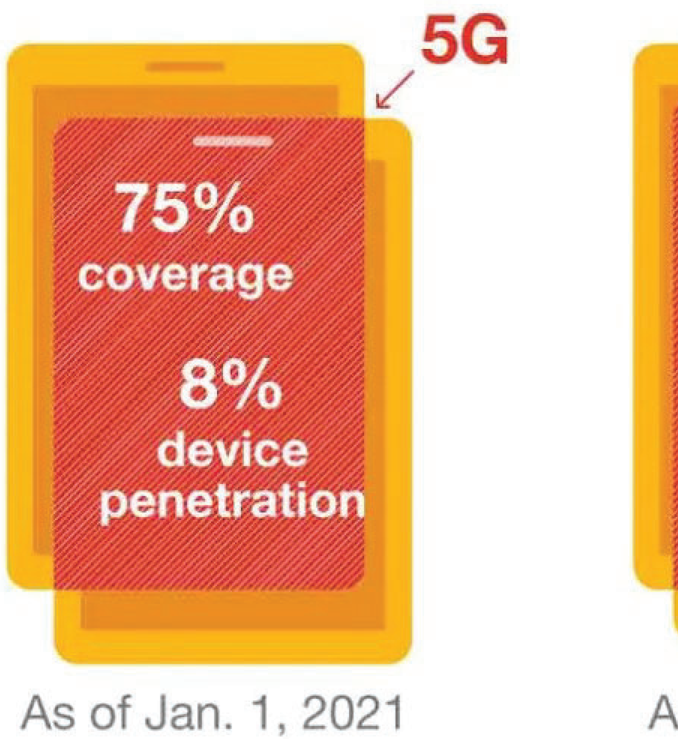
or years to come. According to our US
e trajectory of 5G, as of January 2021,
e gains, reaching 75%. By July 2021,
s expected to have 5G coverage
though the performance of 5G
Expansion of the use of mid-band
nprove urban and suburban coverage.
tion gained traction as pre-holiday
It is expected that 12% of mobile
l will be 5G enabled.

pect 5G to hit a tipping point in 2023.
d device manufacturers face the uphill
e cycles and deployment challenges
eal, exacerbated by COVID-19.



BUSINESS

US, Japan plan 5G push with eye on China in Biden's first summit

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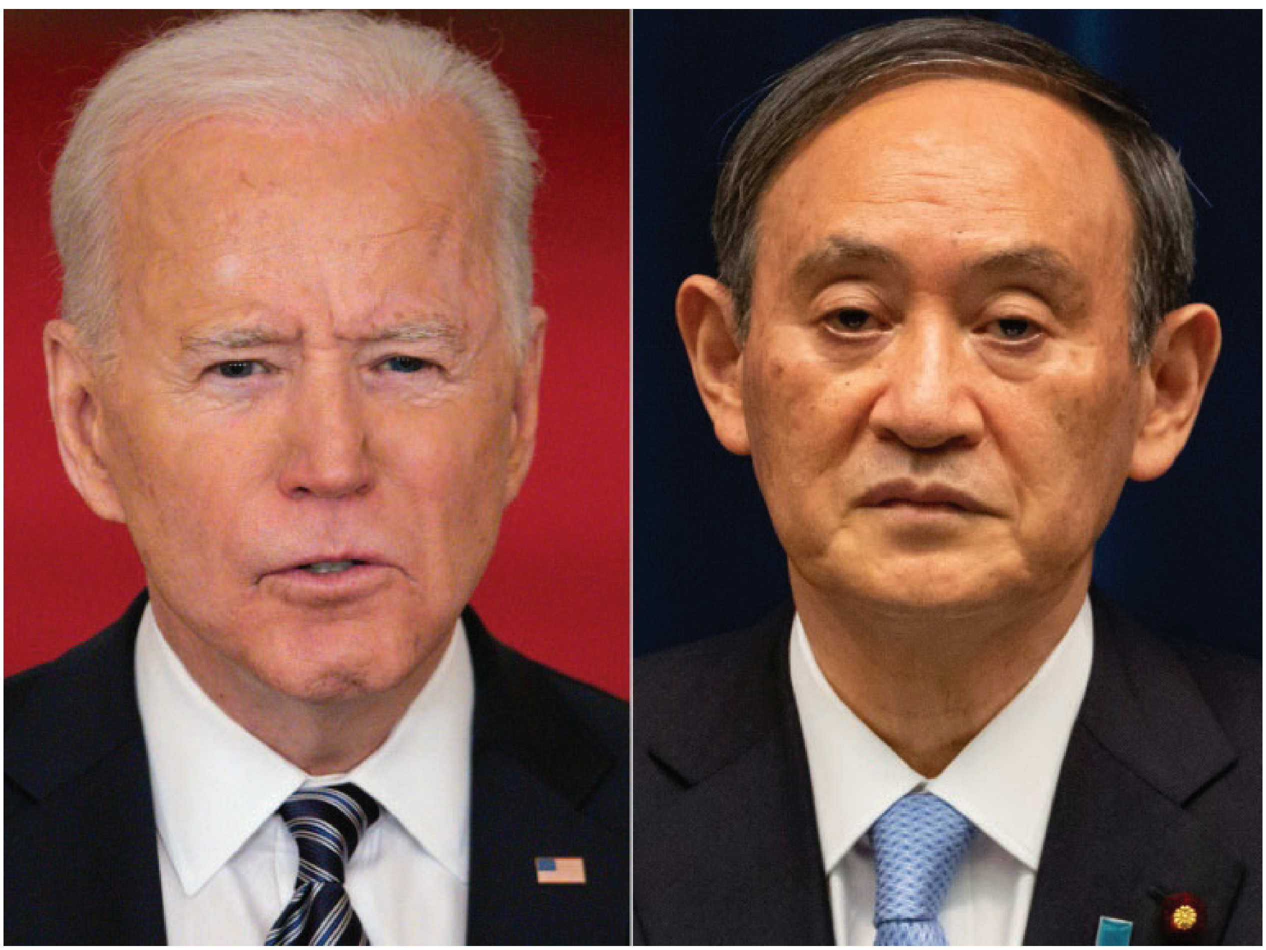

US President Joe Biden will welcome Japanese Prime Minister Yoshihide Suga for his first foreign summit

WASHINGTON: President Joe Biden on Friday receives Japan's prime minister for his first in-person summit, with the leaders expected to announce a $2 billion 5G initiative as part of a concerted US push to his renewed priority on US alliances as he zeroes in on a rising China as America's most pressing challenge.

A senior US official said that technology leader Japan would announce a "very substantial commitment" of $2 billion in partnership with the United States "to work on 5G and next steps beyond."

China's Huawei has taken an early dominance in fifth-generation internet, which is becoming an increasingly crucial part of the global economy, despite heavy US pressure on the company, which Washington argues poses threats to security and privacy in the democratic world.

The official said Biden will also speak to Japan about its climate goals as the US prepares to hold a virtual summit on climate change next week.

And the official said they will discuss growing tensions over Taiwan as the island has reported growing penetration of its airspace by Beijing, which claims the self-governing democracy.

"Neither country is seeking to raise tensions or to provoke China, but at the same time we're trying to send a clear signal that some of the steps that China is taking," the official said, are "antithetical to the mission of maintaining peace and stability."

While the timing was coincidental, the official said it was appropriate that Suga was visiting two days after Biden made the momentous decision to withdraw from Afghanistan after 20 years, ending the longest-ever US war.

The pullout will "free up time and attention and resources from our senior leadership and our military to focus on what we believe are the fundamental challenges in the 21st century and they lie fundamentally in the Indo-Pacific," the official said.

"The United States can only be effective in Asia when the US-Japan relationship is strong and Japan is steady and stable," he said.

Suga in September succeeded his ally Shinzo Abe, Japan's longest-serving prime minister, who was one of the few democratic allies to manage to preserve stable relations with Biden's volatile predecessor Donald Trump.

Biden's inaugural summit -- held an unusually late three months into his term due to the Covid-19 pandemic -- is expected to be a tame affair after the Trump era, with the president welcoming the soft-spoken Japanese leader for one-on-one talks and an expanded meeting with the cabinet before a joint news conference.

for the US line on China, which remains the vital top trading partner for resource-scarce Japan.

Tokyo since Abe's time has worked to stabilize relations with Beijing and not joined Washington in sanctions over rights concerns in Hong Kong and Xinjiang.

"The Biden administration, I think, is concerned at how aggressive China has been and how much ground the US has lost in recent years in Asia and wants to catch up quickly," said Michael Green, who was the top Asia adviser to former president George W. Bush and is now senior vice president at the Center for Strategic and International Studies.

"I think the Japanese view is that they have had a strategy in place and they want to move forward steady as she goes," he said.

"So there's a bit of a nuanced difference in public tone but not in direction," he said.

But Japan will welcome what is expected to be a fresh declaration that the Japanese-administered Senkaku islands -- where Beijing, which calls them the Diaoyu, has been increasingly assertive -- fall under the US-Japan security treaty that requires mutual defense.

Suga, and Moon next month, will also consult Biden as he reviews US policy on North Korea, where Trump's unusual personal diplomacy with leader Kim Jong Un eased tensions but did not bring a lasting accord on Pyongyang's nuclear program.

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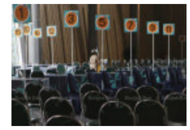


Health authorities on Sunday reported 42 more Covid-19 fatalities on Saturday and another 3,995 new transmissions, bringing the accumulated toll to 1,912 deaths and the number of cases since the start of the pandemic to 244,447.

08:17

SPORTS

Pathum United keep Thai hopes alive with big win

Teerasil Dangda and Diogo Luis Santo were in dazzling form Saturday as BG Pathum United became the first Thai side to win in this year's AFC Champions League, hammering Kaya FC-Iloilo of the Philippines 4-1.

07:00

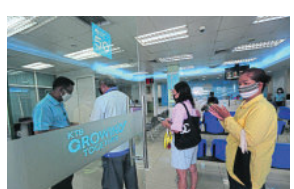
THAILAND

Worker camps sealed

Troops and police have been mobilised to seal off almost 600 construction worker camps in Greater Bangkok to ensure workers will not leave before their camps are closed.

06:44

MORE IN SECTION



for equities

Issue 2: Where did our money go?The rich have more money than we thought?

2021/06/27 09:46:40

I have seen several news recently, which has aroused new ideas. That is, the proportion of individuals in China's foreign financial investment is much higher than that of institutions.

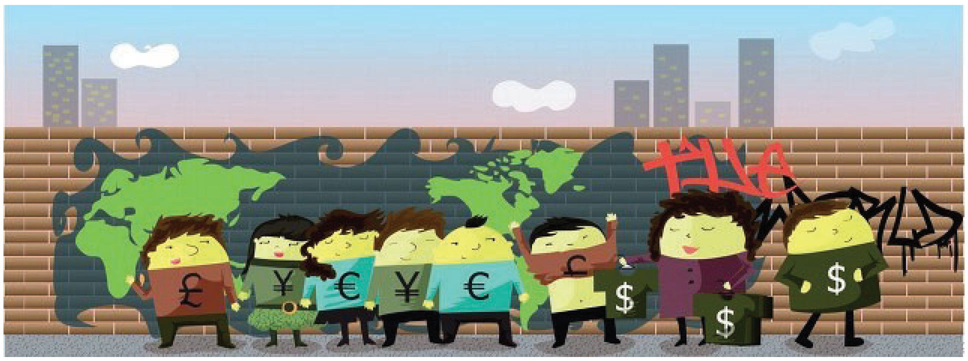
The capital in the hands of the rich is much more than we thought.

one

According to data from the Ministry of Commerce, in 2020, China's industry-wide foreign direct investment was US$132.94 billion, a year-on-year increase of 3.3%, and non-financial foreign direct investment was US$110.15 billion, a

two

The amount of overseas mergers and acquisitions announced by Chinese companies in North America was US$13.89 billion, a year-on-year decrease of 38%, mainly in the TMT, consumer goods and financial services industries.



Three

The amount of overseas mergers and acquisitions announced by Chinese companies in Asia was US$13.7 billion, a year-on-year decrease of 44.1%. They mainly invested in consumer products, financial services and TMT. The top three countries were Saudi Arabia, South Korea and Singapore.

Regardless of investment in North America, most of the investment in Singapore in Asia should be invested in financial

manufacturing industries and TMT.

The last article "Where did our money go?" The trade surplus has grown substantially, and foreign exchange reserves have basically remained unchanged," said that China's large trade surplus in the first quarter of 2021 has disappeared. Among them, we suspected that it was invested in the financial market, but at that time the main direction of the money was not yet clear. Clearly, is it a personal investment? Or institutional investment?

According to the latest data, personal investment probably still plays a major role in this.

Because institutional investment is relatively standardized and easier to count, those that are not recorded in the investment statistics of the Ministry of Commerce should basically be personal investments. According to the data collected so far, institutional investment may account for 30%, and personal investment may account for 70%.

The reason is that in the investment record of 2020, financial investment is only about 20 billion U.S. dollars, and in the first quarter of this year, our country's foreign exchange surplus has more than that amount of unknown destination. Therefore, it can only be explained that this part of the investment is within the statistical scope of the Ministry of Commerce. These money should be private funds that flowed out overseas through various means.

This shows that China's domestic capital is no longer satisfied with the domestic return on capital and has begun to flow overseas on a large scale.

The biggest risk of large-scale capital inflows overseas is that once the Fed raises interest rates, it will cause turmoil in the global market, and China's small and medium-sized players will easily be cut off the leeks.

The main reason is that once the Fed raises interest rates, all currencies in the world except the US dollar, RMB, euro, and Japanese yen will face depreciation pressure, and this depreciation should be very large, and it is easy to spit out all the income from the previous investment. .

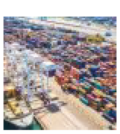
four

Morgan Stanley warned that US inflation will not slightly exceed 2%, but may exceed 2.5%, which is higher than the threshold that the Fed can tolerate. The reason is mainly based on the following two points: the speed of labor market recovery and the uncertainty of the natural unemployment rate. If the inflation level exceeds 2.5%, this may bring a subversive change to the Fed's expectations of tightening policy, which means that the financial market may face huge volatility.

At present, the Fed's interest rate hike cycle is close to the edge of action, and the Fed is still publicizing on a large scale that the interest rate hike cycle will not begin until 2023. The current inflation forecast in the United States has reached about 2.5%, exceeding the 2% red line target set by the Federal Reserve. The Fed may violate its commitments at any time and carry out related interest rate hikes.

In summary, China should warn the Fed's interest rate hike cycle as soon as possible to avoid large-scale losses for individuals and institutions.

Trending News



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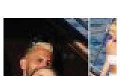

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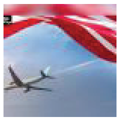

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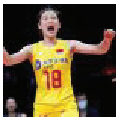

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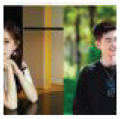

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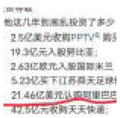

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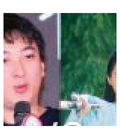

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