Global EV Transportation Market Review

2022

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.

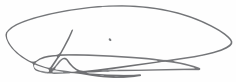
The global political path has been set for the revolution coming in the electrification of transportation, with the majority of major world economies and governments adopting net zero by 2050 targets for transportation. In that regard Europe and China are leading the way, with India following close behind 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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Contents

01

Executive Summary

Executive Summary

Globally, electrification in transportation is key to achieve objectives in carbon emissions control. A phase-out of internal combustion engines (ICE) is thus on the anvil, as per announcements by the government authorities, both at national and/or municipal authority levels. The number of such announcements is on a rise, partly reflecting the convergence of goals worldwide. Some, especially the European Union, are taking a stringent approach at emissions targets while others are yet to devise a roadmap. All the same, such announcements, at the very least, help set the direction and context.

Broadly, the direction is apparent in the trend of passenger electric vehicle (EV) sales – which attract the maximum policy and business attention in the overall scheme of transport electrification. Between 2016 and 2021, global passenger EV sales grew at CAGR 46% (BNEF estimates) and held about 6% share in the total new vehicle sales by end-2021. Such a growth accordingly displaced the ICEs' share in the total automotive sales – from 97% to 87% during the review period. The pattern lends some credence to the contention of a transition underway in transport electrification. It is however a long journey to cover – globally passenger EVs are about 1% of the total fleet. Together with other segments (commercial and buses), the contribution appears negligible.

The pace and momentum of transition are subject to the level of policy support as well as the country-specific local factors at play. Fundamentally, there is a case for incentivising EVs to bridge the gap against ICEs. The latter's dominant position is premised on technological maturity and an efficient fuel distribution, which EVs are yet to match.

Policy support, especially in terms of the upfront purchase subsidies, have proven to be effective in propping up the demand. This is observed in the experience of European countries such as Norway, Netherland, and Sweden, where passenger EV offtake was led by generous purchase price discounts funded by subsidy allocations.

Policy framework however is evolving with the stages of progress countries achieve. There is a gradual shift from a subsidy-led growth (demand-side support for nascent stage) to one based on fleet-wide emission targets incentivising EV adoption (supply-side norms at a mature/growth stage). The European mechanism of punitive measures for manufacturers on average fleet-wide emission levels appears to have equally helped propel the EV sales. The Chinese market demonstrates the same with the stated goal to cease subsidy support by end of 2022. The result is an expansion in product varieties across price points, to propel demand and sales.

A generalisation of such policy trajectory will still be difficult because of country-specific local factors. For instance, decarbonisation goal for transport systems also brings forth other competing drivetrain technologies such as those based on hydrogen, fuel cells or flexfuels. When it is observed in this context, the path to zero-emission transportation could be a combination of multiple drivetrains with EV being one of them. An example in point is Brazil where ethanol constitutes a key component of the decarbonisation move and the related flexfuel ecosystem by automakers. While EV is not ruled out, its rate of adoption will be subject to a competition.

Executive Summary

In fact, the most important local factor is the EV charging infrastructure availability. The inherent disadvantage of batteries in supporting a limited distance range on a single charge, also referred to as 'range anxiety', can be addressed only through a comprehensive and fast-charging network. Between 2016 and 2020, cumulative installed charging connectors across key markets registered a CAGR of 34%. But the installed capacity is skewed, predictably across the markets with high EV adoption – China corners about 60% of it, followed by Europe with a quarter share. Many other EV markets increasingly find charging infrastructure as a potential bottleneck. This will need a mix of public and private investment. Also important is the development of requisite regulatory guidelines (standardisation in equipment, tariffs, etc.) for the EV charging infrastructure.

Government investment is not the only determinant in the upcoming capacity creation in the EV market. The private sector role is gradually coming to the fore, such as in terms of the conventional utilities pivoting to this industry by setting up or acquiring EV charging businesses, or technology startups seeking to cater to a specific segment of the EV business (such as light commercial vehicles). Some of the major investments in this business are from the incumbent automakers for whom the transition to EV-based drivetrain is imminent.

The investments along with the competition in the global EV market appear to be determined by multiple factors. Increasingly, with market growth, there is a focus on localisation in EV manufacturing. Europe is the leading example. It leads the EV demand and adoption and is increasingly seeking EV capacities closer to the high-demand regions. Battery manufacturing capacities currently under development in Europe could make it effectively reduce if not displace the Chinese market leadership. The Chinese market will still play the most important role in the EV supply chain even as the new investments seek diversification across the globe.

The automotive industry's conventional globalised supply chain network is under reconsideration by major stakeholders, especially the major automakers and policy authorities. The rapid shocks, initially from the pandemic-led global shutdown and subsequently geopolitical issues such as US-China trade dispute and the ongoing Ukrainian armed conflict, have contributed to a rethink on investments in indigenous facilities. In US, General Motors' and Toyota's renewed investment allocations for electric vehicle manufacturing facilities reflect such considerations.

The investment commitments and capacity development over the next few years will set the base for a potential mass-production scale that can generate economies of scale. Pure-play EV entities may not find this very easy. At the same time, there will be an accelerated need for capacity in developing integrated control and software for EV platforms – something that traditional automakers may not be able to easily transition to. The trajectory of progress is thus more likely to be an uneven one. In either growth scenario, the outlook for electric vehicles' industry is brighter than before, as decarbonisation and electrification in transportation gets traction.

02

Electric Vehicle Penetration and Adoption

Electric Vehicle Penetration and Adoption

Introduction

The Electric Vehicle (EV) market has gradually assumed traction due to the policy direction globally at electrification of the transportation system. The pace and nature of EV adoption however varies. Passenger vehicles' offtake, while promising in trend, faces the challenge of a high ownership cost and is thus limited to select pockets of the global market. The two-wheeler segment on the other hand has had a rapid growth due to greater accessibility in price points for the urban consumer base in developing countries. The competitive cost of EVs, as a culmination of technology improvement, thus holds the key. Meanwhile, to realise the objectives in EV penetration, there is an almost urgent need to ramp up the charging infrastructure.

The global passenger EV fleet expanded at a CAGR of 52.8% between 2016 and 2021

Status and Trend at an Aggregated Level

Between 2016 and 2021, the global EV passenger vehicle fleet (battery electric and plug-in hybrids together) expanded at a compound annual growth rate (CAGR) of 52.8%. For the overall passenger vehicle fleet, that includes the internal combustion-based vehicles, CAGR for the same period stood at 2.4%. The year 2020 could be regarded as an outlier, as pandemic-led restrictions and supply chain disruption led to a sharp decline in conventional vehicles, while that of electric vehicles rose unabated with policy support.

Global Passenger Vehicle Fleet by Drivetrain

Drivetrain	2016	2017	2018	2019	2020	2021	CAGR
Battery electric	995,177	1,698,643	3,028,422	4,614,028	6,734,252	10,058,783	59%
Plug-in hybrid	784,391	1,180,594	1,800,948	2,347,826	3,333,137	4,749,517	43%
Fuel cell	2,749	6,154	10,104	17,856	26,195	37,565	69%
Hybrid	13,092,023	15,645,119	18,459,358	21,670,770	25,581,285	30,397,445	18%
Internal combustion	1,057,448,435	1,094,673,838	1,130,961,065	1,166,547,390	1,187,691,774	1,188,664,187	2%
Total	1,072,322,775	1,113,204,348	1,154,259,897	1,195,197,870	1,223,366,644	1,233,907,497	3%

Source: BNEF Long Term Outlook Report

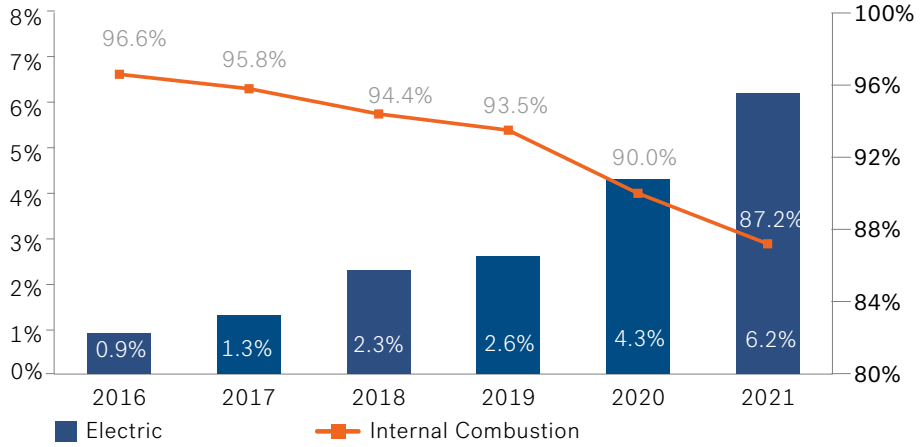
The consistent and sharp growth in electric vehicle sales appears to be displacing the relative position of internal combustion-based vehicles. At 6.2%, EV penetration (share in total sales) is about five times of what it was five years ago. The impact of such a shift is fundamental in the established automotive drivetrain technology ecosystem.

Electric Vehicle Penetration and Adoption

Deliberate policy action is thus critical for the initial market support. Despite the growth so far and the attractive prospects, electric vehicles so far account for just 1% of the total passenger vehicle fleet. This share is lower or even negligible in case of the commercial vehicles or buses. With barriers such as in ownership cost and infrastructural gaps, the process to mainstream EVs is a protracted one, entailing among other things, direct incentives and indirect ones in terms of regulatory norms.

Deliberate policy action is critical for the initial EV market support

Global Share of Passenger Vehicle Sales in Electric and Internal Combustion Drivetrains



Source: BNEF Long Term Outlook Report

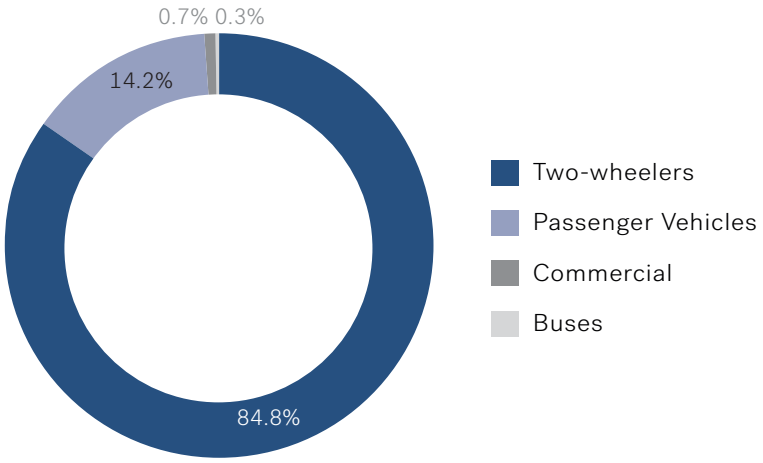
Electric Vehicle Penetration and Adoption

Status and Growth by EV Segment

In terms of adoption, the EV segments broadly include passenger vehicles, buses, commercial vehicles (such as trucks and the related across weight classes) and the two-/three-wheelers. Each has a different dynamic and growth driver. When observed in terms of such segments, EV adoption appears to be progressing in multiple speeds and tracks.

Affordability and subsidies acts as the main growth drivers for adopting electric two-wheeler

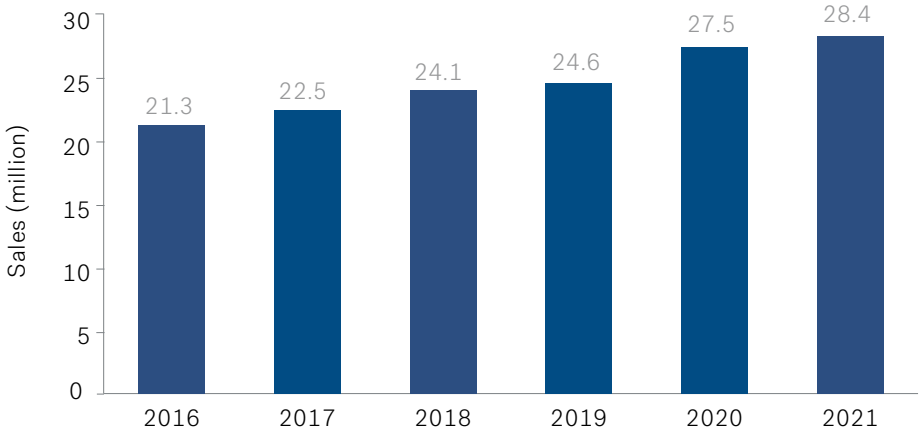
Global EV Sales Volume by Segment (as of 2021)



Note: Commercial category above is an aggregate of light, medium and heavy commercial vehicles
Source: BNEF Long Term Outlook report

For one, the current adoption appears to be predominantly skewed towards two-wheeler segment. This is understandable at an intuitive level. Two-wheeler segment is among the most affordable in the total ownership cost and found steady offtake in China, Taiwan and Vietnam as well as Europe. Policy driver (in terms of subsidies) is a major factor. Notably, startups lately emerged as the major entities pushing the case of electric two-wheelers, which is most discernible in case of shared mobility modes such as e-scooters.

Global Electric Two-Wheeler Sales Trend



Source: BNEF Long Term Outlook report

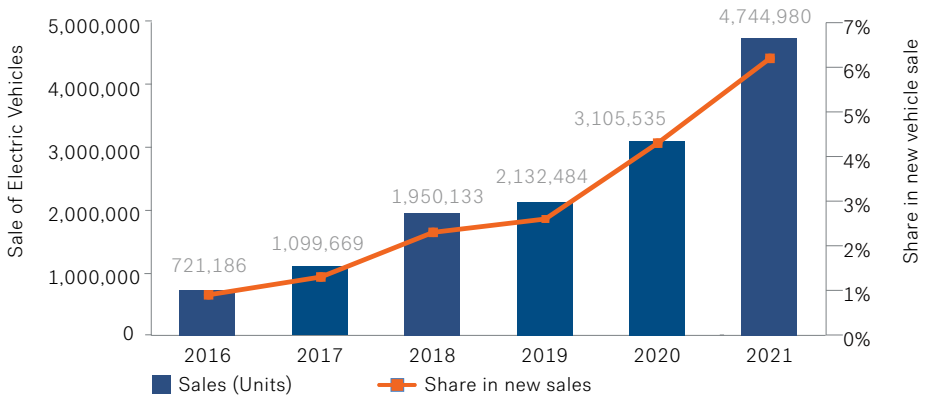
The pandemic outbreak phase appears to have tempered the rate of growth in two-wheeler sales trend – a reflection of the postponed consumer purchases in most of the developing markets. Yet the growth was a sustained one as subsidy support helped prop the market. With decline in the upfront prices, due to cheaper Lithium-Ion batteries, two-wheelers sales are progressively expected to be driven by the high-performance, price competitive option against the internal combustion or lead-acid battery-based vehicles.

Electric Vehicle Penetration and Adoption

The EV passenger market gets the most focus in electrification of transportation. Several countries are joining the fray in announcing a ban on internal combustion cars to make way for EVs in privately-owned transport. In fact, during 2020 the EV sales grew even as that of internal combustion ones declined. In part, this could be attributed to factors such as the huge backlog in production and supply chain and the segment's dependence on higher-income consumer segment than the lower price-sensitive one.

EV passenger vehicles continue to be behind competition in cost, which impedes large-scale adoption in the segment

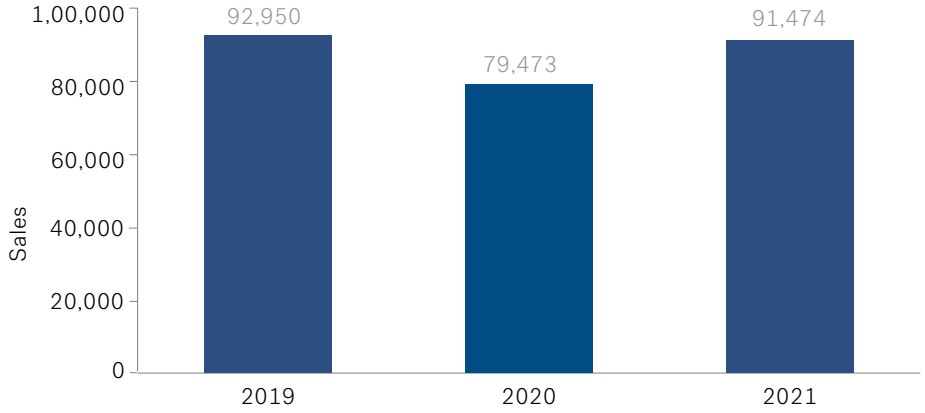
Global Passenger EV Sale and Penetration Trend



Source: BNEF Long Term Outlook report

The EV passenger vehicles however continue to be behind competition in cost, which impedes large-scale adoption in this segment. Demand-side policy incentives in terms of tax exemption or subsidies are thus instrumental in driving offtake, as has been observed to be the case in Europe. The emission norms being enforced in various countries is another major propeller. Several leading automakers for instance increased their EV launches significantly to enable compliance with emission norms of China and Europe, failing which there could be penalties.

Global Sale of Electric Buses



Source: BNEF Long Term Outlook report

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. Rationalisation of the Chinese subsidies in 2019 did impact the market temporarily, after which the outbreak of COVID-19 worsened the growth further. However, the business recovery since then helped improve the prospects. While China is known to be a leader in this, others have made inroads as well. Notable examples are Latin American cities in Chile and Colombia. 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 a reasonable competition to diesel-based fleets any time soon.

Electric Vehicle Penetration and Adoption

EV in shared mobility and/or micro-mobility

EVs are increasingly finding a critical role for the innovations in urban mobility. This particularly refers to the deployment of EVs seen in many countries through shared mobility or micro-mobility solutions. While many of the mobility solutions are being driven by technology-led startups, the corresponding policy and regulatory environment plays a key role in shaping it.

Three-wheelers constitute an important shared mobility vehicle segment in India and China

The growth drivers and dynamics vary by each market's local factors. For instance, the three-wheelers constitute an important shared mobility vehicle segment in India and China, even as globally they account for a smaller market than the overall two-wheelers. These vehicles are typically deployed commercially for the last-mile connectivity in passenger services or for light-freight delivery.

Trend in the three-wheeler EV Fleet (units)

	2016	2017	2018	2019	2020	2021
China	49,400,000	54,000,000	60,000,000	63,646,749	67,525,790	70,800,057
India	900,000	1,737,500	2,350,000	2,930,000	3,088,941	3,273,729
Other	4,128	5,938	7,995	10,344	13,127	17,858
Total	50,304,128	55,743,438	62,357,995	66,587,093	70,627,858	74,091,644

Source: BNEF Long Term Outlook report

As part of the shared and micro-mobility models, electric bicycles (referred to e-bikes subsequently) of late emerged as a fast-growing medium. This is most discernible in Europe where e-bike sales growth has been a sustained one. As per the Confederation of the European Bicycle, e-bike sales in the UK and EU rose by 52% year-on-year, as of July 2021. This was also a 20-year record for the region's sales trend. Similar thrust is observed in the US, where e-bike sale is expected to exceed that of battery electric and plug-in hybrid passenger vehicles.

After e-bikes, possibly the next most important segment of urban mobility is the e-scooter. As per EY report, e-scooter sharing services, launched around September 2017 in the US, now is found across over 50 countries. The adoption of this medium has been faster than that observed in e-bikes. Its growth however faces challenges in regulatory compliance, as its initial phase of adoption took place in the absence of a proper regulatory framework. Yet, its prospects remain attractive, especially due to the innovations in business and technology implementation.

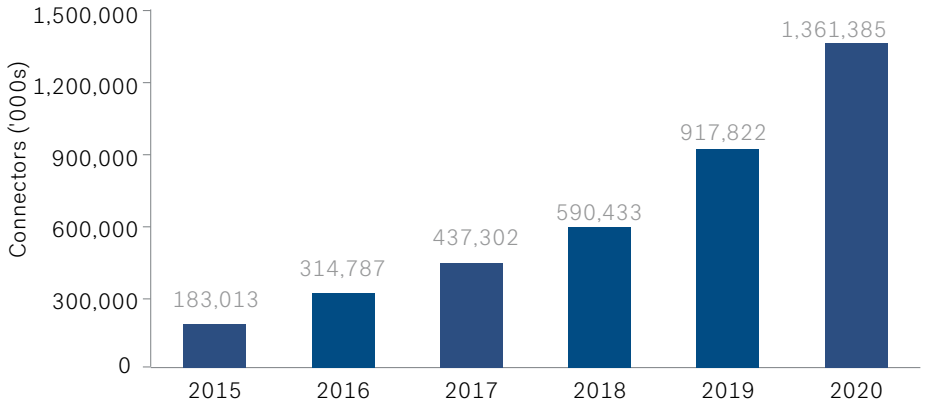
Electric Vehicle Penetration and Adoption

Charging Infrastructure

The most critical element of the EV adoption is the charging infrastructure and batteries. The former plays a bigger role in the sense that a comprehensive and ubiquitous charging base ameliorates the otherwise challenging limitation of range in a typical EV platform. In that context, the growth of public charging infrastructure assumes significance. Expectedly, China leads the way in this. While the absolute capacity size is important, the density of charging infrastructure is the key parameter to track.

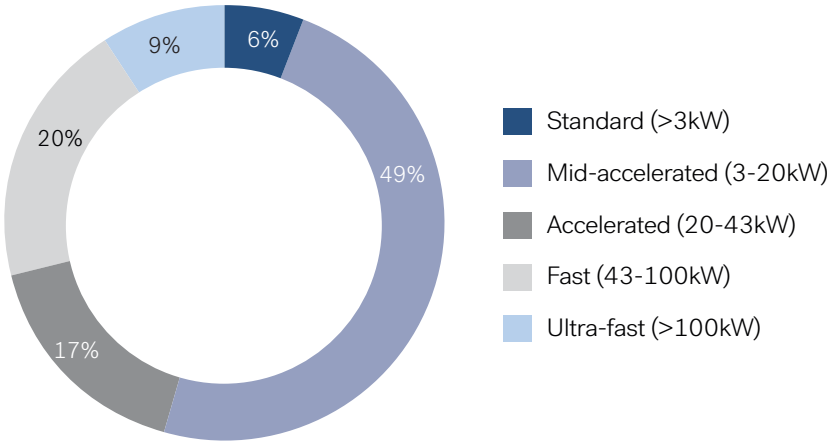
European countries rank among the highest in terms of charger density correlating with the EV sale penetration achieved in the same countries

Cumulative Global Public Charging Connectors



Source: BNEF Long Term Outlook report

Public EV Charging Infrastructure by Power Category



Source: BNEF

When considered in charger density, the European countries rank among the highest. This correlates well with the EV sales penetration achieved in the same countries. As per BNEF data, The Netherlands has the maximum public charging connectors per 100,000 population, at 563. It is followed by others including Norway (315), Iceland (180), Sweden (114) and Denmark (112). To be sure, the variation in density between countries is also a result of factors including prevalence of housing stock (apartments versus standalone), public charging hardware, and the EV fleet stock.

Notably, there is a significant rise in commercial activity around the setting up of charging systems. Several companies lately sought funding options for expansion or towards investing in EV charging companies. Most notable has been the rapid progress by global hydrocarbon majors in acquiring the charging network companies to enter this space. Shell for instance is poised to assume the position of being the leading player in UK's EV charging market. Companies in other sectors such as OEMs are making similar moves – in January 2022, ABB announced the acquisition of InCharge Energy for the latter's charging infrastructure and related solutions for commercial fleets. In 2020, the same company had acquired a majority stake of a Chinese EV charging entity.

Just as charging infrastructure requirement continues to rise, so does the need to upgrade the power standards of the charging points. Increasingly, fast chargers are needed to replace the legacy base of charging points. This is attracting significant interest as investments get channelled at setting up the fast-charging corridors. In September 2021, the equipment manufacturer ABB launched a fast-charger system claiming it as the world's fastest, to offer 100 km range in less than three minutes. More such product launches will be in line as the charging ecosystem evolves, not just in capacity or technology but most importantly in the scale of demand and the business models to deliver it as a service.

03

Regional Overview of EV Adoption

Regional Overview of EV Adoption

Introduction

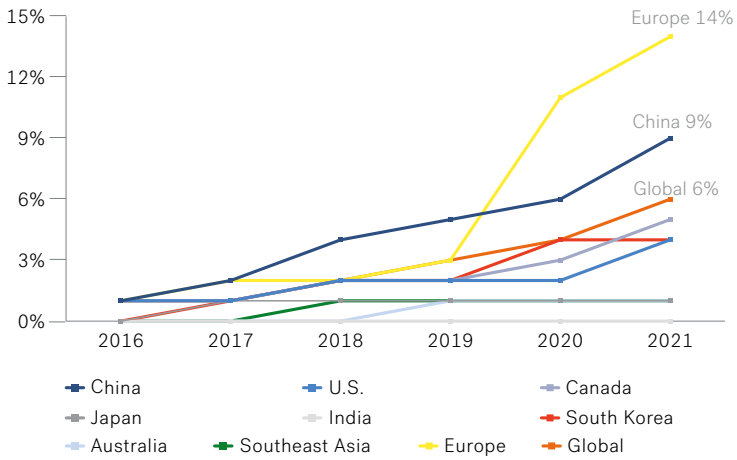
Globally, the EV penetration appears to be led by a select group of European countries, where the share of battery-based vehicles is nearing a tipping point. But, in absolute terms, there is China to contend with. It is the market leader in terms of the total EV sales as well as the entire supply chain to support the same. Both Europe and China's growth trajectory is explained by the policy thrust. There is a mix of mandate and incentives that set the momentum. While other countries, notably the US are poised to catch up, the investor interest is for now, in the European region.

With the mix of mandate and incetives EV penetration growth in Europe and China has gained the momentum

The Top Countries/Regions in EV Adoption

As a region, Europe has a lead in EV penetration, with several of its member countries ranking among the top. China follows next in competition. Asia-Pacific region, excluding China, is yet to progress in any significant proportion. The North American region, led mainly by the US, has been lagging after a brief progress till last year in the EV penetration. The country's lack of federal support and guidance for this market continues to be drag, and just a handful of the states are driving the momentum.

EV Share of New Passenger Vehicle Sales by Country/Region2020



Note: Data refers to BNEF estimates for the year 2021
Source: BNEF

Beyond these regions, all other markets are at a distant level in scale of maturity for EV adoption. It is unlikely to changed drastically in the near to medium term, as each country's local factors determine the rate of EV adoption. Among other things, in many countries, electric vehicles may serve as one of the options in the planned transition to cleaner or zero-emission transportation. Major competitive options in this regard being the flexfuel drivetrains' technologies.

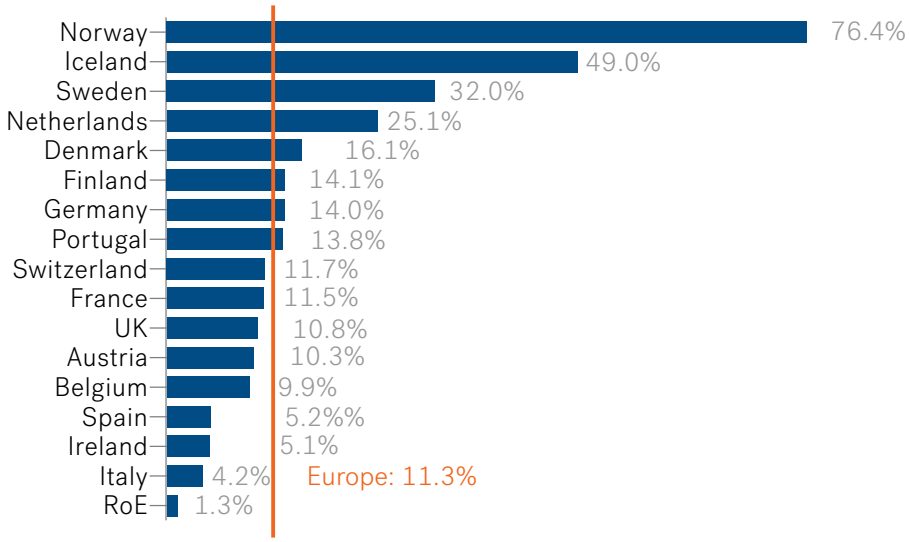
The policy approach and instruments for supporting the electric vehicle market continues to evolve. The Chinese market is an important example. It plans to phase out the purchase subsidies completely in 2022, to make way for a greater role of supply-side mandates – a certain share of all vehicles sold need to be electric, and the manufacturers are supposed to earn points (to avoid penalties) for each EV produced based on range, efficiency, performance, and other parameters. To be sure, there was a temporary impact on sales from such a policy announcement. But it made up for the lost ground with rapid recovery in 2020, despite the general disruption in the automotive industry from the COVID-19 pandemic. Other mature countries are following suit. Select European countries are reconsidering or reconfiguring the suite of policy support measures to optimise the budgetary allocations.

Regional Overview of EV Adoption

European countries are in fact placed better than most to devise market-oriented policy measures replacing those of subsidy-led ones. Select countries in this region are already the top-ranking ones globally in EV penetration. In fact, for most of the OEMs including the Chinese ones, Europe is currently the priority market to address for the sheer policy-led demand growth underway. Countries such as Norway appear to be an outlier against other European countries, due to the progress achieved in penetration. The proximate reasons for this are found in the aggressive policy thrust towards demand-side incentives (tax exemptions, subsidies and similar benefits lowering upfront cost). It also helped that additional support measures during the pandemic that helped check the decline caused by overall disruption in the global automotive industry.

Norway appeared to be an outlier with battery-based passenger vehicles accounting for 76.4% of the new cars sold in 2021

Share of Electric Vehicles in the New Vehicle Sales of European Countries (as of end-2020)



Source: BNEF Long Term Outlook 2021

The European policy thrust however is not limited to incentives. Many European manufacturers face the prospects of punitive costs for failure to meet emission targets. The latter stem from the goals of reducing total carbon emissions in the economy, in which electrification of transport assumes an integral role. The regulations are even expected to impact the bottom-line in the short-term. For instance, last year Volkswagen faced fines for overshooting the 2020 emission levels at fleet-level. European Commission's recent proposals suggest a higher stringency level – 55% cut in the CO2 emissions by 2030 (over 2021 levels), as compared to 37.5% in existing regulations.

Regional Overview of EV Adoption

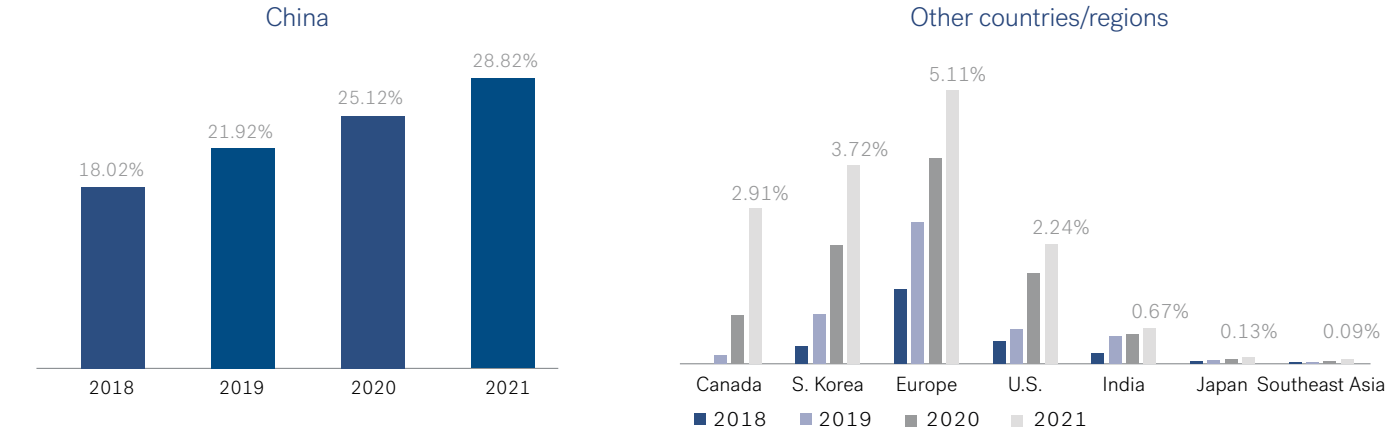
Electric Buses

With extensive subsidy support, China has emerged as largest e-bus market globally

Buses constitute another key segment for EV penetration. 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. As per BNEF estimates, electric buses account for approximately one-fifth of the total global bus fleet. At a regional level, this is even lower for the otherwise leading global passenger EV markets.

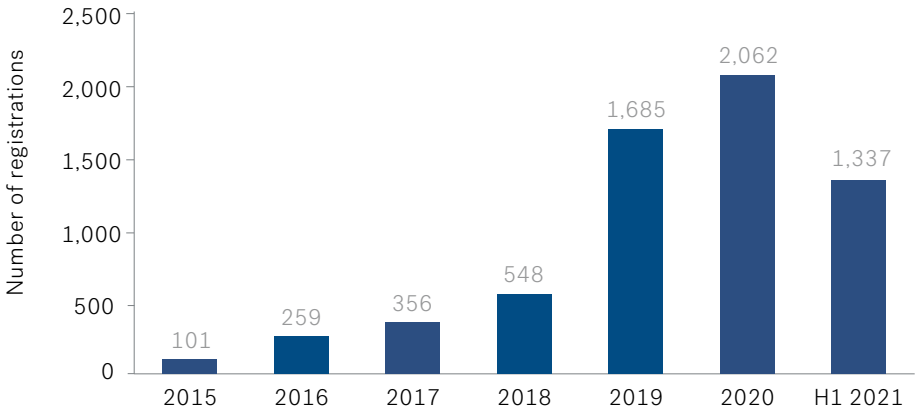
China holds the largest share of electric buses in its total fleet. In this context, it comes across as the largest e-bus market globally. Subsidies drove this growth predominantly, which is also why electric bus sales registered a decline since the phaseout of subsidy support. Yet it has gained significant traction as a market. The Chinese province Shenzhen, for instance, is reported to have an electric bus fleet bigger than that of the US. Municipal bus fleet expansion, as the Chinese experience shows, is a major driver of adoption. Furthermore, China's electric bus manufacturing base of late emerged as a major supplier for all global markets. Its two leading manufacturers – BYD and Yutong, account for the predominant share of electric bus sale in Europe and other regions where demand is rapidly inching up from key segments such as municipal/public transport fleets, school bus fleets, etc.

E-bus Share of the Total Bus Fleet across Key Regions/Countries



Note: Data refers to BNEF estimates for the year 2021
Source: BNEF Long Term Outlook 2021

Trend in Electric Bus Registrations in Western Europe and Poland



Source: Sustainable Bus (attributed to Chatrou CME Solutions)

Starting with a significantly lower base, the European region is rapidly scaling up the e-bus fleet. Some of the key countries in focus include Poland, France and the Netherlands are seeking replacement of their existing bus fleet with the e-buses. The trend in the electric bus registrations in the Western European region is an attestation to this.

Regional Overview of EV Adoption

Two- and Three-wheelers

As per BNEF China, India, and Indonesia account for about 3/4th of the global two-wheeler sales

Volume-wise, it is the EV two-wheeler and three-wheeler segments that hold the predominant share of the units sold. With lower ownership costs and dependence on lower-cost lead-acid batteries, these modes have been driven by the price-sensitive population segment typical of the developing markets.

As BNEF estimates indicate, about three-fourths of the global two-wheeler sales come from three countries – China, India, and Indonesia. From the policy perspective in such countries, two-wheelers are the lowest-hanging fruit in stepping up EV penetration and minimising carbon emissions. This was the approach that China undertook early on to expand EV penetration. In this regard, the Indian market is projected to be the next biggest for electric two-wheelers, as China approaches saturation.

Share of Electric in Total Two-Wheeler Sales by Market

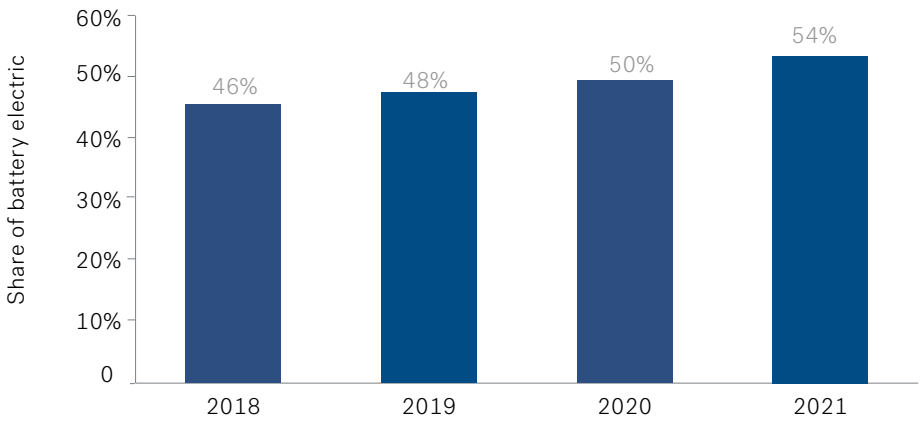
	2016	2017	2018	2019	2020
China	59%	59%	63%	61%	68%
Vietnam	9%	11%	9%	12%	14%
India	0%	0%	0%	1%	1%
Taiwan	5%	5%	12%	19%	10%
Europe	1%	2%	4%	5%	6%
South Korea	0%	0%	4%	12%	14%
Global	**28%**	**28%**	**29%**	**30%**	**37%**

Source: BNEF Long Term Outlook 2021

With each year, however, the focus on an electric two-wheeler is no longer expected to be concentrated in the developing markets. This is because of the emergence of EV segments such as shared mobility and micro-mobility. Electric scooters and electric bicycles are thus emerging as among the rapidly growing segments, attracting interests from startups and policymakers alike. This explains the growth of two-wheeler penetration observed in Europe as well as South Korea, the latter being an entrant in this only since 2018. Despite the popularity, shared mobility such as through e-scooters is also a major focus of regulatory oversight due to the grey areas around the safety and legality of such transportation in several major European markets including the UK, Netherlands, and Germany among others.

The three-wheeler segment is a smaller market than that of two-wheelers globally. It is largely about the two major markets – China and India where this is deployed for commercial use, either in last-mile connectivity or for short-distance freight transportation. Key aspects such as regulatory loopholes (lack of clarity in safety norms, licensing, etc.) as well as low ownership costs (lead-acid batteries instead of Lithium-Ion) helped drive the adoption.

Share of Battery Electric in India's Three-wheeler Vehicle Sale



Source: BNEF Long Term Outlook 2021

Both India and China achieved high electrification levels in the three-wheeler transportation segment. As of end-2020, China's three-wheeler fleet (about 80% in global fleet share) had 78% electrification, against India's 37%. Progressively, the attention is likely to shift to the Indian market as rationalisation in costs spurs higher adoption.

Regional Overview of EV Adoption

Battery and Charging Infrastructure

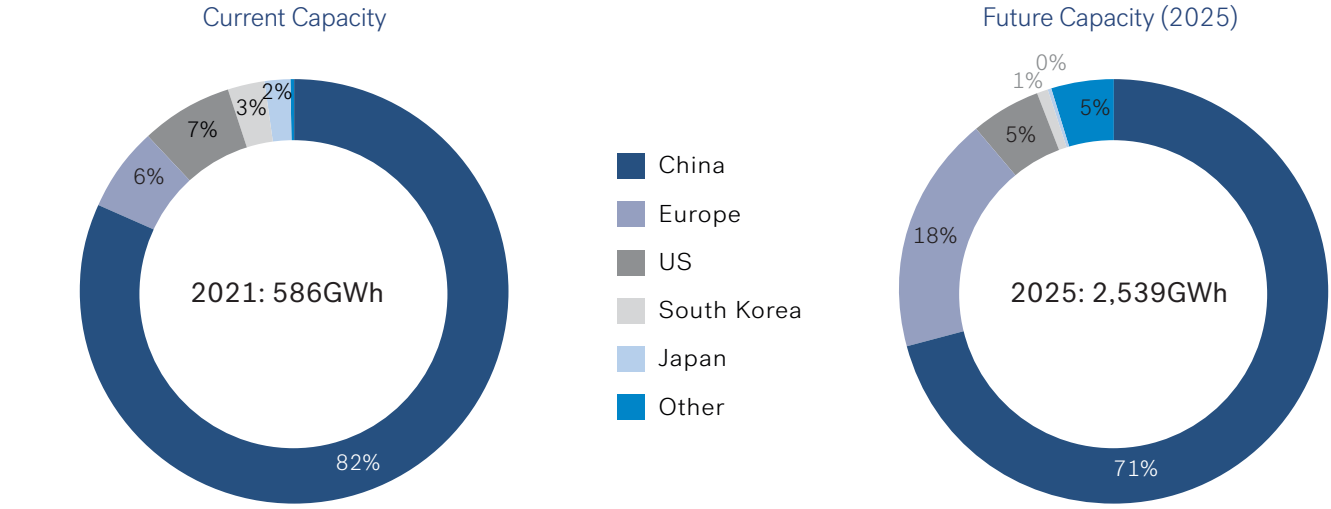
The demand for batteries globally is predominantly driven by the EV industry, in which the passenger EVs are the most important (almost two-thirds in share among segments). All existing manufacturers are in the process to expand capacities at an unprecedented scale. Localisation is key for suppliers to maintain competitive product prices, which is why many of the upcoming capacities are planned closer to the demand centres in the US and Europe.

BNEF estimates suggest that, with ongoing facilities under development, the total battery manufacturing capacity globally could quadruple by 2025

BNEF estimates suggest that with ongoing facilities under development, the total manufacturing capacity could quadruple by 2025.

One striking element of the upcoming manufacturing capacity is the diversification of base underway. While China's market dominance is a given, the European region is poised to massively enhance its indigenous production base. Over 38 Gigafactories are planned in the region – the latest being Tesla's commissioned at Berlin, Germany in March 2022. In the last two years, battery production capacity tripled in Europe. Furthermore, the need for a diversified of supply chain could assume urgency, as geopolitical factors make it difficult to rely on select countries of competitive advantage.

Lithium Cell Manufacturing Capacity by Plant Location Region



Source: BNEF Long Term Vehicle Outlook 2021

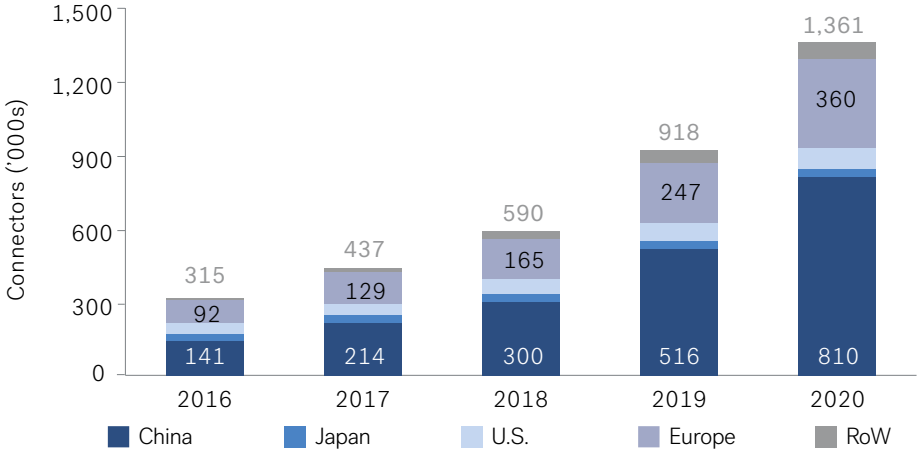
After batteries, the next key input for the EV business is the availability of charging points. In this regard, the infrastructure is in the phase of catching up to the demand. In absolute terms, it is apparent that the infrastructure base is significantly high in China relative to other regions. Europe currently has the major thrust on public charging infrastructure as it expands upon the electrification of transport. For many countries, this entails a significant change in policy and regulation to enable the provision of charging infrastructure, especially in terms of engaging private operators. For instance, in India, it was only recently that the regulation allowed private operators to devise tariff structures towards the charging points. Similarly, policy measures are being tweaked – such as through changes in building codes to mandate provision of charging points in residential housing before any approval.

Regional Overview of EV Adoption

With the expansion in charging infrastructure, the charging points also need to be upgraded in rating. Fast chargers are required to enable greater ease of use and adoption of EVs across segments. Also, there are efficiencies involved. Considering the already limited base so far in the provision of the charging infrastructure, the growth of fast chargers is restricted to mature markets. Another pertinent point in focus is that the provision of fast charging is contingent on the local demand in the region – the power distribution operators will have to accordingly make changes in the local grid supply infrastructure.

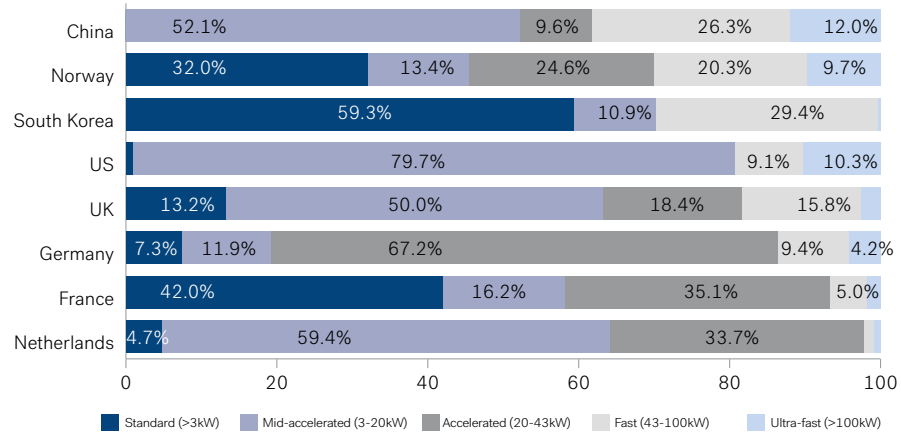
BNEF estimates show that the total investment in the charging infrastructure as of 2021 is about USD8 billion, of which a significant share is likely to be devoted towards fast-chargers

Cumulative Global Public Charging Connectors



Source: BNEF Long Term Vehicle Outlook 2021

Share of Public EV Charging by Speed/Rating, in Select Major Markets

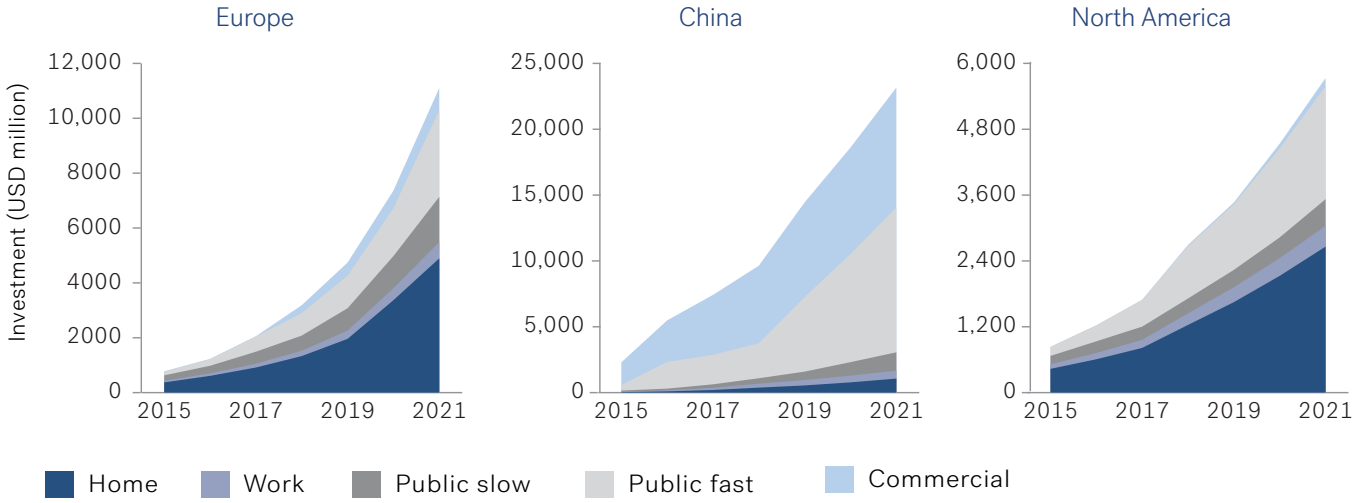


Source: BNEF Long Term Vehicle Outlook 2021

BNEF estimates show that the total investment in the charging infrastructure as of 2021 is about USD8 billion, as compared to the USD4.6 billion committed in 2019. A significant share of the planned investment in this space is likely to be devoted towards fast-charger stations in public network. This is because despite the lower volumes involved (relative to home/office or commercial), fast-or ultra-fast chargers are priced higher in both equipment and installation. In a regional perspective however, the pattern of such investment could vary. As the trend indicates, home charging network investments have been relatively the most important segments in Europe and North America, whereas in China, it is the commercial and fast-charging networks that led the investments. Local factors (residential/ housing structure, adoption rate of electric vehicles, charging behaviour, local grid capability, etc.) shape the investment trajectory in such infrastructure services.

Regional Overview of EV Adoption

Infrastructure Investment in Key Regions across the Charging Categories



Source: BNEF Long Term Vehicle Outlook 2021

04

Trends and Drivers

Trends and Drivers

Introduction

The transition to EV-based drivetrain is gaining momentum, from being a niche product-line to one for mainstream mass consumption. To be sure, with barely 1% of the global passenger vehicle fleet by drivetrain, EVs have a long way to make a dent in this market. The role of internal combustion engines is even more pronounced in case of bus fleets and commercial vehicles. This is likely to be the case, as EV adoption faces the challenge of ramping up capacities fast enough to meet the projected demand.

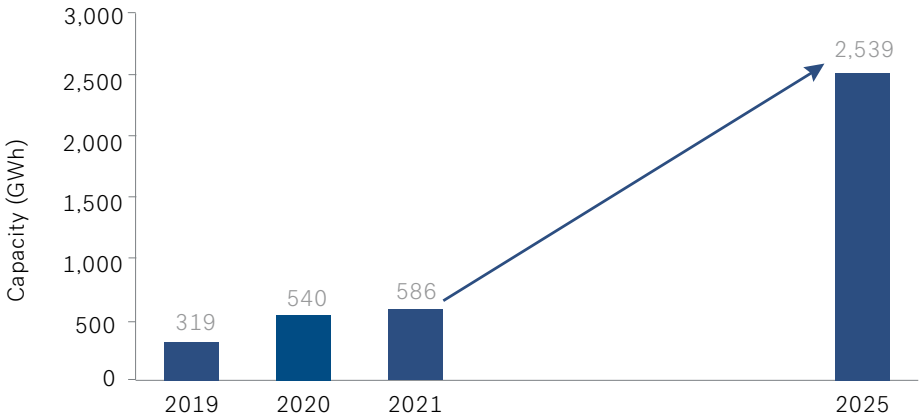
A mix of policy measures, starting from regional/national level emission control norms to local municipal rules on zero-emission traffic have contributed to setting the context and roadmap

Nevertheless, the progress towards electrification is more visible than it was earlier. Deliberate policy and regulatory action are responsible for such clarity. Of late, a mix of policy measures, starting from regional/national level emission control norms to local municipal rules on zero-emission traffic – contributed to setting the context and roadmap. For several automotive manufacturers, technology providers and related stakeholders, policy and regulatory measures (such as phase-out of combustion-based vehicles) propelled a drastic shift in business orientation.

The following sections of this chapter present a brief review of some of the major trends and drivers under way in the growth of EV business across the world.

Battery Cost and Supply

Lithium-Ion Battery Manufacturing Capacity Trend and Projection



Source: BNEF Zero Emission Vehicles Factbook (November 2021)

The Lithium-Ion battery plays the predominant role in the entire electric vehicle ecosystem even as alternate battery technologies continue to be under development or deployment. With technology maturity in this battery technology, it finds a ready acceptance in the industry. Over time, economies of scale further helped in enabling lowering the costs, as leading suppliers scaled up capacities to cater to the emerging and imminent demand.

Existing annual battery manufacturing capacity stands at about 586GWh in 2021 – almost double that in 2019. As per BNEF estimates the various manufacturing projects in pipeline globally, point to an expected quadrupling of the current capacity by 2025. While the Chinese leadership in this space is expected to continue largely unchallenged, it is important to note that the European share is projected to rise from 6% currently to over 18% by 2025.

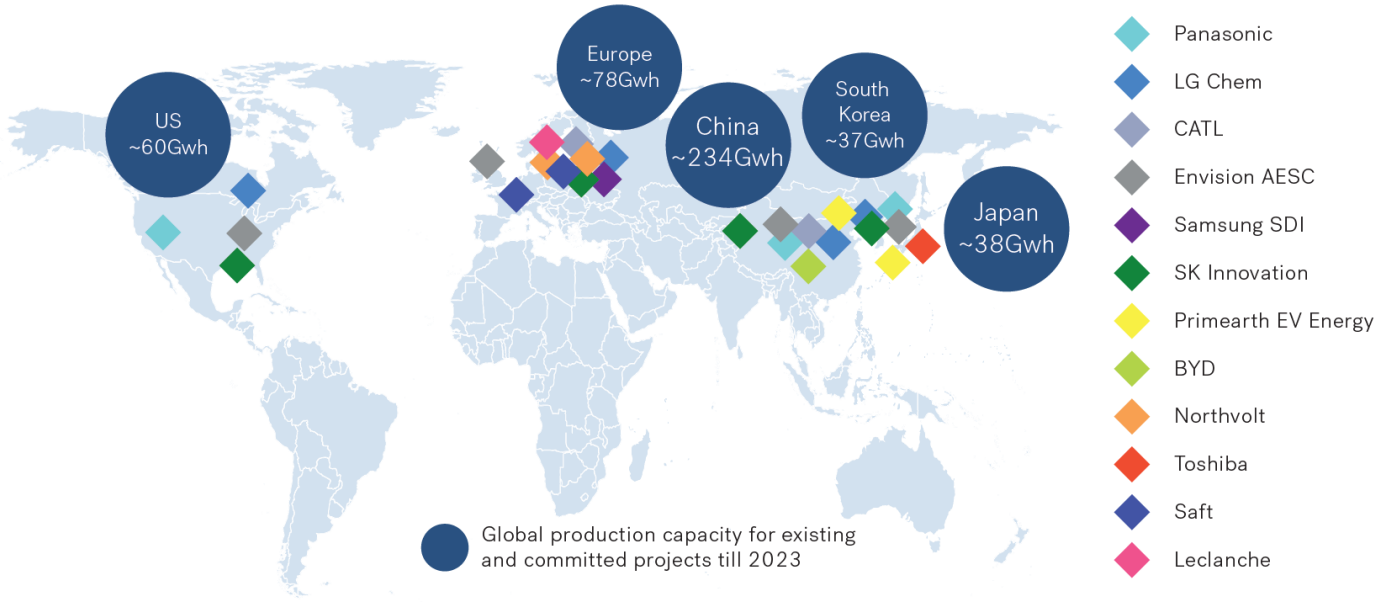
The demand-pull combined with the pressure to achieve lower unit costs is driving higher capacity sizes – evident in the planned construction of Gigafactories. As per McKinsey's estimates, about 60 new Gigafactories with average production capacity of 25GWh are in pipeline for commissioning by 2030. Furthermore, such gigafactories are likely to scale higher in their production sizes, reaching up to 100GWh in some cases. The time will be the key, considering the lead time involved in getting all such capacities to full utilisation levels – most gigafactories need 3-6 years to ramp up for full capacity.

Trends and Drivers

Globally, the battery manufacturing capacity is concentrated in select production hubs. At the same time, the emerging battery cell manufacturing sites are being located closer to the demand regions in the US and Europe. China's competitive advantage can thus be observed in this context, as it not only has access to critical material supply but also has the facilities set up for the supply chain. The country dominates over a three-quarter share of total global capacity in this regard.

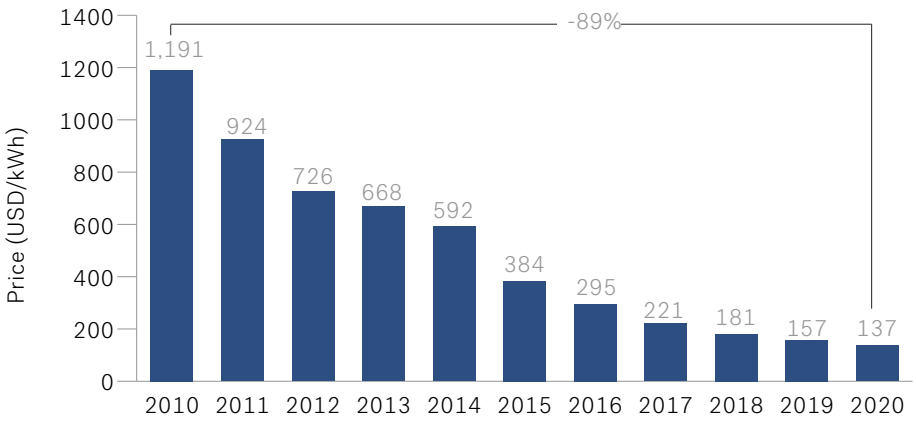
The near to medium term battery pack prices may fluctuate but the long-term trend is clearly that of further decline as additional capacities come onstream

Global Battery Cell Manufacturing Locations and Key Players



Source: KPMG and CII report on EV Landscape in India

Trend in Volume-weighted Lithium-Ion Battery Pack Price (Real 2020 USD/kWh)



Source: BNEF Zero Emission Vehicles Factbook (November 2021)

The sharply declining trend in battery prices reinforces the competitiveness of Lithium-Ion technology over other storage options in the market. Factors such as rising global manufacturing capacity, rising order sizes from the major automakers, increasing energy density and introduction of new cell and pack designs – all together contributed towards the long-term decline in battery prices. The near to medium term battery pack prices may fluctuate but the long-term trend is clearly that of further decline as additional capacities come onstream.

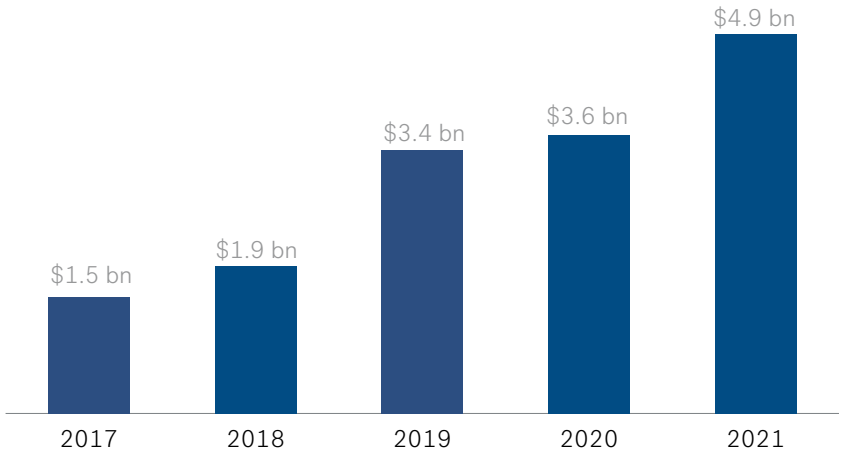
Trends and Drivers

Charging infrastructure

Progressively, the charging infrastructure availability is assuming a critical role in EV adoption. It is at the same time contingent on the EV sales growth – countries with relatively higher EV penetration are also the one undergoing the most rapid and sustained expansion of charging infrastructure. The trend is clearly visible from the experience in high EV penetration European countries against the nascent markets of Latin American region (Chile, Mexico) or Asia-Pacific (India).

Fast chargers constitute about 20%-40% of the annual public charger investments

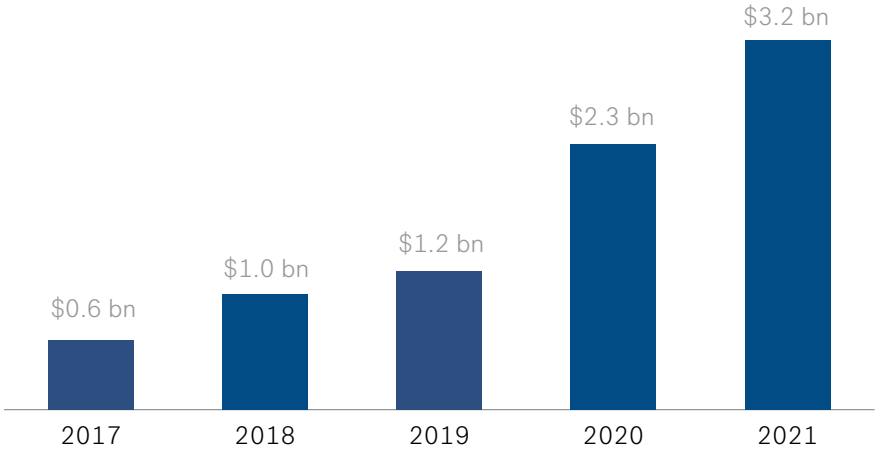
Trend in Public Charger Investment



Note: Data for 2021 is an estimated one
Source: BNEF Zero Emission Vehicles Factbook (November 2021)

The trend shows a consistent rise in investment commitments for charging infrastructure. The total annual investment in 2021 in this regard stands at an estimated USD8 billion. Public charging has a relatively higher share in this, partly due to the higher unit cost of the equipment involved. However, such infrastructure proves to be a cost-effective option once the utilisation rates rise. As per BNEF estimates such charging points can cater to a range of five to over 100 vehicles' requirement in a year, in contrast to 1-2 vehicles in case of home charging points.

Trend in Home Charger Investment



Note: Data for 2021 is an estimated one
Source: BNEF Zero Emission Vehicles Factbook (November 2021)

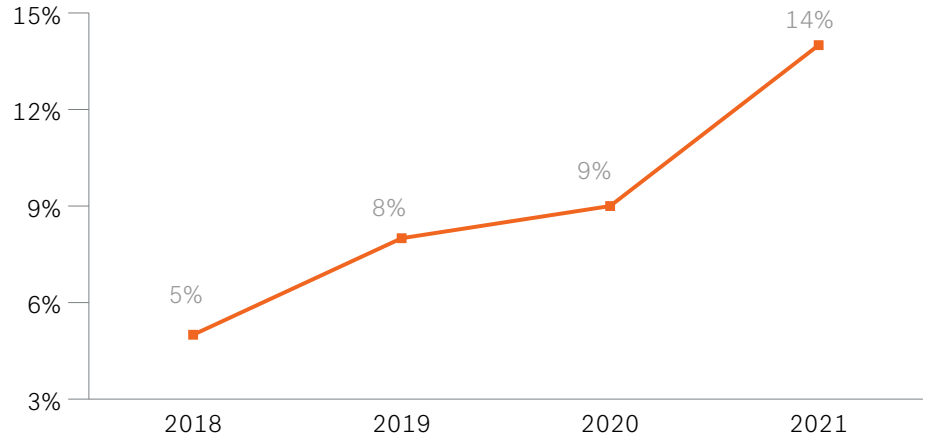
Also notable is the fact that the fast chargers constitute about 20%-40% of the annual public charger investments, even as their share in total installations averages around 20%. At the same time, the ultra-fast charging stations (rated above 100kW) installation shows a rising share. Such installations are progressively taking place in urban locations such as supermarkets or on the public highways. Public fast chargers entail a high cost of investment (ranging USD30,000 – USD180,000) against those of home charging (averaging around USD1,000).

Trends and Drivers

In volume terms however, home charger installations outnumber those in public segment. By 2021, the number of home charging installation rates were estimated to be about four times of that in 2019. As per BNEF estimates, this trend is most discernible in case of US and Europe as drivers have the facility for a home charging point. Even so, the share of drivers installing home chargers is expected to decline over the decade with the rise in share of drivers without such facility (relying on public charging).

By 2021, the number of home charging installation rates were estimated to be about four times of that in 2019

Trend in Share of Ultra-fast Charging Capacity



Source: BNEF

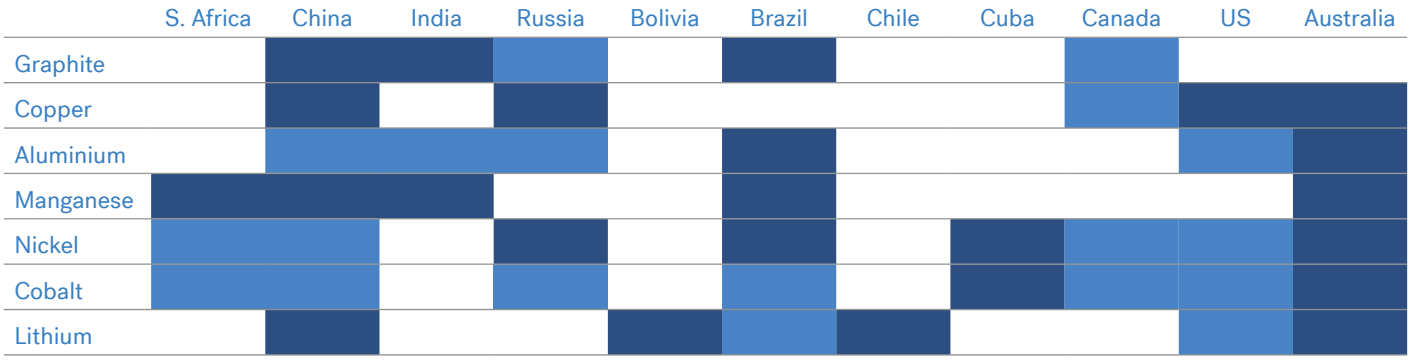
Trends and Drivers

Localisation of Supply Chain

With the rise in product launches, EV manufacturers and suppliers are seeking expansion in target markets and setting up facilities to localise the production of vehicles and components. Tesla got its locally produced EV in China by end of December 2019, after setting up a local facility at Shanghai. It recently commenced production at the Berlin Gigafactory in Germany. Other auto majors such as Volkswagen and Toyota announced plans for manufacturing plants across the countries, such as China and Mexico.

China's predominance over the global EV battery supply chain is gradually being countered by Europe and the US

Reserves of Lithium-Ion Battery Raw Materials in Selected Countries



Source: KPMG report on Electric Vehicle Landscape in India

China's predominance over the global EV battery supply chain is gradually being countered by Europe and the US. Some of the key initiatives in this regard have been from the European region, reflecting the need to cater to the booming EV market there. The battery cell manufacturing is being located closer to demand, with most of the new capacity set to come up in Central Europe.

Chinese entities too are similarly following this trend – the Chinese battery manufacturer CATL signed new contracts with several international OEMs and plans to set up a factory in Germany. Other critical parts of the supply chain are similarly taking steps at scaling up through localisation. For instance, Cathode active material producers, such as Johnson Matthey, Umicore and BASF, announced plans for setting up material plants in Europe.

Localisation is also observed in manufacturing processes of automakers. Battery pack production, for instance, is being increasingly carried out in-house. This is because this component of EV typically gets customised for each vehicle make and transporting it adds to the cost. Thus, the Lithium-Ion battery production in close proximity to automobile and battery-pack production is helping OEMs minimise supply chain risk.

It also helps that a rising number of auto OEMs are favouring the joint venture route with battery/technology companies to take a holistic approach. Some of the notable examples of the partnerships include LG Chem and General Motors in US, Saft AB and PSA Peugeot Citroen in France and Germany and Northvolt with Volkswagen and Bayerische Motoren Werke (BMW) in Europe.

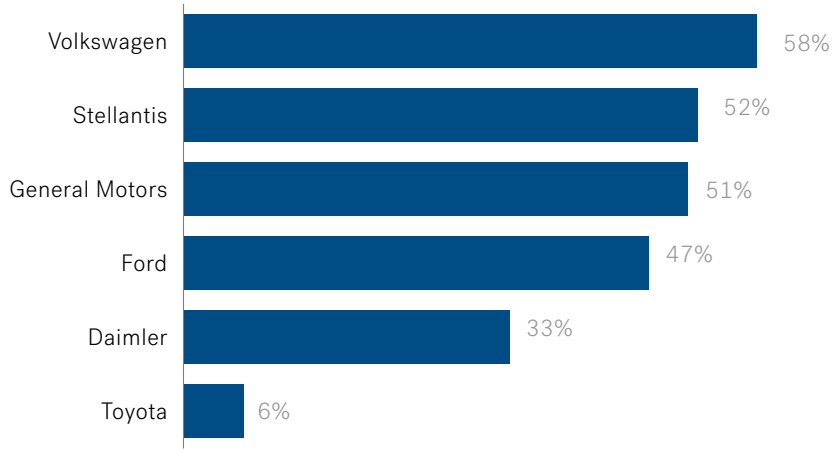
Trends and Drivers

Corporate Sector's Initiatives and Commitments

A significant part of the progress in EV industry is driven by the corporate sector's steps, regardless of the available support from respective government authorities. One evidence of such intention is the capital outlay towards EV research and development (R&D) and related digital technologies (such as battery management systems, etc.). Setting up the value chain for transition in automotive drivetrain is a significantly capital-intensive exercise and fund allocation indicates commitment. It is also notable that some of the biggest automakers globally have committed an accelerated capital spending plan for electrification within the next five years.

During 2021, at least 12 major automakers announced global, regional, or subsidiary-level targets for phasing out ICEs

Major Automakers' R&D and Capex Commitments on EV and Digital Tech in 2020 (% of total)



Source: BNEF zero emission vehicles factbook (Nov 2021)

Related to the capex commitment is the planned phase-out of internal combustion engine (ICE) drivetrain by the leading automakers. During 2021, at least 12 major automakers announced global, regional, or subsidiary-level targets for phasing out ICEs. The manufacturers such as Audi, Fiat, Volvo chose 2030, while GM targets it for 2035. Mercedes-Benz put this in 2039 and Honda Motors in 2040. Others such as Ford, Hyundai, and Volkswagen announced regional phase-out plans specific to Europe. In a trend perspective, such announcements of intent stand out because none of such leading auto companies made any pledges to phase-out the conventional technology vehicles.

Select Manufacturers' Targets for Zero-emission Commercial Vehicles

	2025	2030	2040
Daimler Trucks and Buses	-	Up to 60%	100% (2039)
Volvo	-	>35%	"Absolute majority" as per company
Traton	-	10% Scania in Europe	• 50% (Scania) • 60% (MAN delivery trucks) • 40% (MAN long-haul trucks)

Source: BNEF

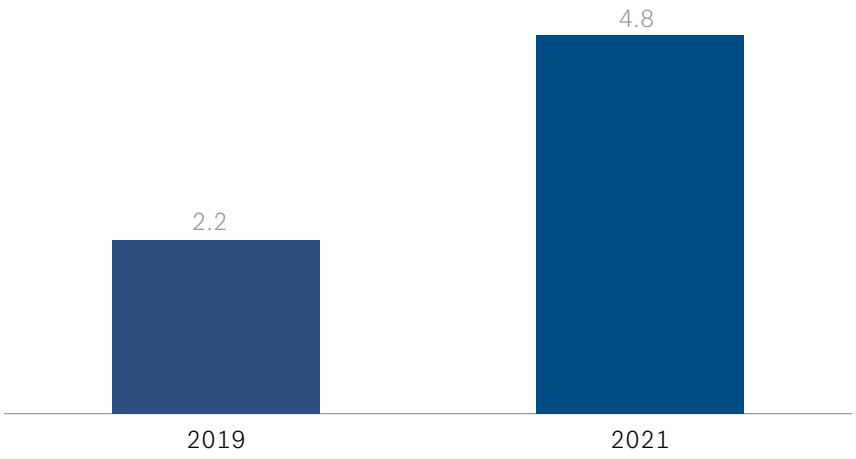
Trends and Drivers

Market Players and Competition

While the progress in commercial vehicles in slower than that of the passenger cars, some of the major manufacturers in this segment came forth with roadmap on zero-emission medium- and heavy-duty trucks. The available clear evidence of such plans – namely Daimler, Volvo and Traton account for almost a quarter of the global medium to heavy-duty truck business (based on 2019-20 sales).

The Chinese major BYD, with over 80% of its total sales attributed to EVs, has emerged as among the key players in global EV marketplace

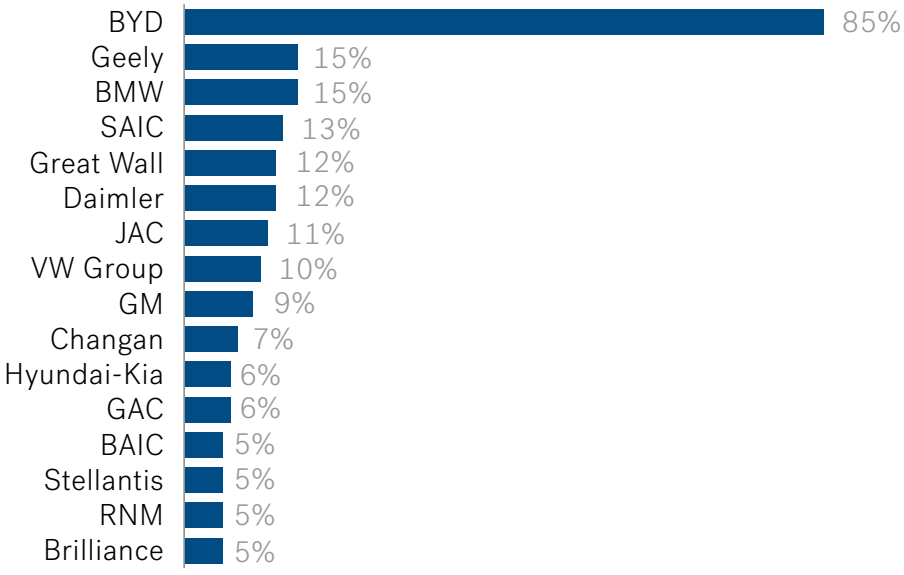
Vehicles Covered Under the EV100 Pledge (million)



Source: BNEF Zero Emission Vehicles Factbook (November 2021)

Lately, the non-profit entity Climate Group's EV100 initiative – a broad grouping of some of the major global companies to pledge/support transition to electric drivetrain – has gained significant currency as a corporate sustainability measure. Under this initiative, companies participating in this grouping commit to 100% electrification of their vehicles by 2030. The number of EV100 members promising fleet electrification rose from 53 in 2019 to 91 in 2021, while the corresponding number of vehicles under this commitment shows a 117% rise.

Share of Battery Electric Vehicles in Automakers' Total Sales, Q32021



Source: BNEF

To be sure, for many incumbent automobile manufacturers, the shift to EV is now part of the inevitable, as they face pure-play EV manufacturers such as Tesla and NIO. An important player in this regard is the Chinese major BYD. With over 80% of its total sales attributed to EVs, this company has lately emerged as among the key players in global EV marketplace. On the other end of the spectrum, is the contrasting picture of incumbents such as GM where EV is yet to play an important part of the sales.

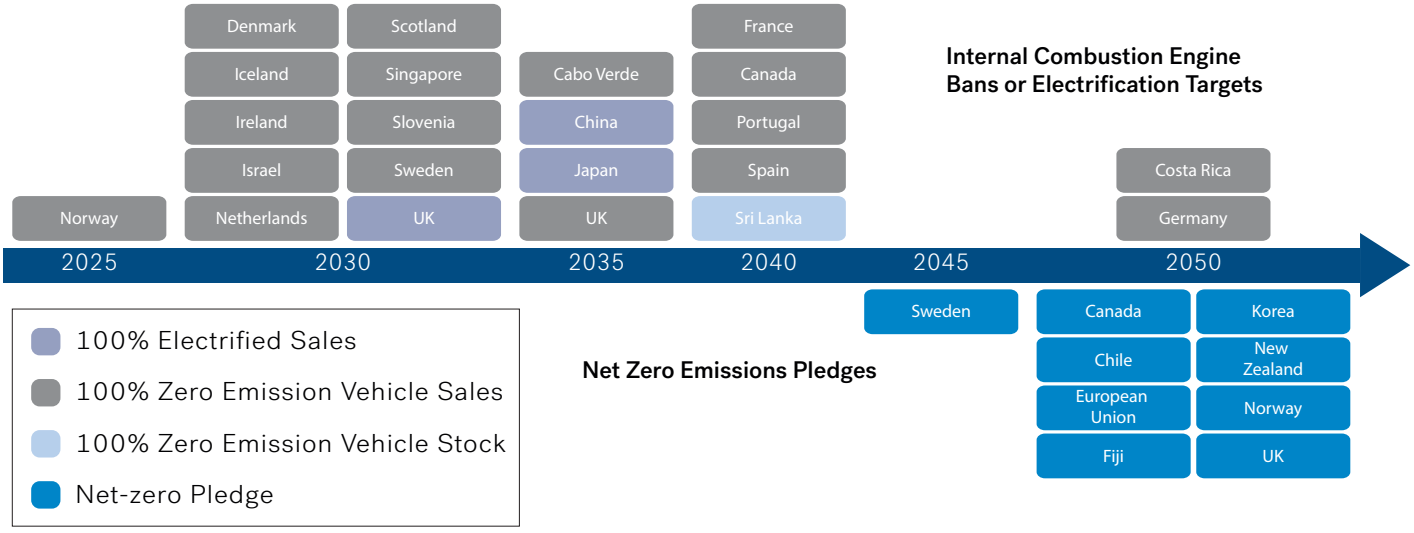
Trends and Drivers

Role of Government

Globally, the growth fundamentals of EV market are being underpinned by the policy and regulations. The country or region-wide (as in Europe) policy position on mitigating carbon emissions defines the business case for EV penetration. The recently held UN Climate Summit at Glasgow was notable for the national governments explicitly committing the phase out, including countries such as India and Kenya which tentatively agreed to accelerate the zero-emission vehicles' adoption. At the same time, some of the other leading industrialised countries such as US, China and Germany stood out for their refusal to commit such a roadmap at national level.

Globally, the growth fundamentals of EV market are being underpinned by the policy and regulations, while the policy position on mitigating carbon emissions defines the business case for EV penetration

Countries with Stated Policy Goals on Electrification and Net-zero Transition



Source: IEA Global EV Outlook 2021

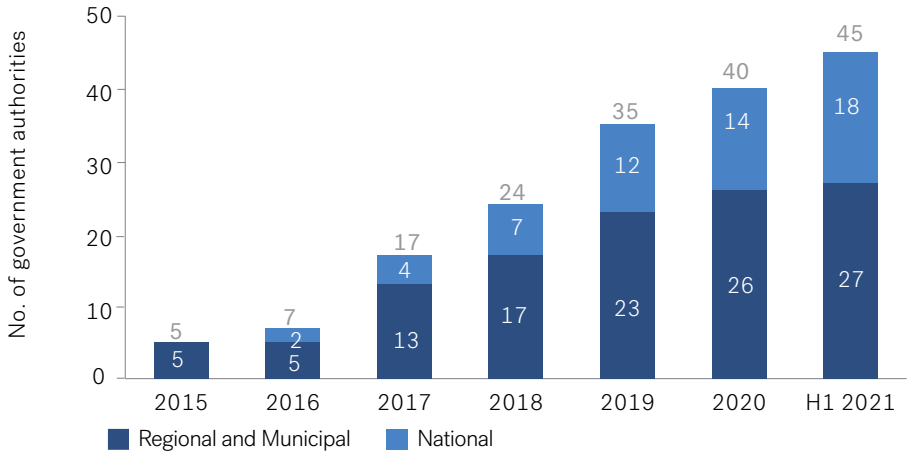
There are notable examples of state- and/or municipal-level policies driving EV adoption instead of the centralised government norms. Notable cases of regional or provincial policies, as distinct from national/central, are observed in the countries of US (states of California, Massachusetts and New York) and Canada (provinces of British Columbia and Quebec). The importance of state-level regulations can be understood from the fact that even though US does not have a national-level ICE phase-out target, the state-level targets account for a quarter of total vehicle sales in the country. It should however be pointed out that the legality and enforcement of the bans remains uncertain in many of the cases. This is because of the limited regulatory direction (norms and their enforcement) to complement the stated policy goals by governments. Moreover, the phase-out announcements in many cases are vague on many of the aspects such as the inclusion of EV categories such as hybrids or the penalties that could be imposed upon non-compliance.

Trends and Drivers

A few cases where such steps were taken include Canadian province of British Columbia where a law was passed incorporating the date of phasing of combustion-based vehicles. In UK, the phaseout announcement was clarified to highlight the inclusion of hybrids and plug-in hybrids. In case of European Union, the legality of the bans is in question after Denmark's phase out target in 2019 was regarded as a violation of EU rules.

As per the estimates from IEA, electric car sales rose 40% year-on-year in 2020 attributing to the higher purchase incentives and stimulus offered

Cumulative Number of Government Authorities Announcing the Phase-out of Internal Combustion Vehicle Sales



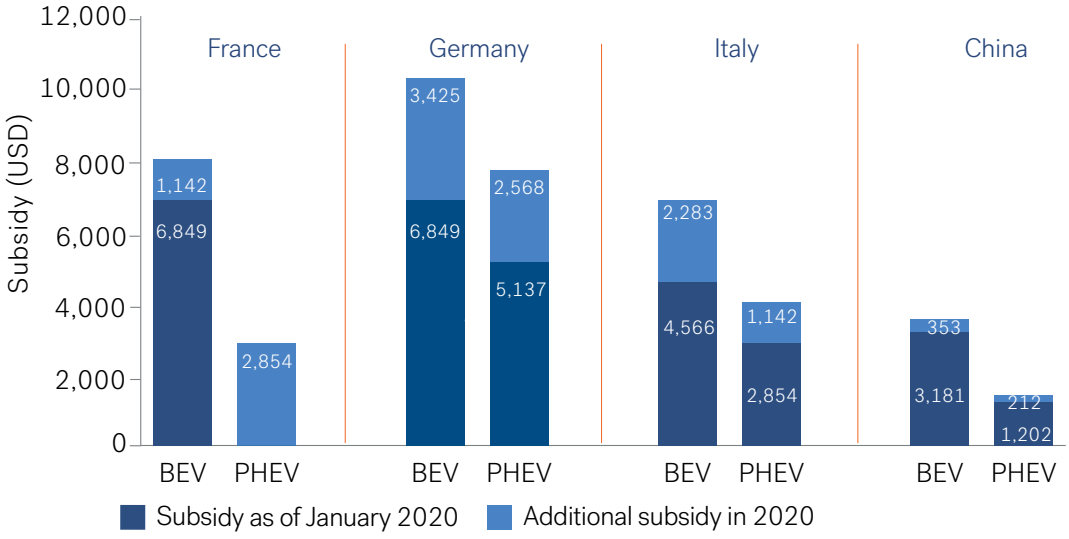
Source: BNEF Zero Emission Vehicles Factbook (November 2021)

There is a bigger role that local or municipal-level policies play, acting both in favour and against the EV adoption trend. The charging infrastructure availability rests on municipal authorities. They also take the decisions on public transportation, shared mobility, and micro-mobility. There are learnings from various cities globally as EV penetration rises.

The Dutch cities of Amsterdam, Rotterdam, and The Hague provide free charging points on request of individuals and businesses, due to the emphasis on public charging. But in Los Angeles, there is a better case for home charging than public facilities, due to which the local authorities aim to focus on home charging to rapidly scale up charging capacity at relatively lower costs. On the flip side, popular electric micro-mobility modes such as e-scooters face bans or other restrictions in various European cities due to licensing, safety, or other norms.

In 2020, the government role in driving EV market came forth through the additional subsidy support. As per the estimates from IEA, electric car sales rose 40% year-on-year in 2020 – a major contrast when all other vehicle categories reported a contraction in sales due to the pandemic. In countries such as Germany, France and Italy, higher purchase incentives offered in early 2020 helped drive the sales sharply during the first half of that year. Additional stimulus released by around mid-2020 helped boost the sales towards the end of the year even when the pandemic's second wave impacted other markets otherwise. Some of the key factors that stood out in the stimulus packages released during this period include – a specific focus on electric and plug-in hybrid, an integrated approach that took into account the charging infrastructure, public transport and non-motorised mobility.

National Subsidies Before and After Economic Stimulus Measures in 2020



Source: IEA Global EV Outlook 2021

05

Outlook

Outlook

Introduction

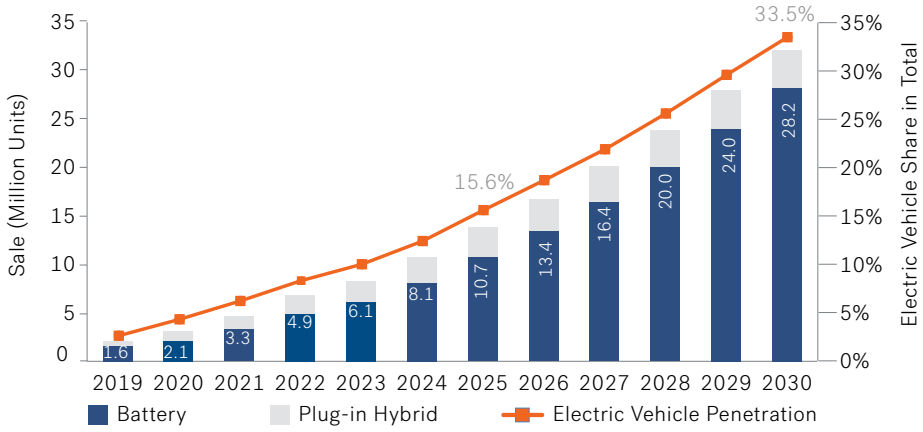
Globally, the transition to EV-based drivetrain is underway in varied pace and momentum. The leading markets, as in China and European region, set the context due to the rapid growth and the predictable policy roadmap on the same. To be sure, the transition entails a significant change. It impacts key players in the overall value chain, such as automotive manufacturers managing a future phase out of combustion engines, municipal authorities accommodating the public charging infrastructure in urban plans, and utilities/ grid operators preparing a bigger role of EVs in the network.

Passenger electric vehicles, being focal point in policy framework, are likely to account for a rising share of new vehicle sales, reaching a projected one-third level by 2030

EV Adoption and 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 COVID-19 outbreak was an outlier event that disrupted the supply chain of automobile manufacturers across the globe. Yet, the EV sales relatively held up better than the combustion engines in most of the countries, partly because of order backlog, new models as well as conducive policy support.

Projected Global Passenger EV Sales and Penetration



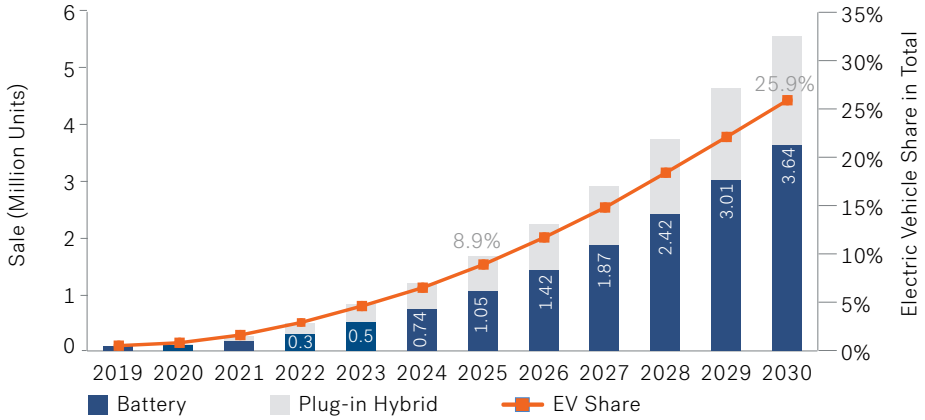
Source: BNEF

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 a projected one-third level by 2030. Importantly, the projected growth is expected to be led by battery electric vehicles even though the plug-in hybrids could lead the way in the short- to medium-term.

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.

Outlook

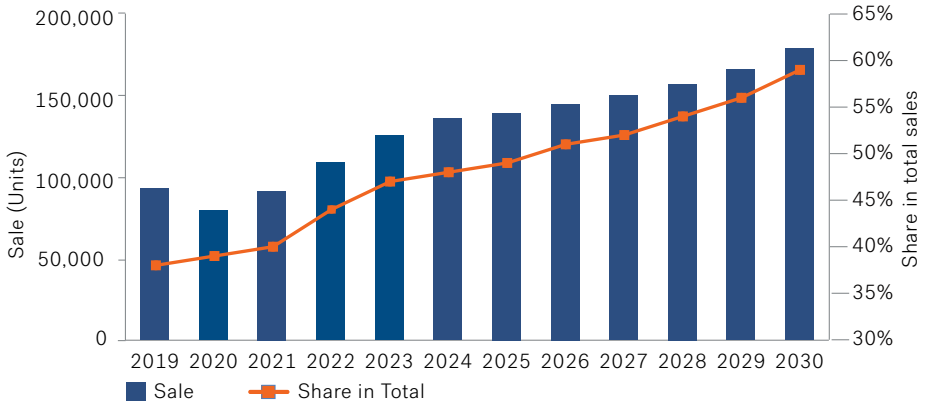
Projected Global Commercial EV Sales and Penetration



Source: BNEF

The electric bus segment is likely to maintain its momentum as various national and city-level authorities extend public funding for bulk fleet-replacement procurement

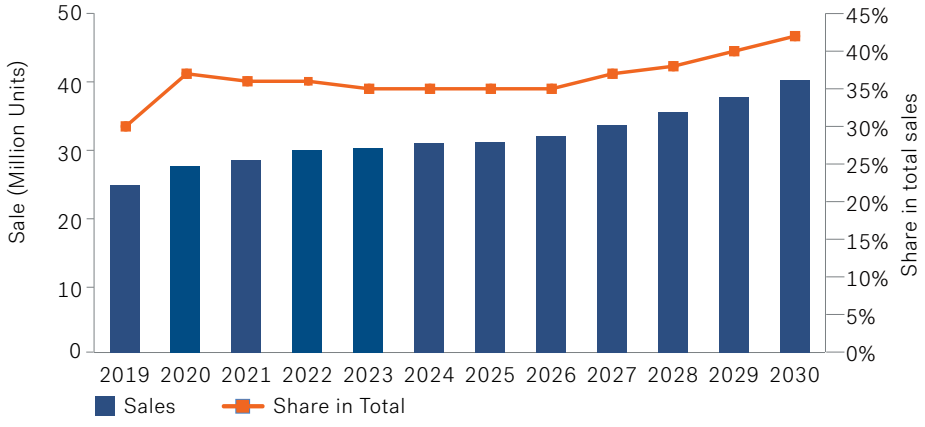
Projected Global Electric Bus Sales and Penetration



Source: BNEF

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.

Projected Global Electric Two-Wheeler Sales and Penetration



Source: BNEF

Somewhat similar progress in electrification is observed in case of the two-wheeler segment. Led mainly by the developing countries, the attractive price points of vehicles in this segment coupled with subsidy support, helped ramp up the penetration early on. This is expected to continue. While China is the global leader in this space, growth is expected to be driven by countries such as Taiwan, Vietnam and India in the next phase.

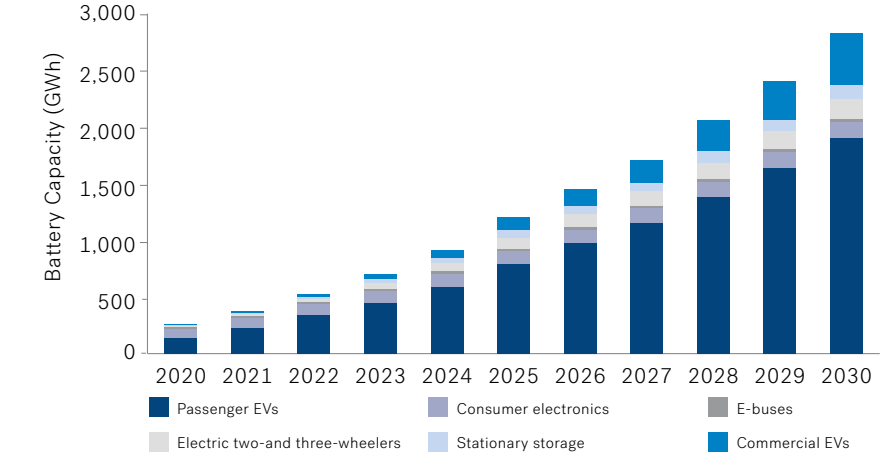
Outlook

Battery and charging infrastructure

For all the segments taken together, electric vehicles account for an important share in the overall battery demand. As per BNEF, for Lithium-Ion batteries, the predominant battery technology, passenger electric vehicles accounted for over half of the total demand in 2020. On taking the other electric vehicle segments into account, the contribution to total demand rises to 63%. Projections, using the same source, show that electric vehicles' share in global battery demand rising up to 90% by 2030.

BNEF estimates electric vehicles' share in global battery demand to rise up to 90% by 2030 from 63% in 2021

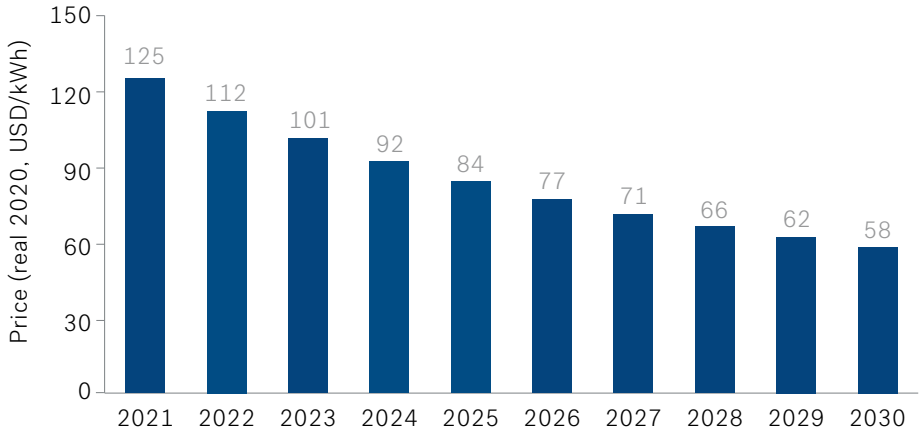
Projected Lithium-Ion Battery Demand Outlook



Source: BNEF

The cost trajectory of batteries is key in driving adoption of EVs, especially those in passenger segment. The historically declining trend observed in battery prices so far, is likely to sustain further. It will be not only due to manufacturing scale, but also due to the varied technological options being tried out. The industry survey results appear to indicate that prices are on a declining path ahead.

Projected Lithium-Ion Battery Pack Price



Source: BNEF

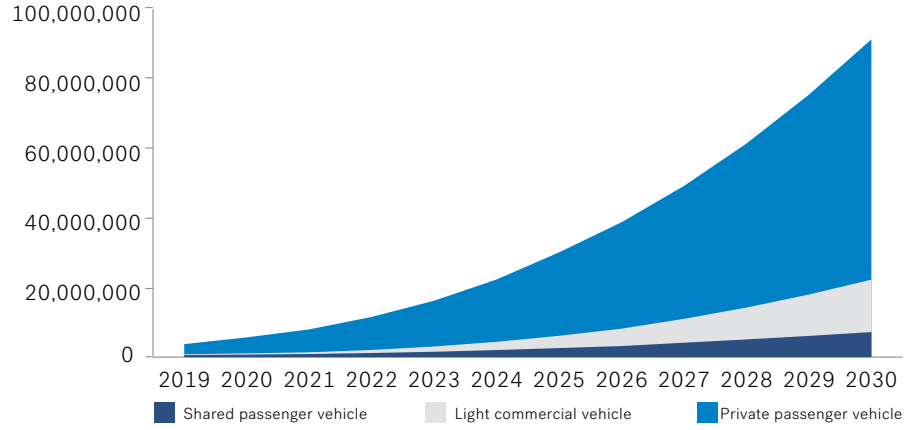
As per BNEF survey results, the volume-weighted average price of a Lithium-Ion battery pack, at USD137/kWh in 2020, was the lowest reported one since 2010. Rising order sizes, expansion in sales, as well as introduction of new cell/pack designs continue to drive the EV battery prices down. The rate of decline in battery pack prices is instrumental in determining the price parity between EV and the internal combustion engine platforms. Below the USD100/kWh level, the cost of battery-based electric vehicles is expected to be competitive across the segments and markets.

Outlook

Charging infrastructure is the next important and critical factor to support the potential growth in the electric vehicle market. In volume terms, the passenger electric vehicle market holds the maximum importance for the required charging connectors. The projected requirements are largely based on the energy demand likely from the emerging electric vehicle demand across countries. The moot point will however be not just the total network capacity but its timely availability. It is on this count that many of the markets are woefully behind the curve.

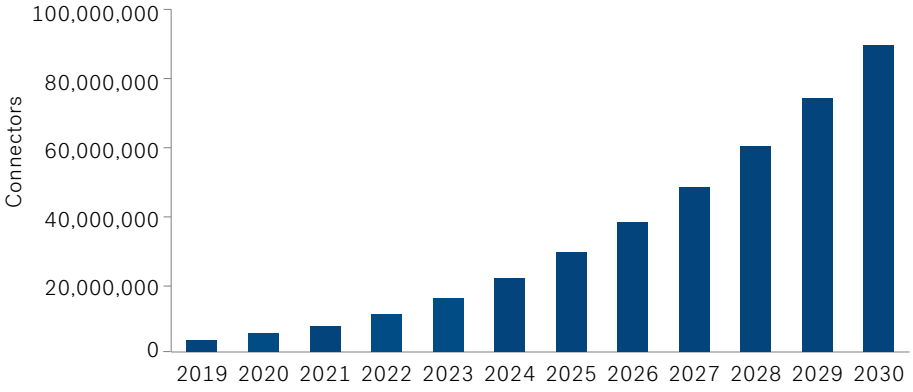
Charging infrastructure is the next important and critical factor to support the potential growth in the electric vehicle market

Projected Public Charging across Major Electric Vehicle Segments (no. of connectors)



Note: The three segments' requirements as shown above, accounts for over 95% of total.
Source: BNEF

Projected Public Charging Capacity for Home/Office Category (7-22 kW)



Source: BNEF

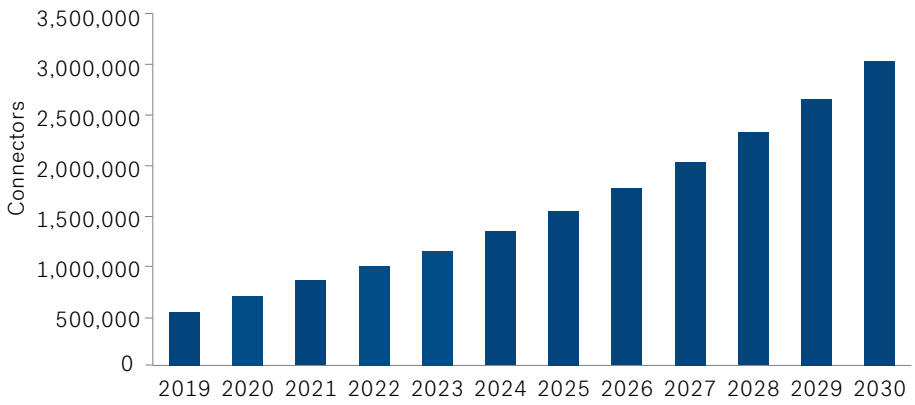
Home charging is the largest category, accounting for 80% of share in the projected capacity. As the projections indicate, much of this growth will be led by the existing base of relatively slow chargers (up to 22 kW) that are amenable for AC power connections at home/office. Supporting regulations in this regard such as modification in residential building codes as well as harmonisation of equipment standards are likely to gain further importance in this segment of the charging infrastructure.

Outlook

Fast charging (50 kW and above) is gaining traction, partly with the push from EV manufacturers to enable the adoption. Along with larger-sized batteries, the availability of faster-charging infrastructure supports the case of longer route travel. This has implications for EV fleets related to commercial vehicles especially in context of trucks. Notably, with availability in faster charging infrastructure, the number of EVs per public charging connector rises, resulting in better utilisation levels. For instance, Norway currently has about 20 EVs per connector – this is a level projected for Europe and US by 2030 by when fast charging systems become available at requisite levels.

Wireless or inductive charging is one technology option that offers an alternative to the physical setup of charge points

Projected Public Fast Charging Capacity (50 kW and above)



Source: BNEF

Evolving Business Case of Wireless Charging

Wireless or inductive charging is one technology option that offers an alternative to the physical setup of charge points. The technology concept is not a novel one but its application for electric vehicles is both an innovation and challenge due to the adaption needed for the specific requirements. In such technology, using magnetic coils, electric current can pass through over a short distance without wires and charge the electric vehicles in a moving or stationary state without plugging in. The promising results at research laboratories have spurred efforts toward commercialization.

Pilot projects are underway across countries to test its viability for an eventual large-scale rollout. While the mainstream implementation of the technology may take time (due to factors such as standardization of equipment standards, preparation of infrastructure, etc.), various markets might likely find a limited launch for specific segments. For instance, in February 2022, the US-based wireless technology company WiTricity announced a limited beta release of its Halo wireless charging system, to be released for broader availability in 2023. Notably, the company has been offering the same to automakers but now plans to market it as a consumer aftermarket product.

As the ongoing pilot projects indicate, the potential deployment of a wireless/inductive charging system appears to be best suited for the segment of heavy-use commercial vehicles and taxis. The next round of investments is thus most likely to be focused on developing wireless charging infrastructure around high-traffic motorways, parking lots, and taxi fleets to ensure a widespread impact.

Outlook

Illustration of the Major Pilot Projects in Wireless EV Charging

Company	Country	Pilot project particulars
Volvo	Gotenburg, Sweden	In March 2022, Volvo launched a three-year wireless charging pilot project at Gothenurg, Sweden. Other partners in the project include Volvo Bil, Vattenfall, Göteborg Energi and Business Region Gothenburg.
Electreon	Gotland, Sweden	In April 2022, Electreon announced a one-year extension of its Smartroad pilot project in Gotland, Sweden. The extension is being funded (EUR2 million) by the Swedish Transport Administration.
Office for Zero Emission Vehicles (UK government)	Nottingham, UK	The UK's Office for Zero Emision Vehicles is funding a GBP3.4 million investment for trial of wireless charging-based electric taxis in Nottingham.
WiTricity	Massachusetts, US	Since October 2021, the wireless technology company WiTricity has been running a pilot based on Tesla Model 3 for its wireless charging offering being sold as an aftermarket product.

Source: BNEF

In March 2022, Volvo launched a three-year wireless charging pilot project at Gothenurg, Sweden

Integration of EVs in Power System

The unprecedented rise in EV adoption will necessitate steps to balance the overall power system with which it is to be connected. As of end-2019, the global EV fleet entailed a total power consumption of 80TWh, marking a 40% rise over previous year (IEA estimates). As per BNEF projections, by 2030, the electricity demand from such vehicles could reach almost 800TWh. Proportionately, this is a small part of the total global electricity consumption and on it own is unlikely to cause any displacement.

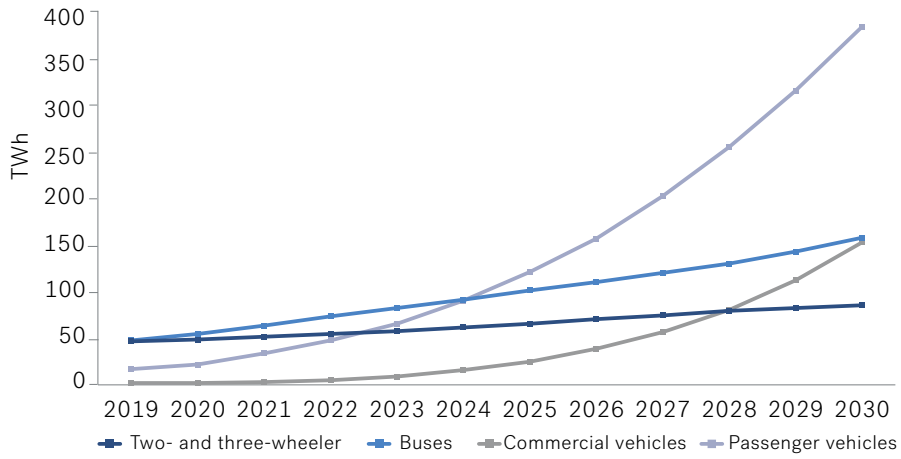
The concerns are however centred around the potential impact on grid management and integration, as multiple demand and supply modes become active. As the trends show, the share of renewable energy generation could reach about 17% of total consumption by 2030. As per one projection scenario of IEA, in a typical unmanaged charging setup, the share of EV charging in the average evening peak demand could reach up to 4-10% in some of the major EV markets (China and Europe primarily) over the next ten years.

There are apparent gaps in the infrastructure – most glaringly in the lack of adequate charging station capacity. A high concentration of electric vehicle on limited charging network could potentially strain the local power infrastructure and trigger a cascading response at the extreme. At the same time, it could exert pressure to ramp up capacities in both grid network and peaking power facilities. Global investments in power transmission and distribution networks show a decline in recent years, mainly due to limited capital spending in developing countries.

According to a study published by Deloitte, Eurelectric and European Distribution System Operators (EDSO), by 2030 the European power distribution systems will require investment ranging EUR375-425 billion to accommodate for the transition to renewable energy as well as the rising electrification in transportation and heating. In the US context, the projected investment requirement is understood from a recent report by American Society of Civil Engineers. As per this, the US grid infrastructure faces an investment gap worth USD208 billion by 2029, of which the distribution segment accounts for almost a quarter.

Outlook

Projected Electricity Demand Attributed to Electric Vehicles

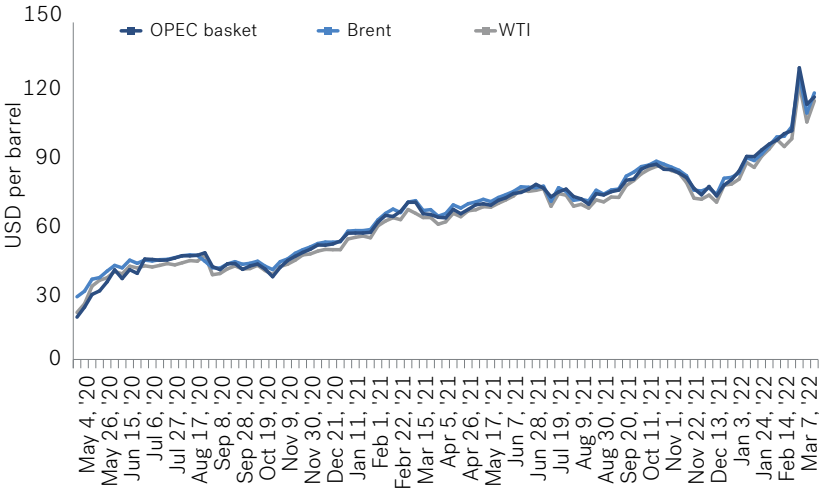


Source: BNEF

As of end-2019, the global EV fleet entailed a total power consumption of 80TWh, marking a 40% rise over previous year

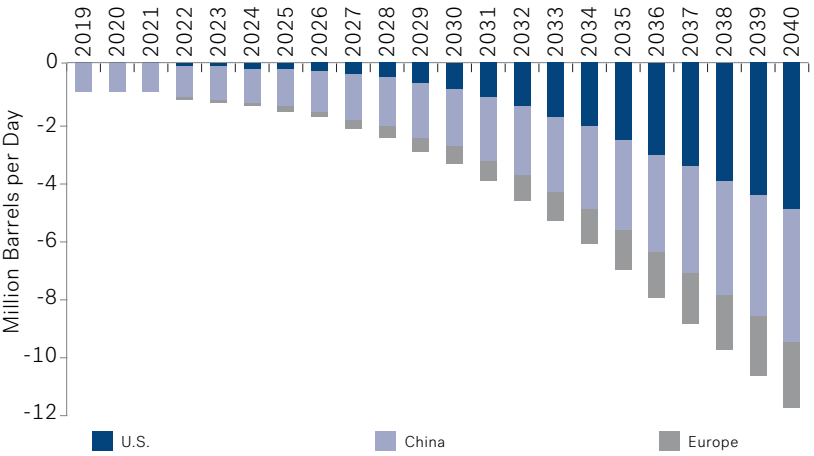
Volatility in Global Hydrocarbon Energy Supply and Pricing

Trend in Global Crude Oil Prices



Source: Statista (attributed to Bloomberg, OPEC)

Projected Oil Demand Eroded by Electric Vehicle Adoption



Source: BNEF Long Term Electric Vehicle Outlook 2021

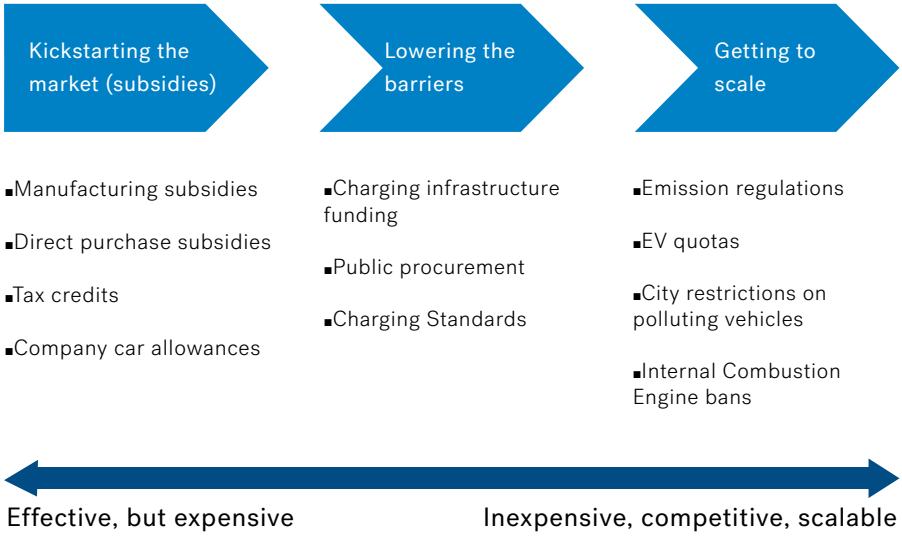
The trend in global oil supply and prices have material changes in the competitive proposition of the electric vehicle, in varied measures across countries. The current price volatility observed in the global market is thus relevant in this context. While price shocks in global crude oil market are not new, the one during 2022 is notable for multiple factors. The current price rise is led by a demand-pull coming in aftermath of a post-pandemic business recovery. At the same time supply has not been forthcoming as the OPEC cartel did not ramp up production in required proportions while US shale supply lagged as well. Inventories meanwhile are also significantly depleted as major countries drew down on the reserves to control prices.

As per IEA, globally higher oil prices strengthen the case for electrification of transportation. The impact could lie in an acceleration of its electric vehicle adoption, as payback period of such purchases appear competitively shorter. Furthermore, at a policy level, higher prices of crude oil could make an effective case for active support in electric vehicle adoption, whether in terms of subsidy support or through development of the requisite infrastructure.

Outlook

Policy/Regulatory Outlook

Evolving Policy Structure for Electric Vehicle Market



Source: BNEF

As per BNEF estimates at least 60% of the new car sales will have to be electric in 2030 to meet the targatted CO2 reduction by 37.5% till 2030 against 2021 level

The global policy trajectory for electric vehicle is conditioned by the country-specific local factors. For this reason, the outlook for policy and regulatory cannot be generalised across global markets. Even then, the experience so far points to a broader pattern – 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.

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. China, the global market leader, will be completely phasing out the passenger vehicle subsidies in 2022, while the same for public transport could be rationalised by 20% during the year. 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 decarbonisation objectives.

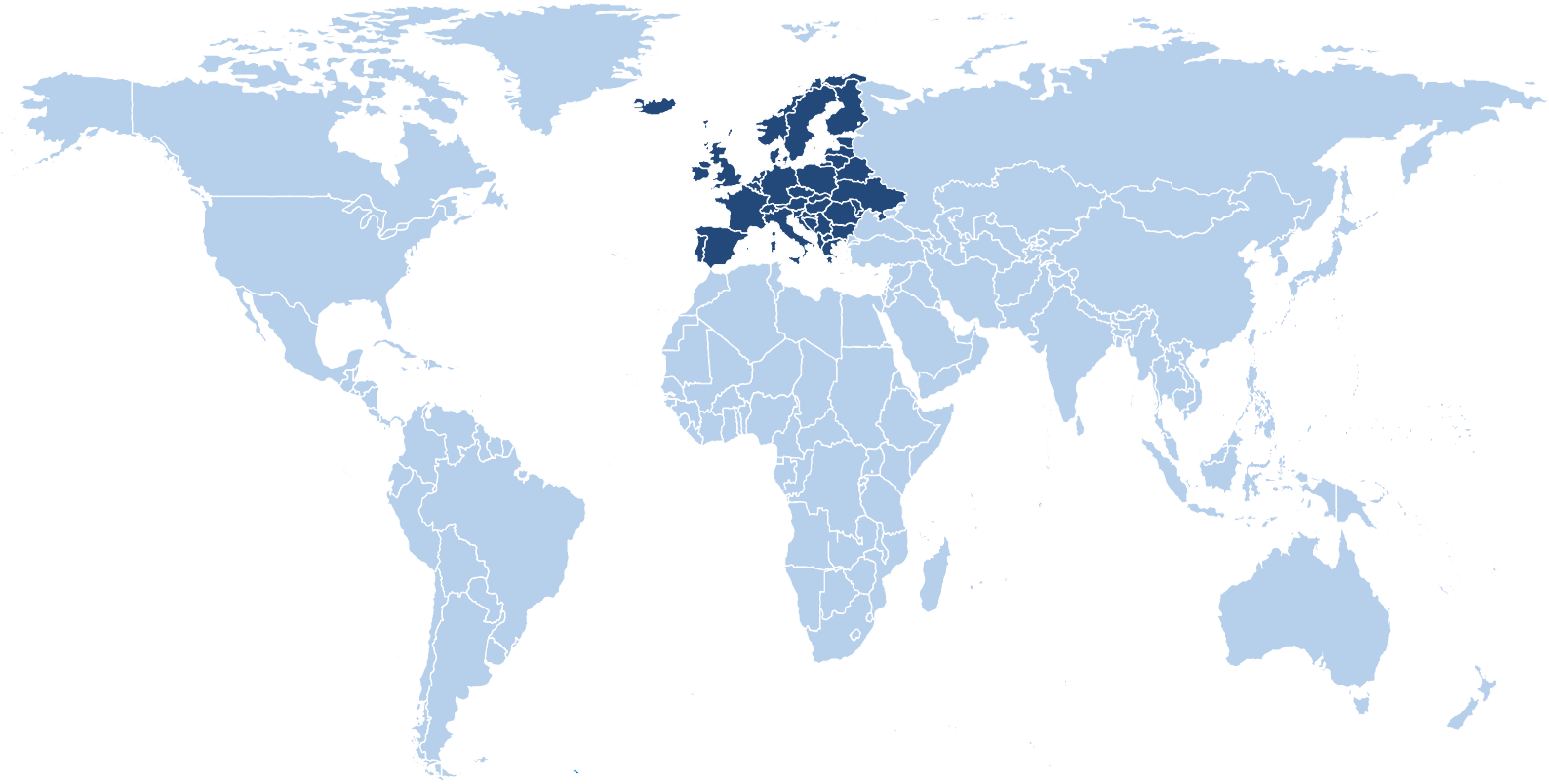
The globally leading markets of China and Europe are thus progressively shifting to adoption of supply-side policies. Fleet-wide fuel economy targets are gradually gaining traction. Both markets have some of the most stringent standards in place and their compliance effectively means expansion in the 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. European Union's targets are a case in point.

Europe's fuel economy standards, which were already stringent since 2020, require a 37.5% reduction in CO2 emissions by 2030 (against the 2021 level). The European Commission could be planning even tougher targets, with a proposal for CO2 emission reduction target (during 2021-2030) to rise from 37.5% to 55%. As per BNEF estimates, assuming battery electric vehicle-based sales, at least 60% of the new car sales will have to be electric in 2030 to meet such targets. The Commission also plans to phase out all the conventional drivetrain-based vehicles by 2035, as is the case with other national governments as well.

06

Key Regional Markets

Key Regional Markets - Europe



Countries Covered

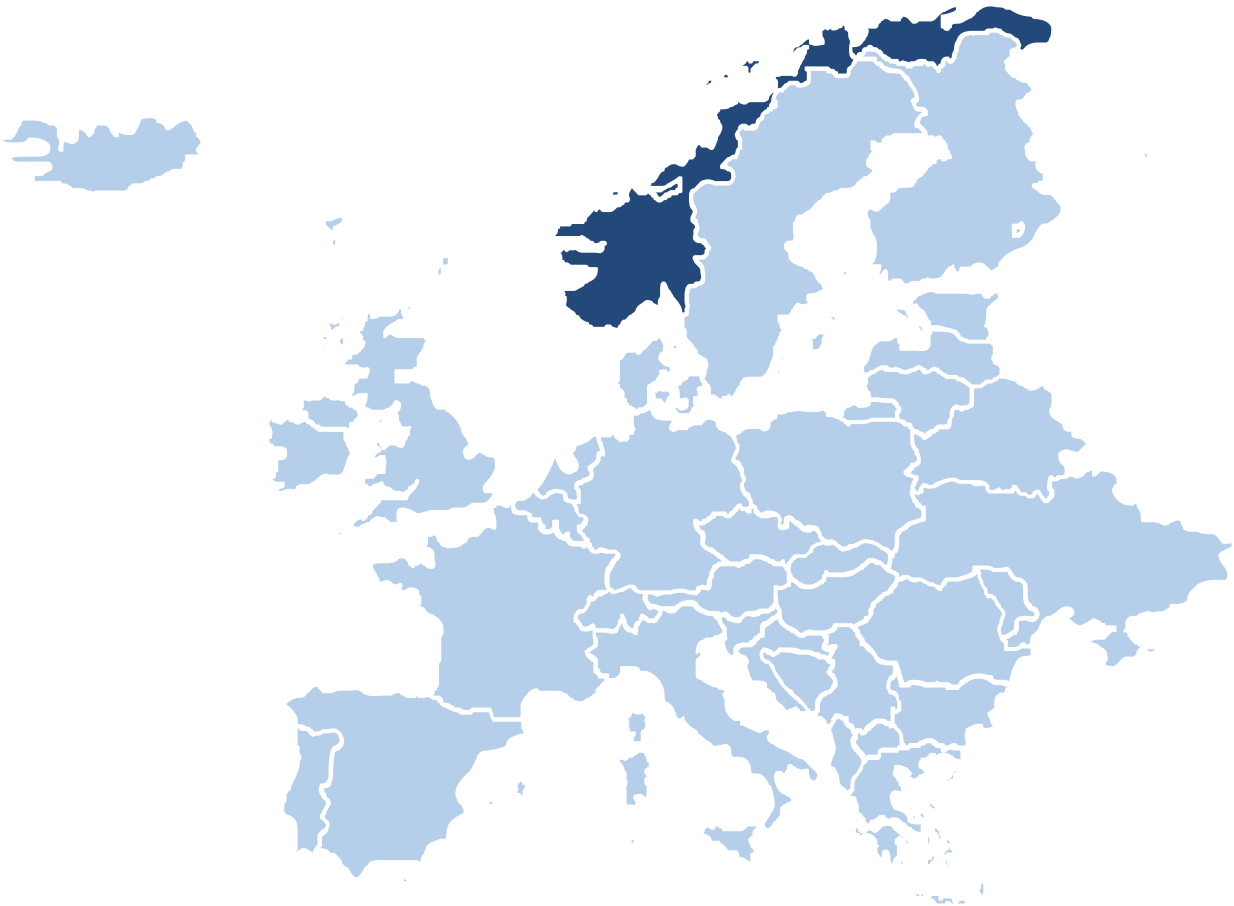
1. Norway
2. Sweden
3. The Netherlands
4. Finland
5. Denmark
6. Germany
7. France
8. United Kingdom
9. Spain
10. Italy

Norway

Over the years, Norway emerged as the leading example of EV penetration. By the end of 2021, EVs accounted for almost two-thirds of the new passenger vehicle sales. A major reason for the progress has been active policy steps at promoting the EV adoption, in terms of incentivising it vis-à-vis the conventional vehicles. A major driving factor in policy measures is the country's stated objective of phasing out the conventional vehicles by 2025.

GDP (Current Prices) USD (2020)	362.52 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.63%
EV Penetration	65% of total new car registered (2021)
EV Target	1.5 million EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2025

GDP Source: IMF, World Economic Outlook

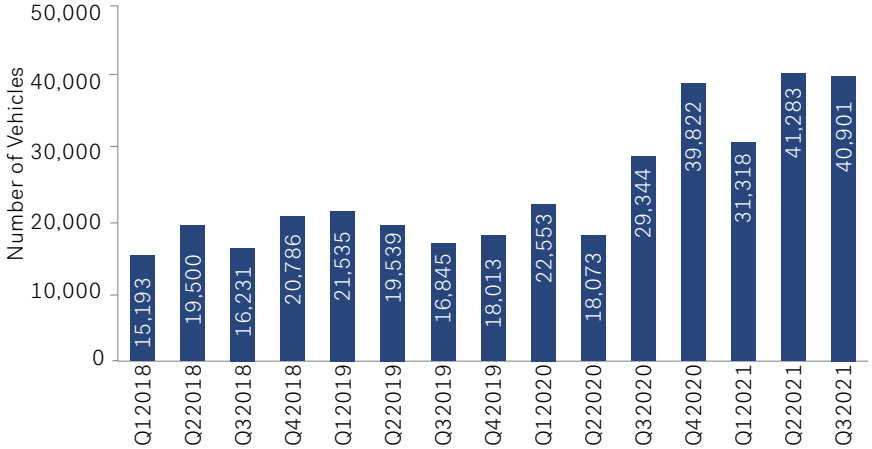


Norway

EV Penetration and Trend

As per Norway's Road Traffic Information Council (OFV)[1], battery electric vehicles (BEVs) accounted for about 65% of Norway's new car registrations by the end of 2021. This marked an 11-percentage point rise over previous year's level. It conforms to the ongoing consistent trend in the country's EV adoption – share of EVs in new car sales was 42.4% in 2019 and a mere 1% a decade back. Notably, the estimates also indicate a rise in the plug-in hybrid electric vehicles (PHEVs) – from 19.4% in 2020 to 20.8% in 2021.

Trend in EV Passenger Vehicle Sale[2]



Source: BNEF

Electric Vehicles in Norway's Total Passenger Vehicle Fleet (March 2020)[3]

Category	Total units	Share in total stock
Petrol engine-based	1,250,305	45.0%
Diesel engine-based	1,256,453	45.2%
Electric	270,309	9.7%
Others	405	0.01%
Total	**2,777,472**	**100.0%**

Source: Road Traffic Information Council (OFV)

Importantly, 2021 was also the year when Norway's total passenger car sales (across fuel types) achieved a record registration levels at 176,276. Furthermore, the latest registration data also points to about 10,000 older cars with internal combustion engines (ICE) disappearing from stock altogether. This might suggest a progress towards the policy target of a complete phase out of ICEs.

At current rate of progress, by end of 2022, the country's passenger vehicle fleet of 2.8 million could have EV platforms contributing by at least about one-fifth. It also helps that the leading EV brands are progressively introducing newer offerings such as four-wheel drive vehicles and SUVs that tap into the fast-growing demand. Over half (56.5%) of the new EV passenger vehicles had four-wheel drives in 2021.

The EV penetration achieved in passenger cars is finding its way in other vehicle modes as well. The notable case in point being that of vans[4] – while diesel makes for the predominant share, electric vans are on a steady rise. In 2021, electric van registrations grew by 122%.

Select Norwegian cities however adopted an aggressive approach in expanding the electric bus fleet. In January 2022, the public transport operator Unibuss placed a major order of 183 electric buses with Polish manufacturer Solaris, for an expected delivery by 2023[5]. The city council of Oslo has a stated goal of electrification of entire bus fleet by 2023, for which an additional NOK50 million was planned to be allocated annually[6].

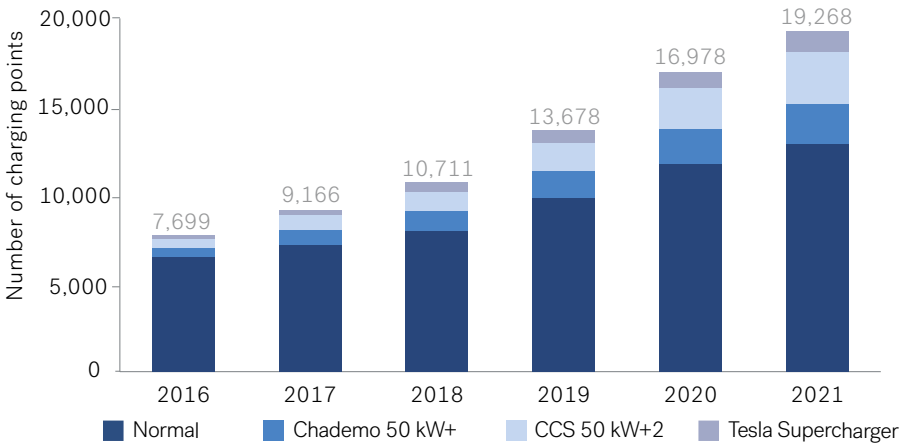
Concerns around sustainability have led policy makers to focus on shared mobility options as vehicle ownership loses relevance in an emission free environment. The city of Bergen took a lead in this direction becoming the first Norwegian city to start a mobility hub. The objective was to establish permanent, reserved parking space for shared vehicles, preferably electric ones[7].

Micro-mobility is also gaining traction. Oslo's city centre officially became car free in 2019 because of a concerted push by policymakers to popularise micromobility in the form of electric bicycles and e-scooters[8]. Lime rolled out the first fleet of e-scooters in Oslo in July 2019. However, a rising number of safety-related incidents involving e-scooters also led the city council to impose restrictions on e-scooters, such as restriction on rental time and number of e-scooters to be available on hire at a point of time[9].

Charging Infrastructure

Norway's tremendous progress in the EV market has been enabled, in part, by a strong drive to expand the charging infrastructure, to support the growth in the number of electric vehicles on the road. Initially, the charging infrastructure started developing centred around Oslo, where the first municipal EV charging point came up in 2008.

Trend in Norway's Charging Infrastructure[10]



Source: NOBIL

With policy emphasis on public charging infrastructure, the number of EVs per charging point has sharply declined – from over 160 in 2010 to a level of less than 120 now[11]. The country's charging infrastructure is about 9% of EU's total charging network, despite having a population share of only 1%. The Norwegian government has outlined a goal to achieve one fast charging station every 50 kilometres on major highways[12]. Providers are offered subsidies to accelerate the pace of roll-out of public charging stations.

Norway's installed capacity for power generation is skewed towards hydropower with almost 90% of the country's production capacity being sourced from hydropower generation. It also accounts for roughly half of the hydropower reservoir capacity in Europe, placing the country in an ideal position to play a leading role in the energy storage market. For battery capacity, there are notable projects in the pipeline to set up a manufacturing capacity to cater to Norway and the region's EV demand.

Policy and Regulation

Norway's policy and regulatory measures actively incentivise EV adoption, against the conventional options[13]. This includes a combination of direct fiscal incentives (taxation) and indirect ones (such as in parking, lane access, etc.). Fiscal incentives such as elimination of import tax and decreased registration tax on EVs initially helped offset the higher production costs of EVs.

EV users are provided several benefits whether they lease (no VAT on leased EVs) or own (exemption from purchase tax and VAT, no road tax, 40% reduction in company car tax) the vehicle. In addition, usage costs are markedly lower via incentives such as 50% discount on parking charges, ferry fares and toll road charges. EVs have access to bus lanes nationwide making the riding experience much more convenient vis-à-vis fossil fuel vehicles.

Local governments offer Electric Vehicle Supply Equipment (EVSE) grants to housing associations to incentivise setting up charging infrastructure. While the quantum of grants varies across regions, it generally covers a maximum of 20% of the cost of the EVSE purchase up to an upper limit which averages NOK 5,000 per charging point[14]. Although Norway's charging ecosystem is a heterogenous one, with participation from the government, local municipalities and private investors, there has been a concerted push to expand the number of public charging facilities and fast charging points.

The subsidy-led push for EV adoption however has also imposed a burden on public finances, that may require corrective measures. There is an estimated $2.2 billion worth of deficit in tax revenue, attributed to the taxation foregone from exempting electric vehicles (and ICE vehicles rapidly falling in share of new sales). There are thus some discussions underway for raising taxes on select segments of EV ownership (such as plug-in hybrids)[15].

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 likely to create a fleet of 1.5 million EVs by 2030, as per NVE, the electricity market regulator in Norway.

The charging infrastructure, while conventionally led by government investments, is gradually finding a rising interest from private sector, especially OEMs. In January 2022, Tesla announced the expansion of its pilot programme to Norway and France, pertaining to opening-up its Supercharging network to EVs of other manufacturers. The company is expected to allow access to EV drivers to a wider pan-Europe charging network[16]. There are other private investments that appear to be tapping into the need for standardised and reliable EV charging network. Mer, a renewable energy company owned by government-owned Statkraft, recently announced tying up with Israel-based software company Driivz to standardise its EV charging network in Norway and Sweden[17].

A bigger investment opportunity lies in the establishment of battery manufacturing. As of May 2021, Morrow Batteries finalised an agreement with the Norwegian city of Arendal for construction of a battery cell factory. Starting in 2023, the facility will have an 8GWh annual capacity in each of the four stages planned for completion. Total cost of this facility is estimated at EUR470 million[18].

Another major development in the same context, is that of Freyr Battery – a developer of clean battery cells. As of February 2022, the company entered into nine frame agreements with raw material suppliers for the customer qualification plant (CQP) planned at Mo i Rana, Norway. Another four frame agreements are in advanced stages of negotiations. The agreements form the basis of the CQP and the Gigafactories planned[19].

Hydrovlt, a JV between Norwegian materials processing company Hydro and Swedish lithium-ion battery manufacturer Northvolt, is constructing a lithium-ion battery recycling plant capable of processing over 8,000 tonnes of EV battery modules annually. This entails an investment of NOK120 million[20].

Stavanger based battery technology company announced a new financing round of NOK 125 million (~$14.8 million) from investors such as Arendals Fossekompani, DSD Investering, Equinor Ventures and Must Invest in December 2020. Similarly, Australian mining company Mineral Commodities has announced plans to build a factory to manufacture low-emission anodes for battery production in Norway. Further upstream, Norwegian major Elkem has announced plans to build a new graphene factory which will boost access to environmentally friendly graphene production for manufacturing batteries.

Outlook

Norway's growth in EV sales and penetration is globally regarded as an exemplary one. The expansion in EV fleet is expected to continue apace, considering the attractive incentives available in terms of the various tax exemptions and other incentives. However, there is a rethink on the extent of such exemptions, considering the impact on government finances. This may entail a gradual claw back in the incentives, especially in VAT and purchase tax exemptions.

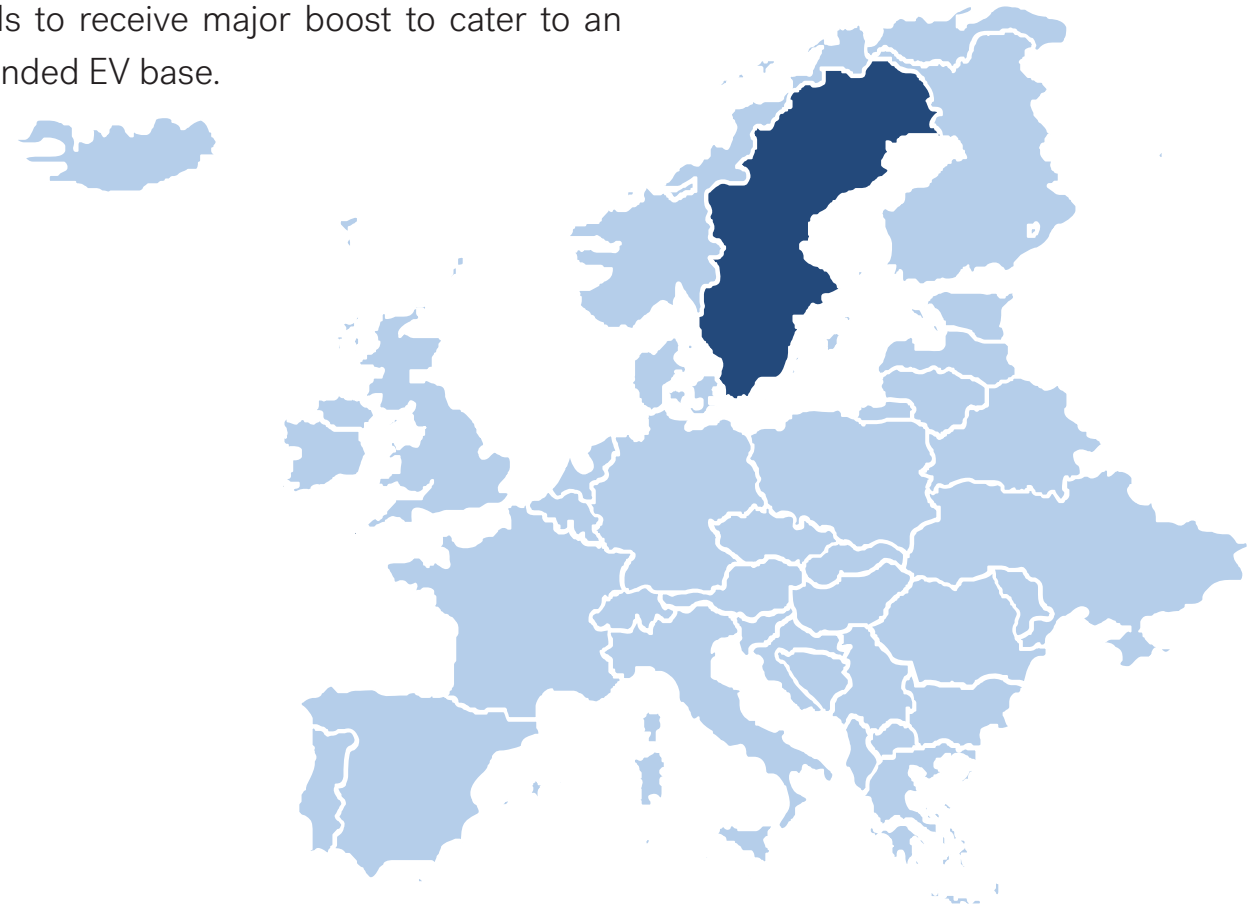
A 2019 study commissioned by Norway's power regulator DNV GL estimated that there will be 1.9 million electric cars in Norway by 2040, implying an increase of ~3.9x over existing fleet size. This is likely to result in a combined annual power requirement of 5 TWh, requiring an investment of $1.3 billion in the electricity grid by 2040 to accommodate the power demands of a largely electric vehicle fleet in the country[21].

Sweden

Sweden is one of the leading countries in terms of EV penetration in Europe, attributing to the subsidies and tax benefits offered by the government. By end of 2021, the passenger EV segment accounted for almost half of the total new vehicles registered in the country. Notably, the pressure put on timely delivery of charging infrastructure by growing EV usage was, to a certain extent, handled by investments injected by government in 2021. However private investments in the segment are yet to suffice the need. Additionally, indigenous battery manufacturing capacity needs to receive major boost to cater to an expanded EV base.

GDP (Current Prices) USD (2020)	541.06 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.84%
EV Penetration	45% of total new vehicle registered (2021)
EV Target	Complete carbon neutrality by 2045
Planned Year of Phasing Out ICE Vehicles	2030

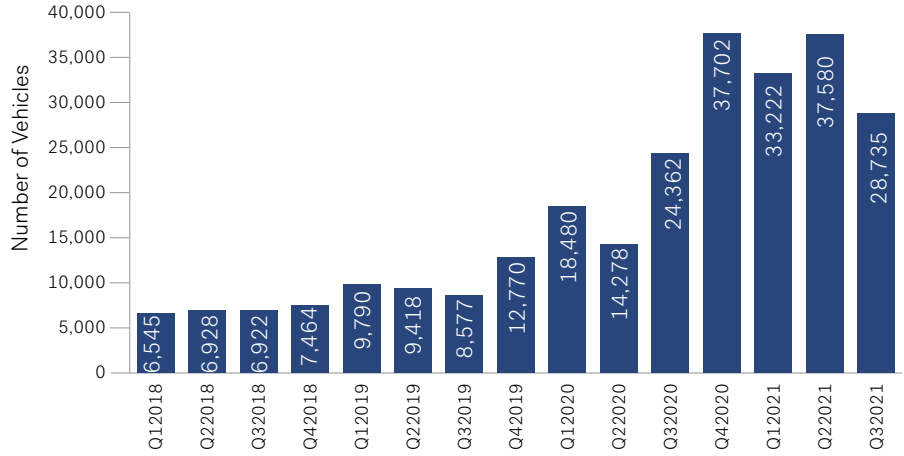
GDP Source: IMF, World Economic Outlook



Sweden

EV Penetration and Trend

Trend in Passenger EV Sales[1]

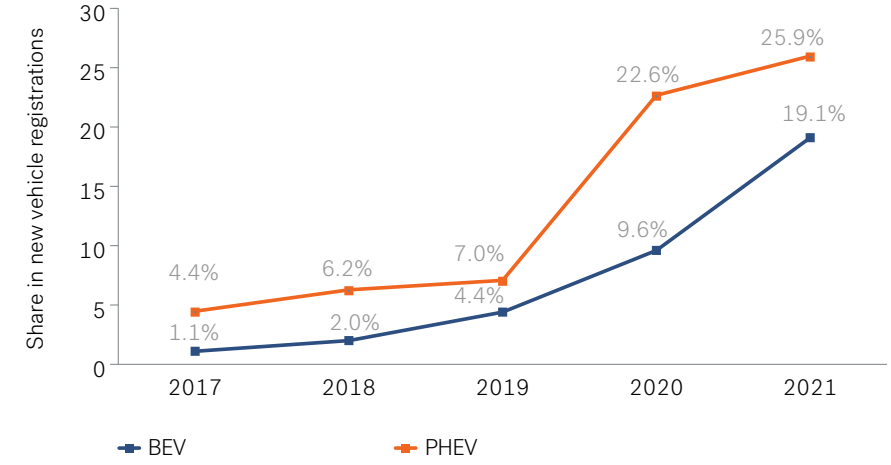


Source: BNEF

According to BNEF estimates[1], during Q32018 - Q32021, the EV sales in Sweden increased at CAGR of 61%. Similarly, on quarterly basis, the EV average sales maintained stable growth trend till Q3 2019, rising to 9,200 units between Q12019 - Q32019 from 6,700 units recorded during Q12018 - Q32018. By end of Q32020, the sales doubled, pushing average to 19,000 units during the comparable period, while by end of Q32021, the trend continued with the average sales reaching 33,100.

The comparable estimates from Swedish industry association, BIL Sweden, helped provide a view of the trend in passenger EV growth[2]. The EV registration data shows that in 2021 around 45% of the new vehicle registrations in the country were EVs, growing from 32% in 2020. PHEVs have been the growth driver in the segment, which accounted for the predominant share of 57% in 2021. The share of electric light trucks amounted to 7.5% and the electric buses (E buses) to 24.6%.

Trend in Passenger EV Share in New Vehicle Registrations[2]

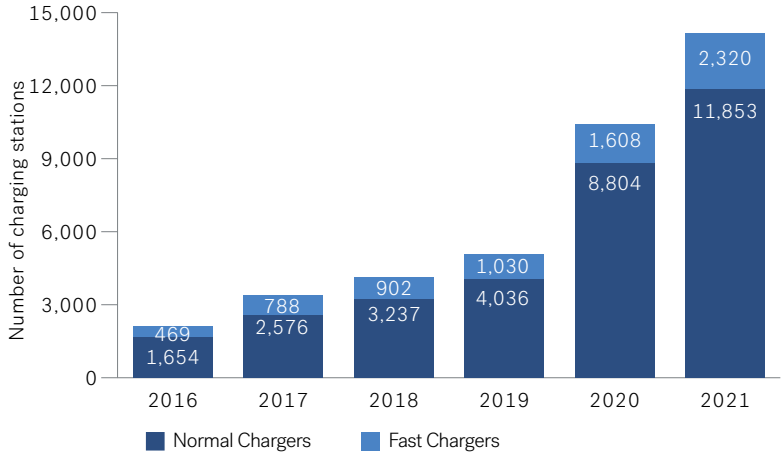


Source: BIL Sweden

The association data underlines that in December 2021, the share of rechargeable passenger car registrations was 60.7%, which was the highest proportion ever in a single month. BEVs dominated the registration stats, accounting for 36.4% while, plug-in hybrids had share of 24.3%[3]. Plausibly, EV sales in 2021 exceeded those of diesel-based vehicles in the country, becoming the second most registered vehicles following petrol-based vehicles.

Charging Infrastructure

Trends in Public Charging Infrastructure[4]



Source: European Alternative Fuels Observatory

Sweden is facing the pressing challenge of needing to improve public EV infrastructure at pace to keep up with growing demand despite all the progress. Over the period of 2016-2021, the number of chargers in the country grew at a CAGR of 46%. Normal chargers dominated the market with share of 84% of the total capacity in 2021, recording steeper growth compared to that of fast chargers. During 2016-2021, the normal chargers grew at CAGR of 48%, while fast chargers grew at CAGR of 38%.

Nevertheless, as mentioned above, the country has done a great job in terms of developing necessary EV infrastructure within a short span of time. As of October 2021, over 65% of the Swedish EV drivers had access to charging stations either at home and at work or in other public places[5]. Notably, the country has launched the world's first electrified road in Stockholm, which actively charges cars and lorries using an innovative energy transfer system.

Enriched with mineral resources, Sweden possesses the potential to build one of the largest EV battery production units in Europe in the coming years. Commissioning of Europe's first Li-ion Gigafactory in December 2021 by Swedish manufacturer Northvolt is a strong testament to this fact. The plant seeks to have production capacity of 60GWh with an aim to capture at least a 20-25% market share in Europe by 2030[6]. The manufacturer has already secured USD30 billion worth of contracts from customers including BMW, Fluence, Scania, Volkswagen, and Volvo Cars.

Policy and Regulation

In 2019, the Swedish government set the target of complete elimination of internal combustion engine (ICE) by 2030[7]. To this end, grants, and subsidies from central government as well as local-level incentives are key instruments mobilised for promoting EV adoption.

The Swedish government has introduced various subsidy programs to facilitate the EV usage in the country. The government offers Bonus Malus scheme to both individuals and businesses passenger EVs. The grant of 25% and up to EUR6,800 is offered on the purchase price of BEVs, while maximum subsidy of EUR2,800 is offered for PHEVs[8].

In case of E buses, the 20% grant is available on purchase price for public transport authorities, municipalities, or limited companies. While, for the private buses, the grant of up to 40% is offered on the price difference between E buses and diesel bus.

The government has also opted for subsidies and incentives for the charging infrastructure at national as well as at municipal level in the cities such as Stockholm, Gothenburg, Malmö, and Uppsala. At the national level, EV Charging incentives include schemes such as "Charge the car grant" and "Swedish Transport Association Fast Charging Grant". The former covers the cost of EV equipment and materials up to 50% with maximum amount of EUR1,000 per charging point for individuals and EUR1,500 for companies, municipalities, councils, and foundations. The latter provides grant of up to 100% of the costs of fast charging public-use equipment to encourage the implementation of fast chargers.

Market Opportunity

Supportive policies provided by Sweden are paying off, as reflected in growing EV penetration. The incentives hike to around EUR7,000 by end of June 2021 boosted demand for EVs in the country, leading to the exhaustion of the EV subsidy budget by end of Q3 2021[9]. However, the steady upward trend in demand has attracted investments inflow, enabling further expansion in the production, which has encouraged government to invest in the necessary infrastructure.

In the beginning of 2022, Volvo Cars, a Swedish automaker, announced two major investment ventures to take place in the country. The company plans to invest around USD1.1 billion in its Torslanda manufacturing plant to upgrade its EV manufacturing. The enhancement involves adding better raw materials such as aluminium body parts along with setting up of new battery assembly plant[10]. Secondly, Volvo in collaboration with Northvolt[11] seeks to invest in the battery infrastructure in Sweden. With total investment of around USD3.3 billion, the venture plans to set up a 50GW/h factory, that will produce special battery cells used in pure electric Volvo and Polestar cars. The factory is expected to start operations from 2025. Both these projects tend to have ecological as well as economical benefits. The better raw materials will help to improve EV performance thereby encouraging demand, while the new factory will boost employment in the economy with an anticipation of creating around 3,000 jobs.

Electrification of the public transport is on the cards in Sweden. Volvo and BYD are the major players in the segment, who continue to receive contracts for E buses in the Swedish cities. In May 2021, BYD received an order of 79 E buses from Swedish public transport operator Bergkvarabuss for Skåne region with scheduled delivery by end of 2021[12]. Accordingly, in December 2021, BYD delivered 45 pure electric buses[13] to the transport operator, which marked the debut of E buses for regional and long-distance transportation in the country. Similarly, in September 2021, Volvo got the contract of 122 E buses from operator Nobina for use in three Swedish cities, namely, Gothenburg, Malmö and Hässleholm to be delivered during 2022-2023[14].

Along with EV production, the Swedish government focuses on developing sufficient charging infrastructure in the country. Accordingly, government has set a budget of EUR15 million to build up the fast-charging network during 2020-2022[15]. Additionally, it also has implemented new set of regulations to boost the availability of charging points in both residential and non-residential buildings.

Investments are also in line for the power transmission and distribution network in Sweden. While the network maintains high reliability levels, it requires timely replacement of ageing assets. This is more so as the grid must accommodate the rising share of renewable energy as well as EVs in its service levels. Sweden's transmission system operator Svenska Kraftnät has established a 10-year investment plan that details the transmission grid investments. Svenska Kraftnät plans to realise the total investment of SEK100 billion over the period of 10-year, 2022–2031, varying annually between SEK6 billion – SEK12 billion[16].

Outlook

The Swedish government aims to reduce carbon footprint of transport sector by 70% till 2030 and become carbon-neutral by 2045[17]. Hence rigorous investment in the EV production and infrastructure development can be seen in the country. The upward trend observed in the passenger EV segment during last couple of years has unveiled the opportunity for significant transformation in near future. However, the market trend also is expected to exert pressure on the entire supply chain and thus requires an acceleration in the provision of charging facilities.

From the beginning of 2021, the Swedish government took significant steps towards expanding electrification of the transport system, including, subsidy upgrades and establishment of pilot project of electric roads. With an aim to encourage pure EVs, the subsidy ranges were updated during Q1 2021. The maximum subsidy amount offered on BEVs was raised, while PHEV subsidies experienced a cut back. According to the data provided by BNEF, these attempts to switch consumer preferences towards more eco friendly options worked, as the BEV sales during Q2 2021 ramped up, while that of PHEV recorded contraction. Though, the total EV sales saw a dip during H2 2021, the PHEV sales fell more dramatically compared to BEVs' during the same period[18].

As mentioned above, the government also took up the planning of pilot project of electric roads, targeting the inception of the work to be done during 2022[19]. Accordingly, in January 2022, country's first permanent electric road was finalized to be a 21km stretch of the two-lane E20 between Hallsberg and Örebro. This electric road is planned to be used for heavy transport trucks and is expected to be operational by 2025[20].

With rapid expansion in BEVs, the challenges of balancing the growth against sustainability will have to be managed. This is in context of the adverse impact that EVs carry, such as in toxicity, acidification, and eutrophication potential in the environment[19]. Battery life cycle extension is among the crucial aspects in this which could gain relevance. By 2025, around 250,000 metric tons of EV batteries are expected to reach end-of-life for the use in EVs, but the batteries will still retain 70-80% capacity. Recycling this would make for a sustainable use besides improving the business case of the overall EV market.

The Netherlands

The Netherlands is one of the leaders in global EV market, on account of considerable efforts the country has taken to expand EV penetration. By end of December 2021, EVs' share in total new passenger vehicle sales in the country was 65%, showcasing the strengthening consumer market. Sustaining subsidy environment, whilst expanding necessary infrastructure has boosted EV demand, thus encouraging investors to enter the market. Owing to these affirmative factors, The Netherlands' role in global EV market has grown stronger over the years.

GDP (Current Prices) USD (2020)	913.13 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.48%
EV Penetration	29.8% of total new passenger vehicle sales (2021)
EV Target	1.9 million EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2030

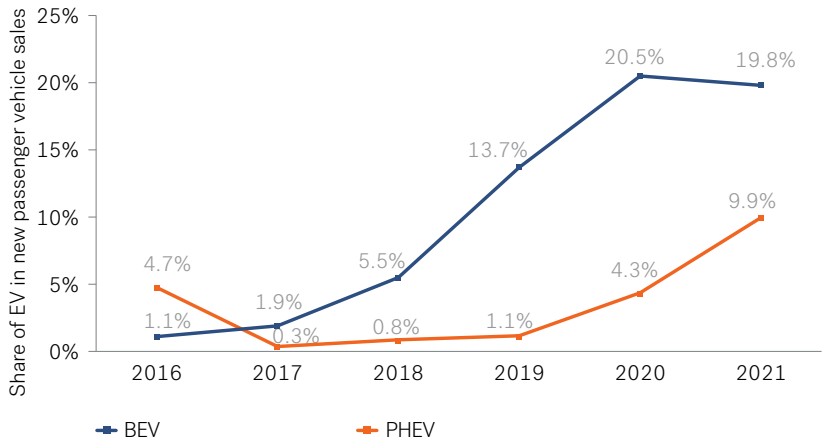
GDP Source: IMF, World Economic Outlook

Netherlands

EV Penetration and Trend

According to the data provided by The Netherlands Enterprise Agency, EV penetration in the country is steadily expanding. In 2021, EVs' share in new passenger vehicle sales increased to 29.8% in 2021 from 24.8% in 2020. Battery electric vehicles (BEVs) predominantly accounted for 19.8% of the total passenger vehicle share in 2021, however, down from 20.5% recorded in 2020. On the hand, share of Plug-in Hybrid Electric Vehicles (PHEVs) grew to 9.9% from 4.3% during the same period.

Trend in Share of EV in New Passenger Vehicle Sales[1]



Source: Netherlands Enterprise Agency

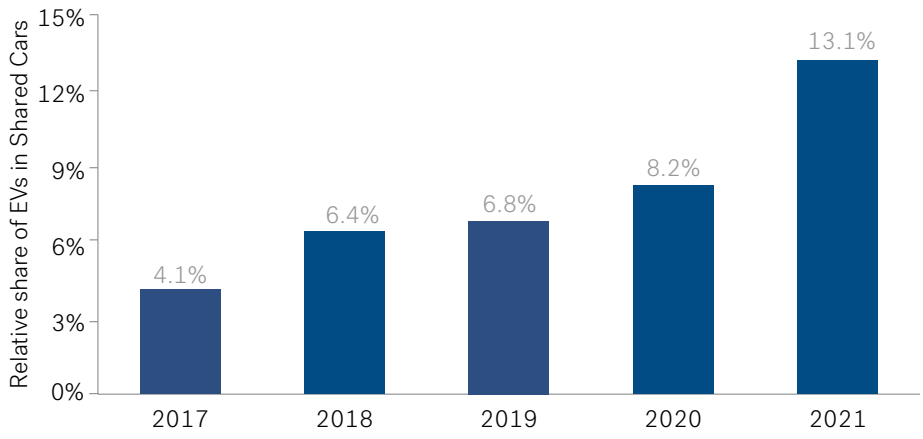
Public transport in The Netherlands is also under the transformation. More eco-friendly options are being adopted in order to reduce the carbon footprint. In the country, Electric bus (E bus) fleet registration saw fourfold rise during 2017-2021, reaching 1,397 in 2021. BEVs dominated the E bus fleet in The Netherlands with share of 97%, while only 5 E buses were PHEVs as of 2021.

Trend in Registered EV Fleet by Segment[1]

Segment	2017	2018	2019	2020	2021
Passenger cars	117,885	138,272	197,068	273,259	381,815
Buses	316	421	797	1,218	1,397
Commercial Cars ≤ 3.5 tons	2,161	3,120	4,355	5,996	9,127
Commercial car > 3.5 tonnes	143	160	264	246	249

Source: Netherlands Enterprise Agency

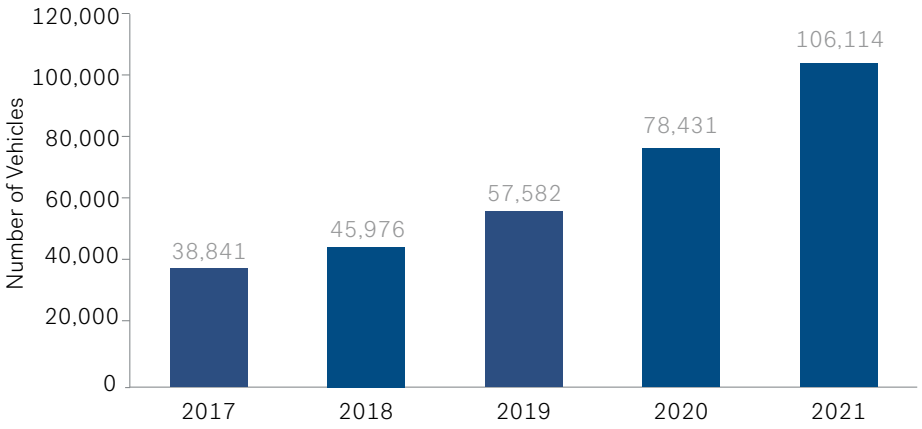
Trend in Share of EVs in Shared Cars' Fleet[1]



Source: Netherlands Enterprise Agency

The penetration of EVs in shared mobility segment is encouraged in the country, attributing to the policies' aim of emission-free transportation mechanism. In The Netherlands, the share of EVs (battery and plug-in) showed a hike in overall car-sharing fleet, from 4.1% in 2017 to 13.1% in 2021. As has been the case in overall passenger EV trend, here too BEVs account for the predominant share of around 10% for the same period.

Trend in Registered Two and Three-wheeled Light Electric Vehicles[1]



Source: Netherlands Enterprise Agency

Electrified micro mobility options such as light mopeds, motorbikes, quadricycle, and microcars are growing popular among younger generations in the European countries and The Netherlands doesn't underline different trend. Under the category of 2 and 3 wheeled Light EVs (LEV), BEVs specifically, light mopeds, with speed limit of 25 km/h, dominate the number of registrations since last five years, with share of 56% in 2021. The registered fleet of the light mopeds grew at CAGR of 29% during 2017-21. Notably, regulations forbid E-scooters (and similar other platforms such as E skateboards and others) from plying on public roads. Instead, the scooters are classified under the category of 'special moped' and are expected to comply with a list of criteria on vehicle's structural stability/safety[2].

Charging Infrastructure

As a policy, The Netherlands has stated the emphasis on public charging points. To support its goal of emission-free transport fleet by 2030, it is understood that the country's requirement for charging points will rise by at least three-fold by 2025[3] and possibly by eight-fold till 2030. The growth in public charging points can be understood in that context.

Between 2017 and 2021, the public charging points (including regular and fast charging) grew at a CAGR of 26%. The private charging points showed steeper growth trend during the same period. As of end-2021, the number of EVs per charging point stood at 4.3 in The Netherlands, growing steadily from 3.5 in 2017. This suggests a dense public charging infrastructure coverage compared to other countries in the region or globally. In 2021, European Union had 15 EVs per charging point[4].

Trend in The Netherlands' Charging Infrastructure[1]

Type of Charging Point	2017	2018	2019	2020	2021
Regular Public (24/7 publicly accessible)	15,288	20,228	27,773	39,968	51,423
Regular semi-public (limited accessibility)	17,587	15,633	21,747	23,618	31,453
Fast charging points, public and semi public	755	1,116	1,262	2,027	2,577
Private charging points	~68,000	~80,000	~114,000	~158,000	~221,000

Note: Data on private charging points are estimations; regular charging points are at ratings up to 22kW; Fast charging points are rated above 22kW
Source: Netherlands Enterprise Agency

The country has been aiming towards expanding energy storage capacity thereby injecting investment as well as encouraging private players' participation. As of 2021, most of the installed capacity in The Netherlands was based on Li-ion and Ni-Cad battery technologies[5]. Marking the expansionary vision, by end of 2021, the country announced plans to install its largest energy storage system project to provide support to power grid stability. Additionally, the system is expected to be the first large-scale grid storage project in Europe to use lithium iron phosphate (LFP) battery technology. The project, GIGA Buffalo battery, will receive 25-MW/48-MWh storage system from The Netherlands-based energy storage company, Wärtsilä and is expected to be operational by end of 2022[6].

Policy and Regulation

The Netherlands' aim to have only emission free transport vehicles by 2030[7] has led to the implementation of various policy and regulatory measures promoting the case for EVs. Among other things, this entails policies and regulations at both central and the regional/ local level for electrification in private, commercial as well as shared mobility modes.

With an aim of encouraging eco-friendly driving, in June 2020, the government introduced a new subsidy scheme electric passenger car for private individuals (SEPP)[8]. During 2020 - 21, the scheme granted EUR4,000 for the purchase or lease of a new vehicle, while EUR2,000 was offered for used vehicle. However, for 2022, the grant for new vehicle is revised to EUR3,350, while it remained same for used ones. The prerequisites for EVs to be eligible for the grant hold still, including original value to vary between EUR12,000 - EUR45,000, with necessary range of at least 120 km among others. The tenure of subsidy is updated to remain valid till December 2024, while budget being determined every year. For 2022, EUR71 million are budgeted for new EVs, while EUR20.4 million for used EVs.

The Dutch government also provides tax benefits that extend to EV owners; separately for pure EVs and PHEVs. The tax benefits include exemption for pure EVs while from 2025 the purchase tax was fixed at EUR360[9]. In case of PHEVs, the tax rates are to be based on a different methodology, for instance World Harmonised Light Vehicle Testing Procedure CO2 testing method. Other tax benefits for EVs include exemptions or discounts based on the type, pure EV or PHEV. At an enterprise level, added benefits include exemptions from value added taxes (VAT) and investment deduction (though for eligible EV list).

Notably, company electric car(s) used by employees also benefit from tax reductions in The Netherlands. The added taxable income rate of 4% on BEV's first purchase price up to EUR45,000 was applicable in 2019 including VAT and registration tax. However, in H1 2020, the tax rate growing to 8% along with COVID-19 outbreak resulted in fall in number of passenger cars registered. While demand recovery started during H2 2020, sales were impacted by additional tax going up to 12%[10].

The Dutch government also have implemented regulations for LEVs[11] entailing their size and mobility. The width of the vehicle is restricted at one meter with maximum eight children allowed as passengers. Driving license age requirement is 18 years and the vehicle shall possess a registration number as well as insurance.

The government offers incentives to the enterprises involved in the EV penetration. 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[12]. Under Environmental Investment Allowance (MIA) and Random depreciation of environmental investments (VAMIL), enterprises are eligible for investment deduction up to 36% and 75% respectively, for the cost of charging point. At an individual consumer level, a request can be placed with the local municipal authorities for a free (imply no cost for purchase or installation) public charging point.

The country's policy/regulatory position on popular micro mobility options such as E scooters[13] has been brought to question and debate. In the The Netherlands, such vehicles are legally prohibited to run on public roads except for the mopeds designed by the Ministry of Infrastructure and Water Management and RDW. Segway and Swing are allowed on public roads while remaining type of E scooters are only allowed on private property.

Market Opportunity

The Netherlands' rising demand for charging infrastructure, led by the provincial or municipal authorities, offers a significant and untapped opportunity. Estimates suggest that for around 1.9 million EVs to be active by 2030, the country would need around 1.5 million charging stations[14]. Accordingly, Dutch municipal authorities are increasingly inviting tenders from private charging operators for scaling up the infrastructure. The government reportedly plans to spend about EUR30 million in charging station network across key regions, with special interest in smart charging systems for economising on space and related logistics.

In November 2021, Tesla announced a pilot program of setting up supercharger stations at 10 locations across The Netherlands[15]. The program permitted access to non-Tesla EV drivers through the Tesla app but with higher charging price. In February 2022, Tesla announced expansion of this program to all of its 36 charging stations, making the company one of the biggest fast-charging EV network operator in the country. Tesla also announced installation of around 18 additional charging stations in The Netherlands during 2022.

With an aim to facilitate the clean energy transition, a Dutch start up named Leap24[16] could raise around EUR4.25 million seed investment to set up fast charging stations across North-western Europe. The 2021 founded start up plans to open around 240

charging stations covering 40 locations in The Netherlands during 2022, first of which is expected to commence operations during Q2 2022. These fast-charging stations are mainly set up considering vans and trucks at easily accessible locations with several charging points to avoid waiting.

Considering the growing demand as well as expanding infrastructural facilities, international EV charging center was set up in the country. The test center known as ElaadNL Testlab[17] was co-funded by the Province of Gelderland and the Ministry of Infrastructure and Water Management. Located in Arnhem, the center allows companies to test their electric cars, buses, trucks, and associated charging stations.

High EV offtake along with renewable energy options such as solar is driving newer business opportunities including smart solar charging projects. The city of Utrecht[18] is among the notable examples in this regard. Unlike a typical charging technology, where the power flow is from energy source to the battery, in smart charging it is bi-directional. Such technology, referred to as Vehicle2grid technology, offers flexible storage and is instrumental in grid management.

The focus on infrastructure also includes the battery storage capacity, where there is huge scope. There are investments planned for promotion and development of the battery technologies, that can be deployed for the upcoming EV requirements. For instance, the Dutch Province of North Brabant and the national government aims to invest EUR4.5 million in a demonstration project[19] for a prototype of solid-state batteries based on Lithium Ion. The aim is to incentivise technology development for an eventual scaling up at competitive costs.

In the country not only new EVs market but also the used EV market is soaring[20]. The Netherlands became the first country to grant subsidy on used EVs in 2020, leading to growth in demand. The complete utilization of the subsidy on used EVs in 2021 thus showcased shift in the consumer preferences towards second-hand market, as it offered greater choice and security along with factory warranty on battery. Attributing to the growing demand, the Dutch government have increased budget for used EV from EUR13.5 million in 2021 to EUR20.4 million in 2022, encouraging better penetration.

Outlook

The government's policy framework points to potential 1.9 million passenger EVs to become active by 2030[21] in The Netherlands. At existing fleet level, this implies an approximately eightfold jump. Adding to this will be the growth in commercial EVs, especially the E bus fleet as well as micro mobility options. To this end, the timely availability of the critical infrastructural requirements of energy storage and charging infrastructure will play a key role.

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[22]. Among other things, this will also entail exploring options in areas such as flexible generation and microgrids among others. Thus, it is notable that the grid operator TenneT aims to commit investment of EUR4-5 billion annually towards energy transition in the network.

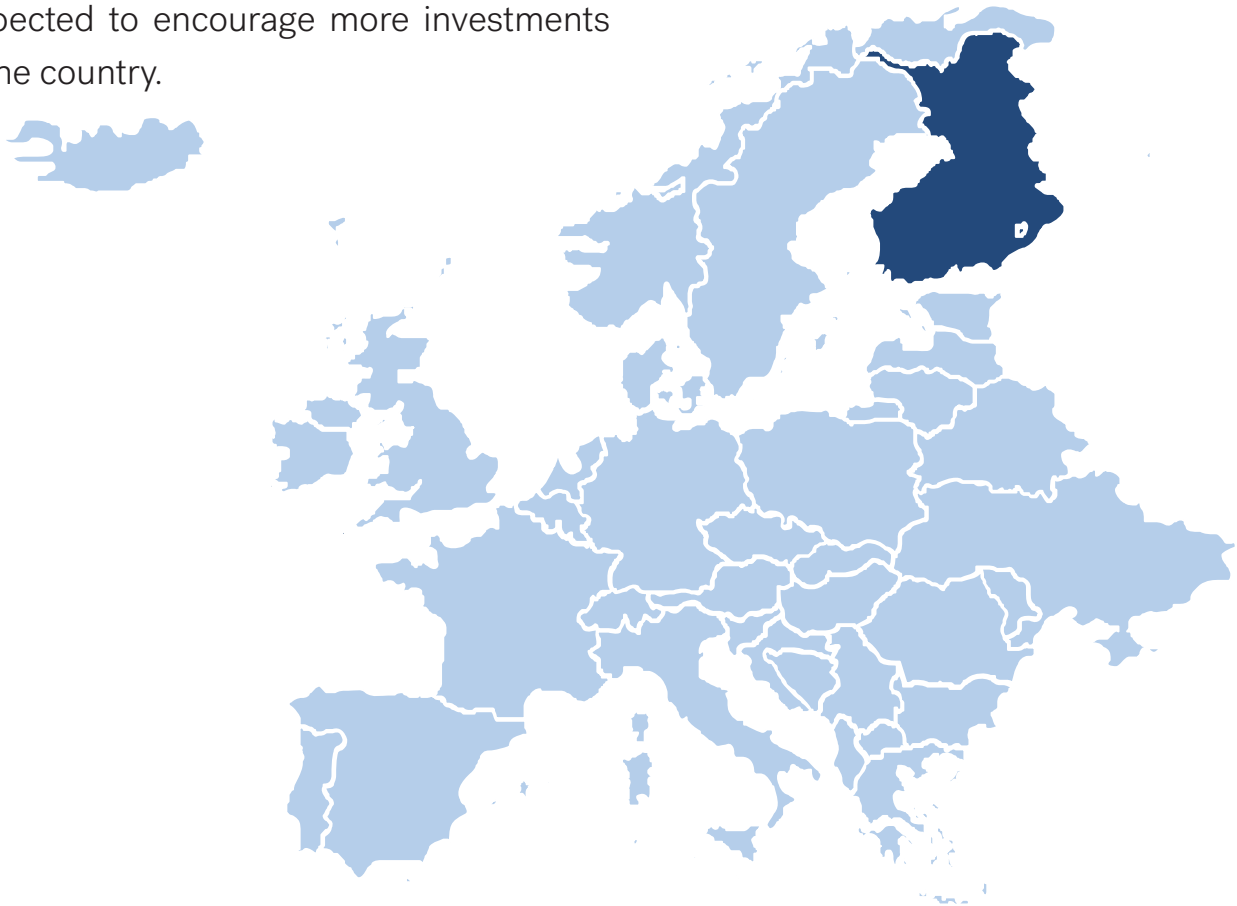
The subsidy-led growth model of EVs is proving to be encouraging for the penetration of the vehicles in the country. The subsidy budget allocated in 2020 to buy new EVs was exhausted within eight days. While in 2021, the used EVs' subsidy was exhausted before the year end. Progressively, the budgetary allocation for the segment may, however, need to be tapered down to allow for market fundamentals. On the other end, the private participants, especially in the vehicle and the battery manufacturing will need to tackle the long-standing issue of 'range anxiety' that remains as a key market barrier for expansion.

Finland

EV Penetration in Finland continues to grow in wake of EU's emission targets. While subsidy support plays an important role, the focus areas must be in a rapid expansion of fast charging infrastructure. With a market leading position in EVs globally, Finland is progressively poised to play a key role in the battery manufacturing industry within the European region. Its natural resource base and manufacturing capabilities could be a counterbalance against China's predominance in the raw material space of batteries. EV market demand along with development of sufficient infrastructure is expected to encourage more investments into the country.

GDP (Current Prices) USD (2020)	269.56 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.01%
EV Penetration	"Passenger: 3.6% in total vehicle fleet (2020) Vans: 0.3% in total vehicle fleet (2020) Buses: 2.6% in total vehicle fleet (2020)"
EV Target	250,000 EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2030

GDP Source: IMF, World Economic Outlook

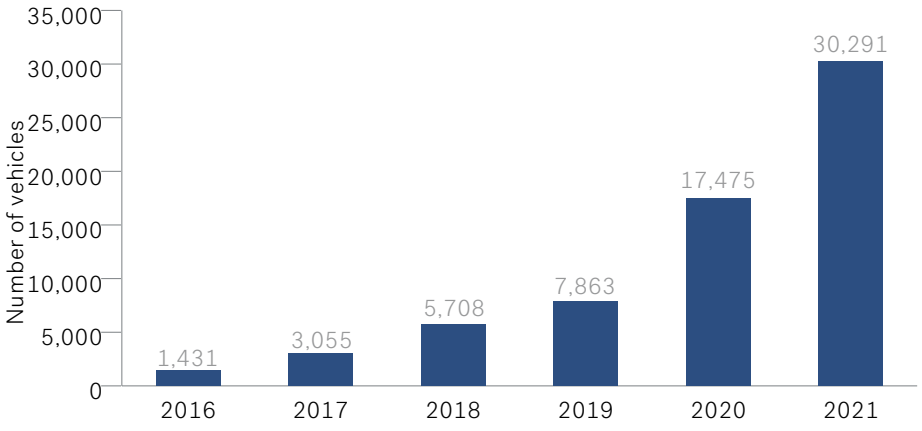


Finland

EV Penetration and Trend

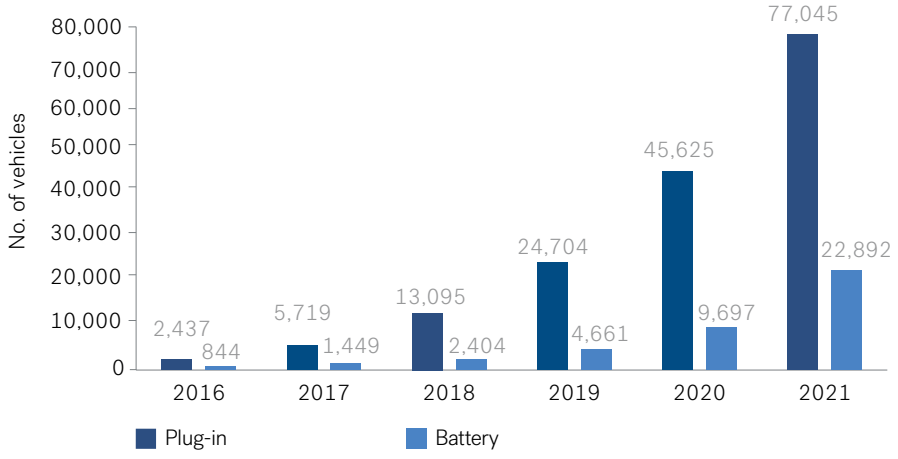
During 2021, the automotive industry experienced sluggishness in the production. The aftermath of COVID-19 brought scarcity in the components of new cars[1], leading to production slowdown. Though the demand for EVs spiked during 2021, as of January 2022, the new registrations of electric and plug-in hybrids dropped by over 15.9% against the corresponding period of previous year[2].

Trend in New Passenger EV Registrations[3]



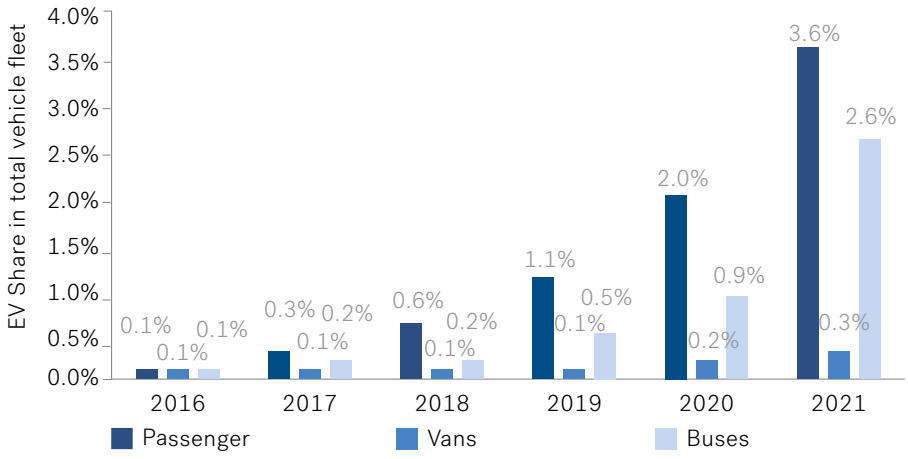
Source: Finnish Information Centre of Automotive Sector

Trend in Passenger EV Fleet[4]



Source: Finnish Information Centre of Automotive Sector

EV Share in Total Vehicle Fleet across Broad Segments[5]



Source: Finnish Information Centre of Automotive Sector

In Finland, new passenger EV registration expanded at a CAGR of 84% during 2016-2021, showcasing inclining consumer preferences towards eco-friendly options. The growth in the registrations was prominent in 2020, as the number more than doubled. The steeper increase continued in 2021 as well, recording annual growth rate of 73%.

During 2016-2021, the fleet of BEVs and PHEVs on Finnish roads grew steadily, recording CAGR of 94% and 100% respectively. Predominantly PHEVs accounted for 77% of the total EV passenger cars fleet in the country in 2021, growing by 69% annually. On the other hand, BEVs covered remaining 23% in passenger EVs, however recorded significant annual growth rate of 136% in 2021[4]. The trend showcases preference towards Plug-in hybrids EVs.

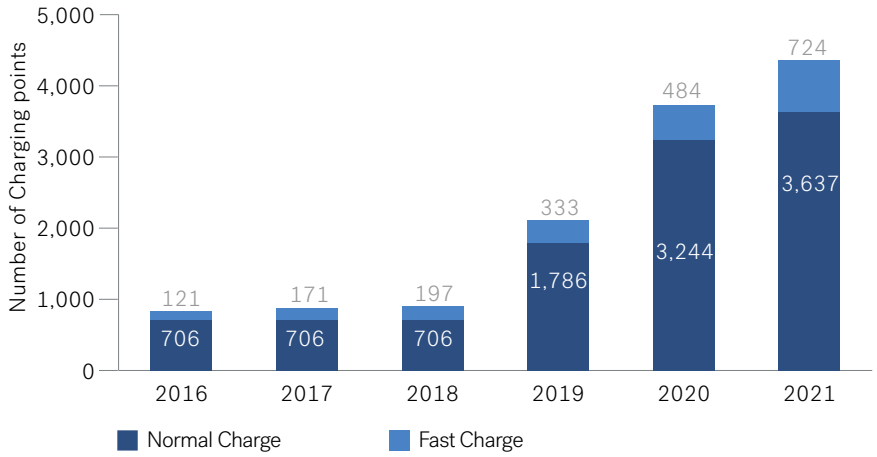
Over the period of 2016-2021, major penetration has been towards the passenger vehicle segment, followed by buses and commercial segment (in terms of Vans).

In 2020, the demand for E bikes in Finland spiked[6], attributing to the COVID-19 caused mobility restrictions. The trend continued in 2021, with estimates of 260,000 units sold. The government incentives promoting E bikes boosted demand, ultimately exhausting the stock, and thus creating shortage in Finland. Despite the price rise, the demand for E bikes continued to soar, especially for lighter and more technically advanced products.

Charging Infrastructure

Charging infrastructure in the country has seen five-fold growth during 2015-20 and it expanded further in 2021. While fast chargers grew rapidly during 2016-2021, the number of normal chargers stayed stagnant until 2018, post which they started increasing at a sustained pace. This can partly be explained by the subsidy support announced in 2019. The support has been aimed at housing estates instead of private individuals, indicating the policy focus on public charging.

Trend in Public Charging Infrastructure[7]



Source: European Alternative Fuels Observatory

Progressively, there is a demand for fast chargers, especially in densely populated areas as well as the business clusters. Between 2018 and 2021, the number of fast chargers quadrupled, while in 2021 alone the supply grew by 50% from 2020. This is driving significant business interest. This includes initiatives such as setting up brand-neutral charging station which can cater to four EVs simultaneously.

Policy and Regulation

The Finnish government recently drew up a draft roadmap on planned transition to carbon-free transportation by 2030[8]. It puts forth the objective to halve the transport emission of 2005 levels over the next decade. This follows an earlier ministerial working group's statement in October 2020 indicating that the country needs to replace its combustion-based vehicles with 700,000 EVs.

Presently, the target is to ensure the active presence of 250,000 EVs in the country by 2030. In line with this target, Finland also have strategized national plan for distribution network for alternative transport fuels projects which aims to have at least 25,000 public charging points functional by 2030. The estimate is based on a previous policy directive which indicated an average of one public charging point for 10 passenger vehicles.

Tax rebates have been major part of incentives offered for EVs[9]. For the period 2018-2021, the Finnish government budgeted EUR24 million for passenger car purchase and conversion subsidies. A subsidy of EUR2,000 is offered on the purchase of a new EV or signing of a long-term lease agreement for EV, while a subsidy of EUR 1,000 is offered for converting a petrol or diesel car to run on gas. This is subject to preconditions such as the car being fully electric, only private individuals as buyer or lessor availing the subsidy, maximum value of the car at EUR50,000 (including taxes), and availability of funds (annual budgeted allocation is worth EUR6 million).

Apart from the subsidy, the Finnish government issued a law for 2018-2021[10] to expand infrastructural support for EVs. It also announced EUR5.5 million outlay for the charging infrastructure in 2020 and 2021. During H2 2020 the government updated the law to facilitate the targeted investments towards most impactful projects. This support was extended to charging point network in the country. The recommendations of the national biogas programme in terms of the use of biogas in transport were also included in the program.

Among other incentives are the tax benefits available for passenger EVs[11]. There are registration tax benefits in the sense that an EV buyer is required to pay only 5%. EVs are also subject to the minimum rate (5%) of the CO2 based registration tax. Secondly, companies that provide EVs along with charging facility can avail a refund of up to 35% of the total purchasing and installation costs for charging infrastructure. This refund can increase to 50% if at least half of the stations offer power of >11 kW.

Market Opportunity

In the wake of growing need for EV infrastructure, government of Finland established national battery strategy in January 2021 and made an allotment of around EUR450 million[12]. The strategy aims at attracting prospective investors to develop and expand battery manufacturing facilities in the country over the period of 2021-25. The strategy underlines objectives such as renewing the country's existing battery and electrification cluster, sustainable raw material sourcing, exploring the key areas in battery manufacturing supply chain and advancing the digital innovations. Notably, Finland is the only European country that has mining operations in Cobalt – a critical battery component. The country has about ten active production and exploration projects, of which three produce nickel, copper, and cobalt concentrates.

Investments have been kicking in thereby supporting the development of Finnish battery infrastructure. In January 2021, the state mining company, Terrafame[13], received long awaited environmental permit to set up a battery chemicals production plant in eastern Finland. Functional since H1 2021, the plant contains one of the largest production capacities in the world. Keeping clean energy aim in mind, battery minerals, mainly nickel sulphate and cobalt sulphate, are sustainably mined and refined thus facilitating the EV supply chain. With an investment of around EUR240 million, the battery chemical plant has become the successful partnership venture between Finnish Minerals Group and Terrafame.

BASF, a German chemical company, has been actively investing into Finland[14]. The company is in process of setting up a precursor cathode active materials plant (PCAM plant) in Harjavalta, Finland. The plant seeks to supply Cobalt and Nickel via co-located Nornickel refinery, using the renewable energy generated in the region.

Apart for these, BASF Finland has partnered with state-owned energy company Fortum and mining company Nornickel to set up a recycling cluster, that helps to address the case of valuable battery metals[15]. Fortum, separately, working on battery recycling solutions enabling lower carbon footprint. Through the process, cobalt, lithium, nickel and other scarce metals could be reused in the other production activities. Considering its benefit, by end of 2021, EUR10 million worth of funding was granted to Fortum from Business Finland, to enable lithium recovery from recycled battery materials at the hydrometallurgical recycling facility of Harjavalta.

To expand the charging infrastructure in the country, the Finnish government laid out significant investment opportunity in its "Integrated Energy and Climate Plan"[16]. Based on an average investment cost of EUR40,000 for each fast charger and EUR14,000 for each medium-speed charger, the investment value for building public charging infrastructure is estimated at about EUR415 million by 2030. This further assumes that about 10% of the public charging points are fast chargers.

Outlook

Finnish government has been implementing strategies to expand charging infrastructure and battery supply in the country, paving the way for strong growth prospects of EV market in coming years. To meet European Union's carbon neutral goals, electrification of transportation system has become a focused area. According to the market trends, rechargeable hybrids are likely to retain their popularity even as all-electric ones emerge as the alternative.

Apart from passenger EV adoption, emphasis is also given on expanding E bus network in the public transportation. This has attracted some of the leading global players as well. For instance, the Chinese manufacturer BYD secured a second major order from public transport operator Nobina Finland to deliver 70 latest generation electric buses by the summer of 2022[17]. In the first order BYD delivered 106 E buses to Nobina in the summer of 2021. Also, recently in February 2022, global bus manufacturing leader Volvo secured a deal to deliver 82 E buses to various locations in Finland[18]. There are expectations that electrification of the public transport network is likely to gain further momentum as cities are gearing up in this direction.

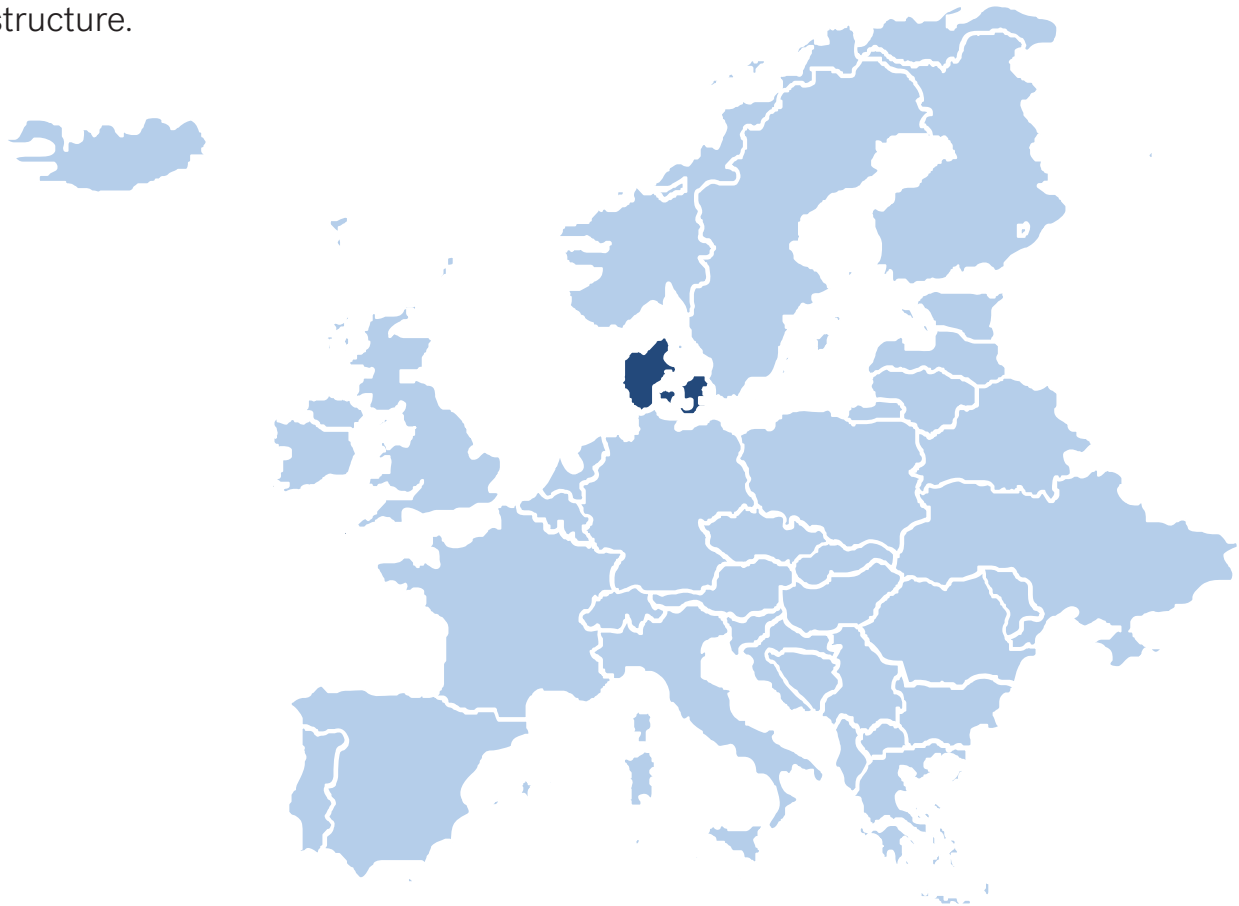
There have been some investment ventures in charging infrastructure build up. DIF Capital Partners has announced its plans to acquire stakes in Plugit[19], a Finnish EV charging infrastructure company. The Finnish company has successfully installed around 4,000 charging points and with DIF's support, it intends to expand its network.

Denmark

Denmark has lately made significant progress in the growth of EV penetration. Fiscal incentives helped drive the penetration in passenger EV segment, while in case of public transportation, enhanced government funding helps municipal authorities phase out the diesel and other options in favour of electric ones. At a policy level, there is a goal to phase out ICEs by 2030, which partly helps set the base for all the initiatives in this regard. The investment requirements are however huge, especially to ramp up charging infrastructure as well as the renovation of grid infrastructure.

GDP (Current Prices) USD (2020)	356.09 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.46%
EV Penetration	5% of total passenger car registered (2021)
EV Target	775,000 electric and hybrid EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2030

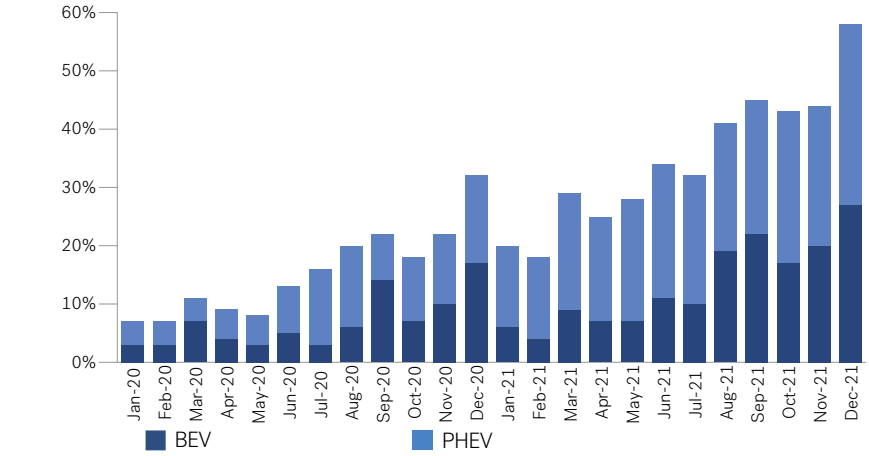
GDP Source: IMF, World Economic Outlook



Denmark

EV Penetration and Trend

Trend in Share of EV Passenger Vehicles in Total Sale



Source: Association of Danish Car Importers

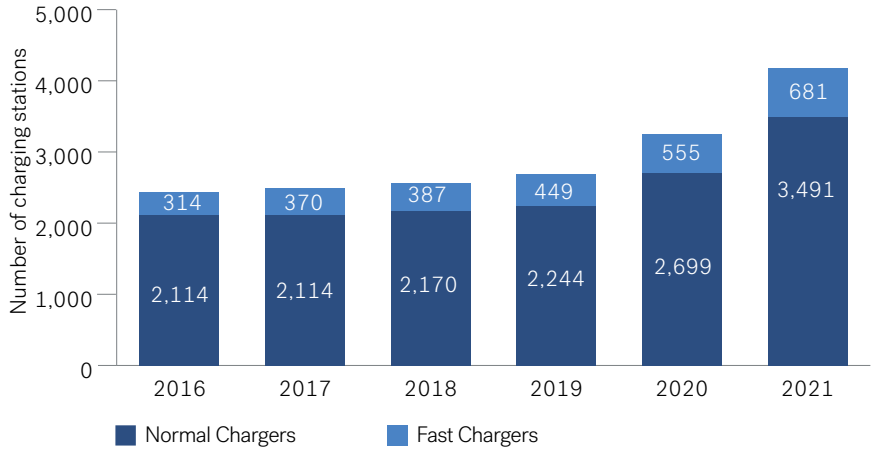
By end of 2021, Denmark set a record in the sale of electric vehicles[1] with a year-on-year growth of 75%. Notably, December 2021 was marked for a record 58% share of electric vehicles in the total automobile sales in the month. Plug-in hybrid vehicles rose even higher, at over twice that of the previous year. But the sharp rise in the plug-in hybrid vehicles is unlikely to sustain with the new tax regime that lays emphasis on the carbon emission levels.

Overall, in 2021, a total 2,781,855 passenger cars were registered, of which the electric cars constitute 144,498 units. Notably there was a decline in other passenger vehicle sales, due to the semiconductor shortages worldwide.

Denmark has also been leading the way in adopting electric buses. As per a report by Transport & Environment[2], Denmark in 2021 stood out for the maximum zero emission buses in the European Union, with electric buses accounting for 78% share of new vehicles. Unlike other European cities, the rapid deployment in Danish context has been attributed to the long-term contracts undertaken by the municipal authorities that mitigated risks for operators, while enabling cooperation between the various stakeholders in adhering to the targets.

Charging Infrastructure

Trend in Charging Infrastructure



Source: European Alternative Fuels Observatory

The trend in Denmark's public charging infrastructure[3] shows significant expansion during 2016-2021 registering a CAGR of 10.6% for the normal chargers (rated capacity of up to 22kW) and 16.7% for the fast chargers (above 22kW).

The country's record sales of electric vehicles progressively face a bottleneck in charging infrastructure availability[4]. By end of 2020, there were about 11 electric vehicles per public charging point. Based on the registered vehicles by end-2021, many entities have expressed concerns that the lack of adequate charging capacity and the long waiting time for users to get timely charging, could potentially deter the EV offtake in 2022.

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.

Development of battery storage capacity is at a nascent stage in the country. However, a few national players are foraying into this space lately. Denmark's Aarhus University is leading project Helios[5] aimed at developing the next generation of electric car batteries with a recharging time of just six minutes and a range of 350 kilometres. The project received funding of EUR11.5 million from the EU Horizon 2020 programme.

Policy and Regulation

Denmark has a stated target of 775,000 electric cars (battery and plug-in hybrids together) by 2030. This made the basis for most of the policy measures undertaken for the EV ecosystem. The government primarily offers partial fiscal and policy support for all groups (private, industry & public) associated to EV and charging infrastructure. At the same time, Danish taxation on vehicle is also widely regarded as being expensive and complex when compared to other countries.

The revised legislation[6] passed in February 9, 2021 lays down the taxation norms applicable for the battery electric vehicles and plug-in hybrids. The vehicle's CO_2 emission forms the basis of determining registration tax. For electric cars, a tax exemption of up to DKK 488,000 is provided for (earlier this was DKK400,000). Also, taxation of employer-funded charging stations at the employee's private address gets a waiver, and a temporary battery deduction was introduced. In effect, the taxation structure makes the conventional vehicles relatively expensive than the EVs.

For EV charging the incentives[7] on offer include tax reduction on the electricity used. In case of charging involved for electric buses, favourable tariffs are available till 2024.

Market Opportunity

Denmark notably has a private sector participation to support the policy objectives in expanding the charging infrastructure coverage. Some of the recent examples attest to the rising interest. In September 2021, Norlys and EVBox signed a multi-year partnership for installation of about 300,000 charging stations across Denmark by 2030. Norlys is among Denmark's largest telecom network service provider[8]. Similar large-scale investments are underway by other infrastructure providers. In March 2022, the Copenhagen Airport signed an agreement with the Jutland Energy group EWII to set up 1,350 charging points over next 10 years[9]. The first 195 of these will be set up by 2022. The project has EU support, as Copenhagen Airport is also part of the EU project ALIGHT that pursues sustainable investments for the aviation industry.

Battery energy storage system (BESS) is being actively considered in rolling out fast-charging station network. In November 2021, Danish fast-charging network operator Clever signed a partnership[10] with Hitachi Energy to launch a EV station pilot at Køge. This project is notable for a pioneering deployment plan of Hitachi Energy's e-mesh1.2 MW / 1.5 MWh PowerStore BESS. The pilot entails establishing eight charging stations, to be scaled up to an additional 10,000 by 2025.

Technologies are also being tested for the grid supporting role of electric vehicles. The vehicle-to-grid (V2G) technology – involving the connection of electric vehicles for grid supporting services such as frequency regulation, voltage support and others – has found traction in Denmark. The Danish demonstration project Parker[11] that started in 2017, has by now established the feasibility of V2G across electric vehicles of different brands. As of November 2021, this project was undertaking tests for different grid services in this context.

Publicly funded procurement is underway for a gradual electrification the bus fleet. In November 2021, the public transport operator Nobina signed a contract with Ebusco[12] to procure 22 emission-free buses for the greater Copenhagen area. The delivery is scheduled for 2022. This is the fourth such order since March 2021, from the same operator and with the same supplier. Similar procurement is underway at multiple other cities such as at Aarhus where 29 electric buses are to be delivered by the supplier Solaris[13].

With a growing focus on the charging infrastructure, Denmark's power transmission and distribution network needs investments for upgrades. With Denmark's high share of renewable energy in the total power consumption, there will be a significant scope for network investments to accommodate the emerging requirements. Notably, the Denmark power transmission network operator has an allocation worth EUR43 billion to renovate and modernise the power transmission infrastructure for the period till 2028[14].

Outlook

The transition to EV, led primarily through fiscal support, is likely to entail a strained public financial position. This is part of the conclusions of a Denmark government commission report , according to which, the fiscal deficit burden could rise significantly as a result of subsidies on EV purchases and the taxes imposed on ICEs. The net loss is thus estimated at EUR5.7 billion by 2030, particularly when the existing public budget relies significantly on the road and vehicle taxes[15].

The government is thus working with the Danish Council on Climate Change for ways to switch from to EVs without jeopardizing the budget. Among the various measures suggested, the most important is to determine a fixed evolution of tax reductions and other benefits for zero- and low-emission cars over time, which also includes a gradual phasing out of benefits. The expectation is that technological advancement would make EVs cheaper and therefore price competitive over time.

There will be significant investment commitments involved to ramp up Danish power transmission network. The transmission system operator's report suggests the need to renovate the ageing assets in time to meet the emerging requirements. While an investment outlay is set aside for this, the measures required will necessarily involve greater use of technology options in areas such as smart grid.

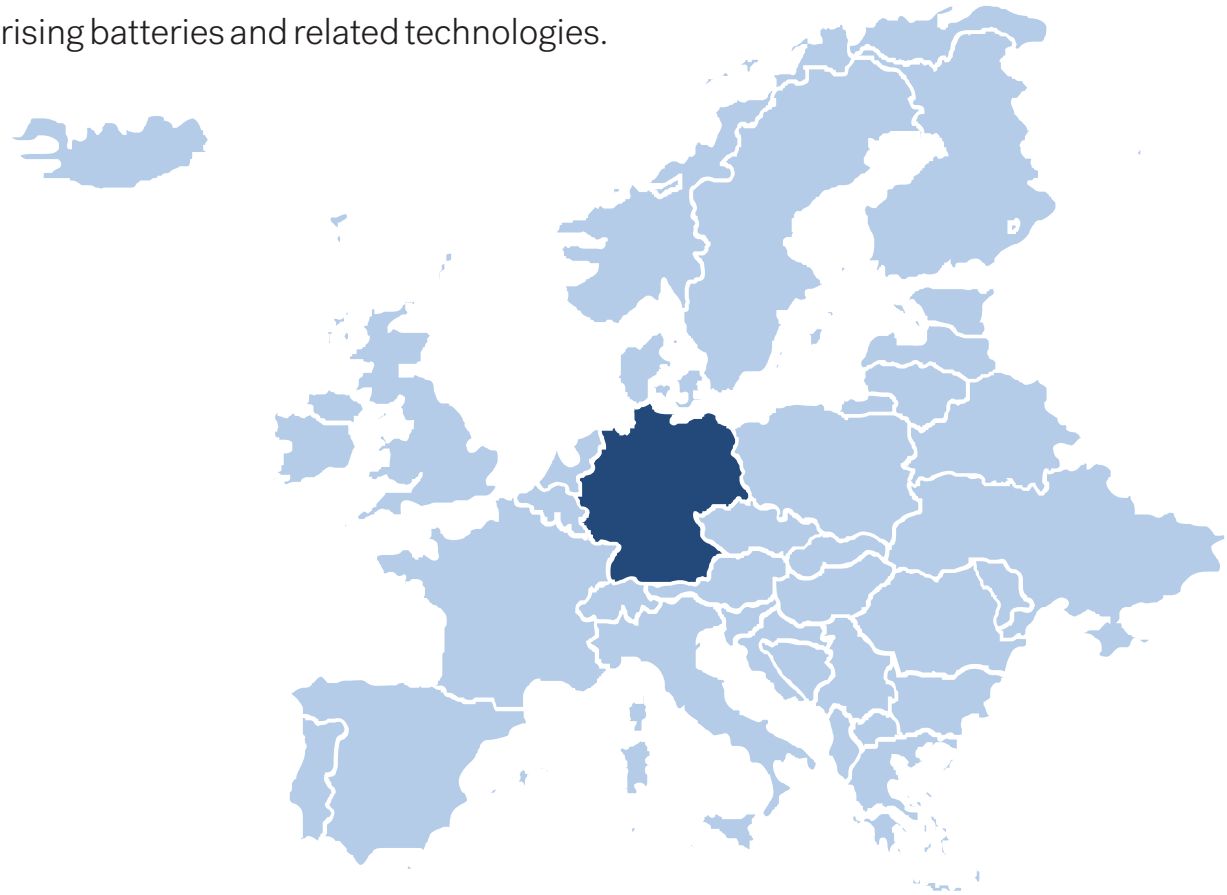
Germany

Germany, as Europe's largest auto market, registered among the highest growth in EVs by end of 2021. New vehicle registrations grew by 83% over previous year's level. The policy goal is to put 10 million EVs by 2030 to achieve 55% cut in carbon emissions.

GDP (Current Prices) USD (2020)	3,843.34 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.34%
EV Penetration	42.4% of total new vehicle registered (2021)
EV Target	15 million EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2030

GDP Source: IMF, World Economic Outlook

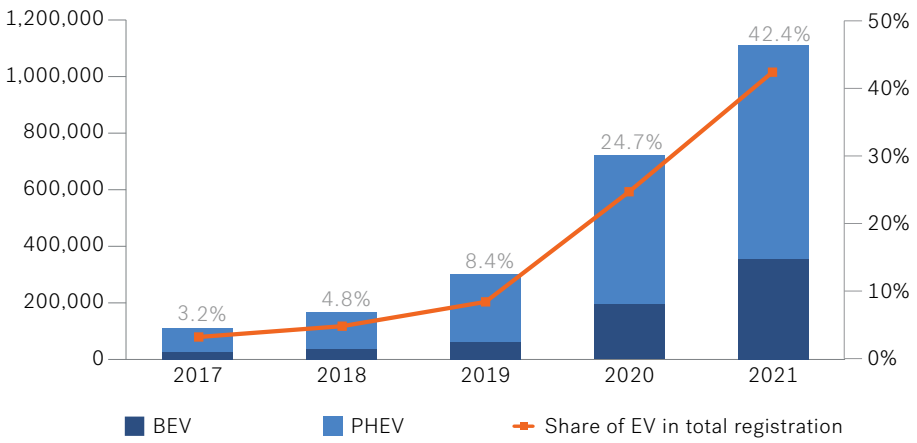
Germany's important position in the global auto market has also attracted the global OEMs to set up base. This in turn makes it an important market not only in terms of the EV penetration but also in establishment of the critical backward linkage – the ecosystem comprising batteries and related technologies.



Germany

EV Penetration and Trend

Trend in EV Registration



Source: Federal Motor Transport Authority (KBA)

According to Germany's Federal Motor Transport Authority (KBA)[1], battery electric and plug-in hybrids together accounted for 42% of the total registrations by end-2021. In effect, the share of conventional vehicle platforms is receding in relative share, although this could be due to the global supply chain bottlenecks arising from semiconductor shortages.

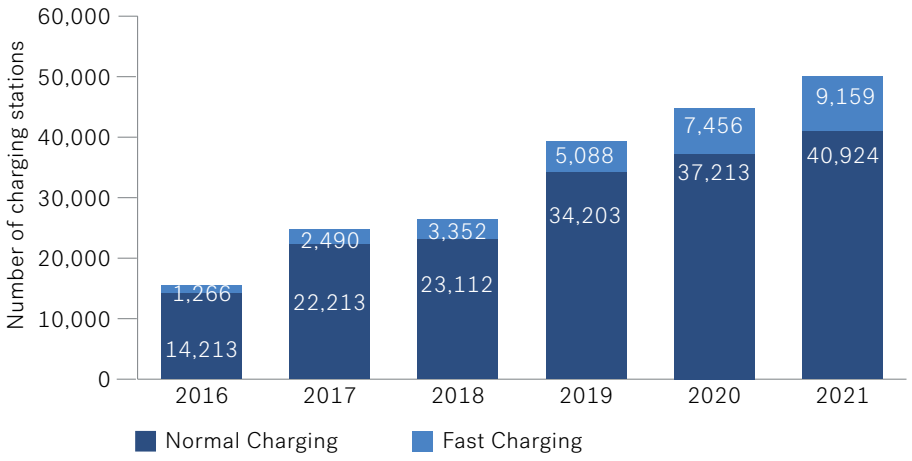
Most of Germany's electric vehicle registration is based on plug-in hybrids. Yet, battery electric vehicles' share is on a consistent rise, as evident in the trend showing 32% in 2021, compared to the 23% achieved in 2017. More importantly, battery electric vehicles now account for 13.6% of total registrations – more than double the level of previous year. Such vehicles' registrations grew by 83% in 2021. In 2020, growth was 207%.

While policy-push incentivizes demand, the supply-side of the market has been enabling growth as well. Germany's EV market is characteristic of multiple product launches at various price points by the global auto majors. Some of the major global OEMs such as Volkswagen, Renault and Stellantis lead the way in product sales[2]. Tesla is an important player and is expected to assume a major role once its manufacturing facility comes onstream.

Electrification is also underway at a fast clip in public transportation. At a policy level, the targets have been set for fleet emissions and minimum procurement targets. The deployment of electric buses has thus been on a sharp rise in Germany, led by municipal bus procurement. In December 2017, just 183 electric buses were registered[3]. By end-2021, this rose to 1,299, thus marking a compound annual growth rate of 63% during 2017-2021. Traction in this market is led primarily by federal funding for the procurement of zero emission vehicles (electric and fuel cell).

Charging Infrastructure

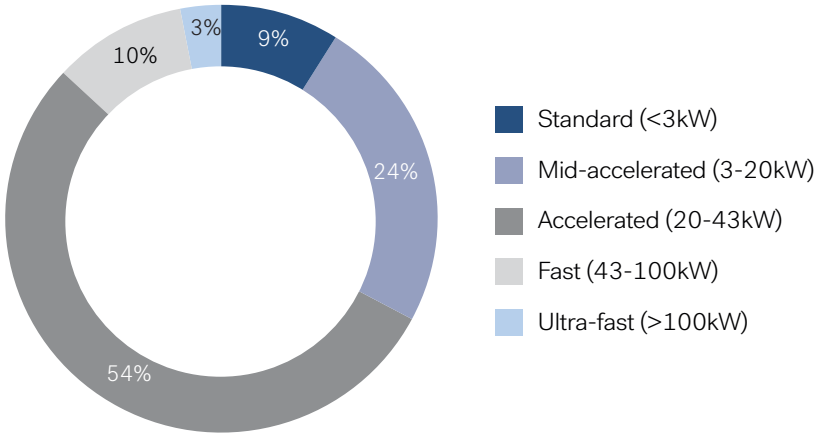
Trend in Public Charging Infrastructure



Source: European Alternative Fuels Observatory

The rapid transport electrification is finding a reflection in the charging infrastructure, especially in the public mode. As per the European Alternate Fuels Observatory (EAFO), the trend in Germany's public charging infrastructure shows a CAGR of 26% during the period 2016-2021. Notably, the ultra-fast charging stations in the country (150 kW and above) doubled[4] in number year-on-year by 2021, reaching about 3,000.

Share of Public Charging Infrastructure by Speed



Source: BNEF

BNEF estimates on the distribution of the public charging infrastructure by their rating capacity shows that the German EV charging network is fairly equipped with fast-charging capacity. About two-thirds of the installed capacity is that of fast-charging. Most of the charging capacity is operated by the utilities. There is a high focus on rapidly expanding the public charging capacity, due to the long-term goals in emission reduction.

Policy and Regulation

Germany is among the very few countries where fiscal support and purchase subsidies are available at national, state, and municipal levels for EVs and charging infrastructure. The German automakers and the government are working collectively to support the mass acceptance of EVs. In 2019, an agreement was signed between the government and German automotive industry majors to facilitate mass production of EVs.

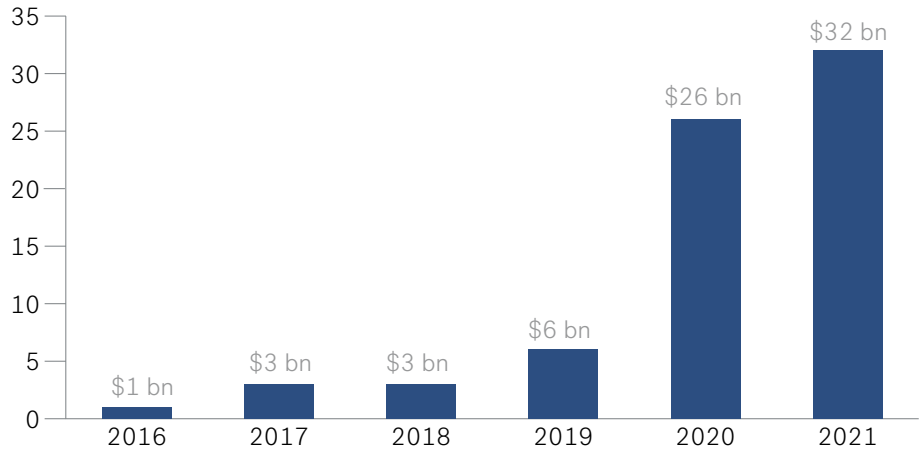
To help enable rapid offtake, there has been an increase in the consumer subsidies for passenger EVs[5]. In 2021, the government's total expenditure towards subsidising EV purchases stood at EUR3.1 billion. The recently appointed government reaffirmed its intention of continuing with the subsidy support. This means buyers of battery electric vehicles are entitled to an incentive of up to EUR9,000, while for the plug-in hybrids, the incentive is capped at EUR6,750. For the vehicles priced up to EUR65,000, the grant on offer is EUR7,500 and EUR 5,625 for battery electric and plug-in hybrid, respectively.

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 up to enable private participation, it is the local or municipal-level incentives that make the difference. Some of the notable cities/municipalities taking the lead in the available incentives include Nordrhein-Westfalen, Munich, Hannover and Limburg[6].

As of November 2021, the government enhanced the funding allocation for residential charging stations[7] – bringing the total outlay to USD800 million to fund grants for private individuals, housing associations and developers towards equipment purchase and installation. Preconditions for the grant include 11kW rating, intelligent and connected systems that enable vehicle-to-grid applications, and the entire power supply needs to be based on renewable energy sources. Apparently, this scheme found significant interest, with 620,000 applications received in July 2021.

Market Opportunity

New Investment Commitments in Electrified Transport



Source: BNEF

Germany has of late seen a rise in investment commitments related to transport electrification. This is directly related to the policy goals related to lowering the fleet emission levels as well as phasing out of the conventional vehicles in the transport network. BNEF estimates confirm this with estimates on investment commitments in electrified transport, that reached USD32 billion by 2021, contrasting the less than one-fifth of this level two years ago.

Charging infrastructure has attracted significant attention. Policy-wise it is acknowledged as the single-most important factor and a potential bottleneck against the stated goals in transport electrification. In March 2021, the office of German Chancellor announced a planned USD6.5 billion worth of funding towards setting up charging infrastructure[8]. The allocated funds will be available till 2024.

The policy focus on scaling up the charging infrastructure is high, due to which the government is keen to attract various entities to expedite the process. In August 2021, the German transport ministry launched a tender to accelerate the construction of charging stations[9]. The tender aimed at securing companies to undertake establishing about 1,000 charging stations in designated areas, with charging price capped at USD0.44 per kWh.

As a legal basis for the planned tender, the government enacted the Fast Charging Act[10], to enable launching a Europe-wide tender and facilitate construction of the planned charging stations. The aim is to have the 1,000 fast-charging stations in place by 2023.

The public-private mode of investment planned by the German government is likely to attract further investments in the time to come. In February 2022, Israel-based company Chakratec announced securing order from Germany for three ultra-fast charging stations[11]. More such projects are likely to follow as the government pursues its aim of putting in place a million public charging points by 2030.

A greater impetus appears to be towards battery manufacturing in Germany, the aim being to develop local supply chain that can cater to German as well as the larger European region demand. Germany has six gigafactories planned at advanced stages. The US-based EV manufacturer Tesla's 100 GWh Gigafactory is close to commissioning during March 2022[12].

Upcoming EV Battery Manufacturing Capacity in Germany

Location	Developer	Expected commissioning	Other details
Saarland	SVOLT	2023	Expected capacity at 24 GWh/year, EUR2 billion investment; construction started in 2021
Arnstadt	CATL	2022	Expected capacity at 14GWh/year by 2022; EUR1.8 billion investment; construction started in 2019
Salzgitter	VW, Northvolt	2023	Expected capacity at 16GWh/year by 2023 and 24 GWh by 2024; Pilot running since Sept 2019
Kaiserslautern	Opel (part of PSA), Saft	2024	Expected capacity at 8GWh by 2024, rising to 24GWh; EUR2 billion investment

Source: S&P Global Platts

Outlook

To meet its carbon emission targets as a country, the stated policy target is 15 million EVs by 2030[13]. Furthermore, this corresponds with a targeted 1 million charging points for the projected EV fleet. The estimates from other industry reports vary widely. While some suggest that the projected EV fleet could exceed the government target, there are others which point to a slow progress. Nevertheless, there is a clear pointer towards the significant step in the passenger EV sale.

The subsidy-led growth model is likely to continue, as has been evident from the recent government steps at continuing the subsidy commitments. Yet, the level of support might undergo some tapering[14]. For instance, from 2023 onwards, the grants on offer could be conditional to the EV driving range, to reflect the impact such vehicles have on climate mitigation objectives.

The expansion of the charging infrastructure, while attracting a significant policy interest, has also revealed the need for integrated planning and greater private operator participation. Utilities, who own the financial burden of rolling out EV charging stations, differ in perspective with that of the automakers. While the utilities complain of under-utilised charging stations, the OEMs' lobby seeks faster expansion, at about an average weekly installation of 2,000 charge points to meet a government target for 1 million points by 2030 for up to 10 million EVs[15].

The German government's innovation premium has improved price competitiveness of EVs and raised the acceptance of e-mobility. This is even more critical because the charging infrastructure still has significant potential for improvement in terms of supply density as well as actual availability and reliability. Focus also needs to turn to private charging with the German Association of Energy and Water Industries ("BDEW") estimating that 85% of EV charging will be either at home or work with regulation required for buildings and the service sector.

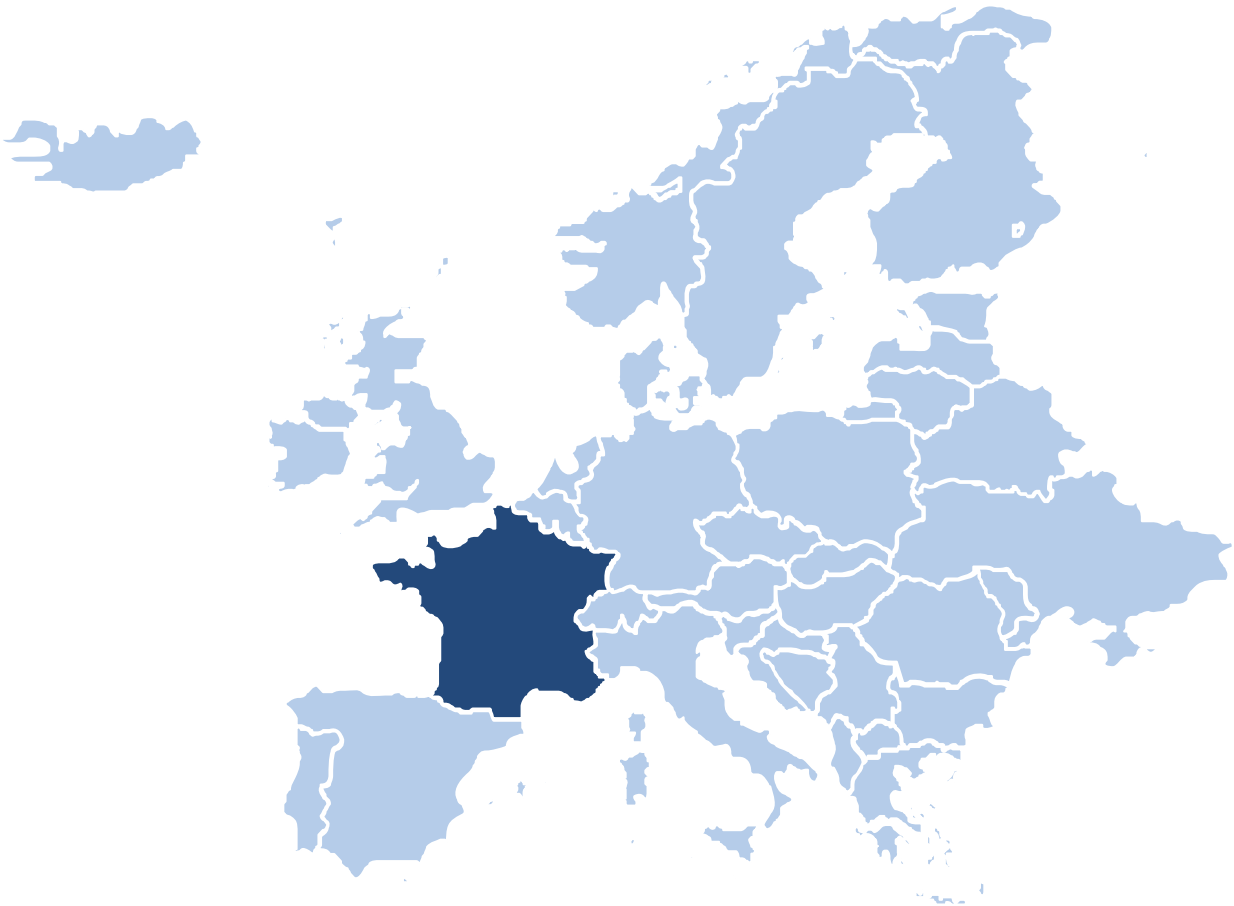
France

France is one of the largest auto markets in Europe and possesses potential to be the region's largest EV market. The target set by the country to ban fossil fuel cars by 2040, followed by 2050 target of carbon free energy serve as the base for EV friendly policy measures in the country. The results are visible in terms of growth in passenger EV and E buses sales, along with expanding investment base for charging infrastructure in France.

GDP (Current Prices) USD (2020)	2,624.42 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.99%
EV Penetration	15% of total passenger vehicle sales (2021)
EV Target	Domestic production target of 2 million units by 2030
Planned Year of Phasing Out ICE Vehicles	2040

GDP Source: IMF, World Economic Outlook

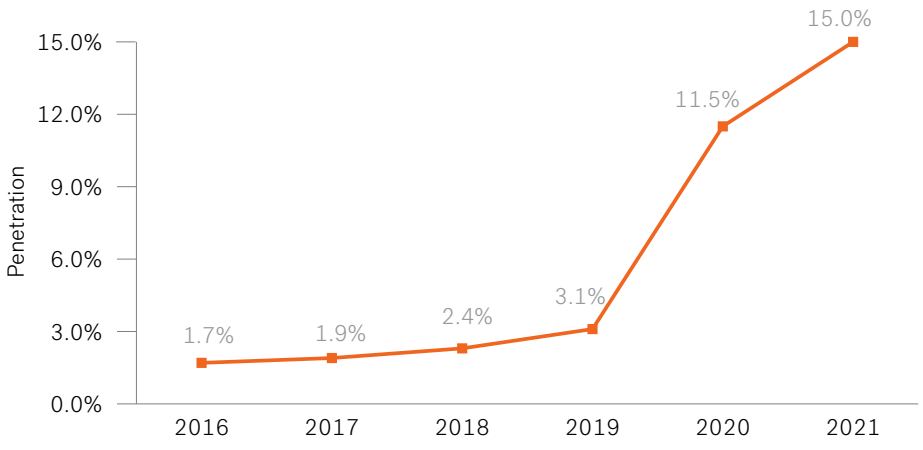
Note: French government's EV target is part of the government's industrial revival plan called "France 2030".



France

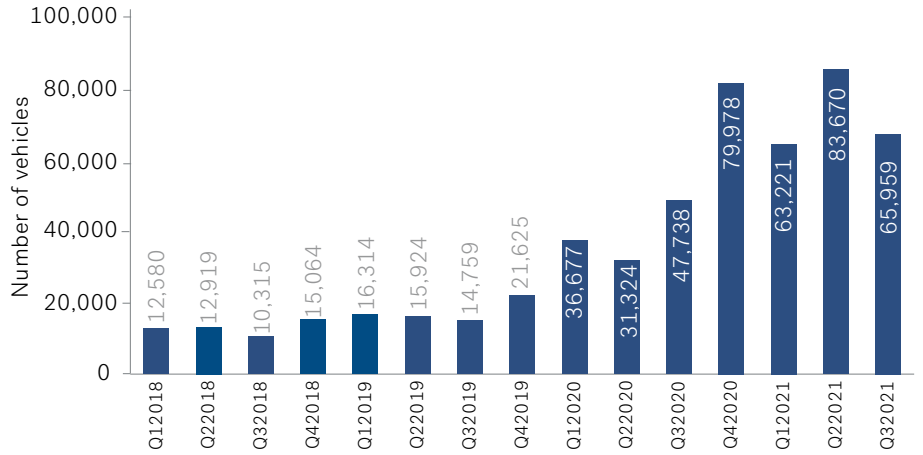
EV Penetration and Trend

Trend in Passenger EV Share in Total Vehicle Sale[1]



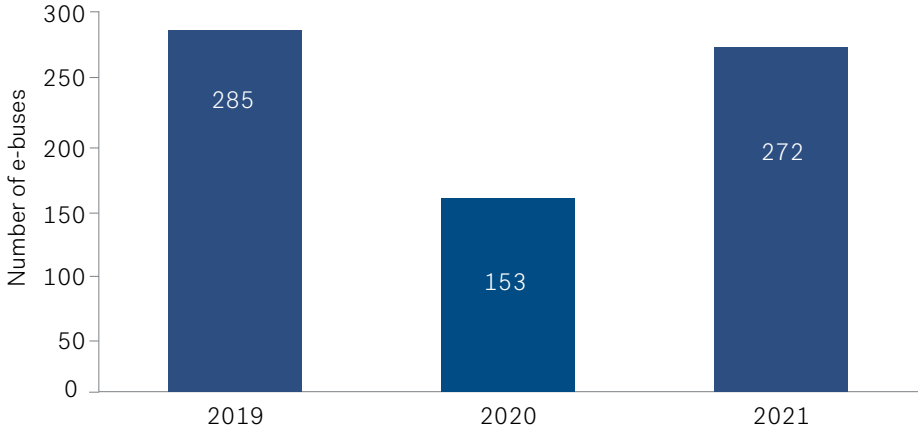
Source: BNEF

Trend in Passenger EV Sales[1]



Source: BNEF

Trend in E-bus Sales[2]



Source: BNEF

The expanding EV penetration in France is reflected in steady growth rate of passenger EV sales. In 2020 EV sales saw a sharp spike and grew further in 2021. The battery-based electric vehicles (BEVs) dominated the market, accounting for 63% of the total EV sales in the country in 2021.

The steady upward trend in the EV sales can be attributed to the fiscal incentives provided by the French government. The subsidies along with tax benefits have proven to be effective tools to boost the EV usage. The downturn caused by COVID-19 outbreak during Q2 2020 was contained by a recovery package of the government, implemented to support the affected industries. Since then, the market has been expanding, supported by public and private investment ventures for EV production as well as to develop necessary infrastructure.

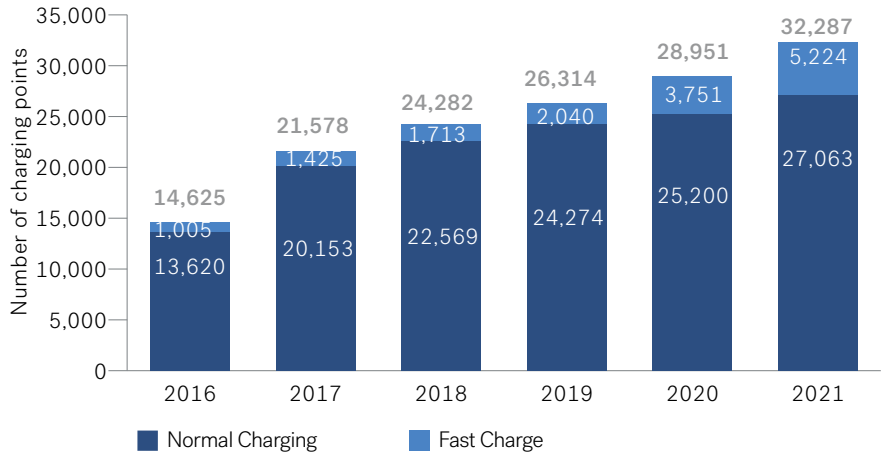
Electrification of public transportation has gained momentum. The damped sales during 2020, due to COVID-19 led public transport restrictions, recovered in 2021. French cities, such as Paris, have actively begun E buses inclusion in their public transport vehicle fleet.

Shared mobility is another key segment in the French EV market. Given the convenience of the shared EV car, especially for the consumers with no vehicle on their own, has created the demand, not only in metros but also in towns and villages[4].

Micro-mobility modes, such as E scooters and E bikes, have gained significant traction in France. Along with them, hoverboards are also popular among youth. The E scooter and boards, together called as engins de déplacement personnel motorisés (EDPM), are used by approximately 72% of the population aging 18-34[5]. However, the use of EDPM is subjected to speed limit regulated by fines. French municipalities also have set slow zones where pedestrians, cycles and scooters share spaces[6].

Charging Infrastructure

Trends in Public Charging Infrastructure[7]



Source: European Alternative Fuels Observatory

Rapidly expanding EV penetration in France is supported by steady growth in infrastructural facilities, as showcased by rise in public charging points at a CAGR of 17% during 2016-2021. The normal charging points continued to dominate the segment, accounting for 84% of the total strength in 2021. However, fast chargers marked stronger jump in the number of points added compared to that of normal points, recording CAGR of 39% and 15% respectively during 2016-2021. Similar trend can be observed annually, with fast charging points increasing more rapidly compared to the normal charging points.

Charging infrastructure investment momentum is essential to support the transition of all types of shared and personal passenger electric cars and light commercial vehicle fleets through 2035 to put France on a path toward achieving 100% fully electric vehicle sales by 2040[8]. In this regard, the government is working with some of the large companies such as EDF Energy Group, TotalEnergies and Renault to expand the charging network[9][10].

The growth of the country's electric vehicle battery market is likewise propelled by increasing government investments and support for boosting their production to reduce the reliance on Asian suppliers. For instance, in June 2021, the French government announced its participation of EUR200 million in the battery cell production project of Automotive Energy Supply Corporation (AESC)[11]. The Gigafactory will produce 9GWh annually and is expected to commence operations from 2024, supplying mainly to the Renault Group. Through such investments, government has underlined its support for the new projects in the segment and has facilitated the process for larger corporations to position themselves as manufacturers of advanced battery storage technology.

Policy and Regulation

The government of France have been taking steps toward 2050 goal of carbon free energy[12] via various laws and legislations. The country is amongst the very few countries where fiscal support and purchase subsidies are available for EV adaptation at national, state, as well as municipal levels.

The downturn faced by the domestic automotive business due to COVID-19 pandemic stimulated the French government to draw the recovery plan, valued at EUR8 billion[13]. The plan partly focused on rebooting the automotive industry in the country through incentives for extensive EV penetration. The measures included environmental bonus that offers grant of 27% and up to EUR6,000 on purchasing price of a new EV for less than EUR45,000, while vehicles with price between EUR45,000 – EUR60,000 can get bonus of EUR2,000[14].

The aid also includes conversion bonus subjected to household income and the date of vehicle registration. For the vehicle owner with income lower than EUR 13,489 per part, and vehicle registration date before January 2006 if petrol and January 2011 if diesel, is eligible for grant up to EUR5,000. The Hybrid vehicles are eligible for the grant of EUR1,000 till June 2022. Notably, the deadline for the subsidies offered by the government has been pushed to July 2022, however, the amount of the bonus will taper gradually[15].

Support is as well extended to the owners and operators of charging points. For companies who seek to install the system, subsidy of up to 40% of the purchase and installation costs is granted, while for the residents / condos, subsidy of up to 50% is available. Municipalities are also given subsidy of up to EUR2,160 per charging point. EV drivers are allowed to request the installation of a charging point within a radius of 500 meters of their place of residence or work[13].

In October 2021, the government announced EUR30 billion worth 5 year investment plan for developing innovative technologies and industrial activities such as building small nuclear reactors, electric cars and greener airplanes[16]. The plan involves budget of EUR8 billion to develop energy technology enabling lower emissions. Around EUR4 billion are allotted to manufacturing of about 2 million electric and hybrid cars by the end of the decade.

Market Opportunity

The French government has been encouraging municipalities to expand their electric bus fleet. Thus, an uptick can be seen in the E bus orders by major municipalities such as those in Paris. By end of 2019, public transport operator RATP announced its 'Bus2025' roadmap, which aimed at having a fleet of 800 E-buses by 2024[17]. Accordingly, in January 2021, RATP ordered 109 Bluebus E-buses by Bolloré Group[18], 35% of which are expected to be delivered during 2022-2023. Additionally, in August 2021, RATP awarded contract of 180 12-meter full electric buses to IVECO BUS, accelerating the march towards the target[19].

European Commission (EC) has extended its help in the same regard. In September 2020, the Commission released EUR54 million, an additional tranche over the EUR2 billion committed for clean transport towards five sustainable transportation projects[20]. One segment of this capital aimed at funding the purchase of 303 electric buses together with charging infrastructure in Paris. In particular, the support of EUR23 million was provided to Île-de-France Mobilités' and RATP's Bus 2025 plan in October 2020[21].

The deepening EV penetration is asking for speedy infrastructural developments in France, which offers a great untapped opportunity. The country, by involving larger conglomerates, aims to install extensive charging infrastructure by 2030 to accommodate the growing EV fleet[22]. Moreover, the transmission user tariff reductions by mobility orientation law on transport (LOM) would encourage the implementation of charging infrastructure where it is needed.

Some of the recent investment examples include TotalEnergies' plan to allocate around EUR200 million during 2022 to develop electric mobility in France. The investment objective is to have around 200 motorway service stations with EV charging points along with additional 100 stations in urban areas[23].

The focus on infrastructure also includes manufacturing of advanced battery storage systems. The rise in the production of EVs has boosted the demand for the EV batteries in the country and thus has presented attractive investment opportunities for the battery manufacturers. TotalEnergies has expanded its presence in the segment by setting up a 25MWh battery storage project in France in January 2021. In December 2021, the project was expanded further with launch of the largest battery-based energy storage facility located in Dunkirk. The facility has a power capacity of 61MW and a total storage capacity of 61MWh[24].

Outlook

During 2021, France announced the target of producing around 2 million electric and hybrid cars domestically by 2030[25]. Stringent emission regulations on one hand and incentives and subsidies for consumers and manufacturers on the other are among the key steps ensuring that the target is met. The government also aims to develop and expand the necessary charging infrastructure for the EV penetration during the same period.

The E bus penetration is expanding rapidly in the municipalities of France. City of Paris, being the front runner, has been rigorously investing in the E bus fleet, giving importance to lower emission standards. By end of November 2020, the city of Paris received its first electric coach for public transportation, while more buses are scheduled for 2023. Similarly, other municipalities are also in the process of receiving electric coaches[26].

In case of charging infrastructure, private charging seems to have a strong forte in the segment. In 2021, private charging demand, including home and parking lot, dominated the market, owing to the presence of large number of detached or semi-detached houses in the country. France will also be benefitted from availability of nation-wide manufacturer of EVs and charging infrastructure[27].

All things apart, consumer sentiment is the major driver of the market trend. Reliable charging infrastructure backed by a national installation strategy requires to address concerns around driving range. Also, standardization in terms of various components of the plug-in vehicle/charging infrastructure "ecosystem" to facilitate interoperability, cost-competitive infrastructure, and management of electricity demand would be vital.

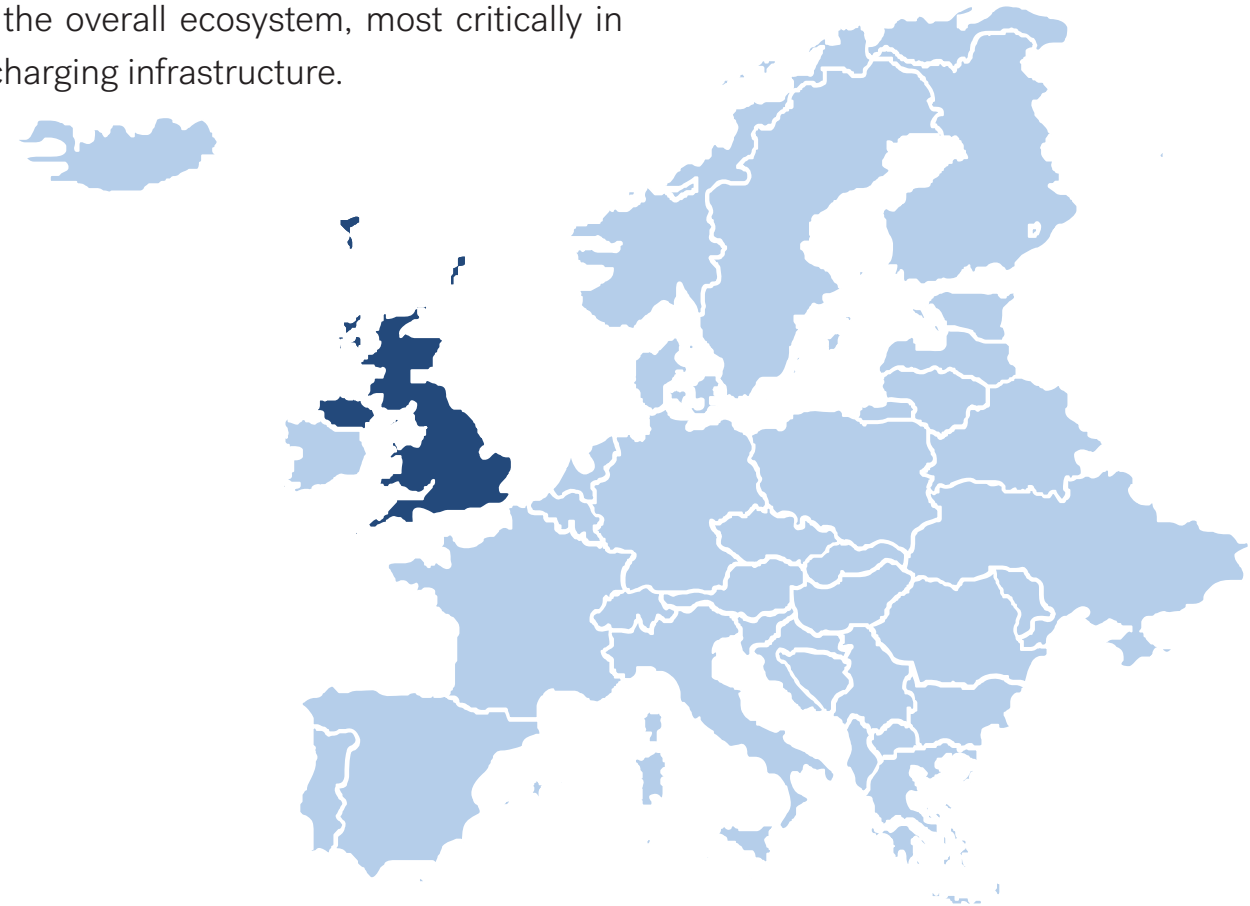
United Kingdom

The rapid rise in the UK's electric vehicle adoption puts it among the leading markets in the European region. The emphasis on sticking to the targeted phase-out of conventional vehicles by 2030 helped set the tone for the market which has been marked by new product launches and a spike in both passenger ad commercial electric vehicle sales. Funding support for this market gradually appears to be approaching a stage of tapering off as penetration rises. The next phase of growth will be defined by the channelisation of private investments, not only in vehicles but also the overall ecosystem, most critically in the charging infrastructure.

GDP (Current Prices) USD (2020)	2,709.68 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.37%
EV Penetration	18.6% of total new passenger vehicle registered (2021)
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2030

GDP Source: IMF, World Economic Outlook

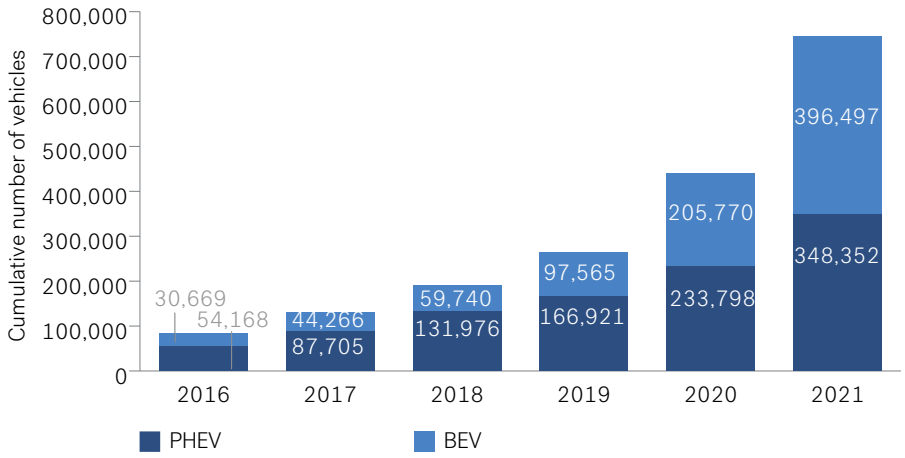
Note: The government's target refer to the phaseout of conventional vehicles and the setting up of a specific number of charging points for the electric vehicle transition.



United Kingdom

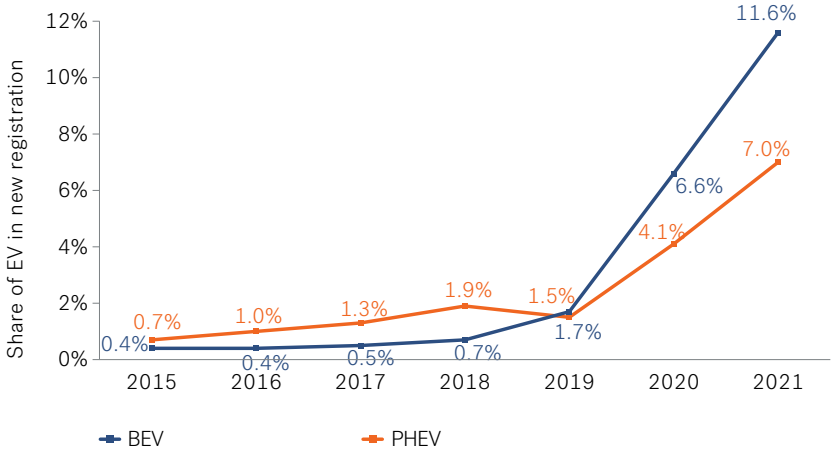
EV Penetration and Trend

Trend in Passenger Electric Vehicle Registrations



Source: Zap Map (attributed to SMMT, OLEV, DfT Statistics)

Trend in Share of Passenger EVs in Total New Vehicle Registration



Source: Zap Map (attributed to SMMT, OLEV, DfT Statistics)

The electric vehicles' segment is propelling growth in the UK's automotive market. The country's new car registration went up marginally by 1% in 2021 due to weak recovery from the pandemic and the persistent semiconductor chip shortage[1]. Yet, the year 2021 had more new battery electric vehicles (BEVs) registered than the previous five years combined (2016-2020) – 190,727 new BEVs joined the UK's roads (11.6% of total sales), while the plug-in hybrids made up 7% or 114,554 cars. Relative to the European region, the UK ranks among the top markets for PHEVs in terms of volume.

By the end of 2021, the passenger EV penetration[2] rose to 18.6%, led by BEVs. This has been the trend since 2020 when the market saw a reversal in relative share of BEVs against PHEVs. Incentives, new product launches, and improvement in charging infrastructure contributed to the rise in EV adoption. Yet much more could be needed for preparedness towards the policy goal of phasing out internal combustion engines by 2030.

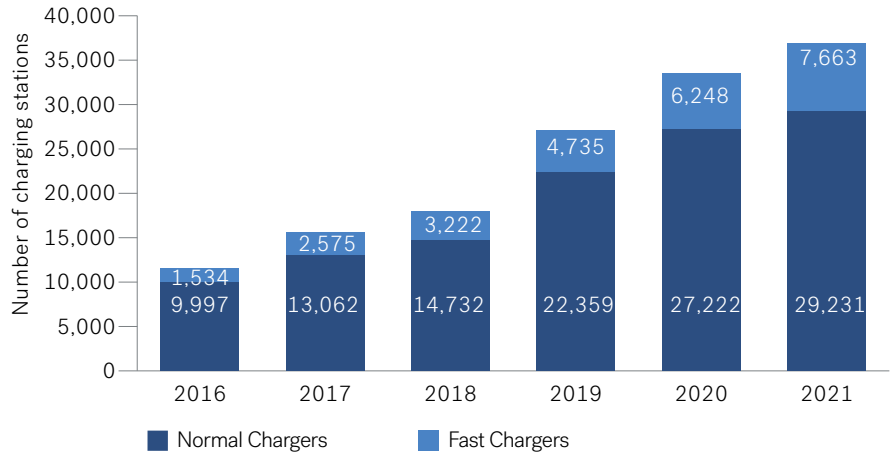
While the passenger vehicle segment leads the way in electrification, there is a gradually rising interest in commercial electric drivetrain[3]. This is observed in the registration for battery electric-based vans – share of such electric vehicles in total van registrations doubled to 3.6% over previous year, marked with a 142% spike. While the penetration is far behind that of the passenger vehicles, it is expected to rise faster in 2022 as conventional platforms continue to be hamstrung with component shortages and electric ones appear as a better proposition for commercial applications.

Since early 2021, the UK's electric bus segment has slowly gained traction. In March 2021, the UK government launched the Zero-Emission Buses Regional Area scheme (ZEBRA) to enable local transport authorities to roll out zero-emission buses[4]. Funding allocation of up to GBP120 million is being made available from 2021 to 2022 through the scheme, allowing local transport authorities to deliver up to 500 zero-emission buses, supporting the government's wider commitment to introduce 4,000 zero-emission buses.

Among the battery-electric micromobility options, e-scooters are among the most popular modes in the UK. There are over a million of them in operation[5] though they are legally restricted – except for the pilot testing phase underway, e-scooters in UK can be run only on private property. In practice, this has not been the case. There is a thus a regulatory gap in the e-scooter segment, even as overall sales and adoption rise exponentially.

Charging Infrastructure

Trend in Public Charging Infrastructure



Source: European Alternative Fuels Observatory

The UK has witnessed a significant increase in public EV charge points in the past few years. As per the European Alternative Fuels Observatory[6], between the end of 2016 and 2021, the UK's public charging infrastructure shows growth at a CAGR of 26.19%. The normal chargers (with a rated capacity of up to 22kW) hold the predominant share at 82% of the total installed capacity between 2016 to 2021. But there is rapid increase in the fast-charging points, growing at a CAGR of 37.95% in the same review period.

The rise in UK's electric vehicle penetration is a sharp contrast against a lagging and uneven charging infrastructure network. As per UK's Competition Authority's latest report (July 2021)[7], the country has an average 34 chargepoints per 100,000 people. At a regional level, this varies from 17 (Northern Ireland) to 80 (London). It further highlights the inadequacy of the network to face the emerging rise in electric vehicle traffic, in line with government objectives of decarbonisation.

Policy and Regulation

The UK government fixed 2030, as the targeted year from when sale of all new petrol and diesel cars and vans will be banned in the country[8]. This is the precursor to the next stage of mandating all new cars and vans to be zero-emission at tailpipe from 2035 onwards. This goal underpins most of the measures devised at promoting transport electrification in the country.

So far, the UK government has allocated GBP3.5 billion worth of funding to enable the transition to zero emission transport[9]. This includes recent investments like an additional £350 million to support the electrification of UK vehicles and their supply chains. Besides this, an additional GBP625 million was allocated (topping-up a GBP1 billion allocation) for infrastructure, especially towards the local on-street residential chargepoints.

The grant scheme for zero-emission vehicles was updated to optimise the funding with focussed targeting in adoption. Earlier, drivers could claim GBP2,500 towards the price of a new EV costing GBP35,000 or less. After the revision, the grants are available for up to GBP1,500 for cars priced under GBP32,000. Wheelchair-accessible electric vehicles continue to be eligible for the £2,500 grant and higher £35,000 price cap. For large vans subsidy support was rationalised from £6,000 to £5,000 while for small vans it was reduced from £3,000 to £2,500, with a limit of 1,000 grants per customer annually. For Motorcycles and Mopeds, the revised structure provides GBP500 for motorcycle and GBP150 for mopeds with a price cap of GBP10,000.

The Electric Vehicle Homecharge Scheme, which provided individual buyers of eligible EVs to receive a grant for up to 75% of the total purchase and installation costs of one EV charger for their home, stands discontinued from April 2022. It will however be open for homeowners residing in flats as well as those in rental accommodation[10].

There are other fiscal incentives available for the electric vehicles. Pure electric vehicles are eligible for zero Vehicle Excise Duty, including an exemption from the premium rate[11]. Furthermore, since 2020, company car tax for pure-electric models has been lowered[12], from 16% to 0% for FY 2020-21, then 1% for FY 2021-22. It is now rated at 2% for FY 2022-23.

Additional policy support measures include the green number plate scheme for preferential treatment as in terms of free parking, using bus lanes, and accessing areas cut-off from conventional vehicles. Separately, there are incentives from the regional government authorities. The Scottish government offers an interest-free, six-year loan of up to GBP35,000 to switch to a new electric/hybrid vehicle. In Northern Ireland, grants of up to GBP5,000 and GBP3,800 are available for private and commercial electric vehicles respectively. For London-based drivers, BEVs and PHEVs are exempt from Congestion Charge Scheme till 2025. Local authorities could also avail of the On-Street Residential Chargepoint Scheme (ORCS) that reimburses three-quarters of the total capital costs incurred in procurement and installation of the on-street chargepoints in residential zones[13].

Market Opportunity

The UK government's targeted phase out of internal combustion engines from 2030 and the resulting electrification of transportation imposes huge investment requirements for augmenting the charging infrastructure. As per Deloitte's analysis, investments ranging between GBP8 billion and GBP18 billion will be required for the period 2020-2030 for scaling up the number of chargepoints in the country[14].

At policy level, there is a rapid charging fund to help motorway and major road service area operators prepare the network for emerging electric vehicle-based traffic. It is a GBP950 million fund that works along with a GBP90 million fund, both put forth in November 2020, for larger-scale local charging projects. Importantly, the government's National Infrastructure Strategy (as per which the charging infrastructure funding was budgeted) clarifies that the private sector is expected the deliver the chargepoints where commercially viable, while public sector role will be only in cases where there is market failure[15].

The role of private sector investments in UK's charging infrastructure market is a clear one. Some of the recent examples indicate varied levels of interest in tapping into this market. In November 2021, the infrastructure company Connected Kerb announced a GBP1.9 billion investment plan to add 190,000 on-street chargers in the UK[16]. In September 2021, the UK-based company Osprey Charging announced a GBP75 million investment plan for setting up 150 charging hubs at 150-175kW rating in the UK[17]. Notably, this initiative is slated to involve Kempower technology, which the company claimed to be the first one considering it in the country.

In May 2021, the country's energy regulator approved GBP300 million worth of funding by energy network companies to install 1,800 ultra-rapid chargepoints for motorway service stations and a further 1,750 chargepoints in the towns and cities[18]. A point of emphasis, from policy perspective, is the apparent lack of competition in the charging infrastructure service. For instance, one entity – The Electric Highway Company, has had exclusive rights to operate chargers at UK's motorway services since 2012, but has been unable to bring forth new investments. The Hitachi-backed GridServe bought the Electric Highway network in 2021 and plans to install 30 high-speed charging hubs in 2022[19].

UK is also attracting investor interest in the manufacturing space, as various entities seek to make the most of the emerging demand. As per the news reports, there are discussions underway for setting up about six Gigafactories in the country for localized battery supply. Ford, Nissan, LG, Samsung and startup entities Britishvolt and InoBat are some of the key enterprises involved in such consideration[20]. Similar investment interest is also visible in the manufacturing space of vehicles – Bentley Motors in January 2022 announced a GBP2.5 billion 10-year investment plan towards becoming a luxury electric vehicle brand. The planned investment includes research and development and upgrades to its manufacturing campus at Crewe, England[21].

Outlook

UK's energy regulatory authority's survey in May 2021 indicated that over 6.5 million households planned to buy an electric vehicle over the next five years. Proportionally, this is about a quarter of the total households in the energy network[22]. Regardless of the exact absolute numbers of vehicle units, there is an imminent jump in such transport as the 2030 timeline approaches.

In supporting the projected growth, UK's supporting infrastructure for charging appears way behind the schedule. While funding allocations are being made, the progress has been slow. Investor interest has also been impacted by the tedious procedures that delay the process. The competition authority's report has already flagged concerns in this regard of a lopsided development of charging network. It will thus be a major factor to track for investors as well as prospective customers – the latter particularly could be tempted to postpone such purchases if charging appears as a challenging part.

Spain

Electrification of transport is picking up pace in Spain, as reflected in the growing EV penetration in the country. With an aim of minimizing use of fossil fuels by 2040, the country is scaling up its investment programs along with subsidies to boost EV market. Being Europe's second largest auto manufacturer, the country is competing with Germany and France to overhaul the supply chains and retool its manufacturing bases to be relevant to global auto industry's tectonic shift towards electric vehicles and greater technological integration.

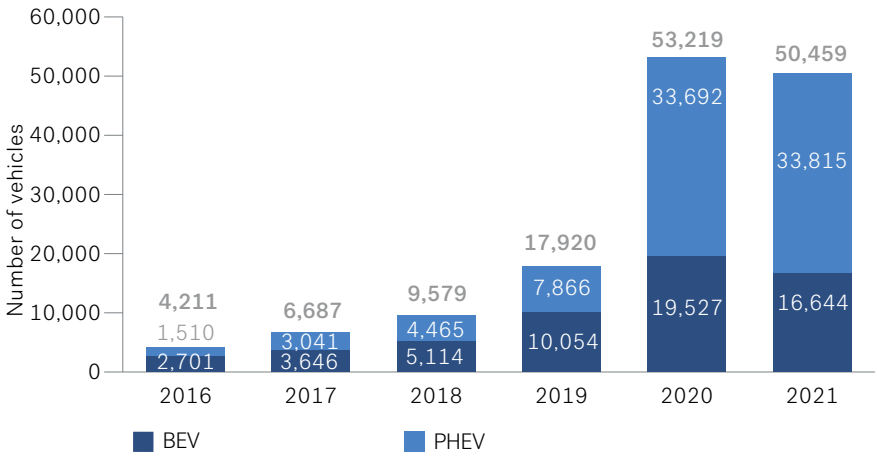
GDP (Current Prices) USD (2020)	1,280.46 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.66%
EV Penetration	EV sales growth at CAGR of 64% during 2016-21
EV Target	5 million EVs by 2030
Planned Year of Phasing Out ICE Vehicles	2040

GDP Source: IMF, World Economic Outlook

Spain

EV Penetration and Trend

Trend in Passenger EV Sales[1]



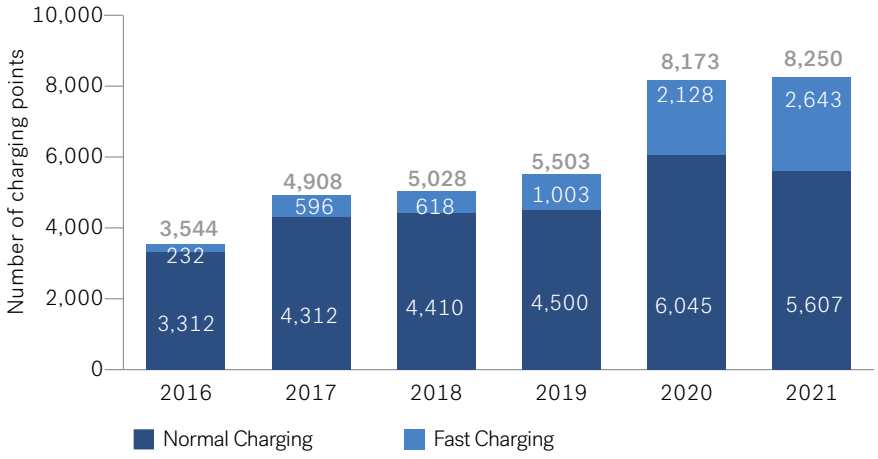
Source: BNEF

In 2020, EV registrations in Spain recorded an upward trend[1], despite COVID-19 led sluggish industrial expansion. Registration of new electric vehicles spiked immensely in 2020 with growth in EV investment on national level under MOVES II[3] subsidy plan as per vehicle manufacturers' association Anfac[2]. The consecutive subsidy plan, Moves III, established in H1 2021 strengthened the sales by extending EV incentives in the country.

During 2016-21, EV sales in Spain increased at CAGR of 64%. Annually in 2020, the EV sales saw three-fold rise, however, in 2021 the sales dipped by 5%. Since 2020, PHEV has dominated sales and the trend continued in 2021, with PHEV's share grew to 67% in 2021 from 63% in 2020.

Charging Infrastructure

Trend in Public Charging Infrastructure[4]



Source: European Alternative Fuels Observatory (EAFO)

EV charging point infrastructure in Spain recorded growth with CAGR of 18% during 2016-2021. Fast chargers grew rapidly during the same period, compared to normal chargers, with the former recording more than two-fold jump annually in 2019 and expanding further in 2020 at proportionate rate. In 2021, fast chargers recorded annual growth of 24%, while normal chargers registered decrease by 7%.

Policy and Regulation

Since Spain has set the goal of prohibiting the sale of fossil fuel vehicles by 2040[5], investments along with subsidies and incentives are being injected in the economy. The government introduced subsidies programs; Moves I (2019), Moves II (2020) and Moves III (2021) providing grants to the EV owners, thereby encouraging the demand. Moves I had budget of EUR45 million[6] while Moves II had budget of EUR100 million, which was later increased to EUR120 million[7].

In April 2021, Spain introduced Moves III[8] subsidy program with initial budget of EUR400 million, which can be increased to EUR800 million in case needed, covering the period till end of 2023. The program aims to have active fleet of minimum 250,000 EVs along with around 100,000 charging points in the country by the end of 2023. Under this program, the BEVs and PHEVs, with price under EUR45,000, are eligible for the subsidy of up to EUR7,000 when scrapped and EUR4,500 for unscraped EVs. Additionally electric two wheelers are eligible for subsidy of up to EUR1,300 on prices below EUR10,000. The subsidy scheme also includes electric vans, which are eligible for a subsidy of up to EUR9,000 with prerequisite of scrapping old vehicle to access the full incentive[9].

Additionally, Moves III provides specific incentives to companies using EVs[10]. For small and medium-sized enterprises (SMEs), a grant of up to EUR1,700 is offered on EVs with electric range between 30km – 90km; while, for the EVs with range beyond 90km, the grant amount can be increased to EUR2,900. For large companies, the grant amount is EUR1,600 for EVs with electric range between 30km – 90km, while EUR2,200 is availed on EVs with range above 90km.

The tax benefits offered in the country involve complete exclusion of BEVs from car registration tax bracket[11]. In case of ownership tax, local administrations have their own set of policies. For instance, city councils, including Madrid and Barcelona, have reduced the annual circulation tax (ownership tax) for EVs and fuel-efficient vehicles by up to 75% in 2021.

The subsidy program also includes grants for charging infrastructure. The grant, covering 30% - 40% of the purchasing and installation costs of public charging stations is available to companies and public entities[12].

Market Opportunity

In 2020, Spain successfully implemented the long-awaited climate law which commits the country to cut emissions 23% by 2030, compared with 1990 levels, which is significantly lower than goals set by other major European emitters. The law also enshrines a goal to generate 74% of the country's electricity with renewable sources by 2030 and reach emission neutrality no later than 2050[13]. Being a late entrant on the Decarbonisation pathway, Spain would have to make a "huge effort" to catch up with its neighbours. Automotive sector has the most significant role to play in this regard as Spain continued to be heavily dependent on fossil fuels. Thus, the Spanish government is injecting as well as encouraging investments in EV segment and related infrastructure with the objective to have 5 million electric vehicles on road by 2030[14].

In July 2021, the Spanish government launched its first 'Strategic Project for Economic Recovery and Transformation (PERTE)[16] under the umbrella of 'Recovery, Transformation and Resilience Plan' (PRTR)[15] of Ministry of Industry, Trade, and Tourism, which aims to create the necessary ecosystem in the country for development and manufacturing of electric vehicles and associated infrastructure. The plan was approved by the European Commission in December 2021[17], which envisaged to attract investment of EUR24 billion over the period of 2021-23 through public private partnership, of which EUR4.3 billion are committed by Spanish government while remaining are to be injected by private sector. The first tranche of the government investment is part of EUR13 billion package earmarked for sustainable mobility. The objective is to use part of EUR70 billion of European Union pandemic relief funds allocated to Spain.

Electrification of public transport system is gaining momentum in Spain as cities and town are investing in E bus fleet. The transforming cities include Zaragoza, which aims to replace its current bus fleet with E buses by 2023-2024, thus marching towards its objective of emission neutrality by 2030[18]. A Polish public transport vehicle producer, Solaris, is one of the major players in E bus segment in Spain[19]. The company has an active fleet of around 300 E buses in the country and it continues to receive E bus contracts from Spanish municipalities, such as Martorell, Catalonia, Basque Country with estimated delivery by end 2022.

Growing investments towards EV production is calling for equally rigorous deployment of EV charging infrastructure. The need of the time has attracted not only government funding but also investment from international agencies such as EU. In January 2021, the EU bank announced its investment plan of EUR50 million to set up around 470 fast and ultra-fast charging stations in Spain, along the motorways by end of 2022[20]. Regional efforts can also be seen to develop mega charging infrastructure. Underpinned with stimulus funding, Iberdrola, a Spanish multinational electric utility, has expressed interest in installing mega charger infrastructure in heavy-duty freight truck corridors in Spain by 2025[21].

The Spanish government as well injected EUR525 million in terms of various fiscal measures by end of 2021, focusing on developing charging infrastructure under the PRTR plan[22]. The investment is expected to support the aim of having more than 100,000 charging points by 2023.

The country has also taken steps to develop necessary battery storage facility. In February 2021, the government established battery storage strategy with an objective to have storage capacity increased from 8.3GW currently to 20GW by 2030 and expanding further to 30GW by 2050. The strategy seeks to deploy 400MW of behind-the-meter battery storage by 2030, considering the potential for batteries in self-consumption systems for homes and businesses[23].

Outlook

Spain is progressing towards its goal of emission neutrality by 2050, which is dividing it into decade wise phases. The holistic PRTR plan under which the government has started phase wise electrification by implementing PERTE plan, is expected to bring overall development.

The PETRE plan is anticipated to pave the way for investments in R&D along with eco-friendly measures in the supply chain for electric and connected vehicles. Boosting the economic expansion of Spanish, the plan will give the required tailwind to investment inflow while achieving net zero goal. The plan is projected to create more than 140,000 job in the economy and uplift EV sector's share in GDP from 10% in 2021 to 15% by 2030.

Micro mobility market in Spain is slowly expanding. In January 2021, Spain legalised E scooters, subject to speed limit at 25km/h and prohibited use in tunnels, on pavements and or motorways[24]. The Spanish government, to encourage safe micro mobility, made significant additions to the road safety laws, that are to be implemented from 2022. These regulations are in a way encouraging safe but increased use of E scooters, however, their impact is yet to be seen.

The Spanish National Integrated Energy and Climate Plan ("PNIEC")[25] estimates EV to reach a price parity compared to conventional vehicles in 2025, thus from 2025 onwards there won't be any need to provide public funding for EVs.

Italy

Despite being a slow starter, Italy's position in the global EV market is strengthening, as reflected in growing EV penetration. By end-2021, passenger EV sales in the country surged significantly, attributing to the incentives and tax benefit offered by the government. To sustain the rise, improvements in charging infrastructure were facilitated by positive investments outlook. There is a renewed focus in EVs, as policymakers seek to tap into this industry to meet the larger objectives in emission norms as well as electrification of the transportation network.

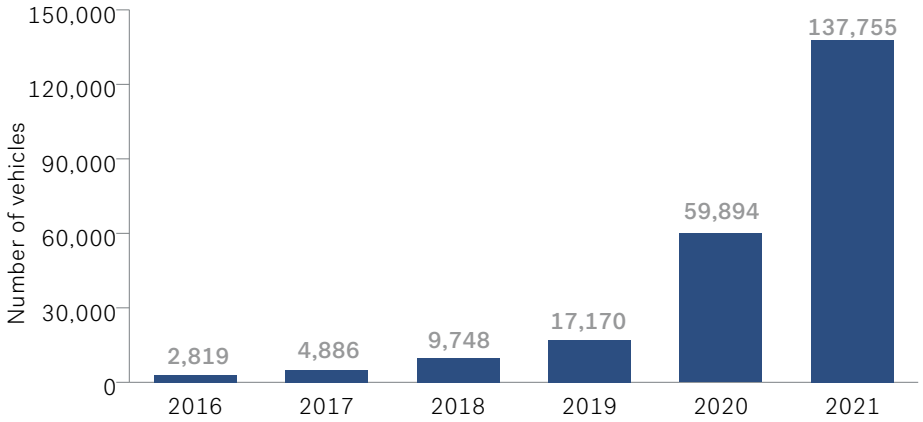
GDP (Current Prices) USD (2020)	1,884.94 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.73%
EV Penetration	15.3% of total passenger vehicle sales (2021)
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2035

GDP Source: IMF, World Economic Outlook

Italy

EV Penetration and Trend

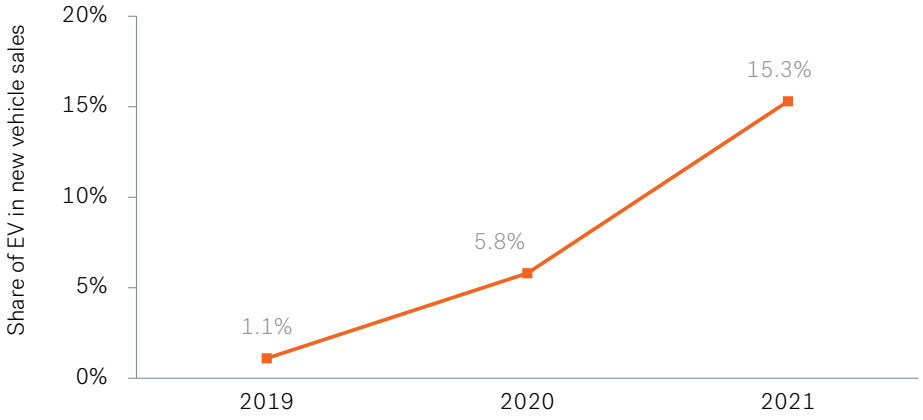
Trend in Passenger EV Registrations[1]



Source: European Automobile Manufacturers Association

Since 2018, EV penetration in Italy gained momentum with more than two-fold rise in the number of EV registrations being observed. Over the period of 2018-2021, the EV registration in the country recorded increase at a CAGR of 140%, while annually it grew by 130% in 2021. The upward trend is attributed to the strengthened policy support as well as incentives offered by the government.

Trend in EV Share in Total Passenger Vehicle sales[1]



Source: European Automobile Manufacturers Association

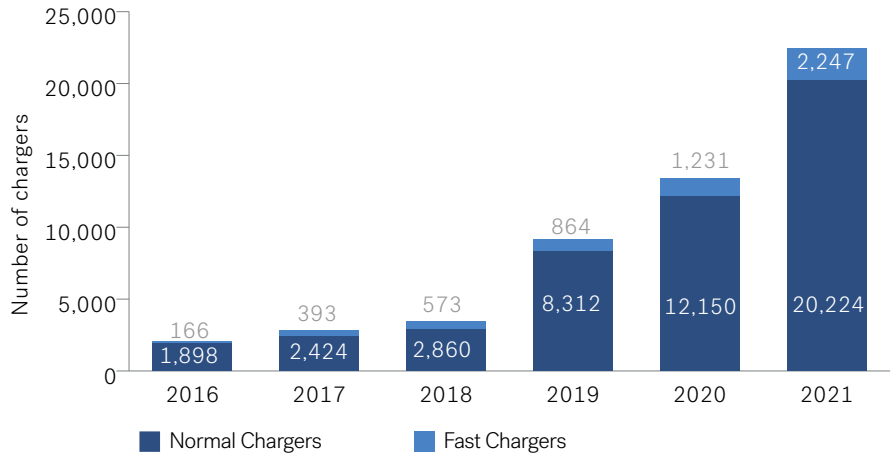
Based on the vehicle registration data reported by the European Automobile Manufacturers Association, passenger EV penetration in Italy continued to expand in 2021. Both BEV and PHEV registrations experienced sharp increase, while latter recorded the stronger upward movement. On the other hand, a general decline in the conventional engine[1] based passenger vehicles took place in the country.

As showcased in the data, the share of EVs in new vehicle registration in Italy grew steeply over the period of 2019-2021. In 2020, more than threefold rise in registrations was recorded, which strengthened in 2021. Annually in 2021, the registrations grew twice the 2020 number, while share in total new vehicle registration highlighted sharp expansion.

Micro mobility options such as E scooters grew significantly during the pandemic phase as the conventional public transportation option went out of bounds. Various mobility companies are investing and launching newest E scooter models across more than 30 cities and towns of the country. Italy has the second largest rental E scooter market in Europe, behind Germany. As of July 2021, there are 40,000 shared e-scooters available for hire on the streets of Italy.[2]

Charging Infrastructure

Trend in Public Charging Infrastructure



Source: European Alternative Fuels Observatory (EAFO)

According to the data provided by European Alternative Fuels Observatory[3], during 2016-2021, public charging infrastructure in Italy grew at a CAGR of 60%. Of the whole infrastructure, 90% of the charging infrastructure is of normal speed with rating capacity up to 22kW, while remaining 10% is fast charging facility with capacity greater than 22kW.

The normal charging infrastructure expanded at CAGR of 61% during 2016-2021; while that of fast charging grew at CAGR of 68% during the same period. However, in 2021 fast charging infrastructure experienced steeper upward trend compared to normal charging infrastructure, recording annual growth rate of 83% and 66% respectively.

Italy's existing Lithium-Ion battery-based storage capacity is aligned to its renewable energy generation plants. As of October 2021, battery storage capacity in the country reached 252MW from 190MW recorded in December 2020[4], thereby indicating the rigorous investment deployment, most of which was installed in Lombardy region. However, a wider scale of investment in battery storage is still awaited in the country. EV-based capacities are yet to be onstream, even as there are competing demands on battery-based storage systems.

Policy and Regulation

Italy has opted for subsidies, incentives, and tax benefits along with investments to encourage EV usage in the country. One of such examples is Eco-Bonus programme started in 2019, that involved allocation of EUR70 million for disbursement of subsidies towards EVs and charging infrastructure in 2020 and 2021. This programme is part of the policy goal of achieving zero net emissions by 2050, and to ensure EVs replacing the internal combustion engines (ICE) by 2035 or earlier.

By end of 2021, Italian government added EUR100 million to the subsidy budget for EVs[5], subjected to emission standards. Around EUR65 million were allocated to the vehicles for purchase and leasing with CO2 emissions between 0-60 g/km. Currently subsidy for the vehicles with emission between 0 and 20 g/km is available at EUR6,000 if scrapped, while EUR4,000 is available for vehicles without scrapping. Similarly, vehicles with emission range of 21-60 g/km CO2 are subsidised at EUR2,500 (scrapped) and EUR1,500 (without scrapped).

Along with subsidies, Italian government also provides tax benefits for EV users. From date of registration, BEVs and PHEVs both are exempted from ownership tax for five years. Once the period is covered, the EVs can avail a 75% reduction of the equivalent tax rate of most of the petrol vehicles[6]. In case of company cars with emission less than 60 g/km CO2, 25% tax discount can be availed. Additionally, there is 'eco tax' for the ICE-based vehicles registered between March 2019 and December 2021.

Government also has extended support towards EV charging infrastructure. The tax reduction of up to 50% is available for individuals, companies, and condominiums on the purchase and installation cost of EV chargers. With a validity period till December 2021, the subsidy disbursement was capped for each at EUR3,000 and was available for charging structures with rating capacity up to 22kW. Under a separate government decree, a higher tax deduction of up to 110% is available. This, however, is relevant for the EV charging facility with rating capacity ranging 3.7kW – 22kW.

E scooters are gaining popularity in the country; however, specific rules were clarified for e-scooters in early 2020[7]. These include minimum age requirement of 14 years for riders[8], specific speed limits for road and pedestrian areas etc. Owing to the surge in accidents, the government is planning to regulate this vehicle segment and enforce more stingent norms. To be sure there are incentives available as well for this segment – a EUR500 worth of reimbursement was made available during the aftermath of pandemic towards purchase of micro mobility modes such as E bikes, and E scooters.

Market Opportunity

The demand for E bus in the country is growing, thereby encouraging investments in the segment. Considering the market trend along with clean energy goal, Italy aims to increase share of E bus in the public transportation from approximately 5% as of 2021 to more than 20% in coming years and beyond 30% by 2030[9]. In early 2020, BYD secured contract to deliver 100 E buses in Turin city with budget of EUR72 million. From May 2021, the company delivered four E buses which were part of 1st 50 E buses in Turin city[10]. City of Bologna also initiated E bus activity as showcased by the public transport operator TPER ordering seven E buses from VDL Bus & Coach. The delivery is expected in 2022, and the order can possibly be extended to 20 E buses[11]. In October 2021, Poland's Solaris won AMT contract to deliver 30 E buses in Genoa. The contract is valued at EUR15 million with expected delivery period to be Q1 2022[12].

Growing demand for E scooters in Italy has encouraged micro mobility leaders to enter the market. US based micro mobility player, Helbiz, in collaboration with Telepass, launched 300 E scooters in the city and surrounding areas of Reggio Emilia region in H2 2021[13]. Continuing with the trend, in January 2022, Helbiz announced its partnership with Vmoto Soco seeking expansion in the country. The joint venture plans to deploy 2,000 electric mopeds across Italian cities[14].

Private investments are picking up in the space of EV charging as demand is expected to outstrip the existing supply. In July 2021, Enel X and Volkswagen entered a partnership to expand the EV charging infrastructure in Italy. Over the period of 2021-2025, the combined entity will install, and maintain around 3,000 high power charging stations at 700 locations in the country[15].

Autostrade per l'Italia, Italy's key toll-motorway operator managing over 3,000 km of the country's motorway network, is in the process of undertaking investments to equip all its fuelling stations with fast-charging points. Beginning with the first phase, it aims to develop 300+ kW fast-charging stations (each with 4-6 charging points) at 67 fuelling stations which were identified and agreed upon with the Ministry of Transport. It is expected that by the end of the entire process, the company may be able to establish the most extensive EV charging network in Italy[16].

Outlook

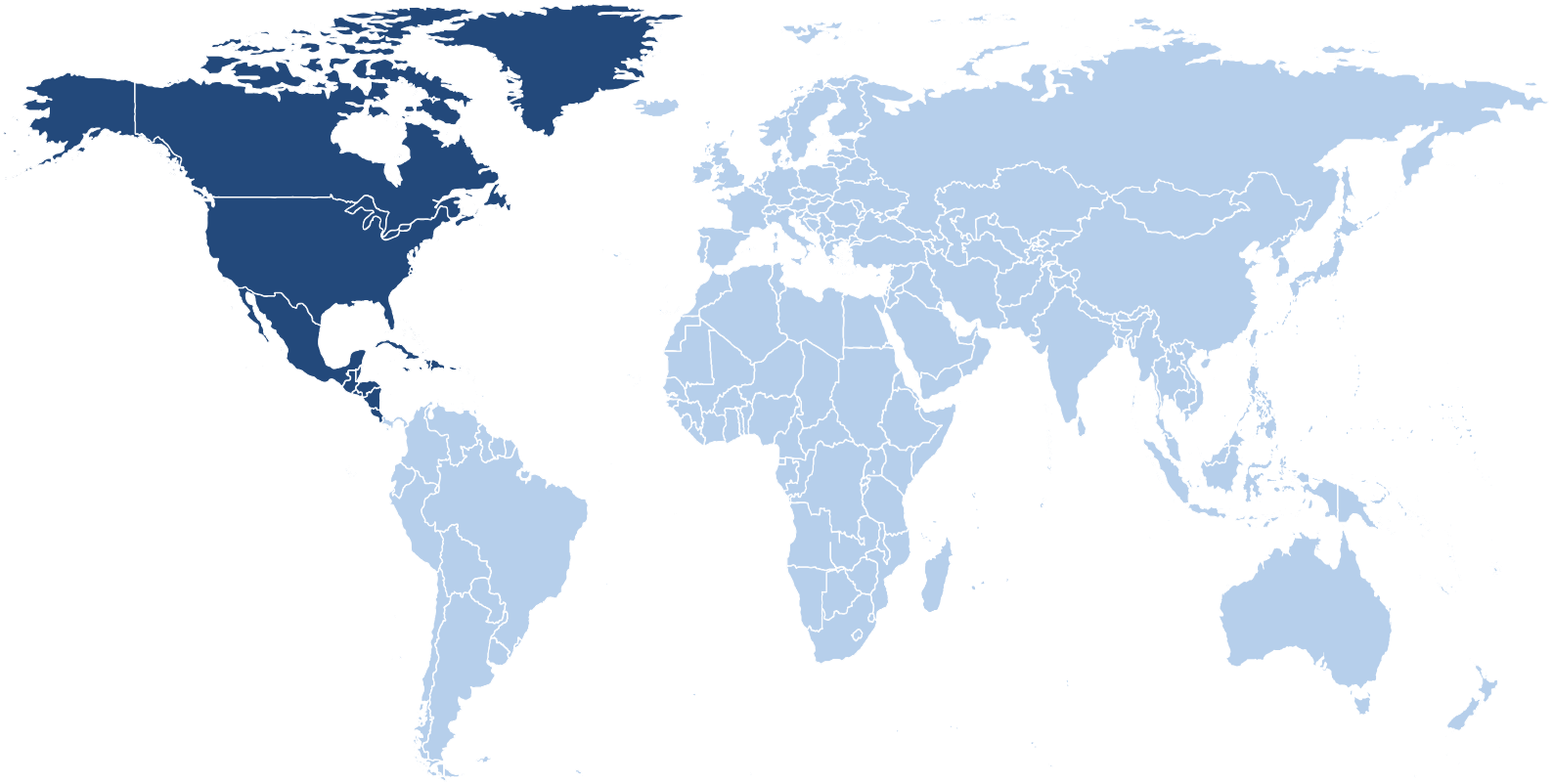
The government support along with fresh capital injection are maintaining the electrification momentum in Italy. By end of 2021, exhaustion of EV funds affected the sales negatively in the country[17]. However, government continued to invest in the necessary infrastructure, thereby boosting demand.

By end of 2021, Italy announced its plan to ban ICE cars by 2035 and light commercial vehicles with combustion engines by 2040[19]. The announcement will pave the way for rapid EV penetration. The plan, however, has its downside of possibly leading to job contraction in the automobile sector. The threat of unemployment is expected to hit the Italian economy harder due to strong presence of SMEs in the country which, without government's aid, will not be able to sustain their businesses. Thus, strong investment injections along with incentives are needed to safeguard jobs against transformation[20].

In January 2022, the government made an announcement of deploying aid of around EUR1 billion every year for next three years to finance incentives, encouraging purchase of low polluting cars and conversion of existing facilities to manufacture EVs[18]. The aid also involves supporting the battery plant in southern Italy planned by Stellantis.

The scope of the electrification is widening, which calls for more policy and regulatory steps to be implemented. One key focus area in this regard will be to develop regulatory standards for the EV charging infrastructure, based on which interoperable systems could be developed across the country. Among other things, harmonised standards will enable innovations such as RFID-based charging of EVs. Similar other innovations and developments, such as in smart charging will require enabling regulations for the investors.

Key Regional Markets - North America



Countries Covered

1. United States
2. Canada
3. Mexico

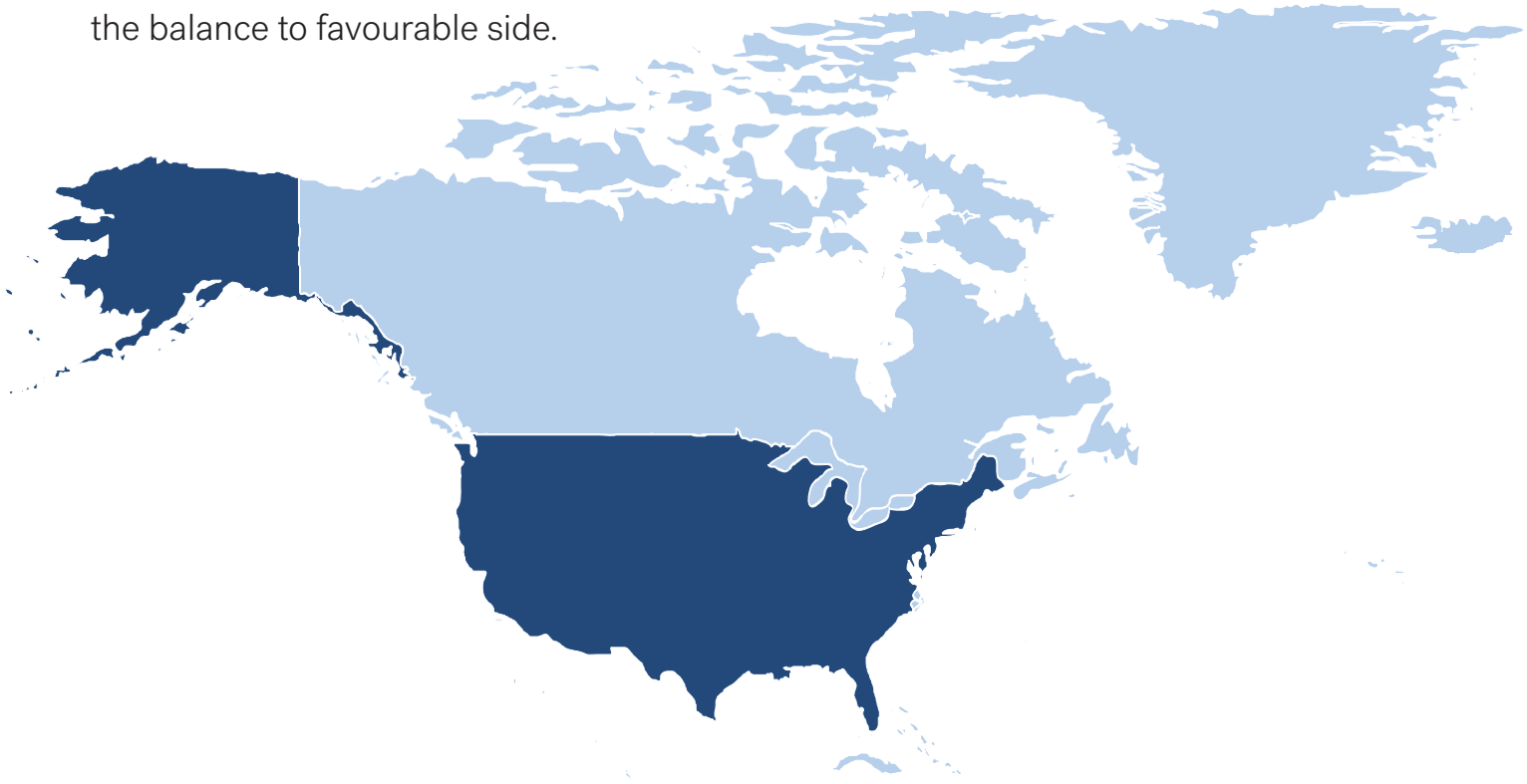
United States

The US electric vehicles' market has been slow to take advantage of the momentum picked up elsewhere globally. The recent major policy announcements such as those of infrastructure spending indicate steps at recovering the lost ground in both investment commitments as well as infrastructure construction. The country's economic heft ensures significantly high and sustained investor interest, as the planned investments by automakers indicate. An incentivized policy framework, some of which is already seen among the leading US states, could help tip the balance to favourable side.

GDP (Current Prices) USD (2020)	20,893.75 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.35%
EV Penetration	3.5% of total passenger vehicle sold (2021)
EV Target	No federal targets determined. All of such goals are at state-level
Planned Year of Phasing Out ICE Vehicles	-

GDP Source: IMF, World Economic Outlook

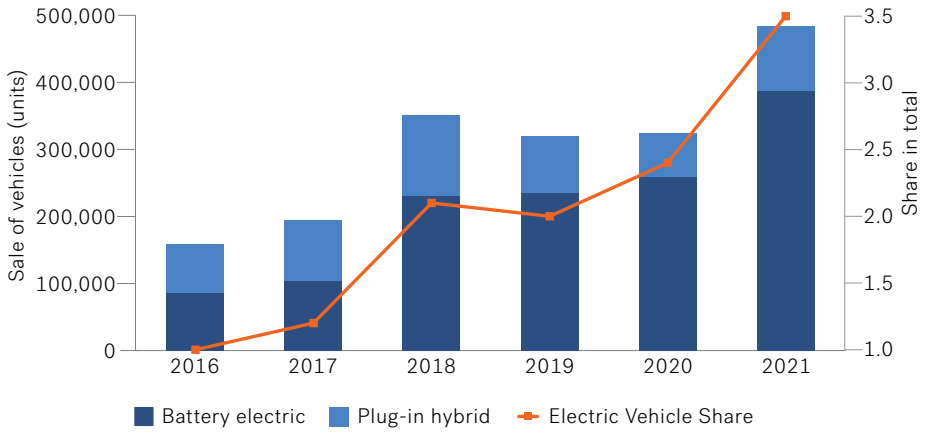
Note: US states have separately announced ICE phaseout roadmaps.



United States

EV Penetration and Trend

Trend in Passenger Electric Vehicle Sale and Penetration

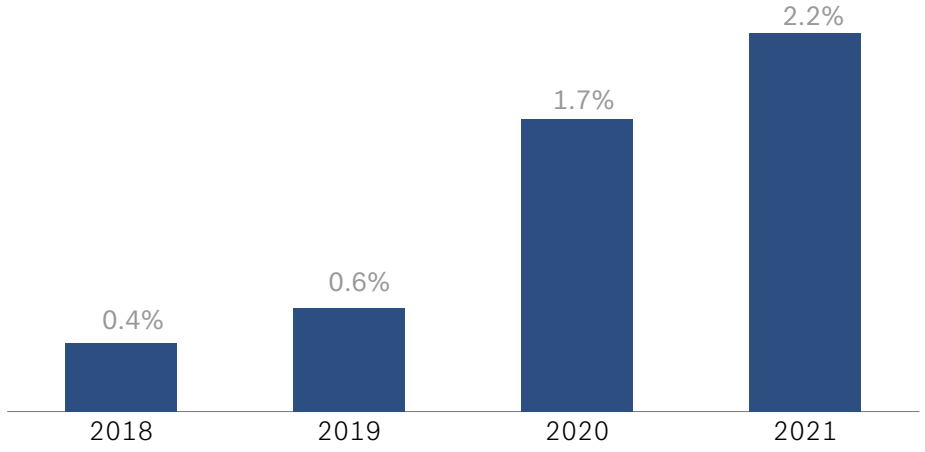


Note: Data for 2021 estimated

Source: BNEF Long-Term Electric Vehicle Outlook 2021

The US market's electric vehicle adoption lags far behind the levels in comparable mature and prosperous countries such as in Europe. The share of electric drivetrain (including both battery and plug-in hybrids) in passenger vehicle segment reached an estimated 3.5% in 2021 compared to 2% in 2019. The battery electric vehicles show a higher offtake in the trend during 2016-2021, registering a CAGR 35.3%. In case of plug-in hybrids, CAGR was 5.8% for the same review period. Reflecting the global automotive market experience, the US market trend shows a decline in the sale of conventional vehicles in the same period.

Trend in Electric Bus Penetration (share of sales)



Note: Data for 2021 estimated

Source: BNEF Long-Term Electric Vehicle Outlook 2021

In the US, electric vehicle adoption has been an uneven one. The state of California for instance shows a significantly higher penetration of electric vehicles, driven by active policy support and investments. At federal level however, there is no unified structure of policy incentives that reflects in the overall progress.

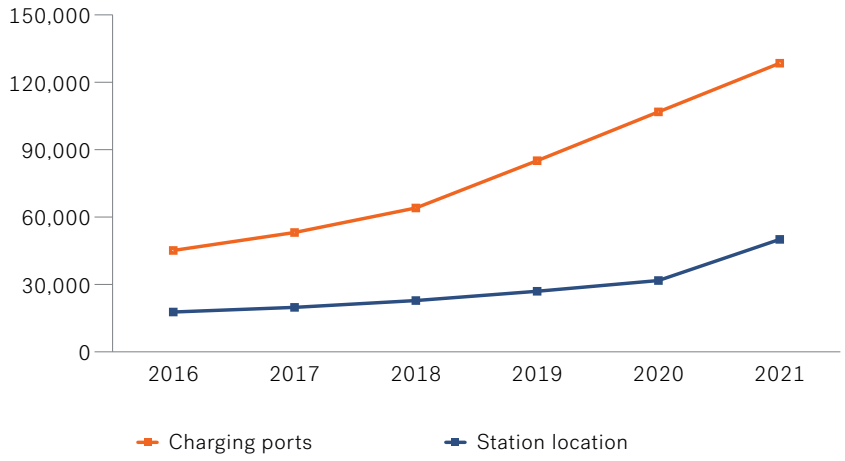
Electric buses show the similar level of trend – led by municipal level policy support in fleet transition of the public transport network. In comparison to several other markets, electric bus market opportunity is largely untapped.

Some of the recent developments do however indicate an anticipated pick-up in key segments such as the school buses.

Shared/micromobility transport is another important segment in the US market that shows rising demand. Dockless bikeshare and e-scooter systems' coverage has grown rapidly since introduction in 2017. As per US Bureau of Transportation Statistics[2], there were 36 dockless bikeshare systems and 248 e-scooter systems by the end-August 2021. While pandemic led to a temporary disruption in shared mobility, the micromobility modes such as e-scooters continue to rise in demand.

Charging Infrastructure

Trend in Number of Charging Ports and Station Locations



Source: Alternative Fuels Data Center

The trend in charging infrastructure[3], in terms of the number of connectors and station locations, while showing an upward trend, lags considerably behind the requirement. The number of charging stations in particular shows a largely stagnant growth till 2020 – suggesting a skewed growth in the total number of connectors. California for instance accounts for about a third of the total public charging stations[4]. In Washington D.C, the estimate is that there is one charging station available for every 487 privately-owned cars and trucks. The comparable national average is one for every 2,570 vehicles.

The country's electric vehicle battery manufacturing capacity is at about 44GWh[5], led predominantly by the Panasonic-Tesla Gigafactory of 37GWh annual capacity. There is however, a substantial pipeline of upcoming battery manufacturing capacities to cater to automakers' demand for localization and supply chain diversification.

Policy and Regulation

US State Governments' Phase-out Targets for Conventional Vehicles

State	Targeted year
Los Angeles	2030
Seattle	2030
California	2035
Massachusetts	2035
New York	2035
Hawaii	2045
Connecticut	2050
Maryland	2050
Oregon	2050
Rhode Island	2050
San Antonio	2050
Vermont	2050

Source: BNEF Zero-Emission Vehicles Factbook

At the federal level, the US government's fuel economy norms[6], laid out under the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule, does incentivize the case for electric vehicle adoption. But it is not a very strong one, in the sense that to comply with the rules of this policy, just 5% of electric penetration will be sufficient. The current US administration has proposed a revised policy framework, which can raise the bar for compliance and thus set a higher penetration requirement.

Notably, at a national-level, US does not have a target timeline to phase-out internal combustion engine vehicles. Instead, such targets have been put forth by the state-level government authorities. Together these states account for roughly a quarter of the country's total vehicle sales (BNEF, 2020).

In terms of incentives for electric vehicle, at federal level, there is an income tax credit of up to USD7,500 available for eligible owners of the battery electric and plug-in hybrid new vehicles purchased since 2010[7]. Unlike the European countries however, there are no upfront purchase subsidies offered at the national level. This makes for a stark difference in policy support available in the US market. It should also be noted that the government plans a higher income tax credit of USD12,500 for the indigenously manufactured electric vehicles. But this is stalled for now, as it met with significant resistance from the regional trade agreement partners and is likely to be resolved through international arbitration.

At the state-level, the scenario of policy and regulation is markedly different than that of federal government. About 45 states and the District of Columbia offer an incentive for the electric vehicles, through a utility in that state or through legislation. Incentives include tax credits, rebates to fleet acquisition targets, exemptions from emission testing and utility time-of-use rate reductions[8]. Colorado had a USD4,000 tax credit through 2021 for light-duty electric vehicles. At Connecticut, the biennial registration fee was reduced to USD38 for the electric vehicles.

Most important has been the lead taken by California, where the state's policy has moved to the next stage of promoting electric vehicle adoption through performance targets. California has low-emission and zero-emission vehicle emission standards that require manufacturers to sell a minimum specified number of vehicle units to comply with such regulations. Till August 2021, 13 states adopted California's regulatory standards. These include – California, Colorado, Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island, Virginia, Vermont, and Washington.

Furthermore, there are 28 states that have laws in place for a special registration fee for battery electric vehicles, while 14 states have a fee specific to the plug-in hybrids. The fees range from annual USD50 (Colorado and Hawaii) to USD212.78 (Georgia). A few other states have differential fees depending on criteria of weight, etc.

Market Opportunity

An important market impetus for private investments is the funding from US government's infrastructure bill[9]. In February 2022, the government's plans in this regard indicated about USD5 billion worth of funding over next five years to build up the electric vehicle charging infrastructure. About USD600 million in funds will be available within 2022 based on the plans submitted by the states. Federal funds, in this scheme, will cover 80% of the electric vehicle charging costs while private or state funds bear the rest of it.

To attract automotive manufacturers' investments, a host of incentives are in line from various states and municipal authorities[10]. Reportedly, various governments approved incentives worth USD2 billion in 2021 to make a strong case for construction of electric vehicle and battery manufacturing plants. Among other reasons such a development is also notable since a similar subsidy/grant allocation of federal government continues to be stalled.

In December 2021, Michigan authorities approved a USD1.5 billion allocation for promoting the electric vehicle production in the state. Subsequently, in February 2022, General Motors announced its plans to invest about USD7 billion in the state. The company stands to receive USD824 million in incentives for the proposed project. Earlier, Ford announced its plans to invest USD11 billion in Tennessee and Kentucky. It received USD1.3 billion in incentives for the manufacturing projects. Another such entity is the start-up electric truck company Rivian which could receive USD400 million in incentives from Georgia for the plant to be set up.

Localisation of the electric vehicle is an important factor of consideration for the automakers, due to which investments are in line for large-scale electric vehicle battery production. There are 13 plants announced (as of October 2021) for setting up over the next five years[11]. Of these, eight are based on joint ventures between automakers and battery manufacturers.

New Battery Manufacturing Plants announced by Automakers

Manufacturer	Location	Expected
Ford	Northeast of Memphis	2025
Ford and SK Innovation	Central KY	2025
Ford and SK Innovation	Central KY	2026
General Motors and LG Chem	Lordstown, OH	2022
General Motors and LG Energy Solution	Spring Hill, TN	2023
General Motors and LG Energy Solution	-	-
General Motors and LG Energy Solution	-	-
SK Innovation	Northeast of Atlanta, GA	2022
SK Innovation	Northeast of Atlanta, GA	2023
Stellantis and LG Energy Solution	-	2024
Stellantis and Samsung SDI	-	2025
Toyota	Southeast of Greensboro, NC	2025
Volkswagen	Chattanooga, TN	-

Source: CleanTechnica

On the demand side, beyond the passenger electric vehicles, there is an emerging rise in interest for the electric drivetrain in commercial applications[12]. Logistics' chain companies are actively exploring the options in electrifications, led primarily by the relatively competitive offerings in terms of total ownership costs. Some of the recent examples attest to this opportunity. The British startup Arrival partnered with logistics company UPS for latter's order of 10,000 electric vans. These will be produced in both US and the UK. BrightDrop, part of General Motors,

is building battery-based commercial vans for companies including FedEx and Walmart. Similarly, Rivian has an order for 100,000 electric vans to be delivered to Amazon through 2024. Amazon also holds a 20% ownership interest in that company.

Outlook

BNEF projections indicate that the passenger electric vehicle sales in the US market could double between 2021 and 2023 to achieve a million-plus units. Further ahead, the projections indicate that, all things being same, the sales could reach over 8 million units by 2035, led entirely by the battery-electric based ones. While the actual rate of growth would surely vary widely as the market evolves along with other factors, the implications of such a transition in automotive market is huge.

The projections indicate the magnitude of preparations that may be in order to enable such a transition. This especially includes critical areas such as setting up of charging infrastructure, but also includes policy measures such as standardisation of charging norms, enabling incentives/penalties for EV adoption, etc. The existing policy framework, that is largely devoid of a federal regulatory structure, may not help as an enabler for the policy goal net-zero US emissions by 2050. The recent policy steps towards infrastructure spending constitute a good start at addressing the lacunae. But a timely implementation holds the key.

Canada

Despite having the advantages of an established and competitive automotive manufacturing base and a rich endowment of minerals and metals, Canada's EV market could not make a serious dent so far in the global EV business. The rise in passenger EV penetration, while noteworthy, is led by just three provinces. Of late, the Canadian market shows progress in catching up. There are planned investments in the EV and battery manufacturing space. It also helps that the country's proximity to the US market puts it in a position to capitalise upon a wider EV market.

GDP (Current Prices) USD (2020)	1,644.04 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.24%
EV Penetration	11.3% of total vehicle registrations in Q3 2021
EV Target	100% share of zero emission light-duty cars and passenger trucks by 2035
Planned Year of Phasing Out ICE Vehicles	2035

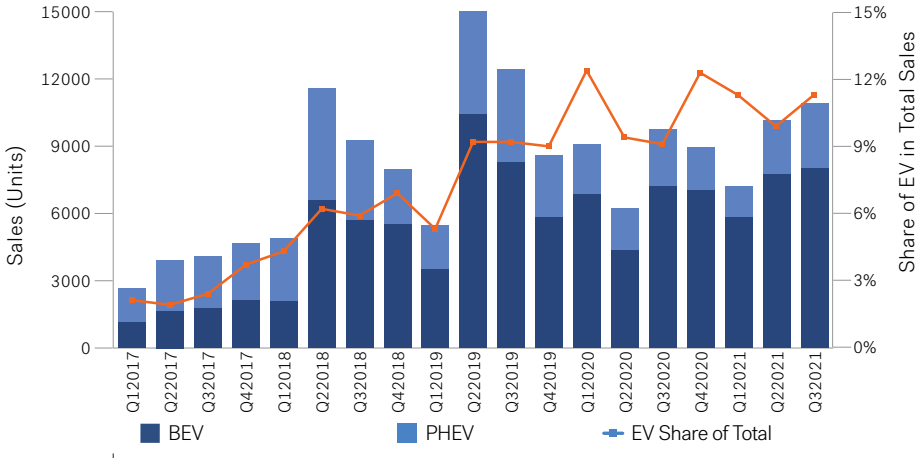
GDP Source: IMF, World Economic Outlook

Canada

EV Penetration and Trend

Canada's EV adoption shows an upswing after a temporary slowdown. As of Q32021, battery electric vehicles' registrations stood at 8,005 units[1] – marking an 11% rise over the corresponding period last year. A higher growth (15%) is observed in case of the plug-in hybrids for the same period. Yet, it is the battery electric vehicles which appear to be the preferred modes. As the quarterly trend shows, registration of the plug-in hybrids trail that of battery electric ones by a far margin. As a result, by Q32021, the share of battery-based passenger cars reached 8.3% of the total registrations, contrasting the 0.9% in Q1 2017. In case of plug-in hybrids, the expansion in share rose from 1.2% to 3.0% during the same period.

Trend in Canada's Passenger EV Registration



Source: Statistics Canada

Canada's fast growth in electric vehicles, while impressive, is yet to become mainstream across the country[2]. It is instead skewed towards two provinces – British Columbia and Quebec, reflecting the EV sales quota enforced by the respective provincial authorities. Both provinces corner more than three quarters of the total EV sales. Other provinces thus have an under-developed dealer network to cater to the demand for EVs – in many cases there is a six months' long waiting time for getting a vehicle

Charging Infrastructure

As per Natural Resources Canada[3], the latest availability of public charging stations stands at 15,823 across 6,752 station locations. In February 2021, the number of charging stations was 13,320. While growth is underway, it is clearly not sufficient. A survey by BC Hydro pointed to 70% of respondents expressing concern over the range limitations and holding it as the reason for not choosing an EV over conventional vehicle. Furthermore, the skew in the infrastructure is all too evident – 90% of the available capacity is in three provinces.

Public Charging Infrastructure across Provinces (number of charging stations)

Province	Normal Charging	Fast-charging	Total
Quebec	5,175	1,009	6,184
Ontario	4,180	973	5,153
British Columbia	2,255	678	2,933
Alberta	444	164	608
New Brunswick	153	86	239
Nova Scotia	168	32	200
Saskatchewan	70	96	166
Manitoba	76	57	133
Newfoundland and Labrador	83	18	101
Prince Edward Island	77	14	91
Yukon	1	12	13
Northwest Territories	2	0	2

Source: Natural Resources Canada

The DC fast-chargers are on a rise, indicating the focus on getting high capacity charging points. The latest number of chargers (3,139) is a 39% rise over that reported in the previous year. Continued roll out of fast-chargers is important for developing and sustaining the market growth in the country.

Canada presently does not have any EV battery manufacturing in the country. This gap could however close soon with several investment proposals in pipeline, both from government and the private sector. The notable element in this is Canada's resource endowment in the critical minerals involved in the EV battery packs.

Policy and Regulation

Pursuing decarbonisation in the transportation sector (a quarter share of country's total greenhouse gas emission), the Canadian government mandates a 100% share of zero emission light-duty cars and passenger trucks by 2035. This is an advancement in schedule from the previous time horizon of 2040. The policy mandate appears to indicate an urgency in undertaking the transition in Canada's road transportation network[4].

The federal government is also funding a five-year CAD280 million Zero Emission Vehicle Infrastructure Plan ending in 2024. It aims at addressing the charging infrastructure (as well as those for alternative fuels for zero emissions) gaps that currently hinder the EV adoption. An RFP in this regard is expected during Spring 2022.

The near-term target is to achieve 50% zero emissions in all new passenger vehicles by 2030. To this end, there are deliberations to stipulate national-level EV sales quotas[5] by end-2022. Such a mandate is prevalent in just two provinces which also account for most of the EV sales. The proposed measure could change this for the better, with a planned implementation across the country.

The Canadian province of British Columbia[6] separately offers incentives for EVs. Through 'The CleanBC Go Electric light-duty vehicle rebate program', it offers point-of-purchase rebates of up to CAD3,000 for purchase or lease of a new battery electric, hydrogen fuel cell, or longer-range plug-in hybrid electric vehicle and CAD1,500 for purchase or lease of a shorter-range plug-in hybrid electric vehicle. Furthermore, a price cap of CAD55,000 is in place for supporting those seeking lower-cost vehicles.

British Columbia also offers "The SUVI Program" for the specialty-use vehicles[7] not included in the "CleanBC Go Electric Vehicle Rebate Program". The buyer or lessor stands to receive up to 33% of the vehicle MSRP or the maximum rebate amount listed in the respective vehicle category, whichever is less. The rebate percentage for eligible tourism operators (members of B.C. Destination Marketing Organizations) for on-road medium and heavy-duty vehicles is 66%, with a cap CAD$100,000.

Similar support is extended by the Quebec government[8], with a CAD8,000 rebate for individuals, businesses, organisation and municipalities for purchase or lease of a new electric vehicle (with retail price up to CAD60,000). For plug-in hybrid vehicles, the available rebate is based on battery capacity. Other electric transport modes eligible for rebates are electric motorcycles (rebate of CAD2,000) and limited speed electric motorcycles or electric scooters (CAD500).

Market Opportunity

There is a gradual step-up in public investments to expand the charging infrastructure capacity. In March 2022, the Natural Resources Canada announced a CAD2 million investment in Alectra Corporation Corporation to support installation of 340 charging points across Ontario[9]. Previous such investments by the government agency granted public charging points in Windsor-Essex County in Ontario, Alberta, the Greater Toronto and Hamilton Area, and Nova Scotia. The government programme to fund the chargers is underway and it is aimed that all fast chargers are deployed by end-2022[10]. As things stand, almost two-thirds of the planned fast chargers are in place and are accessible for public use.

The scope however is huge. An analysis by Natural Resources Canada points to an average requirement of one charger for every 20 EVs by 2025. A separate estimate by the industry association points to the fact that meeting the European goal of having one public charger for every 10 EVs translates to about 4 million charging points in Canada by 2050. The concern thus is that of a limited rate of capacity expansion currently underway[11].

Electrification of public transportation could receive a significant boost with government funding. The Canadian government in February 2021 announced federal funding worth CAD14.9 billion over the next eight years on public transportation projects across the country[12]. Electrification will be a key focus area as municipalities focus on cleaner options with such funding support. Under this funding scheme, in March 2021, the government announced a CAD2.75 billion outlay to subsidise the procurement of 5,000 zero emission buses for municipalities, transit agencies and school boards[13]. The funding will be available till 2026. Notable bus manufacturers active in this context include Nova Bus in Saint-Eustache, Lion Electrique in Saint-Jérôme, GreenPower in Vancouver and New Flyer in Winnipeg.

Meanwhile, Canada Infrastructure Bank (CIB) has been funding electric bus procurement under a CAD1.5 billion zero emission bus initiative[14]. The latest one in this regard was in November 2021, when a CAD400 million loan outlay was announced in an agreement with Quebec-based Carriers Federation for purchasing 400 electric school buses in Quebec over five years. Previous CIB investments in this context include a CAD30 million funding for 280 electric buses in British Columbia and a CAD15 million partnership with Quebec-based Autobus Séguin for 131 zero-emission buses.

There is also an added policy push towards EV manufacturing capacity[15]. In October 2020, the federal and provincial (Ontario) government funding was announced for a proposed Ford Motor Company's CAD1.8 billion project at Ontario's Oakville Assembly Complex. This project involves federal and provincial contribution of CAD295 million each. With the funding in place, the Oakville Assembly Complex could become one of Ford's largest volume battery electric vehicle manufacturing plants in North American region. The facility is expected to come on stream by 2025.

But the US legislation on Build Back Better is a factor of uncertainty over Canada's EV industry[16]. The US legislation allows a tax credit of up to USD12,500 for the electric vehicles manufactured at American facilities – in effect acting as an implicit tax on Canadian manufactured vehicles. Similar concerns are apparently playing out for other multinational investments in this context. For instance, LG Energy Solution's plan for a CAD2 billion battery facility at Ontario was held up to monitor the situation arising from the progress in the legislation.

Outlook

The Canadian government has indicated clear stance towards de-carbonising its transportation sector through electric and other options in zero emission vehicles. Among the most discernible step is the planned ban on all new combustion-engine cars and light-duty trucks from 2035[17]. In the province of British Columbia, a total ban on fuel-powered cars and trucks is planned to be effective from 2040.

These are ambitious targets that impose significant transitory measures to ensure minimum disruptive impact for both industry and consumers. The task of expanding EV penetration so far remains fraught with challenges. There is a lack of strong incentive structure beyond the leading provinces. Furthermore, the EV charging infrastructure remains concentrated instead of a widespread one. This will require rapid investments from both government and private sector. Also important is the need for localised manufacturing ecosystem to ensure competitive offering in the global EV market.

Mexico

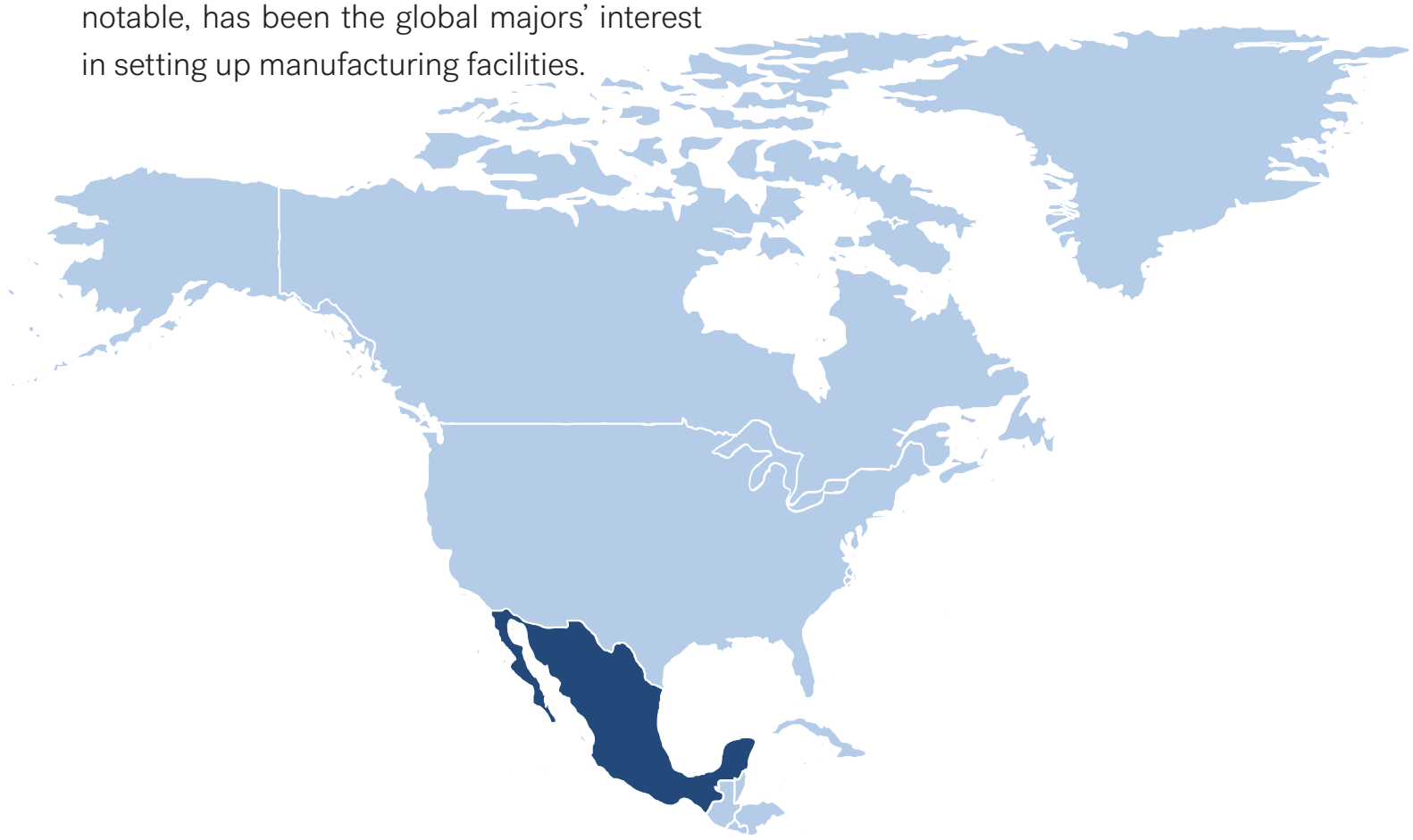
Mexico ranks among the top automotive markets for its role and position in the global automobile value chain. The country has a regional trade agreement with US and Canada which makes its industry an important one. Yet, in context of the electric vehicles, the policy focus has not been very high.

GDP (Current Prices) USD (2020)	1,073.92 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.29%
EV Penetration	5% of total passenger vehicles sold (2021)
EV Target	Carbon Neutrality by 2050
Planned Year of Phasing Out ICE Vehicles	2050

GDP Source: IMF, World Economic Outlook

Note: Policy goal is to achieve carbon neutrality by 2050. But there is no specific target for electric vehicles.

The growth in electric vehicles has thus been a limited one. Slow but gradual public procurement of electric buses are propping up the demand for such platforms. Also notable, has been the global majors' interest in setting up manufacturing facilities.

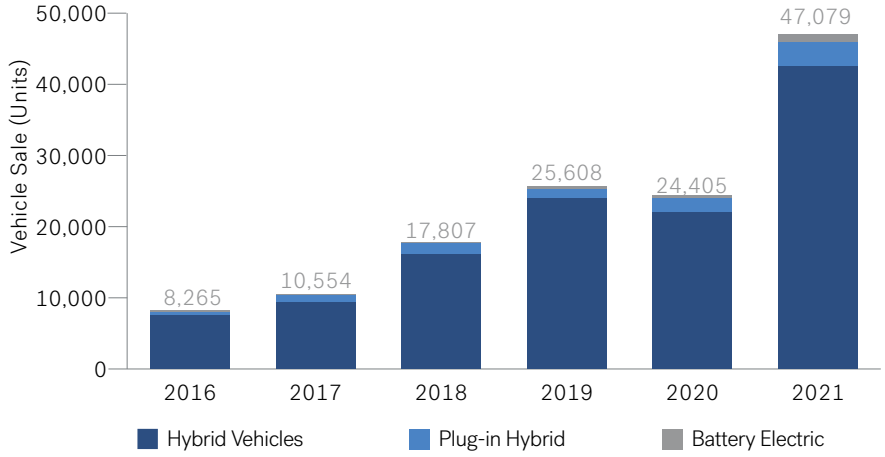


Mexico

EV Penetration and Trend

The electric vehicle sales in Mexico reflect the industry's nascent stage of growth[1]. As with most of the countries globally, the year 2021 marked a phase of business recovery for Mexico's automotive industry. The same drove a jump in the electric vehicles' sales as well. However, the share is insignificant. While about 47,000 units of electric vehicles (including hybrids which are not plugged-in) were sold in 2021, the country's automotive industry registered total sales of about a million units in passenger vehicles[2].

Trend in Sale of Electric Vehicles



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

Though with a low base, growth is discernible. Between 2016 and 2021, electric vehicle sales registered a compound annual growth rate (CAGR) of 42%. Plug-in hybrid vehicle sales had a CAGR of 46% during this period indicating the rising interest in this segment. This is because the hybrid vehicles (non plug-in) hold an average 90% share of the total electric vehicle sales throughout the review period in consideration. The country's continued reliance and focus on the conventional engine automobiles sustains the relatively higher interest in hybrid vehicles than those of battery electric vehicles.

The other segments of the electric vehicles, notably the electric buses or micromobility modes (e-scooters, e-bikes and others) are slowly making progress though insignificant in share. Electric buses have been fairly recent in the transportation network, led by the public procurement done under specific schemes. E-bikes have similarly gained currency – a survey[3] dated 2018 tracked e-bike share at 4.6% of all the bicycle trips done in Mexico City. Supporting regulations such as those related to dockless e-bikes or scooters in 2019 helped in growth of such modes.

Charging Infrastructure

Mexico has about 1,200 private charging stations[4], with more than half being that of the ChargNow network. Tesla has another 500 charging stations (specific to the Tesla-make) and 16 super-chargers. The number of public chargers could be more but there are no confirmed official estimates on the same. It is regarded that there are over 2,500 public charging stations, with all of them being free to access.

Mexico's charging infrastructure is larger than its regional peers[5]. The deployment of the charging network has been led by the power utility CFE along with the private entities. In addition, there are proprietary charging stations operated by automakers such as Tesla. Public charging networks such as the ChargeNow network was developed jointly by CFE, BMW group and Nissan Mexico. Further, there is a BMW Group fast-charging corridor linking San Luis, Potosi, Mexico City and Puebla. Another charging corridor is between Monterry and the US border.

Policy and Regulation

The Mexican electric vehicle market has limited access to policy and regulatory support[6]. Considering the country's position in the international automotive trade and value chain there is an absence of proactive policies to tap into the opportunities. This is not only in context of promoting electric vehicle adoption, but also enabling the domestic automotive industry to make the transition towards the emerging change in drivetrain technologies.

The available incentives are largely around tax exemptions or select few measures from the agencies[7]. Battery electric, hybrid and hydrogen-based vehicles are not subject to the federal new car tax. Also, there is a ceiling on the increase in the maximum amount of deductible income tax related to payments for temporary use of hybrid or battery electric vehicles.

At the state level, in most cases there is an exemption from ownership tax and in some of the states there is also a relaxation of environmental verification. The government-owned power utility CFE provides an independent meter for the home-based charging stations (thus enabling a differential billing rate). Among other measures, in 2019 a 20% discount was offered on select identified toll rates, through a special prepaid card called Ecotag.

Among added measures, the Ministry of Economy in August 2020 considered import tariff exemption[8] for new electric cars and trucks. Based on an amendment of the tax laws, this tax benefit was aimed at getting electric vehicle adoption competitive in the overall automotive market.

Mexican auto industry's close trade linkage with that of the US makes it prone to latter's policy revisions. The latest instance of such vulnerability is US government's planned tax credits for indigenous electric vehicles[9]. The Mexican government disputed this for apparent violation of trade principles, more so as the country is part of the regional trade agreement with the US (termed as United States-Mexico-Canada Agreement). The matter is likely to be resolved through an arbitration panel[10], as proposed by Mexico (under the terms of regional trade agreement).

Market Opportunity

Of late, some of the leading global automakers announced plans to set up electric vehicle manufacturing and/or assembling facilities in Mexico. Ford Motors plans to commence production of two of its leading electric vehicles' brands at its Cuautitlan plant in Mexico[11]. This is tentatively planned to commence from 2023. In April 2021, General Motors announced a USD1 billion investment to manufacture electric vehicles in Mexico at the Ramos Arizpe production complex[12]. The production facility is expected to come onstream from 2023 onwards.

Besides the established automakers, investments are also being lined up from various other quarters. The renewable energy company Citizens Resources has a USD165 million investment plan, partnering with Chinese entity and EV Dynamics, and another Spanish one QEV Technologies. The proposed facility is to be set up in Puebla[13] for production of last-mile and passenger electric vehicles, tentatively targeted at early 2023.

Electric bus is another major demand segment that is attracting some of the major suppliers worldwide[14]. In October 2021, the Chinese manufacturer Yutong delivered 10 electric buses for Mexico City. The company joined several other entities such as VEMO, Mobility ADO, and Metrobús to participate in the MX47 million green mobility initiative of Mexico City.

Local manufacturing plans are underway as well. The Swedish manufacturer Scania plans to develop and supply electric buses locally at Mexico in partnership with Mexican bus body manufacturer Beccar[15]. Similarly, Volvo in July 2021 announced its plans for local manufacturing of electric buses and the related drivetrain technology in Mexico[16]. Subject to the regulatory approvals, the company aims to set up the plant at Tultitlán for both local demand as well as export.

The largely untapped area of electric charging infrastructure is open for private sector investments. So far some of the leading automakers have committed investments in this direction. A notable example in point is the joint venture of Nissan Mexico and BMW Group[17] which, as a collective entity, built 700 charging stations, worth USD4.9 million by August 2021. Separately, both companies have installed strategic charging stations as well.

Outlook

Mexico's automotive industry ecosystem is entrenched in the conventional drivetrain technologies, even as investments pour in for the emerging ones. At a policy level, even as there are emission reduction goals for 2050, there is little on ground to effect a transition path. As a result, the Mexican electric vehicles' market caters to a very small (and affluent) segment of the total potential consumer segment.

In the absence of direct and targeted budgetary support on competitive pricing of such electric vehicles, the current position of electric vehicles is unlikely to change significantly in the near to medium term. While this does not rule out the growth in electric vehicles, the realization of opportunity will be a small fraction of potential.

With conventional internal combustion engines retaining importance, the market is expected to retain the predominance of hybrid vehicles. At the same time, the public investments in the segments such as electric buses could propel the demand and growth faster than expected. Also important to look forward is the progress on planned investments in electric vehicle manufacturing space. The country's endowed advantages in automotive manufacturing linkages could help get an edge over other markets.

Key Regional Markets - South America

Countries Covered

1. Brazil
2. Chile

Brazil

Brazil is regarded as the most important among the Latin American markets for electric vehicles. This is borne out by the latest estimates of the electric vehicle sales in the country. The progress however does not match against the leading countries globally. A fundamental reason is that Brazil's emphasis on the decarbonization and energy efficiency in transportation does not limit itself to electric vehicles. Instead, biofuels, flex fuels as well as fuel cells are part of the overall scheme. Taking this into account, the rate and direction of progress in Brazil is likely to be very different from the one observed in other countries.

GDP (Current Prices) USD (2020)	1,444.72 bn
GDP Growth Forecast (constant prices) (2021-2025)	2.60%
EV Penetration	1.8% of total passenger cars sold (2021)
EV Target	-
Planned Year of Phasing Out ICE Vehicles	2030

GDP Source: IMF, World Economic Outlook

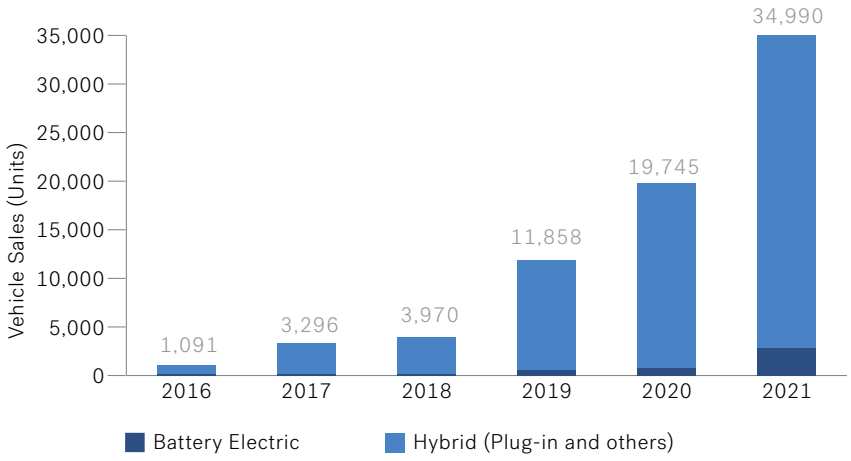
Note: The country does not have a target on electric vehicles.

Brazil

EV Penetration and Trend

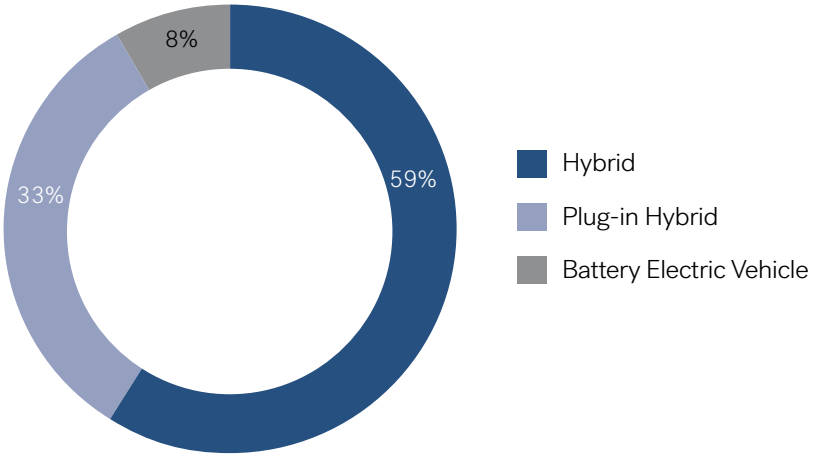
Though operating on a very low base, Brazil's electric vehicle market shows a sharp growth in sales[1]. By end-2021, the total passenger electric vehicle sales marked a CAGR of 100% during 2016-2021. This is still a miniscule proportion of the near 2 million odd cars supplied in this market. Yet, the sharp year-on-year growth makes it a promising prospect.

Trend in Light and Commercial Electric Vehicle Sales



Source: Brazilian Electric Vehicle Association (ABVE)

Distribution of Electric Vehicle Drivetrain as of end-2021



Source: Brazilian Electric Vehicle Association (ABVE)

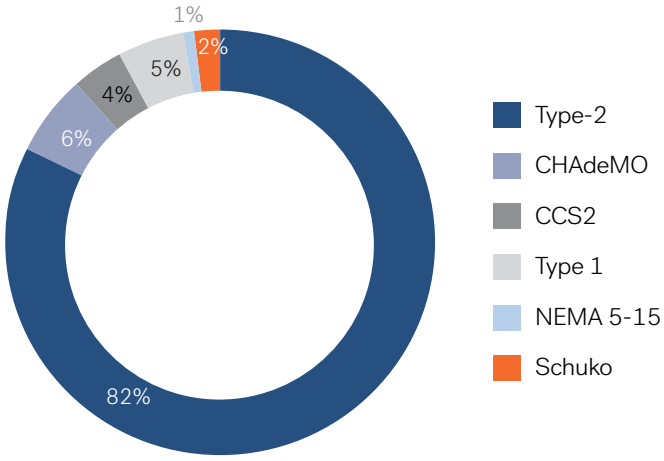
As is typical characteristic of the Latin American market, hybrid electric vehicles (including plug-in hybrid as well as hybrids combining other fuels) hold a predominant share. As the trend of 2016-2021 indicates, the share in Brazil is consistently over 90%. Such a trend is unlikely to change any time soon – reflecting partly the inadequacy of charging infrastructure and the competitive availability of biofuels as an option in the overall low-emission transportation plan. Yet the sharp spike in battery electric vehicles in 2021 (256% year-on-year) suggests a sizeable demand base to build upon.

Among other transportation segments, it is electric bus where the penetration has lately risen due to the public procurement undertaken. However, this is predominantly in the city of Sao Paulo[2].

Charging Infrastructure

Brazil's electric vehicle charging infrastructure has been mostly led through the power distribution utilities or the vehicle manufacturers. The country currently has about 1,000 charging points across regions[3]. The charging capacity is far from the scale required to accommodate an acceleration in electric vehicle penetration.

Brazil's Charging Connectors Type[4]



Source: Statista

Notably, fast-charging stations have been installed in the strategic transportation corridors and highways that are used by heavy goods vehicles and passenger vehicles. Public charging however remains low in the country, in part because of the prevalence of home charging so far. This has been driven by the luxury vehicle category that characterizes the electric vehicle consumer base so far.

Policy & Regulation

Brazil's policy and regulatory framework is largely towards vehicle energy efficiency, taking into account all fuels including biofuels for decarbonisation. Most of the measures are thus broad in nature, and the implication on electric vehicles thus gets inferred from the overall sectoral impact. While there are some fiscal incentives towards electric vehicles, there is an absence of direct purchase subsidy that is notable in most of the leading markets in this industry[5].

In 2018, the policy "Rota 2030" was introduced with mandatory requirements in vehicle efficiency and safety levels. Under this, the tax incidence on industrial products and electric vehicles, hybrid vehicles as well as flex fuel vehicles was reduced by at least 3%. However, the actual tax implication was tied to the vehicle weight – in effect resulting in higher taxes for electric vehicles in many cases. Starting in 2022, an 11% improvement target in fuel consumption over 2017 levels is set for the new light-duty vehicles.

The policy-level funding lines available for the transportation sector, underwent changes in 2017. In a revised structure, the non-polluting buses (implying electric vehicles as well as those based on ethanol, fuel cells, etc.) got a priority allocation in accessing the BNDES funding from 2018.

The regulations allow for some tax exemptions. In October 2015, import taxes were removed altogether for battery electric vehicles, while it was set at 0%-7% range for the hybrid electric 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. Further, there is an annual car ownership tax that was set at 4% since 2018. But this is exempted in seven Brazilian states including Ceará, Maranhão, Pernambuco, Piauí, Rio Grande do Norte, Rio Grande do Sul and Sergipe. A lower rate of the same tax is applicable in the states of Mato Grosso do Sul, Rio de Janeiro and São Paulo.

Some of the other measures of policy support include exemption provided to electric vehicles from São Paulo's circulation restrictions (also referred to as Rodizio Vehicular) in force since 2014. As per this regulation, conventional vehicles have a restricted access to São Paulo city during defined peak hours of the day, based on the final numbers of licence plates.

There are several other policy/regulatory measures that context-specific to São Paulo municipality. Since 2021, the São Paulo municipality law allows electric vehicle owners to offset a part of their property taxes with the municipal share of annual car ownership tax paid. The same law also has a schedule laid out for the switching of diesel-based buses to low-emission ones. It sets 10-year and 20-year targets for CO2 emission reduction by 50% and 100% respectively. Since 2020, the São Paulo municipality law provides for the mandatory provision of charging facility in the city's new residential and commercial buildings.

The focus on scaling up the public charging facilities appears to be rather limited. In Brazil's current electric vehicle market dominated with 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

Several entities appear to be keen at tapping into the charging infrastructure space. São Paulo, which accounts for about half of the total charging infrastructure, will have a significant rise in the investment spending. Tupinambá Energia has a USD2 million investment plan to deploy 500 charging points by end of 2022, in partnership with Raizen (also one of Brazil's largest fuel distributors)[6].

Notably, fuel distribution companies have been entering in the sector. In February 2022 Vibra, a former subsidiary of Brazil's Petrobras, announced its BRL5 million investment in electric recharge startup Easy Volt[7]. The latter is a leading player in the country's electric vehicle charging market, for the pioneering role in setting up 'charging as a service' model.

Other companies are similarly joining the fray. In January 2022, Brazilian auto manufacturer WEG announced a partnership with power company Neoenergia (part of Spain's Iberdrola) for electric vehicle charging stations. Under such arrangement, Neoenergia will be responsible for providing equipment of the requisite ratings, while WEG will be the exclusive supplier of charging stations[8].

Other major global automakers have been participating in this market through various arrangements. As of January 2020, under the Efficient Electric Mobility Solutions programme[9] (designed by energy regulatory authority), an outlay of BRL464 million been budgeted for electric vehicle infrastructure. While the regulator's share was BRL392 million, the rest was from the energy companies.

Other companies participating in this programme include Volvo, BMW, EDP, Volkswagen (VW), Audi, Porsche, Siemens, ABB and Electric Mobility Brazil from São Paulo. Volvo has been working on installation of about 250 charging stations, in cooperation with two major shopping and supermarket chains. Similarly, BMW has been working with station network Ipiranga for a planned 180 charging stations.

Beyond the charging infrastructure, there is an emerging space for manufacturing investment. Brazil ranks among the major automobile manufacturing countries globally and can thus be expected to play the role in electric vehicle manufacturing as well.

As of February 2022, China's Great Wall Motors Group announced a planned USD1.8 billion worth of investment in production of hybrid and battery electric vehicles in Brazil[10]. In August 2021, the company signed a purchase agreement to acquire Daimler Group's Iracemápolis plant where the planned vehicles are to be assembled. Tapping into the demand for electric buses, in September 2021, Daimler Trucks' Brazil-based Mercedes-Benz do Brasil confirmed the launch of electric bus chassis to be supplied from the São Paulo location[11].

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 its 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 particular 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 the 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 integrated biofuels. Once the scale is achieved, this could be a key differentiator in the global market.

Chile

Chile has an ambitious goal of phasing out most of the internal combustion engine-based vehicles by 2035. This is part of the larger scheme of rationalising the emission level of its transportation sector, through a mix of initiatives in promoting electric vehicle industry. Implementing this will involve a mix of steps such as using electric vehicles along with other fuel options such as hydrogen or drivetrains based on hybrid modes. The case for electric vehicles will be contingent on same major pre-requisites (incentives and charging infrastructure) that have been observed in other major electric vehicle markets across the world.

GDP (Current Prices) USD (2020)	252.82 bn
GDP Growth Forecast (constant prices) (2021-2025)	3.92%
EV Penetration	0.2% of total passenger vehicle sold (2021)
EV Target	Emission-free passenger and freight transport by 2045
Planned Year of Phasing Out ICE Vehicles	2045

GDP Source: IMF, World Economic Outlook

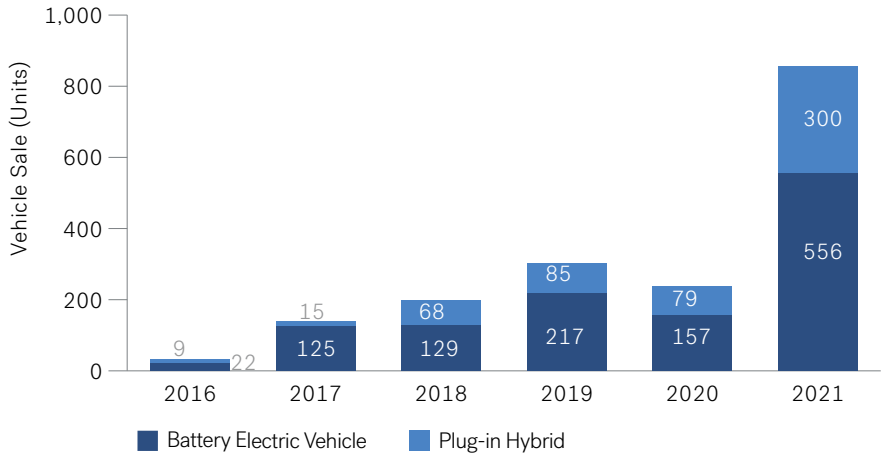
Chile

EV Penetration and Trend

The nascent stage of Chile's electric vehicle industry is evident from the scale of business. As per the National Automotive Association of Chile[1], of the 415,581 passenger vehicles sold in 2021, just about 0.2% could be attributed to electric drivetrain (battery electric and plug-in hybrid). Conventional vehicles continue to play an important role in the country, with total sales reaching record breaking levels during 2021 in a post-pandemic business recovery phase.

In a relative sense though, the trend in electric vehicle adoption shows a sharp rise. In 2021, the sale of battery electric vehicles grew 254% year-on-year. Sales quadrupled over the last five years as the policy focus sharpened over promoting zero or low-emission transportation to mitigate emissions attributed to this sector.

Trend in Passenger Electric Vehicle Sales in Chile



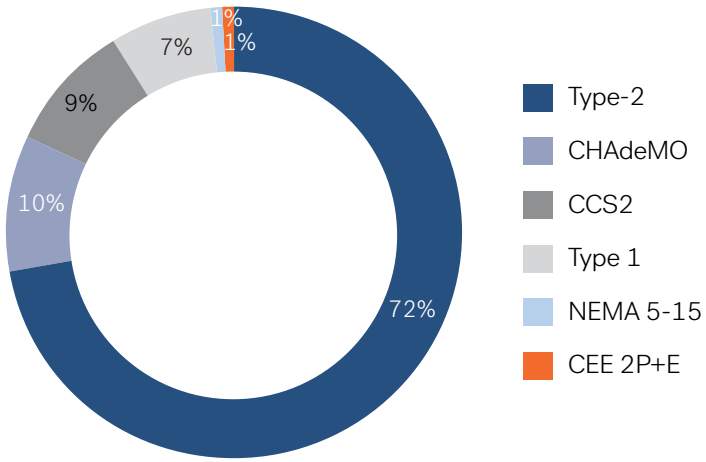
Note: The above data was categorized as 'light and medium vehicles' in the source
Source: National Automotive Association of Chile

A discernible progress is observed in case of electric buses, where policy priority and the budgetary outlays seem to have helped. The Chilean city of Santiago, with an electric bus fleet size of about 800 vehicles[2], now ranks among the exemplary cases of leading cities globally in electric bus adoption. Procurement is on to add to the electric bus fleet, as part of the measures for zero emission public transport network.

Charging Infrastructure

As per Electromaps, there are 245 charging locations and 533 connectors in Chile[3]. Moreover, there are 22 charging terminals for electric buses. Majority of the installed charging connectors are Type-2. Reflecting the gradual pick up in electric vehicle penetration, the charging infrastructure is slowly gearing up to the potential demand. There are currently two fast-charging corridors – one is VOLTEX located in the Central-South Zone of the country, while the other is located in the southern part, and is connected to the Argentinian province of Neuquen[4].

Chile's Charging Connectors Type



Source: Electromaps

The existing charging infrastructure is not only inadequate but also skewed in distribution. It is located in select major cities such as Santiago. Inadequate charging facility also explains the relatively higher popularity of the plug-in hybrid vehicles, as range anxiety results in users seeking options to make up for the absence of timely recharging in long distance journeys[5].

Policy and Regulation

In February 2022, the government published the latest iteration of its National Electromobility Strategy[6]. This is a long-term policy outline that lays out the roadmap for reducing transportation sector emissions. In effect, this policy aims to implement zero emission vehicles' sale throughout the country, to be done in three stages between 2035 and 2045.

One of the major goals of the National Electromobility Strategy is to enforce sale of zero emission vehicles by 2035 in segments including light and medium vehicles, public transportation (buses, taxies, and shared taxies) and heavy machinery. From 2045 onwards the policy mandates all new vehicle sales related to the long-distance passenger transport and freight transport should be emission-free.

Additional support especially in terms of incentives for electric vehicles are yet to be implemented. These are being considered in terms of tax breaks for the low emission vehicles including electric vehicles. The plan is to offer a graded tax exemption structure[7] involving full exemption for the first two years, followed by a 75% discount in the years 3-4, a 50% discount in years 5-6, and 25% for years 7-8.

Incentives are also considered in select segments of transport electrification. In January 2021, the Energy Ministry presented a plan to subsidize 50 electric cabs in Santiago[8] – amounting to USD11,000 worth of support from the government to reduce the cost of purchasing an electric cab.

At a policy level, the Energy Efficiency Law[9] enacted in 2021 provides 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

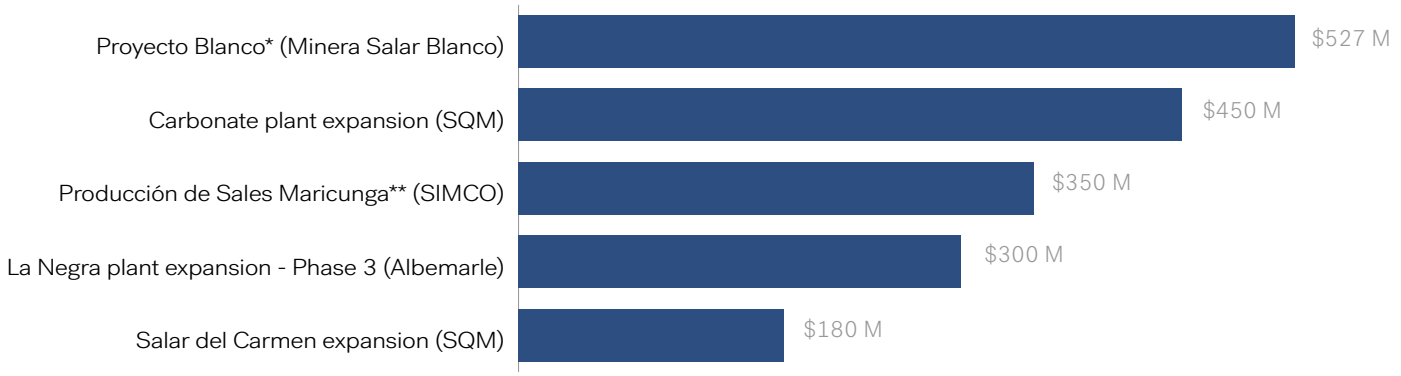
The National Electromobility Strategy sets the framework for potential investments in the Chilean electric vehicle industry. About 85 companies and public institutions got in a public-private electromobility agreement to commit expansion in the number of electric vehicle models, expand the charging infrastructure and promote new use-cases of electromobility. Recent developments indicate a rise in private investor interest in tapping into the huge demand.

In January 2022, EnelX, the advanced energy services arm of Italian energy company Enel, commissioned Chile's first fast-charging station for electric vehicles[10]. Located at Santiago, it has 23 charging points with 20 fast and ultra-fast chargers at capacity ratings of 50kW and 150kW respectively. With this, EnelX has installed over 320 charging points across Chile. In December 2021, EnelX had entered into an agreement with Uber[11] for installation of new charging points in Chile

The public procurement of electric buses is a major thrust to the transport electrification. The Chilean city of Santiago continues to be a focus area as the authorities expand the electric bus penetration. As of February 2022, a culmination of a bidding process than began in December 2020, contracts for 991 electric buses were awarded for various Santiago bus routes[12]. Meanwhile public tender issues are being considered for other municipal areas including Arica, Antofagasta, Copiapó, Valparaíso, Concepción, Temuco and Puerto Montt.

Another area of significant opportunity and investment is lithium production. Globally, Chile is one of the leading producers of lithium. It is projected that electric vehicles could account for almost a quarter of the total lithium demand in Chile by 2030. As of October 2021, the portfolio of investments in Chile's lithium extraction projects[13] amounted to over USD1.8 billion.

Planned Investments in Lithium Extraction in Chile



Source: Statista (data as of November 2021)

Outlook

In keeping with the National Electromobility Strategy, Chile is expected to ban all new combustion engine vehicles starting 2035. While this is a major policy goal, the groundwork to enable such a major transition appears to be less than adequate. Fundamental issues in this regard include the weak adoption of electric vehicles in the country. Battery electric vehicles are far from reaching even 1% of the total passenger vehicles sold annually. The preference for conventional vehicles is thus clear and unlikely to change very easily in the short-term without clear and tangible incentives.

There is a barrier in electric vehicle adoption that needs to be enabled with incentives, following the same path as other major peer countries in the Latin American region. The continued lack of such incentives and the delay in finalizing them does little to strengthen the case for the industry. Compounding this issue is the lack of adequate charging infrastructure that makes the case relatively weaker. The private sector investments in this context could prove instrumental. With timely amendment in regulations related to the electric vehicle charging standards, pricing and other details, private investors' interest can be tapped into for an accelerated growth.

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