

Automotive & Assembly Practice

McKinsey Electric Vehicle Index: Europe cushions a global plunge in EV sales

McKinsey's recent analysis of global electric-vehicle markets shows both challenges and opportunities ahead.

This article was written collaboratively by members of McKinsey's Automotive and Assembly Practice: Thomas Gersdorf, Patrick Hertzke, Patrick Schaufuss, and Stephanie Schenk.



McKinsey's proprietary Electric Vehicle Index (EVI) assesses the dynamics of the e-mobility market in 15 key countries worldwide (for more information on the metrics evaluated, see sidebar "What is the Electric Vehicle Index?"). EVI results for 2019 and the first quarter of 2020 provide important insights about market growth, regional demand patterns, market share for major electric-vehicle (EV) manufacturers, and supply-chain trends.

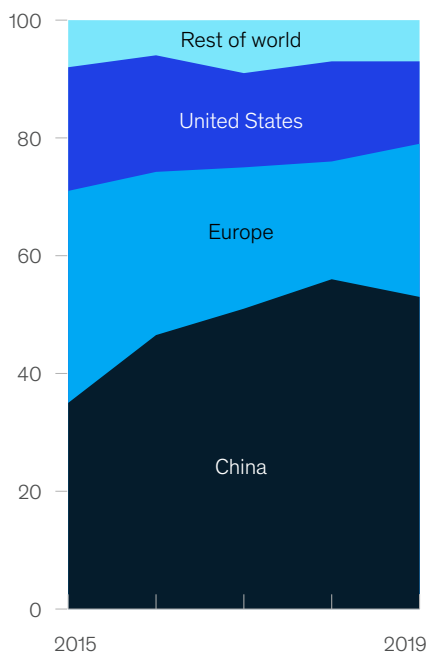
Growth in the electric-vehicle market has slowed

EV sales rose 65 percent from 2017 to 2018 (Exhibit 1). But in 2019, the number of units sold increased only to 2.3 million, from 2.1 million, for year-on-year growth of just 9 percent. Equally sobering, EV sales declined by 25 percent during the first quarter of 2020. The days of rapid expansion have ceased—or at least paused temporarily. Overall, Europe has seen the strongest growth in EVs.

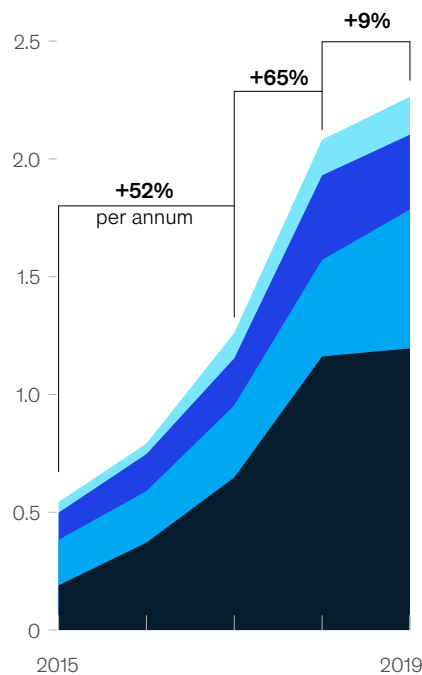
Exhibit 1

In contrast to a slowdown of EV sales globally in 2019 and in the first quarter of 2020, Europe expanded its market share to 26 percent, growing by 44 percent.

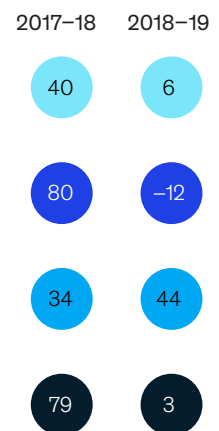
Global electric-light-vehicle sales by region, % share



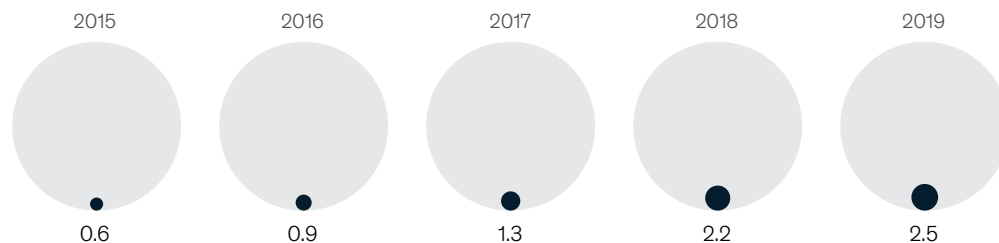
Global electric-light-vehicle sales by region, million units



Electric-vehicle growth, %



Global electric-light-vehicle sales, % of total sales



Source: Ev-volumes.com; Light Vehicle Sales Forecast, May 2020, IHS Markit

What is the Electric Vehicle Index?

McKinsey's proprietary **Electric Vehicle Index (EVI)** focuses on battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). Since we created the EVI, several years ago, it has given organizations in the automotive, mobility, and energy sectors a detailed view of the electric-vehicle (EV) market, while highlighting potential future trends.

The EVI explores two important dimensions of electric mobility:

1. **Market demand** analyzes the share of EVs in the overall market, as well as factors affecting EV penetration in each country, such as incentives (for instance, subsidies), existing infrastructure, and the range of available EVs.

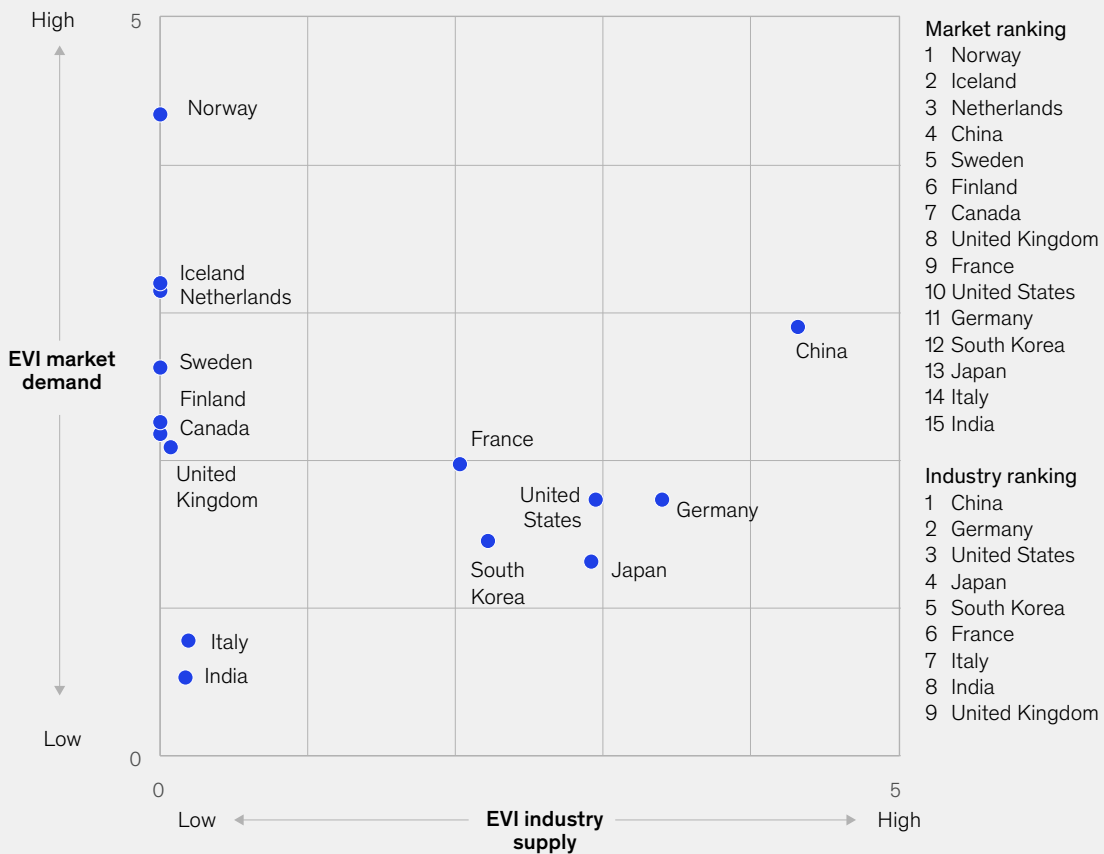
2. **Industry supply** explores the share of a country's OEMs in the production of EVs and EV components, such as e-motors and batteries, looking at both current and projected numbers.

The EVI assesses the key performance indicators in each country and rates them on a scale from 0 to 5 for every dimension. These scores serve as the basis for the final country ranking (exhibit).

Exhibit

The Electric Vehicle Index for 2020 shows that Nordic countries lead for market demand, while China and Germany dominate industry supply.

Overall Electric Vehicle Index (EVI) results, score (range from low of 0 to high of 5)



Source: McKinsey Center for Future Mobility

Although these developments are disappointing, they largely reflect the decline of the overall light-vehicle market, which fell by 5 percent in 2019 and by an additional 29 percent in first-quarter 2020. Despite the overall drop in sales, global EV market penetration increased by 0.3 percentage points from 2018 to 2019, for a total share of 2.5 percent. With additional growth in the first quarter of 2020, EV penetration is now at 2.8 percent.

To gain different perspectives on the EV industry's growth and other topics, we interviewed various McKinsey experts (see sidebar, "Expert views on the electric-vehicle sector's future development"). The remainder of this section explores regional market variations.

Expert views on the electric-vehicle sector's future development

How will the global electric-vehicle (EV) market develop over the short to mid term? Many uncertainties persist, so we asked some McKinsey experts about their views on pressing issues.

China's declining EV sales, resulting from the government's subsidy cuts, raise concerns about the sustainability of customer demand in the country. How will sales develop, especially considering the COVID-19 crisis, and what is the government's strategy to achieve its 25 percent sales target for new-energy vehicles (NEVs) by 2025?

Ting Wu (partner, Shenzhen): NEVs are still a top priority for the Chinese government and take center stage in its post-coronavirus stimulus plan. The government recently decided to extend NEV subsidies by two years, to the end of 2022. In addition, RMB 10 billion (\$1.4 billion) will be invested to expand the charging network for electric vehicles (EVs) this year. Overall, increased government purchases will probably drive the market. Nevertheless, achieving the 25 percent target by 2025 will be a challenge and probably require additional policy instruments and new business models to spur sufficient consumer demand.

Automakers are relying on EVs to achieve Europe's upcoming carbon-dioxide emissions limits for 2020 and 2021.

Although we have seen strong dynamics across countries, will the industry sell enough EVs to avoid looming penalty payments, and what might be the impact of the COVID-19 crisis?

Patrick Schaufuss (associate partner, Munich): OEMs have invested more than €30 billion in EVs over the past two years to meet Europe's upcoming carbon-dioxide regulations. OEMs plan to make a spot landing on the targets. Every gram these companies miss costs the industry about €1.5 billion, but overachieving would tighten their 2030 targets.

In the first quarter of 2020, we saw increased momentum on the consumer side for buying EVs, despite the COVID-19 pandemic. Other signs also suggest that the momentum of EVs will be sustained in Europe—for instance, the creation of additional purchase incentives, the timely creation of EV standard operating procedures, and an infrastructure rollout.

Given the recent loosening of the US federal emissions regulations, how will the trajectory of the US market and the

EV strategies of traditional automakers evolve over the coming years?

Russel Hensley (partner, Detroit): Vehicle electrification strategies will remain relatively consistent, despite the uncertainty about current regulations and the ensuing debate between federal and state policy makers. While some automakers may have cut or delayed their EV programs, domestic OEMs must continue their efforts to enhance the average fuel economy of their new fleets, given the large share of light trucks, SUVs, and compact utility vehicles.

Many automakers use plug-in hybrid electric vehicles (PHEVs) as a bridge to a fully electric future. How will this technology develop?

Ruth Heuss (senior partner, Berlin): Over the past few years, sales of plug-in hybrid electric vehicles have been growing more slowly than sales of pure battery electric vehicles (BEVs). PHEVs represented less than a third of the global EV market in 2019. While most automakers offer them, the number of available models will remain less than half of the number of BEV models over the coming years. Although a higher driving range is one of the major advantages of PHEVs, the electric range of BEVs has

been constantly increasing: it rose by 55 percent from 2017 to 2020 and is now around 400 km. Given typical driving behavior, PHEVs recently started to face regulatory headwinds as their environmental impact raised concerns. In reaction, some countries have reduced or entirely abolished monetary subsidies for PHEVs, further increasing their already higher price point for consumers. In 2019, among the key EV markets, PHEVs dominated EV sales in only three countries: Finland, Iceland, and Sweden. We therefore currently forecast that PHEVs will represent only 5 to 10 percent of the global market by 2030. That could fall even further as emissions regulations are increasingly based on real consumption.

We hear very little about hydrogen-fuel-cell EVs, except for a few models from Japanese and South Korean manufacturers. Will the technology contribute to green mobility in the future, and if so, will it emerge first in the passenger or light commercial-vehicle segment?

Anna Orthofer (associate partner, Vienna): There is actually quite some noise around hydrogen on the commercial-vehicle front. Most large OEMs have teamed up to work on the technology—for example, Daimler and Volvo, Toyota and Traton, and Honda and Isuzu. New players, such as Nikola and Hyzon, are entering the market, and Chinese companies are moving fast. The big suppliers are following by building a comprehensive system offering in fuel cells.

Overall, we see fewer and fewer OEMs that do not think about hydrogen as a necessary part of their powertrain portfolios. In light of carbon-dioxide regulation for trucks (such as the European Union's “–30 percent by 2030” target), each ton in weight and each kilometer in range will improve total costs of ownership for fuel cells relative to batteries.

For long-haul trucks, our models show that fuel-cell electric vehicles can break even with battery electric vehicles within the next five years. They will also achieve lower total costs of ownership than diesel before 2030.

Markets such as China, Sweden, and the United Kingdom have reacted strongly to EV-incentive changes. Yet customer demand—independent of government subsidies—remains a major concern in the industry. Who is currently buying EVs, and what is required to scale up the market?

Timo Möller (partner, Cologne): Early adopters of BEVs appear to constitute a specific segment of consumers, best described as tech-savvy urban people with above-average incomes and a familiarity with online shopping. Beyond first movers, consideration of EVs has significantly increased among consumers over the past few years as they have come to recognize the numerous benefits of EVs. To scale up the market, OEMs should thus systematically try to affirm the consumers' growing positive attitudes about many aspects of EVs, such as the driving experience and subsidies. OEMs should also disprove consumer fears, such as range anxiety, that do not reflect reality and solve pressing pragmatic problems, such as the availability of charging stations.

Shifting portfolios from internal-combustion engines (ICEs) to EVs is a major challenge for traditional automakers, especially considering profitability. What is the current view of profits for EVs sold today? Will falling costs and rising consumer demand overcome the need for government support, and how can OEMs share the pain?

Patrick Hertzke (partner, London): Shifting the vehicle portfolio from ICE to PHEV/BEV—a change driven by regulation

and shifting consumer demand—is now a paramount focus for traditional automakers. Many of them are concerned about profitability. The majority of EV models are still unprofitable, but this is changing. At-scale EV producers will have a clear cost advantage in the near term, while other OEMs are more likely to seek partnerships to co-develop EV platforms or even fully merge. EV growth across transport sectors also remains one of the most critical levers in global efforts to reduce carbon-dioxide emissions and improve urban air quality. EV supply chains will get even greener over time with the expansion of renewables and the recycling and reuse of batteries. COVID-19 and the related economic crisis will raise the stakes further as the world seeks cleaner transport solutions but could require governments to continue their subsidies and penalties as well. They may also need to add other measures, such as green early-scrappage programs, which encourage consumers to swap older cars for EVs.

Inspired by the ambitious EV strategies of automakers, battery-cell suppliers are ramping up their capacities. What are the key trends and challenges for the battery supply chain?

Markus Wilthner (associate partner, Vienna): The uptake of EVs has supercharged industrialization and expansion in the industry. Battery-cell makers have an outside growth opportunity in front of them. By revenue, they could become some of the largest automotive suppliers globally. This opportunity comes with huge challenges and trade-offs. They need to ramp up production capacities fast, while remaining disciplined about capital expenditures. Battery-cell makers must also stabilize production processes and achieve very high yields, while constantly pursuing product innovations. Every

year, they must reduce costs to deliver on long-term contracts and remain competitive, while simultaneously seeking new business models and opportunities for differentiation. Finally these suppliers must solve challenges related to sustainability by turning the whole battery value chain, from mining to recycling, into a sustainable and responsible industry.

Demand for battery cells is expected to increase at least fourfold over the next five years, and cell chemistry is moving to nickel-rich cathodes. What are the developments and challenges on the battery raw-materials side?

Ken Hoffman (expert, New Jersey): There are three main challenges for the battery

raw-materials supply stream. First, will the industry produce the quality of the nickel, lithium, and cobalt necessary? Second, will it produce the extremely specific quality needed? Third, can this production meet the ever more stringent environmental, social, and governance requirements imposed by regulators?

What will enable a truly sustainable form of electric mobility in the future? Where does the industry stand on sourcing raw materials sustainably, green electricity, and battery recycling? Is awareness of these challenges increasing?

Hauke Engel (partner, Frankfurt): The journey to truly sustainable electric mobility has only begun. The industry has made

great progress increasing the number of available hybrid and fully electric-vehicle models, and costs keep coming down. Now the industry must work hard to drive down the cost of batteries and to achieve end-to-end sustainability—from truly sustainable raw-materials supplies (such as zero-carbon steel) to circular-economy principles in vehicle design. I'm excited to see OEMs increasingly starting to recognize and embrace these challenges. The scale and complexity of the problems may seem daunting, and solving them will require imagination, determination, and new forms of collaboration. Failure is not an option. We must simultaneously solve the climate challenge and secure the prosperity of our automotive industries and the people they employ.

EV market trends vary by region

Key EV markets suggest shifting regional dynamics, with China and the United States losing ground to Europe. EV sales remained constant in China in 2019, at around 1.2 million units sold (a 3 percent increase from the previous year). In the United States, EV sales dropped by 12 percent in 2019, with only 320,000 units sold. Meanwhile, sales in Europe rose by 44 percent, to reach 590,000 units. These trends continued in first-quarter 2020 as EV sales decreased from the previous quarter by 57 percent in China and by 33 percent in the United States. In contrast, Europe's EV market increased by 25 percent.

China

The relatively slow 2019 growth of China's EV market reflects both an overall decline in the light-vehicle market and significant cuts in EV subsidies. The central government, for example, eliminated purchase subsidies for vehicles that achieve electric ranges (e-ranges) of less than 200 kilometers and reduced subsidies by 67 percent for battery electric

vehicles (BEVs) with e-ranges above 400 kilometers. These cutbacks reflect the government's strategy of scaling back monetary incentives for new-energy vehicles (NEVs) and transitioning to nonmonetary forms of support. Since 2019, OEMs have received credits for each NEV produced. The credits take into consideration factors such as the type of vehicle, as well as its maximum speed, energy consumption, weight, and range. Regulators base credit targets for each OEM on its total production of passenger cars. If a manufacturer does not reach the target, it must purchase credits from competitors that have a surplus or pay financial penalties.

In first-quarter 2020, China was heavily affected by the COVID-19 pandemic. EV sales dropped by 57 percent from the fourth quarter of 2019 as consumer demand declined sharply. Several EV manufacturers were also forced to halt production. In response, the central government extended through 2022 (though at reduced rates) monetary incentives that were about to expire. The government also prolonged the purchase-

Key EV markets suggest shifting regional dynamics, with China and the United States losing ground to Europe.

tax exemptions of NEVs through 2022. These measures, together with the government's recent decision to invest billions of renminbi in the charging infrastructure as part of an economic-stimulus program, could help EV sales rebound in 2020.

The United States

EV sales rose by 80 percent in the United States in 2018, driven by the market launch of the standard version of the Tesla Model 3. The increase slowed in 2019 because of several developments. With Tesla's overseas deliveries increasing and the gradual phaseout of the federal tax credit in January and July 2019, the brand's US sales for that year declined 7 percent, or 12,400 units. Meanwhile, the Chevrolet Volt was phased out, and its sales fell by 14,000 units. Sales of the Honda Clarity also decreased by 8,000 units.

Some international OEMs did successfully launch new models in the United States in 2019, including Audi (the e-tron) and Hyundai (the Kona). Sales of VW's e-Golf also increased. These three brands accounted for more than 24,500 units of EV sales, but their strong performance could not offset the decline of other models. US sales of EVs decreased further in first-quarter 2020, by 33 percent from the previous quarter.

The federal government's recent moves to loosen regulations could further decelerate the EV market in the United States. In March 2020, for instance, the government revised fuel-economy standards, to a 2026 target of 40 miles per gallon (mpg), from 54 mpg. Today's low oil prices are also contributing to the EV slowdown, since they significantly lower

the total cost of ownership for vehicles powered by internal-combustion engines (as compared with EVs). These changes are creating great uncertainty, and the US EV market's development could depend largely on the number of states adopting California's Zero-Emission Vehicle Program and on the vicissitudes of oil prices.

Europe

Unlike other key EV markets, Europe has seen significant EV growth. In 2019, sales increased by 44 percent, the highest rate since 2016. The European Union's new emissions standard—95 grams of carbon dioxide per kilometer for passenger cars—could also boost EV sales because it stipulates that 95 percent of the fleet must meet this standard in 2020 and 100 percent in 2021. BEV sales picked up speed substantially, with a 70 percent growth rate propelled by three models: the Tesla Model 3, Hyundai Kona, and Audi e-tron.

EV sales increased by double-digit percentages in 2019 in almost every European country. Sales in some smaller markets, such as Estonia, Iceland, and Slovakia, declined in absolute terms. EV sales in Germany and the Netherlands contributed nearly half—44 percent—of overall EV-market growth in Europe; in both countries, units sold increased by about 40,000 units. Those numbers translate into a 2018 growth rate of 55 percent for Germany and 144 percent for the Netherlands. In both countries, these strong EV sales resulted from increased demand for new models, the availability of existing models with larger battery sizes, and changed government incentives (for more information on the power of incentives, see sidebar “Purchase subsidies juice EV sales.”)

Purchase subsidies juice EV sales

As recent developments in China and Europe show, government subsidies remain a major driver of electric-vehicle (EV) sales. In 2019, several countries changed these incentive schemes in ways that show how sensitive customers are to price adjustments. For instance, the EV market in China declined by 31 percent in the second half of the year after the government cut subsidies. In the United Kingdom, sales of plug-in hybrid electric vehicles (PHEVs) fell by 15 percent after the government stopped subsidies for hybrids. Government subsidies also play an important role in increasing growth. When Germany reduced the company-car tax in January 2019, it promoted a surge in EV sales later that year. Similarly, the strong 2019 showing of the EV market in the Netherlands occurred

partly because consumers wanted to purchase vehicles before the benefit-in-kind tax rate increased in 2020.

As first-quarter 2020 figures show, the EV markets in several European countries could accelerate this year because of recently increased incentives:

- France revised its bonus–malus (reward–penalty) scheme, based on carbon-dioxide emissions. Companies must meet new requirements to receive the environmental bonus for low-emitting vehicles and face a drastic increase in the environmental penalty for high-emitting ones.

- Germany extended tax incentives for electric company cars through the end of 2030. It has also increased purchase-price subsidies for EVs and will continue them until the end of 2021.
- Sweden implemented a bonus–malus system in 2018. A January 2020 amendment for test procedures to determine the carbon-dioxide emissions of vehicles will benefit PHEVs.

While government subsidies obviously have a strong influence on the development of the EV market, future growth may depend largely on the extent to which the COVID-19 pandemic hits EV markets in the short term.

In the first quarter of 2020, European EV sales rose as the overall EV penetration rate increased to 7.5 percent. With the exception of Hong Kong, all of the top ten markets for EV penetration were in Europe (Exhibit 2). The strong regulatory tailwinds and high purchase incentives in several European countries could dampen the impact of the COVID-19 pandemic and further boost the EV market. That said, EV sales will probably face tougher impediments in second-quarter 2020, when the pandemic's impact on Europe's countries and economies should peak. So far, no European OEM has changed its plans to roll out EV models, and several countries are discussing additional purchase incentives as part of their economic-stimulus programs.

Electric-vehicle makers are debuting new models and boosting sales of existing ones

Automakers launched 143 new electric vehicles—105 BEVs and 38 plug-in hybrid electric vehicles (PHEVs)—in 2019. They plan to introduce

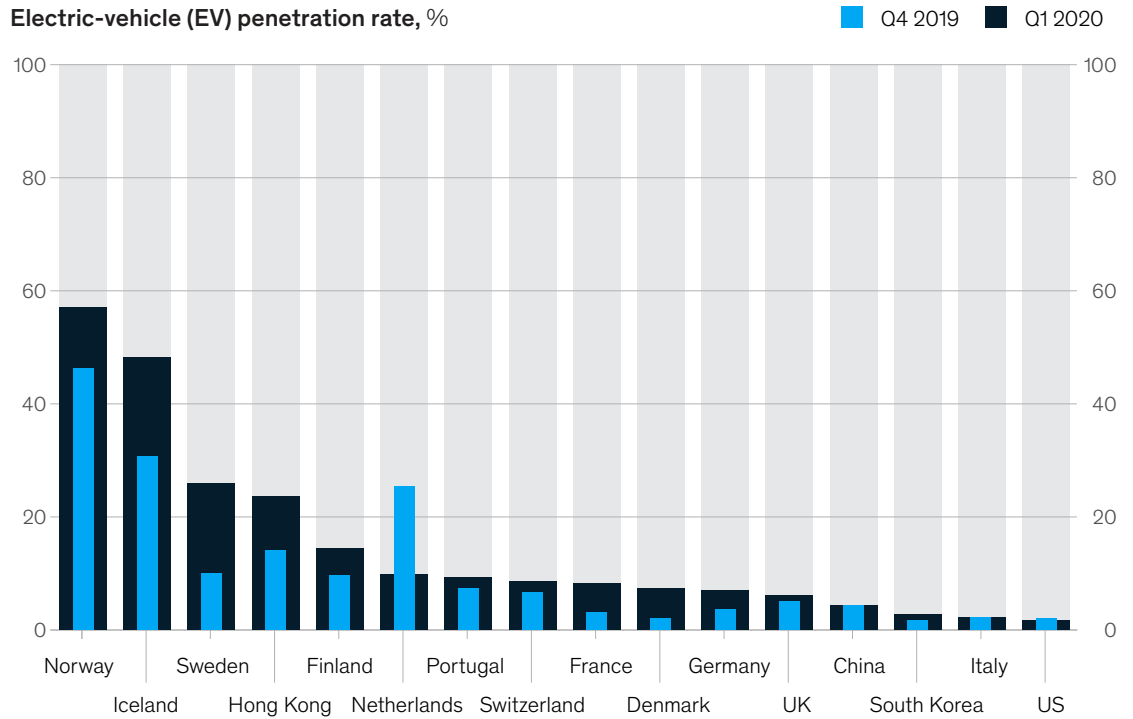
around 450 additional models by 2022 (Exhibit 3). Most are midsize or large vehicles. Given the estimated production levels, German manufacturers, with an expected volume of 856,000 EVs, could overtake Chinese players in 2020. That would boost Germany's global production share from 18 percent in 2019 to 27 percent in 2020.

New emissions regulations in Europe and China, which will come into force between 2020 and 2021, partly explain why EV-model launches have increased significantly. These regulations pose major challenges for automakers, since they will face potential penalties of up to several billion euros unless they increase their EV penetration rates significantly.

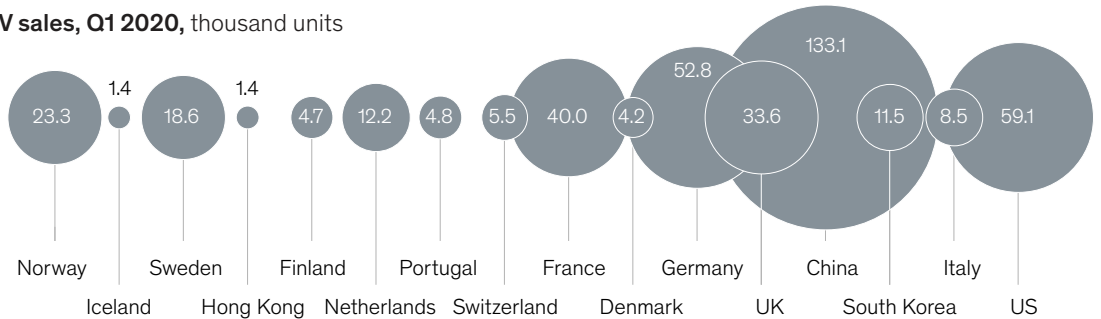
Among EV manufacturers, Tesla continued as market leader in 2019, with 370,000 units sold globally, for a market share of about 16 percent, up from 12 percent in 2018 (Exhibit 4). The launch of the Model 3 outside of the United States was the main reason for this surge. With 300,000 units

Exhibit 2

Nine of the top ten markets for electric-vehicle penetration rate were European.



EV sales, Q1 2020, thousand units



Source: Ev-volume.com; Light Vehicle Sales Forecast, May 2020, IHS Markit

sold worldwide, the Model 3 outpaced sales of the BJEV EU-series threefold and sales of Nissan Leaf fourfold.

At the brand level, most Chinese EV manufacturers faced declining sales, while demand was high for the EV offerings of some international OEMs.

The supply chain is localizing

With announced launches of new EV models spiking, both automakers and suppliers are increasing their

global footprints in target markets by localizing the production of vehicles and components. For example, Tesla began construction of its Shanghai plant in January 2019 and delivered the first locally produced EV that December. The company plans to build its next production plant in Germany by 2021. Similarly, Volkswagen and Toyota have announced plans to set up EV plants in China.

In a similar development, battery-cell manufacturers are increasing their production capacities in target markets. The total lithium-ion-battery market

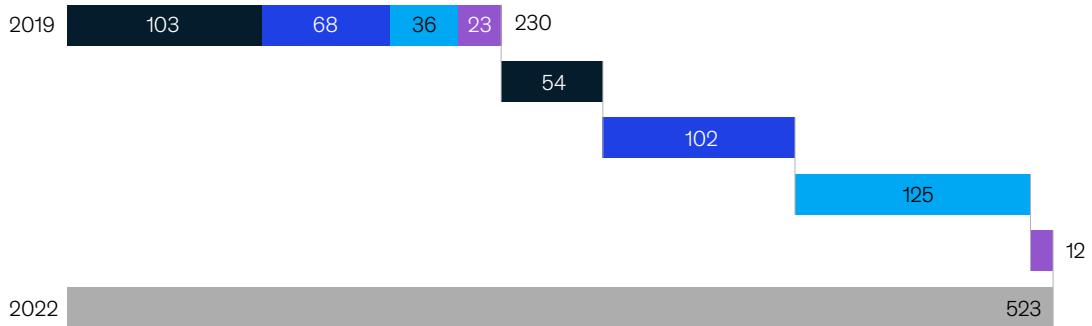
Exhibit 3

About 450 new electric-vehicle models will be launched through 2022.

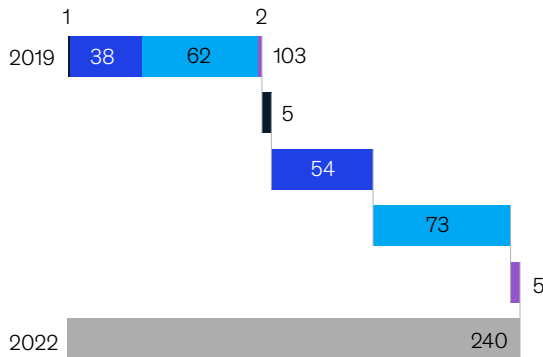
New models by car size, number

■ A/B segment ■ C segment ■ D/E segment ■ Others

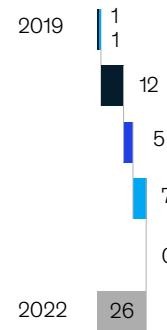
Battery electric vehicles



Plug-in hybrid electric vehicles



Range-extended electric vehicles



Source: IHS Light Vehicle Powertrain Forecast, May 2020

for EV passenger cars grew by 17 percent, to 117 gigawatt-hours in 2019, enough to power 2.4 million standard BEVs. Most of the new capacity will be established in Central Europe, with companies preparing to meet demand throughout the region. Company announcements suggest that the global market should expand to about 1,000 gigawatt-hours by 2025. The Chinese battery maker CATL had the largest market share in 2019, at 28 percent, while its absolute capacity grew by 39 percent. CATL has recently continued its global expansion, signing new contracts with several international OEMs and setting up a factory in Germany.

South Korean manufacturers are trying to catch up with large-scale investments in new overseas production plants. SK Innovation, for example,

announced it would invest an additional €5 billion in its planned US factory, while LG Chem is investing \$2.3 billion in a joint venture (JV) with General Motors in the United States.

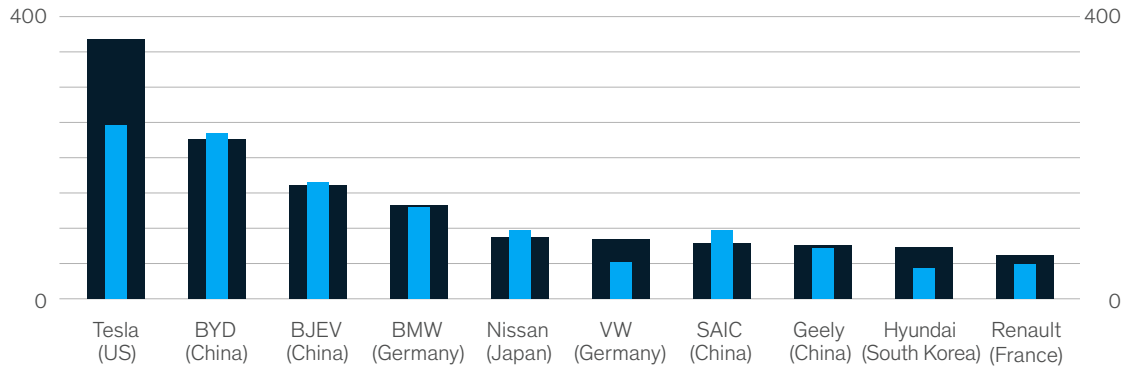
Overall, JVs are becoming a popular collaboration model in the battery industry, with an increasing number of partnerships announced in 2019. This trend mainly reflects the fact that JVs enable automakers to lock in enough capacity to reach their ambitious sales and production targets. Automakers also prefer multisourcing strategies involving a number of cell makers. Even Tesla, which used to rely solely on cells from Panasonic, signed new contracts with CATL and LG Chem for the Chinese market in 2019.

Exhibit 4

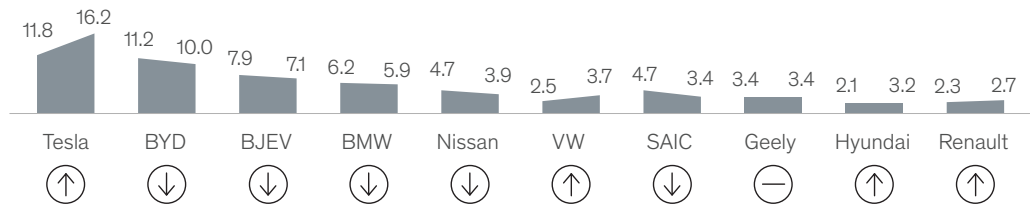
Tesla increased its global market share to about 16 percent in 2019, with the Model 3 alone accounting for 13 percent of sales.

Electric-vehicle (EV) penetration rate by brand, thousand units

■ 2018 ■ 2019

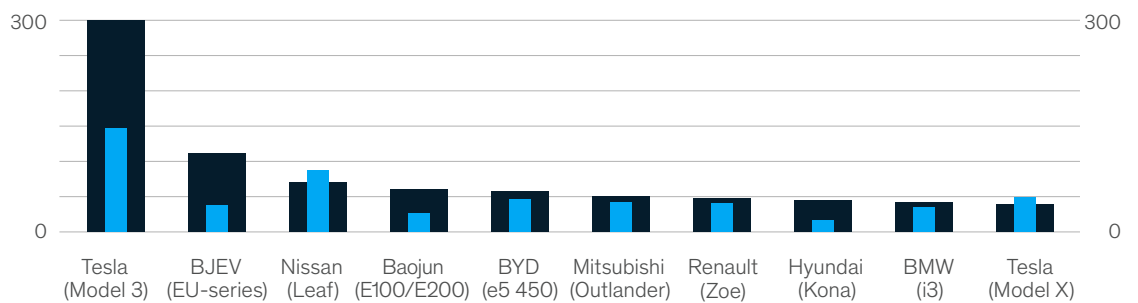


Market share by brand, 2018 and 2019, %

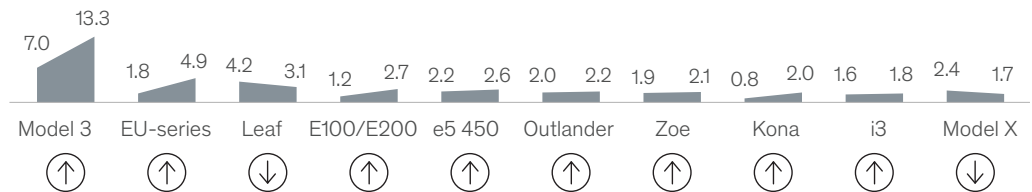


EV penetration rate by model, thousand units

■ 2018 ■ 2019



Market share by model, 2018 and 2019, %



Source: Electronic Vehicle World Sales Database, EV-volumes.com; McKinsey analysis

The EV market has grown quickly, but the dynamics vary by region. In key markets, the transition from ICEs to electric powertrains reached a tipping point in 2019, fueled by more stringent emissions regulations, access restrictions in cities, advancing EV technologies that lengthen driving ranges and cut prices, and the expansion of the charging network. The same forces will further expand uptake over the coming years, but their evolution will vary by market.

To win, automakers and suppliers must develop a detailed view of what's happening in each market by monitoring the regulatory environment, customer preferences, infrastructure development, and the moves of competitors—especially new entrants, including start-ups from outside the industry. Companies that match customer demand with suitable EV models and catch regulatory tailwinds may secure the most promising pockets of growth going forward.

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