

Recharged

The electric vehicle and EV charging markets regain stability

EV Charging Index
Edition 4 | 2023

Roland
Berger



After a turbulent first half of 2022, the electric vehicle (EV) and EV charging market returned to strong growth according to the latest edition of Roland Berger's EV Charging Index. Several key market indicators, such as EV sales and charging infrastructure developments, hit record highs, despite turbulent energy prices in some markets.

The fourth edition of the Index, covering 30 markets in five regions – Europe, China, Americas, Middle East and Asia (other) – and 31 indicators, is based on industry interviews, primary research and a survey of 16,000 participants from all regions conducted in the first half of 2023. In this report, we present the overall findings and focus on four topical areas.

First, with global EV sales penetration reaching a record high in 2022, we look at how the factors affecting interest in EVs differ across the regions.

Second, we assess the drivers behind the rapid expansion of public EV charging networks, from new technologies to convenience.

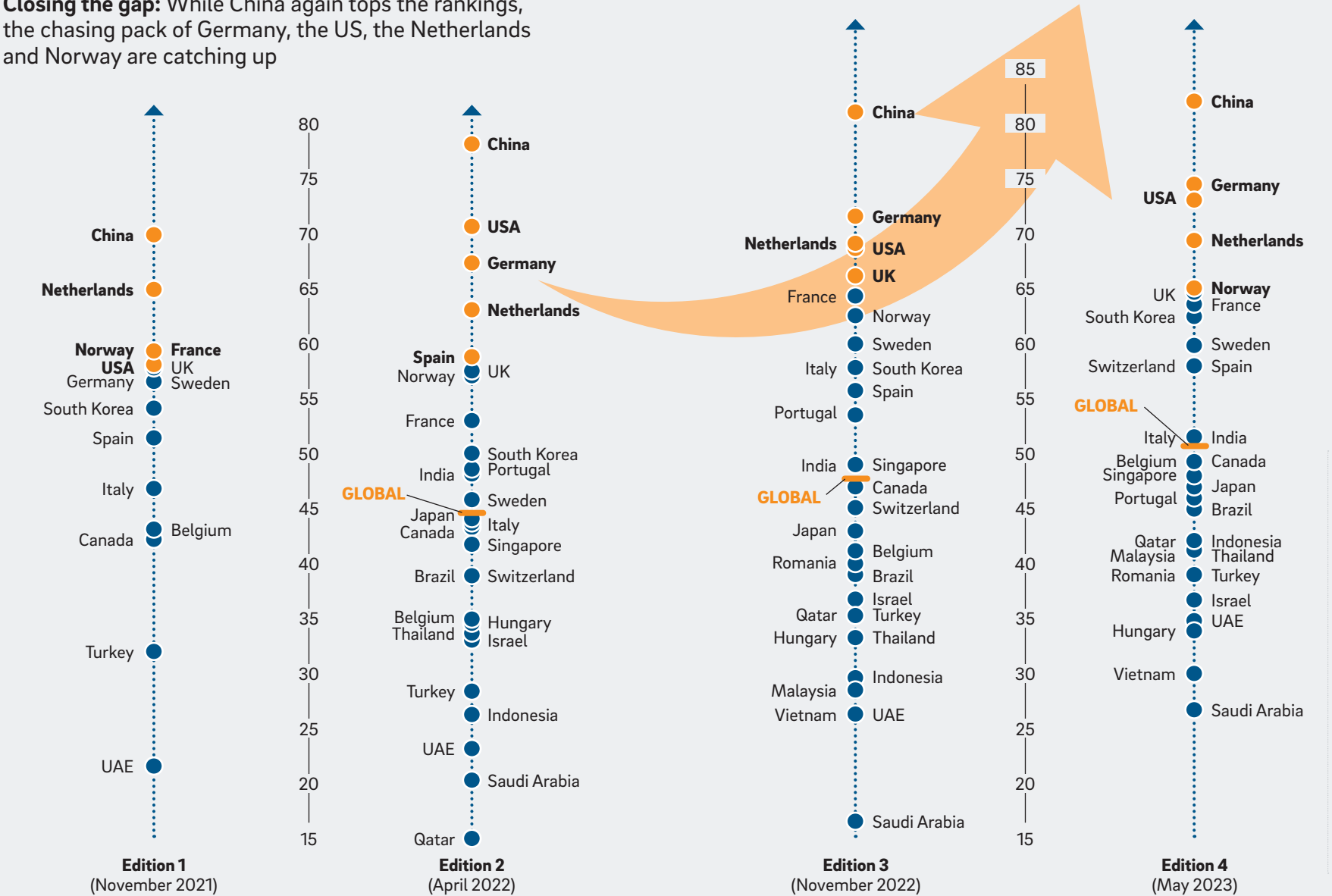
Third, as the percentage of EV owners who report using public charging reaches 90%, we analyze changing customer behaviors and find that range anxiety is still a major problem.

Lastly, we examine the emerging regionalization of OEMs' strategies with regard to EV charging infrastructure, especially the different approaches applied in the United States and China.

Scores and rankings: The pack closes on leader China, with improvements across the board

Closing the gap: While China again tops the rankings, the chasing pack of Germany, the US, the Netherlands and Norway are catching up

All of the top five performers in the fourth edition of the Index increased or maintained their score compared to the previous edition, with all at record-breaking highs. China topped the rankings with a total of 82 (out of 100), followed by Germany (74), the United States (73) and the Netherlands (69). Norway (65) knocked the United Kingdom out of the top five by less than one point. The gaps between the top five narrowed considerably, with Germany and the United States, in particular, making ground on China.



Source: EV Volume; Roland Berger EV Charging Index

There was positive news at the other end of the table, too. Several countries showed a big improvement in their score, with Malaysia (41) and Indonesia (41) both jumping by 12 points, and even bottom-of-the-table Saudi Arabia jumping from 16 to 27 points.

In fact, the improved performance of countries across the Middle East and Southeast Asia helped to drive up the average country score from 45 to 51 points. This indicates a healthy and growing global EV charging market.

Global growth: Improved scores in almost all 30 countries reflect across-the-board improvement in EV charging



Source: Roland Berger EV Charging Index

Several recent events in the EV market have helped drive this overall increase in scores.¹ A key factor is that a price war has broken out. While the choice of higher-price-segment EV models has always been strong in global markets, the pickings in the lower-price segment have been slim.

OEMs have been slow to fill this gap but are now acting. Tesla, for instance, is cutting prices on its existing models and is exploring a low-cost option, while BYD is set to offer its basic Seagull model from USD 12,000 in China. Volkswagen is also considering a low-cost model for the European market.

Developments in the charging market itself are also having an impact. For example, in late 2022 Tesla began exploring opening up its much envied and fast expanding supercharger network to all EVs in more countries. California, one of the world's biggest EV markets, announced it was investing USD 2.9 billion to more than double the US state's number of public chargers to around 170,000.

New partnerships also continued to spring up. In October, Hertz announced a deal with energy giant BP to build an EV charging network in the United States to service the rental firm's growing EV fleet. In addition, GM announced a push into holistic charging services through its new subsidiary, GM Energy.

We are beginning to see the impact from of a series of new laws and investment in electrification by the US federal government, as billions in funding is starting to be disbursed. Its Inflation Reduction Act (IRA), National Electric Vehicle Infrastructure (NEVI) program and CHIPS and Science Act will together have a major impact on EV sales, charging infrastructure and semiconductor capacity in the U.S.

¹ To better reflect these and other developments, we adjusted some indicators of the customer survey in the fourth edition of the Index. We replaced several "EV purchasing" indicators with "EV charging experience" indicators, including "experience on charging speed" and "convenience of public charging". The aim is to better reflect customer satisfaction with the development of charging infrastructure.

EV market: The sector remains resilient

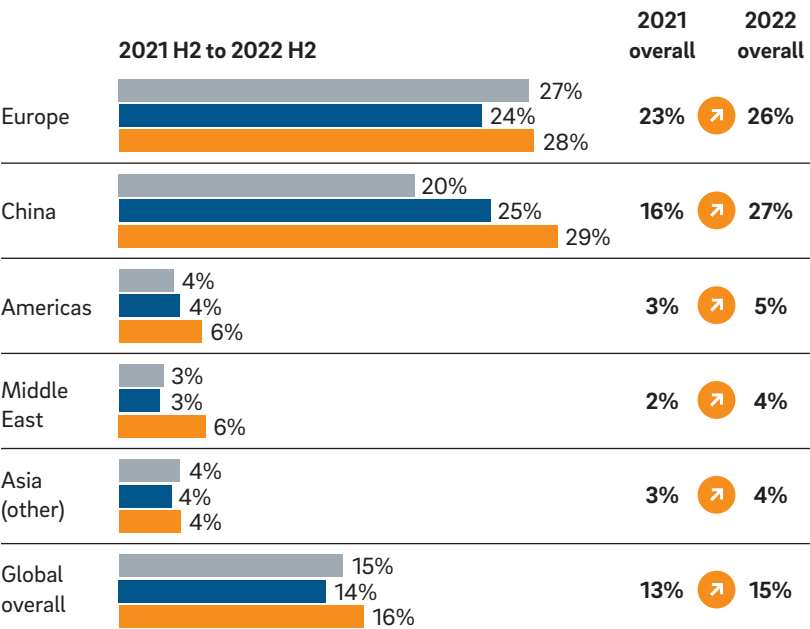
Global EV sales penetration rates (the share of EVs sold as a percentage of total vehicles sold) reached record highs in the second half of 2022, hitting 15% at the global level. The market therefore appears relatively resilient to external factors, while consumer sensitivity to input energy costs and risks has receded since the last edition of the Index.

European EV sales rebound

The fourth edition of the EV Charging Index shows that EV sales in major European countries rebounded in late 2022 after a downswing in the first half of 2022. The underlying reason behind this dip was the energy crisis and EV drivers' high level of price sensitivity – our customer surveys in 2021 and 2022 showed that 42% and 59% of participants, respectively, regarded costs as a key concern for EV purchasing.

Back on track: EV sales penetration rates leaped in H2 2022 as electricity prices returned to pre-Ukraine war levels

EV SALES PENETRATION RATES [H2 2021 to H2 2022, %]

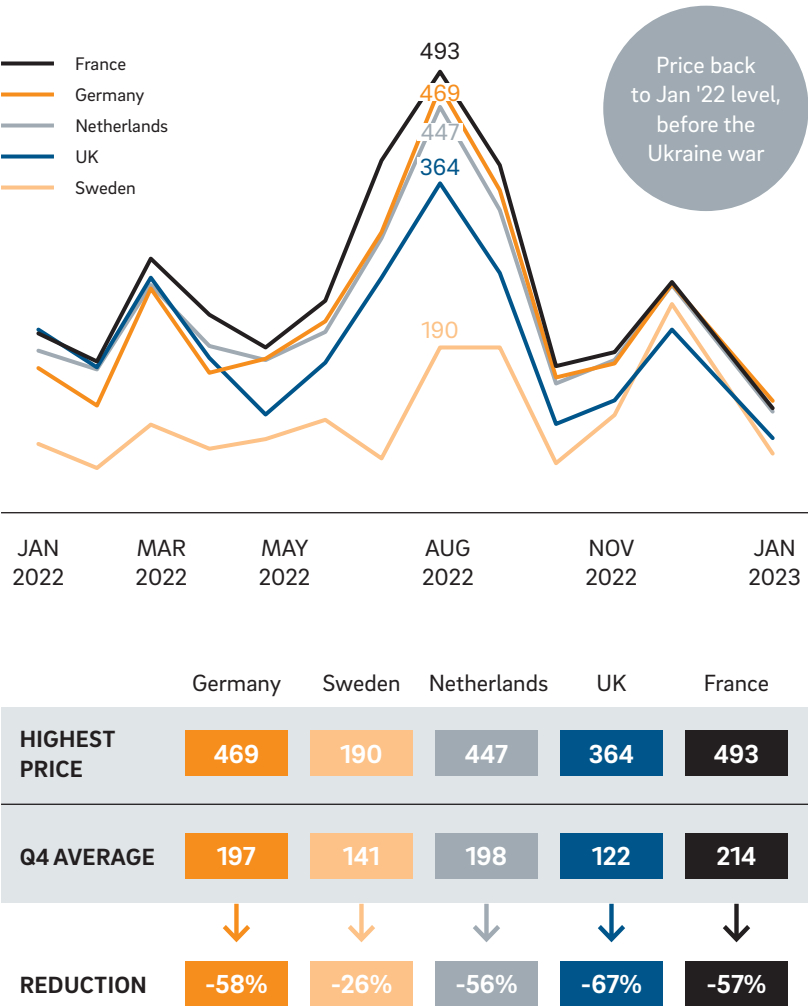


2021 H2 2022 H1 2022 H2

Source: EV Volumes; IHS; Roland Berger

European electricity prices soared to an unprecedented level in early 2022, significantly pushing up the cost of EV driving and undermining customers' confidence in EV ownership. However, once supply and demand conditions allowed some normalization of costs, the European EV sales and penetration rate in H2 2022 surged to 28% from 24% in H1 2022, higher than in H2 2021.

MONTHLY AVERAGE ELECTRICITY WHOLESALE PRICES
[Euros per MWh, 2022.01 to 2023.01]



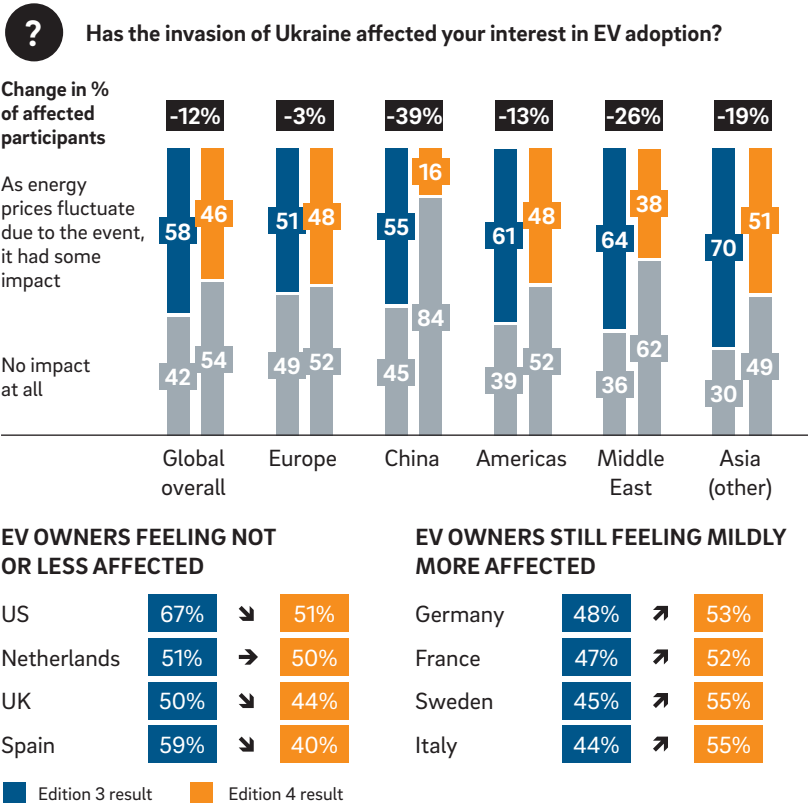
Source: DIEM Platform; Roland Berger

Ukraine war still has global impact

In the third edition of the Index (H1 2022), we asked our survey respondents about the impact of the war in Ukraine on their interest in EVs. Globally, 58% expressed concerns over fluctuating energy prices and the resulting diminishing EV total cost of ownership advantages. In the fourth edition, EV owners seem to have adapted to the effects of the conflict. Now, only 46% overall have concerns about the war's impact, although the degree of adaptation varies.

Respondents in China and the Middle East now register the lowest levels of concern (16% and 38%) and saw the biggest drops since the previous edition. But while they also both recorded sharp falls, around half of respondents in Europe and the Americas still harbor concerns about the impact of the war on EV purchases. In Europe, this is most likely due to the proximity of the conflict and continued uncertainty over energy prices.

The cost of war: While concerns about the impact of the war in Ukraine on EV adoption have fallen, almost half of our global respondents remain wary



Source: 2023 EV Charging Index Ed.4 customer survey; Roland Berger

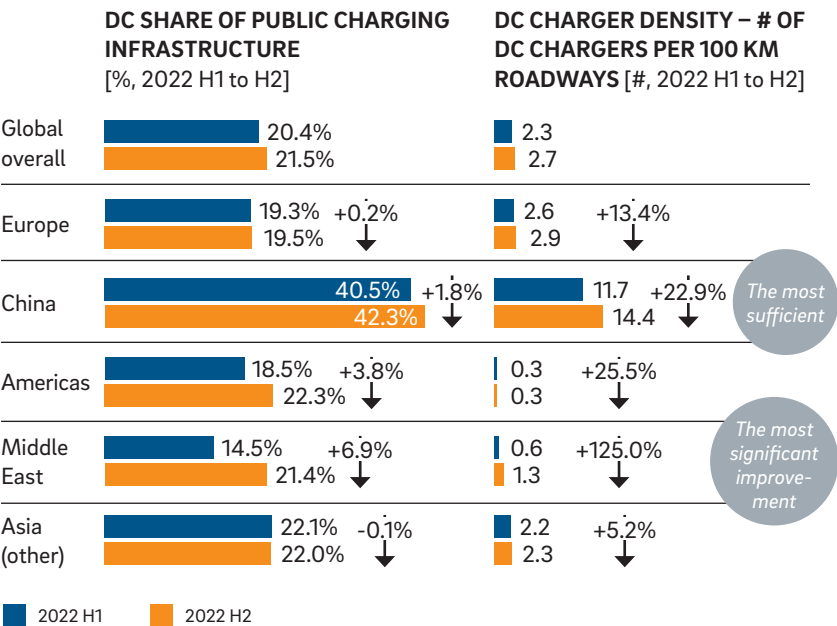
Public charging: The rising share of fast chargers is boosting satisfaction levels

The recent boom in EV sales has given a huge boost to the global EV charging market. In particular, public charging networks have been rapidly expanding, while the ongoing rollout of fast-charging technology has transformed the structure of charging networks. According to our survey results, the combination of the two made charging EVs at public charging stations much more convenient in H2 2022 than before. In this section we take a closer look at fast charging and perceptions of public charging networks.

Fast charging and the DC champions

Fast chargers accelerate the charging process by converting AC power (from the grid) to DC power (required by the battery) at the charging station and delivering the DC power directly to the EV's battery. DC chargers are now growing faster than AC chargers in public charging. They are especially prevalent along highways, where drivers want to charge up rapidly before continuing their journey.

Powering ahead: All regions saw growth in fast DC charging share and density in 2022, with China leading the way



Source: EV Volumes; desk research; Roland Berger

Our survey results show a growing global trend in public DC chargers as well as DC charger density more widely. China is leading the way in the rollout: Its share of DC chargers in public networks exceeded 42% in H2 2022, for example. Meanwhile, the Middle East is a rising DC star: Its DC charger share grew by 7% in 2022 to more than 21%, while its DC charging density rose by 125% to 1.3 DC chargers per 100 kilometers of road. Both figures are set to grow rapidly.

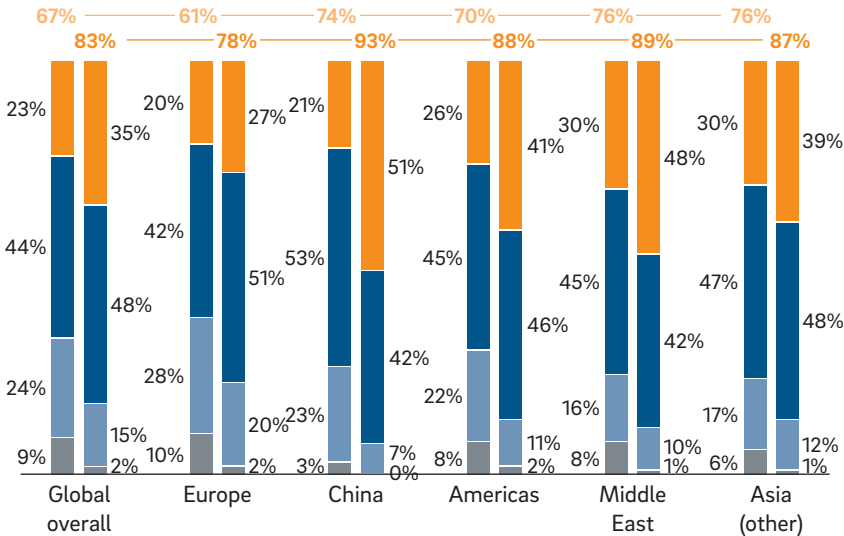
Customer perceptions about public and fast charging

Unsurprisingly, EV owners are responding positively to the expansion of public charging networks and DC fast charging. In our survey, respondents from all five regions showed higher levels of satisfaction with the convenience of EV charging. A total of 83% said that public charging networks were easier to access in H2 2022, compared with 67% in H1 2022. EV owners in China, the Americas and the Middle East recorded the highest levels of satisfaction.

Ease of access: The share of global survey respondents who think public charging has become easier to access grew by 16% between H1 and H2 2022

? Do you think public charging has become easier over the past 6 months? [results of 2022 H1 vs. 2022 H2]

PERCENTAGE WHO FEEL IT IS MORE CONVENIENT (much more convenient + a bit more convenient)



Overall satisfaction rates: xx% = 2022 H1 xx% = 2022 H2

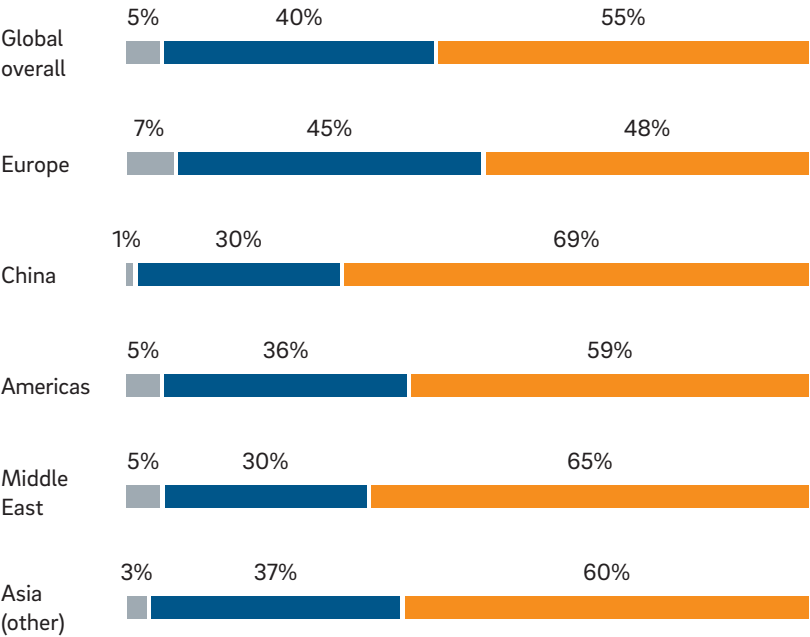
■ Much more convenient ■ A bit more convenient ■ No difference ■ More difficult

Source: 2023 EV Charging Index Ed.4 customer survey; Roland Berger

When it comes to public charging speeds, EV owners in China and the Middle East are the most satisfied, with around two-thirds of respondents in both regions agreeing that speeds are sufficient. Across all regions, the majority of respondents are satisfied.

Fast enough: More than half of EV owners think public charging speeds are sufficient, with Chinese respondents particularly satisfied

? Based on your experience, are you satisfied with the charging speed of current public charging facilities?



I don't have an opinion No, there's major room for improvement on charging speed
Yes, it's generally fast enough

Source: 2023 EV Charging Index Ed.4 customer survey; Roland Berger

Customer behavior: EV owners are becoming increasingly dependent on public charging

A key purpose of our Charging Index is to gauge and understand the shifting behaviors and preferences of EV owners. In this edition, we focus on customer preferences in public charging.

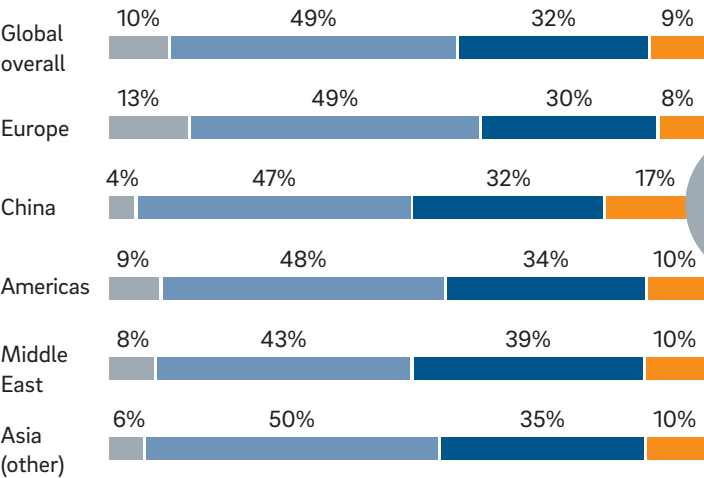
Growing reliance on public charging networks

Globally, only 10% of EV owners never visit a public charging location. More than 30% of EV owners use public charging services three or more times a week.

Chinese EV owners are particularly dependent on public charging networks. Thus, the penetration rate in China is 96%, with 17% of Chinese EV owners visiting public charging locations more than five times a week – significantly higher than the global average.

Frequent visitors: The vast majority of global EV owners use public charging infrastructure at least once a week

? On average, how often do you charge your EV via a public charging network?



Chinese owners depend most on public charging

Never or quite rarely 1-2 times per week 3-4 times per week Over 5 times per week

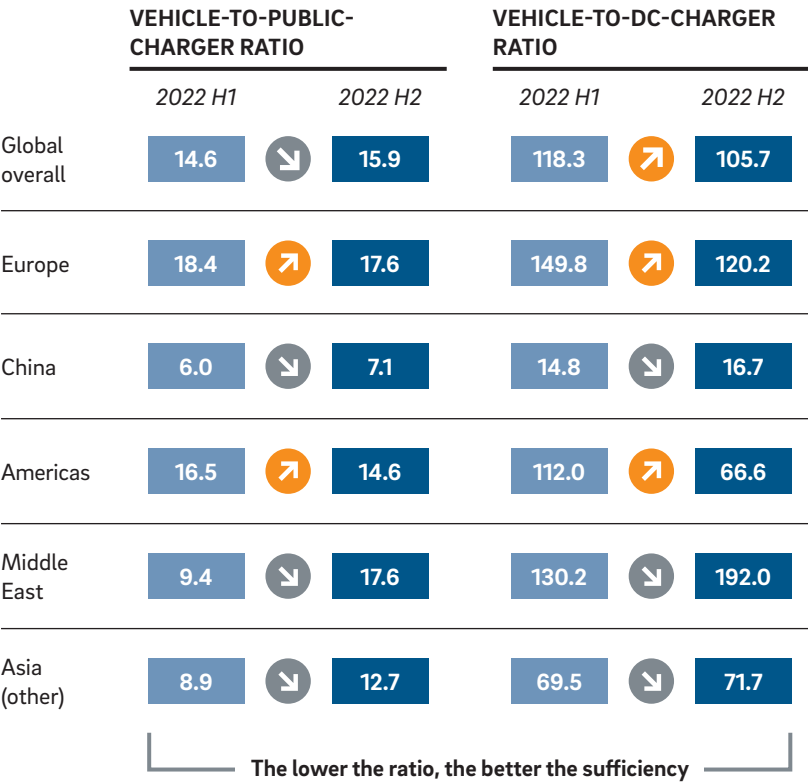
Source: 2023 EV Charging Index Ed.4 customer survey; Roland Berger

Room for improvement in public charging sufficiency

Measuring the frequency of visits to public charging networks does not give us a full picture of public charging sufficiency. This is better done using the vehicle-to-public-charger ratio. Our survey shows poor sufficiency in regular public chargers but better sufficiency in public DC chargers.

In China, the ratios of both types of chargers increased in H2 2022, indicating that the expansion of public charging infrastructure in China is failing to keep up with the country's soaring EV sales and car parc. Europe and the Americas managed to improve their ratios, albeit to a level still significantly behind China.

Ups and downs: While vehicle-to-public-charger and vehicle-to-DC-charger ratios are improving in Europe and the Americas, they are falling in the other regions



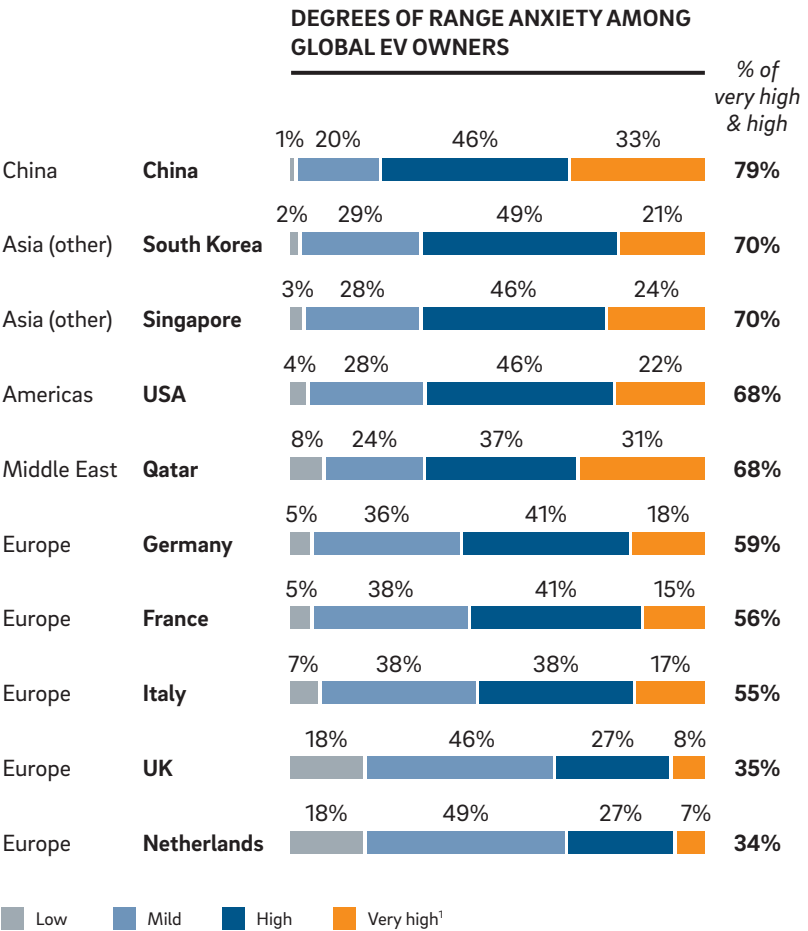
Formula = EV car parc/charger #
↗ Better sufficiency ↘ Lower sufficiency

Source: EV Volumes; Roland Berger

Range anxiety still a significant problem

Due to customer dependency on public charging and generally poor charger sufficiency, range anxiety stubbornly remains a problem for EV owners. For example, our survey showed that more than half of customers expect EVs to manage at least 500 kilometers on a full charge. Overall, 56% of respondents said their range anxiety was high or very high. Asian EV drivers tend to be the most anxious about range, Europeans the least.

Far from resolved: Range anxiety is a particular problem in Asian countries, with European EV drivers more relaxed about finding their next charging station



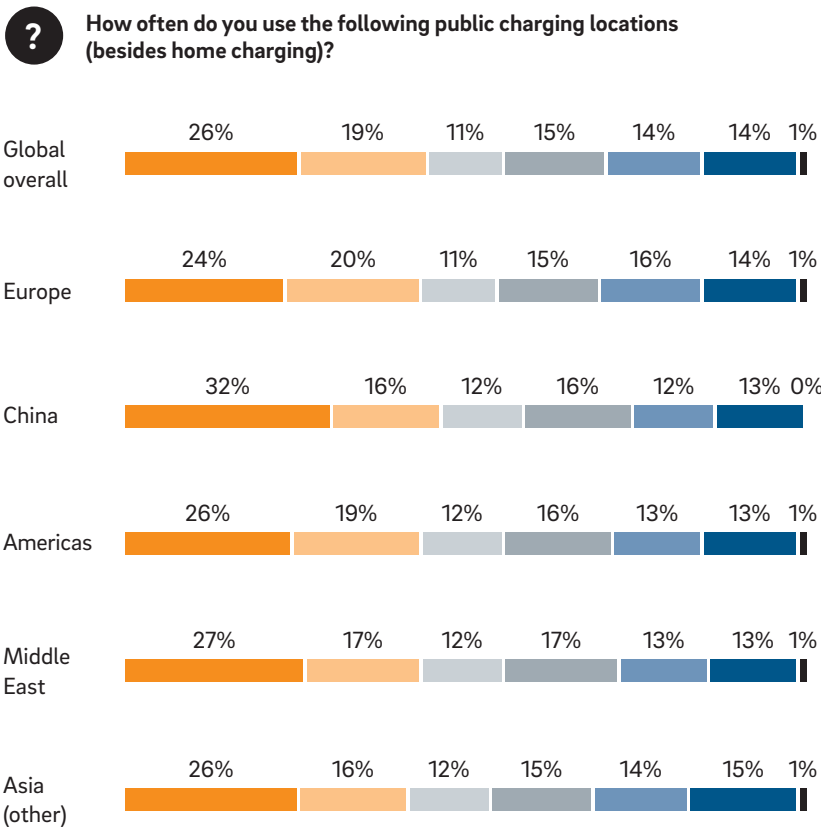
¹ Examples of range anxiety: "very high" – owners demand EV range above 700 km, "high" – 500-700 km, "mild" – 300-500 km; other examples incl. EV owners' satisfaction about public charger sufficiency, charging speed

Source: 2023 EV Charging Index Ed.4 customer survey; Roland Berger

Where people like to charge

In terms of where to charge, destination public charging is the preferred option. According to our survey, workplace charging is the most popular overall choice of location (26%), followed by shopping centers (20%). Hotels and resorts (11%) are also gaining in popularity. Highway charging (15%) is the leading non-destination location.

Location, location, location: Charging at so-called destinations (workplace, shopping centers, etc.) accounts for most public charging usage



- Workplace (e.g., parking lots near office)
- Parking lots at shopping/retail centers
- Parking lots of hotels/resorts
- Community parking lots
- Charging points along highways
- Municipal street-side charging area
- Other

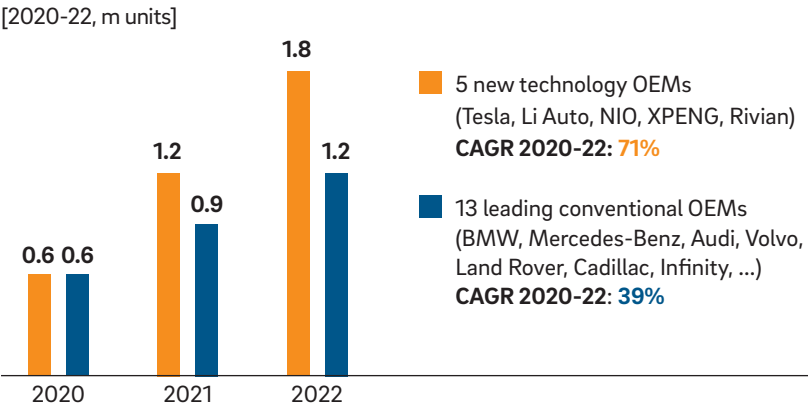
Source: RB online survey 2022

Branded charging: Increased regionalization of OEMs' EV charging infrastructure strategy

Key differentiation between market challengers and market defenders

Global sales of EVs are rising fast and the penetration rate is forecast to surpass 50% by 2030. Especially in the premium sector, the driving force behind this rapid expansion is a small group of EV manufacturers (NTOs – new transformative or new technology OEMs) that have a three-year CAGR of around 71%. Meanwhile, conventional premium brands have unexpectedly fallen behind in terms of capturing market share.

Growing apart: The major conventional premium-brand OEMs are falling behind leading new technology OEMs in global EV sales



Source: IHS; Roland Berger

One of the main ways that NTOs differentiate themselves is by providing branded charging networks, giving customers a seamless charging experience. For example, Tesla now operates around 45,000 superchargers worldwide, while NIO has 13,000, plus 1,300 battery swap locations in China alone.

Our survey results show that 42% of people who own NTO brands are satisfied with their current charging experience, compared to just 34% of those who own conventional premium-brand EVs. In addition, more than

70% of premium-brand EV owners say that the existence of an own-brand network would significantly influence their decision to buy from that brand.

The United States: Increased standardization

OEMs around the globe are pushing the EV transition and developing their own branded charging networks. However, we can observe different strategies in different regions, driven by distinct customer demands and varying competitive dynamics, plus the fact that different regions are at different phases of the transition to electric vehicles.

In the United States, for example, EV sales have grown fast, at around 55% in 2022, yet the penetration rate of EVs, at approximately 6.8%, still lags behind that of Europe and China. US OEMs now see standardization of the charging technology as the key driver to speed up the EV transition and are addressing complaints from their clients about the poor-quality public charging network.

The competition between the North American Charging Standard (NACS) used by Tesla and the Combined Charging System (CCS), historically backed by other conventional OEMs, has reached a tipping point, with Ford and GM, and later OEMs such as Volvo, Polestar and Rivian, and CPO players including Blink and Electrify America, announcing agreements under which their vehicles will be able to access Tesla's supercharger network. SAE International has also announced it will expedite the process for the NACS plug to become a standard by the end of 2023. This standardization will likely further drive up EV penetration in the United States.

China: Differentiation in the EV market

The value proposition of branded charging is quite a different story in China, where EV penetration is relatively high, at around 28% and growing. For Chinese OEMs, branded charging can act as a key differentiating point in their EV strategy, enabling them to promote a unique EV brand image, offer exceptional customer experience and showcase cutting-edge technology, such as superfast charging.

Leading NTOs in China offer a level of service in their branded charging network that has never been seen before, including various charging options (from fast charging to swapping), different locations (from shopping centers and office buildings to highways) and premium services (from valet charging to discounts in nearby stores). Another common sales tactic is to offer users a free charging quota for a certain period of time in the branded charging network. To catch up with China, many global OEMs, including Audi and Porsche, are starting to build their own branded-charging network, allowing them to meet their customers' demands with regards to convenience, diversity and a premium charging experience.

Ready to recharge



There can be no doubt that it's been a busy few months in the global EV charging market. But while striving to bounce back from the fallout of geopolitical tensions and energy price turbulence, the market has shown the resilience to fulfill the long-term vision of the EV transition.



The perceived role of EV charging has been gradually transforming from simply meeting demand to more diverse values – for both EV OEMs and customers. In some markets, premium OEMs are betting on branded charging networks to boost sales and reinforce customer loyalty. On the other hand, customers are expecting charging anxiety to be relieved through sufficiency of charging points with fast charging and diverse coverage of locations.



With all of these positive signs highlighted in the fourth edition of the EV Charging Index, it seems the market is ready to recharge. We will continue to track it and see if the growing trends of scale, diversity and quality are sustained.

Your contacts



Ron Zheng

Senior Partner
Shanghai Office
ron.zheng@rolandberger.com
+86 181 2101 1388



Tim Longstaff

Partner
London Office
tim.longstaff@rolandberger.com
+44 78 8020 2910



Bob Zabors

Senior Partner
Chicago Office
bob.zabors@rolandberger.com
+1 312 953 4741



Jack Zhuang

Principal
Shanghai Office
jack.zhuang@rolandberger.com
+86 156 0160 2410



Erin Sowerby

Principal
Detroit Office
erin.sowerby@rolandberger.com
+1 619 564 9041

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