Global EV Transportation Market Review

2023

CLEANBRIDGE

About

The report provides an insight into the Global Electric Vehicle market. The findings of the report are based on research conducted by CleanBridge and its research partner Alchemy Research and Analytics. The report provides an overview of the Global Electric Vehicle industry with insights on prevailing market conditions encompassing recent trends and drivers, challenges, and outlook in major countries across Europe and the Americas. The report starts with a high-level view on the dynamics of the industry, touching upon the regional variations and analyzing the implications of the same. It then profiles the major markets country-wise, to provide a holistic view of the state of the industry in these countries, highlighting the growth opportunities, demand drivers and prevalent challenges. Macroeconomic data was sourced from the publications of multilateral institutions such as the International Monetary Fund (IMF). The industry-specific data is attributed to industry associations, Government authorities / statistical departments, Bloomberg New Energy Finance (BNEF) and International Energy Agency (IEA). This was supplemented by news reports, trade journals and related sources.

The report is an outcome of a collaboration between CleanBridge and its research partner Alchemy Research and Analytics and was completed in covering 2022. We would like to thank the following team members for their contribution in preparing the report:

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Introduction

Globally, the electrification of transportation will represent the single largest industrial investment made for a generation. In that journey, we are only just at the earliest stages, with decades of future investment needed to transition our industrial, commercial, and personal modes of transportation to an all-electric zero carbon based transportation system. The consequences of the coming transition will be far reaching, and will affect all elements of the global economy, from energy security, industrialization, jobs and employment, and geopolitical considerations across markets.

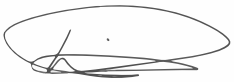
The global political path has been set for the revolution coming in the electrification of transportation, with the majority of major world economies and governments adopting net zero by 2050 targets for transportation. In that regard Europe and China are leading the way, with India following close behind in setting near-in 2030 targets, whereby no new internal combustion engine ("ICE") vehicles may be purchased thereafter. These are material regulatory changes to transportation that are near-in, and that have consequences across the global transportation industrial complex.

Across regions, these are exciting times for a new generation of investment, and employment, as the transportation industries across automotive, truck transport, shipping, and aviation, all look to carbon free and/or lower carbon transportation technologies and options. Investment in new technologies, such as battery technologies, charging infrastructure, power management, have been accelerating over the past 7 – 10 years, with the transportation industrial complex following along in transitioning their manufacturing complex to support the "transportation transition", a transition that will make the "energy transition" look small in comparison.

Our first look into the electrification of global transportation looks at the global policy features involved, then the early investment being made, and the early development activities of the principal market participants. We then explore regional dynamics involved, trends, outlooks, and next steps. We follow by diving into the core markets and economies in providing a closer look at opportunities, challenges, and expected paths forward.

The purpose of CleanBridge's Annual Primer series is to provide a high-level view of the demand drivers, opportunities, challenges and outlook prevalent in major markets. An understanding of global industry trends and country-specific market factors are critical to success for all potential market entrants.

We hope you will enjoy reading our inaugural report on the Global EV Transportation Market, and we look forward to briefing you on other the continuing market's developments in and over the coming months.



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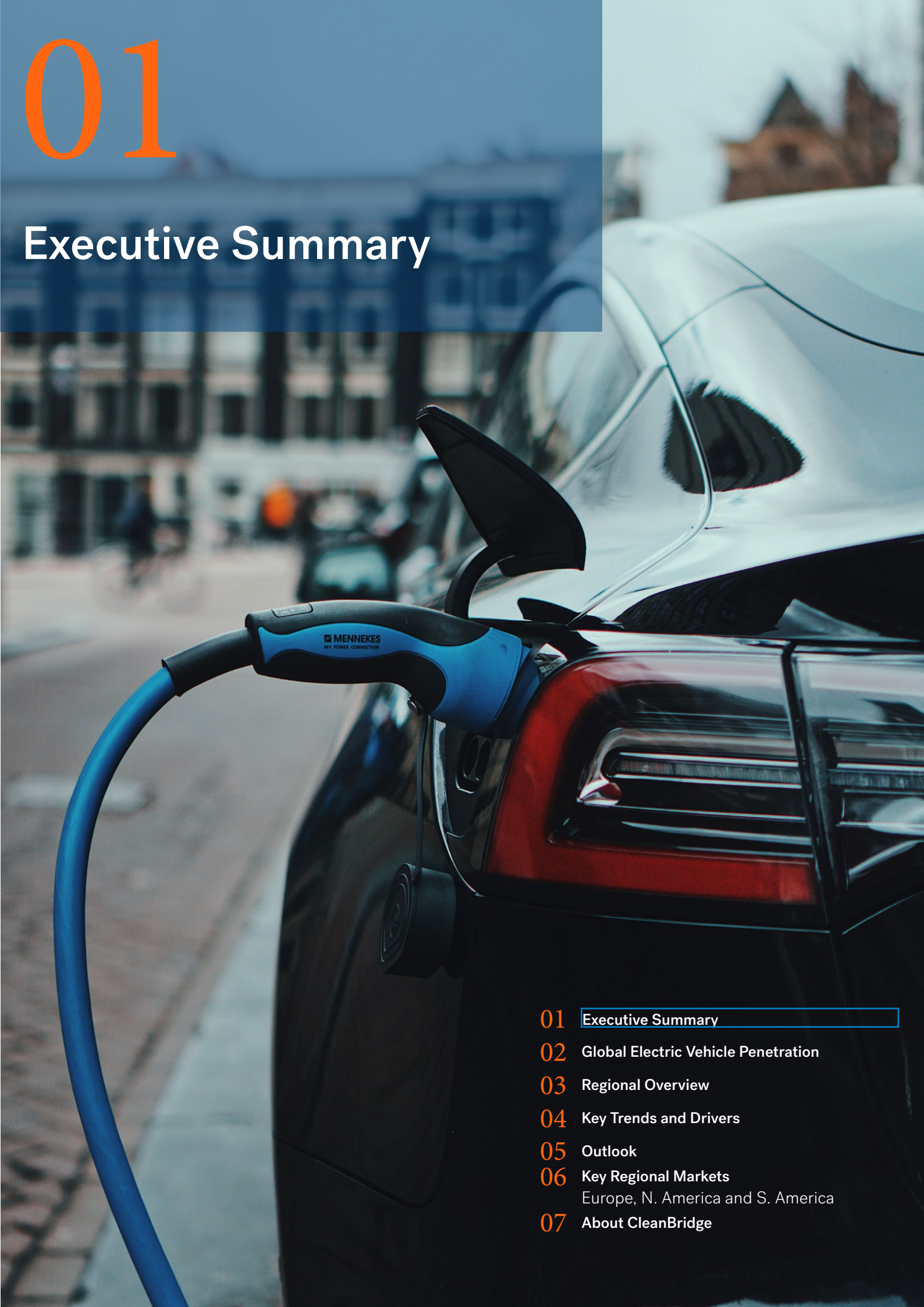

Executive Summary

The global transition to electric transport picked up pace by the end of 2022. The year had over 10 million electric passenger vehicles sold, contributing over 80% of the total spending in electrified transport. The industry is gradually coming to the fore, marking a sharp reversal from a few years ago when the feasibility of making a shift appeared questionable. Progressively, electric vehicle ownership has become competitive to that of the internal combustion engine (ICE) in several markets.

To be sure, displacing the ICE share will take time. ICE-based vehicles still represent 95% of the total fleet. It was at 99% share in 2015, indicating a slow displacement towards electric drivetrains. Sales penetration is a more discernible indicator of the progress in electric vehicle adoption. About 13% of total passenger vehicles sold in 2022 were in electric drivetrain – three times of what it was in 2020. In many of the markets, the rapid growth has translated to a drastic shift in consumer demand as overall automotive sales declined or were stagnant during the same period.

The rapid offtake in electric vehicles came about through a concerted and deliberate policy push and well-defined regulatory framework. The ban on new ICE vehicle sales in many of the developed countries acted as an important indicator of policy intent and goal. European Union countries are now collectively pursuing the policy goal of banning new ICE vehicle sales by 2035. Equally important has been the role of upfront subsidy support. For all the leading markets, the purchase subsidies helped prop up demand to reach the present levels of sales penetration. Some of the late entrants in transport electrification such as Japan are following the same path.

The reliance on subsidies won't continue for long. In China and several European countries, the subsidies are being scaled down even at the risk of taking a short-term hit on sales. The strain on public finances is one reason. The larger goal is to ease the industry to a market-oriented mechanism. The rollback of subsidies is thus followed up with enforcement of stringent supply-side targets for the automakers. In both China and Europe, for instance, there are clear incentives for the automakers to ensure availability of models for compliance with fleet-wide emission standards. Yet, such a policy pattern cannot be generalized. Asia-Pacific markets such as Japan and India have subsidies for select sub-segments to incentivize the offtake. Others such as the US historically did not have federal-level norms and had the respective states devise their own.

Executive Summary

The global policy focus is instead on attracting capital for local electric vehicle manufacturing units. With the rising market size, it is critical for automakers to achieve economies of scale in batteries and the related components. Such capacities must be closer to demand centers for efficiency and competitiveness. Adding to this is the overarching need for diversifying supply chain sources – implying de-risking from dependence on China. The US government's nearly $400 bn Inflation Reduction Act was one of the most impactful one among recent global policy decisions to incentivize local production. Other countries are aiming to match it as much as feasible to avoid losing investors. The opportunity cost is high. By mid-2022, the global Gigafactory pipeline was over 300 (no. of facilities). The US is already expected to corner a major chunk of the planned capacities.

Successful electric vehicle transition will also depend on the ease of access to charging. In this context, the supply lags demand by varying degrees across the markets. Expectedly, the global installed charging point base is correlated to the regions' progress in electric vehicle penetration. China has the predominant share in cumulative global investment (57%), followed by Europe (24%) and the US (12%). The unmet demand in this segment is a significant investment opportunity. The oil and gas majors are spearheading the capacity addition in fast-charging segment. The charging space is also heating up with new partnerships, multiple stakeholders (standalone charging operators, municipal authorities, equipment suppliers, etc.) and technologies (bi-directional charging, wireless or induction charging). Public-private partnerships are likely to be the preferred implementation mode, as observed in the recent European experience. The nature of the investments and the emerging business models (such as energy service provider instead of just a charging operator) makes this a dynamic and interesting space for investors.

The traditional automotive business model itself might be in for a makeover. The ongoing transitory phase comprises many untested and nascent technologies and practices. For instance, the vertically integrated structure of upcoming electric vehicle manufacturing reverses the existing structure of globalized linkages in supply chain. Similarly, the emerging electric vehicle business has a significant intersection with the structure of a typical technology provider – some of which is already taking roots with automakers' in-house capacities in chip and software development. The emerging growth trajectory will necessarily involve multiple growth paths.

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Global Electric Vehicle Penetration

Global Electric Vehicle Penetration

Introduction

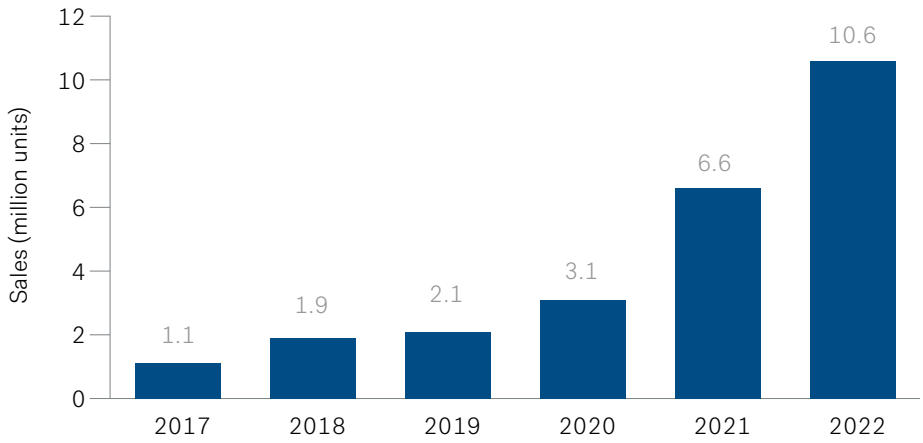
Electric vehicle penetration is one key metric to track the progress in achieving transport decarbonization objectives. An accelerated shift is needed to close the gap against combustion engines as fast as possible. Passenger electric vehicles take the maximum attention in this context, for their role in the total transport sector emissions and the criticality in the ongoing transition. The shift in consumer demand is gradually in motion, helped in significant measure by expanded product variety and improved configuration.

The clean transport spending exceeded $450 billion globally by the end of 2022.

Vehicle Sales and Penetration

The trend in electric vehicle passenger sales accelerated since 2020. While part of the initial momentum was from the stimulus support during the pandemic, the sustained regulatory push helped set the trajectory. Such a growth phase is part of the global transition towards cleaner transportation alternatives. While the pace and direction vary by local conditions, the commitments aggregate to a substantial impact. Globally by the end of 2022, clean transport spending was over $450 billion.

Global Passenger Electric Vehicle Sales



Note: Data for 2022 is an estimated one
Source: BNEF (Zero Emission Vehicles Factbook)

The year-on-year 61% growth by end of 2022, while impressive, was still lower than expectation. It was an outcome of a tempering down of sales growth in key markets such as China after subsidies were scaled down. Inflationary pressure and the supply chain challenges added to the impediments in the market. The consumer demand, however, appears to have gradually tilted in favour of the electric drivetrain. The share of electric vehicles in the total new vehicle sales in some of the key markets such as Norway's are indicative of the emerging tipping point in automotive industry.

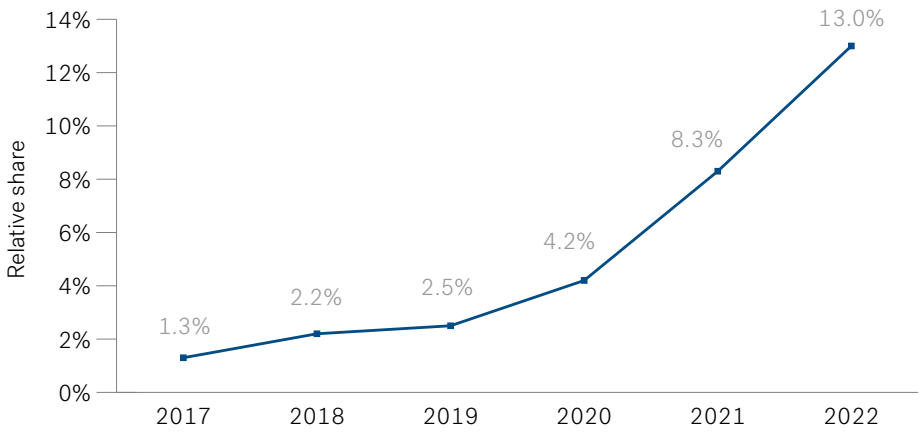
The progress achieved in electric vehicle penetration so far, however limited, is prompting the question of reaching a tipping point. BNEF suggests 5% level as the tipping point, after which the markets head for a mass adoption scale. Taking this as a yardstick, in 2022, the US was among the major markets that joined the list of countries reaching or exceeding the potential tipping point. The scope is much larger than this. Even as the electric vehicle sales rise at a fast clip, the total global four-wheeler road transport fleet of 1.5 billion rose by about 1% in 2022. The displacement of market shares will take much more than the current rate of growth.

Global Electric Vehicle Penetration

The rise in electric vehicle penetration has been marked by expansion in product variety and quality. An important factor for manufacturers is to address the 'range anxiety' involved in such vehicles. Over the years, the vehicle sales trend is marked by the rising average battery pack size and consequently the driving range available. Increasingly, new battery electric vehicles are equipped with fast-charging capabilities in addition to the onboard charger. BNEF estimates indicate that while historically the dominant charging power in the market was 50kW, it rose to 111kW by 2019. In the models launched during 2022, the same was at an average of 195kW. Average driving range shows a similar pattern. Some of the recent models in 2023 had a driving range of up to 580km.

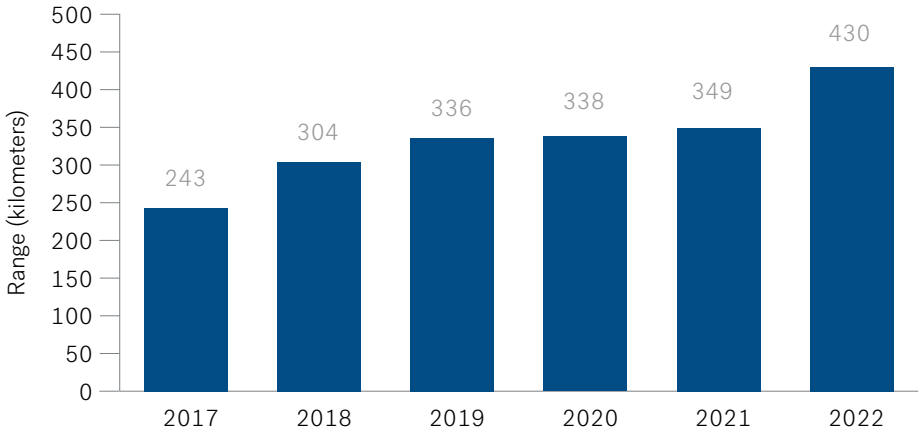
Some of the recent EV models in 2023 has a driving range of up to 580km.

Share of Electric Powertrain in the Total New Passenger Vehicle Sale



Source: EV-Volumes

Average Driving Range of Electric Vehicles



Note: The data for 2022 is an approximate estimate derived from BNEF publication; The data above refers only to battery electric vehicles

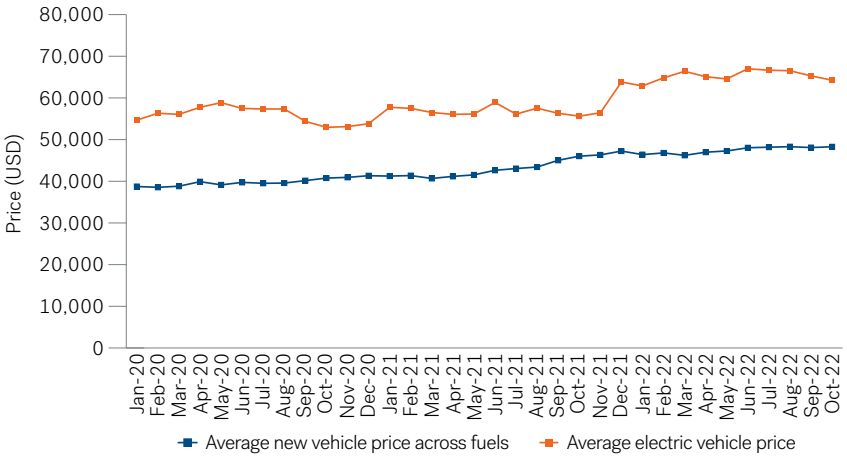
Source: IEA and BNEF

Global Electric Vehicle Penetration

An expanded product lineup with competitive price points is critical for the planned mass adoption. Added support comes from the emerging new technologies integrated in the electric vehicle platforms. While this is helpful for the demand, the true test of the market success will be tested in price parity. Electric vehicles are still part of a premium offering in the passenger vehicle segment. There are few examples of the mass-market products. The price of vehicles, led in a significant part by the battery, thus tends to be at a higher level than those of combustion engines. The prospects of price parity in the market are at a far distance. As the trend in some leading markets shows, there is a considerable and sustained gap in the price that the automakers need to bridge.

According to BNEF estimates, over 2.5% of the global commercial vehicle sales in H12022 were zero-emission variety, with almost all of it based on battery.

Average Price of Electric Vehicles in the US

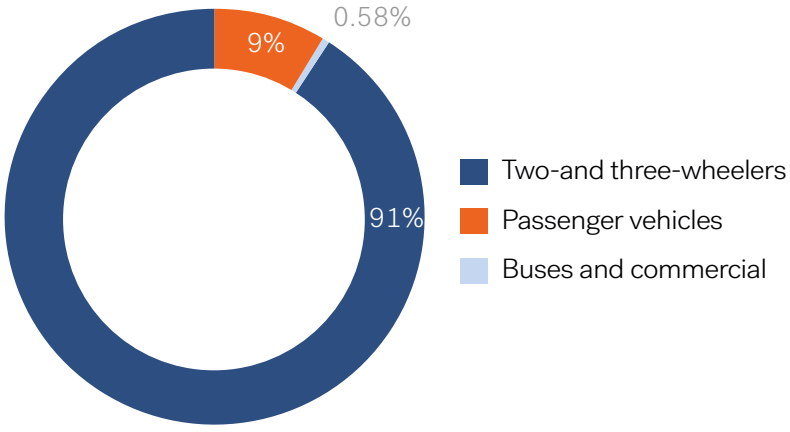


Source: Kelley Blue Book

Electrification of Commercial Vehicles

The adoption of electric drivetrain in commercial applications has gradually picked up. The rate of adoption has been slower than other segments. Its contribution in the overall electric vehicle space, as understood from the fleet size, remains miniscule. A rise in sales in the commercial electric vehicle platforms is largely in select demand pockets. Per BNEF estimates, over 2.5% of the global commercial vehicle sales in H12022 were zero-emission variety, with almost all of it based on battery.

Segment Share of the Global Electric Vehicle Fleet



Source: BNEF (as of June 2022)

Within the commercial electric vehicles, the adoption is higher for the light commercial units, such as vans due to the well-established use-cases of commercial viability in this regard. Countries such as South Korea, China, Germany and the UK are leading the global van-based commercial vehicle electrification trend. Medium- and Heavy-duty electric trucks constitute an even smaller share of the sales. Yet, with the low base, growth shows a sharp uptick. As of H12022, sales in this sub-segment stood at 12,000 units, showing a significant rise against the full-year sales of 10,000 units in 2021 (BNEF estimates).

Global Electric Vehicle Penetration

The growth in electric buses is an outcome of the policy stance on mitigating emissions in overall public transportation. The policy incentives have had a key role in propping up the sales. While China is known to be a leader in this (97% of global electric bus fleet), others have made inroads as well. The European zero-emission bus fleet (predominantly electric) grew by 42% since 2020 due to the policy commitments. Some of the major European cities have notably initiated procurement of only zero-emission buses that added momentum to the sales. Infrastructural challenges are however likely to get the better of most of such plans. The lack of abundant and fast-charging infrastructure network together with absence of conducive local norms/regulations makes it challenging for electric buses to offer any reasonable competition to their diesel-based counterparts.

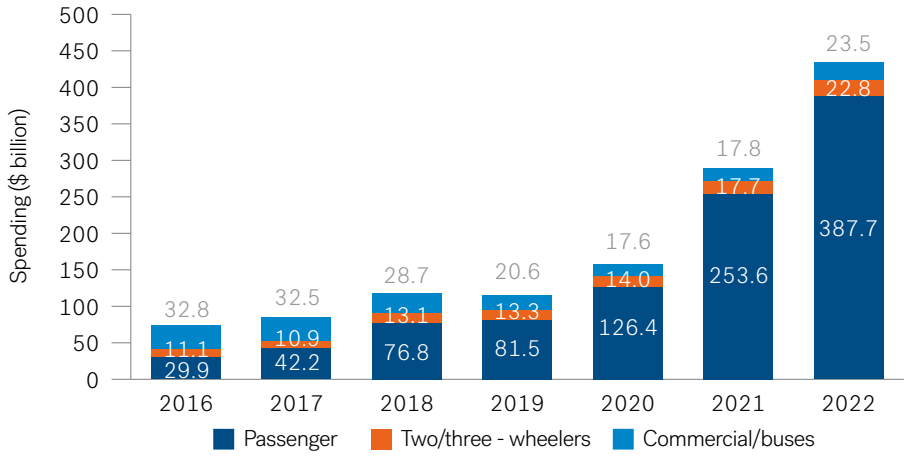
According to BNEF estimates, the annual spending on electric passenger vehicles held a CAGR of 53% during 2016-2022.

Annual Spending

The trend in spending provides another picture of gauging the opportunity in electric vehicle transition. The BNEF estimates show that during 2016-2022, annual spending on electric passenger vehicles held a compounded annual growth rate of 53%. This was the highest across all transport segments, indicating in part the value adds. Also, the last three years of the review period, i.e., 2020-2022 reported the maximum jump. The passenger electric vehicle segment is thus the most important one in focus.

The absolute value of total spend, however, should be observed in perspective. With annual automotive sales at $2.5 trillion globally, electric vehicles are far from making a serious dent. The profitability of such vehicles is also relatively lower. The point of note therefore is the rate of growth. In 2022, it was a 53% rise year-on-year. By end of 2023, the estimate is that the total spend could be in excess of $500 billion. In an otherwise stagnant automotive industry, the electric vehicle part is clearly the fastest moving one.

Global Annual Spending on Electric Vehicles



Source: BNEF

For many of the automakers, the spending trend is a rough-hand indication of the position they take in the emerging transitory phase of mobility. A notable case is that of the Japanese automakers who had a late start and are thus facing a delayed launch of dedicated passenger electric vehicle platforms. Several other automakers are in a similar position with their electric vehicle platforms expected only by the time of 2026 to 2028. At the rate of current market expansion, the opportunity cost of the time could be very high.

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Regional Overview

Regional Overview

Introduction

Globally, the electric vehicle market opportunity is limited to a select group of regions and countries. It is unlikely to change significantly in the next 4-5 years. But the relative market share could. The US market is increasingly poised to expand its share in the global market due to the upfront incentives on offer. The Chinese market is closer to outstripping the European region in electric vehicle penetration rate. At the same time, while mature in several aspects of electric vehicle adoption, the European market could progressively come to the fore in battery manufacturing and sourcing as a counterbalance for supply chain security.

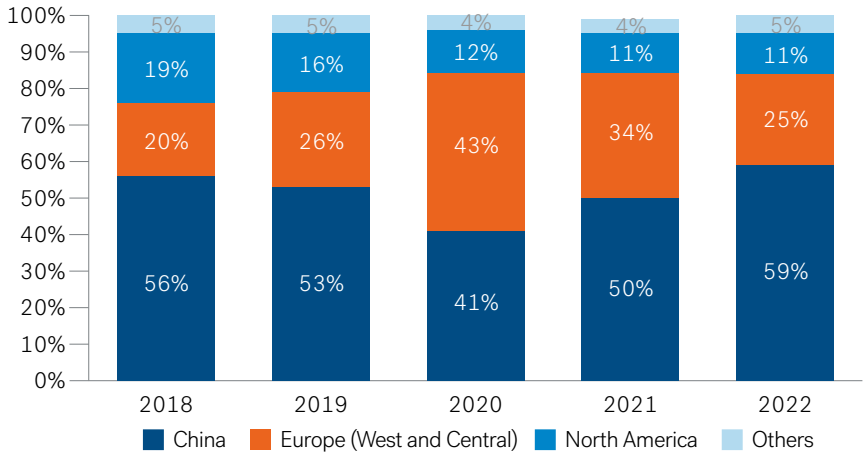
Global EV penetration is led by China, Europe and the US.

Regional Growth Pointers

Global EV penetration is led by China, Europe and the US. The emerging markets in other regions, while promising, do not yet carry a substantial weightage in the global transport electrification ecosystem. The shaping of the global electric vehicle market continues to be led by just the three countries/regions. It is partly a reflection of the policy and regulatory framework adopted in this regard.

The growth in the current leading market is an outcome of sustained subsidy commitments over the last 5-6 years. Others such as US did not follow the same path. The US still does not have a federal-level policy and stands out only for the recent massive investment tax credit plan announced to attract manufacturers. The Chinese, on the other hand, show a shift to market maturity, with subsidy support on the wane. Others such as Norway have followed the same trajectory of market development.

Distribution of the Regional Share of Global Electric Vehicle Sales



Note: The category labelled as 'others' includes Eastern Europe, Asia-Pacific Latin America, and Asia-Middle East
Source: EV-Volumes

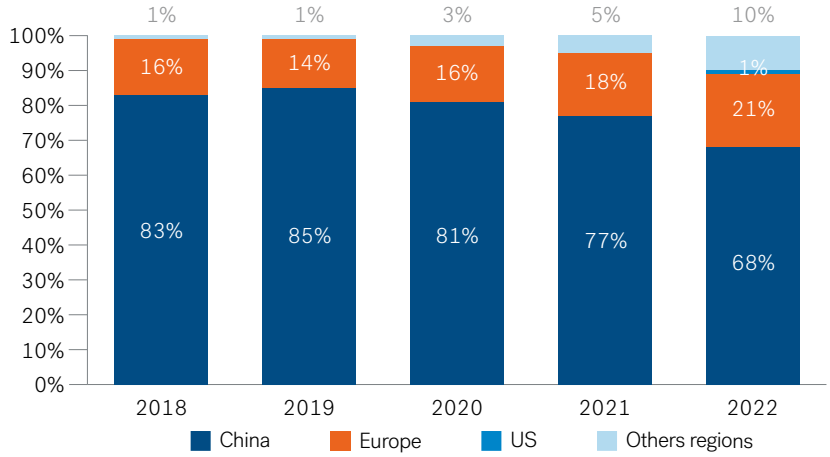
Passenger electric vehicle segment is in the focus for practically the entire electrification initiative. This is attributed to a mix of factors including share in total emissions, technological feasibility of the platforms, and the rate of adoption. The pattern of growth has been varied even between the leading markets. The four-wheeler passenger vehicle sub-segment for instance occupies all the attention in European and US markets. Yet, in case of China, the two-wheeler sub-segment penetration has been high (70% of the total sales).

Regional Overview

The commercial transportation sub-segment shows gradual progress in the electric drivetrain adoption. A key catalyst for growth has been the electric bus. At a policy-level, it is a focus area for the scope of emission control through electrification of existing fleets. So far, the progress in this direction has been limited, in part due to the lack of adequate charging infrastructure. BNEF estimates as of November 2022, indicate a 40% year-on-year growth in electric buses. At a regional level, this is even lower for the otherwise leading global passenger EV markets. A predominant share is that of China, leading in both electric bus fleet size and sales growth.

As of November 2022, BNEF estimates indicate a 40% year-on-year growth in electric buses.

Relative Share of Electric Bus and Commercial Vehicle Fleet across Regions



Note: Data for 2022 is estimated
Source: BNEF

Unlike the passenger vehicle segment, the sales growth in electric bus is led by subsidy support. While the policy-level directions on procurement could be from municipal and local authorities, the budgetary outlay has been vital in propelling the growth. European market for the electric buses is the second-largest after China's. The European demand growth is limited to the select major cities leading the shift in public transit fleets. Furthermore, it has been observed that the competition from diesel bus sub-segment is still a factor for electric buses, as new products complying with emission standards can qualify for bidding rounds. Other than China and Europe, all regions/ countries operate from a very low base of electric bus adoption.

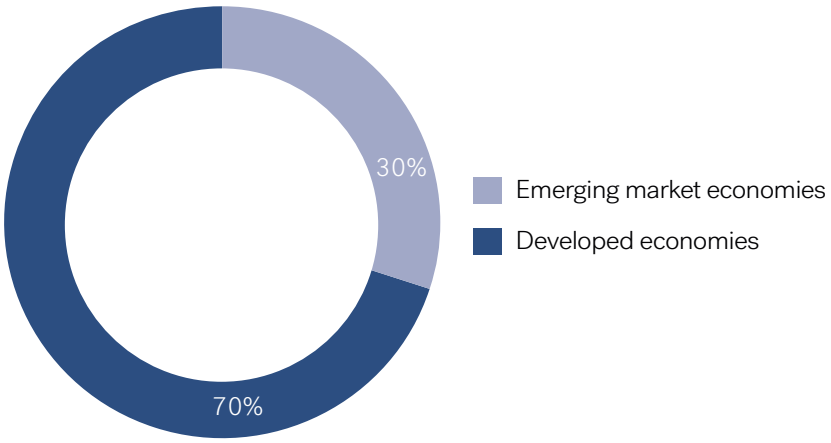
Regional Overview

Emerging Market Economies in Focus

The concentration of electric vehicle sales in select regions can be related to a broader view of disparity – the one between developed and emerging / less developed economies. The growth trajectory is different. The budgetary allocation for the subsidy-led growth in developed economies, together with technology access, cannot exactly be emulated one-for-one in the developing countries' framework. This was indeed the point prominently pointed out in the World Bank's November 2022 report on electric mobility. The path to the region's transport electrification is different. A case in point is the electric two- and three-wheelers' sub-segment, where growth is progressively led by emerging economies such as India, Vietnam and others in the African region.

According to BNEF projections, in absence of progress in electrification of mobility, by 2035, about 40% of the combustion-based vehicles could be located in the emerging market economy.

Share of Internal Combustion Engine Sales in Developed vs Emerging Markets



Source: BNEF

The need to focus on emerging market economies is vital in global transition in automotive drivetrain. Almost a third of the global sales of internal combustion engine vehicles is in the developing or emerging market economies. With economic growth it is more likely that the share of such vehicles could rise, in absence of a stronger progress in the competing electric vehicle options. BNEF projections indicate that in absence of progress in electrification of mobility, by 2035, about 40% of the combustion-based vehicles could be located in the emerging market economy. Reversing such a potential outcome would require international collaboration and technological assistance in circumventing barriers.

Regional Overview

China

As of end 2022, the European Union had a penetration of over 22%.

The Chinese market plays an outsized role in the global electric vehicle market. By the end of 2022, the country had about 30% of its total new vehicle sales based on electric drivetrain (including both battery electric and plug-in hybrid). The same year, it registered an 82% year-on-year growth (estimates of EV Volumes) in the total electric vehicle sales. In 2020, the country's electric vehicle penetration was at about 6%. Both volumes and growth in the Chinese market constitute a compelling case.

To be sure, a moderation is due in the sales, as subsidy rollbacks start working through the market. The policy framework has been clear about phasing out fiscal incentives. Towards the later part of 2022, vehicle registrations rose sharply in the ensuing rush to make most of the incentives that were due to stop from 2023 onwards. The jump was in plug-in hybrid while those of battery electric modes experienced a decline in relative share. A further decline is anticipated during 2023, as the lack of incentives suppresses the market demand temporarily. The ripple effect of an anticipated lower demand is expected to pass across the ecosystem.

Lithium prices (as in the mineral Lithium Carbonate) show a decline from the sharp rise till late 2022. The moderation in Lithium Carbonate and Lithium Hydroxide prices is an outcome of both decline in demand and the expected new supplies to be onstream. A similar impact was on battery supply – the market leader CATL offered discounted offers to counter the impact on sales. The leading automakers took to sharp price discounts, highlighting the competitive pressure. The most notable case is of the US-based manufacturer Tesla (operating through its Shanghai-based Gigafactory), whose multiple discounts till January 2023 made its vehicles cheaper by 14% against local competition and by over 50% when compared to US and Europe. Expectedly other market players followed suit, including the leading global majors such as Volkswagen.

The context of heightened competition in the Chinese electric vehicle market extends beyond the episodic price war between automakers. The subsidy-model that helped cultivate the demand also helped facilitate a strong domestic ecosystem for electric vehicles. Major domestic integrated production facilities, notably the Gigafactories, are part of the success stories of the active state support. Over the years, the local home-grown companies have come on their own in the market. In effect, the Chinese companies offer a stronger competition to the global automakers. The market share of Chinese brands in the domestic electric vehicle segment has, as a result reached 80%. About a decade back, the foreign brands held 70% share.

The flux in the market has significant implications. The major global automakers and related investors have stakes in this market where penetration is almost imminent to exceed Europe's by 2025. The next phase of growth would likely involve more strategic investment commitments including acquisitions (example: Volkswagen's €2.4 bn joint venture investment with Chinese AI chip designer firm Horizontal Robotics). A few other automakers may also face the decision about market exit (example: South Korea's Hyundai and Japan's Honda scaling down Chinese presence).

Europe

The European region has had the most notable progress in transport electrification. As of end 2022, the European Union had a penetration of over 22%. Conventional hybrids (combined with petrol and diesel) constitute another 22.6%. Effectively, the region has been able to implement a transition to alternate fuels in transport, of which battery-electric is a critical component. BNEF estimates indicate that the European region was responsible for about 36% of the global electric vehicle sales in 2021. As of H1 2022 the same share stood at 28%.

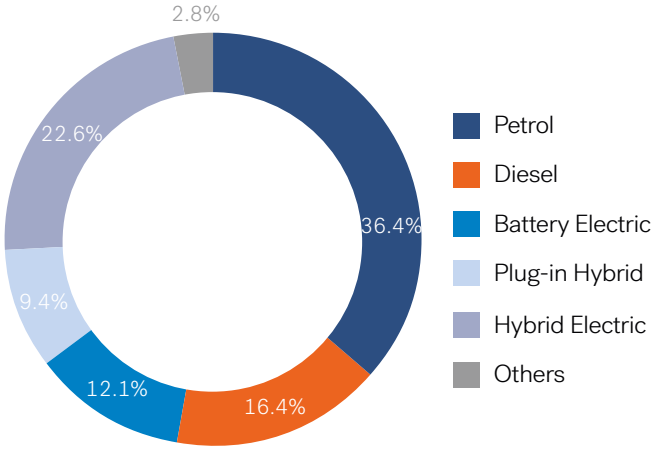
The most visible path to the transition is the European Union's ban on new sale of combustion-based vehicles by 2035. The sustained subsidy support in the policy and regulatory framework helped narrow the gap in parity against combustion vehicles. The Dutch automotive lease provider, Leaseplan partly confirmed this in its latest report, highlighting electric vehicles' total cost of ownership being same or lower across 22 European countries.

Regional Overview

An added backdrop to the European transport electrification is the region's focus on decarbonization and climate change mitigation. The focus on clean energy acts as an overarching goal in the sectoral targets of decarbonization, such as in transport electrification. For the electric vehicle market, such an interrelation has helped tie-in the policy goals and their implementation. For instance, many of the European cities have restricted the circulation of diesel-based bus transport for emission concerns. This, in effect, sets the stage for electrification.

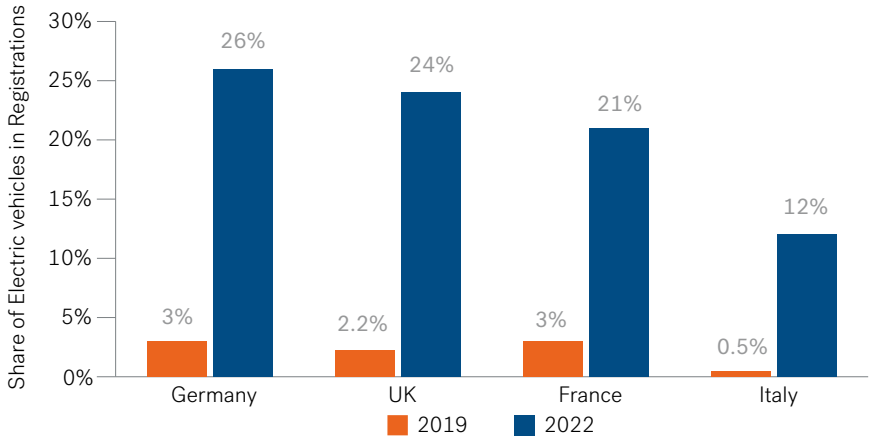
As of mid-2022, Europe's Gigafactory pipeline reached a 780GWh capacity, for commissioning by 2030.

Fuel Mix of New Passenger Vehicle Registrations in 2022



Source: ACEA

Rise in Electric Vehicle Penetration Between 2019 and 2022 in Major Countries



Note: Data refers to a comparison between H1 2019 and H1 20222 time points.
Source: BNEF

The regional estimate of penetration is an average. The leading markets reveal the sharp change. Norway is an outlier, not just for the highest penetration globally, but also the share in total fleet (at 86% in 2021). Some of the other countries with similarly high share of electrified fleet include Finland, Iceland, Denmark and Sweden. There is another set of countries notable for the sharp rise in penetration in the last 3-4 years till 2022. These act as the demand drivers for the next growth phase. Germany for instance is also the emerging hub for battery and other critical component manufacturing.

Helped in fair measure by the demand momentum, Europe is progressively taking a centerstage in global capital flow for battery manufacturing. A major point of contention is to mitigate Chinese concentration in the supply chain. Related to the same is the need for local sourcing for a competitive edge in supply. As of mid-2022, Europe's Gigafactory pipeline reached a 780GWh capacity, for commissioning by 2030. More capacities are in contention as various stakeholders finalize partnerships, joint ventures or even strategic acquisitions. With each such capacity involving upfront investment above €2-3 billion, the potential is a huge one. The externalities that typically arise from such cluster-based investments, such as in terms of technology transfers, development of ancillary industries, etc. make the scope even wider and dynamic.

Regional Overview

US

About $370 billion worth of government incentives is on offer to enable local sourcing.

The US electric vehicle market has been late to catch up to the transport electrification theme. Part of the reason could be traced to the lack of a cohesive national program on the same. Even now, the country's policy targets on electrification are largely at the level of states and local authorities. Yet, the progress has been notable, to the extent that it is the next largest electric vehicle market after China and Europe.

As of end-2022, the electric vehicle sales grew 65% year-on-year even as the overall passenger transport business contracted. The consumer preference for such vehicles is clearly established in the market, with the number of product launches and market entry across price points in the last two years. New entrants such as Rivian have been notable for making inroads in the competitive market. For most of the established market players, however, the focus is on getting the platforms ready for meeting the demand across the board.

The investment landscape for transport electrification changed drastically with the enactment of the Inflation Reduction Act (IRA). The generous tax credits offered for investment commitments set the stage for the manufacturing base of electric vehicles, batteries and the related critical minerals and components. About $370 billion worth of government incentives is on offer to enable local sourcing. With federal incentives, some of the states are bettering the bargain with added support to attract investments. A geographical cluster of the US states, christened as the "battery belt" is emerging as the focal point. While the actual materialization of planned investments is down the line, the US IRA is one unprecedented development for permanent changes in the electric vehicle market structure.

04

Key Trends and Drivers

Key Trends and Drivers

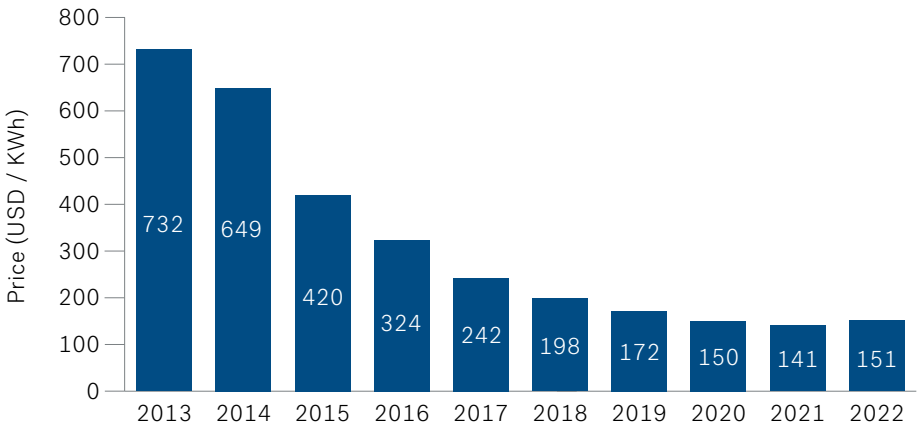
Introduction

The current phase of progress in electric vehicle penetration entails a rapid and profound change in the structure of the automotive business and its overall industrial manufacturing ecosystem. Batteries and the related critical minerals constitute the most important element of supply chain planning. Post-pandemic, manufacturers are wary of the supply chain concentration risks. The Tesla model of vertically integrated manufacturing is gaining currency. In effect, securing supply chain is emerging as key to capture and retain market share advantage.

The price of Lithium-Ion battery pack rose for the first time in 2022, reversing an otherwise historically consistent declining trend.

Battery Cost and Supply

Average Annual Lithium-Ion Battery Pack Price



Source: BNEF

The price of Lithium-Ion battery pack rose for the first time in 2022, reversing an otherwise historically consistent declining trend. Higher costs of lithium, nickel, and other battery components together led to a 7% price rise. The pressure is likely to persist. BNEF's supplier survey indicates a consensus projection of $152/kWh during 2023. A subsequent decline in price is contingent on the new production facilities coming onstream. Such a price movement will impact the rate of electric vehicle penetration. Cheaper batteries are critical to reach parity vis-à-vis conventional vehicles, especially with rationalization in subsidies.

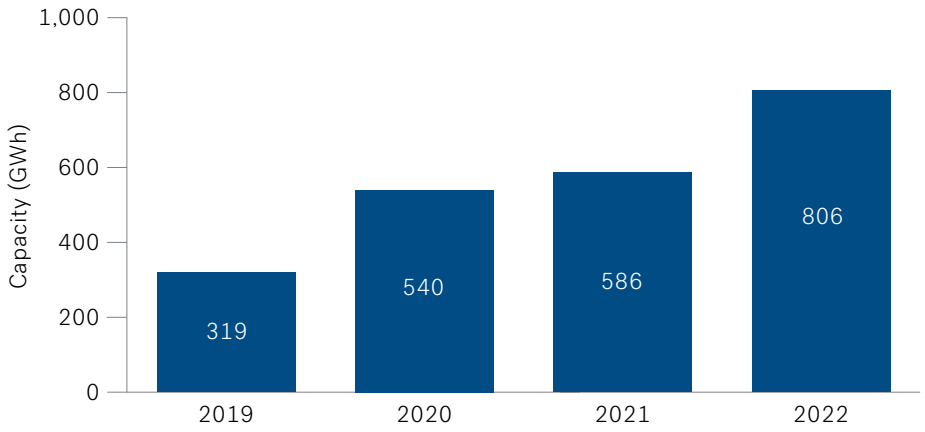
The rise in battery pack price by the end of 2022 was a culmination of a spiked demand in electric vehicles and a widening deficit in critical minerals. The trend in Lithium Carbonate prices till 2022 signifies this most clearly. Yet, there are early signs of moderation in the battery metal prices. A drop in sales in China, as a fallout of subsidy rationalization, signaled a relatively weakened demand. Added push for price slide came from the supply side – from China, Australia, and Chile. Projections from Rystad Energy indicated that the global market deficit in Lithium Carbonate Equivalent could reduce to 20,000 – 30,000 tonnes by 2023, as compared to over 76,000 tonnes in 2022.

Key Trends and Drivers

The tracked battery manufacturing capacity, at 806GWh (BNEF estimates) in 2022 was 1.5 times the level in 2020. Capacity addition has been steadily rising globally to meet the demand, led by electric vehicles (besides others such as grid-scale energy storage). Control over the battery supply is key for electric vehicle manufacturers for stability and control over the business operations. Despite Chinese influence, the focus is thus high on the upcoming capacities in Europe and North America.

Battery manufacturing capacity addition is rising steadily to meet the demand led by electric vehicles besides others such as grid-scale energy storage.

Global Lithium-Ion Manufacturing Capacity



Source: BNEF Zero-Emission Vehicles Factbook

Battery supply chain is central to the electric vehicle manufacturers and investors' strategy. The access to resources and technical know-how is the crucial factor driving current investment plans in adding capacity. The Chinese predominance is a given, with three-quarters of global battery cell manufacturing and 90% of anode and electrolyte production. Efforts are underway to moderate the Chinese concentration. The US and European investments are in this direction.

BNEF's annual Lithium-Ion battery supply chain ranking had China at the top spot. Canada however rose to the second spot this time around, resulting not only from endowed resources but other supporting factors including infrastructure, environmental-social-governance factors and innovations. Interestingly, the US dropped to third spot in the ranking despite the strong policy basis arising from its Inflation Reduction Act.

Key Trends and Drivers

BNEF 2022 Global Lithium-Ion Supply Chain Ranking

	Raw Materials	Battery Manufacturing	ESG	Industry, Innovation and Infrastructure	Downstream Demand	Overall Ranking
China	1	1	17	9	1	1
Canada	3	8	6	4	10	2
US	6	4	16	5	2	3
Finland	9	15	2	1	11	4
Norway	18	10	1	3	7	5
Germany	21	6	4	7	2	6
South Korea	17	2	10	6	5	7
Sweden	21	9	3	2	8	8
Japan	13	3	8	12	8	9
Australia	2	15	9	13	11	10
France	24	10	5	10	5	11
UK	26	15	7	8	4	12
Czechia	23	10	11	11	18	13
Poland	24	5	15	16	15	14
Hungary	26	6	13	14	20	15
Chile	7	18	14	23	19	16
Turkey	15	18	21	15	13	17
India	13	10	26	21	13	18
Vietnam	20	10	20	18	17	19
South Africa	8	18	19	17	26	20
Brazil	4	18	23	22	20	21
Indonesia	5	18	22	27	25	22
Argentina	11	18	12	19	26	23
Slovakia	26	18	18	25	24	24
Thailand	26	18	24	20	16	25
Philippines	10	18	29	28	22	26
Mexico	16	18	27	26	23	27
Morocco	19	18	25	24	28	28
DRC	11	18	30	29	30	29
Bolivia	26	18	28	30	28	30

Source: BNEF
Note: Dark blue signifies highest in the rank and dark orange signifies lowest in the rank

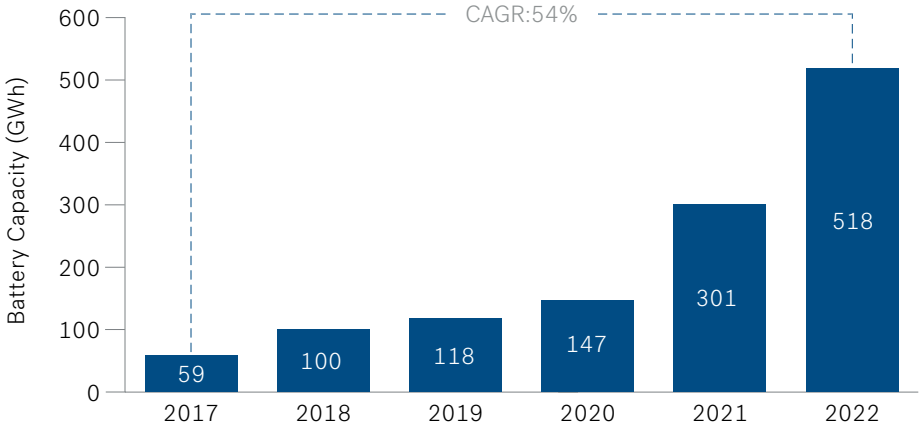
Key Trends and Drivers

Battery Demand and Competition

By the end of 2022, battery usage was more than thrice the level in 2020.

Globally, the predominant demand for batteries is from the mobility sector. Growth has been consistently high. A 2022 study of McKinsey projected a 4.7TWh market in Lithium-Ion battery by 2030. Also notable is how the projections get revised upwards with each year. McKinsey 2019 report on the same topic had projected a 2.6TWh market for the same period. The acceleration in demand upended most projections. By end of 2022, battery usage for electric vehicles was 3.5 times that in 2020. Importantly, this growth also took place in a backdrop of widening demand-supply gap, an inflationary pressure and the rationalization in subsidies. In January 2023, the battery energy held in electric vehicles (based on incremental sales) rose by 18% over corresponding period of previous year.

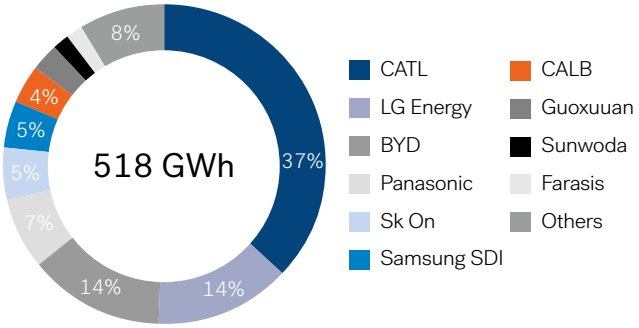
Global Electric Vehicle Battery Usage



Source: SNE Research

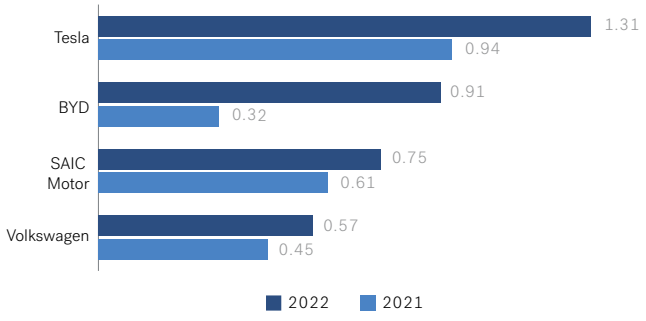
The market share of the battery manufacturers has been accordingly shaped by the sales of the vehicle makes/models incorporating the respective batteries. Panasonic, for instance, as one of the top-10 by market share in 2022, derives its market position due to its primary supply engagement with Tesla. In 2022, Panasonic registered a 45% year-on-year rise in sales. On the other hand, the market leader CATL, managed just a 6.5% year-on-year sales growth in 2022. Its market leadership, however, has been intact in the three years till 2022. Another notable mention among market leaders is the Chinese company BYD. It also ranks second to Tesla in the electric vehicle manufacturing/supply. BYD caters primarily to the Chinese domestic market and has been able to capitalize upon vertical integration in supply chain through battery.

Battery Manufacturers' Market Share



Source: SNE Research

Top Automakers by Deliveries (million)



Source: Wall Street Journal (Center of Automotive Management)

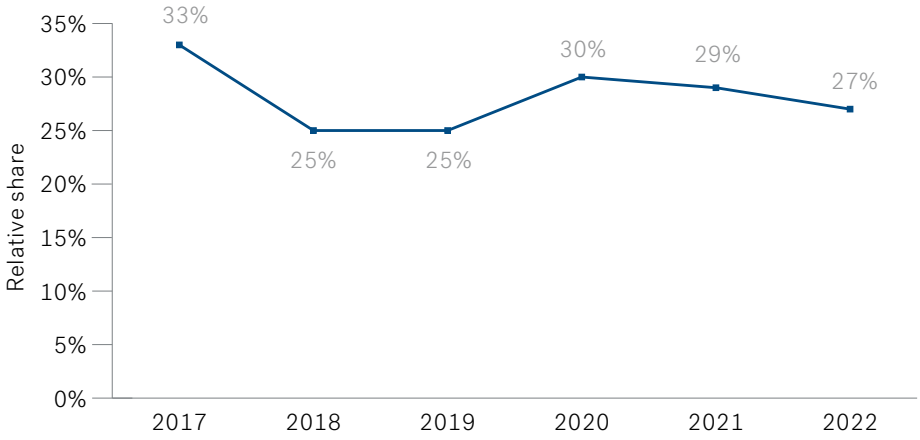
Key Trends and Drivers

Role of Plug-in Hybrids

The relative share of plug-in hybrid vehicles in overall electric vehicle sales is in a declining trend.

Lately, the relative share of plug-in hybrid vehicles in overall electric vehicle sales is in a declining trend. The rapid growth in electric vehicle penetration and a rationalization in subsidy support is gradually shifting the balance in favour of battery-electric vehicles. Till recently, plug-in hybrid powertrains received an equal benefit in the subsidy disbursement, as policy authorities sought to promote the transition. The change in incentive structure, in conjunction with the stricter emission norms, changed the balance.

Relative Share of the Plug-in Hybrid Vehicle Sales



Source: EV-Volumes.com

As regulatory norms vary across markets, so does the outlook for plug-in hybrids. The European emission standards impacted the sales of such vehicles. But the same does not hold true for the US market. In other markets such as Brazil, with alternate fuels offering competitive options, plug-in hybrids find a stronger footing. The supply-side has thus moved accordingly. While earlier, the premise of plug-ins rested on the lack of a developed architecture in full-electric platforms, the current proposition rests on the consumer preference (features such as flexibility, etc.). Leading automakers such as Toyota, Porsche, Mercedes, and Jaguar Land Rover have tapped into such demand, contrasting others such as GM and Volvo which have announced transitioning completely to full-electric vehicles by 2035.

The argument in favour or against the plug-in hybrids is dependent on context. For one, plug-ins have a case to help facilitate the transitory period before a complete pivot towards electric vehicles by a targeted year. It is also a fact that even the leading markets in electric vehicle penetration, such as Norway, are in the process of expanding the charging network. Another factor, in a policy and regulatory context, is emission. Plug-in modes can help in the progress towards emission reduction in transportation.

A study by the International Council on Clean Transportation (ICCT) placed this topic in perspective. The emission profile of the electric vehicles is contingent on the power source involved in charging the batteries. Thus, in Europe (high renewable energy share in grid power supply) emission reduction from electric vehicles are higher than China's (high coal-based power share). ICCT's report adds another element in the analysis. Driving habits have a significant impact on the net emissions' impact of plug-in hybrid vehicles. The report highlights that while regulatory estimates typically assume 70%-85% electricity mode in such vehicles, the self-reported data for personal vehicles indicates the same at 45%-50%.

Emission Savings of Electric Vehicles Compared to the Gas-Powered Ones

	Battery electric	Plug-in Hybrids
US	60 – 68%	42 – 46%
Europe	66 – 69%	25 – 27%
China	37 – 45%	6 – 12%

Source: International Council on Clean Transportation

Key Trends and Drivers

Vertical Integration

EV manufacturers and suppliers are seeking expansion in target markets and setting up facilities to localize the production of vehicles and components.

With the rise in penetration, EV manufacturers and suppliers are seeking expansion in target markets and setting up facilities to localize the production of vehicles and components. Tesla got its locally produced vehicles in China by end of December 2019, after setting up a facility at Shanghai. Europe is the emerging focus for most of the leading equipment manufacturers and automakers. Tesla's Berlin Gigafactory is one example. Automakers such as Volkswagen, Ford Motors, are among the leading ones in planning dedicated electric vehicle and battery production lines. A common thread running across the upcoming capacities, and particularly the Gigafactories, is the vertically integrated structure. In a way, many of the upcoming Gigafactories are emulating Tesla's precedent, as observed in the Gigafactories of Nevada (US) and Berlin (Germany).

For many of the automotive manufacturers, vertical integration is key to securing a competitive edge. In this regard, this somewhat reverses the globalized outsourced model of the conventional auto powertrain production processes. The rising instances of joint-venture or strategic partnerships, direct procurement arrangements in raw materials, or the investments in setting up in-house facilities in battery/equipment – all constitute evidence of the shift towards vertical integration.

Some of the prominent automakers such as BYD are reported to have bought about six mines in Africa, as part of strategy to secure critical minerals' supply. In most cases, partnership with specialized technology providers and equipment manufacturers is a preferred route. Ford, GM, Stellantis, and Mercedes are the notable names which struck major deals with South Korean and German entities for product development. A few others are scaling up for in-house battery production units. Volkswagen plans to build six battery factories in Europe by 2030 and has provisioned about €2 billion for its upcoming German Gigafactory.

Vertical Integration by Select Major Electric Vehicle Manufacturers

	Supply-chain integration*, 2022	
	Chip access†	Battery access‡
Tesla	●●●●●	●●●●●
Volkswagen	●●●	●●●●
BYD	●●●●●	●●●●●
Stellantis	●●●	●●●
GWM**	●●●	●●●●
Renault	●●●	●●●
BMW	●●●●	●●●
Mercedes Benz	●●●	●●●
Nissan	●●●	●●●●●
Geely	●●●	●●●
Ford	●●●	●●●
GM	●●●	●●●●
Toyota	●●●●●	●●●●●
Honda	●●●	●●●

Note: Chip access includes software and related know-how; battery access includes supply/sourcing diversification, quality of joint venture partners, direct raw material procurement and in-sourcing

Source: Economist (attributed to UBS)

Key Trends and Drivers

Though critical, batteries are not the only part to address in supply security. Electric vehicle manufacturers are also seeking options for securing the technology and software embedded in the vehicles. One of the most vital components in this regard is the semiconductor chip. Tesla, GM and Nio are among the electric vehicle manufacturers planning in-house chip design. Volkswagen, among the major manufacturers after Tesla, is working towards customized silicon for its chip requirement. Similar initiatives are underway in building up the software capabilities. Volkswagen's aim is to develop most of its software by 2030. Others such as Mercedes and Toyota are working on the same lines, planning proprietary operating system software for their respective platforms. The transition in this context is a drastic one – the entire business model is likely to come under pressure as the traditional auto manufacturing process and structure gets dismantled.

Electric vehicle manufacturers are seeking options for securing the technology and software embedded in the vehicles.

In-house Chip Development by Electric Vehicle Manufacturers

	Partnership / investment
GM	The company's Cruise division is in the process of developing AI-powered chips. The first set could power GM's planned automated shuttle vehicle.
Stellantis	The company partnered with Foxconn to develop four chip facilities.
Volkswagen	Planned co-development of chips, with ST Microelectronics. Manufacturing could be done by TSMC.
Nio	In-house development of self-driving and LiDAR chips underway, for integration in production line by early 2024.

Source: News reports

05

Outlook

Outlook

Introduction

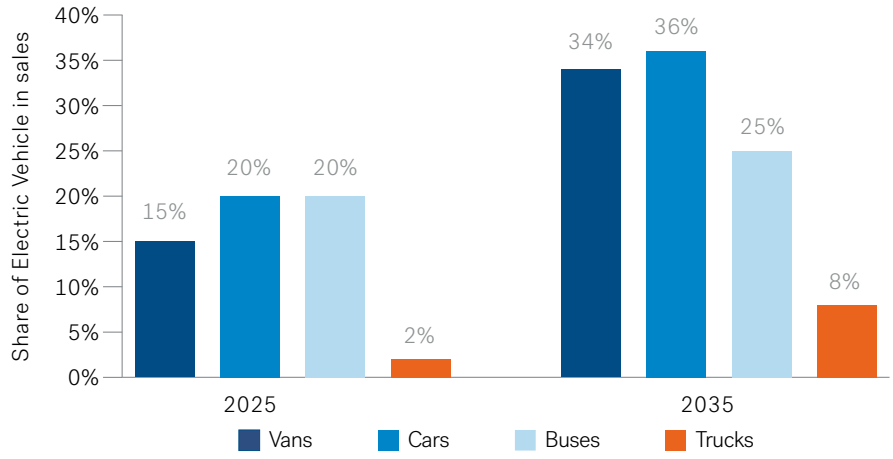
The progress achieved in electric vehicle penetration presents new challenges of sustaining and stabilizing it. There are several moving parts on both demand and supply sides which must run in tandem to realize the opportunity. The consumer preferences, shaped in part by the generous subsidies, would now require competitive market pricing and a wider portfolio of choice. Cheaper yet higher capacity batteries are needed to fulfill the rising demand – for which battery manufacturing must scale up closer to demand centers. The announced nameplate capacities indicate a three-fold jump by 2025. It will entail commensurate capital expenditures in the upstream segment of lithium mining, refining and production. In parallel, there is an upcoming build-out of charging network aiming to match the foreseen demand.

The global electric bus market has a far higher penetration (in terms of share in new vehicle sales) than observed in passenger vehicles.

Electric Vehicle Penetration

The case for EV is set out by the policy roadmaps across markets. It is driven primarily by the transition to a lower emission transportation framework and the related technological and investment growth in supporting elements of battery and charging infrastructure. The transitory phase in powertrain is getting stronger in most of the leading automotive markets – electric vehicles sales outperformed the overall market level.

Projected Electric Vehicle Penetration



Note: The above projections from IEA are based on announced policy targets
Source: IEA (Global EV Outlook 2022)

Passenger electric vehicles' segment attracts the maximum attention in policy framework. Such vehicles are likely to account for a rising share of new vehicle sales, reaching over a third of new vehicle sales by 2035. In this regard, many of the electric vehicle markets worldwide are approaching a tipping point – a level where the electric vehicle adoption can be at parity with that of conventional powertrains and are no longer a premium offering.

The commercial electric vehicles' segment starts from a very low base and is expected to gain traction on the strength of technological maturity as well as the stringent fuel economy standards that actuate automakers to expand their offerings. To be sure, 99% of this market relies on the internal combustion engine drivetrain and is thus unlikely to take a drastic change to a new platform when the support infrastructure is yet to be fully ready. This is more likely the case for heavy commercial vehicles such as trucks and related freight transport. Light commercial vehicles such as vans have had a better performance due to continued availability of purchase subsidies and the expanding product line-up.

The global electric bus market has a far higher penetration (in terms of share in new vehicle sales) than observed in passenger vehicles. This is a reflection of policy-level push at the transition of public transport fleets for gradual electrification. The segment is likely to maintain its momentum as various national and city-level authorities extend public funding for bulk fleet-replacement procurement. At the same time, the anticipated demand from public authorities is driving major automakers (notably Daimler and Volvo) to set up local manufacturing facilities for competitive offering.

Outlook

Decarbonization and net zero objectives will play a greater role in shaping the policy for the respective electric vehicle segments. For instance, even as the emerging and less developed economies lag in their transport sector electrification, progress has been impressive in the segment of two- and three-wheeler vehicles. With growth in penetration of passenger vehicles and light commercial vehicles, the focus could shift to the heavy-duty trucking segment where the progress has been relatively insignificant and thus inconsequential for emission mitigation.

Decarbonization and net zero objectives will play a greater role in shaping the policy for the respective electric vehicle segments.

Projected Transition to Net-Zero in Road Transport

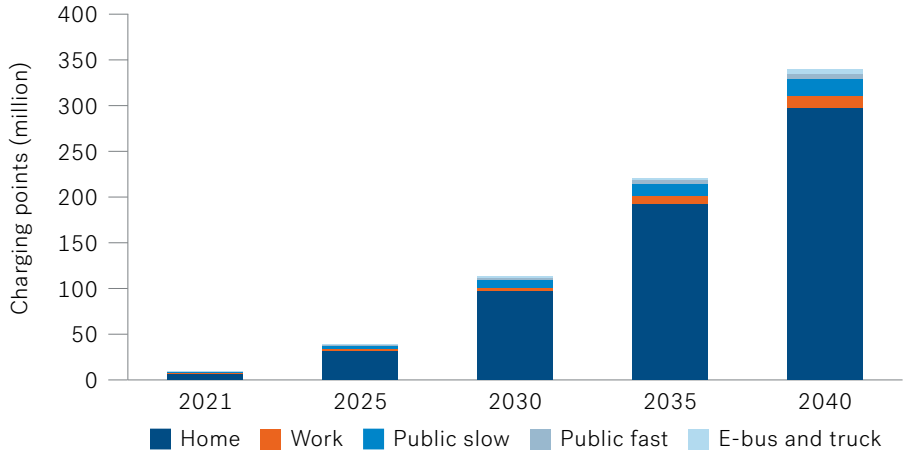
Segment	Share in road transport CO2 emissions	Estimated global fleet	Zero-emission vehicle fleet share by 2050	Extent of policy intervention required for Net-zero by 2050
Two- and three-wheeled vehicles	5%	1.1 billion	Two-wheelers: 74% Three-wheelers: 94%	Minor additional measures
Municipal buses	1%	3.8 million	84%	Minor additional measures
Passenger vehicles	53%	1.3 billion	69%	Moderate additional measures
Light commercial vehicles	11%	160 million	75%	Moderate additional measures
Medium + heavy commercial vehicles	30%	80 million	29%	Strong additional measures urgently

Source: BNEF (projections as of June 2022)

Charging Infrastructure

The rapid growth in charging infrastructure is just a foregone conclusion. It is the timeliness of getting the required capacity that is of paramount importance for all the leading electric vehicle markets. As the BNEF projections indicate, Home Charging segment will have the fastest growth in capacity, followed by Work and publicly accessible slow chargers. Compared across the transportation modes, the passenger electric vehicles hold the maximum share of the demand for charging facilities.

Global Demand for Charging Infrastructure across Segments



Note: The above refers to BNEF's 'Economic Transition Scenario' projection
Source: BNEF (projections as of June 2022)

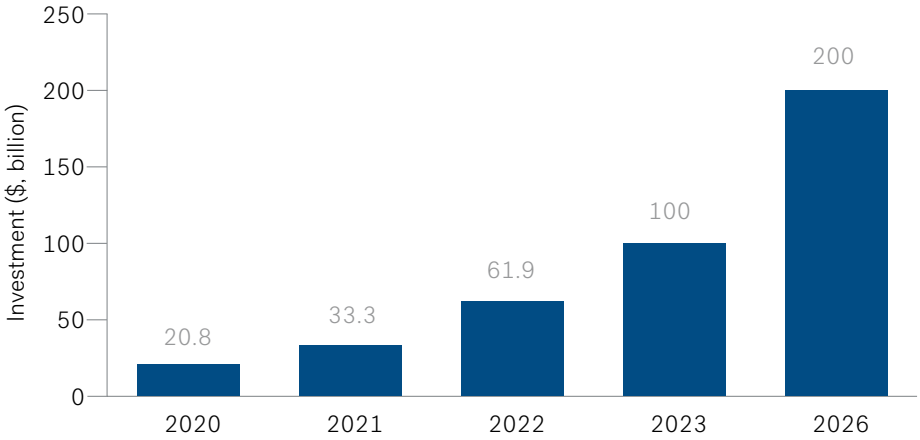
The annual spending on charging infrastructure is poised for a sharp acceleration. The trend shows the momentum picking up in recent years. BNEF estimates for the investment in 2022 suggest it doubled over previous year's level. By the end of 2023, the investment growth could be even higher. Further ahead, as the projections indicate, the next $100 billion of spending after 2023, could be within three years. Such an outlook is shaped by the varied segments and drivers of the investments underway, whether at a policy-level or private enterprises.

Outlook

Much of the rise in projected spend derives from the fast and catch-up mode of growth in markets, such as those of the US and China. European region comparatively has a mature base, and thus a relatively low incremental growth requirement in the outlook period. Policy funding measures such as the US Inflation Reduction Act's $7.5 billion for charging stations are major boosters for the investment flow in this space. The ramp up in private spending is discernible from the recent major announcements from automakers such as Mercedes planning 10,000 ultra-fast chargers or the hydrocarbon majors (Shell and BP) aiming a massive build out of fast-charging to match it with the widespread motor fuel distribution chain.

Policy funding measures such as the US Inflation Reduction Act's $7.5 billion for charging stations are major boosters for the investment flow.

Global Electric Vehicle Charging Investment Outlook

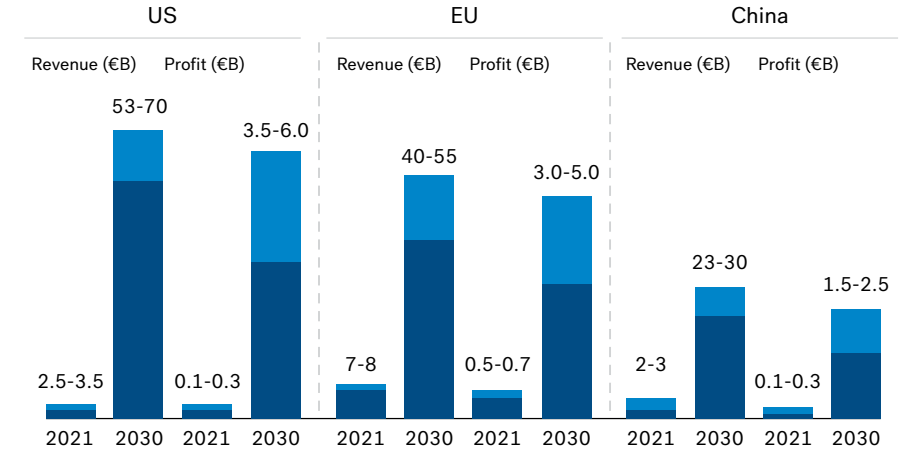


Note: The data for 2022 is an estimated one
Source: BNEF

Though home chargers constitute over three-quarters of the physical capacity, the predominant share of investment will be in public charging infrastructure. This is because of the higher cost of such equipment. Also important is that with capacity expansion underway in most of the regions, the charging equipment supply chains are likely to benefit from economies of scale. The cost of capital would thus be proportionately lower in the projected period.

The rapidly evolving business of electric vehicle charging offers a major potential in revenue and profitability, helped in large part by a significant and inelastic demand. Bain's projections in this context reflect the step up in investments together with the rise in market players such as the electric utilities, standalone charging service providers, technology providers and original equipment manufacturers, among others. Further, the role of smart charging and energy management systems is expected to play a bigger role, as complex networks necessitate advanced tools. For instance, about a third of the charging business by 2030 could be based on the bidirectional or vehicle-to-grid technology in major power transmission and distribution networks.

Projected Revenue and Profitability in Electric Vehicle Charging Business



Source: Bain & Company

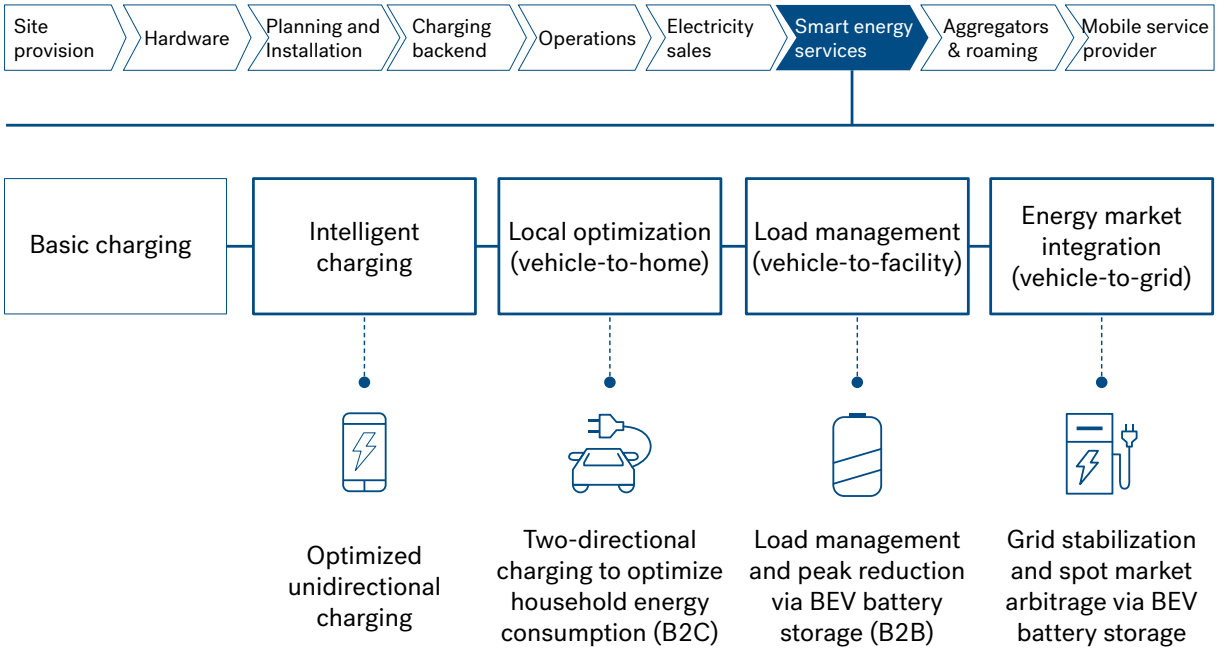
There is a range of business offerings in the electric vehicle charging value chain. The capacity provision will change based on the demand segment before a market player. For instance, the long-distance transit charging segment requires high capital expenditure segment and its profitability is contingent on supply of fast-charging (150kW and above) convenience. BP (through the brand BP Pulse) indicated the same in 2022, with many of its fast-charging stations approaching margins closer to those of petrol stations.

Outlook

The next stage of the shift in charging services will be through the transition to software, in terms of smart energy services for consumers. These technologies are vital due to the changing energy mix of grid power supply (due to rising share of intermittent solar and wind power) and utilities' need for system balance without compromising reliability. Energy management services for work and home locations would be key.

The next stage of the shift in charging services will be through the transition to software, in terms of smart energy services for consumers.

Evolving Business Offerings in Work and Home-based Charging Services

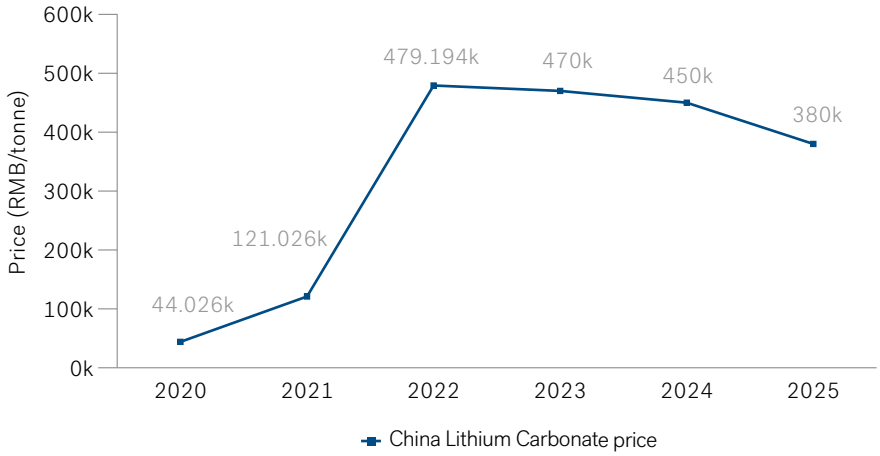


Source: Bain & Company

Battery Supply

The price of Lithium is in a phase of moderation. This comes after a spike till the end of 2022. Many of the underlying factors of 2022, such as demand against lagging supply and inflationary pressure still hold true. Yet, the price correction was triggered since early 2023 from the weakening Chinese demand (a fallout of the rationalization in subsidies). Some of the major battery suppliers, such as CATL have followed it up with discounts in their offerings – a rarity earlier considering the demand pressure and pricing power. Other automakers anticipate a relatively weaker demand than the phase of 2022.

China Lithium Carbonate Price Outlook



Source: DBS

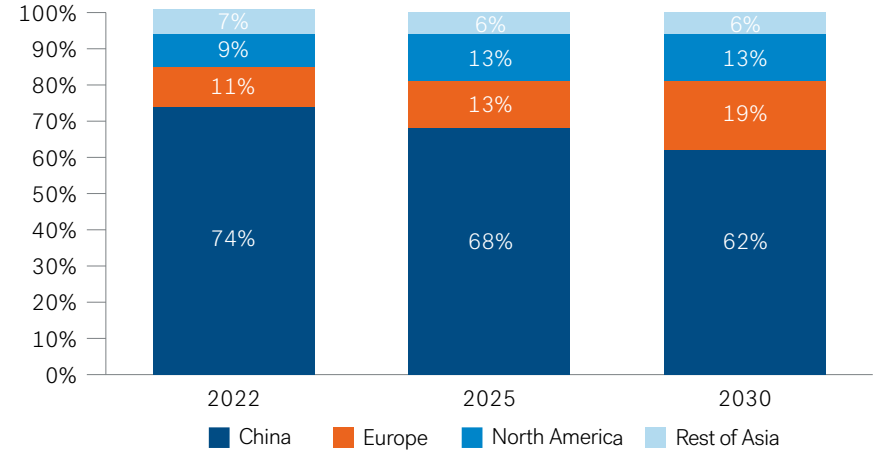
Anticipated expansion in Lithium supply added to the downward pressure on Lithium Carbonate prices. Some of the major capacities are expected to come onstream by end of 2023, though there are doubts if all of them can be operational. Most battery manufacturers and automakers have already locked-in their sourcing requirements during 2021-2022, with the result that they are likely to be insulated from price volatility in the upstream part.

Outlook

Cheaper batteries are critical for industry. Localized battery sourcing is vital to the supply chain efficiency of various leading automakers. Global capital flow is progressively seeking North American and European manufacturing locations to be closer to the demand. Government subsidies and tax credits help make this viable. The US Inflation Reduction Act and the planned Canadian industrial incentives, together seek to pull the investment capital for battery manufacturing that is otherwise dependent on China. The upcoming investments, led by the scale of Gigafactories, would however not radically change the global balance in Lithium-Ion battery supply.

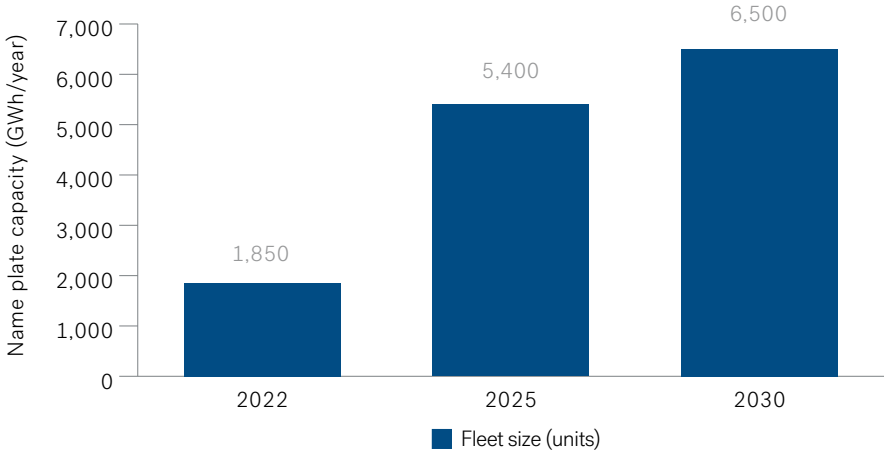
Localized battery sourcing is vital to the supply chain efficiency of various leading automakers.

Regional Share of the Announced Capacity for Lithium-Ion Battery Production



Source: McKinsey

Announced Total Nameplate Capacity for Lithium-Ion Battery Production



Source: McKinsey

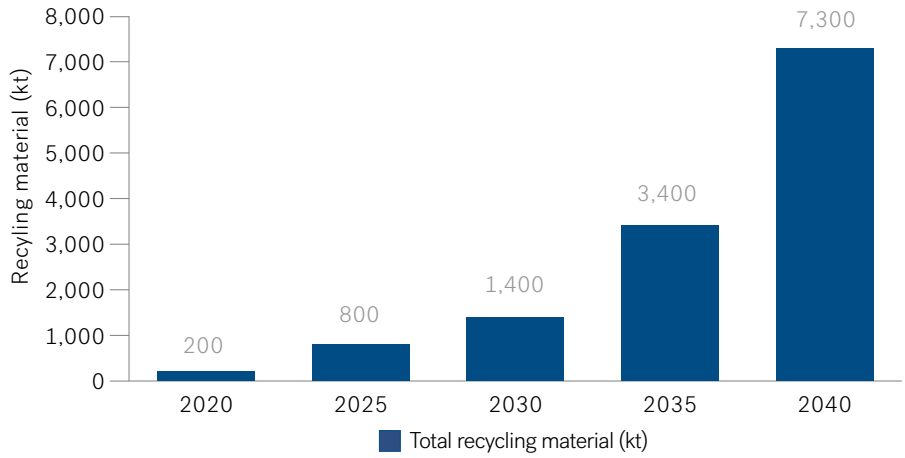
The upcoming battery manufacturing capacities present an attractive market for the recycling business. With cell manufacturing scrap's share at 30% in the early stages of the battery production process, the market opportunity is gradually becoming an important one even for the new factory launches in the works (Northvolt-Hydro venture among the prominent examples). Global supply of batteries for recycling is likely to be mostly led by the production scrap till 2030, after which it is 'end-of-life' batteries. The push for battery recycling is expected to be across the chain – for battery, cell and automotive manufacturers, the considerations will be not just stability of supply chain but also the ethical and decarbonized sourcing.

Outlook

Regulatory incentives or norms constitute the other market driver – for instance the US Inflation Reduction Act provides tax credits in this regard. European regulatory norms require automotive manufacturers to take back the owners' end-of-life batteries.

The global policy trajectory for electric vehicle market indicates slow steps at pivoting towards market-orientation.

Battery Recycling Opportunity

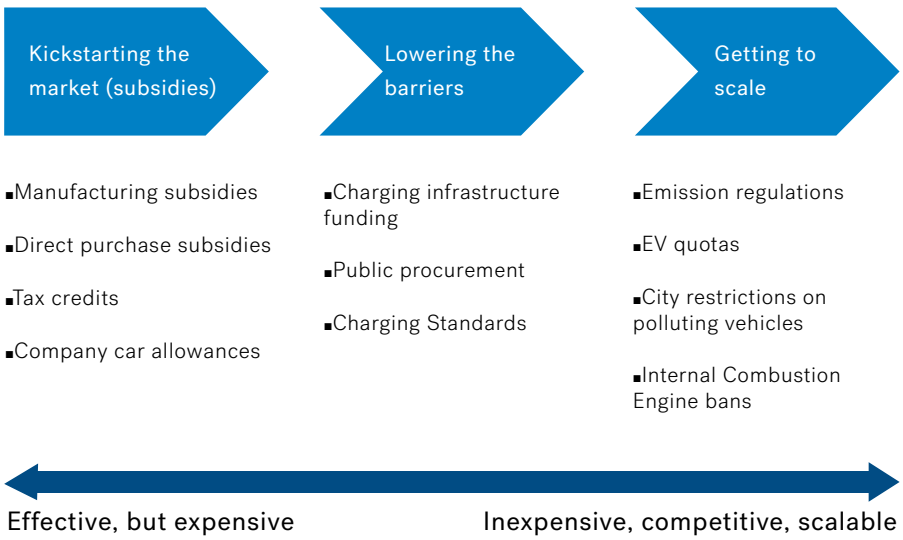


Source: McKinsey

Transition from Subsidy-led Push to Market Demand Pull

The global policy trajectory for electric vehicle market indicates slow steps at pivoting towards market-orientation. It is still conditional to the country-specific factor, but some of the recent examples point to this direction. Even without generalizing, there is a pattern discernible for the global policy and regulatory outlook – upfront subsidy support at the nascent stage to build up the business case, followed by a gradual tapering off in such support and developing norms and standards for wider participation coupled with enabled funding support. It culminates in reaching a scalable model where targets are set for vehicle adoption and the conventional vehicles' platforms are actively penalised.

Evolving Policy Structure for Electric Vehicle Market



Source: BNEF

Direct purchase subsidies, while demonstrably successful in promoting electric vehicle adoption, are also a strain on the public finances. For countries with rapid and credible progress in electrification, there is a rethink on subsidy support. Chinese and Norwegian market experience highlights this. Both rationalized their subsidies in the timeline announced beforehand and a short-term dip in sales is part of the equation. In December 2021, UK similarly announced a reduction in the purchase grants offered for passenger battery electric vehicles and vans. The decision in this case was justified as a means to free up the budget for larger decarbonization objectives.

Outlook

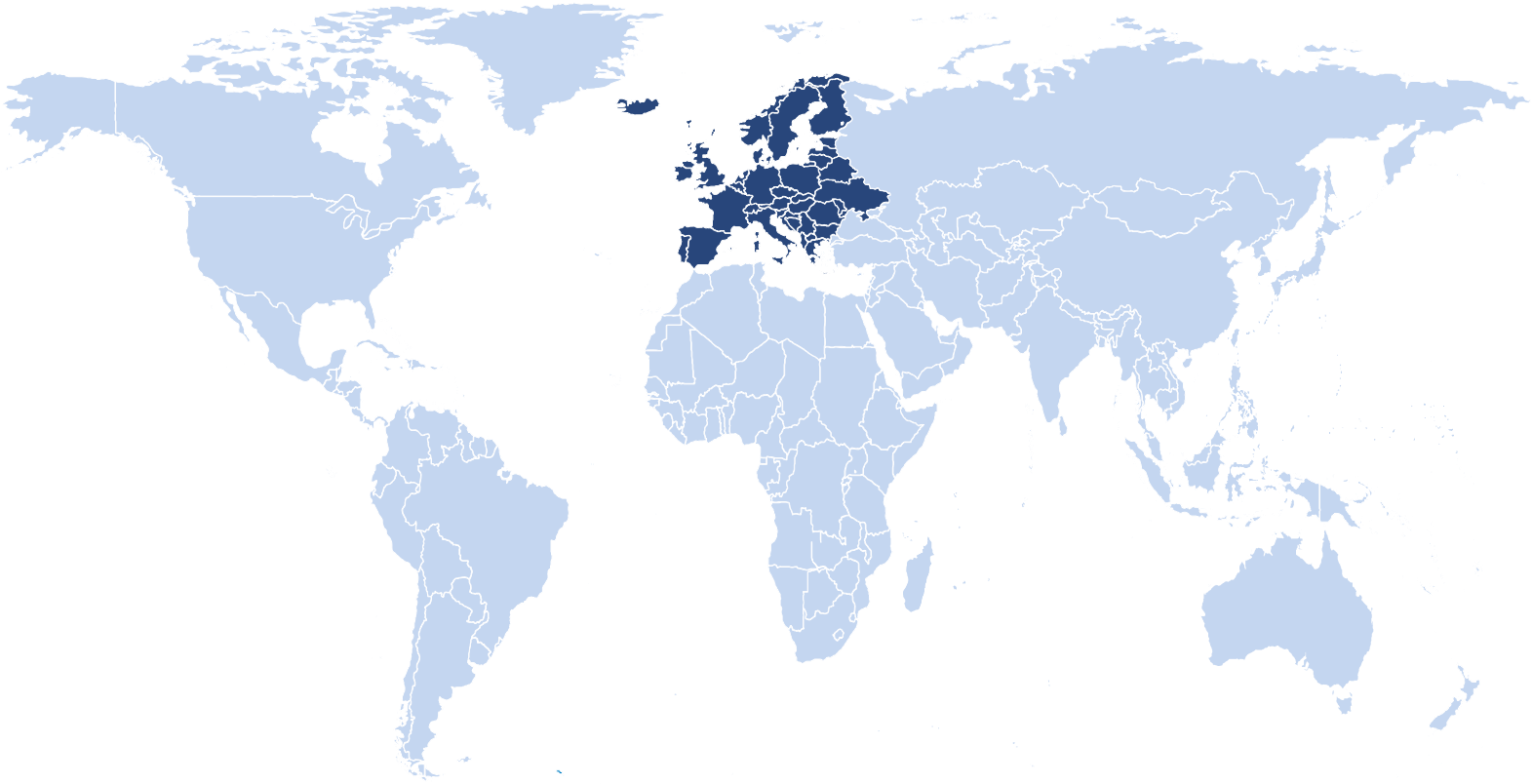
The globally leading markets of China and Europe are thus progressively shifting to adoption of supply-side policies. Fleet-wide fuel economy targets are gradually gaining traction. Both markets have some of the most stringent standards in place and their compliance effectively means expansion in the sale of electric vehicles. As a result, there has been a multitude of electric vehicle models with varied price points by the automakers to expand the sales footprint. Such a policy position is likely to set the template for other markets as well. Most important in this context, is the role of climate and energy policy targets that the governments devise. The European Union's targets are a case in point. Similarly in the US market, stringent Corporate Average Fuel Economy (CAFE) standards might be difficult to adhere to without having a higher share of electric vehicle sales.

The globally leading markets of China and Europe are progressively shifting to the adoption of supply-side policies.

06

Key Regional Markets

Key Regional Markets - Europe



Countries Covered

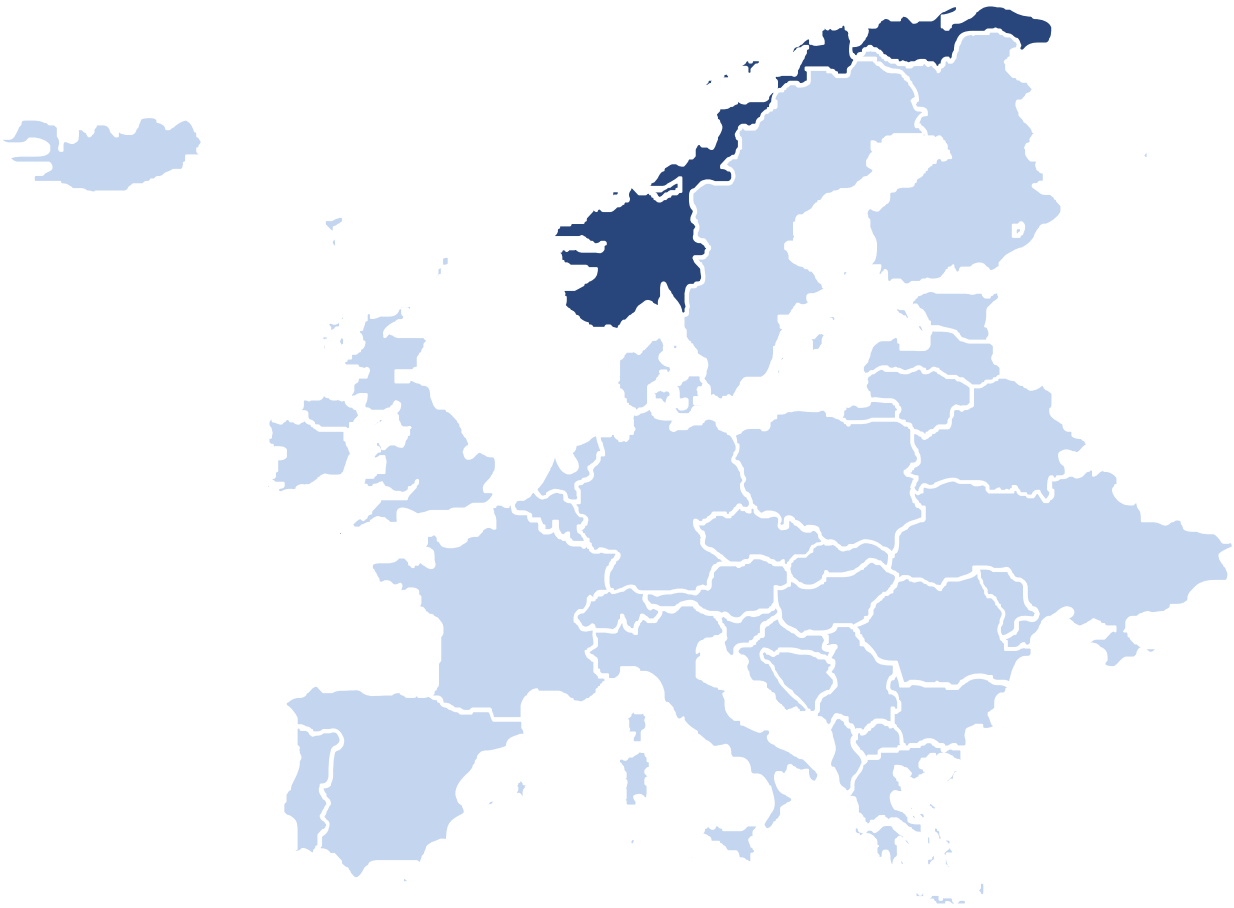
1. Norway
2. Sweden
3. The Netherlands
4. Finland
5. Denmark
6. Germany
7. France
8. United Kingdom
9. Spain
10. Italy

Norway

Norway has set the benchmark for the transition to electrification of transport. In terms of new registrations, electric vehicles have just about replaced conventional ones. Meanwhile, the growth continues to build upon consumer demand and preference momentum. The incentive-led growth model is no longer valid, with the gradual rationalization underway for full-scale market orientation. A vast scope remains yet to be utilized in the infrastructure demand and the battery manufacturing opportunity.

GDP (Current Prices) USD (2021)	482.18 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.79%
EV Penetration	79.3% (battery electric) of the total new passenger vehicle registrations in 2022
EV Target	Zero-emission (electric or hydrogen) drivetrain in new passenger vehicle sales by 2025
Planned Year of Phasing Out ICE Vehicles	2025

GDP Source: IMF, World Economic Outlook

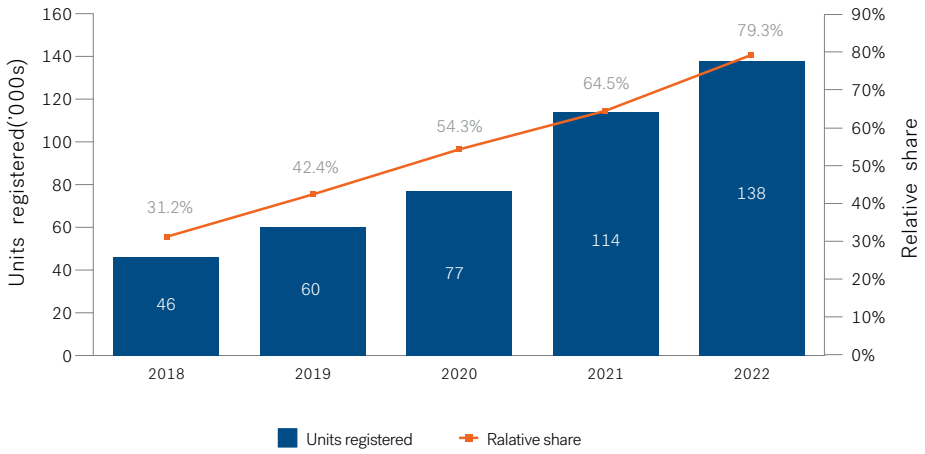


Norway

EV Penetration and Trend

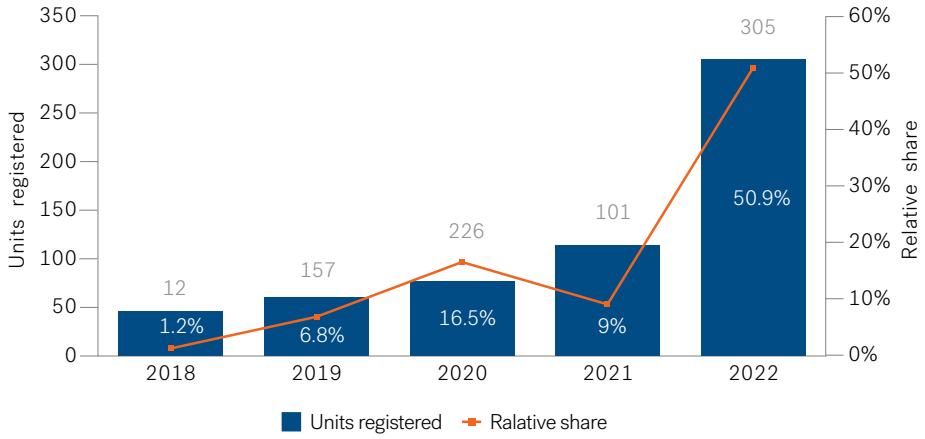
The acceleration in Norwegian electric vehicle penetration has been consistent. During the five years of 2018-2022, the number of new registrations grew at a compound annual growth rate (CAGR) of 32%. The penetration of almost 80% is entirely that of battery electric vehicles. Adding the plug-in hybrid will make it even higher. But plug-in vehicles are not on the same footing with the target of zero-emission new registrations by 2025. Norway's penetration of electric passenger vehicles has reached a tipping point of mainstream adoption, where the purchase of the internal combustion engine appears off the track.

New Registrations in Passenger Electric Vehicles



Source: Road Traffic Information Council (OFV)
Note: Above data refers solely the battery electric vehicles. Per OFV, plug-in hybrids are reported under the overall Hybrid vehicle sales, while electric vehicles are classified under zero-emission.

New Electric Bus Registrations



Source: European Automobile Manufacturers Association (ACEA)

While the demand momentum stays, the new registrations reported by the end of 2022 carry a rider. There was a massive rush by December 2022 as consumers sought to make the most of the expiring tax exemption. The resulting jump in numbers helped reach the penetration as observed. A correction is expected in the same – the decline in January 2023 registrations could be interpreted as one. All the same, a strong supply side with expanded offerings at low price points helps maintain the market's bullish outlook.

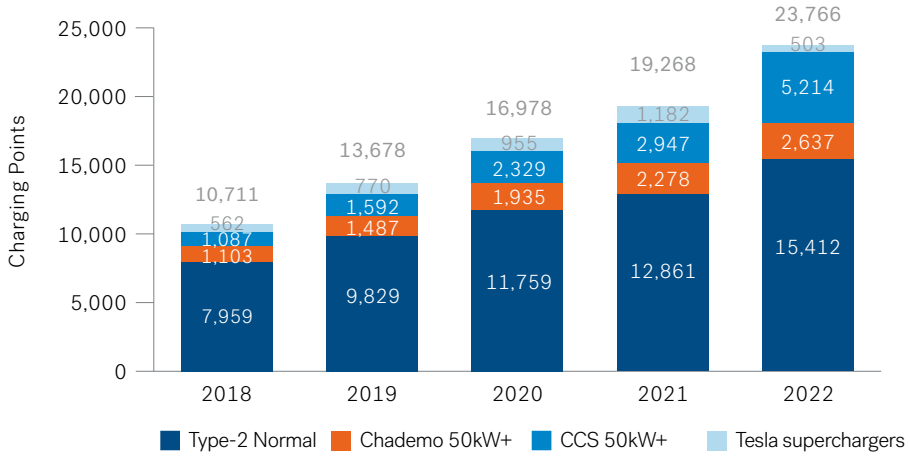
The momentum is also high in the public transportation segment. The government has set a target to ensure that all new city buses are emission-free or fossil-free fuel (biogas) by 2025. Procurement has thus been picking up across the municipalities. The city council of Oslo has a stated goal of electrification of the entire bus fleet by 2023. The overall trend, however, indicates an uneven progress due to the decline reported in 2021.

Concerns around sustainability have led policymakers to focus on shared mobility options as vehicle ownership loses relevance in an emission-free environment. The city of Bergen took the lead in this direction, becoming the first Norwegian city to start a mobility hub. The objective was to establish permanent, reserved parking spaces for shared vehicles, preferably electric ones.

Charging Infrastructure

During 2018-2022, the total installed base of charging points registered a CAGR of 22%. While the slow Type-2 chargers hold the predominant share (reflecting the importance of residential charging), fast-chargers' contribution is gradually rising. The highest growth in the network in the review period came from the fast-chargers (CCS 50kW+). The demand is much higher than what the existing network can service. As a fallout of the high penetration rate, the country has a high ratio of electric vehicles per charging point (33.6) than other leading markets. Regarding the overall network expansion/reach, Oslo ranks among the top European capitals, with 5.47 chargers per sq. km. (as of July 2022).

Installed Base of Public Charging Points by Type



Source: National Charging Station Database (NOBIL)

Home-based charging has had a significant share. Over 80% of electric vehicle users charge at their homes. Accordingly, this segment has been suitably helped by subsidies and regulatory norms for capacity growth. For residential and passenger vehicle applications, the initial growth phase of slow charging points helped set the base. Private investments primarily lead the next phase of fast-charging.

The cost of charging has lately been an issue due to the rise in energy costs. As of September 2022, some leading charging operators reported a 25% - 75% price rise at the charging stations. There was some government support available to cushion the home-based charging costs. For the standalone stations, however, the cost increase considerably narrowed the gap against conventional refueling of vehicles. `

Policy and Regulation

The Norwegian government is gradually winding down the subsidy-led growth model of the electric vehicle market. This has been part of the discussions for some time, as the government weighed the budgetary impact of the support measures vis-à-vis the results and objectives. The considerations align with the principles of equity (paying for the available public infrastructure) and viability (revenue shortfall) of public finance.

The first in the list of incentives phased out is the value-added tax (VAT) exemption. With effect from January 1, 2023, the government abolished the VAT exemption for passenger vehicles costing over kr500,000. The existing tax is at 25% of the incremental car value above kr500,000, which is still relatively lower than the conventional ones. In addition, electric vehicles are taxable by weight – kr12.5 per kg above 500kg of vehicle weight. The weight-based tax effectively covers all electric vehicles. Electric vehicles still benefit from other tax exemptions that are not available to non-electric ones. For instance, there is a one-time fee together with a flat 25% VAT on the list price that is not payable for electric vehicles.

There are ongoing deliberations about other incentives. One is the benefits extended in terms of tolls for electric vehicles in the larger cities. Electric vehicles need to pay just 50% of the toll that conventional vehicle owners otherwise pay. The plan is to progressively raise this share to 70% by 2025 when it is eliminated (only zero-emission transport to be sold by 2025).

In the case of the charging infrastructure, some of the critical measures in the regulatory framework helped set the pace of growth. One of them is the 'right to charge' wherein households could seek charging facilities as an entitlement from their respective municipal or local authorities. Local authorities have been extending incentives, such as free parking, reserved lanes, subsidizing a part of the upfront cost of charging point installation, etc. Steps are underway to harmonize the charging stations' operations for ease of access – as one example, all the charging stations installed from January 2023 must offer a card payment option. A separate timeline is expected for other charging stations.

Market Opportunity

The demand for charging infrastructure is set to grow in Norway as the policy goals expand to cover more modes of transportation. While the short-term goals aim to have 100% emission-free passenger cars, light vans, and new city buses by 2025, all new heavy vans, 75% of new long-distance buses, and 50% of new lorries need to be emission-free by 2030. This is likely to place additional pressure on the charging infrastructure. The transition to emission-free transportation is expected to create a fleet of 1.5 million EVs by 2030, as per NVE, the electricity market regulator in Norway.

The fast-charging segment is attracting interest from multiple stakeholders. The city of Oslo has a grant scheme for fast-charging stations for electric trucks and buses. The first round of funding covered 80% of the installation costs. As of end 2022, the scheme had total disbursement worth €2.3 million. Subsequent funding rounds are expected in this regard to enable capacity expansion. In May 2022, the equipment manufacturer ABB, in collaboration with the charging operator Eviny, installed the first Terra 360 series of 360kW fast-chargers. The pilot installation will be followed up with a phased rollout across the locations of Eviny's operation, besides others.

In 2022, the automaker Tesla opened its proprietary fast-charging network for vehicles of other makes, at company-determined prices. Tesla's initiative is a pilot under evaluation. Adding to the list of initiatives, in August 2022, Chinese electric vehicle company NIO launched its second battery charging and swapping station in Norway. Battery swapping is unexplored and could present an alternate option to the country's overall charging network. Various other enterprises are approaching the charging market through partnerships. In collaboration with charging operator Recharge, IKEA Norway aims to have over 300 new chargers within 2024. The energy company/utility StatKraft has a wholly owned charging operator company Mer for capitalizing the opportunities. The company is of late exploring diversity in Mer's shareholding, for which financial advisors have been appointed.

Battery manufacturing is another significant investment avenue, especially with the Gigafactory project pipeline. In January 2023, Elinor Batteries (established by the company Vallinor) announced its plan to set up a Gigafactory in Orkland. With an estimated investment of €1 billion, the first production batch is expected by 2026. The company FREYR Battery meanwhile is progressing with ongoing development work for its Gigafactory project (named Gigafactory Arctic). The total construction and commissioning cost is expected to be worth €1.7 billion in capital investment. Notably, FREYR has signed agreements with Statkraft and Glencore for renewable energy and material sourcing, respectively. Another company, Morrow Batteries, is in the development stages of an upcoming battery cell production facility in Arendal, Norway.

It is noteworthy that in June 2022, the government launched the national battery strategy, outlining the planned policy steps to help facilitate the local battery manufacturing value chain. Key steps in this include the provision of capital, loans, and guarantees to enable private capital investment, supporting pilots, facilitating access to renewable energy, development of land and infrastructure, and industrial partnerships with other countries.

Outlook

The rate of transition to transport electrification appears aligned with the country's policy goal to have only a zero-emission (electric or hydrogen) drivetrain by 2025 in new passenger vehicle sales. With the progressive maturity of the business, the phaseout of subsidy support and withdrawal of tax benefits could temporarily impact sales. After the abnormally high sales of December 2022 (the last month for tax benefits on electric vehicles), there was an 80% year-on-year decline in January 2023. While supply shortages played a role, adjustment to complete market orientation may take time.

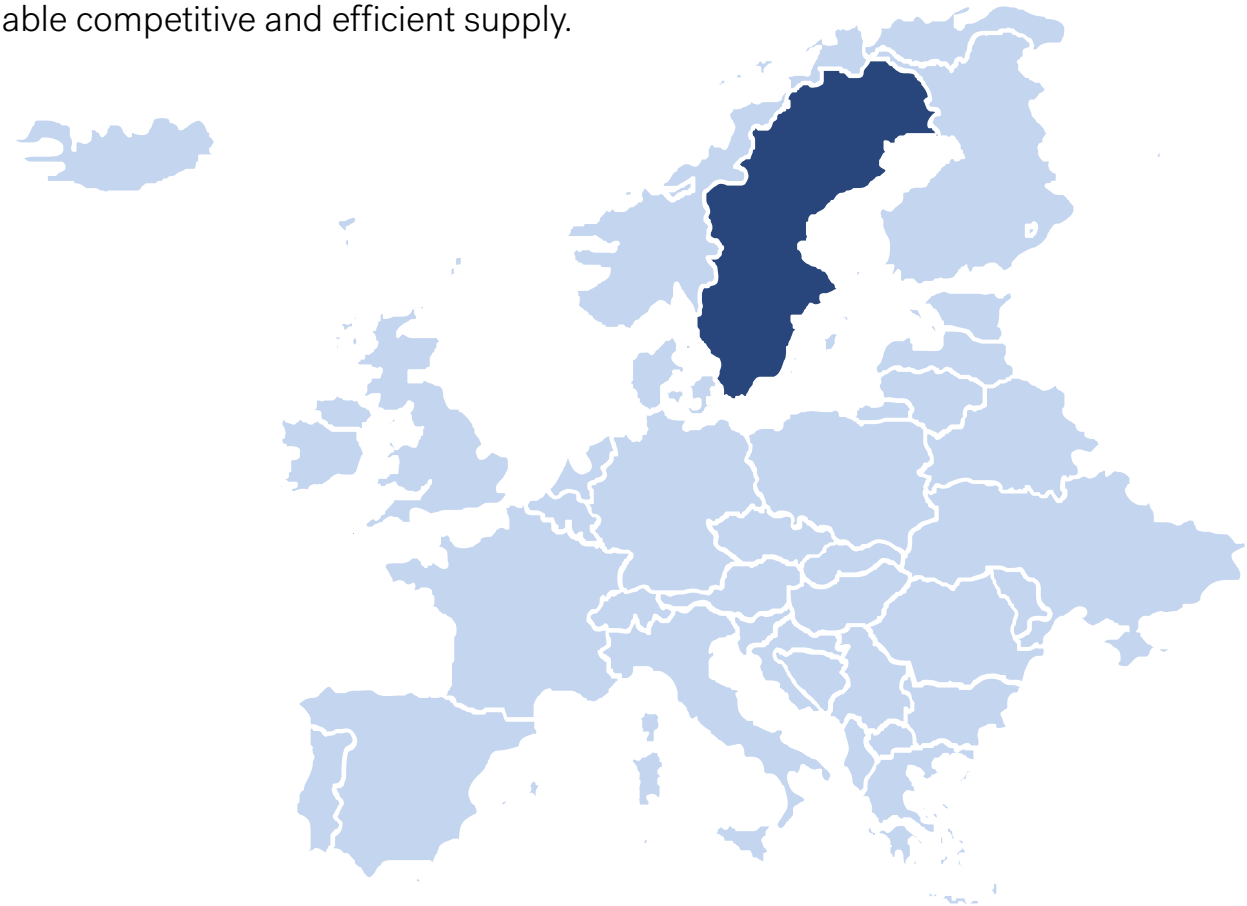
With passenger electric vehicle adoption becoming almost mainstream, the focus on charging network capacity addition will likely change. While there will be significant scope to expand the overall network, the focus will be on heavy-duty, commercial applications where technology improvisation and timely capacity deployment will be essential. Equally important will be the role of smart charging systems for grid management and charging operators. Furthermore, there is a rising need for a regulatory framework to establish a specific structure and standardization in the charging business.

Sweden

Globally, Sweden ranks among the top countries for electric vehicle penetration. Over half of the new vehicles registered in 2022 were battery-electric or plug-in hybrids. The country's recent policy step to stop subsidizing electric vehicle purchases stems from the industry's promising growth. At the same time, the emphasis is high on electrification to achieve the targeted goals of decarbonization. Some of the significant foreseen challenges lie in jumpstarting the rate of capacity addition in the charging network. Also important is the timely growth of the local manufacturing base to enable competitive and efficient supply.

GDP (Current Prices) USD (2021)	635.66 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.40%
EV Penetration	33% (battery electric) of the total new passenger vehicle registrations in 2022
EV Target	Not specific to Electric Vehicle. Overall policy goal is to have net-zero greenhouse gas emission by 2045
Planned Year of Phasing Out ICE Vehicles	2030

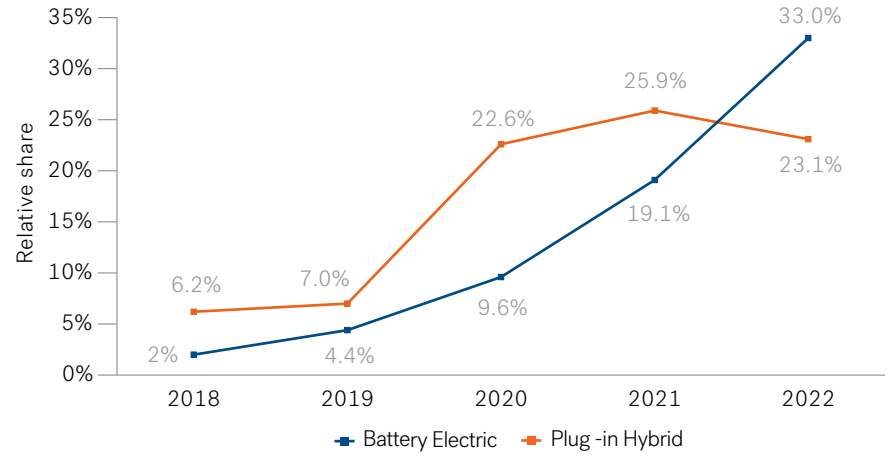
GDP Source: IMF, World Economic Outlook



Sweden

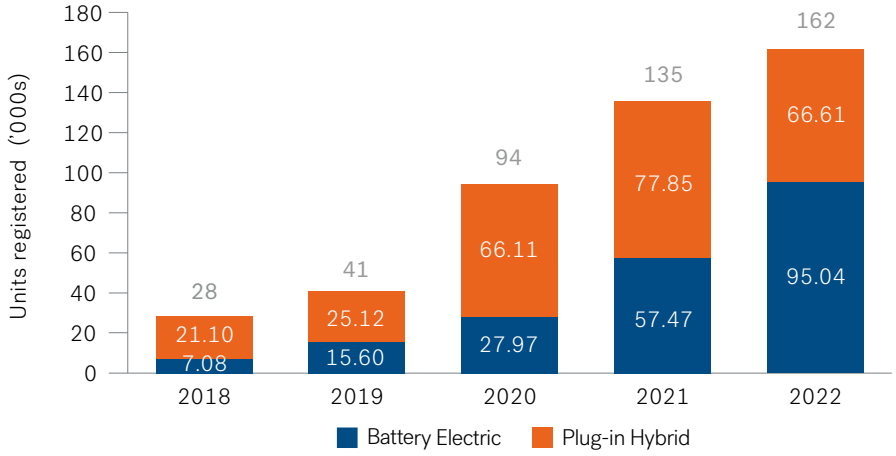
EV Penetration and Trend

Share of Electric Drivetrain in New Passenger Vehicle Registrations



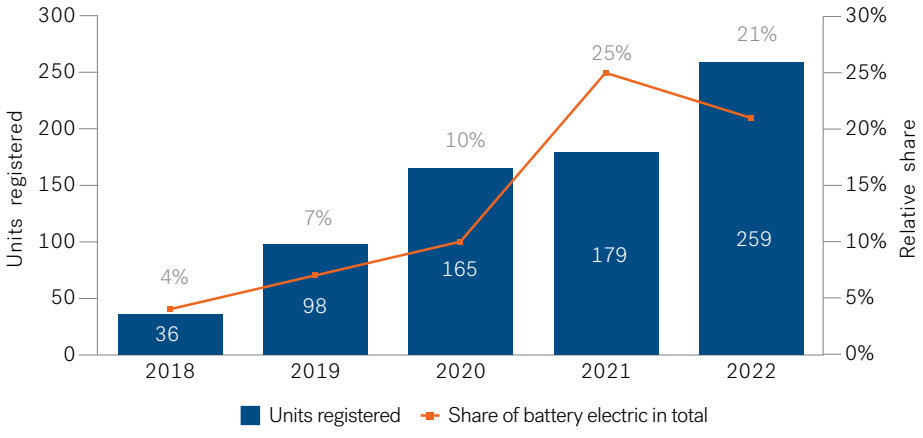
Source: Mobility Sweden

New Registrations of Passenger Electric Vehicles



Source: Mobility Sweden

Electric Bus Registrations



Source: European Automobile Manufacturers Association (ACEA)

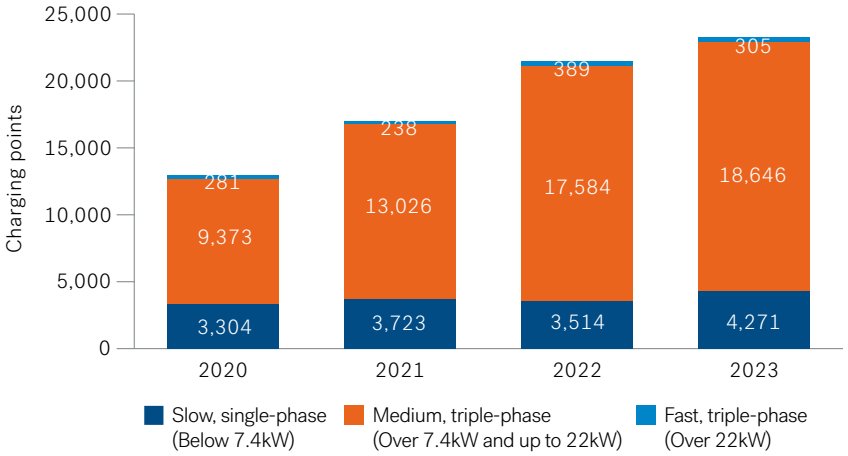
The Swedish market leads globally for the penetration achieved in electric vehicles. By the end of 2022, over half of the new passenger vehicle registration was based on the electric drivetrain. In 2022, battery electric vehicles led ahead of the plug-in hybrids in new registrations. The trend may continue due to a rise in conventional fuel prices and the availability of better product variety in battery electric modes. Also relevant in the context is that the sales took place amidst the semiconductor shortages faced by automakers, which impacted supplies.

During 2018-2022, passenger electric vehicles registered a CAGR of 55%. The battery electric vehicles contributed the most, with a CAGR of 91% in the same period. The segment accounted for almost 60% of the total electric vehicles registered in 2022 (161,649 units), a sharp rise from same relative share of 30% in 2020. Comparing the annual growth in new registrations, the 19% year-on-year growth in 2022 was significantly lower than in previous years. The reasons could be the rising backlog of vehicles and the reigning inflationary pressure.

The commercial segment of the electric vehicle market is comparatively smaller in absolute sales terms. The growth, however, is sharp, picking up from the low base. With rapid procurement orders, the new electric bus registrations reported a CAGR of 64% during 2018-2022. Electrification is still insignificant (6.4%) in the total bus fleet of 14,239 units. The spike in new diesel bus registration caused a dip in the relative share of electric bus registration in 2022. Increasingly, with new diesel buses complying with stringent European emission norms, diesel powertrains remain in contention for the operators. The growth spike is sharper for electric trucks (over 3.5 tonnes). A steady stream of orders vastly expanded the total fleet – from just four units in 2018 to 231 by the end of 2022.

Charging Infrastructure

Publicly Accessible AC Charging Network

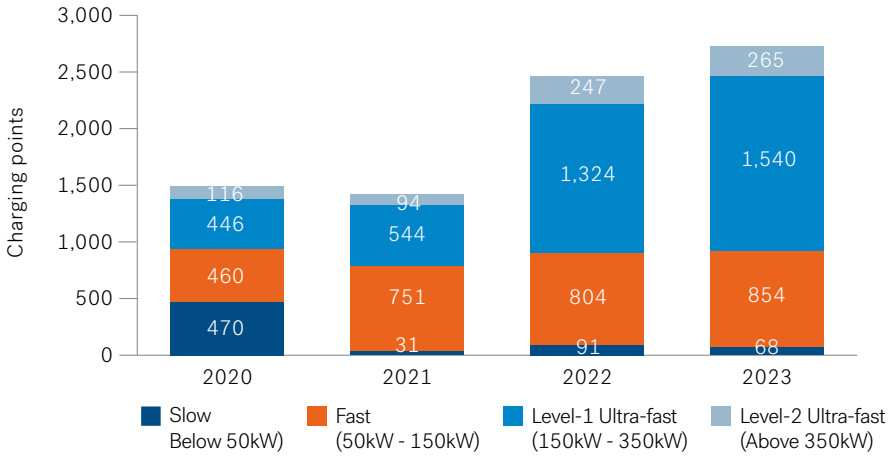


Note: Data for 2023 is as of February 2023
Source: European Alternative Fuels Observatory

Sweden's existing public charging infrastructure, with 25,949 charging points (AC and DC), is in a catch-up mode against over 400,000 electric vehicles (passenger vehicles) in traffic. The expansion is underway at a fast clip. In 2022, the number of AC charging points grew 26% year-on-year, while those based on DC grew by 74%. Almost 90% of the charging network is based on AC power rating. In terms of network coverage, the progress has been good. Stockholm, for instance, ranks among the top 10 European cities in charging density (number of bays per sq. km). As of June 2022, the Swedish charging network size stood fourth among the European countries in a European Automobile Manufacturers Association ranking.

The trend shows a discernible shift favoring higher power ratings, signifying faster charging. In the dominant AC charging network, the medium and fast-charging sub-segments led the growth during 2022, at 35% and 63%, respectively. In the DC network that already operates at a higher power rating, the weightage in capacity addition is skewed towards the fast and ultra-fast sub-segments. Besides the low-base effect, the untapped yet rising demand for dedicated charging in commercial transportation (electric buses and heavy-duty trucks and freight) is a key factor propelling faster charging stations.

Publicly Accessible DC Charging Network



Note: Data for 2023 is as of February 2023
Source: European Alternative Fuels Observatory

Sweden's charging infrastructure also includes an induction-based wireless charging system. Though at a nascent and largely experimental stage, successful trials have helped progress the operationalization of this technology. In 2018, the world's first induction charging system was launched in Sweden, with a 2km stretch of road equipped with electric rails to link Stockholm airport with a logistics site. In April 2022, the technology and equipment company Electreon announced a one-year extension of the same wireless charging project. Subject to fulfilling specific requirements, the technology is regarded as key for the long haulage freight trucking routes and electric bus transit systems.

Policy and Regulation

Sweden's climate policy framework sets an ambitious goal of having net-zero greenhouse gas emission by 2045. In this regard, the mandate for domestic transport sector is to reduce emissions by at least 70% by 2030 compared to the level in 2010. The year 2030 is also the year by when the sale of new conventional fuel-based vehicles is banned. The policy support so far for electric vehicles, along with other alternate fuel transportation, has thus been to support the market-led growth in electrification.

The trend in Sweden's electric vehicle penetration is evidence of a maturing market. This is the reason why the government, as of November 2022, announced a complete cessation of the subsidy support. The subsidy fulfilment during 2023 will be only for the orders already placed. In effect, this also means that vehicles with emissions higher than cut-off level (30 gm CO2 per km) must pay a higher vehicle tax. It means that petrol and diesel-based vehicles continue to be subject to a heavy taxation, as before.

Some subsidy support is available for setting up charging stations. A grant covering 50% cost of a home charger installation, up to €1,350, is available for the residential or multi-home applications. Further, the government has schemes with budgeted outlays to fund the businesses, municipalities, and other entities for specific ideas/projects (including charging infrastructure) that can have a climate benefit. Typically, the funding covers up to 70% of the investment commitment.

Market Opportunity

The electrification of public transport, through electric buses, is an important growth driver. Many of the cities and local authorities are joining in, through placement of orders to replace existing fleet. For leading global manufacturers, bus procurement constitutes an important and increasingly competitive segment. Among recent major orders, Ebusco signed a fixed contract with the operator company Connect Bus (with operations in both Sweden and Norway) for 46 electric buses by end of 2023. BYD, as another major player, secured an order for 52 electric buses from the operator Transdev. Sweden, along with other Nordic countries, constitute an extremely attractive and contested market space for electric buses due to the huge untapped potential of fleet replacement.

With a pronounced focus on charging network expansion, the investment activity is high in this segment. As of July 2022, the parking operator Stockholm Parkering launched a European Union-wide tender for procurement of 10,000 chargers over a period of four years. Notably, the tender is only for purchase and not installation. Also, the planned procurement is aimed to include the city's other parking operators. Separately, Stockholm Parkering engaged CTEK for installing 1,000 charging points in one of it operational locations. The company's long-term aim is to have 100,000 new chargers in place by 2030.

Leading Swedish enterprises are partnering with charging station developers and operators to participate in the space. The Ingka Group, under its IKEA brand, partnered with charging operator Recharge to expand the charging network through its business locations and operations. As part of the plan, IKEA Sweden will have 700 new chargers installed by 2024. Another example is the Swedish commercial property company Regio partnering with charging system developer and operator IONICITY to install and run 108 high capacity (up to 350kW) charging points across 12 sites. The planned capacity, targeted for commissioning by the end of 2023, is aimed at long-distance travelers.

Niche demand sub-segments for charging are gaining focus for investors. One such sub-segment is commercial transportation, particularly the heavy-duty electric trucks deployed in long-distance freight. Though electric trucks are yet to gain any significant share of the entire trucking industry, the growth in stock is generating a sufficiently high demand for dedicated and high-powered charging stations. Equipment companies such as Kempower are among the leading contenders. By the end of 2023, Kempower will supply fast-charging systems for an electric truck charging network. Supported partly by Swedish Energy Agency's grant, the upcoming network will be in Gothenburg, Söderhamn, Sundsvall, and Nordmaling. In this context, it is noteworthy that a recent report by the Swedish non-profit organization PowerCircle projected the need for 1,200 charging stations meant for electric trucks by 2030.

There is a heightened interest in wireless charging after encouraging results from the trial run in 2018. In March 2022, the automaker Volvo Cars announced a wireless charging project in Gothenburg. It will run for three years and deploy a small fleet of Volvo XC40 vehicles to be used as taxis to ply in the city and recharge wirelessly at the earmarked wireless charging points. The aim is to test the technology's feasibility and fitment in a shared mobility environment. Other project partners include Volvo's retailing entities Volvo Bil and Volvo Car Sörred, energy company Vattenfall and its charging network InCharge, city energy company Göteborg Energi and Business Region Gothenburg, a municipal economic development agency owned by the City of Gothenburg.

The company Electreon, involved earlier in the pioneering Swedish wireless charging project, is also involved in the extension of the same project. This €2 million project, funded by the Swedish Transport Administration, will test for upgraded charging capacity features besides software control systems. As the company is implementing similar projects in France, the trial project could benefit from enhanced technology partnerships and know-how before a wider-scale rollout. The company is also expected to lead the race as market players prepare for Swedish authorities' tender for constructing wireless charging-equipped roads in the priority freight corridors.

The opportunity spectrum also includes the battery manufacturing ecosystem. Northvolt is in process of establishing a Gigafactory (called Northvolt Ett) in the Northern Sweden, with a maximum capacity of 100GWh in cathode material. The facility, aimed for commissioning by 2024, will enable assembly at multiple Northvolt facilities. Importantly, Northvolt has partnered with a battery recycling entity in Norway for eventual integration with its planned battery manufacturing process. Other enterprises have similar projects in pipeline. Volvo Group is in the process of finalizing a battery manufacturing plant in Sweden's Skaraborg region. Planning works are underway for requisite regulatory approvals to establish the production site.

Outlook

The net-zero objective of 2045 would entail a much higher dent in electrification. Even a 25% share of the electrification of the passenger vehicle fleet, at the current level, means over a million electric vehicles. This is three times the current electric passenger vehicle fleet. While the new vehicle registration trend is encouraging, it will take longer to displace the fleet-size emission stock. In this context, the abrupt end of subsidies may not sustain the demand pull at the same rate it has so far. While the supply side is prepared due to the rising capacity in production lines, the demand may need more momentum.

The commercial electric vehicle segment could gain a stronger footing in the Swedish market, taking both electric buses and trucks into account. The electric bus demand is propelled by the fleet replacement demand from operators as well as municipal and local authorities. Electric trucks are meeting the rising demand for emission-free transportation in the logistics and construction sectors. One key illustration of the emerging need is Volvo's commencement of series production of heavy-duty electric trucks in Sweden.

A potential demand-supply gap is anticipated in the charging infrastructure base, where availability lags requirement by a wide margin. The European Automobile Manufacturers Association's report of 2022, projecting the leading European countries' gap in charging network capacity addition, held that Sweden was at just 11% of its required expansion of charging points by 2030. It may require a concerted policy push to improve the scenario, especially with the progress achieved in the transition toward electric vehicles.

The Netherlands

Netherlands ranks among the top electric vehicle markets in Europe and globally. The Dutch market is gradually inching closer to the government objective of selling only zero-emission vehicles by 2030. As with most of the mature markets, the policy authorities are gradually scaling back the subsidies. It may have a short-term impact on the sales. At the same time, the requirement of charging points is enormous, even with the progress achieved so far.

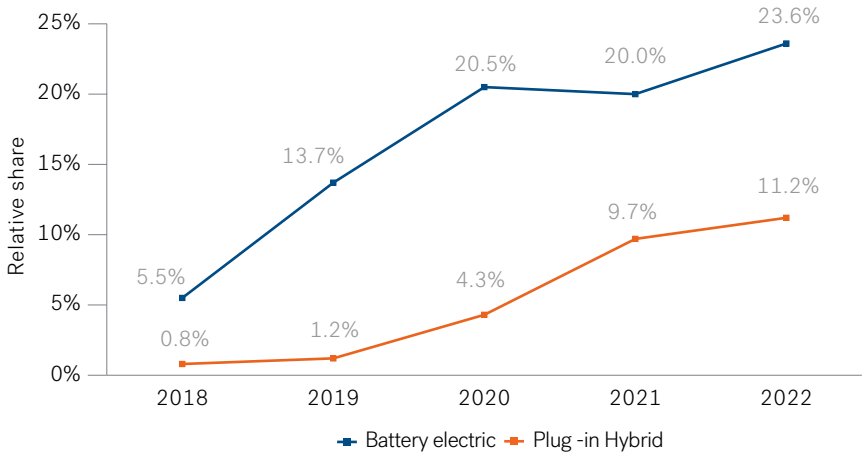
GDP (Current Prices) USD (2021)	1,013.52 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.70%
EV Penetration	34.8% of the total new passenger vehicle sales by 2022
EV Target	50% of all new passenger vehicles sold will have an electric powertrain and a plug by 2025
Planned Year of Phasing Out ICE Vehicles	2035

GDP Source: IMF, World Economic Outlook

The Netherlands

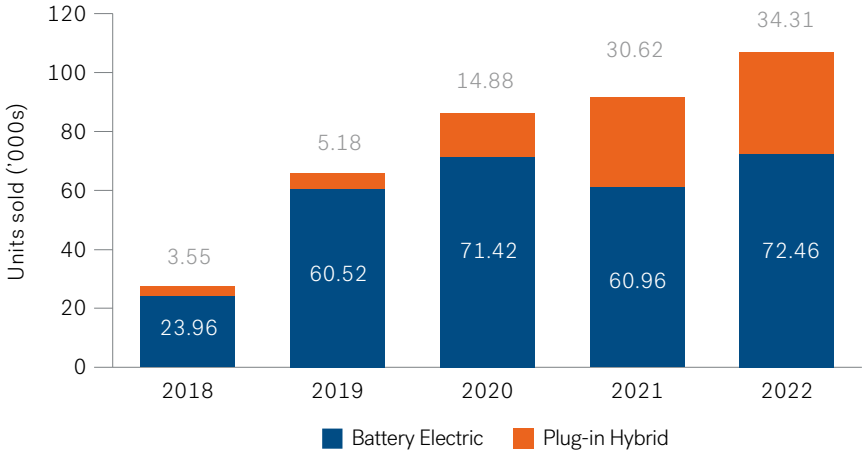
EV Penetration and Trend

Share of Electric Drivetrain in Passenger Vehicle Sales



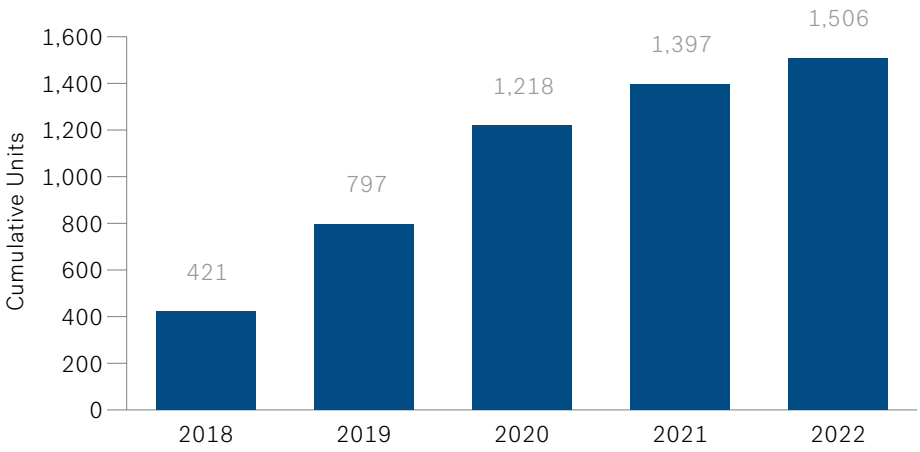
Source: Netherlands Enterprise Agency

Passenger Electric Vehicle Sales



Source: Netherlands Enterprise Agency

Registered Electric Bus Fleet



Source: Netherlands Enterprise Agency
Note: The data refers to trend in total fleet size. Each year's data point is the cumulative total, after netting for new registrations, used-vehicle imports, transfers, or exports, loss from theft, etc.

Netherlands' electric vehicle penetration, in terms of the share in new vehicle sales, is among the best worldwide. Much of the growth in this market has been subsidy-led, due to the policy focus on zero-emission transportation by 2030. But subsidy may have also been the reason for a decline in the sales of battery electric vehicles in 2021. During the year, not only was the subsidy quantum lower (than the previous year) but it was exhausted faster. The plug-in hybrid vehicles apparently gained share in that period. The Dutch definition of zero-emission vehicles also includes the fuel-cell vehicles though the share is negligible so far.

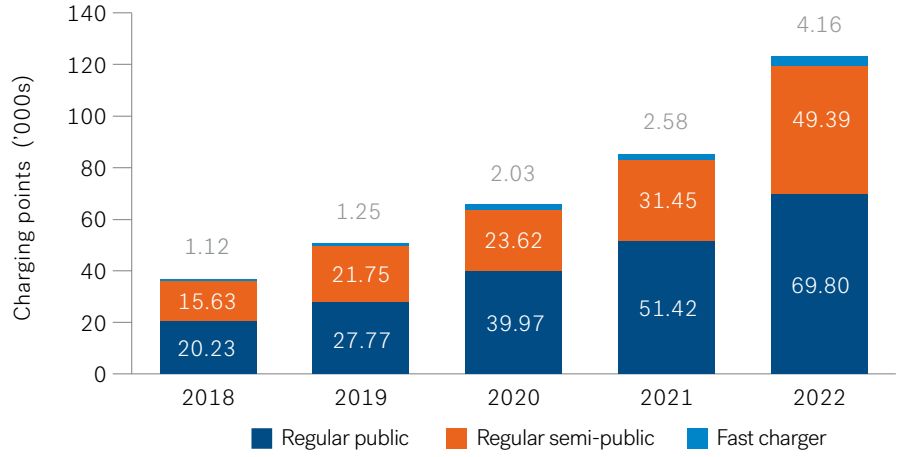
The nearly four-fold rise is sales between 2018 and 2022, while impressive, is still far from making a dent in Dutch passenger vehicle fleet. By the end of 2022, electric vehicles constituted about 6% of the fleet size. In 2018 the same was at 3%. Progressively, as the market deepens (rising product variety and a developed second-hand vehicle segment), one can expect further improvement in the fleet size. It is also pertinent that the Dutch market does not have any ban imposed on future sales of internal combustion engine (ICE) vehicles. It is thus left for the interplay of market forces to determine the contours of the progression of the electric vehicle market.

Growth has also been strong in the commercial sub-segment. By the end of 2022, the Dutch electric bus fleet contributed 16.5% in the total, registering a sharp improvement over the 4.2% in 2018. Almost all of the Dutch electric bus fleet is based on battery electric drivetrain. A stronger base of growth is expected with focused efforts underway for charging systems tailored for the commercial transportation.

Charging Infrastructure

The country's electric vehicle charging network base ranks among the top in the European Union, for its coverage. As the trend shows, the growth has been sharp. Between 2018 and 2022, the total number of publicly accessible charging points registered a compound annual growth rate of 35%. Such charging points are important in the Dutch system due to the preference for publicly accessible facilities in the transportation system. However, private charging points have grown at a faster clip. By the end of 2022, there were an estimated 345,000 private charging points – more than double the level in 2020.

Installed Base of Public Charging Points by Type



Source: Netherlands Enterprise Agency

The growth in charging network has been entirely led by the slow or regular chargers of low power ratings. The share of fast-chargers (greater than 22kW rating) is largely stagnant at around 3% in the five-year trend to 2022. So far, such a skew has not impacted significantly as adequate coverage took precedence over the efficiency. This is the reason why Netherlands might rank low in the availability of fast-charging points but fares better when it comes to the network density. As of 2022, each charging point supported about four electric vehicles (including battery and plug-in). This ratio is regarded as among the best globally.

Policy and Regulation

The objective of emission-free transportation by 2030 largely guides implementation of various policy and regulatory measures in the electric vehicle market. Subsidy-based support is among the key tools deployed to incentivize electric vehicle purchase. In addition, there are other fiscal incentives such as exemption from certain taxes. Netherlands, among other major European electric vehicle markets, had taken an early start in the subsidy-led promotion of electric vehicles.

Policy Objectives Towards Electric Vehicle Penetration

Year	Objectives
2025	50% of all new passenger vehicles sold will have an electric powertrain and a plug. At least 30% of these vehicles will be zero-emission (battery electric or fuel-cell).
2030	100% of all new passenger vehicles will be zero-emission.

Source: Netherlands Enterprise Agency

The subsidy scheme of electric passenger car for private individuals (SEPP) was introduced in 2000. It has continued since then with a progressive scaling down in quantum. The key factors of eligibility are the same. SEPP covers only fully electric vehicles for private purchase. To qualify, the vehicles' list price must range from €12,000 to €45,000 with minimum travel range of 120km. Used electric vehicles are mandated for purchases from dealerships. Most important, among all factors, is the budget allocation. The subsidy disbursement is subject to the availability of budget for that period.

Policy and Regulation

Subsidy for Purchase or Lease of Passenger Electric Vehicles

Year	Subsidy Offered		Total budgeted allocation	
	New	Used	New	Used
2023	€ 2,950	€ 2,000	€ 67 million	€ 32 million
2024	€ 2,550	€ 2,000	€ 58 million	€ 29 million

Source: Netherlands government

As of early March 2023, a quarter of the total year's subsidy budget, worth €99 million has been used up. In 2022, the subsidy budget was exhausted within the middle of that year. It could likely be the case for 2023 as well. Over the years, the budget and the subsidy quantum per vehicle has been in a downward trend. Further, a greater share of the budgetary outlay is getting spent on the used-vehicle segment of SEPP.

Additional support measures are found in terms of tax exemptions. Fully-electric passenger vehicles are exempt from the BPM (tax on passenger vehicles and motorcycles) and motor vehicle taxes. The latter is applicable at half rate for vehicles with CO2 emission ranging 1-50 per km. Further, the electric vehicle owners can access free parking facility at most of the locations. The local authorities and municipalities in this regard have variants of other such incentives for electric vehicles. At an enterprise level, added benefits include exemptions from value added taxes (VAT) and investment deduction (though for eligible EV list).

The government offers incentives to the enterprises involved in the electric vehicle charging business. The public charging points have been a major focus area in the government policies. The government policy document indicates an active engagement with the local city-level authorities and grid operators to determine locations of fast chargers and electric bus chargers. Under Environmental Investment Deduction (MIA) and Random Depreciation of Environmental Investments (VAMIL), enterprises are eligible for investment reduction of up to 45% and 75% respectively, for the cost of charging point. The budget for MIA and VAMIL during 2023 is €192 million and €25 million respectively. At an individual consumer level, a request can be placed with the local municipal authorities for a free (implies no cost for purchase or installation) public charging point.

The government's 'right to charge' norm entitles electric vehicle owners to raise demand for network with the respective municipal authorities. Municipalities are required to set up charging points within 250m of the vehicle owners' residence. Typically, upon receiving a request, the charging points operators validate the demand and identify the charging location based on a variety of factors, such as available capacity, accessibility, visibility, and local impacts. The actual implementation takes place in collaboration with the power distribution system operators.

Market Opportunity

Public charging has a significant position in the scheme of things planned to enhance network access. For most of the projects, public-private partnership is the key avenue adopted by policy authorities. The municipalities have increased their collaboration for a rapid charging infrastructure rollout. The National Charging Infrastructure Agenda is thus structured as one involving multiple stakeholders for a mix of local and macro-level issues.

Smart charging is among the priority areas identified in the ongoing network expansion efforts. Grid operators' concerns about network stability and management add heft to the argument for smart charging systems. With policy emphasis, the investments appear to be picking up in this sub-segment. For instance, the planned 10,000 charging stations by the airport operator, Royal Schiphol Group, includes the smart charging and related technology systems to be implemented by the suppliers and developers Ecotap and FIMIH. Pilot projects for smart charging technologies could help reinforce the business case. A test case of smart charging was undertaken from December 2021 to October 2022 across 126 charging points spread in ten Amsterdam districts. The test results revealed that with a smart charging system in place, three to four times more charging points could be installed within the existing power network boundary.

There are several variants being considered for smart charging rollout based on local requirements. In July 2022, for instance, the municipality of Renkum received the first of 12 'CityCharge' smart street lighting systems that double-up as smart electric vehicle charging points. The project was under the auspices of Smart City Netherlands – a collaboration between Primevest Capital Partners and BNG Bank. Smart City Netherlands' projects on street lighting-cum-charging was subsequently extended to other cities and municipalities. In November 2022, one such set was installed in Eindhoven, with a plan to set up at least 23 units for trial phase. Importantly, in December 2022, the Smart City Netherlands project consortium entities (Dutch Charge,

Heijmans Emobility and Primevest Capital Partners) won the tender for deploying 150 smart charge and street lighting systems at the city of Arnhem.

The emerging demand for fast-charging network aimed at heavy-duty commercial transportation is finding interest from market players seeking an early-mover position. WattHub fast-charging plaza is one of the first projects of its kind initiated in the Netherlands, aimed at catering to the electric trucks and other electrically powered heavy equipment. Its planned 39 charging stations, at rated capacity of 600kW, will be powered by renewable energy. The project is under development, in partnership by Van Oord, Dura Vermeer, Ploegam and Betuwewind, and is scheduled for commissioning by April 2023. Notably, the surplus energy of the proposed hub could be utilized by the adjoining enterprises.

There are alternate charging modes under testing for deployment in electric trucking. In this regard, the manufacturers have been asked to develop the standards for all steps involved in the charging process by the end of 2023. The next step will entail tenders for a phased development and expansion.

Outlook

The goal of having only zero-emission (electric vehicle and fuel-cell) passenger vehicle fleet by 2030 would imply a fleet of about 2 million electric vehicles by then. It also means a quadrupling of existing fleet size. Adding to this will be the growth in commercial electric vehicles, especially the electric bus fleet. While the rising sales penetration is encouraging for progress, the related requirements of charging network are onerous. Despite being among the top European countries for the charging network reach, Netherlands would need to do more to accelerate the capacity addition.

The role of grid infrastructure too will come under the focus with electrification of the transport network. This will necessarily need to be dovetailed with the grid operator's ongoing focus at managing the energy transition in power mix and its resulting impact on grid despatch as well as reliability. Among other things, this will also entail exploring options in areas such as flexible generation and microgrids among others. The grid operator TenneT plans €6.6 billion in investment by 2025 towards power network strengthening and expansion for emerging requirements.

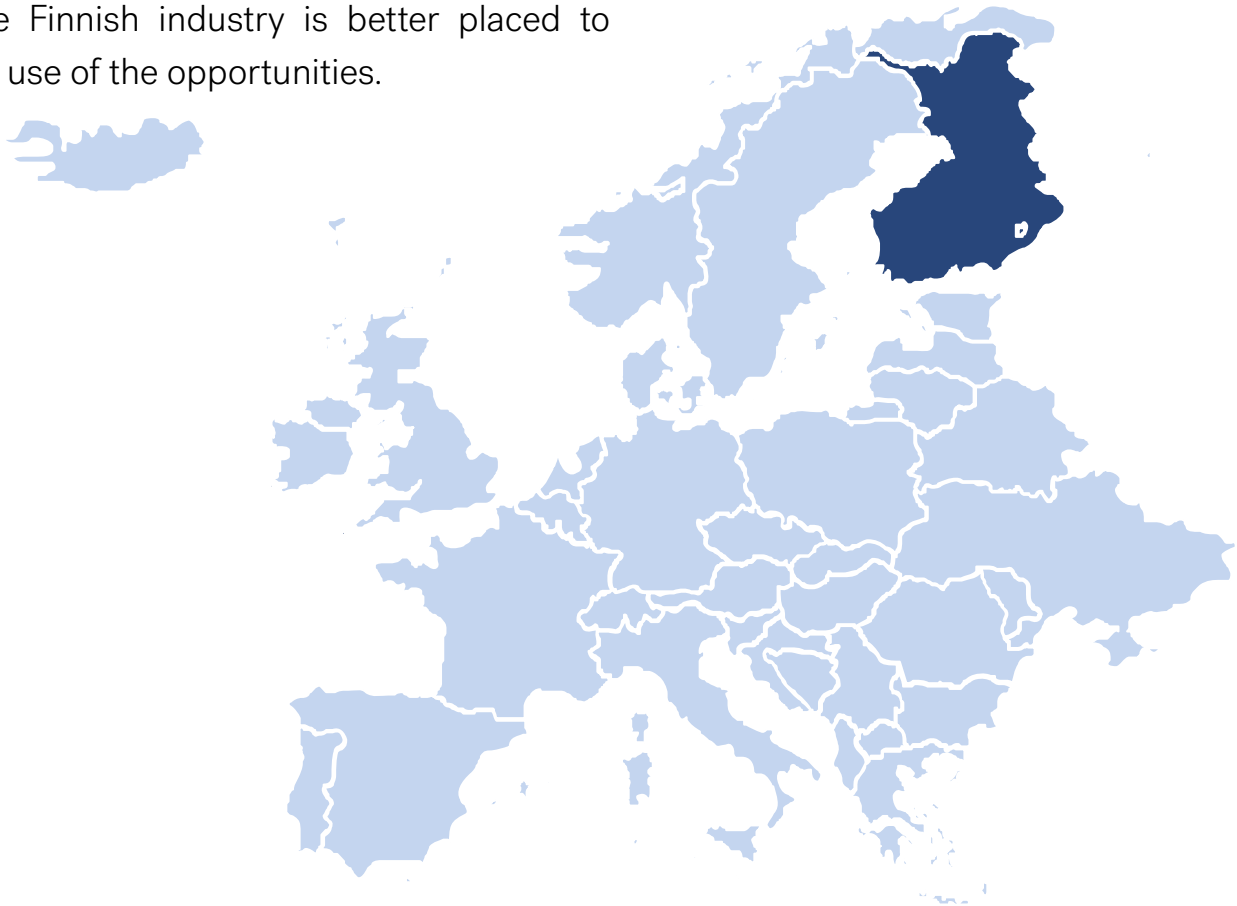
The subsidy-led model of growth sustained the Dutch market for long. With each successive year, the available subsidy support and the budgetary allocation is on a decline. The demand meanwhile is very high, as evident from the rapid exhaustion of the annual subsidy allocation. It is thus an open question as to how the trend will shape once the subsidy package is completely phased out to allow for market forces. The rise in energy costs and the overall inflationary environment are other factors that could impact the market demand, if at all for short-term.

Finland

The Finnish electric vehicle market is an attractive one for the rapid growth in penetration in the last five years. Electrification is key to the policy objective of decarbonizing the transportation sector by 2030. However, much more is needed to support and sustain the growth in electric vehicle sales. The charging network, while expansive, lacks the breadth and quality for the upcoming demand. There are concerns that it could be a bottleneck unless addressed soon. On the other side is the emerging landscape in battery and critical component production, where Finnish industry is better placed to make use of the opportunities.

GDP (Current Prices) USD (2021)	297.58 bn
GDP Growth Forecast (constant prices) (2021-2025)	1.61%
EV Penetration	38% of total new passenger vehicle registrations by 2022
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2035

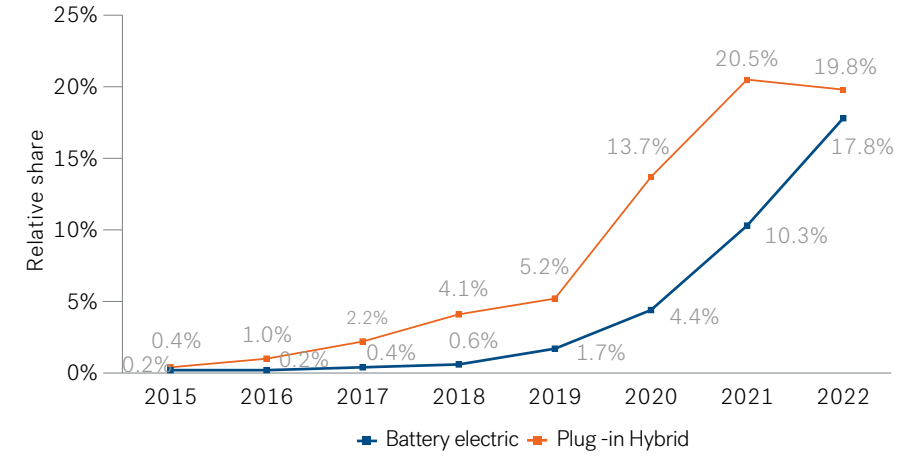
GDP Source: IMF, World Economic Outlook



Finland

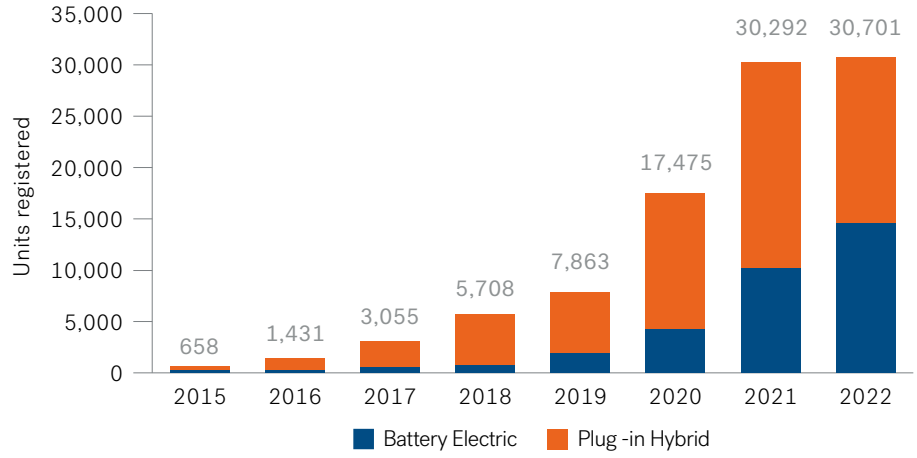
EV Penetration and Trend

Share of Passenger Electric Vehicles in New Registrations



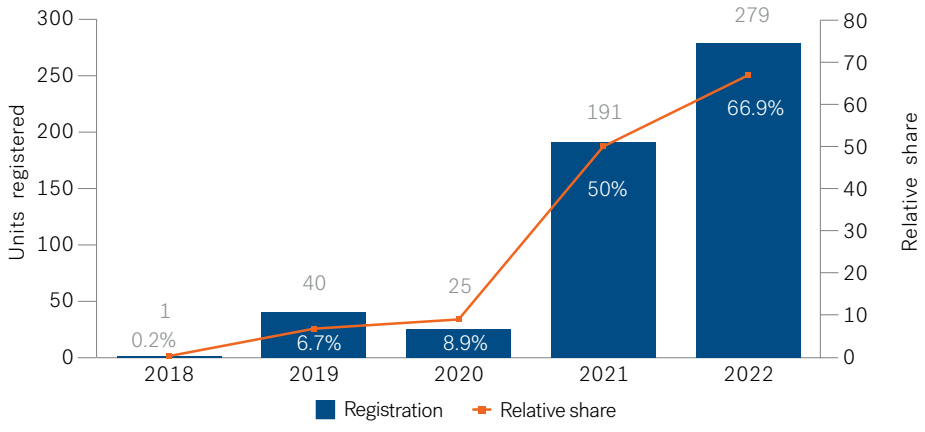
Source: Finnish Information Centre of Automobile Sector

New Registration in Passenger Electric Vehicles



Source: Finnish Information Centre of Automotive Sector

New Registration of Electric Buses



Source: Finnish Information Centre of Automobile Sector

Finland's battery electric and plug-in hybrid electric vehicles together held about 38% share of total new vehicle registrations by end of 2022. Electric vehicle segment was the only one in the country's automotive industry that reported a growth during the year. The spike in conventional fuels during 2021 and 2022 added fillip to the demand – during 2022 dealerships reported huge backlogs for the electric vehicles while those based on internal combustion engines (ICE) had stagnant sales. Supply chain issues and production delays added to the challenges. The second-hand electric vehicles (largely German imports) rose in demand as a result, often with a higher price than the new one.

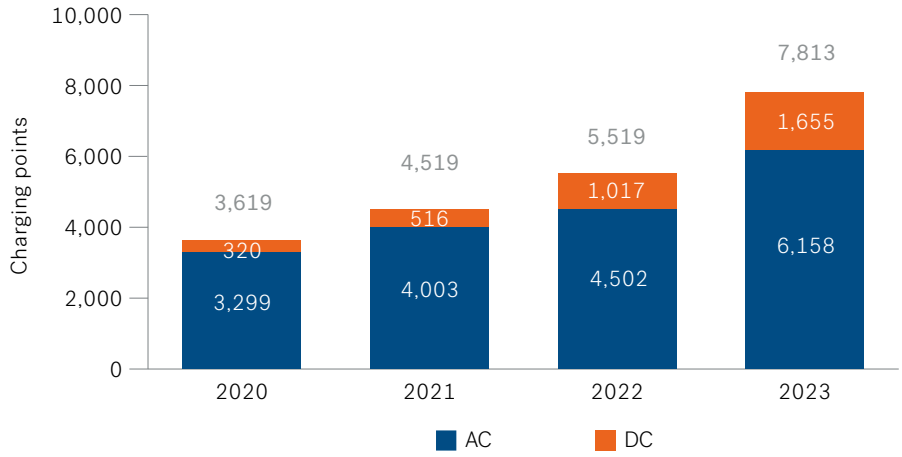
A rising share of new electric vehicle registration is based on the battery electric ones. In 2022, of the total 30,701 electric vehicles registered, battery electric accounted for 47%, compared to 14% in 2018. The rather stagnant performance in the new electric vehicle registrations of 2022 was due to plug-in hybrids (declined 20% year-on-year). The battery-based vehicles grew 43% in the same year. The trend is similar to overall European electric vehicle sales where plug-in hybrid sales have been progressively displaced by the fully electric drivetrains. Manufacturers play the part in this with the rise in product variety and price points for the battery based offerings.

In case of the electric bus segment, there is a faster pick-up in the new registrations due to the push from the municipal and local authorities' procurement. Due to emission reduction targets, there is a rush to replace and convert the fleets. In line with the rest of the major European countries, over two-thirds of new bus registrations going to the batteries. The contribution to the total fleet size remains insignificant though at just 2.6% (as of 2021). It still represents a marked progress from the 0.2% share in 2018.

Charging Infrastructure

With public funding, Finland's charging infrastructure has lately registered a decent growth. The total network capacity grew 23% between 2020 and 2022. A higher growth is expected by end of the 2023, based on the progress achieved so far. It also helps that the rising electric vehicle penetration creates its own demand-pull for charging points, met increasingly by enterprises across sectors to capitalize on the opportunity. Also, considering the low capacity base (in absolute terms), the share of DC-based fast-charging points is significant at around 20%. The equitable spread of the charging network is the factor to contend with – the existing base is concentrated in few major cities, especially in Helsinki.

Installed Base of Charging Points



Source: European Alternative Fuels Observatory
Note: Data for 2023 is as of February 2023

Policy and Regulation

The policy objective is to put in place the requisite systems to enable a phased decarbonization in the transportation sector by 2030. Alternate fuels are part of the instruments in such objective, beyond electric vehicles. The focus however has been on the electric vehicles due to the options available, in terms of enhanced supply and standardized technology platforms. For most part, subsidies have been used to promote the adoption of electric vehicles.

In December 2022, a government order enabled the extension of its ongoing subsidy regime for 2023. This covers subsidized purchase of passenger electric vehicles and conversion subsidies of the existing passenger transport. Also included are the purchases of electric trucks and vans.

A €2,000 subsidy is available for purchasing a passenger electric vehicle with maximum list price of €50,000. Only private purchases are allowed for such subsidies. For electric vans, the subsidy amounts range from €2,000 to €6,000 depending on vehicle size and includes both individuals and companies. In case of electric trucks, the subsidy range is €6,000 – €50,000 depending on the vehicle size, and can be utilized by both individuals and companies. The present legislation, authorizing the subsidies, is valid till December 2024.

In addition to subsidies, electric vehicles also attract favourable taxation position in both private and commercial application. Since April 2022, new electric vehicles up to six months old, were exempted from the tax incidence. The exemption was also allowed for the imported electric vehicles. One result of such exemption was the spike in demand for barely used (ranging 1-3 months) imported electric vehicles from Germany. For battery electric vehicles put to business use, there is a €170 monthly tax deduction during 2021-2025. Also, the provision of workplace charging facility is incentivized through tax deduction.

Market Opportunity

Leading Chinese manufacturers such as BYD, Yutong and Golden Dragon fulfill the rising procurement of electric buses in Finland, along with others in the region. BYD emerged as a major player of late. In 2021 the company contributed to the largest order from bus operator Nobina's Finnish fleet. Other market players are finding similar traction as cities step up procurement. YES-EU's delivery of 26 electric buses in 2022 for the city of Tampere is one more of the several examples of leading manufacturers securing orders from local authorities and transport operators. The momentum could rise with nearing of the European Union deadline for emissions.

Major expansion plans for charging stations are underway at the city of Helsinki. There are already 50 new charging stations to be deployed in 2023, based on previous year's tender. Typically, the winning bid for charging station tenders entails securing lease for street space, for the development of network capacity. While public charging capacity continues to be emphasized, other Finnish enterprises are tapping into the demand for destination charging points, such as in commercial locations of retail, hotels, etc. The retail group Kesko for instance, has been augmenting its charging network, under the brand K-charging. As of mid-2022, the group had charging points across 107 locations in Finland and is in the process of doubling the capacity. Separately, Finland's Motorists Association has undertaken a project to set up charging station in various municipalities, as part of its efforts to support the rising stock of electric vehicles. The plan is to set up about 100 charging stations of 80-100kW power rating.

Battery manufacturing is the most significant investment opportunity in Finland, with the capabilities and resources at disposal. Progressively, a cluster of such capacities are expected in the country, as more enterprises make the foray. The country's battery strategy formulated by policy authorities seeks to utilize the advantages in sourcing and processing of raw materials and the production or related activities associated with battery materials and their recycling. In February 2023, the Finnish Minerals Group and FREYR Battery signed a joint development agreement for an LFP cathode material plant in the city of Vaasa. This is the largest such investment commitment in Finnish industrial manufacturing.

Other enterprises are taking initiatives in the battery ecosystem through new technologies. One such recent example is the sand battery. As of mid-2022, two Finnish companies Polar Light Energy and Vatajankoski deployed the world's first operational sand battery, as an alternate option for renewable energy storage. The battery, storing heat within a sand tank, was installed at the energy company's Vatajankoski's power project. Though not exactly placed as a replacement option to the Lithium-Ion battery systems, sand batteries could offer alternate options for the heating and energy storage applications in residential and process-based industries. The battery processing and recycling segment is meanwhile gathering focus with most of the upcoming factories required to install such systems, as part of regulatory processes. Fortum's battery material recycling plant in Harjavalta, Finland is one of the notable ventures in this context. The facility is aimed at catering to Finnish and Europe-wide battery manufacturing units through restoration of the critical materials involved.

Outlook

Progressively, the automotive industry could expect tighter emission norms as part of the steps to transition to the zero-emission transportation sector. Electrification will accordingly rise manifold to meet such goals. The Finnish Information Center for Automobile's projection (as of 2022) is of 740,000 in total passenger electric vehicle stock by 2030. Charging infrastructure availability will be a critical rider for reaching projected electrification estimates.

The policy focus on zero-emission transportation will also entail alternative fuels, besides the battery electric passenger vehicles. The ongoing subsidy support mechanism, in this context, could be heading the same way as most of the other mature electric vehicle markets. A scaling down of the incentives could depress the sales momentum, even as manufacturers augment their supplies for the demand. Furthermore, a general inflationary pressure could restrict the options for suppliers in pricing their offerings.

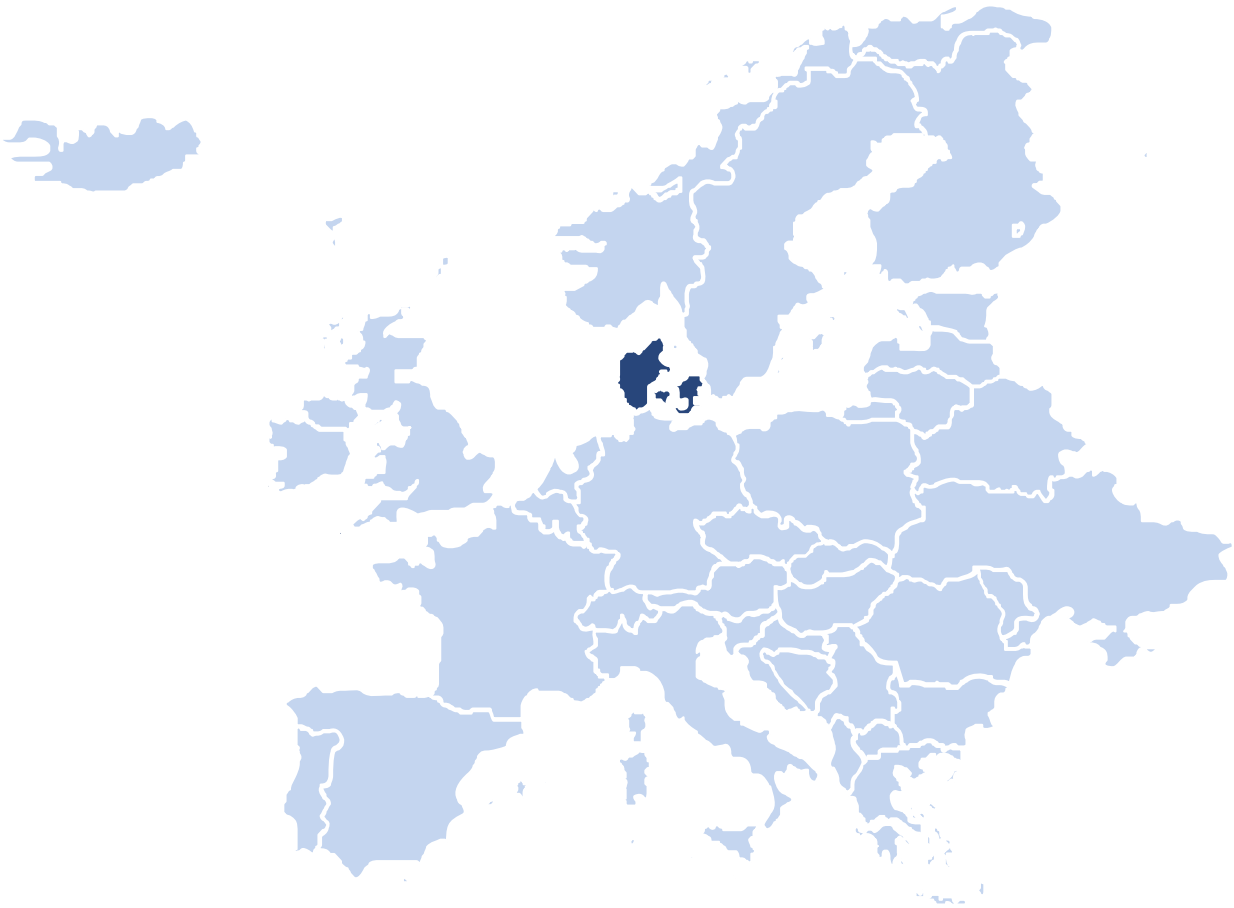
A brighter outlook is in the upcoming battery ecosystem where Finland is better placed in terms of its endowed resources. But attracting the global capital may not be an assured case for the country. After the recent investment promotion packages announced by US and Canada, there is a competitive rush to secure the best deal. Finland's position in this environment will be weighed-in by the investors.

Denmark

Denmark has been relatively behind the curve in the larger European region's trend of electric vehicle adoption. This might change for the better, as the automotive sales of 2022 indicate. The purchase preferences are rapidly shifting in favour of electric vehicles, with plug-in hybrids filling a residual role. The policy push in electric bus procurement helps add to the demand momentum. The rapid rise in demand could potentially get hamstrung for inadequate charging infrastructure without timely capacity addition. The market opportunity thus remains high.

GDP (Current Prices) USD (2021)	398.30 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.35%
EV Penetration	37% (battery electric) of the total new passenger vehicle sales as of December 2022
EV Target	775,000 electric and hybrid EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2035

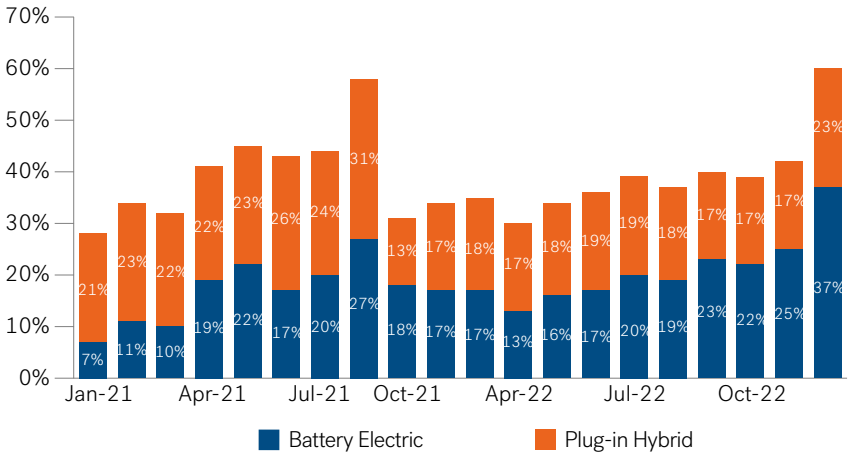
GDP Source: IMF, World Economic Outlook



Denmark

EV Penetration and Trend

Trend in Share of Passenger Electric Vehicle Sales



Source: Association of Danish Car Importers

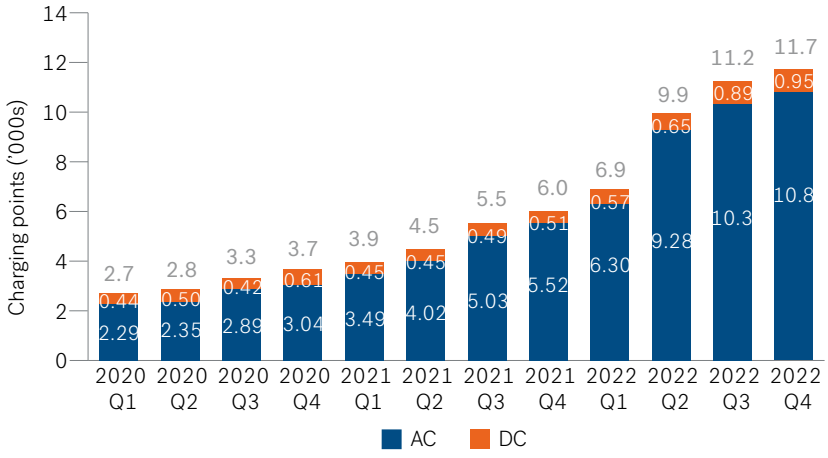
Danish electric vehicle market closed the year 2022 with a record sale, just as was the case in previous year. Within mid-October 2022 the country's electric vehicle sales touched the 100,000-unit mark. It is thus expected to gradually reach the tipping point similar to the direction seen in other leading markets as Norway and Finland. The strength of demand is also supported by the fact that the electric vehicle sales growth contrasted the sluggish growth in overall passenger vehicle market.

The pattern indicates a steady shift in favour of battery electric passenger vehicles, reversing the trend of plug-in hybrids holding the dominant share. The demand has been rising at a fast clip, reflecting in part by major automakers such as Tesla (ranking among the highest) expanding their sales outlets in the country. Imports from neighboring countries added fillip to the Danish market sales of passenger electric vehicles. An arbitrage opportunity, arising from subsidy-supported cheaper vehicles (Germany in particular), were resold at Denmark. The latter's higher import duties made the vehicles dearer. The gap may close progressively with German subsidies expected to taper off in 2023.

Electric buses show similar levels of growth in penetration in the existing transport fleet. For the period ending October of 2022, about three-quarters of the new bus registrations were electric. The progress achieved thus has put the country among the leading ones in the region for its electric bus adoption. At least six cities of the country are set for complete fleet replacement over the next 6-7 years.

Charging Infrastructure

Trend in Charging Infrastructure



Source: European Alternative Fuels Observatory

There is discernible growth in the charging infrastructure since late 2021. Notably, the Danish municipalities are investing considerable amounts towards developing the charging infrastructure to meet climate friendly objectives in their respective jurisdictions. Private sector plays an important role in this regard, as has been reflected in some of the recent measures. The charging operator Clever in this regard presently has a key role, being the entity with the largest operational network.

The country's charging network reach though is still far from optimum levels as the rapid electric vehicle ownership rapidly outstrips available public charging points. In

July 2022, the motorist federation FDM ranked Denmark as Europe's worst for its density of charging points. The municipality of Frederiksberg's density of 3.5 per 1,000 residents is the highest in the country. Copenhagen is at 2.6 while the national average is at 0.8. Beyond public charging network there are the exclusive charging points from automakers. Tesla is the most prominent due to the share of total sales. In Denmark, Tesla has 16 Supercharger (branded to refer fast-charging), marking a sharp rise from the nine in 2019.

Policy and Regulation

Denmark's stated goal of transport electrification entails getting 1 million electric and plug-hybrids by 2030. This target received Parliamentary approval for funding in 2020. The available support in this direction is based on fiscal measures for the zero-emission vehicles. Unlike its European counterparts though, the regulatory framework does not offer purchase incentives to subsidise the upfront cost.

For zero-emission vehicles, the support measures include – payment of just 40% of registration tax, additional DKK167,500 worth of deduction in the registration tax incidence, and DKK1,300 worth of deduction in taxable value. A somewhat graded offering is made available for other vehicles that do not exactly qualify as zero-emission. For those vehicles with emissions at less than 50 gm CO2/km, the support available includes – 50% of the full registration tax, additional DKK48,570 of registration tax deduction, and DKK1,300 deduction of taxable value.

An additional tax benefit was introduced for the period 2023-2026. For the company-owned zero-emission vehicles, a deduction worth DKK15,000 on tax-basis was to be made available. This would be in addition to the DKK30,000 supplement for tax base of the low-emission vehicles such as plug-ins.

Similar few support measures are available for electric vehicle charging. This includes favourable tariff for commercial charging stations, exemption from parking fees for the electric vehicles, etc. However, such measures vary across the local authorities and municipalities for the specific objectives they have with related budgetary outlays.

Market Opportunity

There is a rising pressure on authorities to scale up the charging capacity. An indication of upcoming opportunities in this regard is found in the tenders for capacity development. In November 2022, the Dutch charging operator PowerGo and Danish charging platform Spirii won three tenders for installing 178 AC charging stations across municipalities of Vejle, Vejen and Gladsaxe. The operation will be led by PowerGo, while Spirii will provide the platform and software application.

The leading Danish charging operator Clever is in the process of a significant network expansion. As of September 2022, it engaged Compleo Charging Solutions AG with a major order, meant to fulfill part of Clever's goal of 9,000 new public charging stations by 2025. The planned charging stations of the order are likely to involve pair of 22kW points, following a pattern of similar previous deployments. It is also expected that the charging services' segment could progressively face a rise in competition and added differentiation in services by operators.

In April 2022, the Danish energy company EWII signed a long-term agreement with the Copenhagen Airport for supply and installation of 1,350 charging stations over a period of 10 years, aiming about 10% of the airport's vehicle parking capacity. The planned capacity includes 1,320 charging stations at 22kW, while the rest are to be 180kW DC-based ones, and are to be built in cooperation with entities ZAPP Mobility, ABB and Monta.

Dedicated charging facilities for the bus fleets is another important segment. Vattenfall has delivered 32 fast-chargers to the Danish bus company Tide for the latter's operations in the city of Vejle. In the arrangement finalized, Vattenfall is responsible for both charging solution and the power supply or its procurement. The power supply is currently charged based on spot prices and the charging stations involve Direct Current (DC) fast-charging systems with smart controls. A similar niche sub-segment is of the heavy commercial vehicles as trucks. By end of 2023, the Hirthals Transport Center could have one of the first charging stations (three 400kW chargers) meant specifically for the electric trucks.

Within heavy commercial vehicles' sub-segment, the policy push for electric buses acts as a propeller for demand. The Danish capital city of Copenhagen aims to completely electrify its bus transportation by 2025, being left with just five of the bus routes in this regard (as of February 2023). With such a decision, the bus operator is likely to be compensated for ending diesel-based bus operation ahead of contracts (ending between 2026-2029). Other major cities, notably Aarhus, Odense, Aalborg, Vejle and Frederiksberg, among others are in the similar transitory phase, allowing their existing diesel buses to complete the contracted period.

Rise in electric bus procurement from various local and municipal authorities led major OEMs to make inroads in the Danish market. A discernible development has been the market leadership of Chinese automakers. Yutong is one such company that leads the pack, followed by Golden Dragon and BYD among others. In the process, these market players displaced the position of established legacy OEMs including Mercedes, Scania and Solaris. While the same may not continue, the short-term horizon is clearly in favour of the Chinese manufacturers for the market share cornered in new orders.

Outlook

By the end of 2020, the Danish Parliament had voted in favour of a government objective of putting at least 775,000 electric vehicles by 2030 in the country. The uptick in the electric vehicle sales since early 201 indicates a steady progress towards such a target. The growth in the segment will however be contingent on the factors including product range, competitive price points and the accessibility of the charging facilities.

The requirement for public charging facilities is a critical one. Estimates from Technical University of Denmark (DTU) indicate a requirement of 26,766 public charging points by 2026, and 67,000 by 2030 to support the policy objectives set for electric vehicles. DTU's same estimates also carry the rider that even the latest estimates could need recalibration periodically for the dynamic nature of the electric vehicle market.

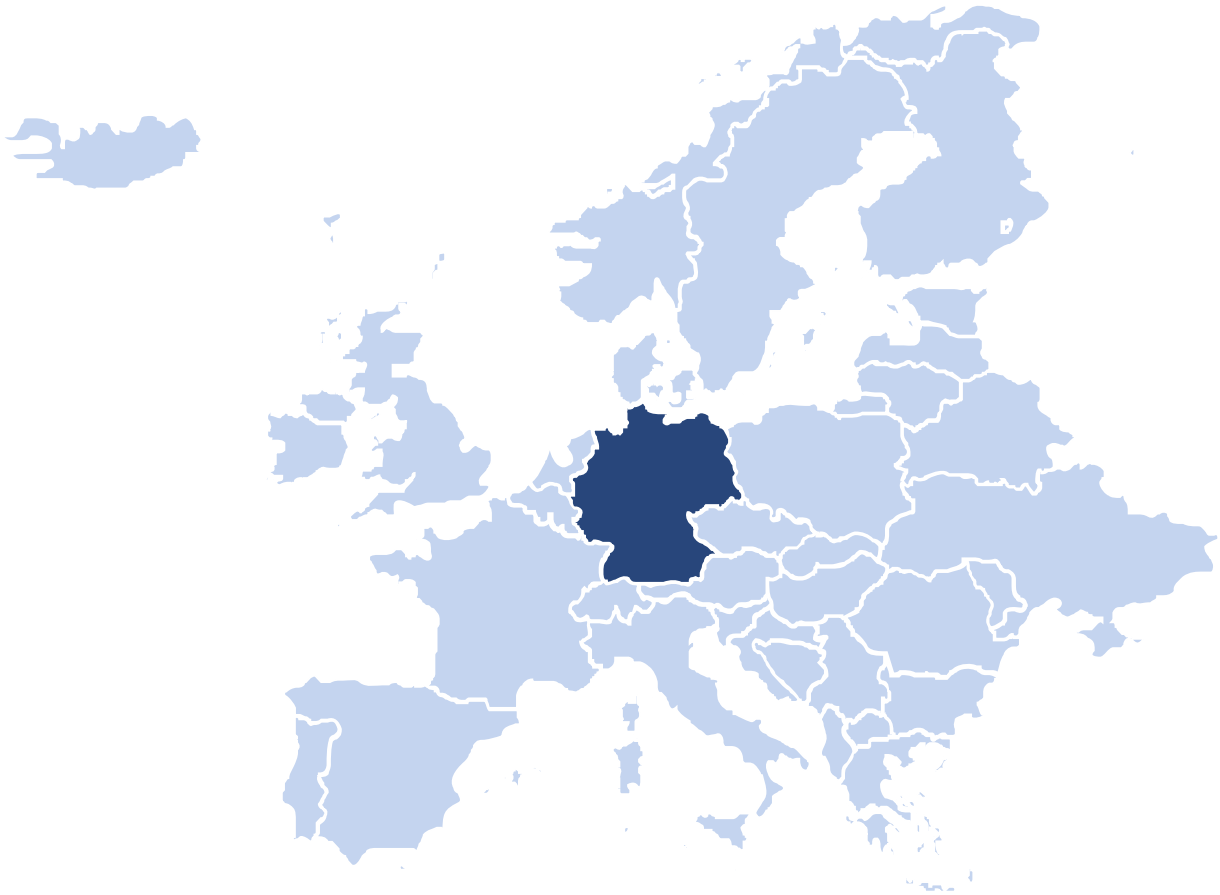
The European Commission's hard stance on emissions of heavy vehicles could help align the incentives for zero-emissions and especially electric drivetrain in heavy-duty commercial vehicles including trucks and buses. The rapid shift in electric buses combined with the relatively higher fuel costs across Europe can further add momentum for transition. It is expected that the European Commission's target for electric buses could be 2030. Of all things, this could make for a stiffer competition between Chinese and the European manufacturers.

Germany

The German automotive market, being Europe's largest, holds significance for the transition towards electric drivetrain. The trend in vehicle registrations points to electrification taking root. Sustaining this growth to achieve the targeted level might become the next central area of focus. The steady demand and sale of electric vehicles could overwhelm the charging network unless timely measures are taken for expansion. Also in focus is the market's dependence on subsidies, which is being tested with the government rolling back the incentives.

GDP (Current Prices) USD (2021)	4,262.77 bn
GDP Growth Forecast (constant prices) (2021-2025)	1.51%
EV Penetration	31% of total new passenger vehicle registrations by 2022
EV Target	15 million electric vehicles in the transportation system by 2030
Planned Year of Phasing Out ICE Vehicles	2035

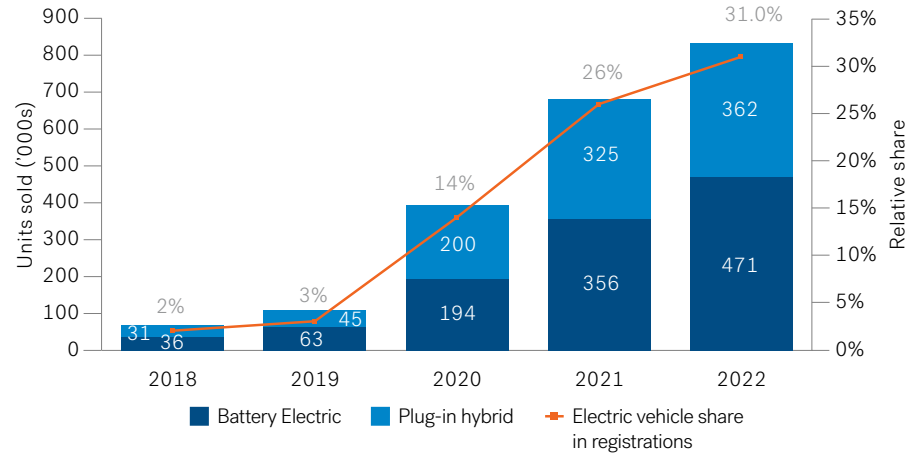
GDP Source: IMF, World Economic Outlook



Germany

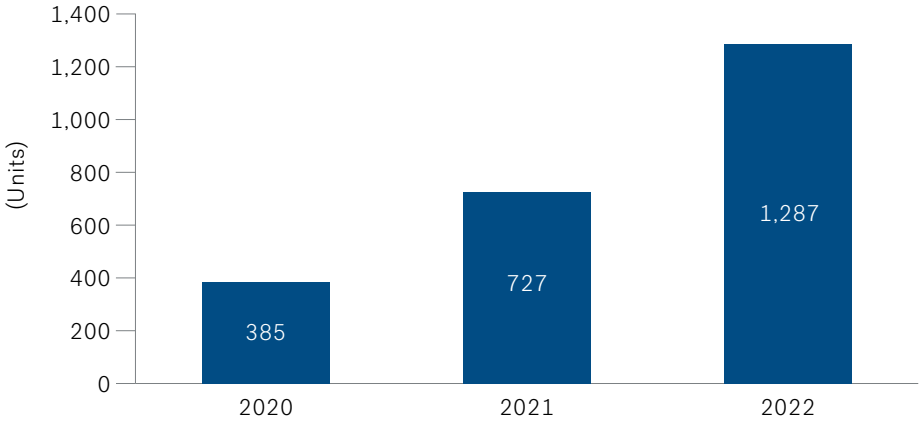
EV Penetration and Trend

Electric Vehicle Registrations and Penetration



Source: Federal Motor Transport Authority (KBA)

Electric Bus Registrations



Source: Statista (attributed to KBA)

According to Germany's Federal Motor Transport Authority (KBA), the share of electric vehicles, comprising both battery-electric and plug-in hybrid electric vehicles, reached closer to one-third of the total new vehicle registrations in 2022. The steady growth in electric vehicle registrations was in the backdrop of a declining trend in overall vehicle registrations -from 3.6 million units in 2019 to 2.7 by the end of 2022. The receding share of Internal Combustion Engine (ICE) is thus evident in the German market.

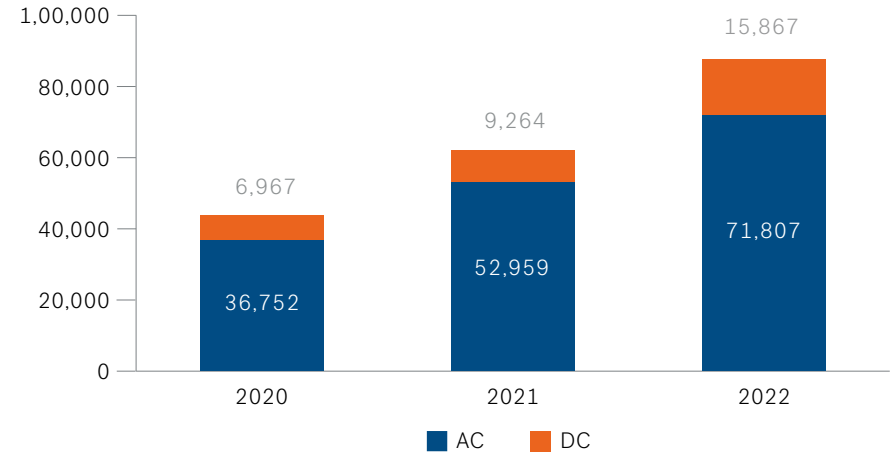
The rising trend in penetration of electric vehicles is also marked by growth in battery-electric vehicles. By 2022, battery-electric vehicles held an 18% share in total registrations, contrasting the negligible 0.7% in 2017. By the end of 2022, plug-in vehicle registrations grew 11% year-on-year, while the same for battery-electric vehicles was 32%. In 2021, the growth rates were even higher.

As subsidies are tapered off, the growth momentum will likely moderate further. As of January 2023, registrations were significantly lower than those of the previous year, indicating a short-term impact of the subsidy rationalization. Meanwhile, the supply side stays robust, with several leading automotive OEMs announcing a complete shift to electric vehicle production.

The commercial segment of electric transport remains equally strong. Germany is among the leading countries in the European Union in terms of growth in electric buses. Traction in this market is led primarily by federal funding for procuring zero-emission vehicles (electric and fuel cell).

Charging Infrastructure

Trend in Number of Charging Points



Source: European Alternative Fuels Observatory

Germany ranks among the region's top countries for the charging infrastructure put in place. At 1.27 charging bays per square km, Berlin stood sixth in the top ten European capital cities (as of July 2022) for the charging network's density. Other high network-density German provinces include Bayern, Nordrhein-Westfalen, and Baden-Württemberg. Besides the metropolitan areas, the cities adjoining or housing the automotive manufacturing majors have benefitted from the expansion in the charger base.

A multitude of players, including independent charging operators, electrical OEMs, and auto manufacturers, among others, leads the expansion of the network. The scope remains enormous. At a policy level, the ratio of charging points to electric vehicles is aimed at 1:15 to be able to make a dent in electrification in overall mobility. The European Union's recommended ratio is 1:10. Germany, in this regard, has a lot of catching up in network expansion.

The fast-charging segment is of significant focus for both policy authorities and businesses. About 2,000 charging operators run the network (as of end-2021), which could change as tenders are issued for expansion. Particularly important is the expansion of charging facilities for commercial use. For instance, an ongoing government-funded project involves a corridor of a fast-charging network for battery-electric long-distance trucks.

Policy and Regulation

The stated policy target is to ensure at least 15 million electric vehicles in the country's transportation system by 2030. Most of this (tentatively about 10 million) is supposed to be based on battery-electric. Further, the overarching policy goal is the European Union's planned ban on the sale of new ICE-based vehicles by 2035. So far, subsidy support and related incentives have helped boost electric vehicle adoption. Lately, though, the subsidy regime has faced a rationalization. From 2023, the government reduced the allocated subsidy payout for electric vehicles.

For vehicles with a list price below €40,000, the incentive is capped at €6,750 (purchase subsidy payout of €4,500 and €2,250 from the manufacturer), while none is available for the plug-in hybrids. For the vehicles with a list price of up to €65,000, the corresponding incentive is worth €4,500 (subsidy payout of €3,000 and the rest from the manufacturer). Notably, from September 2023, the incentives will be restricted to private buyers. Further reduction in subsidy support is planned from next year.

Charging infrastructure attracts significant policy attention. The government thus has various incentives and programmes to ensure a timely rollout of the charging infrastructure. While national-level measures are being taken to enable private participation, the local or municipal-level incentives make the difference. Some notable cities/municipalities taking the lead in the available incentives include Nordrhein-Westfalen, Munich, Hannover, and Limburg.

There are some incentives available for the residential charging sub-segment. A €900 grant is available for the purchase and installation of a home charging setup. Federal Ministry for Digital and Transport (BMDV) has a €500 million budgeted outlay to fund individual project applications meant for public charging infrastructure. The funding, covering up to 60% of the project cost, will aid the construction of new public charging points and the related aspects of securing grid connection. The funding scheme will run till 2025.

Market Opportunity

The fast-charging network is increasingly gaining traction with greater policy attention and funding. In February 2023, the European Commission officially released its approval for the German €1.8 billion bidding scheme for the nationwide rollout of a fast-charging network. The planned tender, led by Federal Ministry for Digital and Transport (BMDV), is for constructing and operating charging stations in 23 regional lots across 900 pre-defined locations. Each bidder could be potentially awarded contracts as a charging point operator for construction and operation across a maximum of three regional lots. At least eight operators will be awarded contracts under this scheme to ensure competition.

Private sector investments are meanwhile in progress to tap into the demand. BP Pulse's (part of the hydrocarbon major BP group) projects are notable in this regard. Through its German retail brand Aral, BP Pulse is building fast-charging corridors for electric trucks along the major logistical routes. In January 2023, the first such corridor, involving six ultra-fast (300kW) charging points, was launched along a 600km length of the Rhine-Alpine freight route. The charging corridor is expected to be the first in a series of charging points to cater to the nascent but rapidly emerging sub-segment of battery-electric medium and heavy commercial vehicles.

Earlier, another hydrocarbon major, Shell, announced investment toward expanding the fast-charging network. In mid-2022, the equipment manufacturer ABB and Shell announced the launch of a nationwide network of the Terra 360 brand of fast-chargers, also held by the company as the world's fastest in its segment. Such chargers have a maximum rated capacity of 360kW. Notably, the planned fast-charging network will be fully supported with renewable energy-based electricity.

In December 2022, another company, ADS-TEC Energy, announced the launch of ChargePost – a compact battery-based charging system enabling fast-charging without depending on the utility's grid supply. Each such station is equipped with two charging points of up to 300kW DC-based power and offers an alternative solution for locating charging points where a conventional grid-based connection could be expensive or time-consuming.

The wireless or induction-based charging system is finding traction, partly with policy support. With €3.2 million in public funding, the company Electreon, in collaboration with the infrastructure provider EnBW, is setting up a pilot project in the city of Balingen. It will test the feasibility of dynamically charging an electric bus over a kilometer-long stretch equipped with two static charging stations. Notably, this project follows a successful pilot based on the same technology in Karlsruhe.

Localized battery availability, among other components, is a critical prerequisite for automotive suppliers to address the upcoming electric vehicle transition effectively. The German manufacturing space is thus gradually gearing up, with some significant investment commitments underway from battery manufacturers, automakers, and others. CATL's 8GWh Lithium-Ion plant is the recent one to have been commissioned. Others, such as Tesla, have been in the fray though the global competition for such investments, especially from the US, makes it slightly uncertain for the time being.

Key German Battery Manufacturing Investments

Company	Capacity	Investment Highlights
CATL	8GWh (first phase) 14GWh (next/final phase)	The Lithium-Ion battery production started in December 2022. Total investment estimated at €1.8 billion.
Volkswagen-Northvolt	16GWh (first [phase)	Part of €30 billion investment commitment for series of battery factories in Europe. The German plant could be online by 2025.
SVOLT	24GWh	A battery cell manufacturing facility that is presently running in a delayed schedule. Production is expected by 2027.
BMW	-	Expansion of Leipzig-based battery assembly line done at an investment of €70 million. New battery assembly plant in Bavaria, in planning stages. With regulatory approvals, construction could commence by 2024.

Source: Press releases and news reports

The boost in manufacturing is also underway through the automotive companies seeking timely expansion in the production lines. In May 2022, Volkswagen Group launched its second electric vehicle site in Germany at an outlay of about €1 billion. Furthermore, the company plans to set up an electric mobility center in the German province of Lower Saxony by 2026, with an estimated total investment of €21 billion. Reflecting the rising competition in the market, the Chinese electric vehicle and battery company BYD is in the process of discussing the planned acquisition of Ford Motor's German manufacturing facility. While Ford's strategic decision is to re-align existing facilities for electric vehicle production, BYD's planned acquisition, if successful, could add to the competition in the local industry.

Outlook

The target of 15 million electric vehicles by 2030 is a tall order, considering that so far, the achieved level is at around 1 million. The subsequent growth stage is critically dependent on multiple factors, including the price competitiveness of the electric vehicles, the ease of charging access, and the overall product variety and demand. The economic environment and other external challenges add to the potential impediments to targeted growth.

There are concerns about lowering subsidies at the current stage of growth. The January 2023 decline in electric vehicle registration is cited as one pointer in this direction. Subsidies helped push sales during December 2022, due to last-minute purchases before the reduction of incentives at the start of 2023. The Association of the Automobile Industry projects an 8% year-on-year decline in sales by the end of 2023, primarily concentrated on plug-in hybrids.

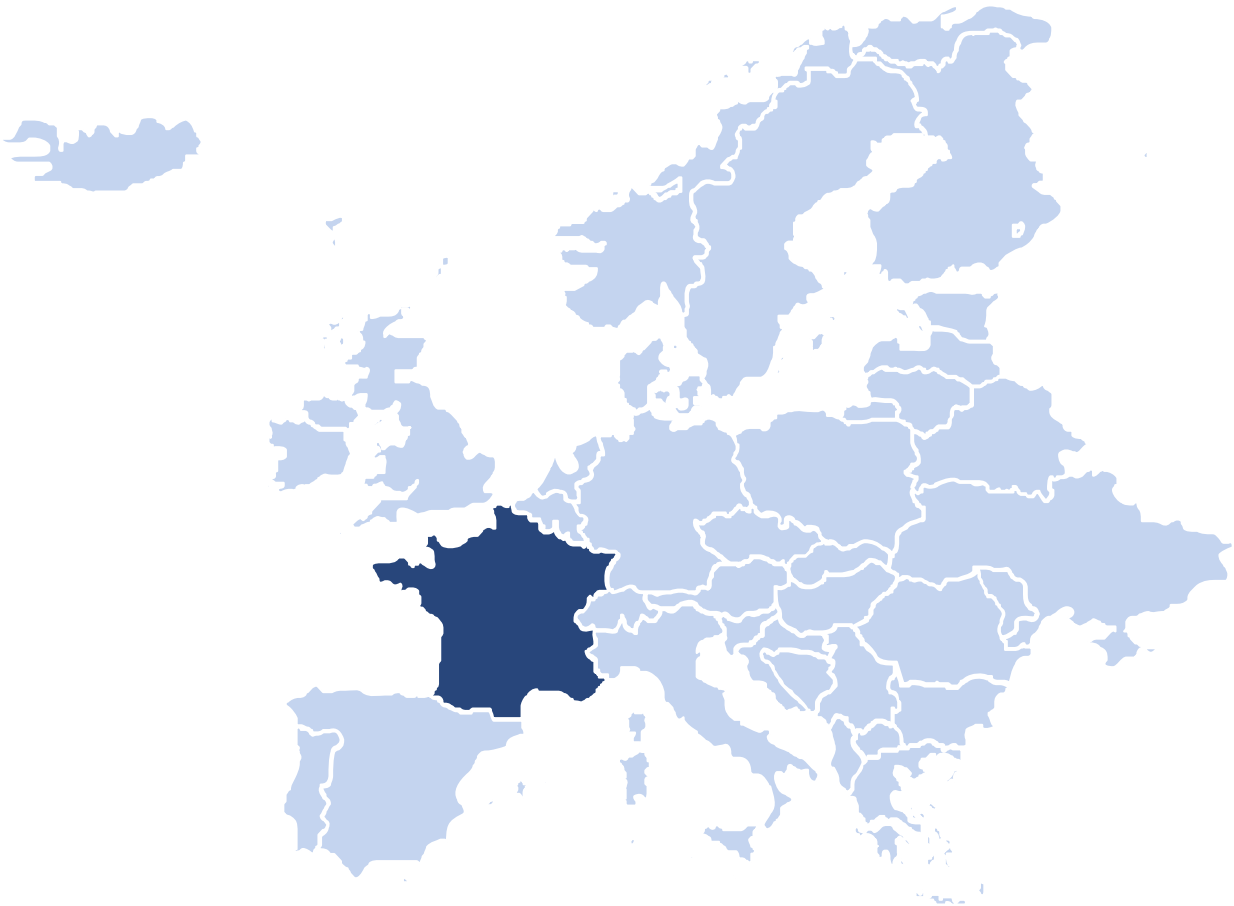
The upcoming investment landscape in the German electric vehicle market might warrant deliberate policy attention, considering the competition from other leading markets such as the US. Established entities such as Volkswagen and Tesla are already actively considering options in the US due to the attractive incentives. The rising energy costs in the country are an additional dampening factor for the typical energy-intensive Gigafactory projects in the pipeline. Prospective investors will keenly watch this progress as similar concerns prevail across the European Union.

France

The French automotive market's ongoing transition to electric drivetrain could progressively make it reach a leadership position in the European region. While there are no national targets for electric vehicles, the progress appears to be guided by the European Commission's goals of phasing out the conventional fuel-based transport. The emerging market demand, as demonstrated in the rapid sales growth, would require timely investments in capacities.

GDP (Current Prices) USD (2021)	2,957.43 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.66%
EV Penetration	14.4% (battery electric) of the total new passenger vehicle sales in 2022
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2035

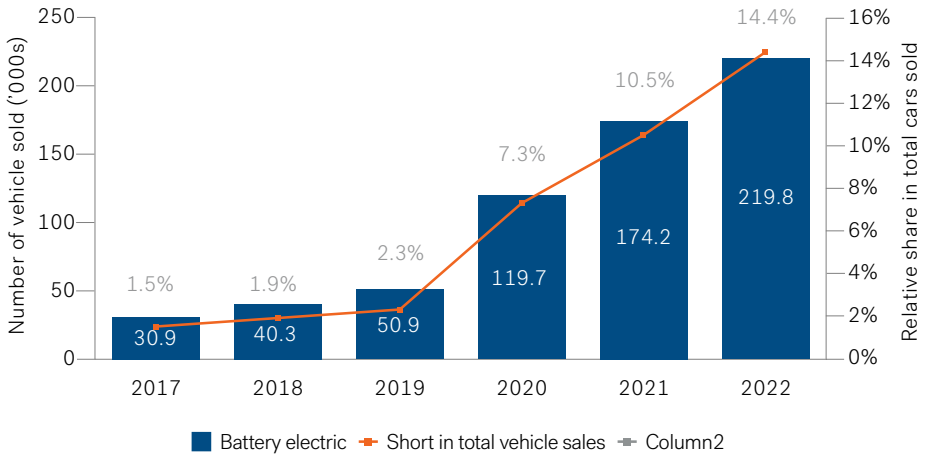
GDP Source: IMF, World Economic Outlook



France

EV Penetration and Trend

Battery Electric Vehicle Sales and Penetration



Source: Statista (attributed to Avere-France and Comité des Constructeurs Français d'Automobiles (CCFA))

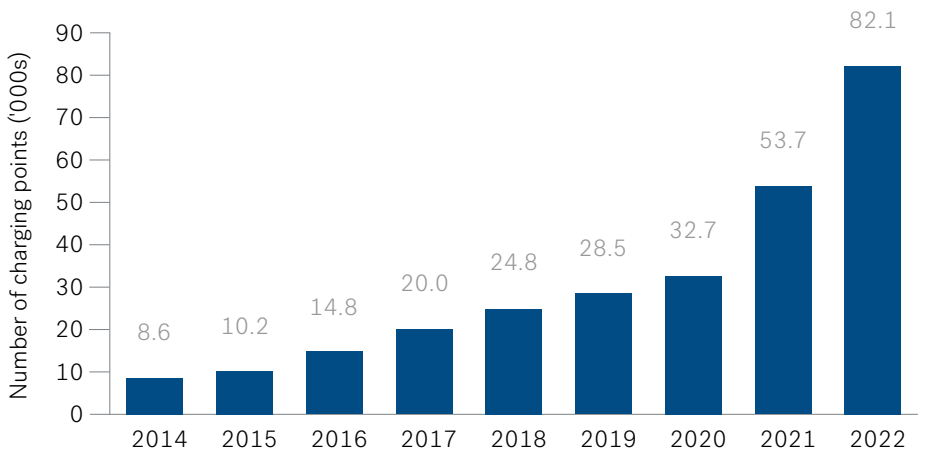
The growth in French electric vehicle market has been propelled by a combination of factors including purchase subsidy support and the rise in price/shortages in Internal Combustion Engine (ICE) vehicles. The sales in total passenger vehicle market by 2022 was a stagnant one, whereas the same for electric vehicles has been buoyant. The shift in demand and sales has been drastic, considering that till around 2017 and 2018, the battery electric vehicle sales in the overall passenger segment constituted a small and niche part of the business. The looming ban on the ICE vehicles by 2035 (in line with European Union targets) too acts as a supporting factor.

Growth in plug-in hybrid electric vehicles declined in 2022, reflecting the gradual shift in balance to battery electric vehicles. Also, the progressively rising market demand has been marked by rise in the number of product varieties at competitive price points. Major automotive brands such as Tesla thus emerged as top contenders, in a departure from recent past when local brands held the market share.

Electrification is also growing at a fast-clip in the public transportation segment in terms of the electric buses. As of end-2021, France was among the top three European countries in terms of electric bus registrations. A total 512 electric buses were registered in 2021. The average sale in the preceding three years was just about 230 units (BNEF estimate). With rising options in local sourcing and a wider choice in product variety, the electric bus orders are much more feasible to fulfill for major entities. It also helps that a project-based funding for the electric buses has helped bridge some part of the costs associated with the electric bus orders.

Charging Infrastructure

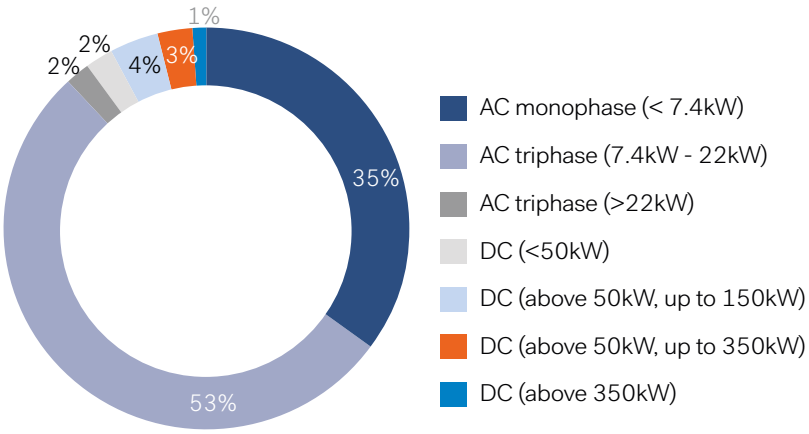
Trend in Public Charging Network Capacity



Source: Avere-France
Note: Data refers to charging points available for public use during the year. Actual installed base could be marginally higher.

Taking both public and private, the total number of charging points by end-2022 is estimated at about 1.2 million. Growth has been particularly sharp in the recent couple of years, reflecting the emphasis placed by various authorities on catching up in network reach. The public charging network presently enables access equivalent to 122 charging points per 100,000 inhabitants. While this is still higher than the European Union average (107 charging points), it vastly lags the level reached in the Netherlands and Germany among other leading EU countries.

Installed Charging Infrastructure by Power Rating



Source: Avere-France

The installed public charging network is largely concentrated between commercial buildings and the public parking spaces – cornering over 70% share in this regard. Also, the network availability is 85% on an average (as of December 2022), though this varies across charging type – in case of fast-charger (150kW) the same was 76%. In any case, the fast-charging capabilities are yet to be enhanced to any significant levels. Over half of the network continues to be operating at less than 7.4kW power rating.

Policy and Regulation

Despite lacking a national-level target for zero emission transport, the country must meet European Union's committed target of banning the new ICE sales by 2035. Various government measures stem from this fact. Subsidies have played an important role as a demand prop. But the government has lately been rationalizing the subsidy allocation. Since January 2023, a maximum €5,000 was fixed for electric passenger vehicle purchases. Earlier, the same was €6,000. The subsidy disbursement, carried out as part of the eco-bonus, was long expected for a gradual tapering.

The available subsidy support is restricted to the battery electric and fuel-cell vehicles with price of up to €47,000 and mass less than 2.4 tonnes. For the leased vehicles, the subsidy coverage is for 27% of the gross price together with the battery cost, within a ceiling of €5,000 for private use and €3,000 for companies. There is no vehicle price restriction in the case of electric vans – for a maximum weight of 3.5 tonnes, the subsidy covers 40% of gross price, with upper limits of €6,000 and €4,000 for private and commercial use respectively. Additionally, battery cost is included in subsidy calculation for leased electric vans.

The subsidy allocation also carries provisions for the low-income households. A maximum amount of €7,000 is available for the battery electric passenger vehicle purchase. For the electric vans, the same is €8,000. Also, the low-income households are allowed a subsidized purchase of used electric vehicles, at €1,000 or €3,000 depending on whether it is a passenger vehicle or van.

There are other incentives through the vehicle scrapping premium. With a certain income threshold, disposing an ICE vehicle during the purchase of the electric passenger transport, makes it eligible for a subsidy of up to €6,000. This is in addition to the rebates already entitled for purchasing the electric vehicle subject to fulfilment of criteria. The plug-in hybrid electric vehicles, in this case, qualify for up to €4,000 in subsidy support. For commercial purchases, the subsidy related to battery-based and plug-in hybrid is €2,500 and €1,000 respectively. In case of the vans, similar income thresholds hold, for subsidy covering 40% of the purchase costs, up to €9,000. In case of disadvantaged households, the upper limit extends to €10,000.

The subsidy regime for the heavy commercial vehicles follows a different approach. Disbursement is based on calls for projects. In 2022, the authorities had one such time-bound scheme, for which the subsidy support was released for specific project applications. For 2023, it will be a similar one. In this process, the expected subsidy support for the electric buses and trucks weighing up to 26 tonnes is €100,000. The previous funding rounds also had additional support for the associated charging system of the heavy commercial vehicles.

Policy-level funding support is also available to encourage charging infrastructure. Starting December 2022, a new scheme with budget of €10 million offers subsidy for installing fast-charging stations at independent petrol stations with annual sale volume of up to 2,500m3, and located in medium or rural density communes. The approved applications under this scheme would qualify for subsidy support ranging 60%-70% of the setup cost depending on rated capacity (50kW or 150kW). Separately, there are fiscal incentives for homeowners setting up their own charging stations. There is a tax break worth about 75% of the expenses incurred, up to €300.

Market Opportunity

The investment momentum in the French electric vehicle ecosystem is gradually picking up, led by the government support and the emerging demand scope. A significant part of the upcoming investments is directed towards battery, battery assembly and related critical components for electric drivetrain. In May 2022, the battery manufacturer Forsee Power commenced production at its 1GWh facility at Poitiers, aimed at meeting the electric bus demand.

Upcoming Major Battery Manufacturing Facilities

Company/Venture	Capacity (GWh)	Description
ACC	8	A joint venture comprising Stellantis, Total Energies and Mercedes Benz. The facility is expected to start by the end-2024.
Verkor	16	The first phase of production commencement is targeted in 2025. In a later phase, capacity could be expanded to 50GWh, for commissioning by 2030

Source: Reuters

Institutional funding is among the support measures extended for the upcoming investments. The €1.5 billion Verkor Gigafactory raised over €250 million funding towards the Verkor Innovation Centre. The financial assistance was led by European Investment Bank. Similar funding support is observed for the adjacent areas of the larger battery ecosystem. For instance, a €30 million government financing was provided for two battery recycling projects. Battery recycling is also expected to be mandatory in coming years, as manufacturing facilities come up.

Focus is also high on the critical raw materials and its supply chain to fulfill the targeted capacity base. Under the 2030 Investment Plan, the government dedicated €500 million to develop an investment fund that could support and sustain the domestic industrial landscape related to critical metals in the battery and electric vehicle value chain. Notably, in October 2022, the French minerals company Imerys announced plans to launch lithium production process at a tentative cost of €1 billion, with construction work expected to start from mid-2023. The planned production could be one of Europe's largest such mining projects.

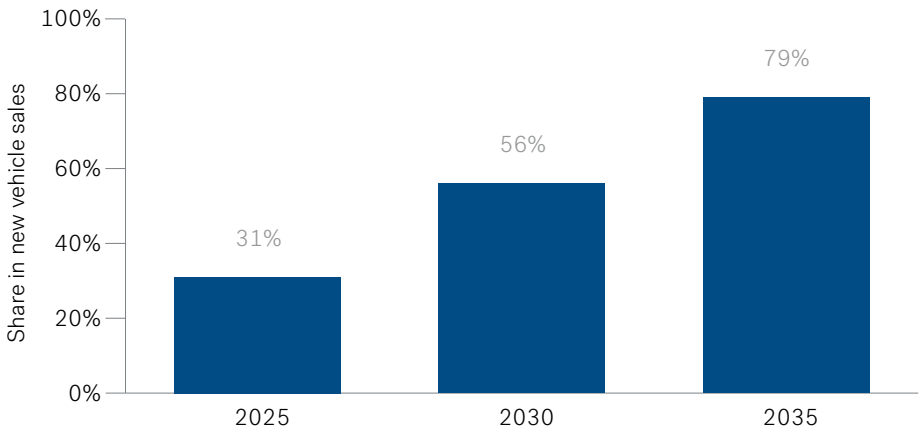
The automotive manufacturers meanwhile are stepping up the capacities to prepare for the demand. In October 2022 for instance, Stellantis announced its progress towards doubling the share of electric vehicles in its total vehicle output for French market. Another major entity, Renault is in the process of a massive expansion in its electric vehicle across three locations, to develop a hub of 400,000 units' capacity by 2025. Notably, the same manufacturer has also been able to significantly ramp up the capacity in electric trucks, to corner a predominant share in the French and overall European market.

A steady expansion in the electric bus fleet, led by the municipal authorities' procurement, is shaping the market contours for the global and regional players. In February 2022, the Dutch company Ebusco signed a Letter of Intent to set up a new manufacturing plant in France, with an initial capacity of 500 electric buses. An emerging major demand from the various cities and municipal authorities appears to be for converting the existing ICE platform buses to electric through retrofitting. Regulatory backing for the same comes from a government order in 2000, allowing retrofitting of vehicles aged five years or more, without permissions from the original manufacturer. About half of the existing operational fleet meets the retrofitting criterion.

Outlook

Reflecting in part the trends of mature market, the expansion in the French electric vehicle market is progressively shifting from being policy-led to one of consumer demand. The gradual rationalization in subsidy support is part of the same rationale. The overarching goal of phasing out the ICE vehicles together with the decisive shift in trend towards battery electric vehicle sales, sets the transitionary path for the automotive industry.

Projected Electric Vehicle Penetration



Note: Projected penetration estimates above are as of November 2021
Source: ICCT

The preparedness for the projected vastly outsized electric vehicle stock by 2030 entails a massive investment and expansion in the charging infrastructure. As per ICCT report, about 7 million chargers (including private and public) will be needed by 2030 to match the demand generated by the vehicle unit stock. The same report also pointed out home charging access as being the key factor in managing public charging requirements, besides other factors such as charger utilization rates and business use cases in charging stations.

Evidently, the investment opportunity is huge. But of late, the global competition shifted significantly with various countries seeking to attract the technological know-how and its supply chain through a targeted subsidy mechanism. The point in focus is the US Inflation Reduction Act. Its subsidy package, as a mix of tax credits and grants, vastly skew the balance for many prospective investors. The French government has thus been vocal about its concerns in this regard, due to the risk of losing out. The resolution of the emerging scenario may lie in devising conducive and cohesive policy measures in the European Union region.

United Kingdom

The UK automotive market's growth trend is shaped by a consistent demand shift in favour of electric vehicles. For good measure, the policy target helped set the narrative. By 2030, the sale of new petrol and diesel vehicle is banned. Further, by 2035, all new cars and vans are expected to be zero emission at the tailpipe. The growth achieved thus far, while impressive, is still behind potential. Much more is required on the supply-side, through enabling incentives for manufacturers and the rapid buildout in charging infrastructure. Securing timely private investments will be the key to realizing opportunities.

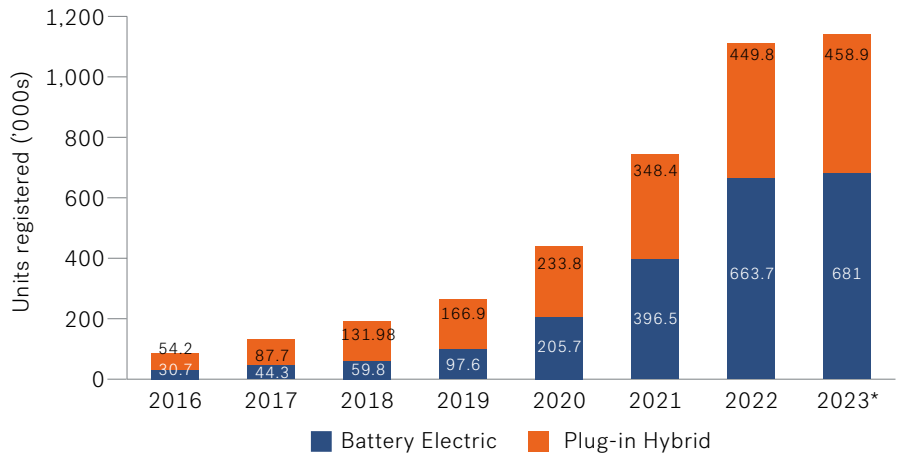
GDP (Current Prices) USD (2020)	2,758.87 bn
GDP Growth Forecast (constant prices) (2020-2024)	0.53%
EV Penetration	16.6% (battery electric) of the total new passenger vehicle registrations in 2022
EV Target	All new vehicles sales (cars and vans) to be zero emission by 2035
Planned Year of Phasing Out ICE Vehicles	2030

GDP Source: IMF, World Economic Outlook

United Kingdom

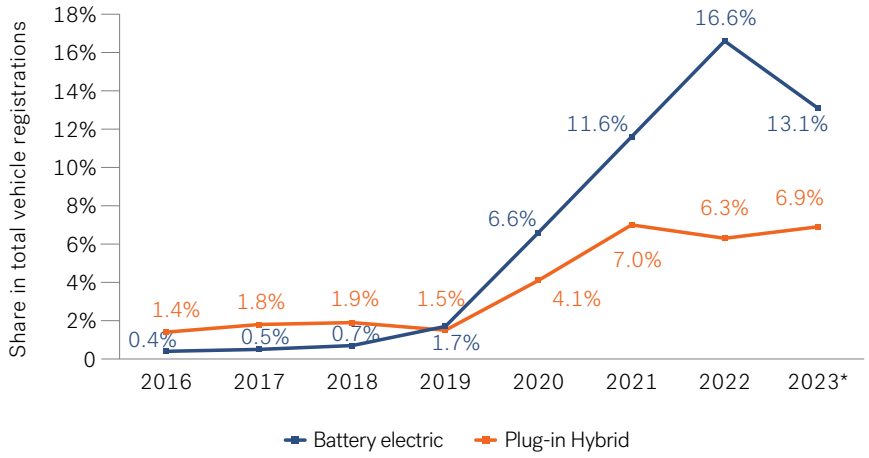
EV Penetration and Trend

Cumulative Registration of Electric Vehicles



*As of January 2023
Source: Zap Map (attributed to SMMT)

Share of Electric Vehicles in the Passenger Vehicle Registrations



*As of January 2023
Source: Zap Map (attributed to SMMT)

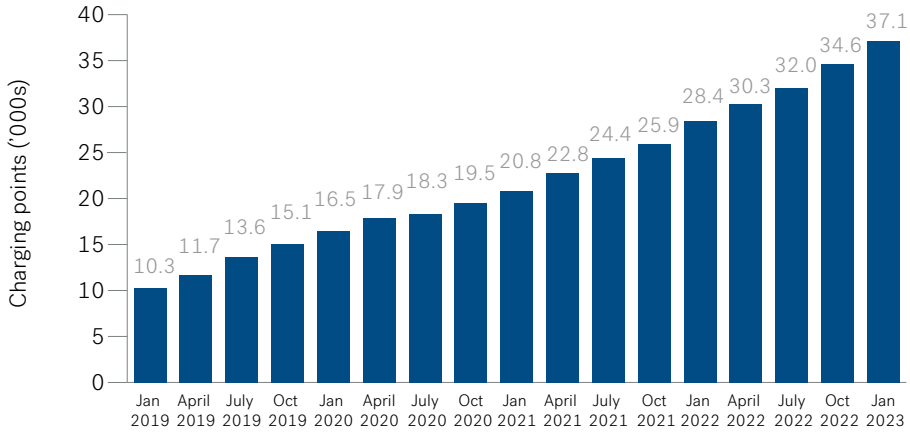
The sale of electric vehicles, including battery electric and plug-in hybrid (PHEV), reached record level in the UK by the end of 2022. Such growth contrasted the 2% decline in the total vehicle sales during the year. The automotive industry's growth is, in effect, led by the transition to electrification. While the supply chain and related issues plague the industry, the electric vehicle sales maintained its pace. It is expected that the supply-side challenges could abate progressively, especially in terms of sourcing of semiconductors. The growth achieved, in such a backdrop, could be an understated one.

While the offtake has risen for both battery and plug-in modes, the trend shows the shift in favour of battery electric drivetrain in the passenger vehicle registrations. Between 2019 and 2022, the share of such vehicles rose 10-fold. Notably, as the estimates from the Society of Motors Manufacturers and Traders (SMMT) indicate, fleets and business buyers play an increasing important role – contributing two-thirds of the registrations in 2022. This could partly explain how electric vehicles sales during 2022 outstripped new diesel vehicles for the first time in the UK. The private purchase of electric vehicles is likely to be under pressure from the continued inflationary pressure and the gradual scaling down of the subsidies. The lag in charging network adds to the private buyers' doubts.

Though slow, but gradually the pre-owned vehicles' market is shaping up for the electric transport. In 2021, as the UK government records indicate, about 3% of the pre-owned vehicle transactions were based on hybrid, plug-ins or battery electric transport. With fleet operators contributing to the lion's share in total vehicle offtake, the rising electric vehicle adoption in transport fleets is likely to feed into the pre-owned vehicle market in successive years.

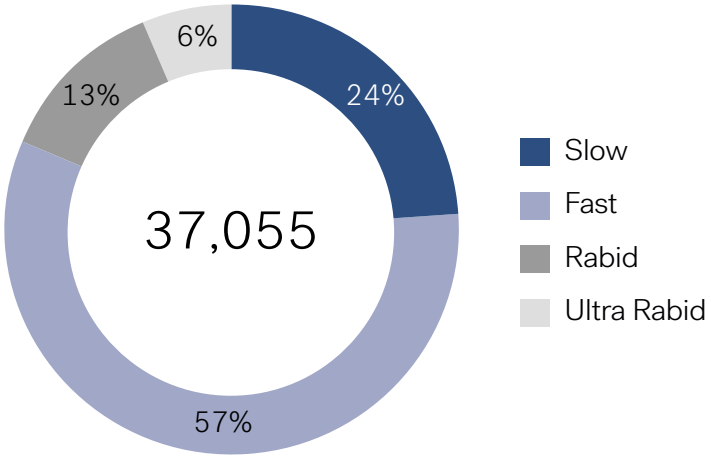
Charging Infrastructure

Installed Public Charging Network Points



Source: Department of Transport, UK government
Note: Data refers to installed charging points at the end of each quarter

Installed Public Charging Capacity by Speed Type



Source: Department of Transport, UK government

The charging network registered a 30% year-one-year growth by the end of 2022. The step-up in the expansion is coming in at a right time, as the transportation system must adhere to the set targets for zero emission operations. The growth in battery electric passenger vehicles and the incentives on offer gave charging operator companies sufficient impetus for the growth. Yet, getting the scale in time is a challenge alike for the policymakers and network operators. The UK's multiple local authorities have a scope to add charging points manifold but have been unable to, either for lack of conducive norms or other challenges.

The expansion of the charging infrastructure is progressively favouring the fast-charging segments. As of end-2022, the fast-charging network had a higher year-on-year growth (33%) than the slow ones (24%). The ultra-rapid charging segment reported an 80% growth during the year, though such a spike is reflective of its low initial base. Rapid and ultra-rapid charging points are critical for the en-route locations (motorway service areas, service stations, electric forecourts and ferry terminals). As of January 2023, the share of en-route charging points was just 6% of total installed base, which can be related to the low reach of rapid charging capacity base. In contrast, about half of the public charging capacity constitutes as the destination chargers, referring to those located only in residential streets.

The network reach is also unevenly distributed, with most of the charging operators and other entities choosing the most appropriate locations for installation. While the average network reach for the UK as a whole is 55 per 100,000, the same for London and Scotland is 131 and 69 respectively. The lowest charging provision is found in Northern Ireland (19 per 100,000), followed by the North West (31) and Yorkshire and the Humber (36). The inference about the skewed network must be done in the context of the ownership mode followed. The charging infrastructure growth in the UK has been largely funded by private investment, aided with grants from the Office for Zero Emission Vehicles (OZEV). While the government too has been part of this, its share has been a minimal one.

Policy and Regulation

The country's policy and regulatory framework of incentivizing the passenger electric vehicles ended by mid-June 2022. This was effective for the newly purchased passenger vehicles, even as applications received before this date stand eligible for the subsidy support. The policy reasoning is that the sales of the vehicles have grown despite successive rationalization of subsidies, which is indicative of resilient market demand. The emphasis is thus on re-orienting subsidies towards other areas such as charging, among others. At the same time, the subsidy budget (around £300 million) continues to be available for the purchase of electric vans, taxis and motorbikes.

For the charging infrastructure, policy-level funding (to supplement private funding) has been directed through various mechanisms and channels. Under the Electric Vehicle Chargepoint Grant (EVCG), 75% of the charging point installation cost in domestic properties is made available. Since April 2022, EVCG replaced the Electric Vehicle Homecharge Scheme. Then, there is On-street Residential Chargepoint Scheme (ORCS) for grant-based funding to local authorities to install the on-street residential charging points. A voucher-based scheme is available under the Workplace Charging Scheme (WCS) for upfront costs associated with purchase and installation. WCS is meant for eligible businesses, charities and public sector organizations. Lastly, there is the Local Electric Vehicle Infrastructure (LEVI) to facilitate the charging infrastructure projects undertaken by the local authorities that could help secure private investments for network expansion.

In March 2022, the UK government committed £1.6 billion under its 'Taking Charge' strategy. About £450 million worth of outlay was set aside for the LEVI fund, with an initial £10 million pilot scheme and £50 million for staff funding. There is also a £950 million Rapid Charging Fund to support the roll-out of planned 6,000 odd fast-charging network points across motorways by 2035.

In January 2023, the government and the energy regulatory authority issued a plan to develop and facilitate smart charging as a key sub-segment. The aim is to enable and unlock the potential benefits from smart charging systems, such as allowing stored energy of the vehicles to power the homes, or disparate electric discharging units such as a lamppost to be capable of charging and selling the power back to grid at appropriate pricing. To this end, a £16 million funding allocation was done to promote innovative smart charging projects.

A new regulatory framework will be rolled out, to build upon the previous directive (as of July 2022) for all new private charging points to incorporate smart charging capabilities. The launch of the plan document also saw funding extended to entities for notable projects including Otaski Energy Solutions (£229,000 for smart streetlights), V2X-Flex (£220,000 for prototype software and business model involving bi-directional chargers), and BEVScan (£165,000 for tool monitoring the battery degradation and suggesting optimization).

The funding extended to various demonstration projects is based on the overall outlay available under the £1 billion Net Zero Innovation Portfolio. Over £3.2 million will be disbursed through the first phase of V2X Innovation programme to develop hardware, software, and the business models critical for the smart charging systems.

Market Opportunity

The government's planned ban on sale of new petrol and diesel vehicles by 2030 acts as a major push for reinforcing the business case for electric vehicles. For heavy goods vehicles, the timeline is 2040. For automotive manufacturers, there is a visible anticipated demand scenario. Added support is there from select policy initiatives. There is, for instance, a £600 million backing from the UK Export Finance to facilitate expansion of Ford Motor's electric vehicle product range at Essex and Merseyside plants. Notably, for the year ending 2022, the UK's automotive industry's electric vehicle production was at a record high and contrasted against the slump in overall production statistics.

Most of the opportunity in electric vehicle market is also dependent on getting the charging network in place. With stated policy support, private investment has a key role in expanding the charging network reach. Some of the major enterprises have thus made significant commitments to tap into the opportunity. In March 2022, the oil and gas product major BP announced £1 billion investment in the UK's charging infrastructure space. The planned investment is to be undertaken under the venture of BP Pulse, part of BP's Integrated UK Business portfolio. Other entities are similarly directing investments, especially for the rapid charging sub-segment.

Planned Private Investments in the Rapid Charging

	Planned Investment
Shell	5,000 rapid and ultra-rapid electric vehicle charging points on forecourts by 2025
Motor Fuel Group	£400 million for installing 2,800 high-powered (150kW and 350 kW) charging points at 500 locations by 2030
InstaVolt	5,000 charging points by 2024/25 and 10,000 by 2030
GRIDSERVE	5,000 high-powered charging points by 2025. Over £1 billion investment planned across its Electric Hub and Electric Forecourt sites
Osprey	£75 million for installation of 150 high-powered charging hubs by 2025
Pivot Power	National network of Energy Superhubs. First such project at Oxford will provide up to 50 charging points

Source: UK Government (Infrastructure Strategy, March 2022)

A promising but nascent and untested sub-segment of electric vehicle charging realm is the wireless or inductive charging technology. Barring isolated and limited-scale tests, the technology remains at a demonstrative and proof-of-concept stage. In the UK, one such trial started in October 2021, at Marlow, Buckinghamshire, involving charging operator (Char.gy), car rental network (hiyacar), Milton Keynes Council, Buckinghamshire Council and the Open University. The results of the ongoing study could potentially set the stage of next round of investments.

Gigafactory investment in the UK has somewhat lagged behind other leading global markets of the US and European region. Presently, there is one 38GWh plant in the pipeline, by Britishvolt, for a planned investment of £3.8 billion. In 2022, the project had £100 million worth of government backing, to be disbursed upon construction progress. As of November 2022, the company announced securing short-term private funding support to sustain its development activities. The latest round of fundraising was of critical importance for this venture, as rising interest rates and an anticipated slowdown impacted most of the fundraisings.

Additional local battery capacity could come onstream through expansion underway. The Automotive Energy Supply Corporation (AESC) – a joint venture between Nissan Motor, NEC Corporation, and NEC Tokin Corporation, is in the process of expanding its existing 2GWh capacity at Sunderland to 6GWh by 2030. Separately, AESC also commenced development work for a 12GWh plant at the same location, aiming a commissioning schedule of 2025.

At a policy level, the UK government is seeking at ways to improve the investor sentiment for battery manufacturing and related technology development. In October 2022, the government committed to £211 million of funding towards battery research and innovation, to be valid till 2025. The proposed funding will be under the 'Faraday Battery Challenge' scheme that was introduced in 2018. Notably, the Faraday Institution suggested a requirement of seven Gigafactories by 2040.

Outlook

The policy target of zero emission new vehicle sales (cars and vans) by 2035 involves several interim milestones – such as implementing new regulatory regime in 2024 related to zero emission vehicles for manufacturers, government vehicle fleet to be zero emission by 2027, and ceasing the sale of new petrol and diesel vehicles by 2030. Battery electric and plug-in hybrid vehicles are integral, if not the most important part, of the emerging policy and regulatory framework.

Having placed ambitious goals in transport electrification, the phasing out of the subsidy support may not have been timed appropriately. With such a move, the UK market may stand out as the only one in the European region as bereft of any policy support for the electric drivetrain. The challenges of a high inflationary environment together with supply chain issues restrict the scope of having multiple vehicle models at attractive price points, thus keeping the retail demand subdued.

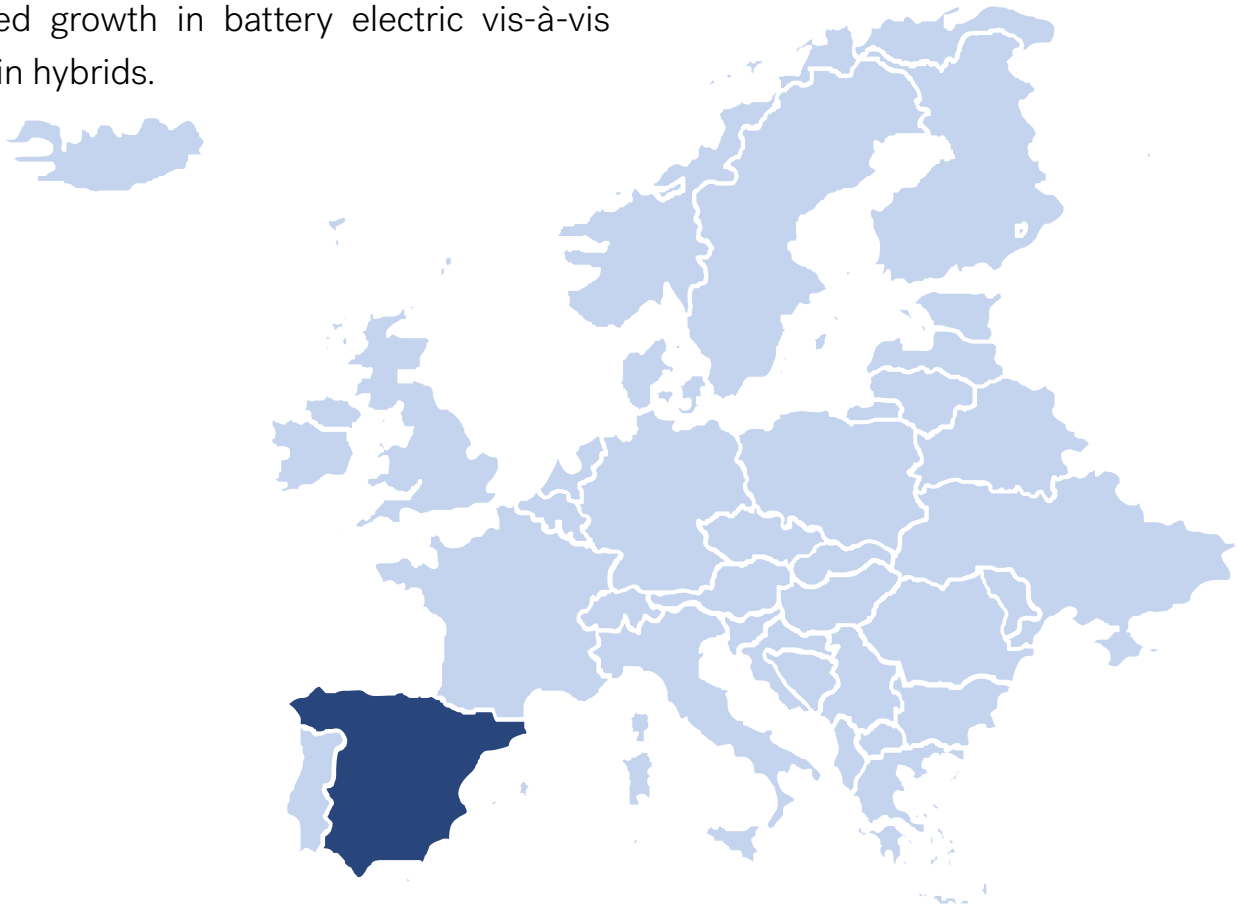
The country's electric vehicles and battery manufacturing landscape is not in the reckoning among the top global markets. This was evident in the select few episodes of annulment of major investments, that led to setting up of a government enquiry panel. The near absence of major Gigafactory players is a discernible factor of comparison. The challenges might just get compounded with the enactment of recent US legislation offering upfront incentives for domestic battery and other manufacturing. It will thus be pertinent that the policy framework is re-aligned to set a different narrative, especially one that provides a visibility of the business opportunity ahead.

Spain

The Spanish automotive market finds significant policy support for transition to an electric mobility model. The funding has helped set the direction for prospective investors, with some of the major investments in electric vehicle and battery manufacturing in pipeline. Yet, more is required for accelerating the growth in electric vehicle market. The country continues to be far behind its leading European counterparts in expanding the charging infrastructure. This may impact the growth momentum in the market, as already evident in some part through the relatively stunted growth in battery electric vis-à-vis plug-in hybrids.

GDP (Current Prices) USD (2021)	1,426.22 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.20%
EV Penetration	9.6% of total new passenger vehicle registrations by 2022
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2035

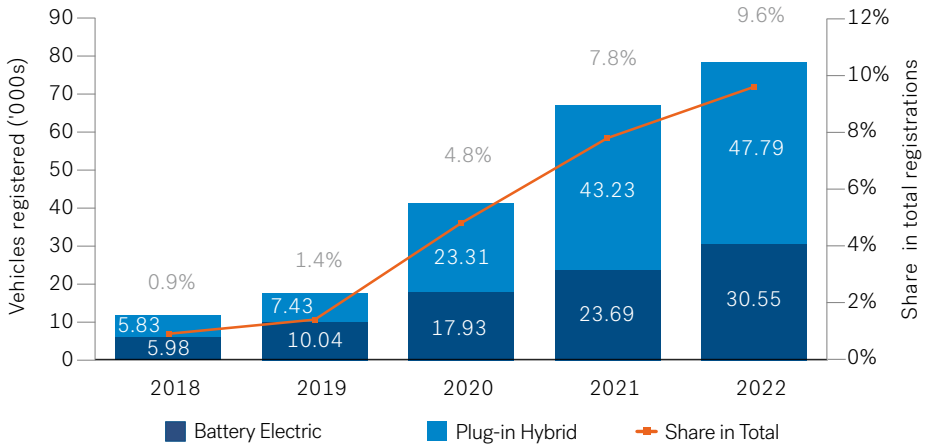
GDP Source: IMF, World Economic Outlook



Spain

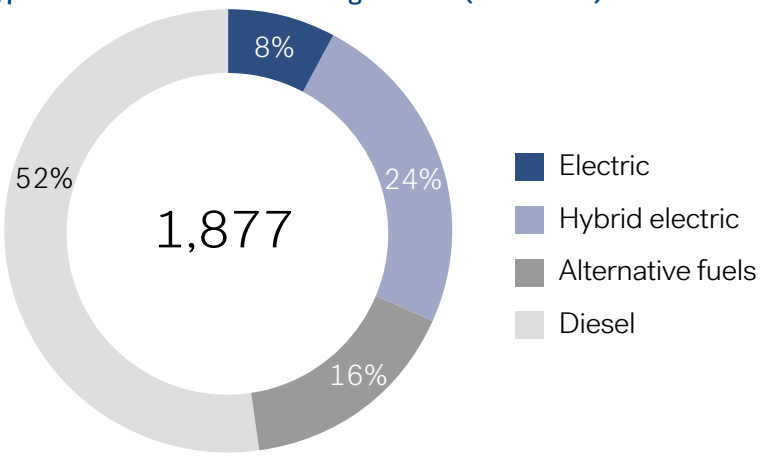
EV Penetration and Trend

Trend in Passenger Electric Vehicle Registration



Source: European Automobile Manufacturers Association

Fuel-type Distribution of New Bus Registration (as of 2021)



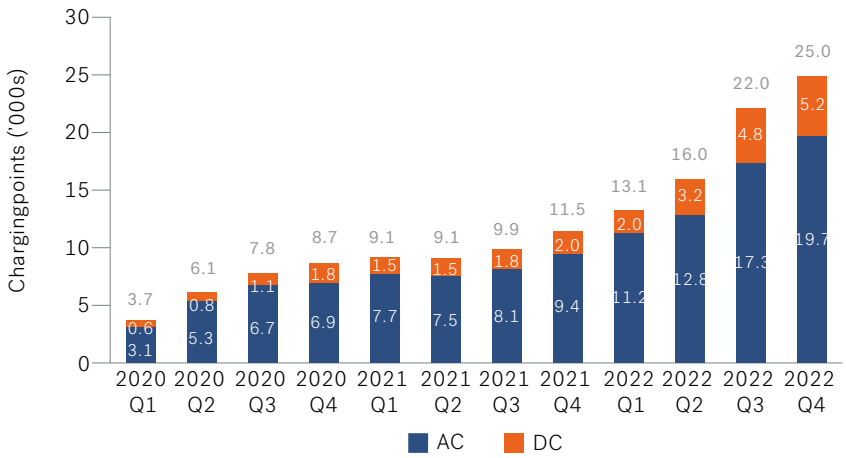
Source: European Automobile Manufacturers Association

The sharp rise in penetration of electric vehicles is unmissable from Spanish automotive market trend. It doubled between 2020 and 2022, when the petrol and diesel-based units reported decline in the absolute number of registrations. The electric vehicles business is thus effectively pulling the automotive industry. Battery electric vehicles are however yet to assume a significant role in the Spanish electric vehicle market. A predominant share continues to be of the plug-in hybrid vehicles with a rising trend in the same. While the trend in battery electric has been consistently positive, its lag against the plug-in hybrid indicates the consumer preference and indirectly the challenge of charging network.

There is an equally sharp growth in other major sub-segments such as the electric bus. With a low base, the new vehicle registrations indicate a spike. Latest estimates of the European Automobile Association indicate that number of battery electric buses almost tripled between 2020 and 2021. For the year ended 2022 a similar proportion could be expected, considering the rapid procurement across the Spanish cities. Hybrid electric buses too have a significant share in this sub-segment, and had a 53% growth year-on-year in 2021.

Charging Infrastructure

Trend in Charging Infrastructure



Source: European Alternative Fuels Observatory

The charging network capacity, in terms of the total number of installed charging points, has risen sharply – by Q4 2022 it was double that of the comparable period in previous year. Yet, a faster growth is needed to be prepared to accommodate the emerging demand and, in the process, match the progress of other key European countries. Spain currently lags far behind other European markets in its charging network. An inadequate coverage is compounded by the lack of fast-charging points – at just about one-fifth of the total capacity. Most of the fast-charging capacity is led by the automakers' proprietary charging points, or other inaccessible points. The publicly accessible charging is thus acutely behind the curve.

Policy and Regulation

Policy focus has been high towards the automotive industry and its transition to electric mobility. Among other measures, upfront funding support was announced to facilitate the investments in electric vehicle ecosystem. The context of the policy and regulatory measures lies in the country's commitment to put an end on combustion engine vehicle sales from 2035. The target is five years ahead of the original one, thus adding to the urgency and pressure. A related point is the importance of automotive industry – about 10% of the GDP and second largest in Europe by production volume.

In July 2021, the government approved the third extension of its incentive package christened as MOVES (Efficient and Sustainable Mobility Incentives Program). Within the framework of the Recovery, Transformation and Resilience Plan, there is funding worth €400 million available, which could also be stretched to €800 million if the need so arises. The reform package thus announced is meant to last till the end of 2023. The scheme notably provides for an additional 10% in aid for select categories such as location in municipalities with population below 5,000, fraught with disabilities, or professional use for taxi or VTC.

Under MOVES-III, there is a €7,000 subsidy available for a new passenger electric vehicle. This is however conditional on scrapping an old vehicle (at least seven years) in connection with the purchase of electric vehicle. Without a related scrappage, the subsidy for purchasing the electric vehicle is €4,500. The subsidy available for plug-in hybrid vehicles is up to €7,000, subject to riders involving mileage of the electric part, sticker price of the vehicle and the seating capacity. Also notable is that the subsidy support is available for other transport beyond passenger vehicles. In such cases, the subsidy is up to €9,000 if the old one is scrapped. Additional criteria in this regard involve vehicle categories as well as the sticker prices. The end goal of the subsidy scheme is to get at least 250,000 electric vehicles and 100,000 charging points by 2023.

There is another scheme under which policy funding support is made available for the industry in the form of subsidy or grants. Under the Strategic Project for Economic Recovery and Transformation (abbreviated as PERTE), the planned disbursal is worth €877 million across ten recipients so far. Over €2 billion worth of payouts are to be done in the subsequent PERTE funding rounds that will follow. The goal is to catalyse investments in the electric vehicles and battery space where Spain can exploit significant opportunities. Presently, Volkswagen's upcoming Gigafactory is the leading example among PERTE funding recipients.

Market Opportunity

There is active policy support to support electric vehicle investments in the country. Its PERTE scheme has a €3 billion allocation, of which €877 million of disbursal was set aside during 2022. The remaining part is for the ongoing year of 2023. The aim is to facilitate the industrial ecosystem around electric mobility. Till 2022, Volkswagen was the front-runner in availing this subsidy support for its planned battery production and electric vehicle capacity in Spain. Other companies are in similar fray though not in similar scale.

The policy-led push for electric buses is another major demand segment for the major manufacturers. It is evident in the recent key investment announcements. In September 2022, the Chinese manufacturer BYD signed a framework agreement with Castrosua, specializing in bus and coach assembly, for a facility in Spain. The aim is to locally meet the order book running across key cities including Valencia, Saint Cugat, Badalona and Badajoz among others. The city of Madrid, however, leads in its electric bus adoption. The transport operator EMT Madrid has been transitioning its fleet towards zero-emission. Its 2023 budget at about €855 million has a significant thrust on procurement of electric buses.

The energy company Iberdrola has taken a lead in expanding the public charging network across Spain. By September 2022, the company's installed charging points grew by over 2,500 units across 500 locations. It is in the process of expanding the network to reach 150,000 charging points by 2025. Various tie-ups and joint ventures are thus being concluded in this context. In 2021 there was an agreement with the company Restaurant Brands Iberia for installing charging points at the latter's Quick Service Restaurant outlets. A fast-charging network is in the works in partnership with BP, which will begin with a 5,000 points network by 2025 before next phase of scaling up. The sub-segment of electric buses is being pursued by partnering transport providers, an example being Irizar-Iberdrola agreement in 2021.

Iberdrola is also working with automakers like Volvo for the fast-charging at the dealership level. There is a partnership with Volkswagen Group for setting up a solar power park to support the battery plant planned in Sagunto municipality. As such, this partnership could be seen as part of the larger investment goal of the Volkswagen Group, which plans to invest €10 billion in Spain for electric vehicles and batteries. The automaker aims to commence work on its 40GWh Gigafactory in 2023, with an aim to reach full-scale by 2026. In April 2022, the Spanish government launched a bidding process for €3 billion worth of loans and grants, as incentive package for electric vehicle production. Presently, the Volkswagen Gigafactory project corners about half of the government subsidy/grant allocation for electric vehicle industry.

As seen with BP, another conventional energy major Shell has been stepping up the investments in its charging network business. In June 2022, Shell acquired Spanish charging developer and operator Cable Energia. The latter had 80 charging points in Spain at the time of the transaction. With this acquisition, Cable Energia became a wholly-owned subsidiary within Shell's mobility business division. Earlier in 2021, the Spanish oil company had announced expansion of charging network at its oil retail outlets with an investment outlay of €42.5 million. The French company TotalEnergies is another such entity in the same chain, offering charging network services as one of the ways to diversify and foray in the emerging market.

Outlook

The Spanish government funding is likely to continue extending support for prospective investors in the electric vehicle market. Battery manufacturing is an emerging segment for the industrial ecosystem. Some of the leading automakers such as Tata Motors are reported to be evaluating options for a Spanish facility. If fructified, this could be the next such manufacturing facility after Volkswagen's ongoing Gigafactory. On an average ballpark, Gigafactory capex could amount to €1-3 billion. Its linkages with auto manufacturing value chain will be part of other positive spillovers.

The auto industry can expect a rebound in the electric vehicle sales, especially upon the low base of 2022. Various industry estimates thus suggest a positive direction. Autovista's projections suggest a 16% growth in sales in 2023 as demand responds to the purchase incentives available. The same source also points to a lower projection of 5% growth in 2024, due to anticipated pressure on the costs and prices while supply backlogs are cleared. The automobile association and related lobby groups have sought added measures in policy support to help prop-up the sales, due to concerns that the Spanish electric vehicle market could fall far behind the other European markets in electric mobility.

The lack adequate charging infrastructure, especially in fast-charging network, could add to the challenges in the market. Spain ranks among the lowest in the European region for its charging network reach. Most of the upcoming capacity is led by the private investments including OEMs and charging service providers. It remains to be seen how this sub-segment comes up while the vehicle sales pick up. Energy costs could also play the part in the use of charging points for public use. A fragile situation on the energy front could still prolong the ongoing inflationary pressure and complicate the business recovery process.

Italy

Italy's automobile industry is up for a major transition with the surge in demand for electric vehicles. The subsidies, coming after a delay, will catalyse the demand for electric vehicles by a significant margin. The policy objective has been clear in terms of the need for electrification to achieve decarbonisation goals and is following the examples of other leading European counterparts. The charging network access is one of the elements that could impact the growth, either in terms of facilitating it or impeding, based on progress.

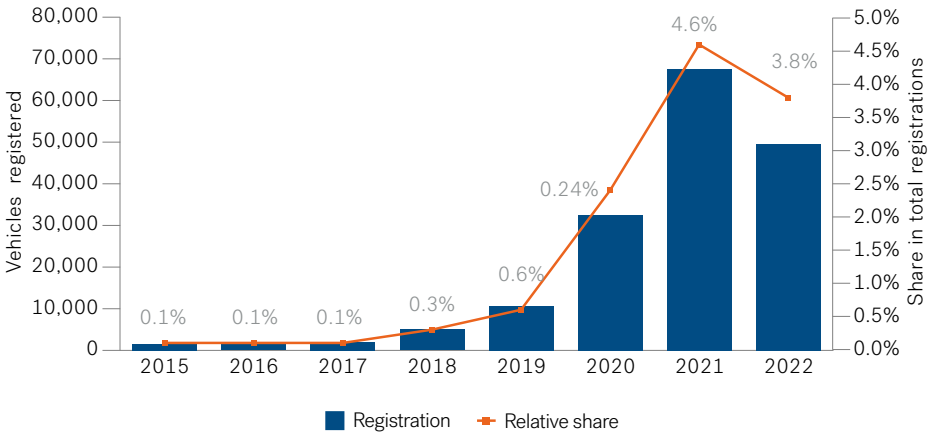
GDP (Current Prices) USD (2021)	2,101.28 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.42%
EV Penetration	3.8% of total new passenger vehicle registrations by 2022
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2035

GDP Source: IMF, World Economic Outlook

Italy

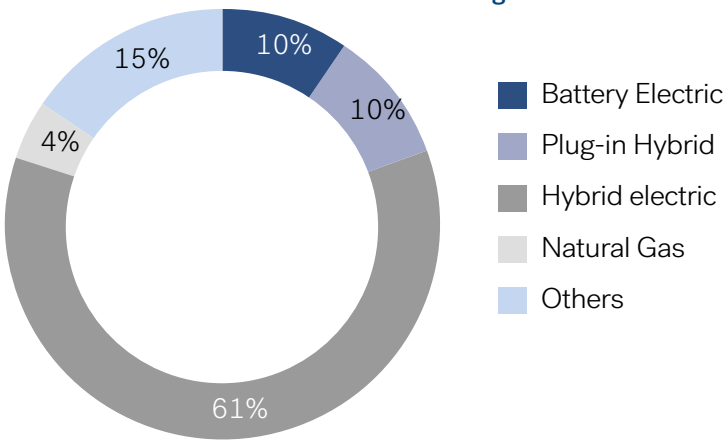
EV Penetration and Trend

Trend in Electric Vehicle Registration



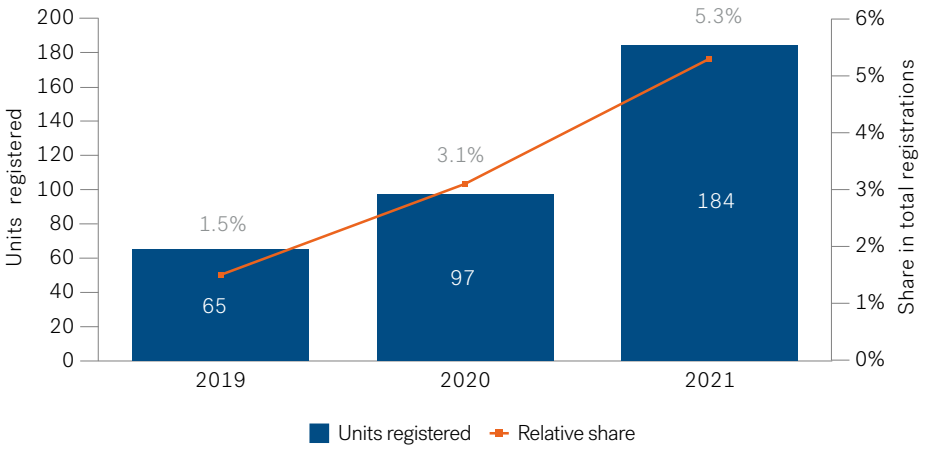
Source: UNRAE
Note: The data above refers to battery electric vehicles and does not include hybrids

Distribution of the Alternate Fuel-based Vehicle Registrations in 2022



Source: ACEA

Trend in Electric Bus Registrations



Source: European Automobile Manufacturers Association (ACEA)
Note: The above data refers to both battery electric and plug-in modes

The long-term trend in battery electric vehicle registrations indicates a consistent demand. Yet, the decline in 2022 was a surprising and contrasting picture to other European markets. This meant that other competing segments namely the internal combustion engines, as well as the hybrids would have held their respective shares. Notably, the plug-in hybrids too reported a decline, but the quantum was lesser than the battery electric.

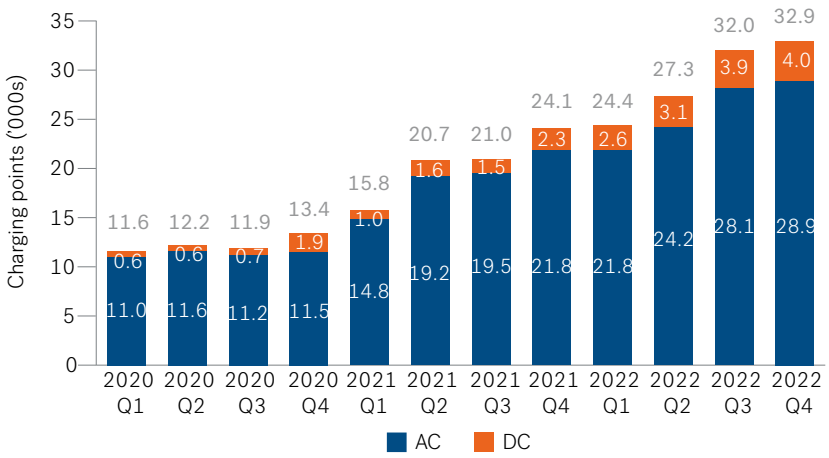
Some of the factors contributing to the decline lie on the demand-side. The Italian automaker association held that the delay in rolling out incentives for electric vehicles, impaired the demand during the year. The inflationary pressure and a depressed purchasing power worsened the overall market sentiment. While policy and regulatory support was introduced, it may have been too little and too late for the period.

It is also pertinent to note how electric vehicles fit in the overall alternate fuel-based transportation. As of 2022, about 693,000 alternate fuel vehicles were registered. Over 70% of them were based on hybrid drivetrains. Making an inroad in such a market would necessitate making battery electric ones as seamless and easier in access as for conventional ones. A constrained access to public charging and limited battery range continue to be impeding factors in battery electric vehicle penetration.

In other sub-segments, the push for electrification appears to have maintained a momentum. Albeit with a low base, the electric bus registrations have gained significant traction. Pending official press releases, the total electric bus registrations by end of 2022 could present a similar growth factor as in 2021. To be sure, diesel-based registrations still hold the sway. It is however expected that the relative balance will gradually shift in favour of the electric ones.

Charging Infrastructure

Trend in Charging Infrastructure



Source: European Alternative Fuels Observatory

The growth in charging network shows a relative acceleration since the end of 2021. The capacity is low when compared to its counterparts in Europe, especially the ones with high electric vehicle penetration. As of June 2022, the European Automobile Manufacturers Association ranked Italy at fifth position for the absolute number of chargers installed. But the top-ranking country in this study (The Netherlands) had four times the capacity as Italy's. With slow pick up in the fast-charging capacity and the disparate growth in network reach, the charging infrastructure is in a catchup mode with the anticipated vehicular segment growth. Among the recent challenges that emerged for the charging services include the costs – rising electricity prices since late 2021 (as a fallout of Ukraine-Russia armed conflict) made charging stations pricier than the gas stations. As of November 2022, such costs more than doubled year-on-year.

Some of the Italian cities have made better progress in expanding charging network reach. Survey results as of April 2022 indicated some of the notable ones in this regard. The city of Florence stands out for the maximum number of charging points – 14.17, available per 10,000 inhabitants. The next few cities in the ranking include Bologna (7.25), Rome (6.04) and Genoa (5.54). Though not established as axiomatic, the association between charging network reach and electric vehicle penetration is a strong one, with one feeding on the other.

Policy and Regulation

A revised set of incentives and support measures were announced in 2022 for the electric vehicle market. The overarching goal is to progress with decarbonisation. The National Integrated Energy and Climate Plan (PNIEC) lays out the targets in this regard. Also important is to stay aligned with the European Union goals in clean energy and its share in total primary energy consumption including transportation. The EU's goal to ban sale of new ICE vehicles from 2035 is incumbent upon Italy, like other member countries of bloc.

In April 2022, the government approved an annual €650 million allocation for the electric and other low-emission vehicles for the period through 2024. The funding was to enable purchase incentives. A subsidy worth €5,000 was made available for the purchase of new electric vehicles that cost up to €35,000 without value added tax. The subsidy amount includes a €2,000 contribution for scrappage of ICE vehicle. In case of the plug-in hybrid vehicles costing up to €45,000, the subsidy was up to €4,000, including a planned €2,000 contribution for old unit scrappage. For the year 2023, the outlay for the electric vehicle incentives is at €150 million.

The formulated incentives have scope for the conventional vehicles as long as their emissions are in the range of 61-135 gm CO2/km. The ambit of subsidies also includes non-electric motorbikes and mopeds. The disbursal of subsidies will follow the principle of 'one subsidy per household' including the cases of leasing contracts. A part of the allocated funds for subsidies is for rental companies, but the stipulation is that the vehicles should be held for at least a year from purchase.

Subsidies are separately allocated for electric vehicle procurement by the small and medium enterprises. The incentives are structured by vehicle weight – €4,000 for up to 1.5 tonnes, €6,000for the ones ranging 1.5-3.5 tonnes, €12,000 at 3.5-7.0 tonnes, and €14,000 for 7.0-12.0 tonnes. This set of incentives was budgeted for €15 million in disbursal through 2023.

Market Opportunity

Leading automakers have been making investments towards preparing for the transition to electric vehicles. The planned investments are likely to manifest in varied forms, such as in terms of joint ventures for competitive and cost-effective locations globally. The luxury auto manufacturer Ferrari, for instance, announced that its first electric vehicle will be launched in 2025. The company projects full-electric and hybrid-electric vehicles to contribute 80% of its sales by 2030. A similar luxury brand Lamborghini is aiming for the similar pivot, with a plug-in hybrid vehicle in 2023 and a full-electric by 2030.

An important planned investment in Italy, among automakers, is that of Stellantis. The company, through its venture ACC (with Mercedes Benz and TotalEnergies) plans three Gigafactories of which one of them is slated for Italy. The planned battery capacity will be established by reconfiguration of its existing engine and gearbox plant at Termoli of Italy. Development work will start from 2024, with initial operations planned for commencement within 2026. The total investment is estimated at €2.3 billion, aided by public funding worth €370 million.

Since last 1-2 years, public procurement of electric buses rose at a rapid pace. Some of the leading cities are thus placing orders for electric buses, as replacement for the existing transit fleet of operators. Leading OEMs such as Solaris have cornered most of the orders in recent year, though others, especially Chinese manufacturers are gradually coming to the fore. In January 2023, the transit company Busitalia signed a framework agreement with Iveco Bus for 150 electric buses required between 2023 and 2025. Notably, the manufacturer Iveco started its new powertrain facility in Turin at Italy in October, in anticipation of the demand. Various other entities are reported with making a market entry to tap into the demand. In June 2022, Enel X (subsidiary of Enel) and Arrival entered into a partnership to test electric bus launch in Italy. The testing, involving Enel X's advance charging services, was aimed at assessing the feasibility of the Italian market.

For practically all investors, a significant part of the attention is towards the Italian charging network sub-segment. With the wide scope of expansion, private players have a huge untapped opportunity even with the upcoming publicly-funded capacities. In June 2022, the electrical equipment manufacturer ABB, under its business segment ABB E-mobility, launched a DC-based fast-charger production facility in Valdarno of Italy. This entailed a $30 million investment, with the result that the company could now avail of a double production capacity.

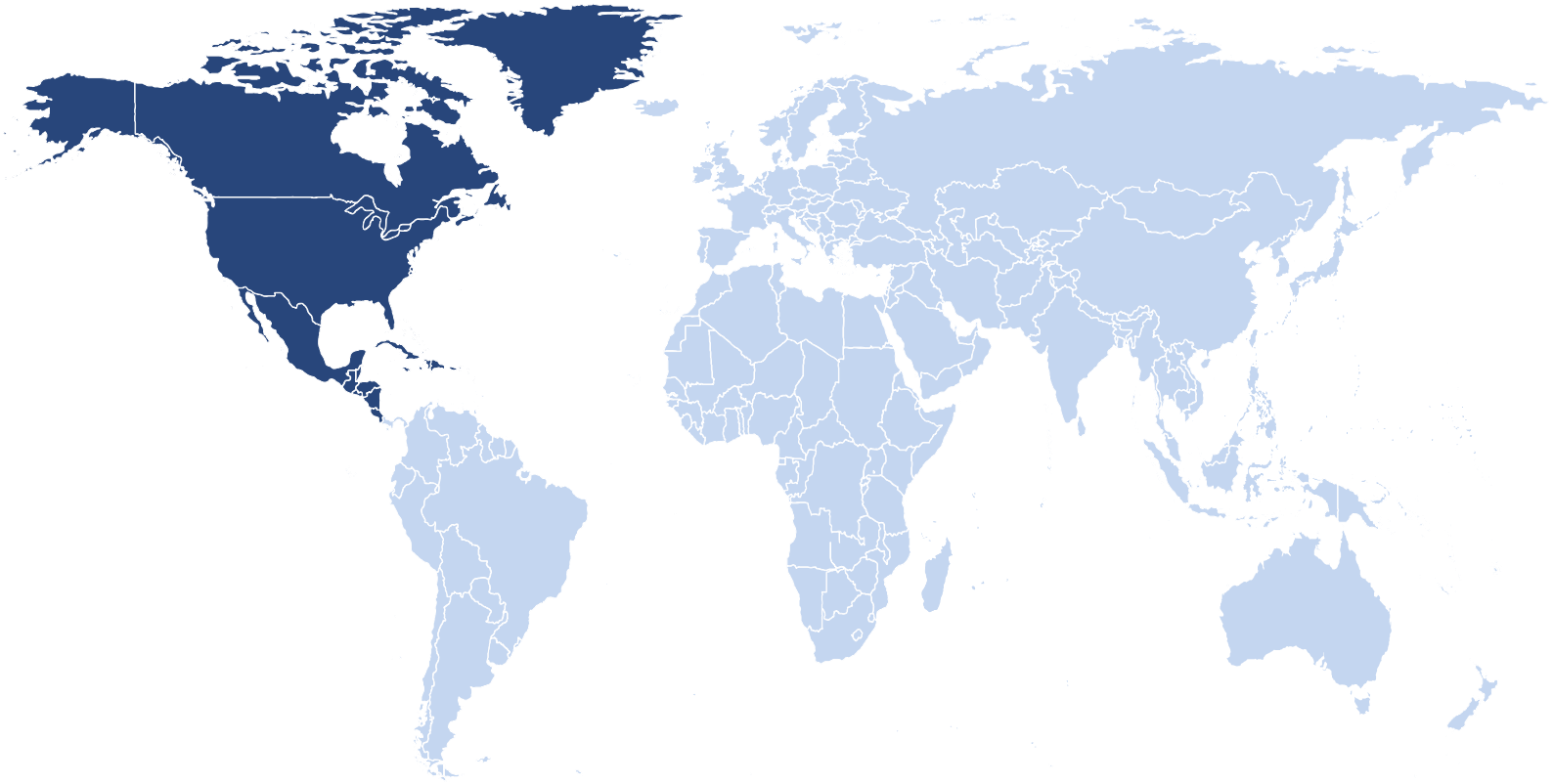
Fast-charging is also the focus of several joint venture investment projects. Enel X Way and Volkswagen launched the joint venture Ewiva to build a high-power charging network of 3,000 charging points across Italy. Each such charging point will be based on rated power of up to 350kW and will be based on renewable energy. The first such charging station was inaugurated in Rome, as of December 2022. The entire project could be completed by 2025. Among other areas, the emerging technology options such as induction charging are under active consideration. In June 2022, the Brebemi highway in Italy's Lombardy had a successful test-launch of an induction charging system, involving an electric bus and passenger car. Funding support for the charging capacities also include institutional support. As of March 2022, the Italian charging service entity Duferco Energia, received €26 million in funding through contracts entered into with Cassa Depositi e Prestiti, Crédit Agricole Italia, and the European Investment Bank.

Outlook

Italy's auto industry faces a major transitory shift for the 2035 goal of stopping new sale of ICE vehicles. The government acknowledges that it is a major challenge for the indigenous manufacturing base, which is why the subsidy allocation for electric vehicles are part of a larger package for the automotive industry's overall restructuring. It is noteworthy that the automakers of this industry have mostly aligned towards hybrid options for now and not majorly towards the fully electric ones. The same reflects in the breakup of registrations in alternate fuel vehicles.

In January 2023, the Ministry of Environment and Energy Security laid out the policy target of installing over 21,000 charging stations by 2026 for the urban and inter-urban roads. This would include financing of at least 7,500 superfast charging points (about 175kW in rated power) and 13,755 fast-charging points (90kW) in the cities. Expanding the charging network will be among the critical points of infrastructural push that could help facilitate the decarbonisation and electrification goals.

Key Regional Markets - North America



Countries Covered

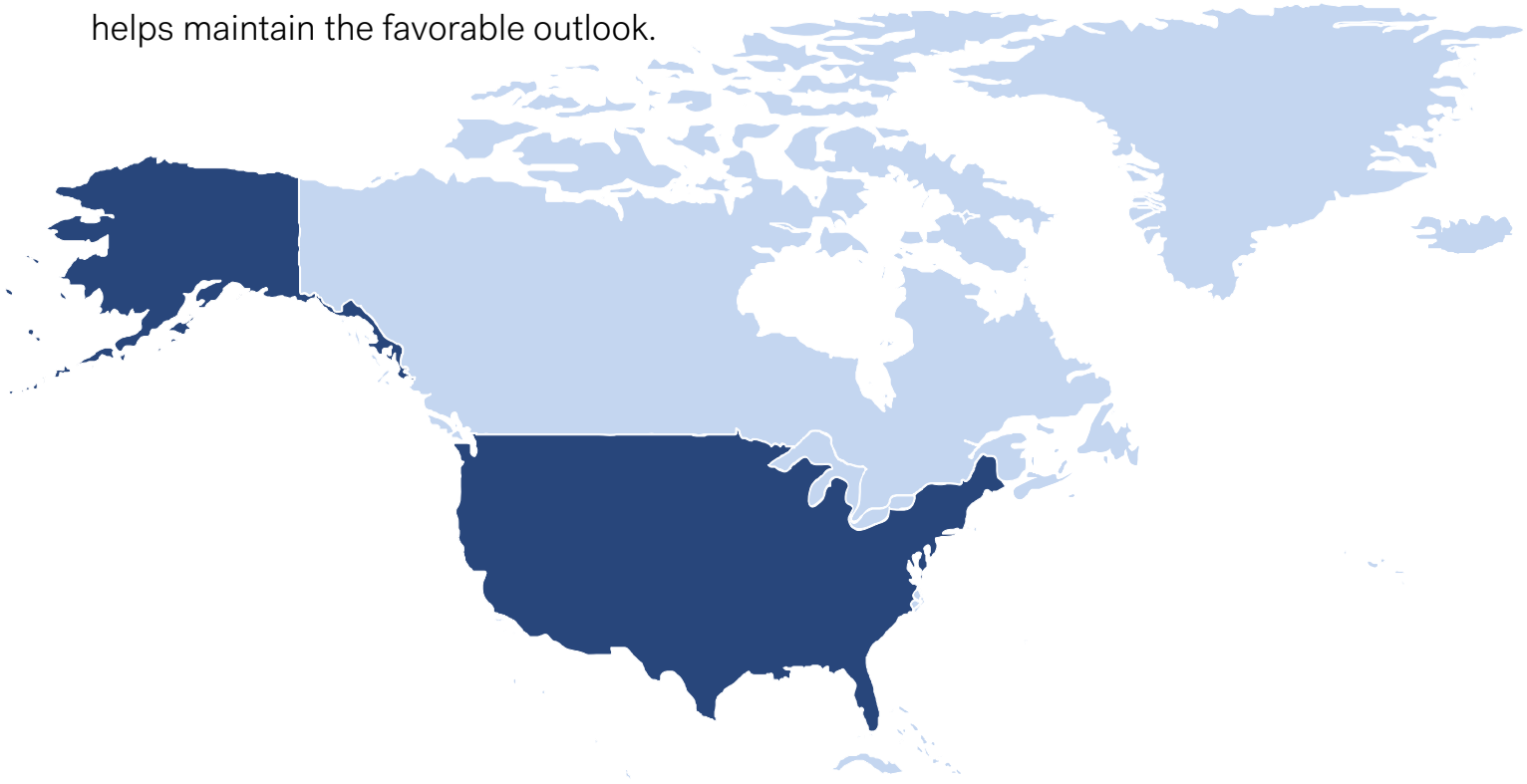
1. United States
2. Canada
3. Mexico

United States

The US electric vehicle market stands to reap significant benefits from federal policy incentives rolled out for the industry. Under the provisions of the Inflation Reduction Act, there are incentives available for the entire electric vehicle ecosystem which makes for a favorable outlook for attracting investments in the industry. The investment announcements indicate a bullish outlook shaping for the battery manufacturing and vehicle manufacturing, though the capacities are far from commissioning. A strong demand and sales momentum in the electric vehicles helps maintain the favorable outlook.

GDP (Current Prices) USD (2021)	22,996.08 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.26%
EV Penetration	5.6% of the total new passenger vehicle sales in 2022
EV Target	50% share of electric vehicles in total new passenger vehicle sales by 2030
Planned Year of Phasing Out ICE Vehicles	No federal-level targets

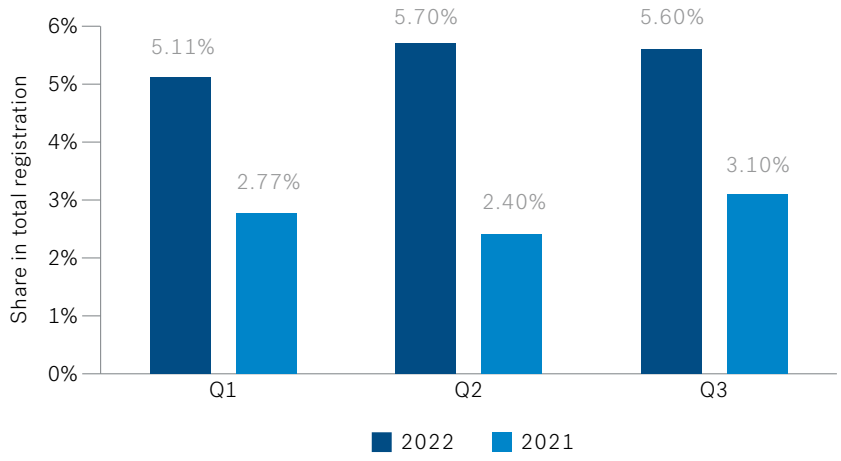
GDP Source: IMF, World Economic Outlook



United States

EV Penetration and Trend

Trend in Passenger Electric Vehicle Penetration



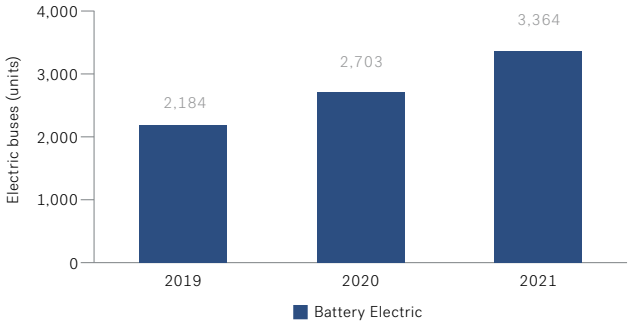
Source: Experian Information Systems

The US market for passenger electric vehicles is gradually inching towards a tipping point. While estimates vary across the industry research reports tracking the sales, there is a convergence in insight – pointing to an acceleration. By end-2022, electric vehicle penetration for passenger segment stood at 5.6% (Kelly Blue Book), marking a sharp contrast against 1.9% in 2019. The demand for such vehicles is already established even as the supply-side seeks to get its act together in terms of the models, price points, and components among others. Over 60% of the sales continues to be skewed to one make of electric vehicle (i.e. Tesla).

While the short-term macroeconomic challenges of rising interest rates and inflation may slow down the growth momentum, the sale of electric vehicles are likely to find a greater thrust from the rapid product launches across automakers. The impact of Inflation Reduction Act however is yet to be assessed for the specific models which qualify for the available incentives. Once clarified, the incentives could catalyze the already high demand.

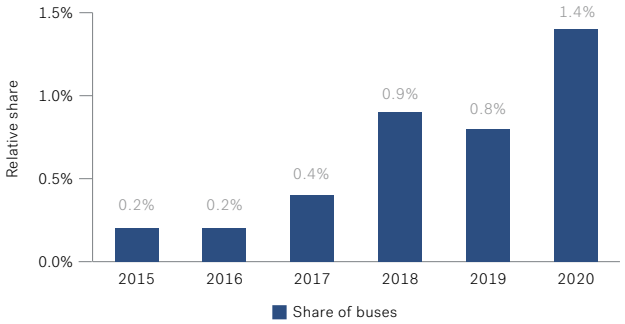
An equally steady demand-led growth could be found in the electric bus segment. So far, the electric bus adoption has been at a nascent stage, especially in public transit. The situation appears to be changing. It shows in the rise in absolute number of units in the public transit fleet (24% rise by end-2021), and the rise in penetration of such buses over the years. While the recent federal incentives help, a bigger role is that of the cities and municipalities propelling the shift to a decarbonized public transportation network.

Electric Public Transit Buses in Fleet



Source: CALSTART

Historical Trend of Penetration of Battery and Alternate Fuel Transit Buses

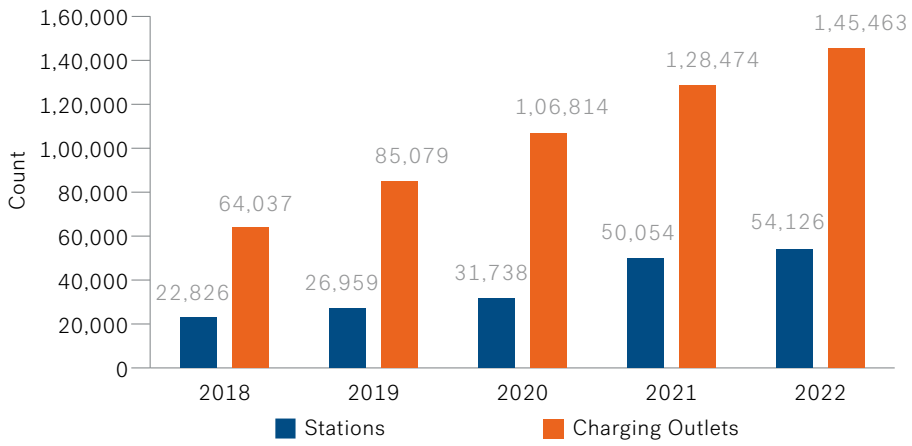


Source: American Public Transportation Association

Micromobility is another segment where battery-based platforms have an increasingly important role. In this regard, the growth in various platforms such as docking or dockless bikeshare and e-scooter systems has been varied. According to the US Bureau of Transportation Systems, as of July 2022, there were 45 dockless bikeshare systems serving 35 cities. The e-scooter systems have had significant growth – reaching 300 in 2022 (158 cities), as compared to 135 in 2018 (58 cities).

Charging Infrastructure

Trend in Number of Charging Ports and Stations



Note: Data point shown for 2022 was sourced as of mid-January 2023

Source: Alternative Fuels Data Center

The trend confirms a rapid growth in US electric vehicle charging infrastructure, as the number of stations rose at a CAGR of 24% during 2018-2022. Yet, an even faster growth is warranted to support the emerging electric vehicle adoption across the country. Further the required growth must be spread out more evenly than the current levels. The state of California has the largest number of charging stations, with more than the combined capacity of the next three states in the ranking (New York, Florida, and Texas). Most of the country's charging infrastructure is placed in the West and East coast regions. The capacity is also skewed due to the concentration of the public charging facilities in high-income urban areas.

The charging infrastructure supply in the US is currently a mix of facilities available through automakers' proprietary charging units, standalone charging facilities, residential and public facilities. Progressively the skew will need to be addressed. The US government's IRA (Inflation Reduction Act) is one important step in this regard due to the emphasis on equitable provision and standardization in technology and equipment. Standardization in the prices and charging speeds are other areas where there is significant scope of standardization.

The battery industry is meanwhile finding significant traction with the slew of investments announced in the recent times. The federal policy incentives combined with those of the respective states helped build the momentum. The existing battery manufacturing capacity (about 44GWh) is largely led by Panasonic whose manufacturing is undertaken in conjunction with that of Tesla for the latter's capacity demand.

Policy and Regulation

The Bipartisan Infrastructure Law, (or the Inflation Reduction Act (IRA)) is the most significant change in the policy framework impacting electric vehicles and its related sectors (such as battery supply). There are other significant policy steps aimed at promoting the indigenous industrial base which potentially impacts the electric vehicle ecosystem. A common thread across such recent policy pronouncements has been the need to incentivize investments in the face of global competition.

The IRA offers a package of incentives. From 2023, the electric vehicle manufacturers won't be subject to the 200,000 units cap on sales to avail the clean vehicle tax credit. This eases the constraint for many of the leading automakers such as Tesla and GM which had met the mark ahead of schedule last year. Also, the cap helps restore some of the relative competitiveness against the imported vehicles. Furthermore, the new vehicles will be eligible for a $7,500 tax credit at the point-of-sale. This credit is bifurcated in two parts, namely the critical mineral and battery components – both of which need to be fulfilled in terms of their sourcing requirements.

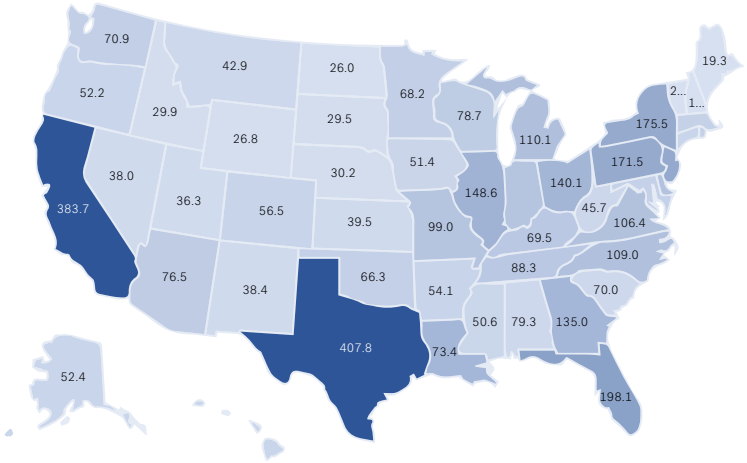
IRA's local sourcing requirements are the most notable, for the larger ramifications it has on the industry. The norms require indigenous sourcing of battery components for the vehicles manufactured after 2023. Also, over 50% of the battery component manufacturing and assembly should be in North America starting 2023, with this share rising by 10% every year through 2028. As a corollary to these regulations, all the vehicles' final assembly is to be in North American facilities.

The IRA provisions also include the commercial electric vehicles in the tax benefits. Starting 2024, clean commercial vehicles will be eligible for tax credit equivalent to 30% of the vehicle cost or the difference between the cost of such vehicle and its conventional engine counterpart.

The federal policy framework devotes notable attention towards the charging infrastructure. This not only involves funding the infrastructure build-up, but also incentivizing the direction of such a growth. In June 2022, the US Department of Transportation (DoT) proposed minimum standards and requirements for the charging projects' funding.

DoT's $5 billion National Electric Vehicle Infrastructure (NEVI) Formula program makes funding available to states for development of charging stations and the related interconnected network for data collection, access, and reliability. Up to 80% of the project costs are covered through the budgeted allocation. The funds are distributed through the Federal Highway Administration (FHWA) based on the outlay of each fiscal year till 2026. The charging stations funded under such a scheme are required to meet certain criteria such as non-proprietary technology, amenable to open access payment methods, be publicly available or available to the authorized commercial motor vehicle operators from more than one company and to be located at FHWA-designated alternative fuel corridors.

Five-year (FY 2022-26) National Electric Vehicle Infrastructure Funding by State (USD million)



Source: US Department of Transportation, Federal Highway Administration

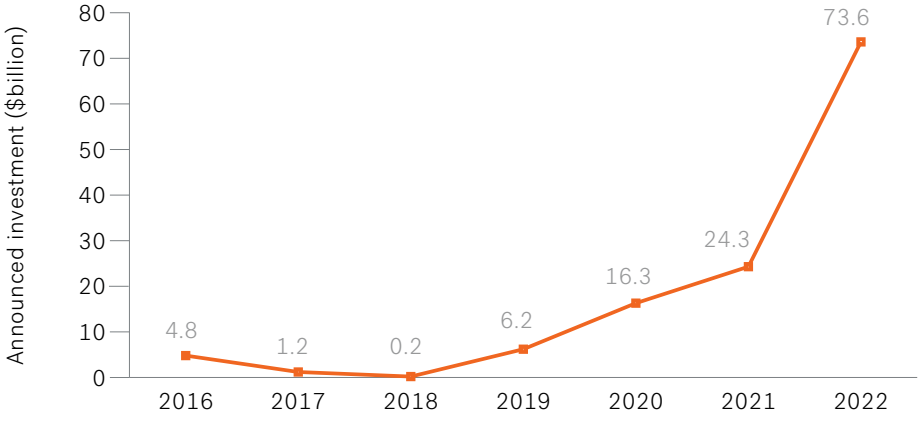
At the state-level, as of April 2022, there were at least 45 states and the District of Columbia offering an incentive for electric vehicles either through a specific utility or through legislation. The incentives include either tax benefits or rebates for meeting fleet acquisition targets, exemptions from emission testing or reduction in the utility time-of-use rates.

Another important federal legislation that adds fillip to the overall industry landscape is the enactment of $280 billion Creating Helpful Incentives to Produce Semiconductors and Science (CHIPS) Act of 2022. The CHIPS Act is aimed at enabling investments in the US domestic semiconductor industry. While this is still in the longer-term, the enabling provisions stand to potentially impact the electric vehicle industry due to the significant technology spillovers involved in the process.

Market Opportunity

The demand across the electric vehicle manufacturing chain is driving investments from global players. The planned investments are led by the incumbent original equipment manufacturers, automakers, technology providers, startups, and strategic joint-ventures between the automakers and battery manufacturers. The traditional automakers stand out for the scale of investment commitments made. Ford Motors has a $35 billion investment plan through 2026 to expand the electric vehicle production, while GM and LG together will avail of a $2.5 billion Department of Energy loan for three production units.

Investments Announced in the US Electric Vehicle Manufacturing Industry



Source: NPR

The most important development to note in the planned or announced investments is the emerging pipeline of Gigafactories, many of which are clustered in the Midwestern and Southern parts (aligned to major automakers' production base). The geographical concentration of upcoming Gigafactories (and their related ancillary units) is also being increasingly referred to as the 'battery belt'. Besides proximity to the automakers' units, some of the key factors driving the Gigafactory capacity locations include energy costs, workforce availability and liveability. The hosting states are, at the same time, extending benefits to competitively attract the investments. An example in point is Tennessee's $884 million incentive package for Ford Motor's planned capacity.

There is a spike in the planned investments for batteries and electric vehicles. The reason is the Inflation Reduction Act's tax credits for indigenous electric vehicle components. The policy objective of attracting investments in the country has also effectively meant a competitive posture against the similar investment destinations in European and other countries. Since IRA's enactment, capacity announcements rose 35% year-on-year (as of December 2022) in the US, against 17% in Europe for the same period. A related point of note is that IRA discourages Chinese investments, with the result that the South Korean and Japanese origin companies are seeking to avail of the benefits.

Policy support is also propelling select sub-segments in the overall electric bus segment. There is federal and the state level push to decarbonize the school bus fleet. The US Environmental Protection Agency's (EPA) Clean School Bus Program enables adoption of low-emission or zero-emission buses. It has a $5 billion outlay for 2022-2026, under the federal infrastructure law (IRA). About $965 million was allocated for the budget year starting October 1, 2022. Independently, states have enacted legislations for school bus electrification. As of July 2022, there were 38 states placing clear commitments for electric school bus procurement. New York was the first state (as of April 2022) to target 100% zero-emission school buses by 2027. Since then, notable examples are of Connecticut, Maryland, and Maine with targets defined in fleet replacement. For many suppliers/manufacturers, this has opened a significant market opportunity. In May 2022, Blue Bird Corporation reported its largest ever order size of electric school buses.

Similar massively sized orders are in line for the commercial electric vehicle segment. In December 2022, the US Postal Service announced plans to acquire at least 66,000 electric delivery vehicles. The planned acquisition, to be undertaken through 2028, is part of the overall scheme of ageing vehicle fleet renewal. The total investment is expected to reach $9.6 billion, including $3 billion from the IRA funding.

A policy push is similarly behind augmenting the critical charging infrastructure needed to accommodate the upcoming transition in drivetrain. The Infrastructure Law's budgeted outlay sets the base. The demand for capital expenditure is much higher than this and necessitates mobilizing private investments. Beyond the large-scale federal investments, companies are formalizing joint ventures and partnerships to tap into this segment.

Partnerships and Commercial Arrangements for Charging Infrastructure (Illustrative)

Partnership Entities	Description
HERTZ AND BP	MoU signed in September 2022 for a national network of charging stations under the BP Pulse brand.
DAIMLER TRUCK NORTH AMERICA, NEXTERA ENERGY RESOURCES, AND BLACKROCK RENEWABLE POWER	MoU in January 2022 for fast-charging network to cater to freight transportation. Initial funding was about $650 million.
VOLVO GROUP AND PILOT	Letter of Intent signed in November 2022 for medium- and heavy-duty electric trucks' charging infrastructure.
ENELX AND HION DISTRIBUTION	Partnership agreement as of August 2022 for the construction and rollout of smart EV charging stations across the US.
NIKOLA CORP. AND CHARGEPOINT	Partnership announced in November 2022 that will enable Nikola customers' access to ChargePoint locations.

Note: MoU: Memorandum of Understanding
Source: Press releases and news reports

Proprietary charging is another segment in the US electric vehicle ecosystem. The automaker Tesla has had an early mover advantage in this regard. A few other companies joined the fray to match the network coverage. The trend may however face other counteractive forces, such as the standardization of charging network protocols (as planned in the US government funded schemes).

Proprietary Charging Networks of Automakers

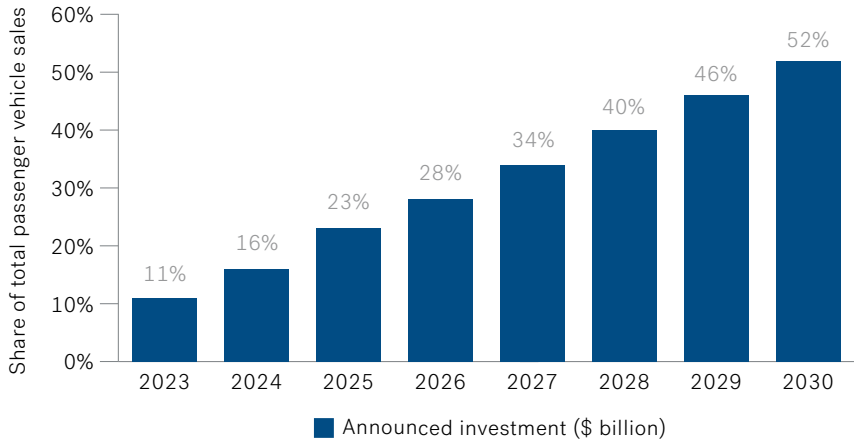
Company	Charging network (existing / planned)
Tesla	A DC-based fast-charging network (branded as 'Superchargers') of 1,400 stations across the US. The company is considering opening this network up to other electric vehicles.
Rivian	A two-fold approach involving an ongoing rollout of DC-based fast-charging stations (branded 'Rivian Adventure Network') and Level-2 charging network ('Rivian Waypoint Network').
Porsche	In May 2022, the company announced its plans to build its branded proprietary charging infrastructure. This will be undertaken even as the company already has partnerships with third-party charging entities for the provision of infrastructure.
Mercedes-Benz	Planned 400 fast-charging hubs and 2,500 chargers across the North American region. The company will be partnering ChargePoint and MN8 Energy for the planned rollout.

Source: Press releases, company websites

Outlook

The US federal government's policy incentives drastically changed the outlook for the electric vehicles in the country. Most of the leading industry reports revised their respective estimates upwards, to reflect the boost in adoption of electric vehicles, especially in passenger vehicle sales. The projections appear to concur with the US government's stated goal of achieving electric vehicles sales share of 50% by 2030. At the same time, it is also notable that the US government stopped short of banning the sale of new internal combustion engine vehicle sales. This may hinder the targeted net-zero emission of 2050. Overall, the US market's progress is likely to lag behind that of the European markets due to the latter's aggressive steps in effecting the transition.

Projected Electric Vehicle Sales Penetration in the US



Source: BNEF (reported in Bloomberg News)

The charging infrastructure will come into a sharper focus than before, as rising number of vehicles could exert pressure on the charging network density. NREL's projections suggest a sharp decline in the density of the fast-charging infrastructure, which is otherwise considered critical in the public charging segment. Key issues such as standardization of the technical standards, infrastructure sharing and access, public-private partnership and the timeliness of capacities will determine growth contours of this segment. It is notable that most of the projected charging infrastructure investments in the US market is in the private / residential segment. The public charging segment however may be crucial for the electric vehicle sub-segments in freight, public transit and related heavy-duty platforms.

Charging Infrastructure Density Projected by 2030 (ports per 1,000 vehicles)

Charging port level	Existing ratio	By 2030
DC fast-charging	9.5	1.8
Level-2	41.5	40.1

Note: The projected ratio is based on NREL's estimate of 15 million electric vehicles by 2030
Source: NREL

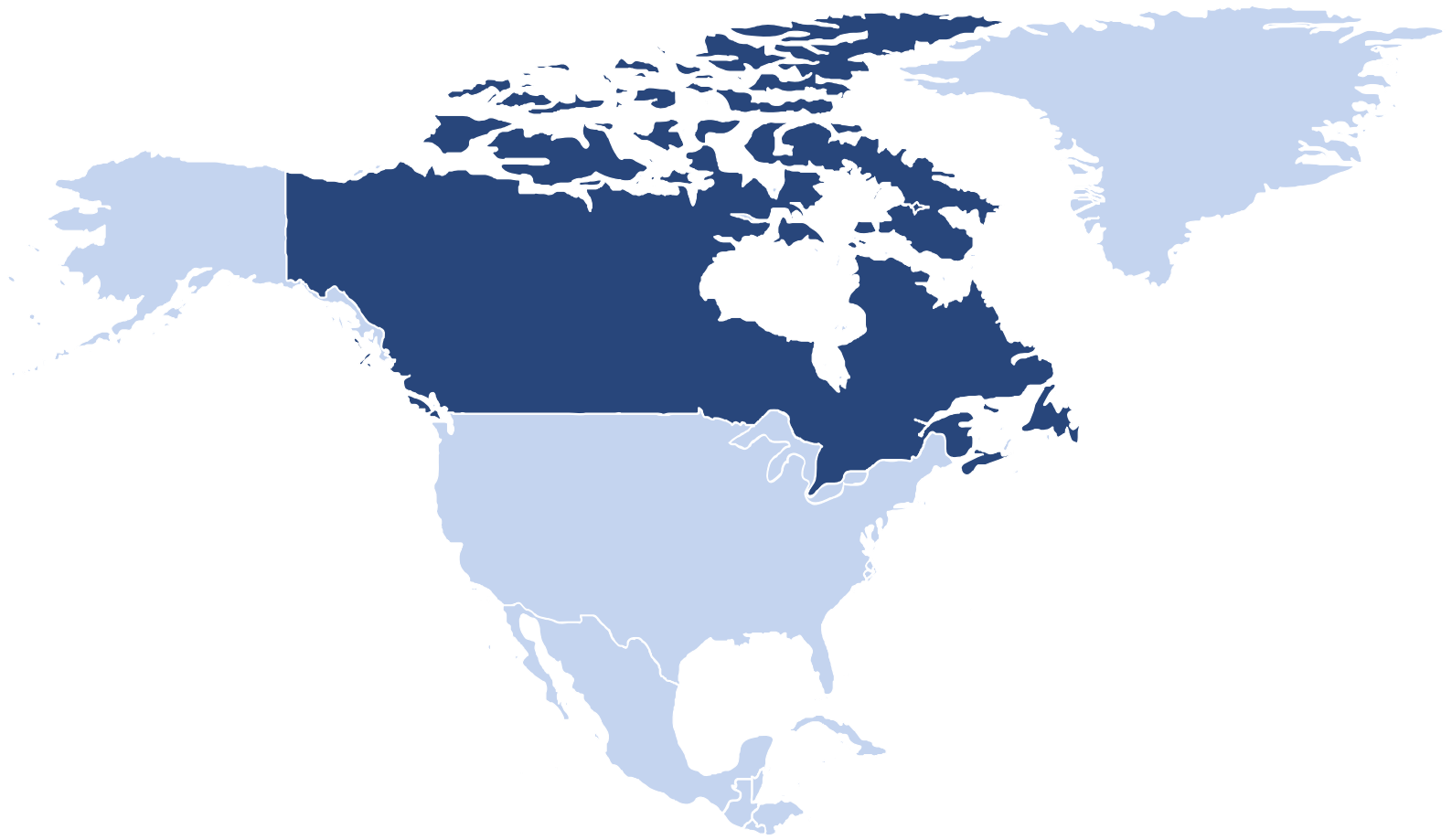
Macroeconomic uncertainties could act as a potential dampener. The electric vehicle industry, for all its strong fundamentals, is in infancy. By early 2023, overall auto sales in the country were reported at their lowest levels in a decade and reflected partly the challenges arising from a recessionary demand pressure. A persistent demand slowdown could act as a stressor on the electric vehicle industry.

Canada

Canada is progressively assuming the centre stage in the global electric vehicle market. The country boasts of a strong manufacturing ecosystem and is devoting a considerable budgetary provision to make it worthwhile for investors. The country's industrial landscape is set for a drastic transformation as the policy seeks to inject massive funding support, in part to counter the extremely competitive subsidies from its trading partners in the region.

GDP (Current Prices) USD (2021)	1,988.34 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.64%
EV Penetration	18% of total new passenger vehicle registrations in Q3 2022
EV Target	By 2035, all new light-duty cars and passenger trucks in Canada must be zero-emission
Planned Year of Phasing Out ICE Vehicles	2035

GDP Source: IMF, World Economic Outlook

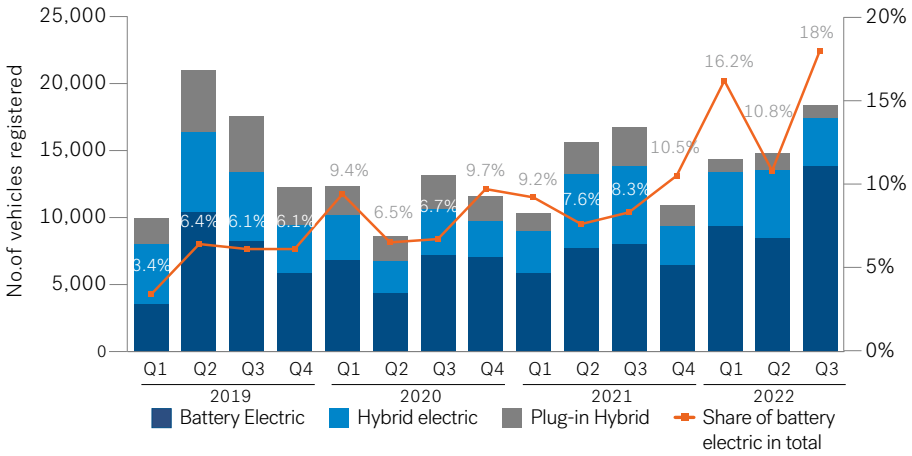


Canada

EV Penetration and Trend

The long-term trend in the Canadian vehicle registrations indicate a gradual shift favouring the electric vehicles. While registrations of overall vehicles (all fuel-types) have declined over the years since 2017, the same has been consistently rising for the battery electric vehicles. By end of Q3 2022, the battery electric vehicle registrations were 18% of the total, contrasting the 1% in Q3 2017. The comparison is also stark when plug-in hybrids are considered – they held 1% share in total registration of Q3 2022, same as it was in 2017.

Trend in Passenger Electric Vehicle Registrations



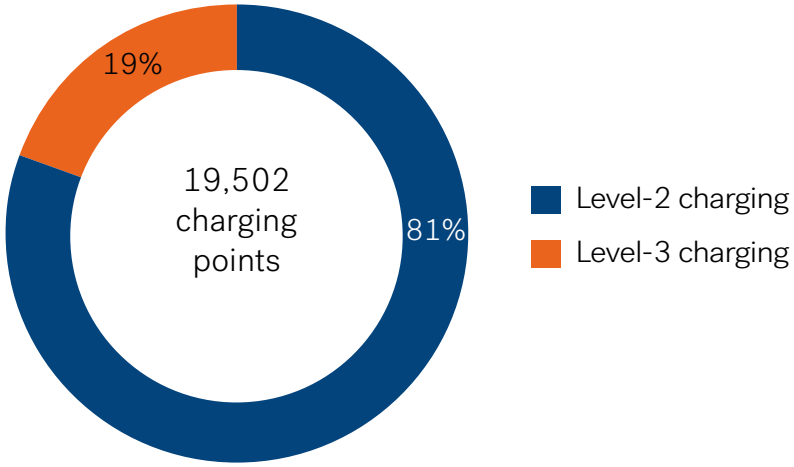
Note: (a) The data refers to vehicle registrations, and is different from sales
(b) Share of battery electric vehicles refers to their proportion in vehicles of all fuel types including conventional
Source: Statistics Canada

Canada's rise in electric vehicle penetration is imminent and steady. But the growth is skewed and not well-entrenched yet in the mainstream automotive market. Just about two provinces of Quebec and British Columbia corner most of this market, in part due to their early start in offering rebates and the sales quotas for automakers.

Charging Infrastructure

As of early 2022, Canada's charging infrastructure comprised 19,502 charging ports across 7,967 sites. About 90% of the total capacity is concentrated between the provinces of Quebec, British Columbia and Ontario, the maximum being for Quebec (39%). Such skew reflects the electric vehicle penetration achieved across the country – a select few provinces have been leading the way in promoting the shift to electric vehicles while others lagged by a far margin.

Classification of the Installed Charger Base by Type



Note: Level-3 charging generally denotes DC-based fast-charging
Source: CSA Public Centre

Studies undertaken to assess existing and projected charging requirements indicate that home-based charging holds a predominant share in Canadian electric vehicle market. About 80% of the charging is dependent on charging at home and access to the same is a determinant in electric vehicle purchase decision. Also important is that most of the households owning electric vehicles stay in single-family house or townhouse with dedicated parking, those in multi-unit residential buildings hold a minor share. The charging infrastructure planning and norms thus must factor-in such a skew.

Canada presently does not have a battery production facility. But this could change soon. It is rapidly emerging as a destination for manufacturing investments due to the availability of critical minerals including Lithium and the related industrial setup. Most importantly, the country ranks among the top globally for the battery production ecosystem (that includes mining, mineral refining and processing, components, and others). BNEF's survey, as of November 2022, had Canada in the second position globally, behind China, in a battery supply chain ranking of 30 countries.

Policy and Regulation

The Canadian government has set targets for phasing out the conventional vehicles in transportation. By 2035, all new light-duty cars and passenger trucks in Canada must be zero-emission. This advanced the previous target of achieving the same by 2040. Transportation continues to be in sharp focus as part of the overall decarbonization objectives, considering the sector's 25% contribution to the total emissions.

The federal regulations offer some incentives to mitigate the upfront cost of electric vehicle purchase. The Zero Emission Vehicles program (iZEV) provides point-of-sale incentives for purchase or lease of listed eligible vehicles. Battery electric or longer-range (battery-based range of at least 50 km) plug-in vehicles are entitled for $5,000. The same for shorter range hybrid or plug-in vehicles is $2,500. For the businesses there is an option to avail of tax write-off for the zero-emission vehicle, as provided since the Budget 2019.

Select Canadian provinces offer higher incentives than the federal level. Quebec is one such case. Its incentives are also cited as one of the reasons why concentration of electric vehicles is higher than in others. For electric vehicles priced up to $60,000, the available rebate is $7,000, while for the limited speed electric motorcycles/scooters, it is at $500. For most of the other provinces, it is the federal incentives that act as the primary option. The provinces of Quebec and British Columbia also appear to have taken a lead in terms of mandating sales targets. The zero emission sales mandates by Quebec and British Columbia refer to 8.5 million and 5 million respectively, with penalties defined for conventional vehicles beyond a fixed level.

Another federal government support comes from the Zero Emission Vehicle Infrastructure Program, valid till 2027, provides for a cost-sharing support for the eligible electric vehicle charging projects. The government's contribution is restricted to 50% of the project cost or maximum absolute value of $5 million, and up to $2 million per project for the delivery organizations.

Funding support under the Zero Emission Vehicle Infrastructure Program

Charger type	Output	Maximum funding	Maximum funding for indigenous businesses and communities
Level-2 (208/240 V)	3.3kW - 19.2kW	50% of total project costs, to a maximum of $5,000 per connector	75% of total project costs, to a maximum of $7,500 per connector
Fast charger	20kW - 49kW	50% of total project costs, to a maximum of $15,000 per charger	75% of total project costs, to a maximum of $22,500 per charger
	50kW - 99kW	50% of total project costs, to a maximum of $50,000 per charge	75% of total project costs, to a maximum of $75,000 per charge
	100kW - 199 kW	50% of total project costs, to a maximum of $75,000 per charger	75% of total project costs, to a maximum of $112,500 per charger
	200kW and above	50% of total project costs, to a maximum of $100,000 per charger	75% of total project costs, to a maximum of $150,000 per charger

Source: Press releases, company websites

Market Opportunity

The Canadian government's critical minerals strategy, unveiled in December 2022, outlined the broad contours of a CAD3.8 billion funding allocation for the emerging mineral demand in the clean energy and zero emission transport technologies. Additional available support includes a 30% exploration tax credit for targeted minerals. Importantly, the strategy document puts forth measures to expedite the regulatory processes across national, sub-national and international levels. Such a policy statement is also pertinent in the backdrop of several government-led investments planned or underway in the electric vehicle ecosystem.

A marked shift in policy focus from yesteryears is the intent at supporting or even subsidizing the costs in the electric vehicle and its related manufacturing ecosystem. It promises a transformative impact on the country's industrial landscape. While a formal statement to this effect is yet to be released, the pattern from recent government support is indicative of the stance. There are other projects in the pipeline for which the formal funding support information was not released due to the commercial negotiations.

The government's statements hold forth that budgetary support for private investments will be scaled up. Leading automakers such as Volkswagen and Mercedes have been in talks for their plans to invest in Canada. In December 2022, Volkswagen committed to setting up a battery production unit in Canada, as part of its agreement with the authorities.

Government Support Extended Towards Indigenous Production Facilities and Technology

Company	Funding support/grant	Description
Stellantis	$529 million	Federal funding to support modernization of assembly plants.
General Motors	$518 million	Funding split equally between Ontario and federal government for reconfiguration of existing capacity
Honda	$130 million	Funding by each of Federal and Ontario government for company's switch to electric / hybrid drivetrains.
Umicore	-	Federal support yet to be announced. Company plans $1.5 billion investment for battery components.
E3 Lithium	$27 million	Contribution under the Net Zero Accelerator Initiative for a demonstration plant of Lithium production.
Vital Metals	$5 million	Federal funding to support processing and production at the existing facility

Source: Canada Prime Minister's Office, Government press release, Globe News and Reuters

The commercial discussions with battery manufacturers are part of the larger policy aim to subsidize operational costs and thus counter the similar federal support available from the US. The end goal is to incentivize entities to set up, or to retain their existing production facilities in the country. The ambit of discussions is thus wider, including not just leading global automakers but also entities in the South Korean battery sector.

The policy narrative is also being shaped by the push for 'friendshoring' – a means to realign the supply chain networks in favour of regimes that share similar aims and practices in government policymaking. The implicit thrust is to enable and develop alternatives to China's near-unavoidable grip on the global supply chain. Despite lacking comparable scale, Canadian manufacturing ecosystem is progressively getting attention for the capabilities and support on offer.

Following the practice of other leading markets globally, the Canadian local and municipal authorities are gradually initiating procurement for electrification of their bus fleets. In January 2023, the capital city of Ottawa received $350 million in funding for a batch of 350 electric buses. By 2036, the city's public transport operator could convert its entire fleet to one based on electric. Other key cities and municipal authorities taking the same route include Toronto Transit Commission (270 hybrid-electric buses ordered in April 2022), Regina (Master Plan approved for electrification), and Saint John (plans submitted to local council for electrification).

Public funding is also supporting the charging infrastructure build up. Federal funding worth $900 million has been made available for about 50,000 charging stations. It includes support from Canadian Infrastructure Bank. There is also the $680 million Zero Emission Vehicle Infrastructure Program that funds eligible charging infrastructure projects through cost-sharing agreements. Public charging points are expected to gain a greater focus as authorities seek to moderate the existing skew in access to charging. A study done on behalf of Natural Resources Canada indicated an investment requirement of about $20 billion over the next 30 years for scaling up the Canadian charging network.

Outlook

To fast-track the targeted shift to electric and other zero-emission vehicles, the government has introduced sales targets, starting 20% of all passenger car, utility vehicle and truck sales by 2026, 60% of the same by 2030, and 100% thereafter by 2035. The manufacturers or importers unable to meet these could expect penalties. Also under consideration is to issue sales credits for such vehicles – sale of fully electric cars or trucks will earn higher credits than plug-ins. Government's estimates indicate that with such targets, new sale of zero emission vehicles could be at 2 million units by 2035.

The targeted electric vehicle penetration is fairly ambitious considering the progress so far. A skewed progress across provinces and the limited scale of charging infrastructure makes it difficult to chart a rapid scale up in the electric vehicle sales. It also does not help that there is a significant variance in the regulations between federal and provincial level. The sales mandates for instance, are being found overtly stringent in provinces against what the federal level prescribes.

A much more encouraging picture is however found in the manufacturing space, where government funding has set the context. Starting 2023, the scale of such government spending, both at federal and the state level could rise. The flip side of the upcoming drastic push for industrial investment is that it comes in the backdrop of a somewhat avoidable competitive subsidy regime where US and Canada strike bargains in their incentive offerings for prospective and existing investment capital.

Mexico

The automotive industry is integral to Mexico's economic growth. The country ranks seventh in global automobile production and is the largest exporter of trucks. With a well-established industrial ecosystem and a trading agreement in North America, Mexico is favourably positioned to capitalize upon investments for electric vehicle manufacturing. The country's own electrification of transport however remains to be seen. With an absence of fiscal incentives and lack of investment in public charging infrastructure, the transition remains uncertain.

GDP (Current Prices) USD (2021)	1,297.66 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.40%
EV Penetration	~3% of total new passenger vehicle sales in 2022 (includes battery electric, plug-in and hybrids)
EV Target	50% of the vehicles manufactured will be fully electric or hybrid by 2030
Planned Year of Phasing Out ICE Vehicles	-

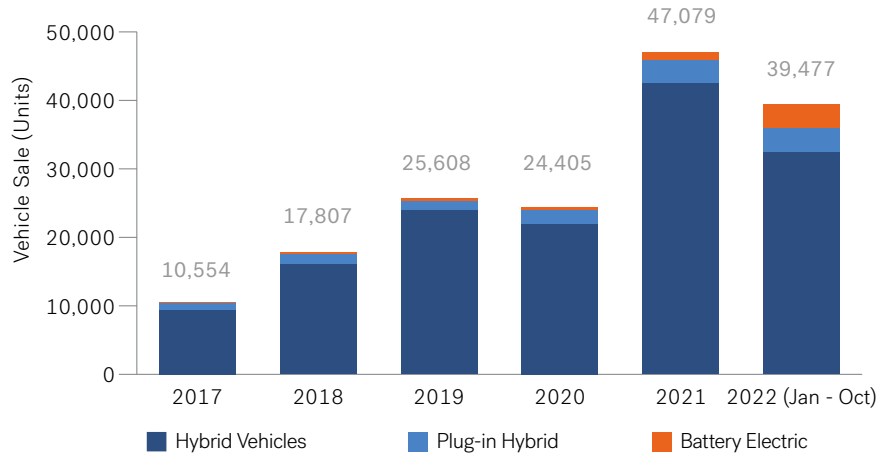
GDP Source: IMF, World Economic Outlook

Mexico

EV Penetration and Trend

Pure electric vehicles (based entirely on battery) are yet to assume any significant position in the Mexican light automotive sales. With hybrids along, the electric vehicle sales come across with some tangible share in a market of over a million units of light duty passenger vehicle sales. The trend however also indicates a gradual yet prominent uptick in the battery electric vehicles. For the period January - October 2022, the sale of such vehicles was three times that of the full-year units clocked in 2021. A greater product variety with the setting up local production units could be one of the reasons for the boost in sales.

Trend in Sale of Electric Vehicles



Source: National Institute of Statistics, Geography, and Informatics (INEGI)

Electric buses are gradually rising in the public transportation fleet. The penetration however is negligible. Presently, just three cities corner almost all of the electric bus operation – Mexico City, Guadalajara, and Monterrey. Mexico City is the leading one, partly due to the boost it received early on from pilot projects in inducting electric buses. Various such schemes are underway to extend the existing electric bus fleet.

Another nascent, yet emerging sub-segment in the commercial electric drivetrain, is that of electric trucks. Mexico's mining and construction industry has lately attracted significant interest from leading entities to launch demonstration projects or pilot products. Among latest examples are – Navistar, BYD, Scania which delivered electric trucks in recent times for deployment in heavy-duty freight and related applications.

Charging Infrastructure

The country's installed charging infrastructure base comprises an estimated 2,100 stations (International Council on Clean Transportation). Mexico City has the highest concentration of the charging stations. The categories of charging stations include Tesla Destination Charger, Type 1 (saej1772), Tesla Supercharger, Schuko (EU plug), CHAdeMO, and CCS2.

Most of the charging stations are apparently based on the specific vehicle brands, instead of standardized public charging units. Thus, for instance, there are charging points available under ChargeNow initiative of BMW and Nissan, while Tesla Destination Chargers are the most ubiquitous. Progressively, the charging service models could change as the electric vehicle penetration shows signs of growth. In November 2022 for instance, Tesla announced a fee-based access to its fast-charging network in Mexico, marking a shift from offering it for free in last six years.

Policy and Regulation

Till recently, transport electrification was not a policy priority for the policy and regulatory structure. Thus, there are no specific directions that can indicate a path for transitioning to electric drivetrain. There have been some key policy announcements in context of the electric vehicle industry. An important one among them is the setting up of US-Mexico joint working group on transport electrification. Three sub-groups are set up within the overall working group for light-duty vehicles, medium- and heavy-duty vehicles and the electromobility in cities. The aim is to develop a roadmap.

In June 2022, President López Obrador announced 2030 as the targeted year by when at least 50% of all the vehicles manufactured will be fully electric or hybrid. There are a few tax benefits available for the electric vehicles (under the zero emission vehicle category) – a temporary import tax exemption till 2024 and waiver of tax on new vehicles. A few other incentives are available from local authorities, such as the exemption of charges for registration for owners of select vehicle categories or makes in the cities of Hidalgo, Morelos, Puebla, Querétaro, Tlaxcala, the State of Mexico and Mexico City.

The preferential tariff regime available under the country's free trade agreement (FTA) with the US and Canada is the only major pull-factor from policy perspective. Under the FTA norms of sourcing, Mexican sourcing of vehicles' components and parts enables certain advantages for companies operating in the trading jurisdiction. Also important in this context is the tax credit that the recent US Inflation Reduction Act allows on certain vehicle categories produced within the FTA member countries.

Market Opportunity

A significant part of the Mexican automotive market's opportunity lies in availability of productive labour resources and a ready industrial base for the US market across its border. Leading US-based and global auto OEMS such as General Motors, Ford, Nissan and Toyota made Mexico as their export base. The country's free trade deal with the US and Canada (USMCA in force from July 2020, replacing the legacy NAFTA regime) helped reinforce this.

While the transition from internal combustion engines to electric drivetrains is a steep one, the same competitive advantages are valid for Mexico to exploit the opportunities. This reflects in the expansion and reconfiguration plans announced for many of the leading entities. In January 2023, the Mexican state of Neuvo Leon put forth an official confirmation of discussions with Tesla for a new Gigafactory. It could be worth close to $1 billion in investment in case plans materialize.

Select Recent Investment Announcements for Manufacturing Facilities

Company	Planned investment focus	Expected commissioning
Ford	Tripling of existing capacity of 7,000 units	End-2023 or 2024
General Motors	$1billion reconfiguration of Coahuila plant for new product variants	2024 (for one plant) 2035 (reconversion of other conventional capacities)
BMW	$866 million investment for electric vehicle production unit at existing San Luis Potosí facility	-
Bombardier Recreational Products	New factory in Querétaro for electric motorcycles and batteries	2024 (motorcycles)
Nidec	$715 million for motors related to electric vehicles	Construction to commence in April 2023

Source: Economist, Mexican Daily

A related yet important point why Mexico's industrial base is ripe to attract investments is the global re-assessment of supply chain by almost all leading automakers and their allied manufacturing partners. The shift in focus to 'near-shore' favours the Mexican industry, especially in context of the North American region automakers. With rules of origin norms under free tree trade agreement with US and Canada, there is a greater merit for the US-based automakers to relocate or diversify from Chinese supply chain networks. The companies considering such a shift is not limited to the US-based ones, and includes German, Swiss, and Spanish origin enterprises to capitalize upon the export-oriented infrastructure.

The manufacturing investment prospects in electric vehicles are not limited to the cars or light passenger modes. The heavy-duty commercial segment is finding similar serious interest. In September 2022, the heavy-duty commercial vehicle assembly

company Navistar announced the production of battery electric truck at its Mexican production unit. The units produced were for delivery in the US and Canada. Scania and BYD are among the other major entities with electric truck offerings in the Mexican market. Scania was also among the earliest to set up a local electric bus manufacturing in Mexico. Volvo recently followed suit with local facility for buses.

Complementing the investment thrust in vehicles, the lagging charging infrastructure base shows signs of a rise in private sector interest. Lately, the company Evergo gained a significant place in this segment, with its acquisition of E-Drive, a charging service company in the country. In the coming years, Evergo plans an investment worth $200 million for setting up 15,000 new public and residential charging stations across the country. Its offerings include Level-2 AC charging (up to 20kW) and Level-3 DC charging (up to 600kW). In January, BMW partnered with Evergo for a planned 4,000 charging stations in Mexico over a five-year horizon and $200 million investment. The Enel Group's planned $4 million project is another example of major private sector investments. The project involves setting up 25 charging stations and interconnection infrastructure for 51 electric buses at the Mexican capital city.

The Mexican electric vehicle ecosystem has a much bigger untapped investment opportunity in Lithium. Government's estimates value the Lithium deposits found in the northern state of Sonora, at $600 billion. It is however subject to successful commercial mining, for which not much progress could be made. In April 2022, the government nationalized the country's Lithium mining and processing activities, reserving it for a state-owned firm established in this regard. At the same time, the government has committed to honour the concessions granted prior to the nationalization.

Outlook

The predominance of conventional drivetrain technology in Mexican automotive industry is unlikely to change significantly in the near term. Retail sales of light-duty passenger electric vehicles, in absence of subsidies, are out of mass market adoption and are restricted to select imported products and models. The progress in the commercial segment, while encouraging, is still slower than other markets as it depends on the budgetary provisions of respective local authorities.

Belatedly, there are several policy announcements aimed at accelerating the transport electrification. This is encouraging for the industry considering the emerging opportunities. Yet, the investors and the industry stakeholders will seek concrete measures especially in terms of incentives. Despite the scope available in the Mexican ecosystem, the landscape changed after the US government's recent legislation that offers incentives for indigenous sourcing. Also pertinent is the fact that even as Mexico attracts investments for manufacturing the electric vehicles, an absence of incentives could keep penetration level stagnant in the domestic market while production picks up to cater to the export market.

Beyond incentives, the country's policy and regulatory framework needs a coherence to set out the plan of action in transport electrification. For instance, there is no binding target for the conventional vehicles selling in the country. Same is true for any supply-side norms to align the manufacturers with policy goals. Furthermore, critical infrastructural requirements in public charging systems will require a concerted push in areas such as defining standards, provisioning for the grid power demand, power tariff structures and interoperability of charging networks.

With a lagging pace of charging stations, the fast-growing electric vehicle market is more likely to stay put on hybrid variety in passenger vehicles. At the same time, with the right steps and measures the country could look forward to secure investments from the leading global automakers for an export-oriented production hub. The mining industry can expect a similar fillip arising from the untapped potential in the critical minerals for global battery supply.

Key Regional Markets - South America

Countries Covered

1. Brazil
2. Chile

Brazil

Brazil's electric vehicle market is a miniscule through growing sub-segment of a larger market led by flex or alternate fuels. The country's flex-fuel automotive market is the world's largest, due to ethanol. This is the context in which electric vehicles must find their space. At a policy level, the decarbonization measures indicate that there is scope for a varied mode of transportation such as in terms of biofuels, fuel cells as well as battery electric. The competitive share of electric vehicles will be shaped by factors including price, ease of access in fast-charging facilities, product varieties and the relative running cost efficiency.

GDP (Current Prices) USD (2021)	1,608.08 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.47%
EV Penetration	17% (battery electric) of the total new passenger vehicle sales in 2022
EV Target	-
Planned Year of Phasing Out ICE Vehicles	-

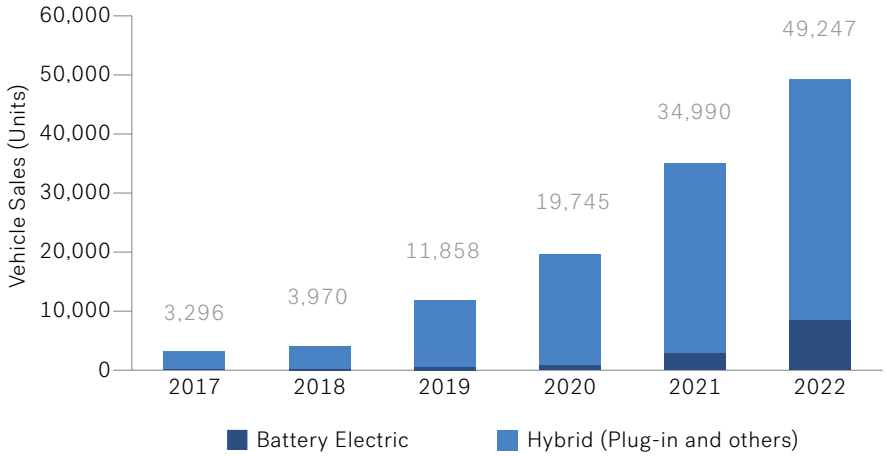
GDP Source: IMF, World Economic Outlook

Brazil

EV Penetration and Trend

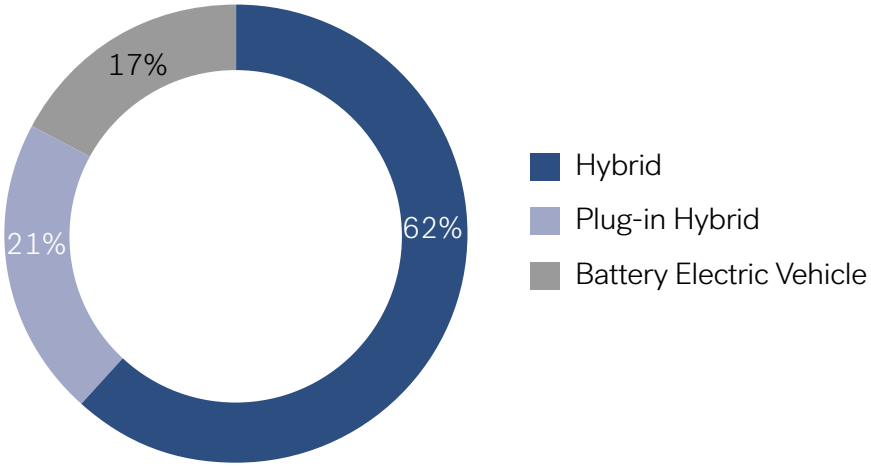
Brazil's electric vehicle market holds a miniscule share of the total automobile sales (about 2 million units as of 2022). Yet, it is a fast-growing sub-segment in an otherwise crowded and competitive market. Since 2019, there is a quadrupling of sales of electric vehicles. But notable growth is of battery electric vehicles where sales grew three-fold year-on-year in 2021 and 2022. The trend shows a sharp rise in the share of battery electric vehicles – from just 5% in 2019 to 17% by end of 2022.

Trend in Light and Commercial Electric Vehicle Sales



Source: Brazilian Electric Vehicle Association (ABVE)

Distribution of Electric Vehicle Drivetrain by Sales in 2022



Source: Brazilian Electric Vehicle Association (ABVE)

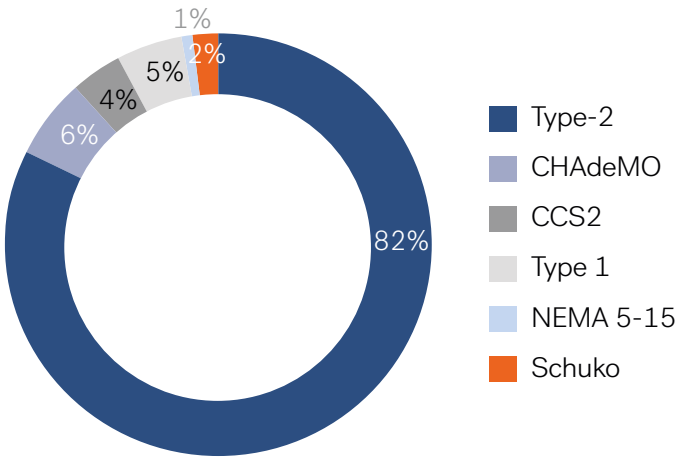
The rise in share of battery electric vehicles is an important and much-needed shift for the overall electric vehicle market. Lack of options in local production (Toyota being the only company manufacturing hybrids locally) together with an inadequate charging infrastructure puts the battery electric sub-segment in an unfavourable position against hybrids or flex-fuel vehicles. Such a skew is unlikely to change significantly. Yet, with improvement in battery electric ecosystem, the retail sales can be expected to pick up gradually.

Electrification is similarly gaining traction in Brazil's commercial transportation sub-segment. Even as the sales penetration is negligible, there is notable evidence of its adoption in key sectors such as those of construction and mining. In August 2022, the global mining company Vale tested 72-tonne battery electric trucks at its Brazilian mining operations. Another mining major CSN Mineracao signed agreement with the Chinese equipment supplier SANY for 100% electric trucks in mining operations.

Leading global equipment manufacturers are finding rising procurement orders for electric buses by the Brazilian local authorities. Sao Paulo is the one city that leads in electric bus deployment. Its total fleet in this regard comprises 18 electric buses and 201 trolley-buses procured under the Zero Emission Bus Rapid Deployment Accelerator pilot programme (International Council on Clean Transportation) of 2019. The city has since then been moving rapidly towards electrification of transportation.

Charging Infrastructure

Brazil's Charging Connectors Type



Note: Data is as of October 2021
Source: Statista

Brazil's electric vehicle charging infrastructure has been mostly led through the power distribution utilities or the vehicle manufacturers. The country currently has about 1,250 public charging stations, of which 47% are concentrated in the Sao Paulo city. Further, the existing capacity lacks fast-charging capabilities which adds to the impediments for the industry seeking growth opportunities.

Policy & Regulation

So far, Brazil's policy and regulatory framework is not targeted at promotion of battery electric vehicles. The available support measures are instead geared towards alternate fuel options based on efficiency or emissions. With the recent change in the country's ruling regime (and its stated intentions at overhauling environmental policies), there are expectations of incentives for the electric mobility, as part of steps for accelerated decarbonization.

Rota 2030, a policy introduced in 2018, laid out the efficiency and safety requirements for manufacturers. The tax incidence for vehicles (especially alternate fuels and hybrids) were proportionately competitive on achievement of required standards. There have been three five-year cycles completed under the Rota 2030 policy, with each cycle of standards and commensurate fines and incentives. The experience shows that the results of this policy have been restricted to the premium segment of hybrid and electric vehicle automakers and their product offerings. To be sure, most of the auto manufacturers have been able to reach the standards of this policy. But this came at a higher product cost.

Rota 2030 also provided for certain tax benefits – about a three percentage-point lower tax incidence for the hybrid and flex fuel vehicles. The overall tax burden however remains higher for the electric vehicles due to the higher federal excise tax rates and the state sales taxes. The lack of indigenous manufacturing base also does not help in enabling a lower tax incidence for electric vehicles.

The absence of specific supportive measures at federal level is somewhat being compensated by the local authorities which are keen to promote electric vehicles. Notable examples are of Minas Gerais, Rio de Janeiro, Sao Paulo where electric vehicles are found in relatively higher share than other cities. The city of Rio de Janeiro was the country's first to have zero-emission garbage trucks. At Sao Paulo, the authorities offer a 50% discount on motor vehicle tax for electric vehicle owners. At Minas Gerais, the government authorities have been actively seeking manufacturing investment due to its endowed lithium resources – the Argentine company Bravo Motors is in the process of starting EV and battery production from 2024.

The focus on scaling up the public charging facilities appears to be rather limited. In Brazil's current electric vehicle market dominated by the luxury demand segment, most of the charging network focus is on the home-based systems. At the same time, while public investments lag, there appears to be a significant private investors' interest in capitalizing upon the demand.

Market Opportunity

Brazil's indigenous auto manufacturing ecosystem provides a suitable environment for electric vehicles and its related production. Importantly, there is traction from the recent entrants and startups in setting up the local manufacturing base. One recent example is that of Voltz, founded in 2017. The company started its electric motorcycle production unit in Manaus, aided by the tax benefits from the local authorities. There are similar examples in auto technology startups such as Mileto producing electric motorcycles and minitrucks and seeking an entry in the passenger vehicles' space.

For some time, the Chinese automakers have been making a foray in the Brazilian market to tap into the electric vehicle demand. Besides a better business environment, such investments are also finding support through local government incentives. In November 2022, BYD marked the market entry with two product launches and a plan to commence local manufacturing from 2024. The local province offered incentives for BYD, which last till 2032. In January 2022, a large ticket-size investment announcement came from the Chinese automaker Great Wall Motor. The company has planned a $1.2 billion investment over the decade to set up electric and hybrid vehicle production units in Brazil, to serve as Latin American export hubs. Many of the leading Chinese auto brands are targeting Latin American markets such? as Brazil's to serve as the base for eventually catering to the global first tier markets. The country's recent change in ruling regime bolstered the favourable perceptions.

Local authorities are helping boost the market through their decarbonization measures, as distinct from the federal level. In December 2022 the Sao Paulo government, for instance, banned the diesel-based bus procurement in the city. It forces transport operators to source zero-emission buses for fleet renewal or expansion. By 2024, about a fifth of the city's bus fleet, amounting to 2,600 buses, is expected to be based on battery electric mode. Such a development also coincides with the local electric bus production announcements of leading automakers, including BYD, Higer, Volvo and Daimler Truck among others.

The inadequate availability of charging infrastructure continues to be a bottleneck in the mass adoption of electric vehicles. In recent times, some of the measures in private sector included automakers, energy service companies and equipment suppliers partnering for charging stations. Key examples include motor company WEG partnering with power company Neoenergia in January 2022, energy company Zlectric partnering with parking facilities network Estapar, and Shell-Cosan venture brand of Raizen to install the charging stations in Shell Energy's petrol pumping and other outlets. In November 2022, four companies set up a partnership venture termed Rota Sul, for a private network of fast-charging infrastructure across the capitals and key cities of Southern Brazil. The first phase of the capacity addition involves investment of BRL2.4 million.

Outlook

Brazil's electric vehicle market outlook is shaped not only by the strong demand momentum but also by other factors such as the competition from ethanol, and flex-fuel options, high import taxes and incentives specifically directed at flex-fuel vehicles. The market is expected to retain it leadership among the Latin American peers, especially as major luxury automakers focus on investments in reinforcing their positions.

Unlike luxury or high-end vehicles, the mainstream adoption of electric vehicles in Brazil will be a long-drawn process. The market lacks a direct purchase subsidy, and the taxation structure ends up raising the price of electric vehicles. The cost barrier will have to be circumvented before electric drivetrain can be an important segment. The expansion in charging infrastructure is a related critical factor in the equation. A limited scale and skewed distribution of charging points will hinder the growth.

Brazil's unique local characteristics could make the growth trajectory deviate from the typical one observed in other leading European countries. Key factors such as the predominance of the hybrid electric vehicles and the policy focus on biofuels (the country is world's second largest producer after US) for decarbonization makes pure electric vehicles' growth less discernible in the outlook. Also notable is the fact that the country's auto manufacturing base is progressively pursuing development of flex fuel engines that integrate biofuels. Once the scale is achieved, this could be a key differentiator in the global market.

Chile

Chile's National Electromobility Strategy puts forth the policy objectives to promote electric vehicles, as part of the steps at decarbonizing the transportation sector. Only electric vehicle sales will be allowed by 2035. The success of such policy goals will however be contingent on the timely investments in charging infrastructure and enabling a rapid adoption of the electric vehicles among consumers. The country has had encouraging progress in electric buses, due to the timely funding and budgetary outlays. The same might be required for developing the country's overall electric vehicle ecosystem.

GDP (Current Prices) USD (2021)	316.77 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.42%
EV Penetration	0.3% (battery electric) of the total new passenger vehicle sales in 2022
EV Target	Zero-emission transportation by 2035. No quantitative targets set
Planned Year of Phasing Out ICE Vehicles	2035

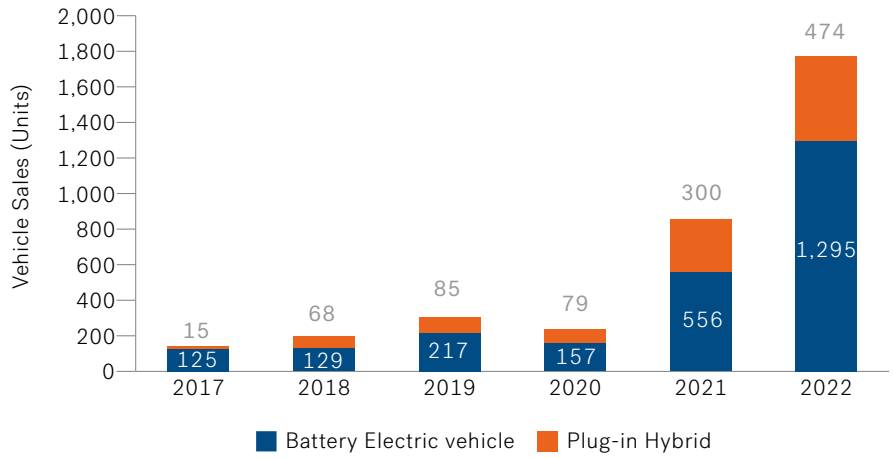
GDP Source: IMF, World Economic Outlook

Chile

EV Penetration and Trend

The Chilean market's electric vehicle penetration is negligible – barely 0.3% of the total 426,777 units sold in 2022 were based on batteries. It is thus a nascent market so far in transport electrification. The growth has been encouraging though, with electric vehicle sales registering a compound annual growth of 60% in the period of 2017-2022. The plug-in hybrids grew faster (99%) in the same period, partly reflecting the infrastructural barrier of charging provision and 'range anxiety' issues in retail sales.

Trend in Passenger Electric Vehicle Sales

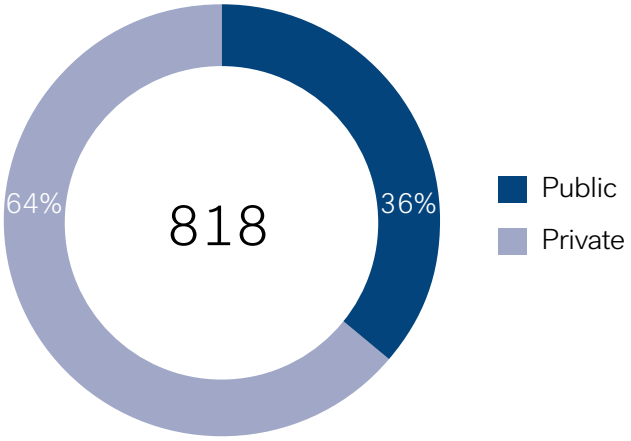


Note: The above data was categorized as 'light and medium vehicles' in the source
Source: National Automotive Association of Chile

The electric bus segment has been an encouraging one in Chile, led primarily by the expansion of fleet in the city of Santiago. This city, with an electric bus fleet size of almost 1,800, ranks among the leading ones in the Latin American region for its fleet conversion. Many other cities and provinces are following a similar path in expanding the electric bus network.

Charging Infrastructure

Charging Station Infrastructure Distribution in Public and Private Segments



Source: BNA Americas (March 2022)

Chile's charging infrastructure is predominantly composed of the slow Type-2 charging points. DC-based fast-charging is scarce and yet to gain traction in proportion to the total charging network. Furthermore, the public charging segment is a relatively minor part of the infrastructure deployment, pointing to limited scope of catering to rapid buildup in the electric transportation in future. The existing charging stations are skewed towards a few cities such as Santiago which gained popularity in recent years due to electric bus deployments.

Policy and Regulation

The government policy framework has been largely responsive towards promoting electric vehicles. In March 2022, the Chilean government officially ratified the National Electromobility Strategy. A key takeaway from the official policy pronouncement is the targeted shift to zero-emission transportation by 2035, referring to the sales of light and medium vehicles (generally the passenger vehicles) and the public transport (buses, cabs and shared cabs). The policy had been on the anvil since October 2021 when it was first put out for public consultation. Its implementation is under the Ministry of Energy and will be subject to a review and update every five years.

Supporting the policy goal of phasing out the combustion-based vehicles, in October 2022 the government enacted the legislation for electric vehicles' tax exemptions. With this, the electric vehicle owners stand to gain an exemption from annual road taxes for two years. Subsequently, a graded exemption level will be available – 75% exemption in years three and four, 50% in years five and six and 25% in the years seven and eight.

The recent legislative changes for incentivizing electric vehicles are not limited to the fiscal measures. The regulations also allow the electric vehicle owners to participate in the power market transactions (through battery storage capacity). Vehicle owners are entitled for incentives proportionate to the energy injected in the grid. This facility dovetails with the energy storage market regulations, where standalone storage is entitled for capacity payment.

Other select policy support measures were initiated to encourage the electric vehicle market. The Energy Efficiency Law enacted in 2021 provided for incentivizing companies to import electric vehicles, creating tax incentives for electric vehicle investments, establishing energy efficiency standards for new vehicles and regulating the interoperability standards of the charging systems.

Market Opportunity

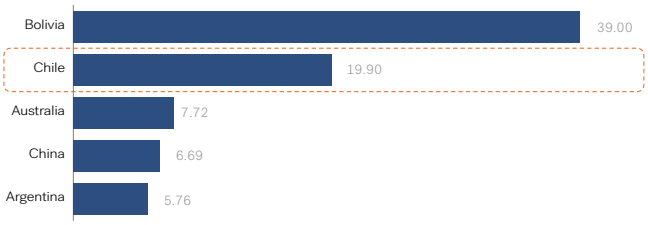
Electric buses appear to show a better traction in the Chilean market than the passenger vehicles. This is observed in the fact of how Santiago (1,770 electric buses) came to the fore, as among the leading cities in the Latin American region for electric bus deployment. With initial funding support including that from World Bank (IFC) for establishing the viability, there is a better environment for attracting private investors in the space.

Reborn Electric Motors, founded in 2016 and later funded by Enel, emerged as a pioneering indigenous manufacturer of electric buses in the country. EnelX (subsidiary of Enel) and the bus operator service Metbus partnered in 2017 for a year-long Santiago pilot project for electric buses. Since then, the partnership of EnelX, Metbus and the Chinese manufacturer BYD, entailed delivery of 100 such buses. By 2023, the Santiago Metropolitan Region's transport agency aims to place a 1,700-strong electric bus fleet. Leading equipment manufacturers and suppliers are gradually tapping into the demand. In August 2022, the Chinese manufacturer Foton wrote its largest overseas order of 1,022 buses for the city of Santiago. Other competing manufacturers such as BYD and Yutong continue to be similarly in the fray for the rising momentum of orders.

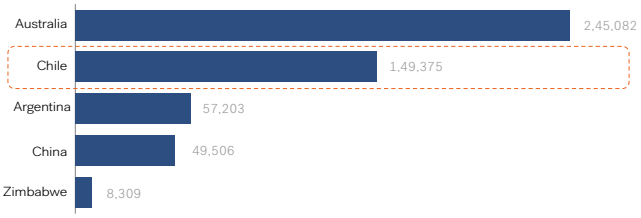
Though slow in picking up, the charging infrastructure shows some encouraging developments to suggest a rising interest from the private sector. EnelX had earlier launched fast-charging hubs in the country, which was a start for the segment in this market. In October 2022, EnelX Way and Volvo Cars Chile announced the launch of a public charging station, incorporating the JuiceBox technology. The inauguration marked the beginning of the planned 100 such charging stations envisaged by the partnership throughout Chile. Similar partnerships, if replicated, could potentially open the largely untapped space of public charging stations.

Chile is endowed with a significant share of global reserves in critical mineral resources. Most important among them is Lithium, where Chile's leadership lies in both reserves and production. With Lithium as the mainstay of the battery storage technologies, there is a significant untapped potential for the companies to develop and source the mineral resource at competitive rates. The permits issued so far have been far and few and the competitive intensity thus remains on the lower side.

Global Position in Lithium Reserves (million tonnes, 2021)



Global Position in Lithium Production (tonnes, 2021)



Note: Data reported as of June 2022.
Source: S&P Global

Outlook

The Chilean government target of 2035 to allow only electric vehicle sales convey the point to the industry stakeholders. It ties in with the decarbonization measures underway, especially in transportation. Public transport based on electric buses, is the most notable area where there is a visible progress in penetration and indicates a favourable outlook of expansion. The National Electromobility Strategy targets 100% electrification in the public transit buses by 2040. A sustained progress to the momentum achieved so far would entail getting private investment for local manufacturing and favourable incentives for the same.

Incentives, or their lack thereof, could also be a factor why the passenger vehicle segment growth has been relatively muted. Its growth, though encouraging, is far from making a dent in a market skewed towards the conventional platform. The demand-side incentives are thus important at such an early stage of growth to propel the market. An even bigger issue is the need for the charging infrastructure, where public investments might be critical to make the difference and attract the private investments in due course.

Chile's policy and regulatory framework has been unable to exploit the opportunity in Lithium mining. It has been, for instance, lagging behind in presenting a clear framework for concessions to developers who can undertake commercial mining. The country's rather unstable and uncertain regulatory framework led to investors considering other options. With Lithium is still important in the global energy scenario, it will be critical that the country expedites the regulatory process and issues the permits for investments.

07

About CleanBridge

About CleanBridge

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Sustainable Energy

Climate Finance

Sustainable Living

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