



Zero-Emission Vehicles Factbook

A BloombergNEF special report
prepared for COP28

December 2023

Foreword

We are delighted to present the third edition of BloombergNEF's Zero-Emission Vehicles Factbook, which was first launched at COP26 to highlight the progress being made on zero-emission vehicle (ZEV) adoption across the world.

This year's Factbook shows that despite geopolitical challenges and rising interest rates, the transition to zero-emission vehicles has continued to accelerate over the last two years. Decarbonizing transport is key to ending dependence on oil, reducing emissions and improving local air quality.

While electric vehicle adoption is rising, ambition from both governments and automakers has stalled in recent years, with very few new targets announced. More action is needed to reap the benefits of the ZEV transition – including cleaner air, new jobs and economic growth – and to keep the Paris Agreement goals within reach.

-Jon Moore, Chief Executive Officer, BloombergNEF



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Introduction and key messages

This special report has been produced by BloombergNEF to coincide with COP28, the 2023 United Nations Climate Change Conference.

Since the last Conference of the Parties, in 2022, global momentum toward zero-emissions road transport has continued to rise. Important signs of progress include:

- Annual passenger electric vehicle sales are on track to reach around 14.2 million units in 2023, up from 6.5 million in 2021 and 10.5 million in 2022. Some 15.5% of new cars sold globally in the first half of this year were electric, up from 8.9% in 2021 and 14% in 2022. Spending on clean road transport globally is set to reach \$685 billion this year.
- The growing number of electric and fuel-cell vehicles on the world's roads could displace almost 1.8 million barrels a day of oil demand for transportation this year, up from 1.5 million barrels a day in 2022. This is over 4% of total road transport demand.
- Global lithium-ion battery manufacturing capacity has increased 31% since 2022, from 1.7 terawatt-hours to 2.2 terawatt-hours.
- Automakers have collectively committed to sell around 47 million EVs a year by 2030. Automakers selling only electric vehicles now account for nearly 7% of global car sales, up from just 1% in 2020.

This *Zero-Emission Vehicles Factbook* documents the progress that has been made toward global net zero in the road transport sector.

Many of the indicators in this report are pointing in the right direction, and EV adoption is growing globally. Yet ambition from both governments and automakers has stalled, with no new significant ZEV commitments made or targets set in 2023.

National, regional and local governments must continue to implement stable, long-term policies that support the growth of zero-emissions transport and manage the phase-out of polluting vehicles.

Continued international collaboration and financial and technical assistance will be needed to accelerate ZEV adoption in emerging economies.

- In over 30% of the global car market, EV share of new vehicle sales is still below 5%. This includes important global car markets like India, Japan and Brazil.
- EVs accounted for 2.4% of the 3.1 million passenger vehicles sold in India in the first half of 2023, crossing the 1% barrier for the first time.

This report is structured around four key elements of the ZEV transition: (1) market overview, (2) market drivers, (3) corporate commitments, and (4) government commitments. We hope you find this factbook valuable, and that it stimulates further debate and discussion on pathways to zero-emission transport.

(Corrects units to gigawatt-hours on slide 47 text, and adds year 2022 on slide 30.)



Zero-Emission
Vehicles Factbook

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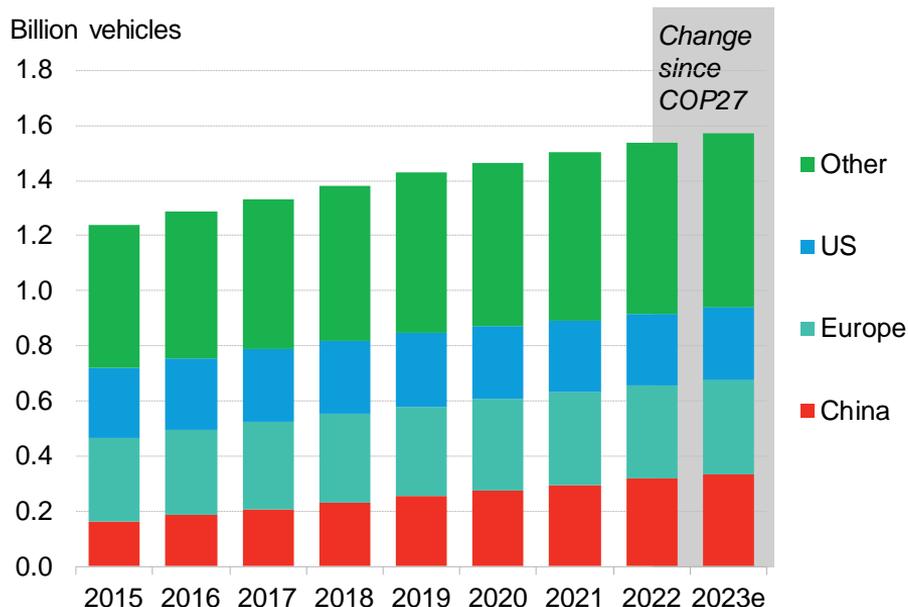
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Zero-Emission Vehicles Market Update

The global road vehicle fleet is still growing

Global four-wheeled vehicle fleet by region



The global fleet of four-wheeled road vehicles continues to grow. It now stands at over 1.57 billion vehicles, up 2.1% from 2022.

- This total includes cars, vans, trucks and buses.
- The growth rate is positive but slowing, with the fleet expected to grow 2% in 2023.
- The US, China and Europe are the three largest vehicle markets, but growth is happening most quickly outside of these regions.

About 94 million new cars, trucks and buses are expected to be added to the global fleet in 2023. Net fleet additions for 2023 are expected to reach around 33 million vehicles.

By the end of 2023, China is expected to represent about 23% of the global four-wheeled vehicle fleet, compared with 17% from the US. China surpassed the US as the country with the world's largest fleet of four-wheeled vehicles in 2020.

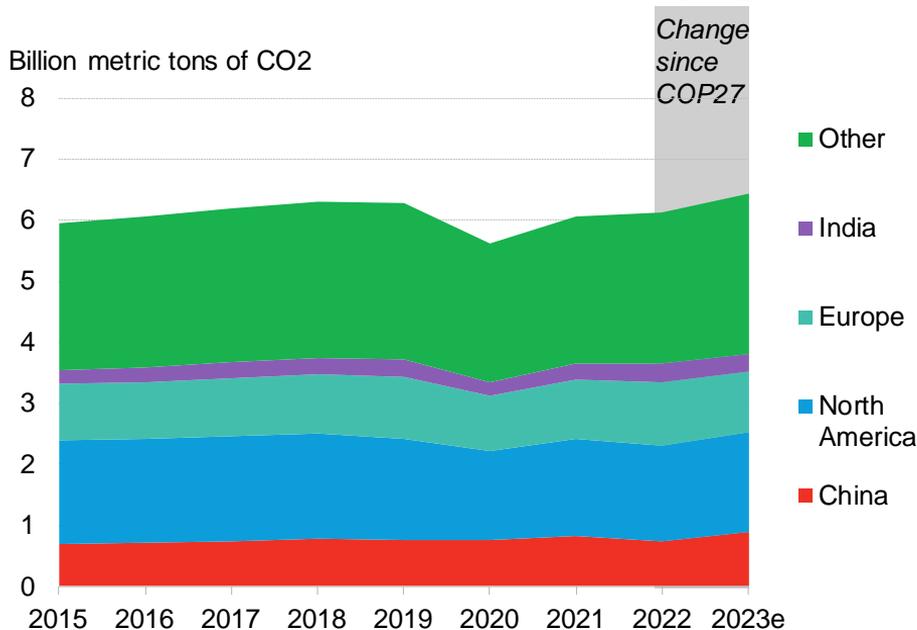
The global fleet of two- and three-wheeled vehicles now exceeds 1 billion units.

China, India and countries in Southeast Asia are by far the largest markets for two- and three-wheelers globally.

Source: BloombergNEF, national statistical agencies. Note: Includes passenger cars, commercial vehicles and buses; excludes two- and three-wheel vehicles.

ZEVs have yet to make a dent in global road transport emissions

Global CO2 emissions from road transport by region



Global road transport emissions continue to rise, despite the growing fleet of zero-emission vehicles. It is estimated that such emissions will hit 6.3 billion metric tons of CO2 (GtCO2) in 2023 – some 5% higher than in 2022.

Zero-emission vehicles can – and have – played a role in curbing increases in road transport emissions, but it will take until later this decade for ZEVs to put a noticeable dent in road transport emissions.

North America has the greatest volume of emissions from road transport, at an estimated 1.63GtCO2 in 2023.

Europe and China are expected to be the next-highest emitters this year, at 0.98GtCO2 and 0.90GtCO2, respectively. These three regions make up 59% of global road transport emissions.

India and other remaining countries are estimated to make up 41% of global road transport emissions in 2023.

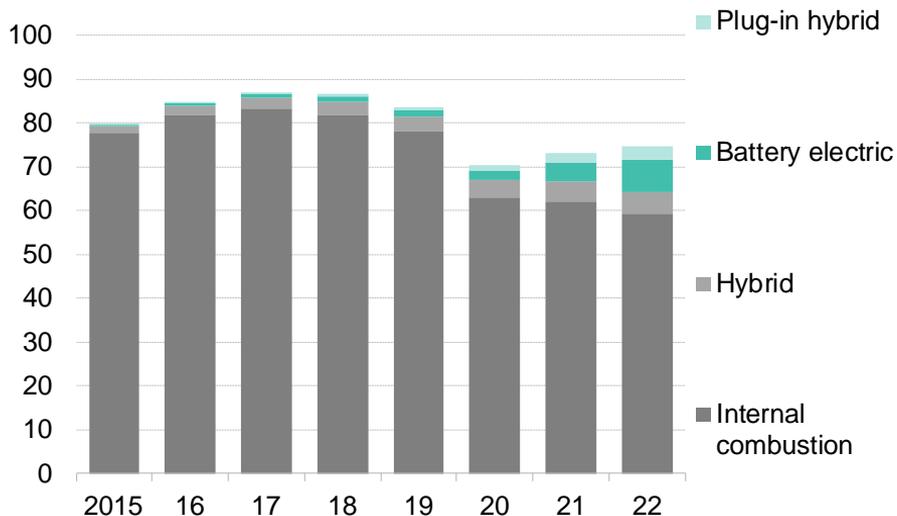
These regions include South Korea, Japan, Southeast Asia, Australia, India and the Rest of World. This group’s estimated 2023 road transport emissions are expected to hit 2.6GtCO2, an 8% increase over last year.

Source: BloombergNEF. Note: Includes passenger vehicles, commercial vehicles, buses and two- and three-wheeler emissions from tailpipe, power. 2023 is estimated based on the fleet size in BloombergNEF’s “Long-Term Electric Vehicle Outlook 2023.”

Combustion vehicle sales have already peaked

Global passenger vehicle sales by drivetrain

Million vehicles



Source: BloombergNEF

Sales of internal-combustion engine (ICE) vehicles peaked in 2017 and are now undergoing a long-term, structural decline.

Globally, just under 75 million passenger cars were sold in 2022 – roughly 2% more than in 2021, but still 11% below the pre-Covid sales figures of 2019.

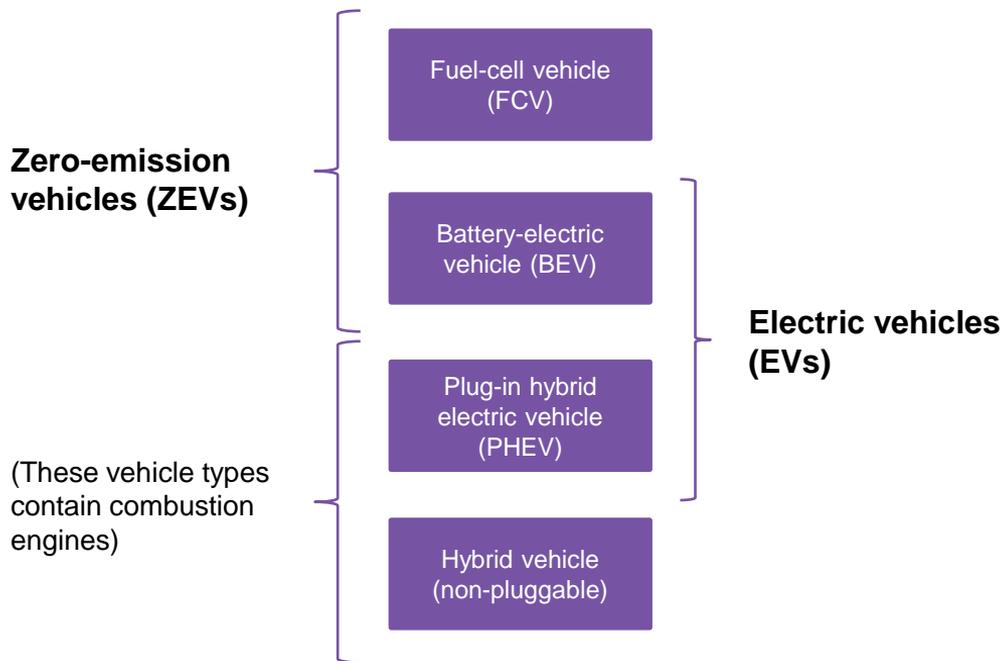
ICE sales have taken the biggest hit, declining on average 6% each year since 2019. In 2022, only 59 million ICE cars were sold globally excluding hybrids – 5% fewer than a year earlier, and 29% fewer than at their 2017 peak.

EVs are quickly displacing ICEs.

As ICE sales have tumbled, sales of battery-electric vehicles have taken off. EV sales were 68% higher in 2022 than the year before – and 253% higher than in 2019.

Plug-in hybrid sales have been increasing as well – by 54% each year since 2017, on average – despite losing some ground to BEVs in Europe.

Defining electric vehicles (EVs) and zero-emission vehicles (ZEVs)



Source: BloombergNEF. Note: Categorisations are only for the purpose of clarifying content in this report.

For the purposes of this report, we define zero-emission vehicles (ZEVs) as those vehicles that never emit carbon dioxide from their tailpipes.

This means that in our categorization, ZEVs only include pure battery-electric vehicles (BEVs) and fuel-cell vehicles (FCVs), neither of which have internal combustion engines.

It is understood that these vehicles should be fueled from clean electricity or hydrogen if they are to be truly zero-emission in operation.

Electric vehicles (EVs) as a category are commonly understood to include plug-in hybrids (PHEVs).

In this report, as in all other BNEF publications, we include PHEVs in our definition of EVs, alongside pure BEVs.

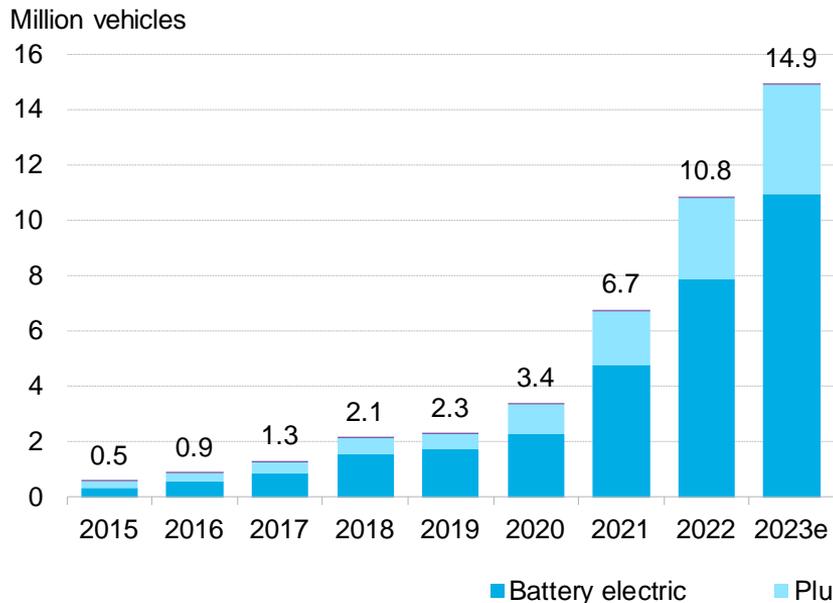
However, PHEVs are excluded in some portions of this report that focus on ZEVs, as defined above.

Pages that focus on the broader category “EVs and FCVs” encompass all of the above.

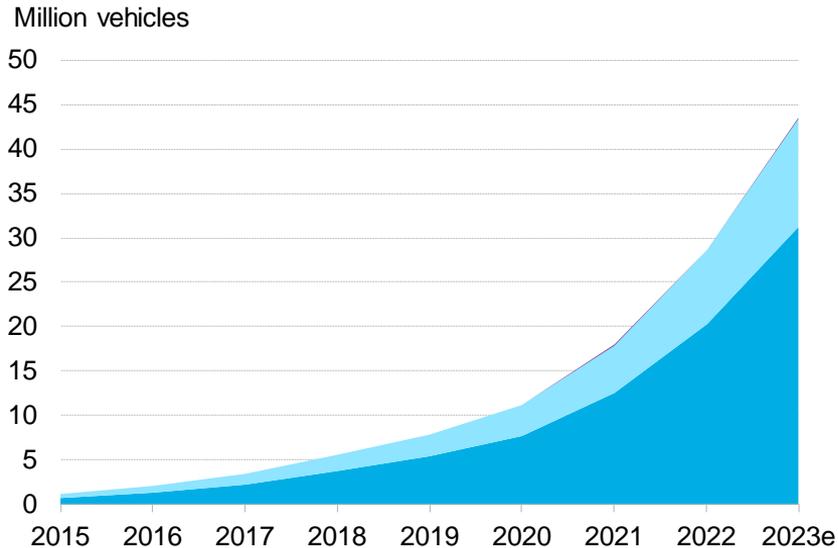
Hybrid vehicles that cannot be charged from an external power source are not included in our definitions of ZEV or EV.

Most zero-emission vehicles are BEVs, not FCVs

Global EV and FCV four-wheeler sales



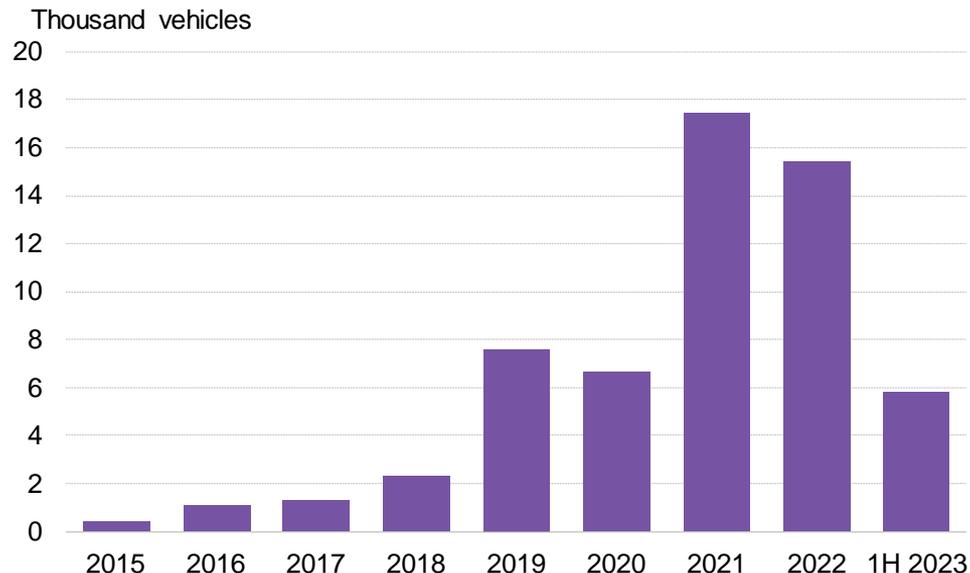
Global EV and FCV four-wheeler fleet



Source: BloombergNEF. Note: Includes passenger vehicles, commercial vehicles and buses. “EVs” includes battery-electric vehicles (BEVs) and plug-in hybrid vehicles (PHEVs), but not fuel-cell vehicles (FCVs). Excludes two-and-three wheelers. 2023e is an estimated value based on sales in the first three quarters of 2023.

Sales of hydrogen fuel-cell passenger vehicles are falling

Passenger FCV sales



Passenger fuel-cell vehicles (FCVs) have failed to take off in the same way their electric counterparts have. While passenger EV sales reached 10.5 million units in 2022, passenger FCV sales reached only 15,000 units, a 12% drop from the year before.

South Korea, Japan and the US state of California have seen the highest sales of passenger FCVs. While automakers like Toyota and BMW have backed the fuel-cell technology, it has yet to gain any significant traction among customers. South Korea's market represented 67% of new global passenger fuel-cell vehicle sales in 2022.

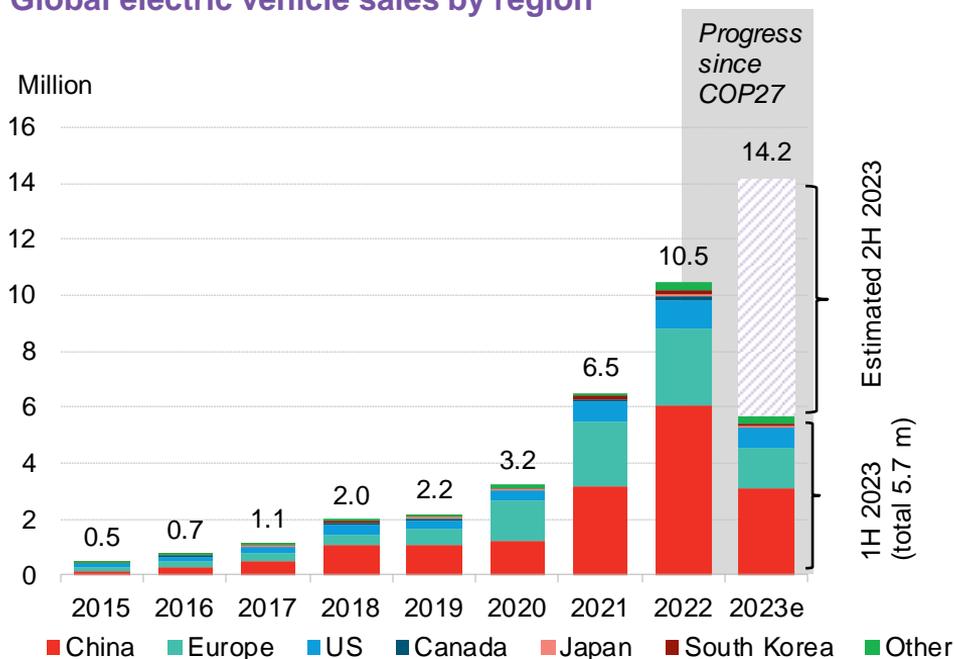
Poor FCV demand has hindered hydrogen refueling deployment, and the network is dwarfed by the EV charging infrastructure. Some refueling stations in markets like California, Norway and the UK have even closed.

In 2022, there were only 905 hydrogen refueling stations available globally, nearly one-third of which were located in Japan and South Korea. That same year, only 169 new stations were installed to support hydrogen fuel-cell vehicles, compared with 952,000 net additions of EV charging stations; in 2021, those numbers were 126 and 520,000, respectively.

Source: BloombergNEF, Marklines, Hydrogen Analysis Resource Center (HYARC), Japan Ministry of Economy, Trade and Industry.

Passenger EV sales continue to rise, but growth has slowed since COP27

Global electric vehicle sales by region



Global passenger EV sales grew by 60% in 2022, to reach 10.5 million.

By contrast, the overall passenger vehicle market saw year-on-year growth of only 2%.

The EV surge has continued into 2023.

In the first six months of 2023, nearly 5.7 million EVs were sold globally – over 35% more than in 1H 2022.

China and Europe have led the global passenger EV market since 2015, but Europe's growth has been slower since 2022.

China and Europe were (respectively) responsible for 58% and 26% of global EV sales in 2022, and 54% and 26% in 1H 2023. The next-largest market was the US, with 12% of the global market in the first half of this year.

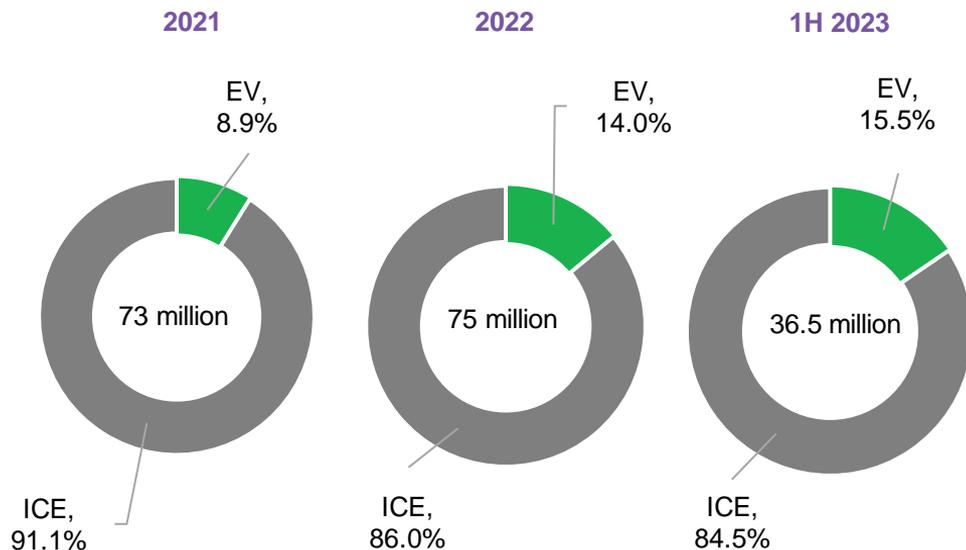
BNEF expects 2023 to be yet another record year for global EV sales, at over 14 million units sold.

Should passenger EV sales hit that mark, they would end 2023 some 34% higher than in 2022, and 115% higher than in 2021.

Source: BloombergNEF, Marklines, JATO, government registration agencies. Note: Includes BEVs, PHEVs and FCVs.

EVs are now more than 15% of the global passenger vehicle market

Global passenger vehicle sales by drivetrain



Source: BloombergNEF. Note: EV refers to electric vehicle, ICE refers to internal combustion engine.

Electric vehicles exceeded 15% of global car sales in 1H 2023, up slightly from 14% in 2022.

Record high EV sales in 2022 kept a cap on sales of ICEs, which fell to 64.2 million, from 66.6 million in 2021.

China and Europe are pulling ahead in market share terms, just as they are in absolute terms.

Some 27% and 22% of cars sold in China and Europe, respectively, were electric in 1H 2023, in contrast to 8.8% in North America and 3.6% in Japan.

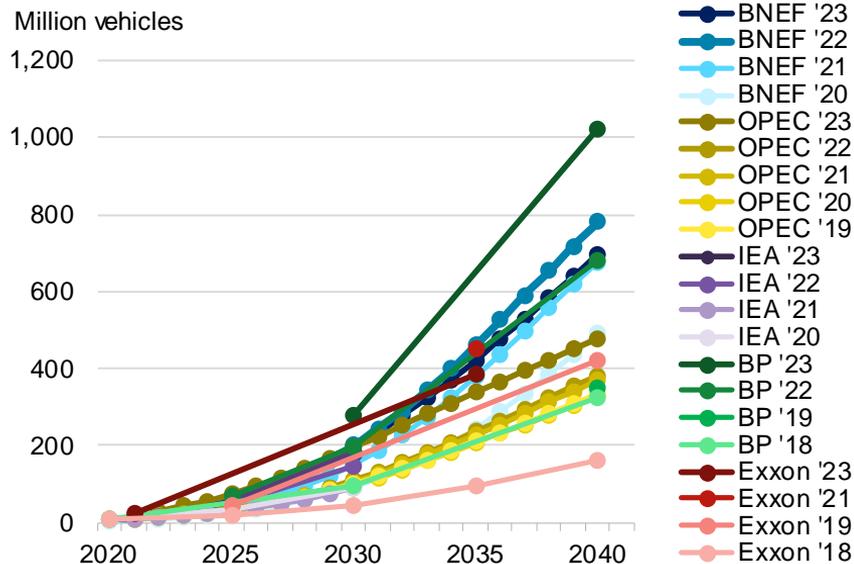
The biggest car markets in Europe have made significant progress since 2019. Between 1H 2019 and 1H 2023, the EV share of sales has increased:

- From 2.8% to 25% in France.
- From 2.2% to 24% in the UK.
- From 3% to 22% in Germany.
- From 0.5% to 9% in Italy.

Progress has also been noticeable in North America, where the EV share of sales grew from 1.8% to 8.8% over the same time period.

The outlook for zero-emission vehicles has again improved markedly

Global passenger and commercial ZEV fleet to 2040, various outlooks



Source: BloombergNEF, International Energy Agency (IEA), OPEC, BP, ExxonMobil. Note: IEA data uses the base-case Stated Policies Scenario for 2020 through 2022. BNEF and IEA scenarios include BEVs but exclude PHEVs and FCVs. OPEC includes BEVs, PHEVs and FCVs. Exxon and OPEC include BEVs and PHEVs.

Long-term outlooks for ZEV adoption keep getting more bullish. On average, new forecasts for the BEV fleet size in 2030 have risen 26% since last year. These upward revisions are due primarily to increased policy support and growing consumer interest.

In its *2023 Long-Term Electric Vehicle Outlook*, BNEF projects the global passenger and commercial ZEV fleet will hit 696 million vehicles by 2040

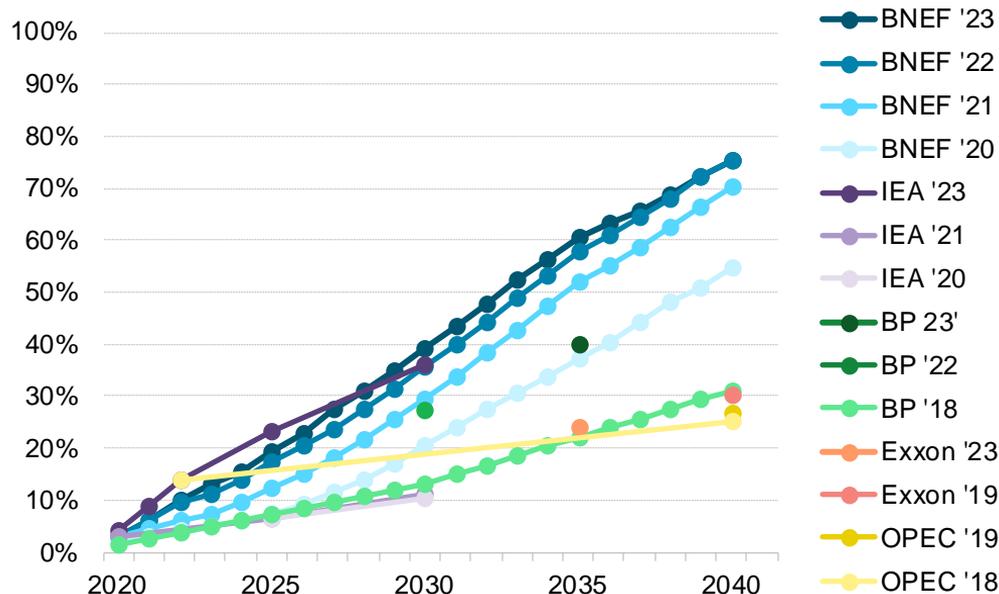
The latest BNEF outlook sees passenger ZEVs making up 44% of the 2040 passenger vehicle fleet, a share that is almost unchanged from the 2022 report. However, the 2023 outlook now has commercial ZEVs accounting for 27% of the 2040 commercial fleet, up two percentage points from last year.

Other organizations have also become more bullish in their most recent publications, increasing their ZEV adoption outlooks.

The IEA's 2023 *Global EV Outlook* increased the size of its expected 2030 BEV fleet by 22%, to 180 million.

ZEVs are now expected to take more market share, sooner

Global ZEV share of passenger vehicle sales, various outlooks



Source: BloombergNEF, IEA, OPEC, BP, ExxonMobil. Note: IEA data uses the base-case Stated Policies Scenario for 2020 through 2022. BNEF scenario is the base-case Economic Transition Scenario. BNEF, IEA and Exxon scenarios include BEVs but exclude PHEVs and FCVs. OPEC includes BEVs, PHEVs and FCVs, while BP includes BEVs and PHEVs.

Recent major reports are projecting ZEVs could capture a higher share of passenger vehicle sales sooner than previously expected, thanks to price reductions and expanded policy support.

Share of sales, which is distinct from total ZEV sales, is a useful metric for comparing these outlooks, since reports diverge on how global vehicle sales will change over time. These distinctions reflect differing views on overall car ownership trends, as well as on the roles of autonomous and shared mobility technologies and other modes of transport.

In the base-case Economic Transition Scenario of BNEF's 2023 *Long-Term Electric Vehicle Outlook*, ZEV share of passenger vehicle sales reaches 75% globally by 2040.

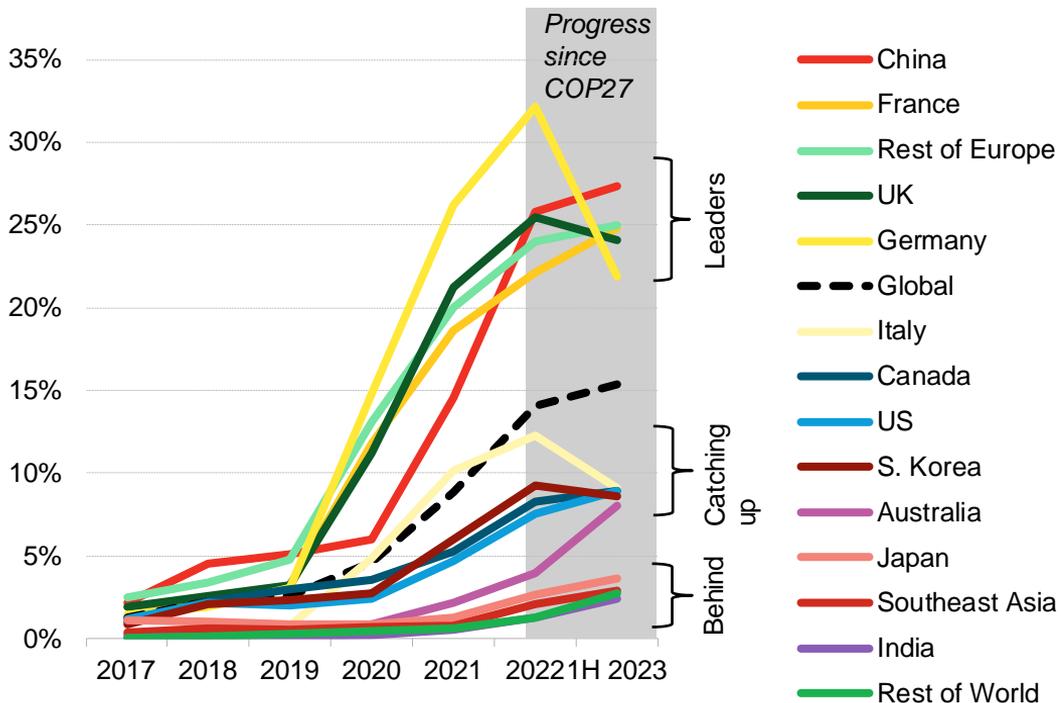
This figure, while unchanged from last year's report, is up significantly from the 2020 *Outlook*, reflecting additional policy support for ZEVs that has been introduced over the past few years.

The International Energy Agency's 2023 *Global EV Outlook* sees an estimated 36% BEV share of passenger vehicle sales by 2030.

That's more than double the 17% estimated in its 2022 report, bringing the IEA's scenario closer to BNEF's 2023 Outlook.

But growth is unevenly distributed

EV share of passenger vehicle sales



Source: BloombergNEF, Marklines, Jato. Note: Includes BEVs and PHEVs.

In over half of the global car market, EV adoption is still below 10% of sales. This includes countries like the US and Japan.

EV share of sales in the US reached 9% in 1H 2023, and 4% in Japan. The Inflation Reduction Act is set to boost EV uptake in the US, while the expanding lineup of electric “kei-car” models and purchase subsidies will increase adoption in Japan.

Over 30% of the global car market is in countries where EV adoption is still below 5%.

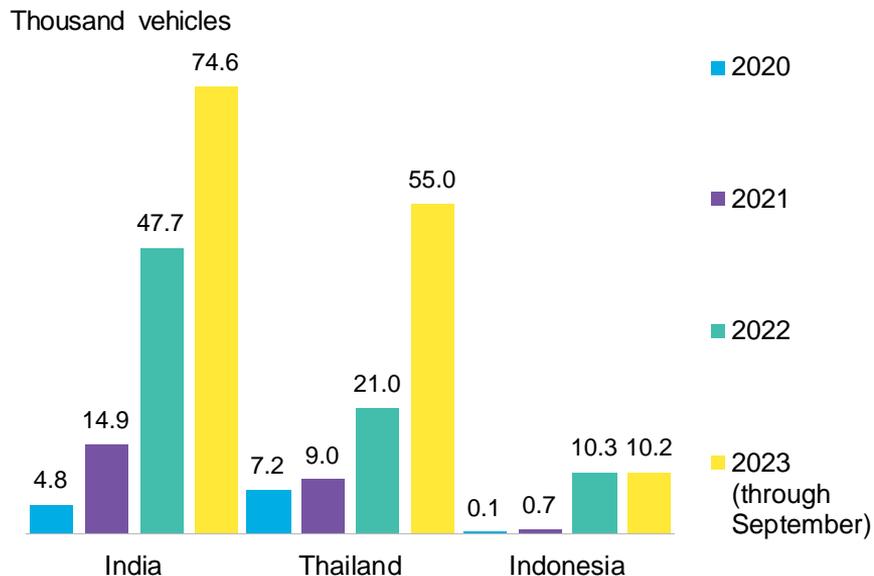
EV adoption in India, Southeast Asia, Japan and the Rest of World category – which includes countries like Brazil or Russia – is climbing, but it was still below 5% in 1H 2023.

In India, the market crossed the 1% EV adoption mark only in 2022, reaching 2% in 1H 2023.

Relatively low-priced vehicles, lack of EV model availability, underdeveloped charging infrastructure, unreliable grids and lack of policy support are some of the issues holding these countries back.

There is new progress on ZEV adoption in emerging economies

India, Thailand and Indonesia passenger EV sales



Source: BloombergNEF, Marklines, JATO. Note: Includes both BEVs and PHEVs.

EV adoption is accelerating in some emerging economies, with India leading the pack.

Sales of passenger EVs in **India** reached 75,000 in 2023 through September, more than double the number of sales over the same period last year. EVs account for 2.4% of the 3.1 million passenger vehicles sold in the country so far in 2023.

Nine months into the year, electric car sales in **Thailand**, which stand at 55,000, are already nearly three times as high as total sales in 2022. Electric cars are now responsible for 9% of all cars sold in the country, up from 5% last year.

Indonesia's EV sales are also increasing, making up 2% of all passenger cars sold in the country this year through September, compared with just 1% in 2022.

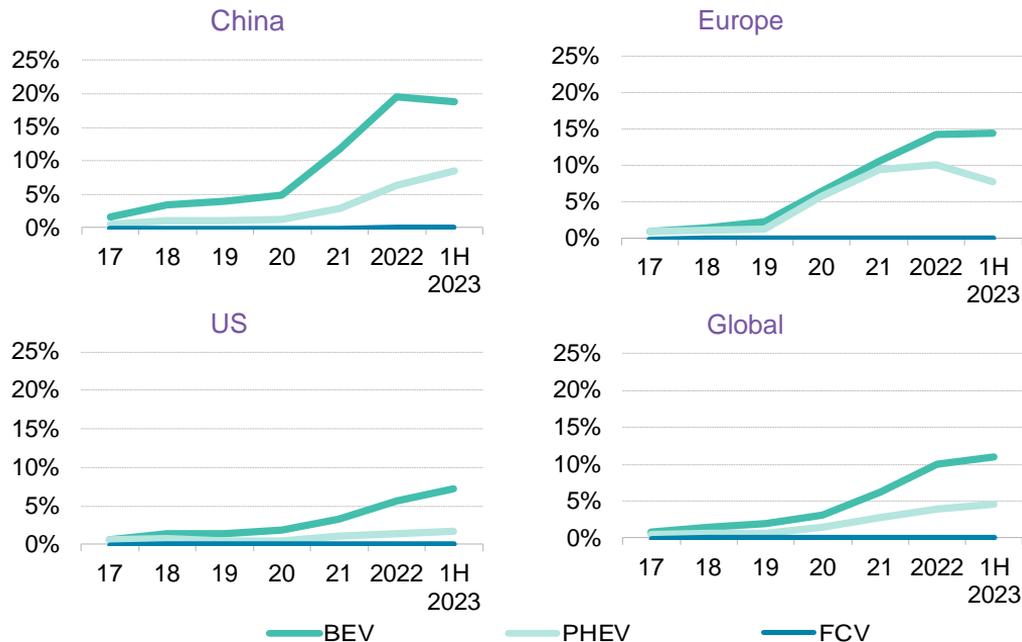
Policy support and low-cost EVs have been key to progress in these countries.

Some 86% of all electric cars sold in India in 2023 through September were priced below \$20,000. More than half of these were models launched just this year, with the cheapest, MG Motor's Comet EV, priced below \$10,000.

Ramped-up EV production capacity from automakers like Wuling and Vinfast underpinned growth in Indonesia, while growth in Thailand was driven by new subsidies and exemptions on import duties.

Pure battery EVs are beating out plug-in hybrids and fuel-cell vehicles

Passenger vehicle share of sales by drivetrain



Globally, sales of battery-electric vehicles (BEVs) are outpacing those of plug-in hybrids (PHEVs) and fuel-cell vehicles (FCVs).

- BEVs made up 11% of 1H 2023 global passenger vehicle sales, while PHEVs were under 5%. This is up from 3% and 2% in 2020, respectively.
- FCVs are a tiny portion of the passenger vehicle market, at under 0.1% of sales globally.

China, the US and Europe follow this same trend.

In China, BEVs' share in total car sales increased from 5% in 2020 to 19% in the first half of 2023. Meanwhile, in the US, BEVs accounted for 8% of all vehicles sold in 1H 2023.

Historically, plug-in hybrids (PHEVs), have fared considerably better in Europe than elsewhere, thanks to strong policy support. Yet the growth of PHEVs in Europe is slowing, while sales in China are still growing.

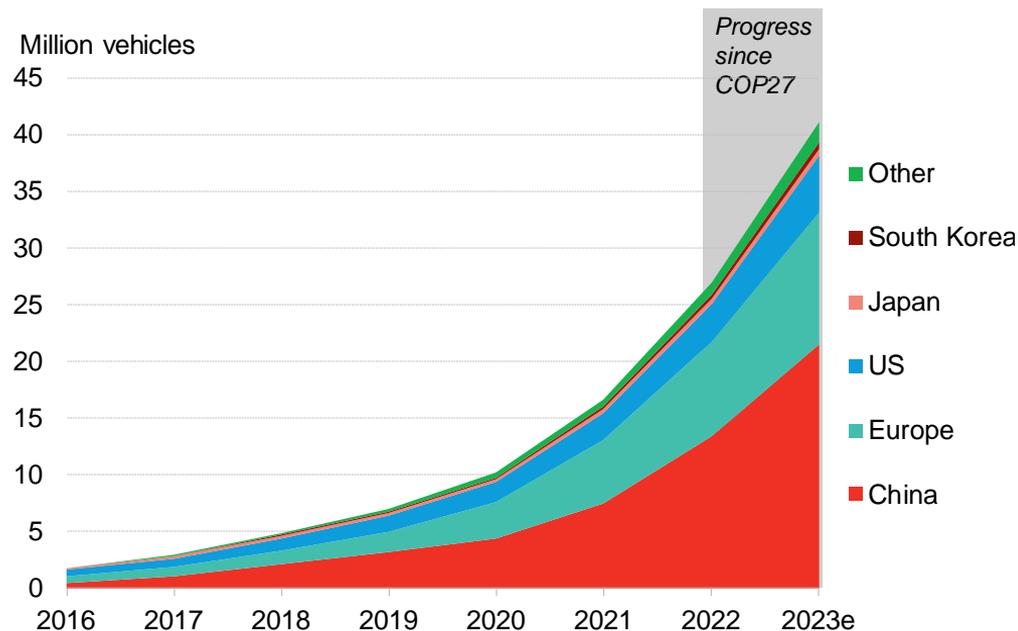
Some 35% of all EVs sold in Europe in 1H 2023 were PHEVs, down from 41% in 2022.

Europe's overall PHEV share of passenger vehicle sales dropped to 8% in 1H 2023, from 10% in 2022.

Source: BloombergNEF. Note: BEV is battery-electric vehicle; PHEV is plug-in hybrid electric vehicle; FCV is fuel-cell vehicle.

There are now almost 41 million passenger EVs on the road....

Global passenger EV fleet



Source: BloombergNEF. Note: Includes BEVs and PHEVs.

The fleet of passenger electric and fuel-cell vehicles has quadrupled in size since 2020.

A cumulative total of 41 million EVs will have been sold by the end of 2023, up from just 10 million at the end of 2020.

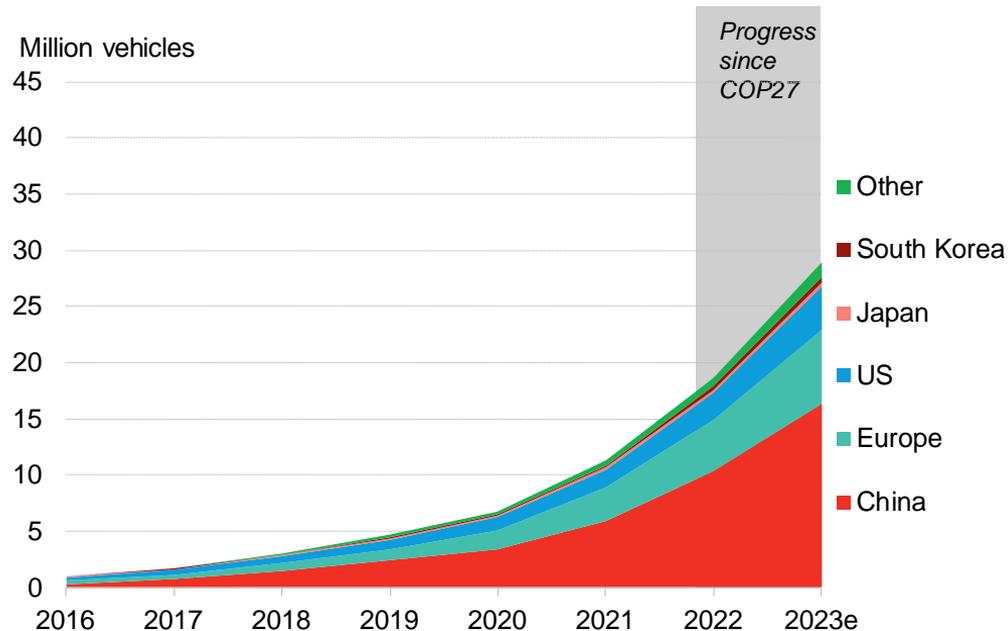
Most of these vehicles are still on the road, which means that EVs now make up about 3% of the global fleet of passenger vehicles.

China and Europe are home to 80% of that EV fleet.

- There are now nearly 22 million EVs on the road in China – five times the 2020 level.
- There are nearly 12 million EVs in Europe – compared to just 3.2 million in 2020.
- The US comes in third, with an EV passenger fleet of 5.1 million vehicles – triple the 2020 value.

....but only around 29 million are truly zero-emission

Global passenger ZEV fleet (excludes plug-in hybrids)



Source: BloombergNEF

Using stricter criteria, the fleet of true zero-emission passenger vehicles (in other words, excluding PHEVs) has more than quadrupled in size since 2020.

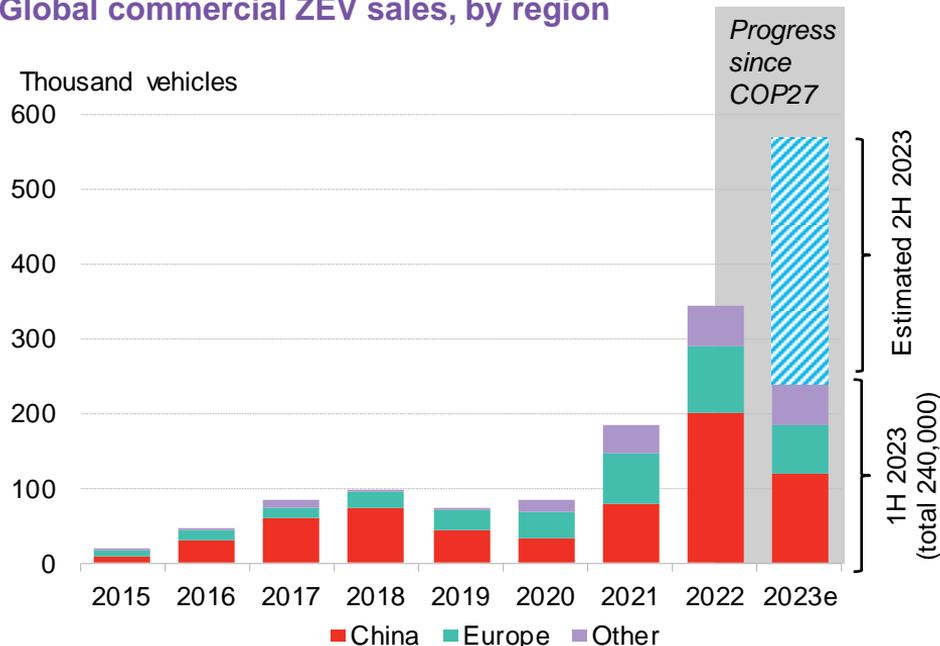
Cumulative all-time sales of zero-emission passenger vehicles reached around 29 million in 2023, up from just 6.8 million at the end of 2020.

Despite Europe's higher share of PHEVs, it is still the second-largest ZEV market globally, after China.

- There are now over 16.3 million ZEVs in China, compared with Europe's 6.6 million.
- The US again comes in third with a ZEV passenger fleet around 58% the size of Europe's, or 3.8 million vehicles.

Commercial ZEV adoption is beginning to take off

Global commercial ZEV sales, by region



Source: BloombergNEF, EAFO, CAIN, Korea Ministry of Transport, national registration agencies. Note: Includes light- (LCV), medium- (MCV) and heavy-duty (HCV) commercial vehicles.

Sales of zero-emission commercial vehicles continue to grow, but sales patterns diverge between segments.

Some 240,000 zero-emission commercial vehicles were sold in 1H 2023. These were almost exclusively BEVs and mostly delivery vans and lighter trucks. China, some European markets and South Korea saw sales of electric light commercial vehicles (e-LCVs) increase between 40% and 95% compared to last year. Sales in the US were up as well, rising 80% compared with 1H 2022 and reaching 2.8% of total segment sales. Adoption of e-LCVs in 1H 2023 was at 9% in China, 7% in Europe and 33% in South Korea.

China dominates the market for zero-emission heavier trucks, which made up nearly 2.5% of medium- and heavy-duty trucks sold in China in 1H 2023.

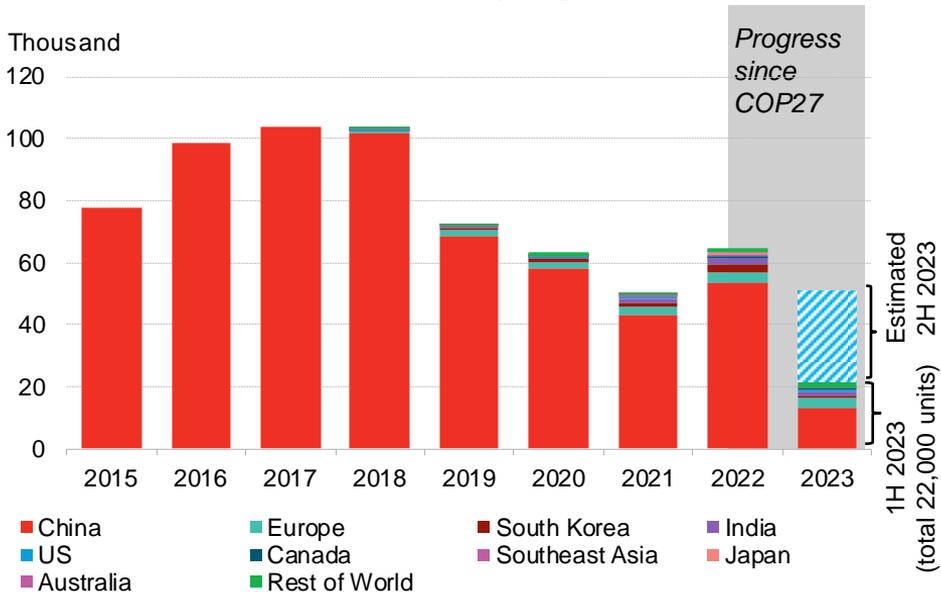
Some 17,000 medium- and heavy-duty battery-electric and fuel-cell trucks were sold globally in 1H 2023, over 40% more than during the same period in 2022. Of those, 80% were sold in China. As in the passenger-vehicle segment, BEVs dominate sales of commercial ZEVs, which are largely used for short-distance distribution, drayage and refuse collection.

Fuel-cell truck sales also increased, but from a very low base.

Hydrogen-powered commercial vehicle sales grew more than a third from 1H 2022. Nearly all of those were sold in China, with a few dozen vehicles delivered in Europe.

Zero-emission bus sales are slowing in China but rising elsewhere

Global zero-emission bus sales by region/country



Global zero-emission bus sales have slowed, but growth patterns vary widely between countries.

Despite increasing by nearly 30% in 2022, the global market in 2023 is likely to finish just above 2021 levels. Yet this figure obscures countries' differing rates of progress. In most tracked markets except China, e-bus sales grew in 1H 2023, while sales in China were 20% lower than during the same period last year. Even though sales in the fourth quarter are typically half of the full year, third-quarter sales confirm a declining trend as some Chinese cities complete the switch to e-buses. Since the country accounts for more than 80% of global sales, it determines the direction of the overall market.

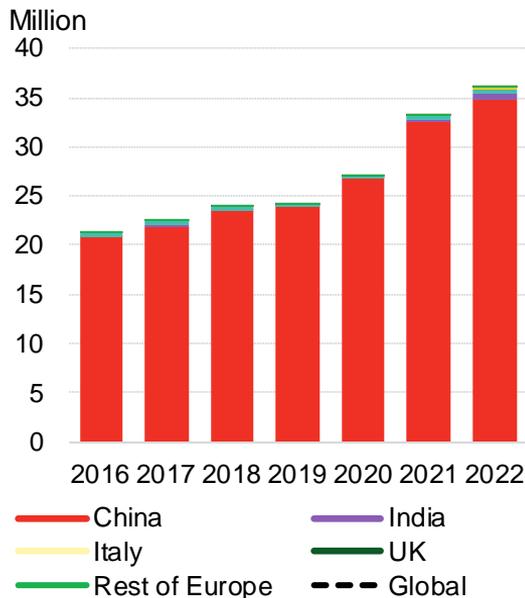
The market for battery and fuel-cell buses is becoming more diverse globally.

Policies and municipal procurement programs continue to support the market. Europe is the second-largest market for zero-emission buses: in 1H 2023, sales were just over 3,200 units, already close to the total 2022 market size. In India, e-bus sales have already exceeded last year's figures. More than 1,500 zero-emission buses were sold in the country in 1H 2023, an astonishing jump from fewer than 100 units in 2020.

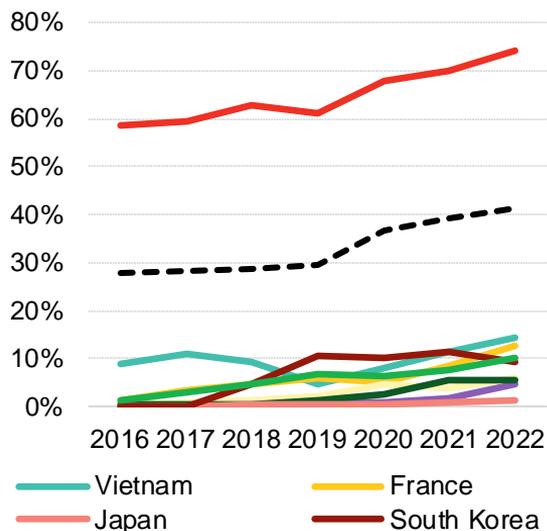
Source: BloombergNEF. Note: China includes municipal and non-muni buses. We have re-classified segments in the Chinese bus market, including historical figures, and mini-buses are not included in China's bus sales.

Electric vehicles fueled the two-wheeler market, with 9% sales growth in 2022

Electric two-wheeler sales



EV share of two-wheeler sales in key markets



Electric two-wheeler sales grew 9% year-on-year in 2022, to reach 36 million vehicles.

Total global sales of two-wheelers reached 88 million in 2022, the highest level since 2010.

More than half of all two-wheelers and 96% of electric models were sold in China. Outside of China, only 4% of all two-wheelers sold were electric in 2022.

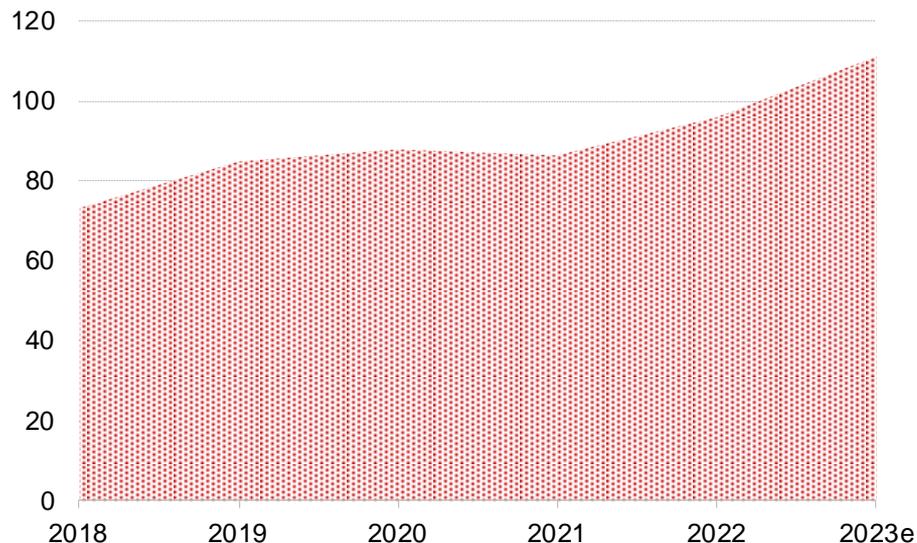
- The implementation of new standards for electric bicycles and mopeds across China, combined with a wide availability of cheap, electric models, boosted electric two-wheeler sales to nearly 35 million in 2022.
- Europe's electric two-wheeler sales hit 150,000 units in 2022, led by France, Germany and Italy. Supportive policies and new model launches brought electric share of two-wheeler sales in Europe to 10%.
- In India, electric two-wheeler sales increased 3.1 times in 2022, driven by subsidies, more EV models and demand from fleet operators.

Source: BloombergNEF, national governments, industry associations. Note: Excludes e-bicycles.

EVs and FCVs are avoiding about 112 million metric tons of emissions per year

Avoided net annual emissions from road transport from EVs and FCVs

Million metric tons of CO₂



Source: BloombergNEF. Note: Chart includes emissions avoided from the tailpipes of passenger vehicles, commercial vehicles, buses and two- and three-wheelers, minus power sector emissions. 2023 is estimated based on the fleet size from BloombergNEF's "Long-Term Electric Vehicle Outlook 2023."

The growing global EV and FCV fleet is already helping avoid carbon dioxide emissions from tailpipes.

Electric vehicles will be eliminating about 112 million metric tons of CO₂ (MtCO₂) per year from global road transport emissions by the end of 2023. This is a 'net' figure, which accounts for the small increase in power-sector emissions resulting from higher electricity demand. It will rise as more ZEVs hit the road.

Avoided emissions at the end of 2023 will be up about 26% from 2020.

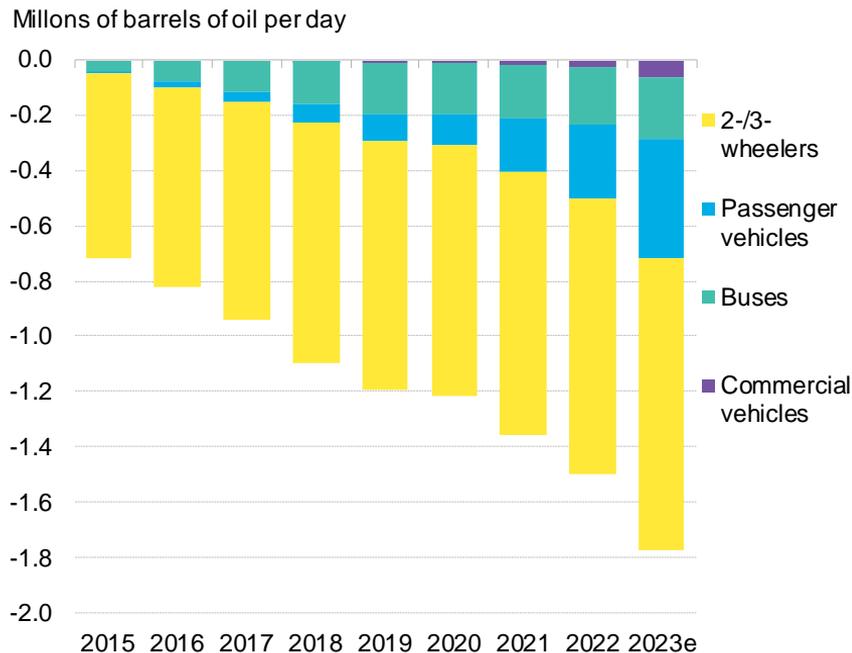
Net emissions avoided were just below 88 MtCO₂ at the end of 2020, and have been increasing as the EV and FCV fleet grows. EVs account for over 99.9% of avoided emissions, with FCVs playing a very minor role.

There is a long way to go – estimated avoided emissions for 2023 are only about 2% of all emissions from road transport.

While EV and FCV sales continue to rise in many regions, it takes years for the vehicle fleet to turn over and begin curbing carbon emissions.

Oil use avoided by EVs has more than doubled since 2015

Oil demand avoided by EVs and FCVs



Source: BloombergNEF, IEA.

Global oil demand for road transport is expected to reach roughly 42.3 million barrels a day in 2023, a slight increase over the past year.

Electric vehicles and fuel-cell vehicles are expected to avoid almost 1.8 million barrels of oil a day in 2023, or about 4.1% of road transport sector demand. This is up from 1.5 million barrels a day in 2022.

Avoided oil consumption increased by almost two and a half times from 2015 to 2023, up from ~720,000 barrels of oil per day in 2015. This is expected to accelerate.

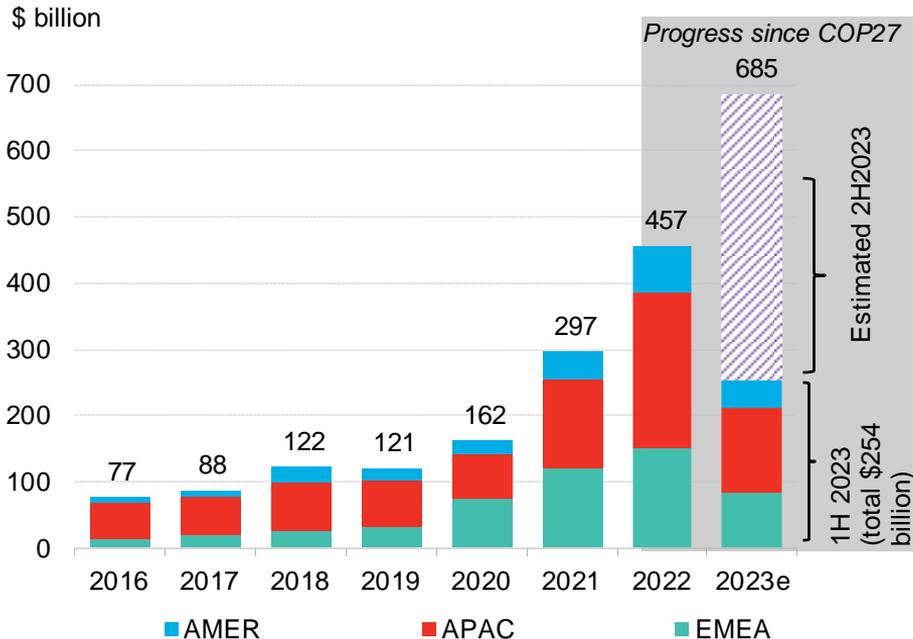
Two- and three-wheeled EVs account for about 60% of the oil demand avoided in 2023 due to their rapid adoption and large fleet, particularly in China, Southeast Asia and India.

Passenger EVs surpassed buses in 2022 to become the second-largest source of avoided oil demand. In 2023, passenger EVs are estimated to represent 23% of total avoided oil demand, while buses and commercial vehicles should represent 13% and 3%, respectively.

Under BNEF's base-case Economic Transition Scenario, EVs and FCVs are set to displace 12.4 million barrels of oil a day by 2035. BNEF's Net Zero Scenario, which achieves a zero-emission vehicle fleet globally by mid-century, an additional 4 million barrels more a day are displaced in 2035.

Clean transport spending could grow to \$685 billion in 2023

Global spending on clean road-transport vehicles and infrastructure



Global spending on clean road-transport vehicles and infrastructure – including BEVs, PHEVs and FCVs – hit nearly \$1.6 trillion cumulatively from 2016 through the first half of 2023.

BNEF tracks investment across an array of subsectors, including clean passenger vehicles, commercial vehicles, buses, and home and public charging infrastructure. This figure includes final purchases of vehicles and investment in infrastructure, but not investment into manufacturing plants or other supply chain steps.

In the first half of 2023, clean transport spending hit an estimated \$254 billion. This is just 14% below total annual spending in 2021.

The Asia-Pacific region (APAC) led spending in the first half of 2023, with \$127 billion. Europe, the Middle East and Africa (EMEA) came in second, at \$83 billion, while the Americas (AMER) saw \$44 billion of spend.

We expect the final total for 2023 to reach \$685 billion, around 50% more than the year before.

Passenger-vehicle investments far outweigh those in other segments.

Passenger EVs and FCVs accounted for 84% of total expenditures in 1H 2023, the same as in all of 2022. As more spending on commercial vehicles and infrastructure occurs, this share should fall.

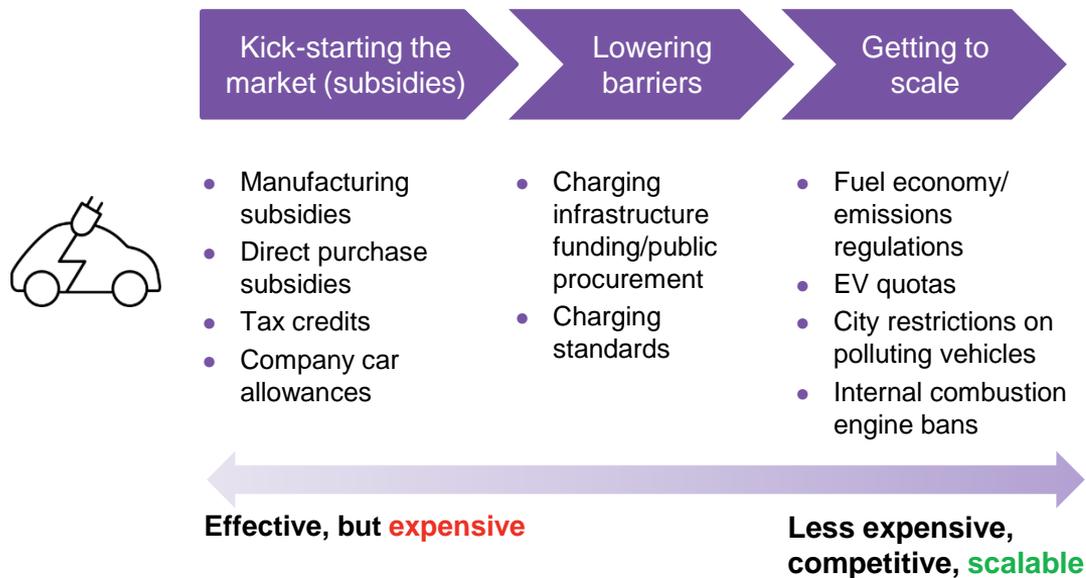
Source: BloombergNEF. Note: Includes passenger and commercial vehicles, buses, public and home charging, hydrogen refueling, BEVs, PHEVs, FCVs.

A photograph of a person in a light blue button-down shirt. They are holding a black coffee cup with a lid in their left hand and a smartphone in their right hand. In the background, a white electric vehicle is plugged into a charging station. The image is split diagonally, with the top-right portion showing the person and the bottom-left portion being white with text.

Market Drivers

**Policy, technology and
infrastructure**

Policies have evolved from subsidies to market-based mechanisms



Direct purchase incentives, which lower the upfront cost of an EV, are an effective tool in incentivizing early EV adoption, but are expensive for governments to support in the long term.

China had some of the most generous subsidies in place from 2010, but reduced them each year until they were fully eliminated at the end of 2022. The 10% purchase tax exemption was extended to 2023.

Supply-side policies, like fleet-wide fuel economy targets, are gaining importance.

- Europe and China have some of the most stringent fuel economy targets in place globally, which automakers must meet. Hitting these goals implies significantly increasing sales of EVs.
- Automakers active in these two regions are thus strongly induced to launch new EV models, and make them attractive to consumers.
- Tightened Corporate Average Fuel Economy (CAFE) standards in the US will also be difficult to meet without much higher EV sales.

Source: BloombergNEF

Policy provides a strong foundation for EV adoption in major car markets

Major EV policies in three key EV markets

Policy	China	US	Europe
Supply side			
Fuel economy targets			
EV quotas			
ICE phase out			
Manufacturing subsidies			
Demand side			
Purchase incentives			
Company car benefit			

In China, purchase subsidies expired at the end of 2022.

Subsidies were a very important driver for EV adoption in the country, but as the market scaled up, they became too costly to continue. There are still purchase subsidies on offer in some cities and provinces, and fuel economy targets still underpin the market.

Fuel economy targets in Europe are probably the single most important policy in the region, pushing automakers to invest in EVs and levying fines if they miss their targets.

Purchase subsidies are, or were, offered by most countries in the region, but with increasing adoption, several countries began to phase those out. The UK was the first to do so when it ended the plug-in car grant in June 2022. The UK has kept incentives for company car purchases and introduced an EV sales quota for automakers.

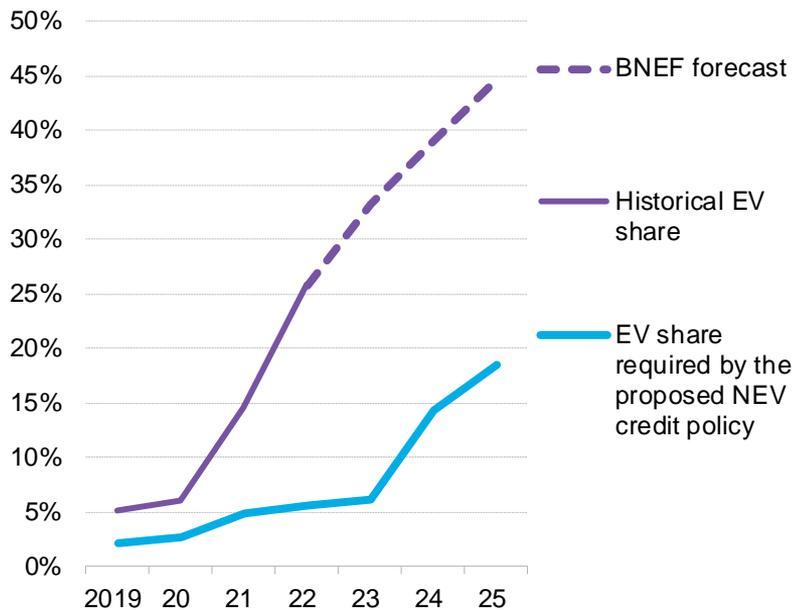
The Inflation Reduction Act (IRA) altered the EV adoption trajectory in the US, bringing in “point of sales” EV purchase incentives and a plethora of manufacturing incentives, for both cars and batteries.

North American EV and battery supply chain manufacturing commitments following the passage of the IRA have topped \$100 billion to date.

Source: BloombergNEF. Note: Red with three cars is “very important but no longer available” or “very important but expired in some countries”. Dark green with three cars is “very important and federal level”, lighter greens (with two or one car) indicate lower importance or “important but available only in some countries/states.”

EV demand in China is running ahead of what regulations require

Historical EV share of new car sales and required share to meet NEV targets



Since 2019, China has been promoting domestic EV sales through the New Energy Vehicle (NEV) credit and Corporate Average Fuel Consumption (CAFC) credit systems.

Under the NEV credit system, automakers are required to generate credits from the production of battery-electric, plug-in hybrid and fuel-cell vehicles.

The NEV target was amended on July 6, 2023. The revised mandate raises the NEV credits automakers must generate to 38% of their total internal combustion engine vehicle production and imports in 2025, up from 18% in 2023. With each EV able to generate more than one credit, BNEF expects the EV share of new car sales would need to reach 14% in 2024 and 18% in 2025 to comply.

Even the updated NEV credit targets are behind the actual sales in the country and lag BNEF's forecasts for EV sales in 2025. Consumer demand in China has taken off since 2020.

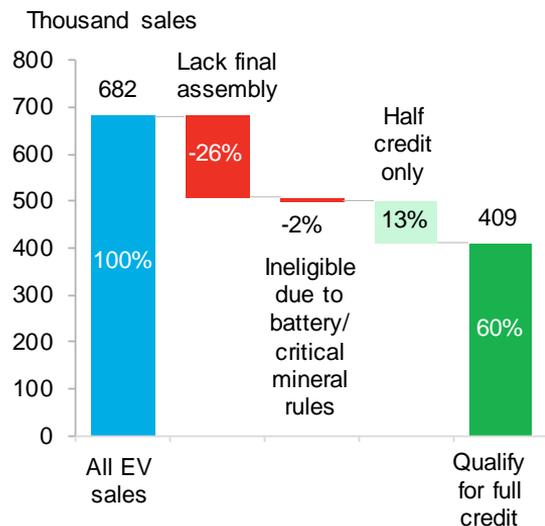
The required 18% EV share of sales for 2025 is lower than the 26% that was already electric in 2022.

In BNEF's forecast, EV sales in China make up 45% of new cars sold in the country in 2025 – 26 percentage points higher than the target requirement.

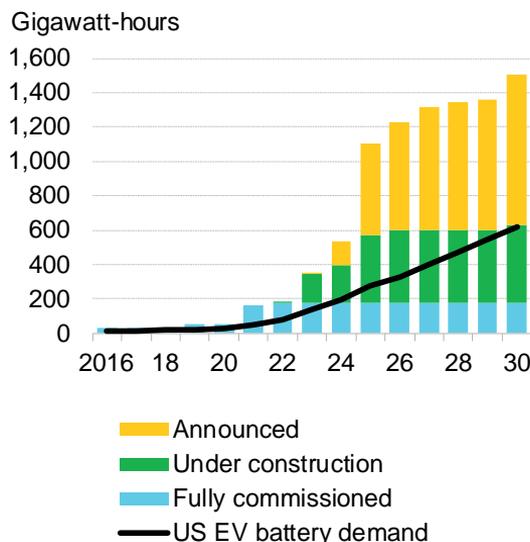
Source: BloombergNEF, Ministry of Industry and Information Technology. Note: Includes BEVs and PHEVs. Required EV share assumes a BEV to PHEV ratio of 7 to 3.

The US EV sector has been energized by new policy and regulation

1H 2023 EV sales that qualify for a portion of IRA credits in 2023



North America lithium-ion cell manufacturing nameplate capacity



The IRA has entered its first full year of implementation, after it was signed into law in August 2022.

The IRA has seen further rulemaking around its clean car tax credit, including stringent requirements that require automakers to use battery components and critical minerals manufactured in the US or sourced from countries that have a free trade agreement with the US.

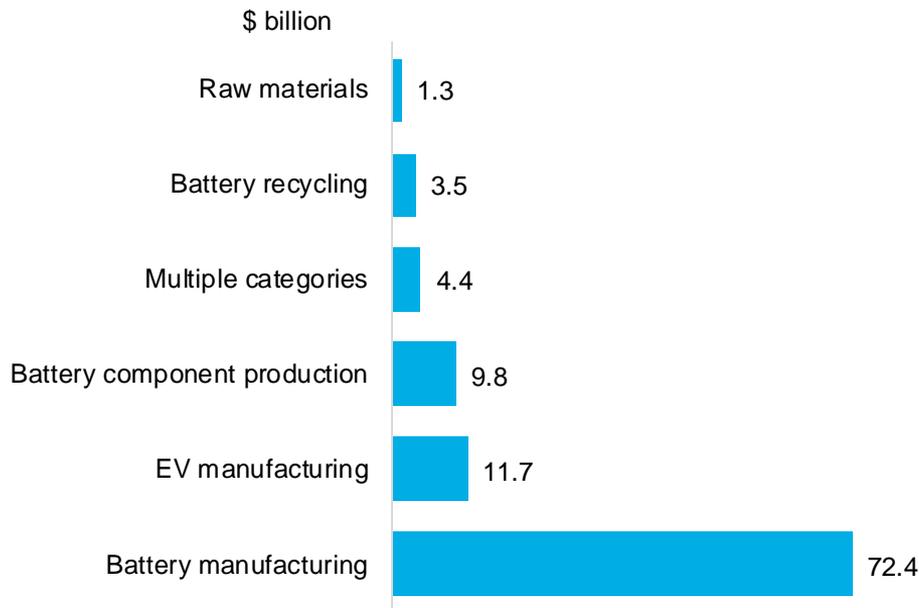
BNEF estimates that 73% of the EVs sold in 1H 2023 would qualify for a full or a portion of the new clean car tax credit in 2023. About 13% of the market only qualified for a half credit, while 60% would receive the full credit – mostly bolstered by Tesla’s high volume of EVs.

The IRA has played a role in the increase of lithium-ion battery manufacturing capacity announced for North America. Compared with last year’s report, the 2030 cell manufacturing capacity would be 76% higher if all the facilities announced come online. This has been driven by powerful incentives like the IRA’s battery production tax credit (PTC).

Source: BloombergNEF, US Department of Energy. Note: Values rounded to nearest thousands. Figures are based on actual 1H 2023 sales and are not a forecast for future sales.

The IRA has already attracted over \$100 billion of EV investment in North America

Electric vehicle investments announced since the passage of the Inflation Reduction Act



The US Inflation Reduction Act has supercharged investments in the North American EV supply chain over the past year.

The IRA has attracted \$103 billion in investments in North America EV and battery manufacturing as well as other key areas, like battery components and recycling.

Nearly two-thirds of all the announced investments have been in battery cell manufacturing.

The IRA's EV tax credit and PTC include stringent requirements that make North America an attractive option for automakers and battery manufacturers alike.

Canada and Mexico also benefit, given their integration in the US automotive supply chain and access to key critical minerals.

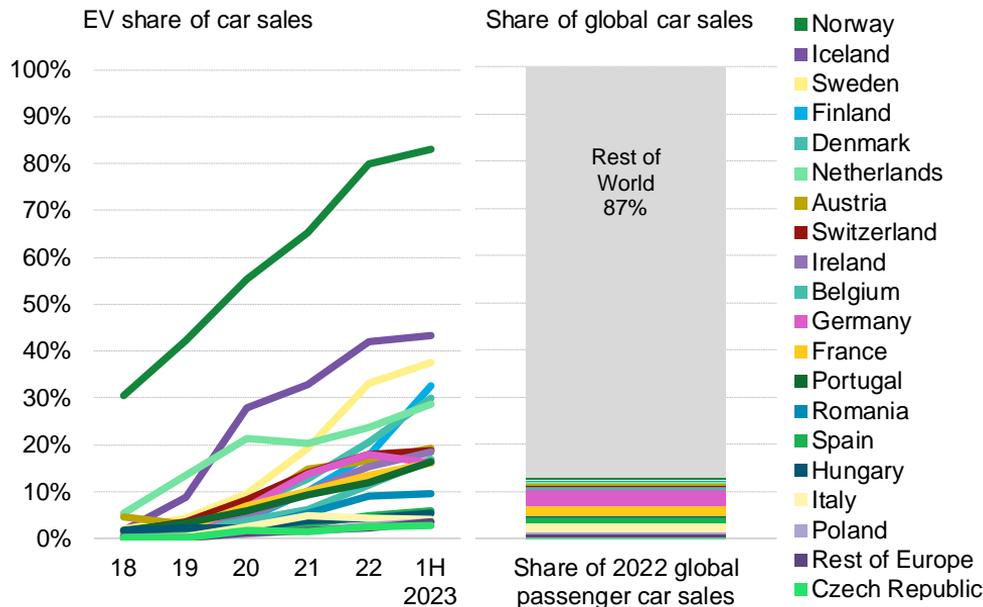
Major projects have been announced by entities like Tesla, LG Chem, BMW, Ford, Toyota, Stellantis and Redwood Materials.

Not every project will necessarily come to fruition. BNEF expects the first IRA-related EV and battery manufacturing facilities to open in the second half of 2024, with more ramping up in 2025 and beyond.

Source: BloombergNEF. Note: Chart shows data through November 3, 2023. "Multiple categories" investments do not disclose amount dedicated to each category.

The EU's plan to phase out ICE vehicle sales covers 13% of the global auto market

Europe's BEV share of passenger car sales and share of global car sales in 2022



The EU's goal to phase out new ICE vehicle sales by 2035 covers over 13% of the global vehicle market.

The target, agreed in March 2023, aims to hit a fleet-wide emissions target of zero CO2 emissions by 2035 for all new car sales, effectively banning PHEVs and conventional ICE vehicles.

Collectively, the EU together with Norway, Switzerland and Iceland – three countries that also have set ICE phase-out targets – recorded 9.7 million passenger vehicle sales in 2022, or 13% of the global total that year.

Nordic EU countries are making early strides toward the 2035 target, but they account for just a fraction of global car sales.

In the first half of 2023, Sweden stands out with a 38% BEV market share, followed by Finland (33%) and Denmark (30%). The three combined made up under 1% of all cars sold globally in 2022.

There is a significant disparity in BEV adoption between the biggest car markets in the region.

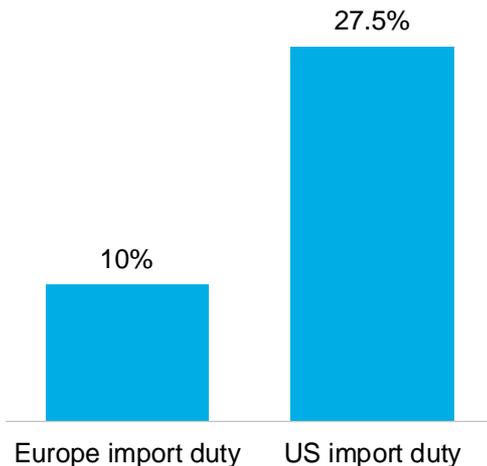
Spain, Italy and Poland, representing 3.4% of global car sales, have some of the lowest BEV adoption rates across Europe, at 6%, 4% and 4% in 1H 2023, respectively.

Germany and France have both reached 16% BEV share of car sales in 1H 2023, 2 percentage points above the regions' average.

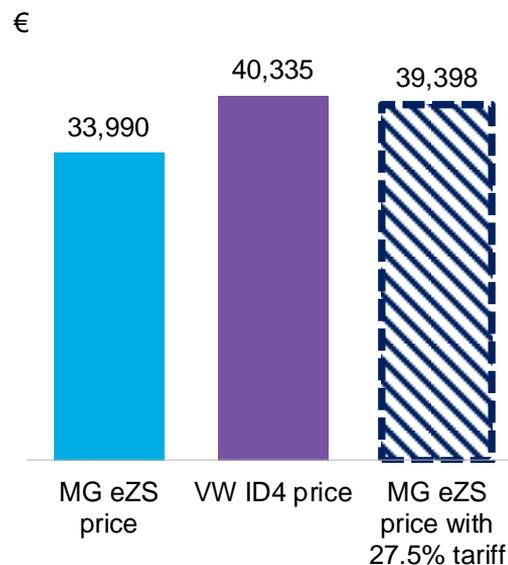
Source: BloombergNEF

Impacts of possible protective measures

Import duty fees imposed on China vehicles in Europe and the US



BEV model starting prices in Europe, and possible price with a 27.5% import duty



The European Commission initiated an investigation into whether the Chinese government provides unfair subsidies to EV manufacturers, as concerns grow that “artificially low-priced” EVs are harming European automakers.

China’s EV exports exceeded 476,000 units in 1H 2023 with over 40% shipped to Europe. This significant surge raised concerns in Europe.

If China is found to be breaking trading rules, punitive measures could include increased tariffs. The EU currently has a 10% import duty on Chinese EVs – lower than the 27.5% imposed by the US.

The price of an electric SUV sold in Europe is on average 53% higher than that of an average electric SUV in China.

The price gap narrows once Chinese EVs make it to Europe, and shipment costs and tariffs are added. Still, many of the imported EVs are cheaper than their European counterparts.

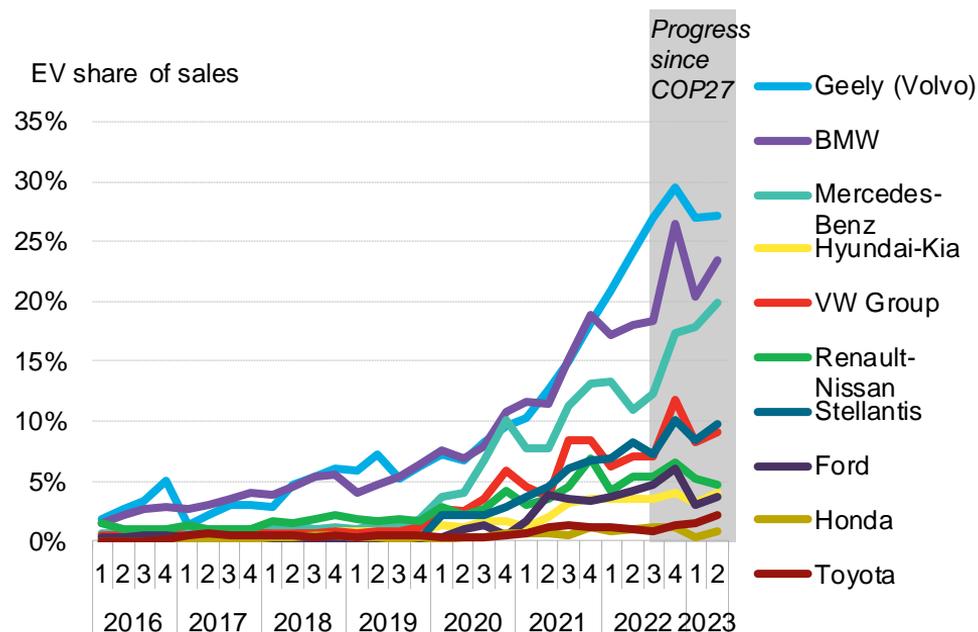
The China-made MG eZS EV is around 16% cheaper than a comparable VW ID4 today, but the advantage would drop to just 2% if the tariff were raised to 27.5%.

However, a lack of affordable BEVs would delay EV adoption in Europe. If the EU opts to increase tariffs on imported EVs, this may hurt its net-zero goals.

Source: BloombergNEF, evdatabase.org. Note: Model prices are for base model trims, in Germany. Data as of October 2023.

Several automakers are at or above 20% EV sales globally

Automakers' EV share of global passenger vehicle sales



Source: BloombergNEF. Note: Includes BEVs and PHEVs. Excludes pure EV companies.

EVs are now becoming critical parts of automakers' share of sales across the globe.

Globally, passenger EVs accounted for 5% of all new passenger cars sales in 2020. By 1H 2023, EVs reached a new high of 15%.

While success may vary on a quarterly basis, Geely, BMW and Mercedes-Benz are among the global automakers to benefit the most from the EV transition in its early days. They have benefited from both the sale of BEVs, as well as a wide set of plug-in hybrid electric models.

Japanese automakers like Honda and Toyota have yet to see strong sales of EVs, though they are reorienting their strategy to incorporate more investment in EVs.

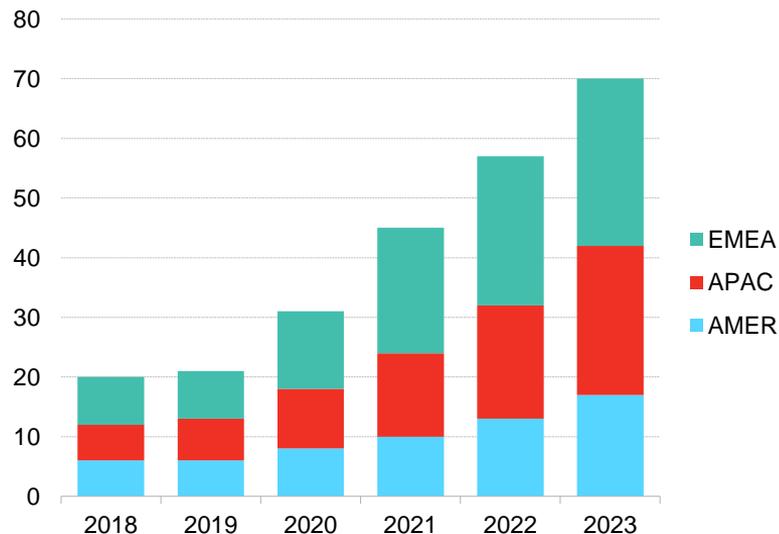
Among the companies shown, the highest EV market shares in the first half of 2023 are:

- Geely (Volvo): 27%
- BMW: 23%
- Mercedes-Benz: 20%
- Stellantis: 10%
- VW: 9%

More policies are targeting commercial vehicle decarbonization

Low- and zero-emission commercial vehicle support policies

Number of policies



Source: BloombergNEF, government filings, news reports.

The number of policies globally targeting the deployment of zero-emission vans and trucks has been growing steadily.

More than 70 policies are in place today, mostly in China, Europe and the US. They include supply- and demand-side measures, from emissions targets to operational benefits for battery and fuel-cell trucks.

In China, the policy environment is transitioning from subsidies to incentivizing the use of zero-emission trucks.

National purchase subsidies have been gradually phased out in China and are now capped at 50,000 yuan (\$7,004). Cities support the sector with funding usage, controlling road permits and access to parts of the city.

Countries in Europe have both supply and demand policies in place to support the uptake of zero-emission trucks.

Emissions targets, purchase incentives, emissions-based road tolling and charging infrastructure provisions form the basis of support in the EU. However, implementation for some policies depends on member states and is not consistent across all countries.

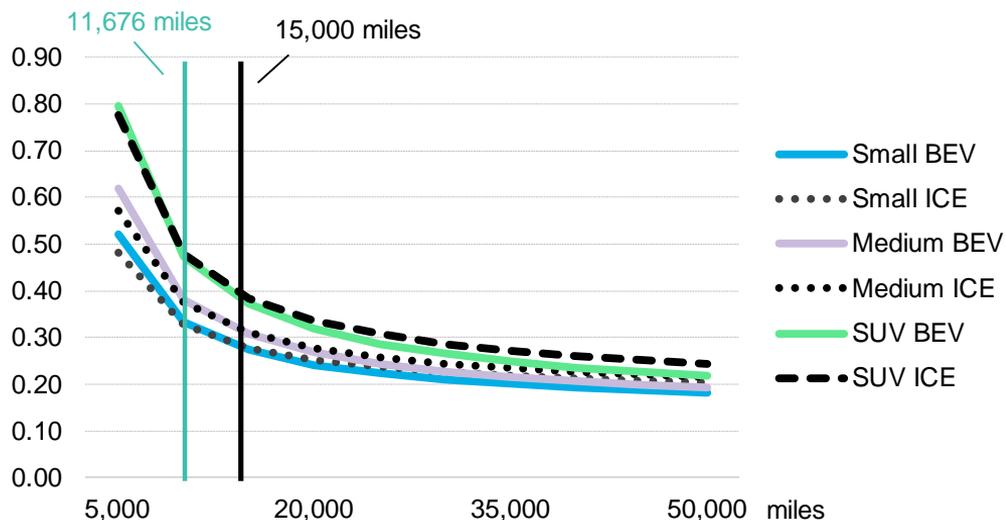
Emissions standards and the IRA are the main federal support policies in the US.

Federal funding is just rolling out in the US for the support of the clean truck market. State-level support, such as in California and New York, is an important driver of adoption, but does not exist everywhere.

EVs can compete with combustion vehicles on total cost of ownership

US passenger vehicle total cost of ownership, 2023 (under different mileage assumptions)

\$ per mile



While upfront price parity between EVs and internal combustion engine (ICE) vehicles is still a few of years away in most segments, total cost of ownership (TCO) parity is already being achieved for some passenger vehicles.

TCO takes into account the upfront cost of a vehicle, but also mileage driven, fueling costs and maintenance.

In the US, small, medium and large ICE vehicles driving an average 12,000 miles per year are still cheaper on a TCO basis than their electric counterparts.

Electric SUVs already have lower TCO than their combustion counterparts at average driving distances.

Higher annual mileage means greater savings due to low BEV running costs.

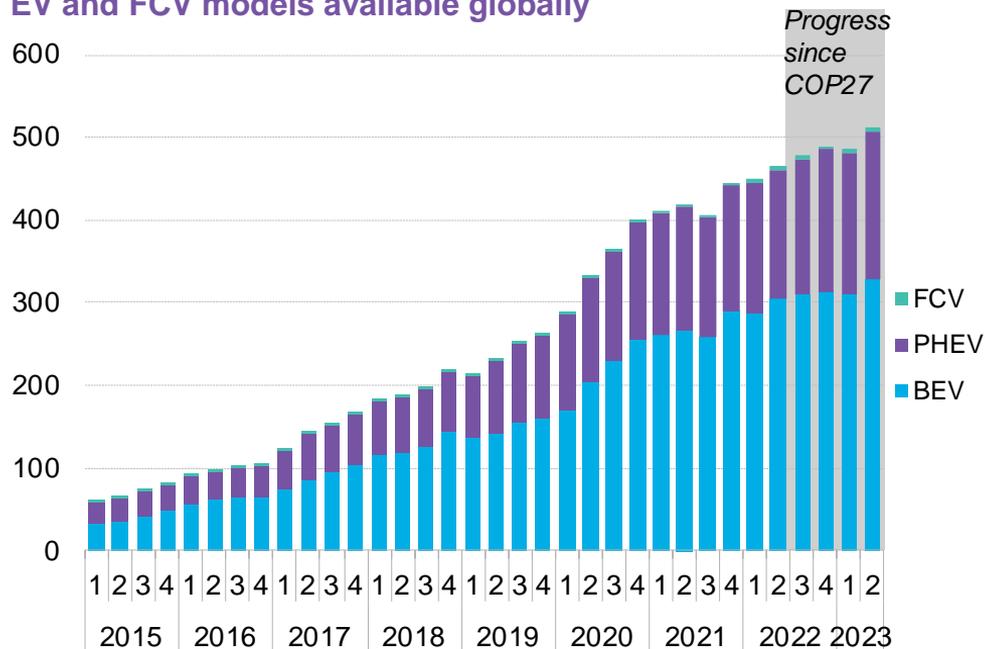
Increasing the average annual distance traveled to 15,000 miles lowers BEVs' TCO to below ICE cars' across all four segments.

Some countries with higher gasoline or diesel prices than the US have already achieved TCO parity.

Source: BloombergNEF. Note: Assumes price of \$2.95 per gallon for ICE, \$0.14 per kilowatt-hour for BEVs. BEV efficiencies vary from 3.3-3.7 miles per kWh, ICE miles per gallon vary from 26-27 mpg, depending on the vehicle segment. The Bureau of Transportation Statistics puts US vehicle mileage at just under 12,000 miles.

Every year, there are more EV models to choose from

EV and FCV models available globally



Source: BloombergNEF

The number of EV and FCV models available around the world has increased 10% since 2022.

At the end of 1H 2022, there were 304 battery-electric and 157 plug-in hybrid vehicle models available globally. By the end of 1H 2023, these counts have risen to 328 and 180, respectively.

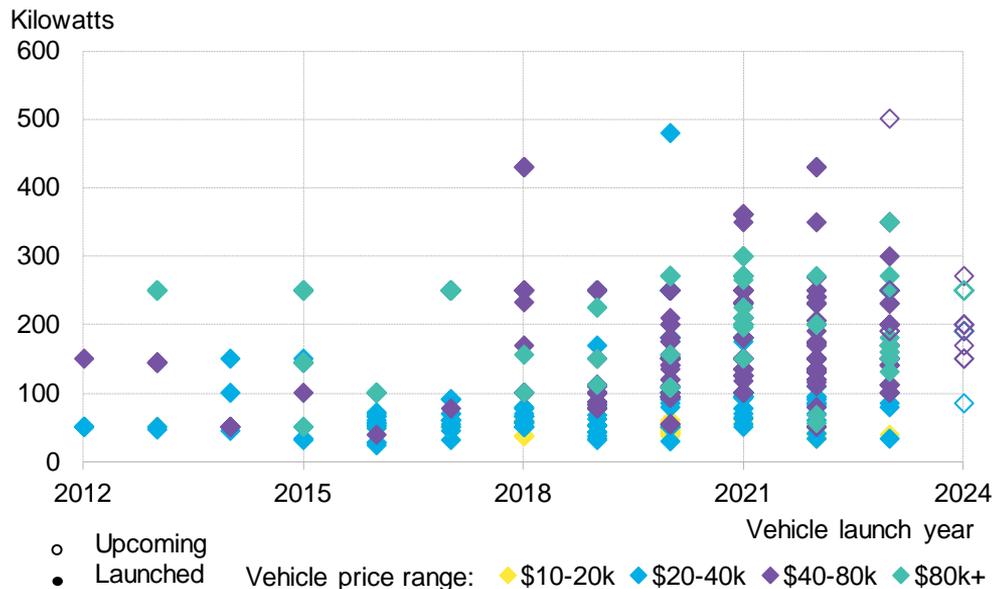
Europe and China are leading in terms of model availability.

By the end of 1H 2023, there were 262 EV and FCV models available in Europe, marginally higher than China's 260 unique models. It is the first time that Europe surpassed China in EV model count.

The number of available EV models increased the most in the US. At the end of 1H 2023, there were 95 EV models available in the country, up 40% compared with the end of first half of 2022.

New BEVs can charge faster...

Maximum charging capability of selected BEV models, by year of launch



Source: BloombergNEF, company press releases.

Today, the vast majority of BEVs available in the market include fast-charging capabilities.

The average max-charging power of a BEV launched in 2023 was 186 kilowatts (kW), 25% higher than the average of models launched in 2022.

The average max charging power of BEVs launched in 2023 increased 44% from those launched in 2015, when the average max charging power was just 130kW.

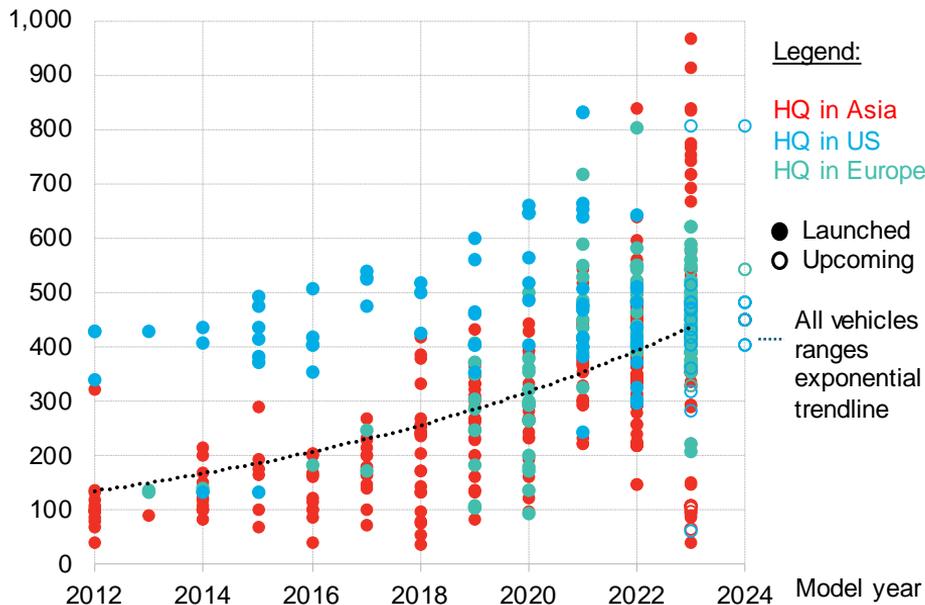
Several car manufacturers have announced implementation of 800-volt architectures to achieve charging powers of 350kW and higher in future models.

Some of the existing EV models already come with charging power of 350kW and up, including the Fisker Ocean and two models from the Hyundai Motor's brand Genesis, the GV60 and GV70. The announced Chinese Li Mega from Li Auto is expected to hit a record charging peak at 552kW.

... and drive for longer distances

Range of launched and upcoming BEV models, by launch year

EPA range in kilometers



Source: BloombergNEF, EPA, Insideevs, EVCompare, Marklines, automaker's websites. Note: EPA electric range used. For models without a verified EPA range, a value was converted from the Worldwide Harmonized Light Vehicles Test Procedure (WLTP) or New European Driving Cycle (NEDC). Regions correspond to automaker headquarters. Tesla variants of the S, X, 3 and Y are shown as individual models.

The average range of newly launched BEV models has steadily risen over the years, exceeding 470 kilometers in 2023.

With range anxiety remaining as one of the barriers for EV adoption, automakers have been progressively extending the range capability of their offerings to meet consumer demand. Since 2018, the average BEV range in the main markets of China, Europe and the US, increased at a compound annual growth rate (CAGR) of 10%.

This trend looks set to continue. So far, models announced for 2024 already have an average expected range of 500km, mostly due to the announcement that the Lucid Gravity's range will reach 800km.

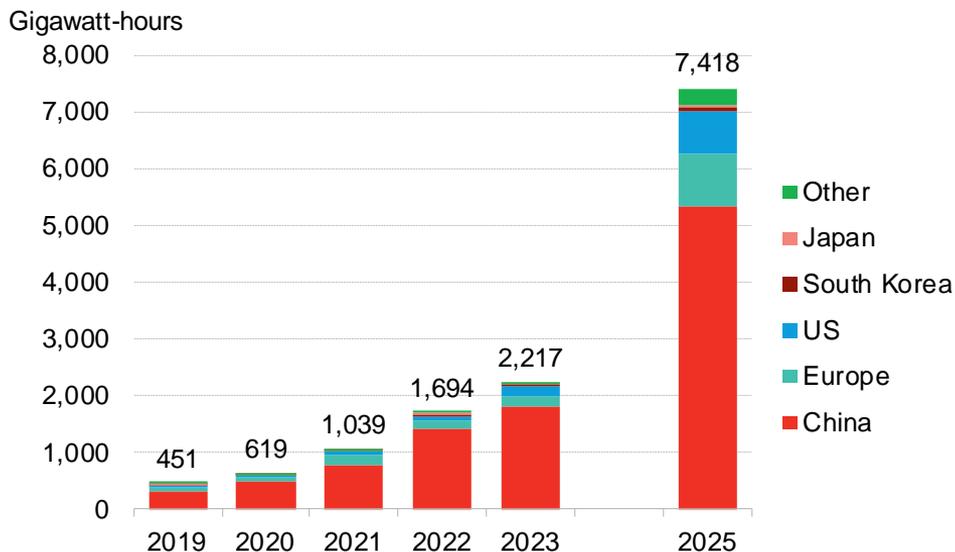
Distances vary across regions, with the US models going further in 2023 than those available in Europe.

BEVs in Europe had an average range of 445km in 2023, against the 517km on average offered in the US.

As the EV market in China matures, automakers there have been progressively increasing the range of BEVs on offer, and in 2023 BEVs launched in China had an average range of 490km – higher for the first time than the average in Europe.

Battery manufacturing capacity has increased 31% since 2022

Lithium-ion cell manufacturing capacity by plant location



Battery manufacturing capacity is growing steadily to meet demand from the EV market.

There is currently 2.2 terawatt-hours (TWh) per year of commissioned lithium-ion battery-manufacturing capacity globally. This is double the capacity that existed just two years ago, and nearly four times the capacity in 2020.

Although China still dominates globally, the US has more than doubled its battery production capacity in less than a year.

By 2025, total capacity would jump threefold, to 7.4TWh/year, if all projects planned and under construction were to be delivered.

China will continue to be the largest lithium-ion battery manufacturer over this time horizon, but the IRA has fueled new cell manufacturing announcements in the US. Some of this has been at Europe's expense.

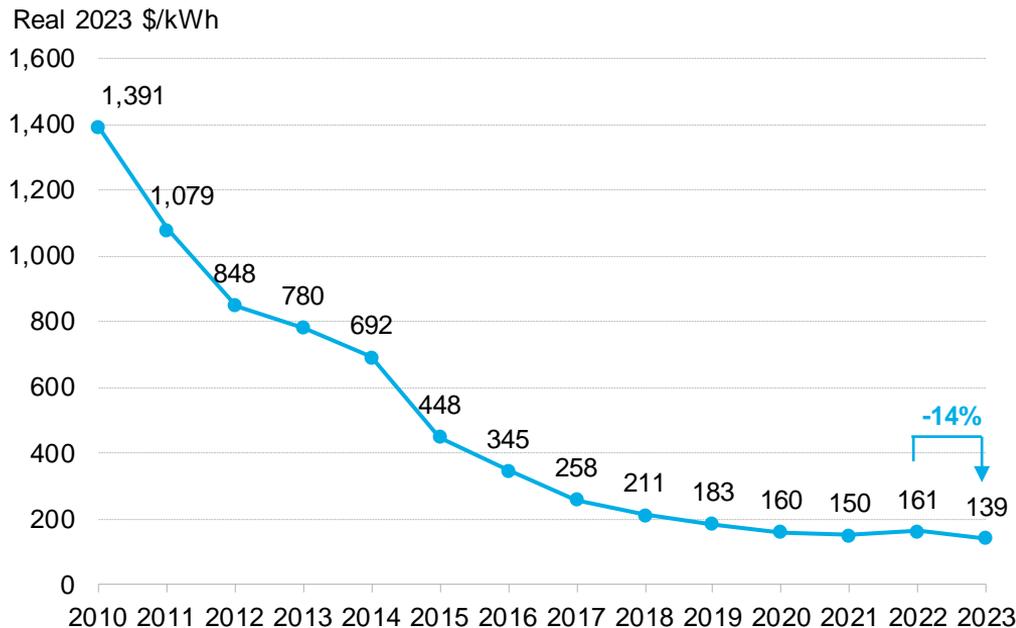
The US is set to grow its share of global capacity from 4% in 2022 and 8% in 2023 to 10% in 2025, driven by many more recent announcements since IRA's passage.

Europe's share has dropped from 10% in 2022 to 8% in 2023.

Source: BloombergNEF. Note: Data for 2023 includes facilities commissioned up to October 24, 2023; an additional 1,565GWh is under construction or announced with planned commissioning by end of 2023. "Other" includes capacity outside of the regions indicated. 2025 capacity based on current announcements without de-risking.

Battery prices are falling again

Volume-weighted average lithium-ion battery pack price



Source: BloombergNEF. Note: Historical figures have been adjusted to real 2023 dollars.

Lithium-ion battery pack prices decreased 14% year-over-year in 2023, to \$139/kWh on a volume-weighted average basis.

Falling raw material prices and component prices, more manufacturing capacity, and lower-than-expected demand reversed the trend from last year and brought battery pack prices back to a declining trajectory.

The volume-weighted average battery pack price in BNEF's annual survey has decreased 90% since 2010, from \$1,391/kWh to \$139/kWh in 2023.

The cheapest packs are still in China.

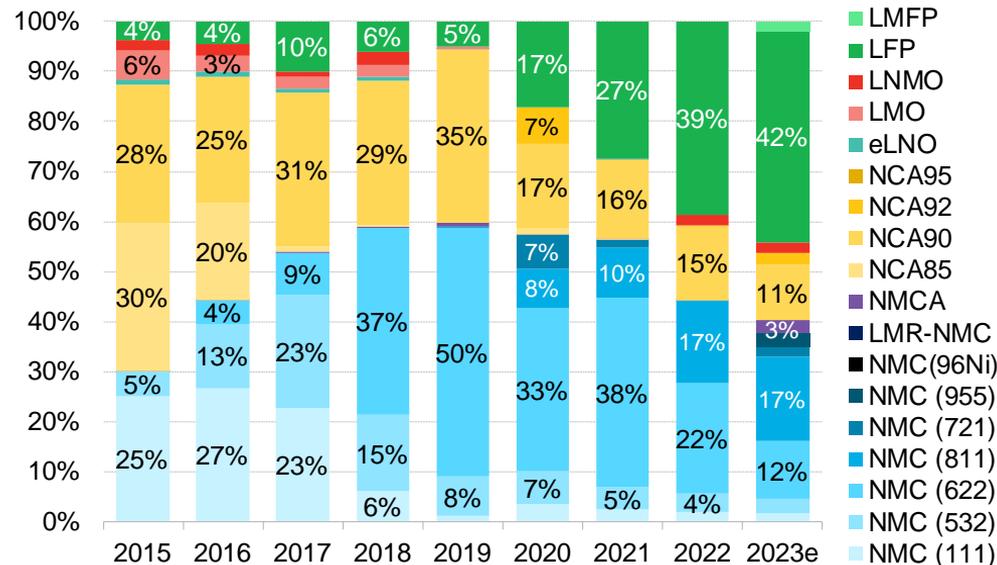
In 2023, the cheapest packs delivered on a volume-weighted average basis were in China, coming in at \$126/kWh.

Chinese electric buses and commercial vehicles continue to have the lowest average battery pack prices, coming in at \$100/kWh in 2023.

The dramatic fall in raw material prices in 2023 should help keep battery prices on a downward trajectory in the near-term.

Automakers are switching battery chemistry to lower costs

Evolution of cathode chemistry across all passenger electric vehicle segments



Source: BloombergNEF. Note: LMFP = lithium manganese iron phosphate; LFP = lithium iron phosphate; LNMO = lithium nickel manganese oxide; LMO = lithium manganese oxide; LNO = lithium nickel oxide; NCA = nickel cobalt aluminum oxide; NMCA = nickel manganese cobalt aluminum oxide; LMR = lithium- and manganese- rich; NMC = nickel manganese cobalt oxide.

Automakers continue to switch battery chemistries to reduce their reliance on metals associated with higher prices.

Lithium iron phosphate (LFP) batteries – which use no cobalt or nickel – benefited the most from the recent price spike in battery metals. Lithium is the only expensive material in LFP batteries.

In 2023, over 40% of batteries used in passenger EVs were LFP, up from just 17% in 2020.

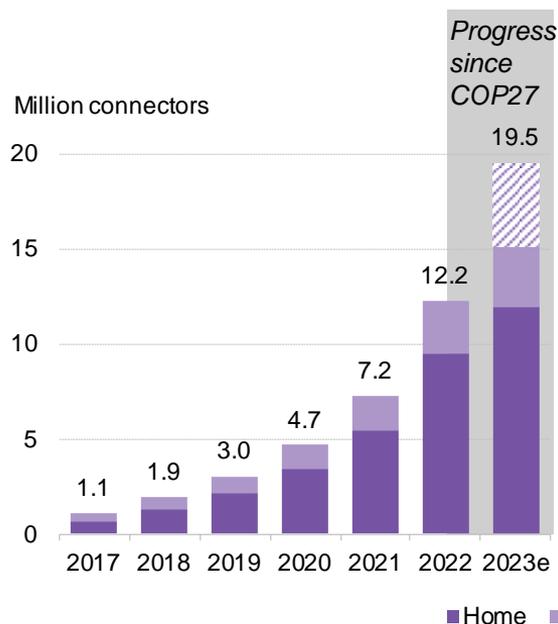
Sodium-ion batteries are a viable, cheap future alternative to lithium-ion batteries.

HiNa Battery, a China-based sodium-ion battery manufacturer, opened the first 1 gigawatt-hour (GWh) sodium-ion facility in the world in China in October 2022. Faradion, Tiamat and Altris have a combined 35GWh capacity announced to come online by 2025.

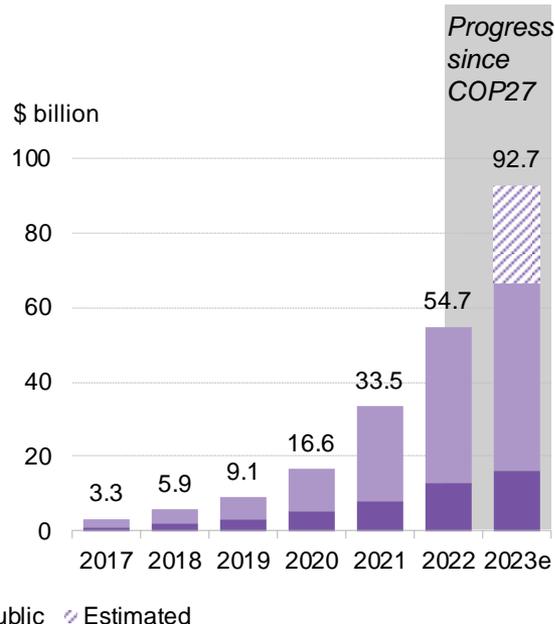
Chery, JAC and Jiangling Motors Electric Vehicles are among the first automakers to partner in 2023 with CATL, HiNa and Farasis, respectively, on sodium-ion batteries.

Cumulative investment in EV charging approaches \$100 billion

Cumulative charger installations



Cumulative charger investments



BNEF estimates that there will be 15.4 million home EV chargers and 4.1 million public chargers installed globally by the end of 2023.

Despite home chargers making up 80% of the cumulative network, public chargers, which serve multiple drivers, account for 78% of cumulative investment.

China dominates cumulative investment in all chargers, accounting for 69% of the global total, followed by Europe (17%) and the US (6%).

Annual investment in home and public charging in 2023 is expected to reach \$37.9 billion, and cumulative investment in the sector will likely pass \$100 billion in the first few months of 2024.

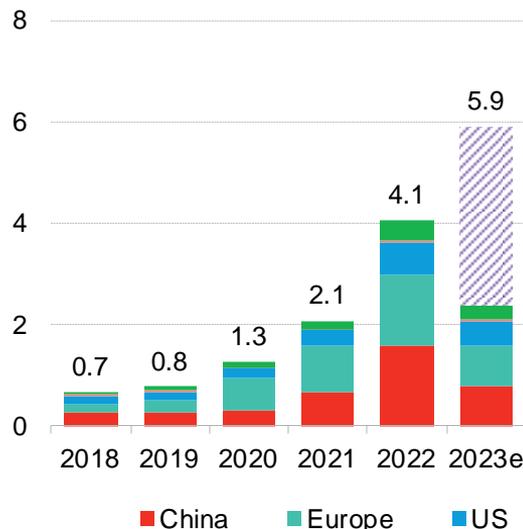
Chinese companies, which have lower costs and larger scale, are a threat for companies from other regions. They have not taken large shares of the European and US market yet, but they are looking to the export product.

Source: BloombergNEF. Note: Excludes workplace and commercial vehicle charging installations. Includes hardware and installation investment.

European home charging companies are benefiting from high sales

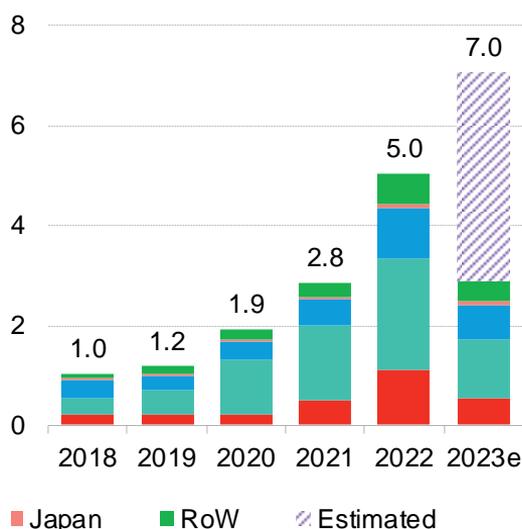
Annual home charger installations

Million connectors



Annual home charger investments

\$ billion



Home charger installations are expected to reach 5.9 million globally in 2023.

Home charging companies have had to deal with fierce competition, which is making it a challenging market for manufacturers but benefits consumers. Companies are aiming to keep ahead by including features such as smart charging, bi-directional charging and integration with solar.

Home charger investment globally is expected to reach \$7 billion by the end of 2023.

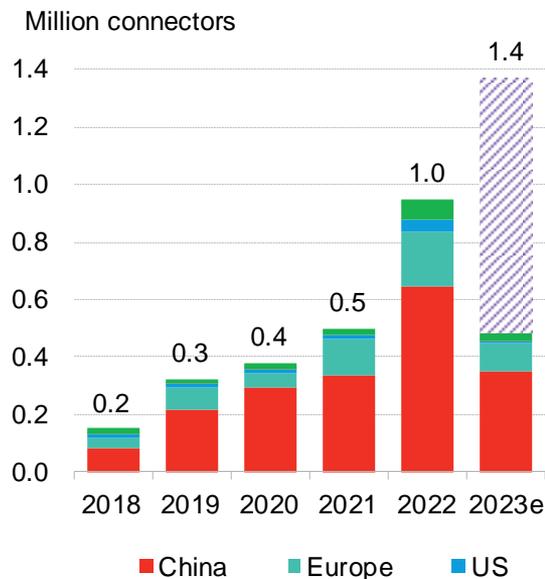
Europe is expected to remain the largest investment market globally in 2023. Investment in Chinese home chargers still lags, despite a similar number being sold, because the chargers are much cheaper.

A higher percentage of European buyers purchase a home charger than Chinese buyers because of a higher prevalence of detached homes.

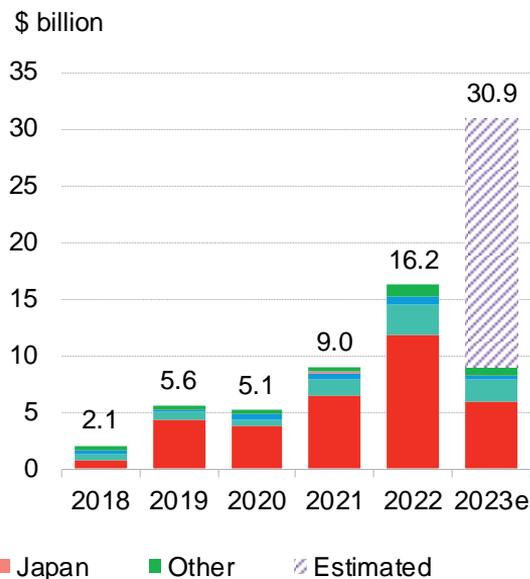
Source: BloombergNEF. Note: Home charger installations are estimated.

Public charger installations to reach 1.4 million in 2023

Annual public charger installations



Annual public charger investment



Annual public charging installations are expected to top 1.4 million in 2023, up from 950,000 in 2022.

Installations in the first half of the year have slowed compared with the second half of 2022, but numbers from September suggest that the rapid pace of installations has resumed in recent months.

China in particular has seen a ramp-up in installations, delivering 70% of the expected 940,000 new public chargers by the end of September, which suggests that almost the same number of chargers were installed during 3Q as in the first half of the year.

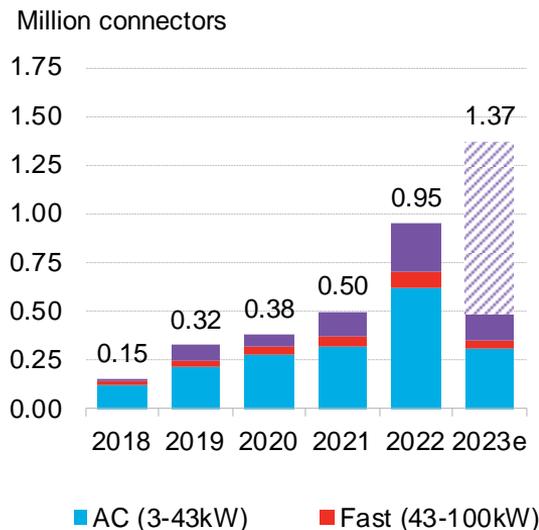
Investment in public charging is estimated to grow 1.9 times from 2022 to 2023, despite a slow start to 2022, particularly in the US.

China is expected to invest \$19 billion in public charging by the end of 2023, compared with an estimated \$2.7 billion in the US and \$5.3 billion in Europe.

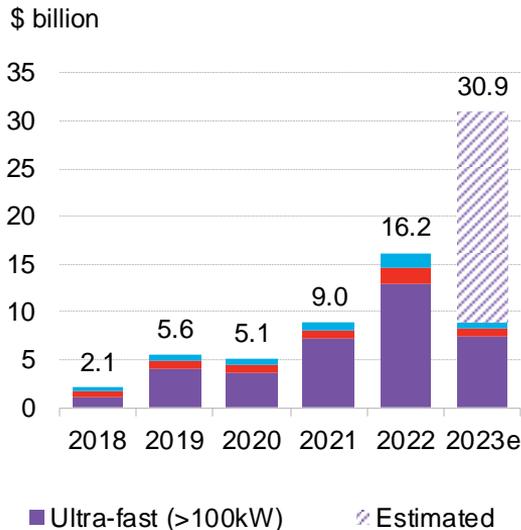
Source: BloombergNEF. Note: Investment includes hardware and local installation costs. Investment numbers are estimated.

DC (fast) charging accounted for 93% of investment in the first half of 2023

Annual public charger installations by power type



Annual public charger investment by power type



Fast chargers made up 37% of public charger installations but 93% of investment in the first half of the year.

Investment is flowing predominantly into fast chargers, and particularly those over 100kW. These are increasingly popular as vehicle manufacturers continue to push faster-charging vehicles, to lower charging times and reduce the barriers to EV adoption.

The ultra-fast chargers are more expensive to build and install, with a typical 100kW+ fast charger costing 2.6x more than a 43-100kW charger.

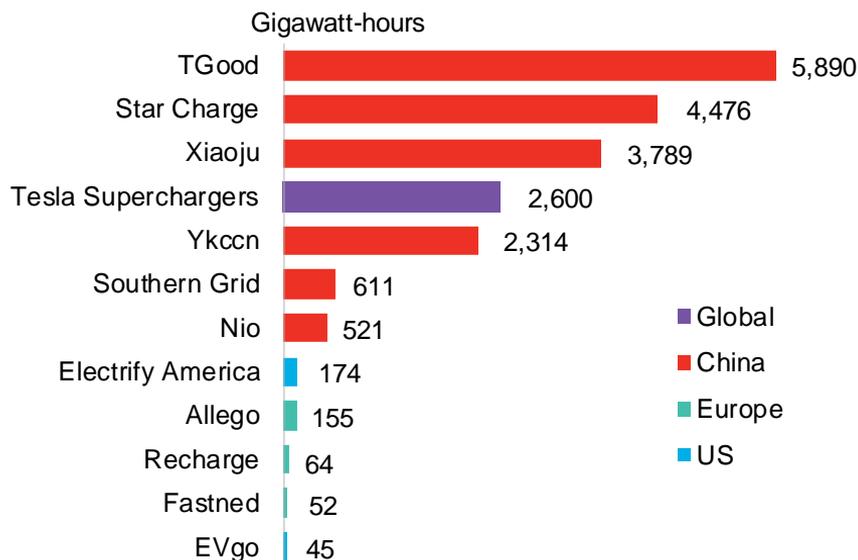
DC charger costs are expected to continue to decline as scale increases and China starts exporting.

Chinese chargers can cost as little as 30% of the cost of chargers produced in the rest of the world. This is partly due to scale. In 2022, there were 220,800 ultra-fast charger installations in China compared with 26,000 in the rest of the world.

Source: BloombergNEF. Note: Investment includes hardware and local installation costs. Investment numbers are estimated.

Public chargers start to consume huge amounts of electricity

Energy delivered by public charger networks in 2022



The largest charging operator in the world, TGood, delivered 5,890GWh to vehicles from its Chinese network in 2022.

Charging networks are expected to consume as much electricity as some of the biggest companies in the world over the next decade. For comparison, Amazon consumed 38,700GWh globally in 2022 – more than countries such as Ireland and Denmark.

Charging operators can help drive clean energy deployment.

As the demand at public chargers continues to soar, operators will have an increasing influence on green energy deployment. Many networks already source green power to meet the expectations of their climate-conscious consumers.

This power can be sourced through renewable energy certificates, but some networks are starting to complete power purchase agreements with renewable generation developers. This can also act as a hedge against future energy price rises. Some operators also include on-site renewable generation.

Source: BloombergNEF, China Charging Infrastructure Promotion Alliance, Company investor presentations. Note: Chart excludes eight Chinese operators that had higher consumption than the European and US ones shown to give a global view. Not all European and US operators shown due to lack of available data.

2023 has been a busy year for electric truck charging as projects increase

Selected high-power electric truck charging projects

Companies involved	Country/ region	# chargers / charger power / site power	Investment	Year
DAIMLER TRUCK   BLACK & VEATCH		8 / not stated/ 4.5MW	Not disclosed	2021
 		Not stated	\$2 million	2022
 and 15 other partners		Not stated	\$13 million	2022
WattEV (3 sites)	US	52MW* (power of all sites)	Not disclosed	2022
Daimler, BlackRock, NextEra JV 		Not stated	\$650 million	2023
WattEV		8MW (site power)	Not disclosed	2023
 TU TeraWatt INFRASTRUCTURE		20 chargers / 7MW	Not disclosed	2024
Daimler, Volvo, Traton JV 	Europe	1,700 chargers	\$510 million	2022
 IBERDROLA	Spain	1MW (charger power)	Not disclosed	2022
 enel x way	Italy, Spain	230/400kW	>\$14 million	2023
 Fraunhofer and 20 other partners	Germany	8* / 0.75MW	\$31 million	2022
DAIMLER TRUCK  EnBW	Germany	6 / 0.3MW	Not disclosed	2022
Along the TEN-T network 	Europe	350kW / 1,400kW	Policy target**	2025

Source: BloombergNEF, press releases. Note: These projects are indicative and specifically target the charging of commercial vehicles; "Year" refers to the start of project development; * refers to the project's 8 Megawatt Charging System (MCS) chargers, while another 8 Combined Charging System (CCS) high-power chargers will also be installed. ** refers to the targets in the Alternative Fuel Infrastructure Regulation (AFIR).

Projects targeting commercial EV charging are already being developed and more are in the pipeline.

Operators in the US and Europe have announced additional plans to build high-power charging stations. For many projects, the total site power can exceed several megawatts.

While such stations can be profitable, building costs, equipment costs, and grid connections can be challenging in several locations.

While many of these projects were originally located in the US, activity is also picking up in Europe.

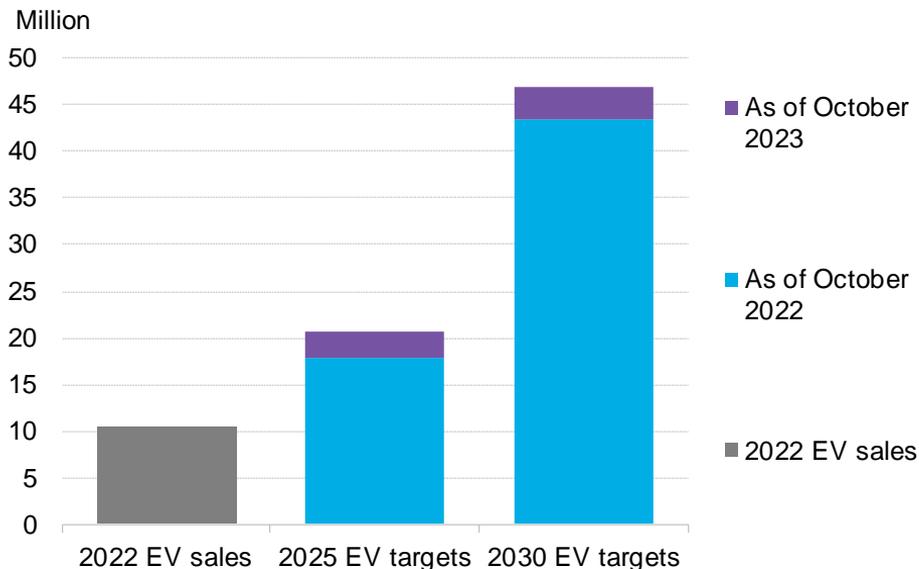
In the US, standalone operators, utilities, vehicle manufacturers and financial investors are involved in building stations. In Europe, the policy push of the Alternative Fuel Infrastructure Regulations (AFIR) and the Connected Europe Facility (CEF) provide the backdrop for further development.



Corporate
Commitments
Stalled

Automakers are now targeting more than 47 million EV sales per year by 2030

2022 actual and 2025/2030 target EV sales of selected automakers



In total, 16 automakers have set goals that could result in 22 million EV sales in 2025, including Tesla's goal of hitting an annual growth rate of 50%.

These 2025 targets are now four times higher than the actual 2022 EV sales by these automakers, at an estimated 4.3 million. Across all automakers, 2022 passenger EV sales reached 10.4 million.

Still, many automakers are pushing back or revising their near-term targets. Stellantis had a stated 2025 target but scrapped it in favor of a new 2030 target. Toyota has moved its 2025 target around a few times, now aiming at a 600,000-unit run rate. Ford and GM have also delayed or scrapped interim targets set for before 2025.

For 2030, automakers have pledged to achieve 47 million in total EV sales, including Tesla's target of selling 20 million BEVs.

Automakers including Hyundai and Kia, Porsche, Mitsubishi, Mazda and Subaru have been setting more aggressive 2030 targets over the past year. Others have held their 2030 targets constant.

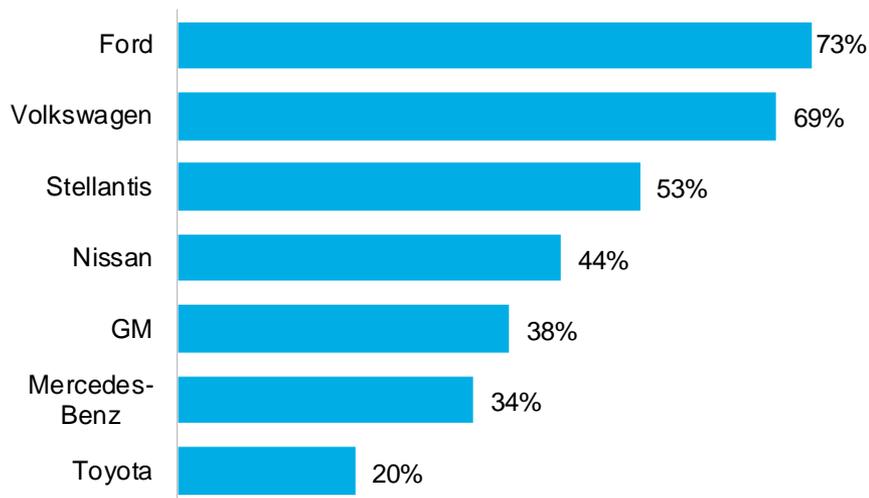
With few exceptions (such as Stellantis), most automakers have set targets based on the catch-all category of "electric vehicles", leaving ambiguity on the role of hybrid drivetrains.

Source: BloombergNEF, various automakers. Note: EV sales estimates come from corporate statements and estimates from the BNEF EV data hub. Passenger EV sales for 2022 includes BEV and PHEV sales from all automakers.

Major manufacturers' investment plans highlight EV commitments

Selected automakers' R&D and capex commitments for EVs and digital tech

Percentage of total R&D and capex



Source: Bloomberg, BloombergNEF. Note: Targets are 2021-2025, except for Ford (2022-2026), VW (2023-2027) and Mercedes-Benz, which is over 10 years. R&D and capital expenditure commitments are the average of a three-year period from 2020-2022.

Investment in research, development, equipment and plants for vehicle electrification is the clearest evidence of the automotive industry's commitment to the EV transition.

Funds deployed to develop new EVs are the proof of concrete action to support long-term decarbonization goals. Automakers started announcing the expansion of EV manufacturing and partnerships to produce batteries as a part of the investments they had previously announced.

Most of these announcements were made in 2020-2021, but they highlight the long-term interest in supporting the transition to zero-emission vehicles, as well as in greater technology spending.

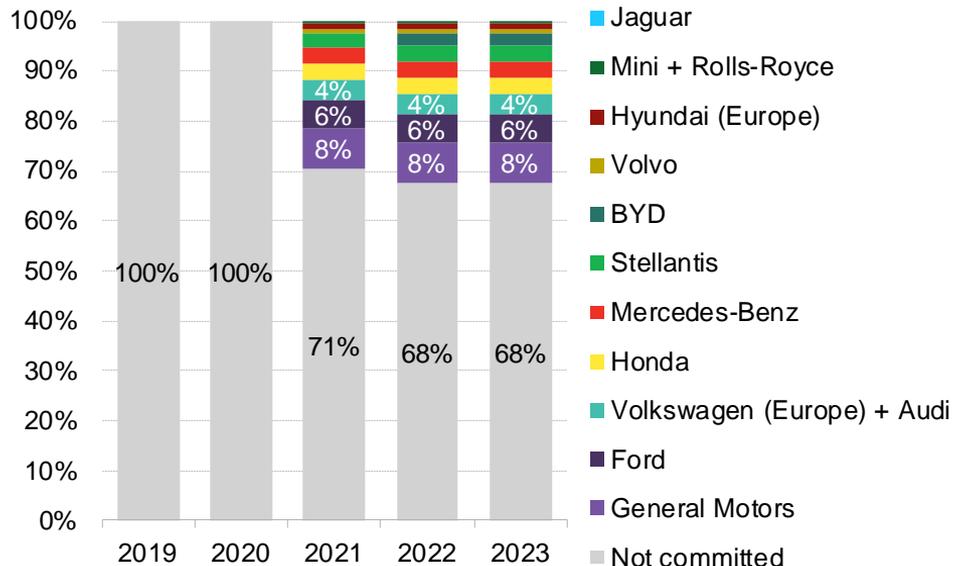
Volkswagen was the latest to update its long-term spending for EVs as part of its investor day. In October 2023, Ford announced potentially delaying some of its EV investment (up to \$12 billion) to await further growth and development of the EV market.

The automakers in the chart sold nearly 38 million vehicles in 2022, representing about 50% of 2022 global sales.

Many other manufacturers, such as BYD, Volvo, Renault, SAIC and BAIC also have ambitious electrification plans and already produce EVs at scale.

Automakers' ICE phase-out commitments now represent 32% of the global market

Share of passenger vehicles sold by automakers with an ICE phase-out announcement



To date, 17 automotive brands have announced global or regional ICE phase-out targets. As a share of global passenger vehicle sales, these automakers represented 32% of all 2022 sales, unchanged from last year.

No new automakers made ICE phase-out announcements in 2023. While the reason behind the slowdown is not clear, the economic and geopolitical uncertainty of the last two years is likely making long-term ambitions more challenging. Still, automakers have not weakened their existing ICE phase-out goals.

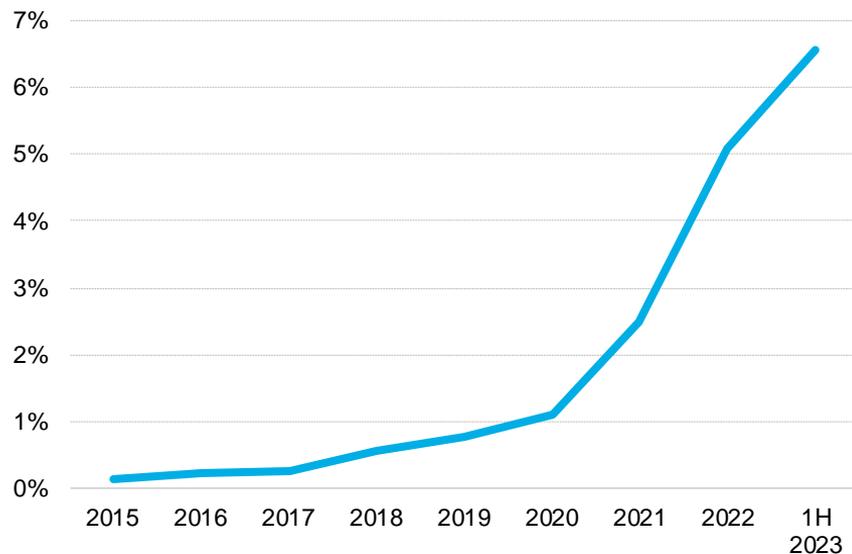
The dates of these phase-out targets range from 2030 to 2040, depending on the automaker.

Certain brands, like Jaguar or Chrysler, have announced ICE phase-out targets in the next few years. Most major brands aim to phase out ICEs after 2030; these include Mercedes-Benz and Volvo. Other automakers, like Ford, Peugeot, Hyundai and Volkswagen, have announced regional ICE phase-outs for Europe, aligning with the EU's 2035 target.

Source: BloombergNEF, Marklines, various automakers. Note: Share of 2022 passenger vehicle sales. Announcements made through November 3, 2023. Stellantis brands include Peugeot, Fiat, Chrysler, Alfa Romeo and Maserati. Ford signed [The ZEV Declaration](#) at COP26, indicating their willingness to go fully zero-emission by 2040 globally, but they have not repeated that commitment in reports to their investors. Ford has a confirmed 2035 target for Europe.

EV-only automakers now represent nearly 7% of all new cars sold globally

Electric-only automakers' share of new passenger vehicle sales



Source: BloombergNEF, MarkLines. Note: Chart includes selected automakers that only produce EVs. BYD's EV sales included in the figure from 2015, though it became EV-only in 2022.

In 1H 2023, 6.6% of all cars sold globally came from automakers selling only EVs. This is up from 1% in 2020.

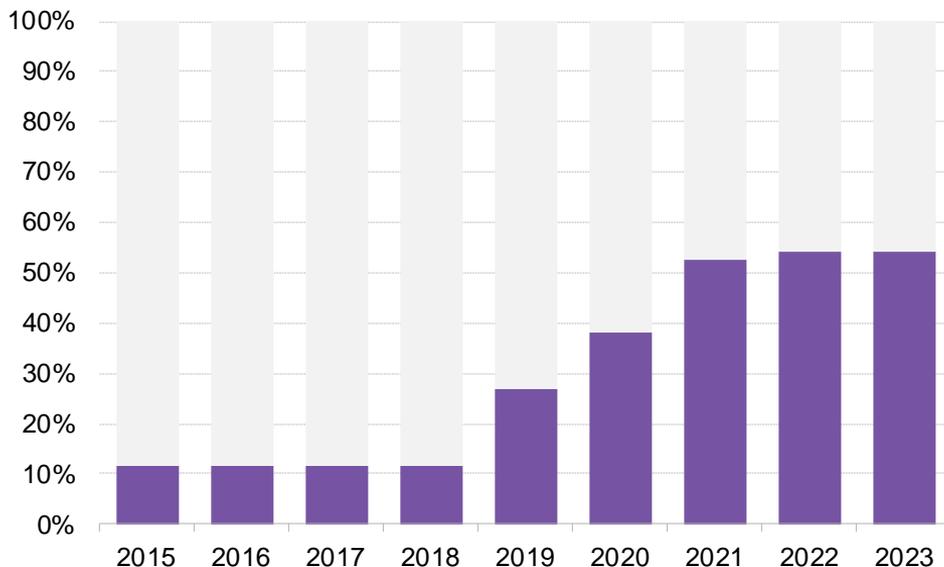
Global EV leaders Tesla and BYD are responsible for the lion's share of that growth. Without the two, only 0.9% of new car sales would have come from pure EV players.

Automakers like Nio, Xpeng, Rivian, Leapmotor and Seres are among those that have introduced EV products over the past decade and are now scaling up.

BYD committed to being an EV-only manufacturer in 2022, following its decision to phase-out ICE vehicle sales. The company still produces plug-in hybrids.

Manufacturers covering 54% of the auto market have set some form of net-zero target

Share of global passenger vehicle sales from automakers with a net-zero target by 2050



Source: BloombergNEF, various automakers. Note: Based on 2022 sales shares. Net-zero data comes from BNEF's Corporate Net-Zero Assessment Tool. Net-zero estimate only includes emissions covered under a net-zero target.

Vehicle manufacturers have joined the global wave of companies pledging to go net zero by 2050.

As of October 2023, 18 automakers of various sizes have made net-zero commitments targeting 2050 or before. These automakers sold over 43 million vehicles in 2022, representing 54% of the global passenger vehicle market.

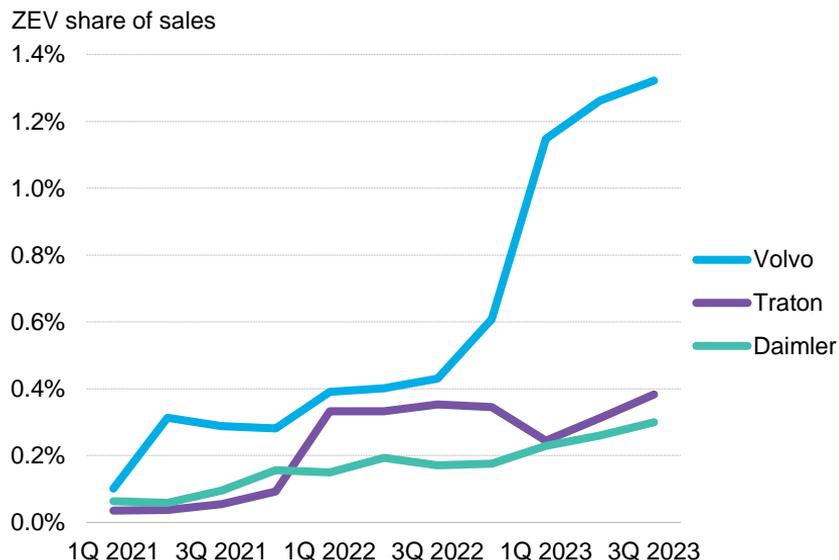
Over the past two years, new commitments have slowed sharply. No new automakers announced net-zero commitments in 2023.

Collectively, these net-zero commitments collectively amount to a total of 1.3GtCO₂ to be reduced globally.

This is based on our estimate of the base-year CO₂ emissions covered by the net-zero targets of these automakers. Note that some of them have only committed to Scope 1 and 2 emissions, and even if a company covers all three scopes, it can exempt certain emission types such as customer's use of a vehicle. If these 18 automakers updated their targets to cover all the emissions in their base year, that would result in over 2.4GtCO₂ of emissions to reduce.

Trucking decarbonization has started, but has a long way to go

ZEV share of sales for Volvo, Daimler and Traton



Source: Bloomberg, company reports, BloombergNEF. Note: Shows ZEV share of year-to-date sales; for example, the 2Q 2023 share corresponds to ZEV and total sales between January and June 2023.

The largest truck manufacturers have ambitious zero-emission commercial vehicles and buses sales targets by 2030.

Daimler Truck, Volvo AB and Traton SE expect that battery-electric and fuel-cell vehicles will make up between 50% and 60% of their total European sales by 2030. The companies have other targets for other regions. Additionally, Daimler and Volvo aim to become net-zero companies close to 2040.

Volvo, Daimler and Traton already sell their zero-emission models, but the scale-up needed is monumental.

In the nine months through September 2023, Volvo's ZEV share of sales was far ahead its peers, at almost 1.4%, compared with Daimler's and Traton's respective 0.3 and 0.4%.

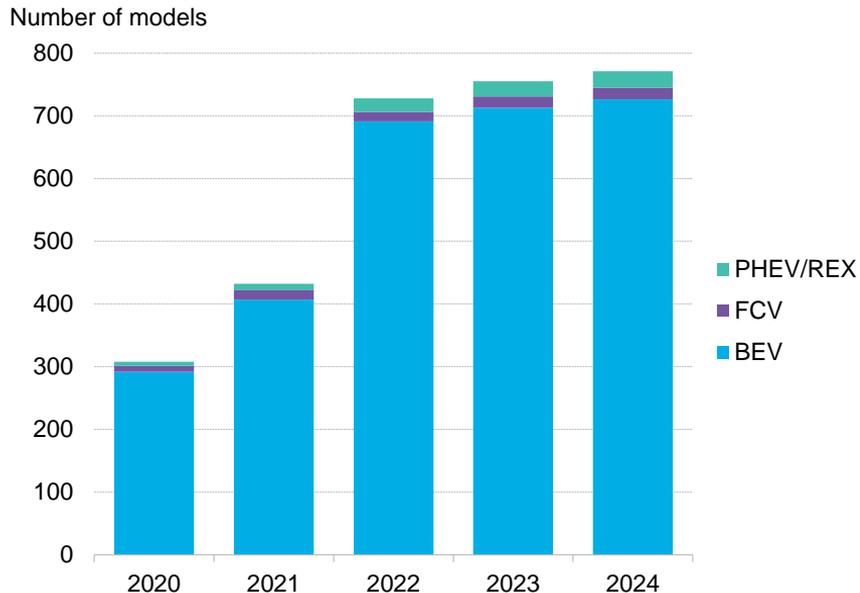
All three manufacturers have launched suitable medium- and heavy-duty truck models, are developing battery technology expertise and are establishing manufacturing lines. Still, they need to be selling orders of magnitude more zero-emission vehicles to meet their own 2030 targets.

The first battery-electric long-haul heavy-duty trucks are now available, but production is still low.

Tesla's Semi, which can drive between 300 miles (480km) and 500 miles on a single charge, has already been delivered and is in operation. Orders for Daimler's long-haul eActros opened in October 2023, but production will properly only start in late 2024.

Close to 800 commercial ZEVs are available in China, Europe and North America

Commercial ZEV models available



Around 750 battery and fuel-cell vans and trucks are available globally for purchase, with more than half sold in China only.

Light-duty commercial vehicles, such as battery electric delivery vans, dominate the global offering, with close to half of all models available. Just over a third of models are heavy-duty trucks, which for now mostly target urban and suburban operations.

Manufacturers have focused on battery trucks, as fuel cells have longer lead times and are available from a few truckmakers only.

Battery electric models outnumber those using hydrogen by about 22-to-1. That reflects the technology maturity of battery-based powertrains versus those using fuel cells, and also the concentration of H2 truck offerings in the heavy-duty class.

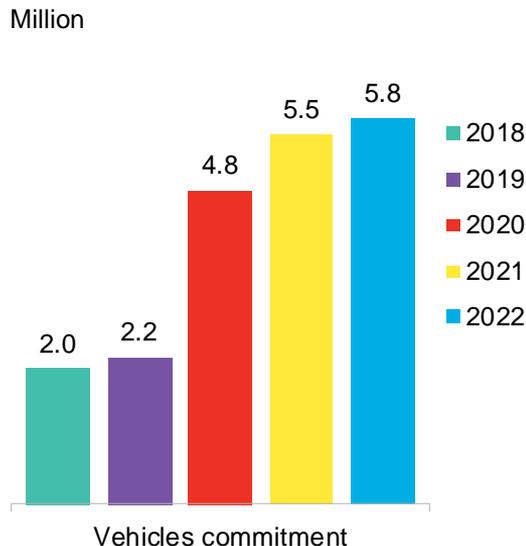
Fuel cell trucks drive farther with one refill, but long-distance battery heavy trucks also are also becoming available.

Average range across FCV models is around 500km, which can extend to almost 1,500km for some models. For BEVs, the average range is around 250km. A handful of models with over 500km of range are available to order, and some have already been delivered, but their number remains small.

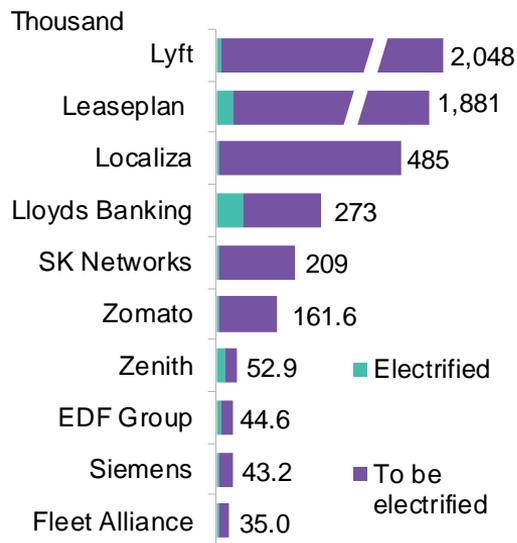
Source: BloombergNEF, company announcements, CALSTART, 360che.com. Note: BEV is battery-electric vehicle. FCV is fuel-cell vehicle. PHEV is plug-in hybrid vehicle. REX is range-extender vehicle. PHEV/REX are zero-emission vehicles for part of their operation relying on battery power alone.

Corporate fleet operators have joined the race to electrify

Vehicles covered by the EV100 pledge



Top 10 EV100 members by committed fleet size



Corporate sustainability initiatives are driving uptake of commercial EVs.

By the end of 2022, the number of vehicles covered by the Climate Group's EV100 fleet commitment, whose members pledge to electrify all of their vehicles globally by 2030, has increased 23% since 2020.

The number of EV100 members pledging to electrify their fleet increased from 23 in 2018 to 127 in 2022.

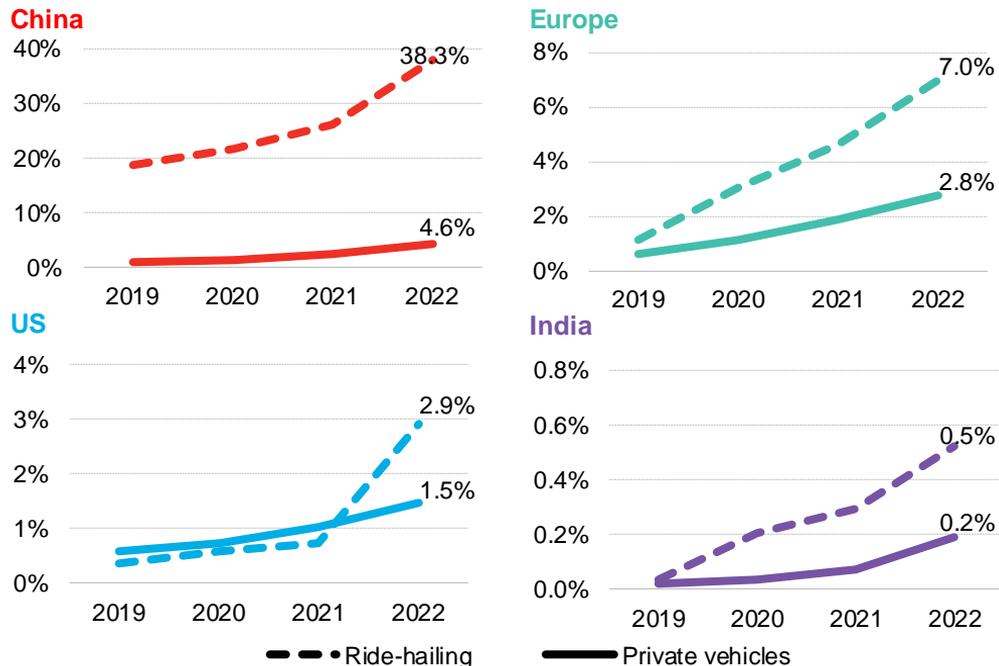
These commitments will underpin a strong source of EV demand in this decade.

So far, EV100 members have electrified 404,608 vehicles to date, or just 7% of committed vehicles.

Source: BloombergNEF, The Climate Group. Note: Based on Climate Group's February 2023 report.

Ride-hailing firms have ambitious EV plans and are starting to see results

Ride-hailing and private vehicle EV share of fleet



Source: BloombergNEF

Ride-hailing companies have made bold commitments to decarbonize their operations by boosting the presence of electric vehicles on their platforms.

A combination of rapidly improving economics and industry partnerships now offers a viable pathway for ride-hailing electrification. Regulations are also helping pave the way toward the industry's electrification.

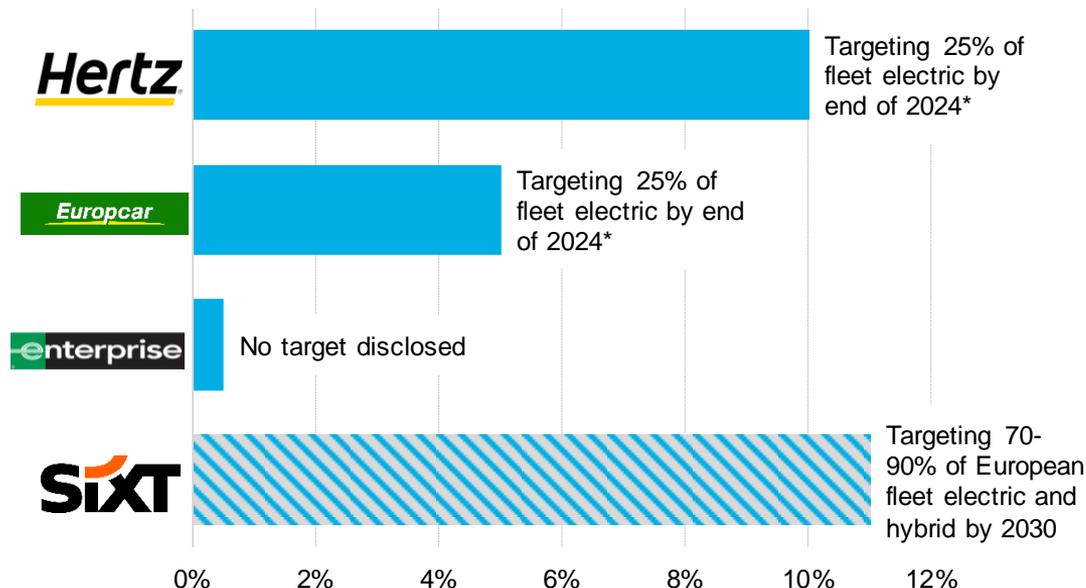
Over 38% of ride-hailing vehicles in China are electric, compared with 7% in Europe and 2.9% in the US. In many geographies, the ride-hailing segment is electrifying faster than the privately owned vehicle fleet.

Some companies have invested significantly toward achieving their electrification goals

Uber has committed \$800 million to help drivers switch to EVs. It has also provided \$245 million through a combination of direct incentives, savings from partners and schemes such as its Clean Air Plan to support vehicle acquisition. Cabify obtained a €40 million (\$43 million) loan from the European Investment Bank (EIB) for their €82 million fleet decarbonization project in Spain.

Rental companies are increasing EV offerings, but hitting challenges

Share of EVs in car rental fleets in 2022 and electrification targets for select companies



Source: BloombergNEF. Note: Sixt reports "clean vehicles" as the combination of plug-in hybrids, battery electric vehicles and mild hybrids. Enterprise's EV fleet share estimated based on company statements and new reports. (*) Hertz stated in October 2023 that it no longer expects to meet this target

EVs make up 3% of the rental vehicle fleet

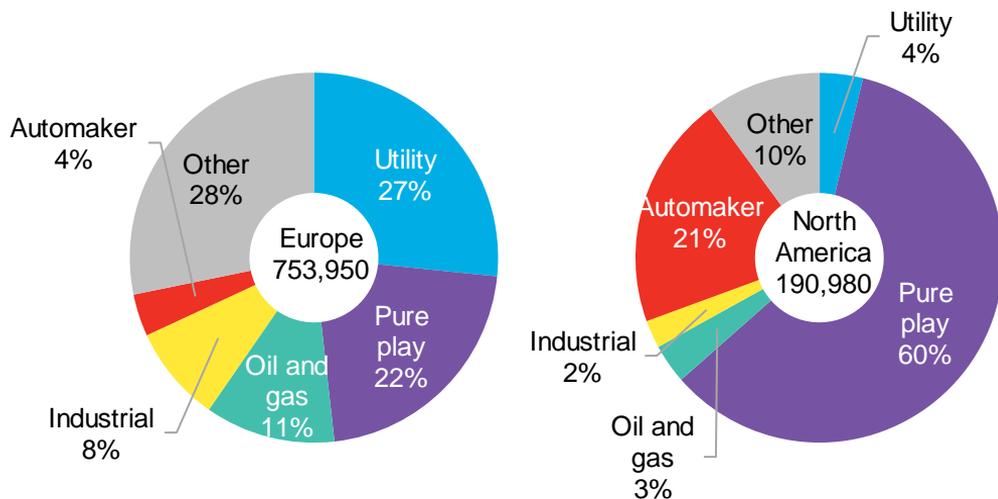
The electric rental fleet and the EV share in the industry are set to expand as large rental companies make purchases from automakers. The most aggressive deals to date have come from Hertz, which planned to add 100,000 Tesla vehicles by the end of 2022, and 175,000 General Motors EVs and 65,000 Polestars by 2027. With the purchase, Hertz aims to increase the EV share of fleet from 10% today to 25% by 2024. However, during its 3Q 2023 earnings call, Hertz announced that it would slow purchases of EVs due to their lower residual values and higher repair costs.

Targets will require obliging automotive partners

Another notable deal was between Sixt and Chinese EV maker BYD, under which Sixt will buy around 100,000 BYD EVs by 2028. Sixt will need to increase purchases from other automakers to achieve its target of electrifying 70-90% of its European fleet by 2030. Europcar has set a target similar to Hertz's, aiming to have 20% of its fleet comprising electric and rechargeable hybrid vehicles by 2024.

Sectors battle for future charging industry market share

Cumulative number of public charging connectors deployed by sector as of September 2023



Public charging is attracting investment from across several sectors.

In Europe, utilities hold the largest market share, closely followed by pure-play operators who have gained significant funding from infrastructure investors. An increasing number are now raising debt, as well as equity funding.

The North American public charging network is only a quarter the size of the European network. Pure-play operators hold the largest market share. As the biggest operator, ChargePoint, does not own the infrastructure, investment is still coming from other sectors.

Oil and gas majors operate 11% of the European network and 3% of the North American network.

Despite standing to lose share of the fueling market, oil and gas companies still hold a small share of the current market. Many have announced roll-out plans, particularly for fast chargers. Shell, for example, has acquired seven charging companies.

Source: BloombergNEF, Ecomovement. Note: "Other" includes a range of companies including supermarkets, telecommunications and parking companies.



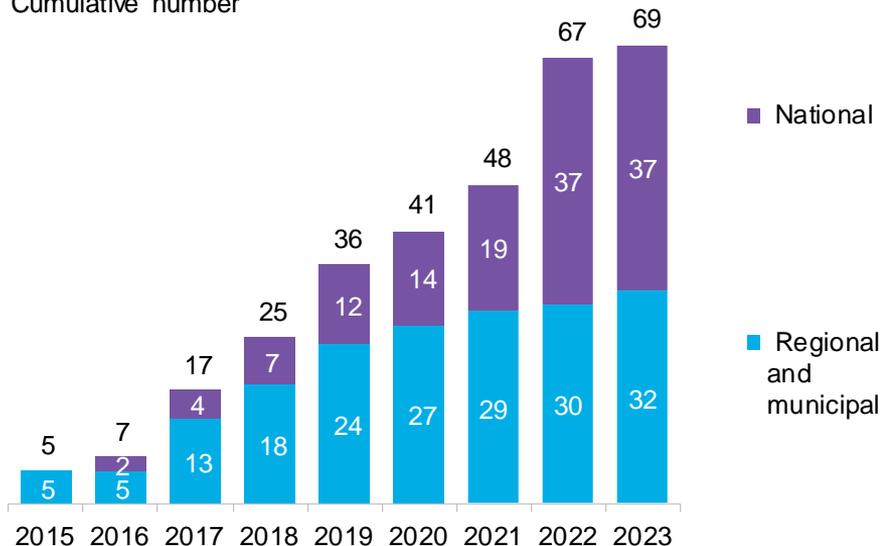
Government
Commitments

**National and regional
ZEV ambition**

Governments of all levels are implementing ICE phase-out targets

National and regional targets to phase out internal combustion engine vehicle sales

Cumulative number



Source: BloombergNEF. Note: Covers ICE phase-out targets announced through October 27, 2023.

There are 69 governments in total targeting a phase-out of new ICE sales.

This includes 37 national governments as well as 32 regional and municipal authorities. We now include the countries that fall within the European Union's 2035 ICE phase-out within the national targets. Still, the EU's target does include an exemption for e-fuels, highlighting that it was slightly weakened in the late stages of negotiations.

National ICE phase-out targets have slowed in recent years as no new countries have joined the list in 2023.

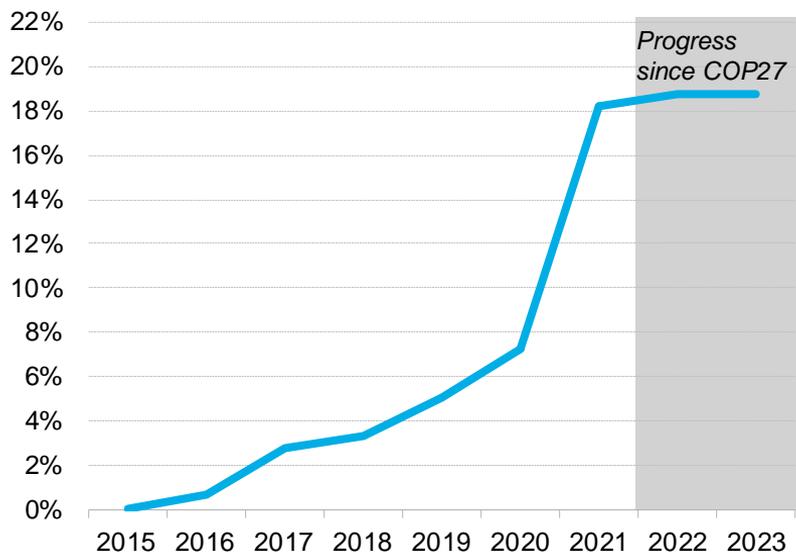
The importance of regional ICE phase-out targets should not be underestimated.

Sub-national targets can drive real impact, especially in countries where national mandates are yet to be implemented.

In 2023 the state of New Jersey adopted California's 2035 ICE phase-out. Stockholm also announced it would ban ICE vehicles from the city center from 2025 onwards.

Countries with phase-out targets still represent only 19% of the passenger vehicle market

Share of global passenger vehicle sales covered by national and EU ICE phase-out targets



Only 19% of 2022 passenger vehicles sales were in countries that now have an ICE phase-out date.

There has been a clear and noticeable slow-down in national ICE phase-out announcements. The EU-wide target was first announced in 2021 and finalized in 2023. The last country to announce an ICE phase-out target was Vietnam, in 2022.

This highlights the importance of targets by major automotive markets like the US, China and India – all of which have no national ICE phase-out policy. Each of these three countries have interim electrification targets, though.

The first country with a national ICE phase-out policy was Norway in 2016. That year, less than 1% of 2022 global passenger vehicle sales were covered by these policies.

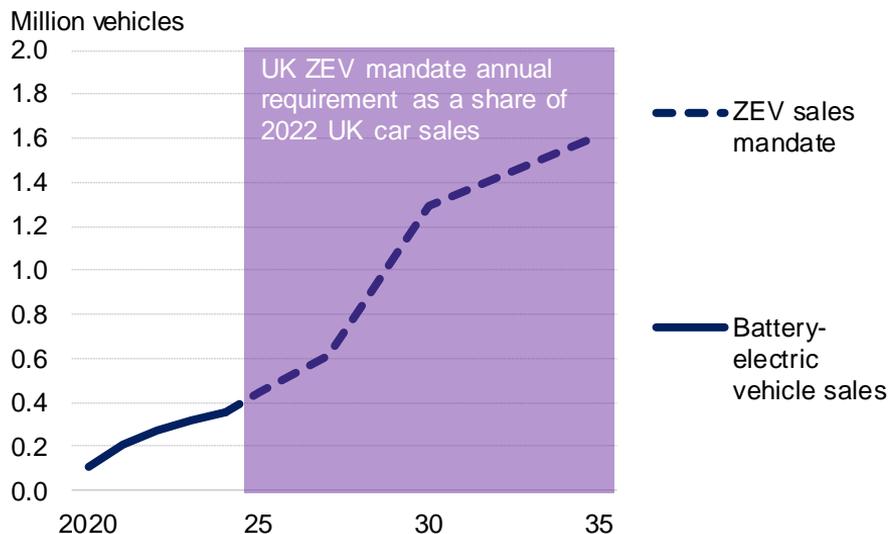
By 2020, 7% of global passenger vehicles sales occurred in countries with an ICE phase-out. This included markets like Canada, France, Spain and the UK. The UK recently announced that it was moving back its 2030 target to 2035, arguing that it was too expensive for consumers to meet the current timeline.

Other markets outside of EMEA have announced targets. Canada and Vietnam are the largest in that group.

Source: BloombergNEF, MarkLines, Bloomberg Intelligence. Note: Share of 2022 global passenger vehicle sales by announcement year of ICE sales phase-out. The European Union has finalized its 2035 CO2 emission regulation. Covers ICE phase-outs through October 23, 2023.

Regulations are being implemented to support long-term targets

UK passenger BEV sales and mandated ZEV share of total car sales



The UK's ZEV mandate – confirmed in September 2023 – sets annual targets for the minimum proportion of ZEVs in automakers' sales.

The mandate kicks in from 2024, when 22% of automakers' cars sold in the UK will have to be ZEVs – up 3 percentage points from an estimated 19% in 2023.

The target then increases to 28% by 2025, 80% by 2030 and 100% by 2035. The 2035 target is in line with the UK's goal of phasing out sales of ICE vehicles by then.

If met, the mandate could amount to 450,000 ZEVs being sold in the UK in 2025.

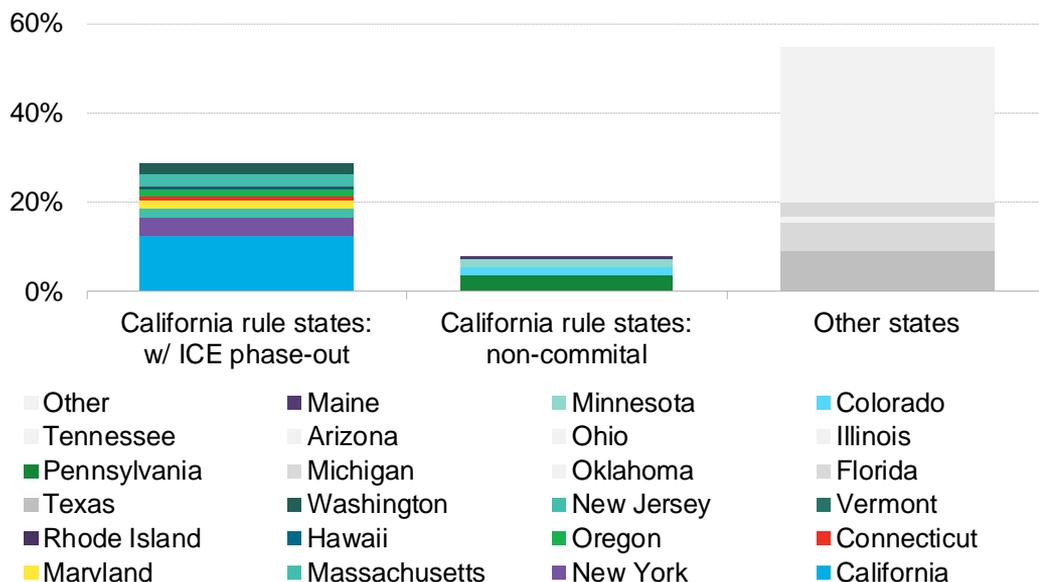
This increases to 1.3 million by 2030, some four times the expected sales in 2023.

The penalty fee for missing the target is set at £15,000 (\$18,800) for every car that does not comply, though automakers are provided some additional flexibilities and can buy and sell credits.

Source: BloombergNEF, Marklines, Bloomberg Intelligence. Note: Share of 2022 global passenger vehicle sales.

In the US, states are leading the transition, representing 41% of the nation's vehicle fleet

Share of US car fleet following California's fuel economy standards



California continues to push ahead with its Advanced Clean Cars II policy, which puts the state on a path to phasing out ICE vehicle sales by 2035. Ten other states have signed or are in the process of signing onto that policy since it was finalized in 2022.

The policy calls for EVs and FCVs to rise to 35% of new passenger car sales by 2025, 68% by 2030 and 100% by 2035. In that year, PHEVs that meet necessary requirements can make up to 20% of new sales.

In the US, 17 states have adopted California's Low-Emission Vehicle and greenhouse gas emission regulations.

These markets comprise 41% of the existing US automotive fleet for passenger vehicles in 2022.

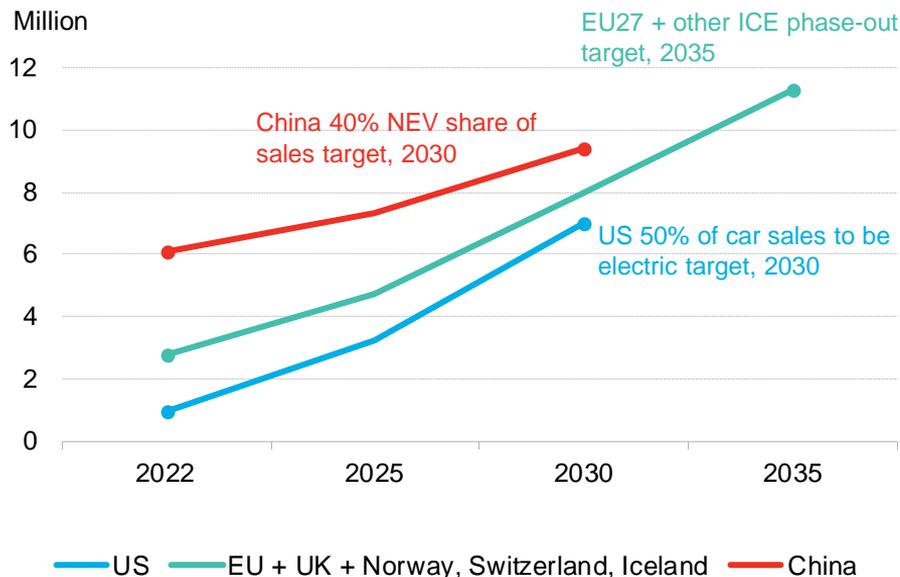
While a national ICE phase-out policy in the US is unlikely, California has previously pushed automakers forward by adopting more stringent standards.

In addition, 15 states have also adopted California's ZEV standard.

Source: BloombergNEF, Experian Automotive. Note: Chart considers states that follow California's fuel economy standards – including low-emission vehicle and greenhouse gas regulation programs, not only ZEV states.

The US and China have substantial EV targets, despite no ICE phase-out policy

Estimated EV and FCV sales based on interim policy targets in China and the US, compared with the EU ICE phase-out



Source: BloombergNEF, various governments. Note: Chart uses 2022 passenger vehicle sales for country to estimate impact of interim targets. The US 2030 target is non-binding, and it includes PHEVs. The EU 2035 target is a full ICE phase-out, and includes Norway, Switzerland, Iceland and the UK. The US and China targets are interim targets. Values between target dates are extrapolated.

Although China and the US do not have national ICE phase-out targets, they have put in objectives aiming to accelerate EV adoption. These targets are unchanged from last year's report but are worth considering as the market advances.

China's target is part of its NEV program, and includes three drivetrain types – BEV, PHEV and FCV. Its interim goal calls for 40% NEV share of sales across passenger and commercial vehicles and buses by 2030. This could amount to 9.4 million passenger EVs and FCVs sold by 2030, which is only 1.5 times higher than last year's EV sales. China also has a 20% NEV target for 2025, which has already been exceeded in 2022.

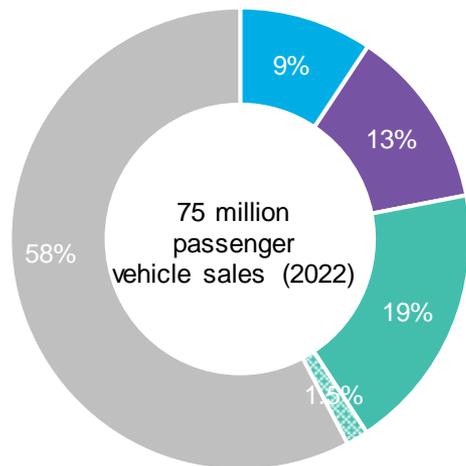
The US has an interim target for 2030, set under an executive order by President Joe Biden, calling for 50% of passenger vehicle sales to be electric.

The EV share of car sales in the US reached 8% in 2022. EV adoption in the country would need to significantly accelerate to meet the 2030 target.

Both interim targets, if achieved, will have a significant impact on global passenger vehicle sales.

Combined national targets cover 42% of the global passenger vehicle market

Share of 2022 passenger vehicle market covered by ICE phase-out commitments and interim/partial targets



- US (2030 target)
- China (2030 target)
- ICE phase-out (in place)
- India (2030 target)
- Not committed

Aggregating ICE phase-outs and interim sales targets reveals that nearly 42% of the passenger vehicle market is now targeted for transition to EVs or ZEVs. This is almost unchanged from last year's report.

As discussed on previous pages, ICE phase-outs represent over 19% of the global car market. Interim/partial targets – including China, the US and India – add another 23%.

Combined, these targets covered about 32 million passenger vehicle sales in 2022. This is similar to last year as no new major targets have been announced.

There remains about 58% of the market not covered by any type of ZEV commitment.

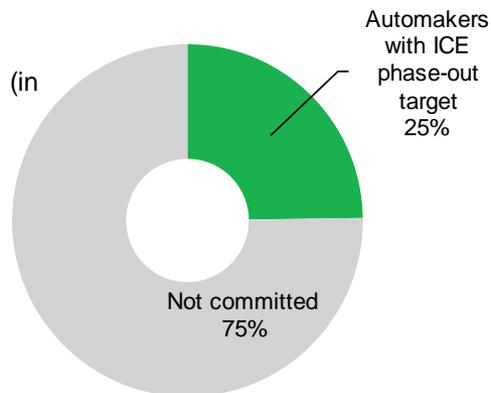
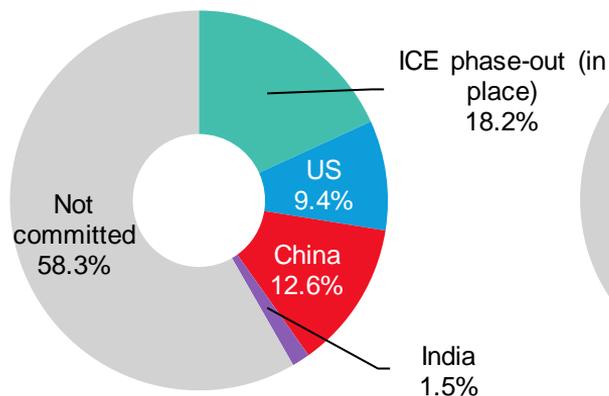
Large auto markets without a current ICE phase-out policy include South Korea, Japan, Russia and Brazil – as well as remaining portions of the three large markets with interim targets (the US, China and India).

Source: BloombergNEF, various governments. Note: Chart uses 2022 passenger vehicle sales for country to estimate impact of interim targets. The US 2030 target is non-binding, and it includes PHEVs. China's targets are for new energy vehicles. India's target includes PHEVs. ICE phase-outs vary by country/region.

Automakers' 2035 ambitions do not match up to country targets

Country ICE phase-out targets and interim / partial ZEV targets by 2035

Automakers' ICE phase-out targets by 2035



Automotive manufacturers' ICE phase-out targets by 2035 are still less ambitious than the goals set by governments. Yet, both automakers and governments have slowed their ambitions since COP27.

Automakers accounting for 25% of the 2022 global passenger vehicle market have stated their intentions to stop selling ICE vehicles by 2035. This is considerably less than the 42% of the global market covered by national and EU targets (including interim ones), as shown on the previous two pages.

However, a like-for-like comparison to strict ICE phase-outs looks more balanced, with national targets of this type accounting for only 19% of the global market.

Some automakers have phase-out targets for 2040; including these increases the share of the market covered by automakers' ICE phase-out commitments to 32%.

Honda has set a target for 2040 for its ICE phase-out. But many automakers have set objectives in line with the 2035 ICE phase-outs in Europe and in leading US states.

Most Chinese automakers have not announced ICE phase-out targets despite strong EV sales. BYD ended its ICE vehicle sales in 2022.

Source: BloombergNEF

Source: BloombergNEF

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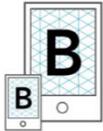
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