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Global Electric Vehicle Review 2022





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1. EXECUTIVE SUMMARY



Executive Summary

Transportation Sector is Going through a Transition Phase

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 both at national and/or municipal authority levels. The number of such announcements is on a rise, partly reflecting the convergence of goals worldwide.

Broadly, the direction is apparent in the trend of passenger electric vehicle (EV) sales. 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 same review period.

Transition to EV is Subject to the Level of Policy Support

There is a case for incentivising EVs to bridge the gap against ICEs. Policy support, 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 observed 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.

Charging Infrastructure is Instrumental for Mass Adoption of EVs

Range anxiety is the most challenging factor to spur the EV demand. Such an issue can be addressed only through comprehensive coverage of EV charging infrastructure. Between 2016 and 2020, cumulative installed charging connectors across key markets registered a CAGR 34%.

Along with government investment, the role of private sector 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. Also important is the development of requisite regulatory guidelines (standardisation in equipment, tariffs, etc.) for the EV charging infrastructure.

Trend of Localisation in EV Manufacturing

Increasingly, with market growth, there is a focus on localisation in EV manufacturing. Europe for example is increasingly seeking EV capacities closer to the high-demand regions. Such a push for localisation is also related to de-risking against the dependence on the Chinese EV market. However, 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. However, 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 led major stakeholders and policy authorities to reconsider automotive industry's conventional globalised supply chain network.

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.

2. EV PENETRATION & ADOPTION

Electric Vehicle Penetration & Adoption (1/5)

Introduction

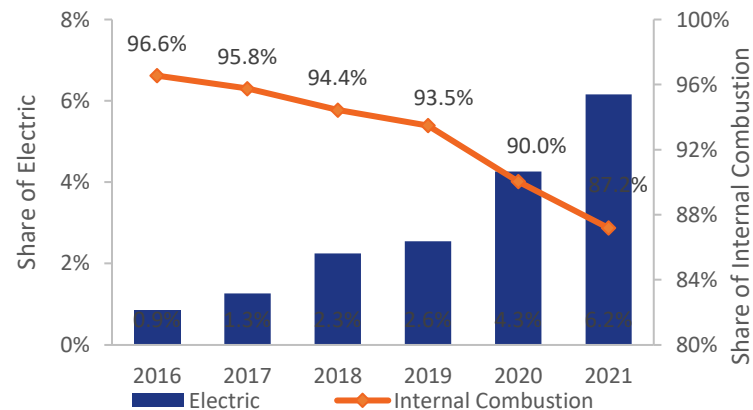
- The Electric Vehicle (EV) market has gradually assumed traction due to the policy direction globally at electrification of the transportation system
- While the passenger vehicles' offtake faces the challenge of a high ownership cost, the two-wheeler segment on the other hand has had a rapid growth due to greater accessibility in price points
- The competitive cost of EVs, as a culmination of technology improvement and ramping up the charging infrastructure hold the key to realise the objectives in EV penetration

Status and Trend at an Aggregated Level

Global Passenger Vehicle Fleet by Drivetrain (BNEF)

| Drivetrain | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| Battery electric | 995,177 | 1,698,643 | 3,028,422 | 4,614,028 | 6,734,252 | 10,058,783 |
| Plug-in hybrid | 784,391 | 1,180,594 | 1,800,948 | 2,347,826 | 3,333,137 | 4,749,517 |
| Fuel cell | 2,749 | 6,154 | 10,104 | 17,856 | 26,195 | 37,565 |
| Hybrid | 13,092,023 | 15,645,119 | 18,459,358 | 21,670,770 | 25,581,285 | 30,397,445 |
| 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 |
| 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 |

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



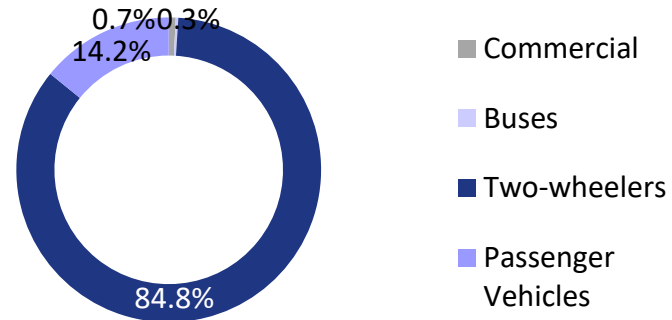
Source: BNEF

- EVs appear to be displacing the internal combustion-based vehicles, albeit slowly. To a significant extent, this is led by the policy consensus on managing carbon emission to mitigate climate change
- However, despite attractive growth prospects, so far EVs account for just about 1% of the total passenger vehicle fleet (IEA)
- With barriers such as in ownership cost and infrastructural gaps, the process to mainstream EVs is a protracted one

Electric Vehicle Penetration & Adoption (2/5)

Status and Growth by EV Segment:

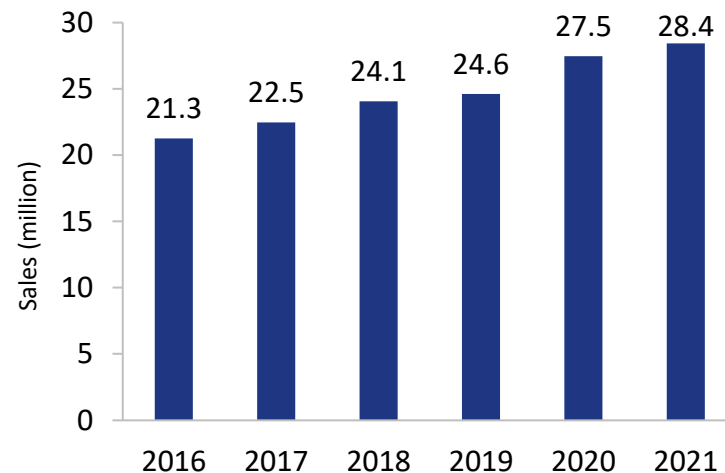
Global EV Sales by Segment (as of 2021)



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

- The current adoption appears to be predominantly skewed towards the two-wheeler segment
- The two-wheeler segment found steady offtake in China, Taiwan and Vietnam as well as Europe because of its affordability in terms of total ownership cost
- Startups lately emerged as the major entities pushing the case of electric two-wheelers, especially e-scooters

Global Electric Two-Wheeler Sales Trend

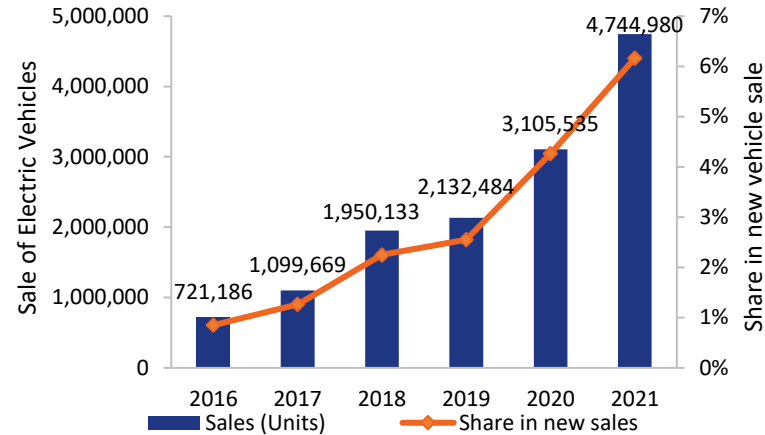


Source: BNEF

- 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
- With decline in the upfront prices, due to cheaper Lithium-Ion batteries, such two-wheelers are expected to be a price competitive option against their IC counterparts

Electric Vehicle Penetration & Adoption (3/5)

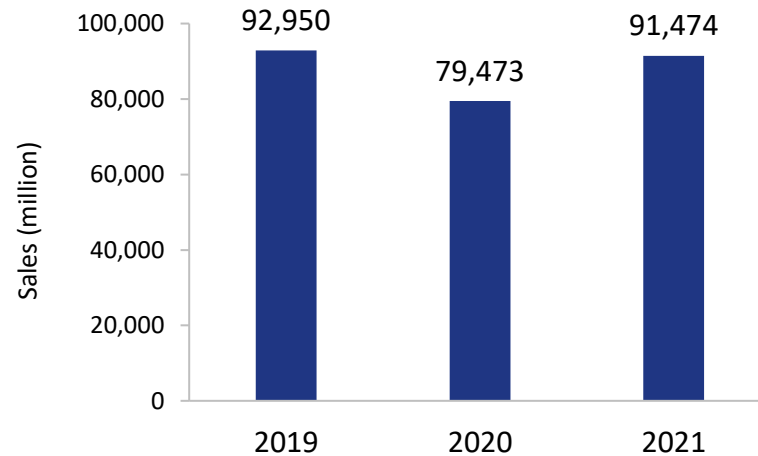
Global Passenger EV Sale and Penetration Trend



Source: BNEF

- The EV passenger market, gets the most focus in electrification of transportation, especially in private vehicle segment
- The EV passenger vehicles continue to be behind competition in cost, which impedes large-scale adoption in this segment
- Demand-side policy incentives and strict emission norms are thus instrumental in driving offtake

Global Sale of Electric Buses



Source: BNEF

- The growth in electric buses is an outcome of the policy stance on mitigating emissions in overall public transportation
- The drop in electric bus sales was observed during 2019 caused by Chinese subsidies rationalisation followed by COVID-19 outbreak in 2020. The business recovery since then helped improve the prospects
- However, despite demand recovery, lack of abundant fast charging infrastructure and absence of supportive local norms and regulations prolong the replacement of diesel-based buses by electric buses

Electric Vehicle Penetration & Adoption (4/5)

EV in Shared Mobility and/or Micro-Mobility

Trend in the Three-wheeler EV Fleet (BNEF)

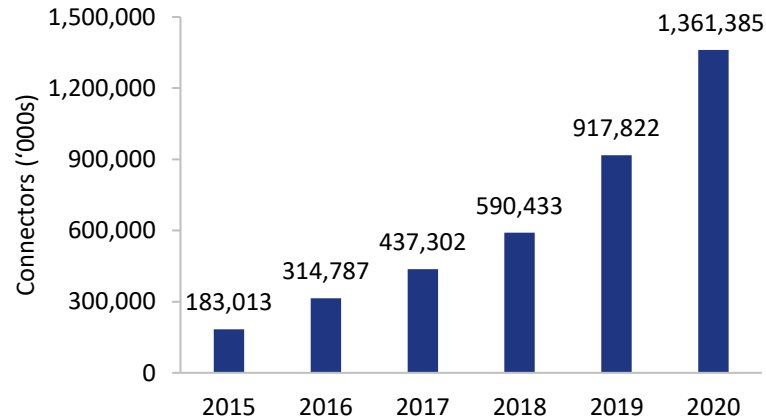
| | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|--------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| China | 49,400,000 | 54,000,000 | 60,000,000 | 63,646,749 | 67,525,790 | 70,800,057 |
| India | 900,000 | 1,737,500 | 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 |

- EVs are increasingly finding a critical role for the innovations in urban mobility, mainly through deployment as shared mobility or micro-mobility solutions
- Policy and regulatory environment in the countries, apart from technological advancements taking place, play vital role in shaping the market
- 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
- Electric bicycles of late emerged as a fast-growing medium. Notably, the sales growth in e-bikes has been steady, while the US is expected to become strong market for e-bikes in near future
- Electric scooter is another important segment, which has market expansion taken place across 50 countries globally, implying faster adoption compared to e-bikes

Electric Vehicle Penetration & Adoption (5/5)

Charging Infrastructure

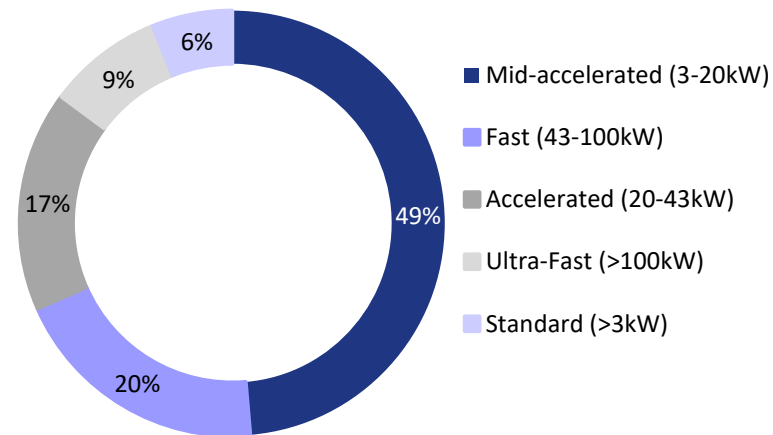
Cumulative Global Public Charging Connectors



Source: BNEF

- Charging infrastructure is the most critical element of EV adoption in the sense that ubiquitous charging base ameliorates the otherwise challenging limitation of range in a typical EV platform
- The growth of public charging infrastructure assumes significance, led by China. While in terms of charger density, the European countries rank among the highest
- As of 2021, the Netherlands has the maximum public charging connectors per 100,000 population, at 563, followed by others including Norway (315), Iceland (180), Sweden (114) and Denmark (112).

Public EV Charging Infrastructure by Power Category



Source: BNEF

- Several companies lately sought funding options for expansion or towards investing in EV charging companies
- Notable has been the rapid progress by global hydrocarbon majors, such as Shell, in acquiring the charging network companies to enter this space
- However, the need to upgrade the power standards of the charging points along with replacement of the legacy base of charging points with fast chargers persists

3. REGIONAL OVERVIEW OF EV ADOPTION

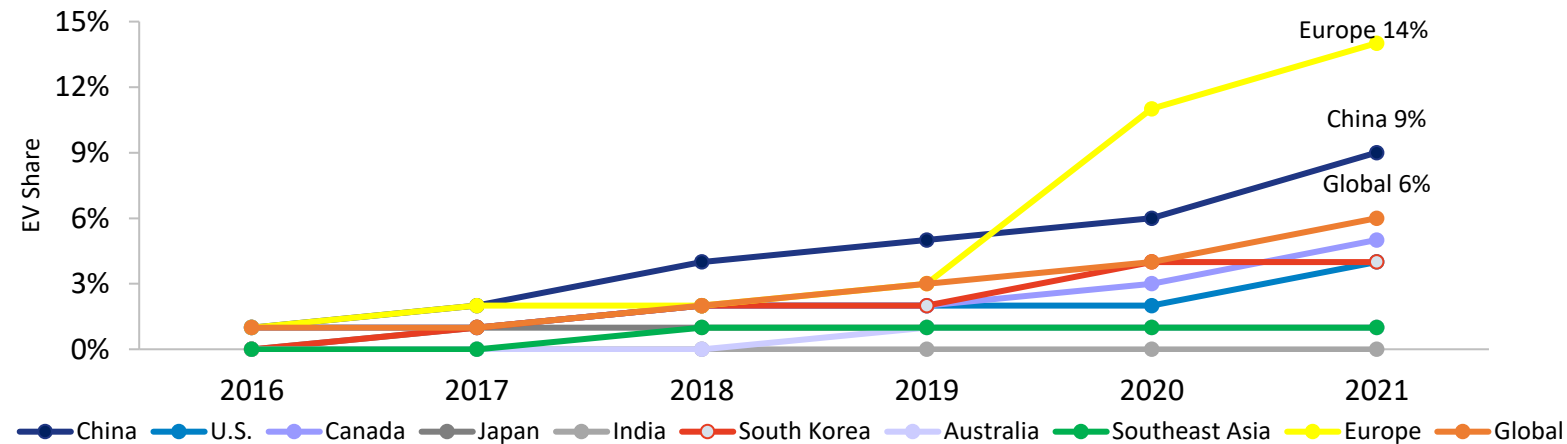
Regional Overview of EV Adoption (1/6)

Introduction

- European countries are the frontrunners in terms of EV penetration, share of battery-based vehicles is nearing a tipping point
- In absolute terms, China is the market leader in terms of the total EV sales as well as the supporting infrastructure
- Extensive adoption of EV in both Europe and China can be explained by strong regulatory support involving mix of mandate and incentives

The Top Countries/Regions in EV Adoption

EV Share of New Passenger Vehicle Sales by Country/Region

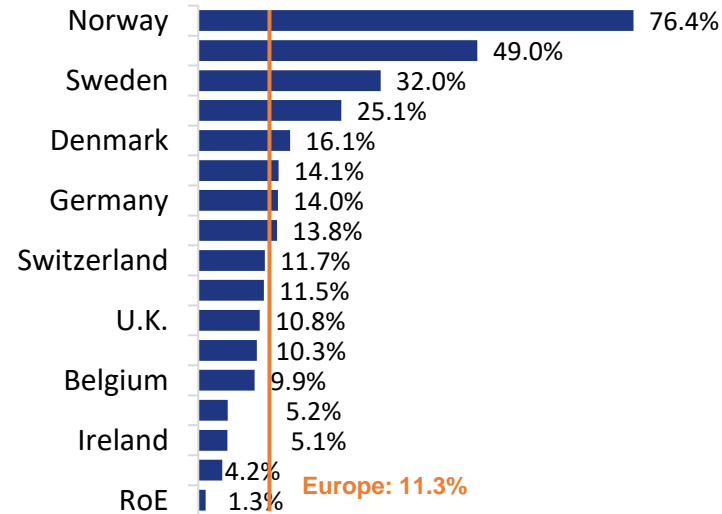


Note: Data refers to BNEF estimates for the year 2021
Source: BNEF

- China continues to be the leading country in terms of EV penetration, while Europe has a lead region in EV penetration
- North American region, led mainly by the US, has been lagging after a brief progress till last year in the EV penetration
- With all the countries taken together except China, the Asia-Pacific region's penetration is much lower
- The thrust for EV adoption in China is attributed to long-term economic growth and some of the strongest policy mandates towards electrification in transport
- Although, national plan of progressive phase-out of purchase subsidy support for EVs by 2022 negatively impacted the sales in China. But it made up for the lost ground with rapid recovery in 2020

Regional Overview of EV Adoption (2/6)

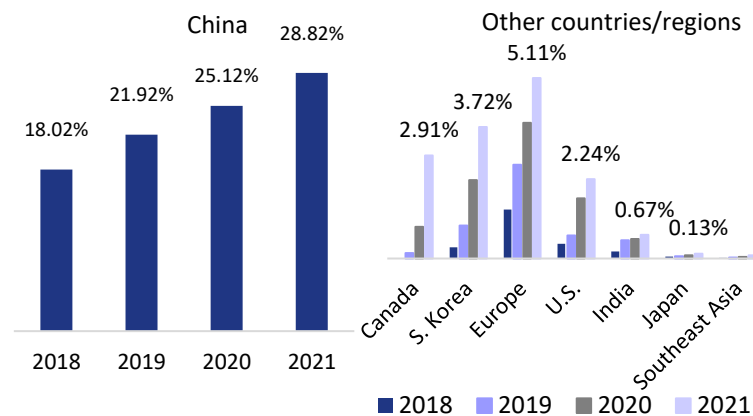
Share of Electric Vehicles in the New Vehicle Sales of European Countries (as of end-2020)



- Selected European countries are already the top-ranking ones globally in EV penetration
- Europe is currently the priority market for most of the OEMs to address for the sheer policy-led demand growth underway
- The manufacturers in the region, however, face the prospects of punitive costs for failure to meet emission targets, stem from the goals of reducing total carbon emissions in the economy
- Nevertheless, the persisting regulations are even expected to impact the bottom-line in the short-term

Source: BNEF

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

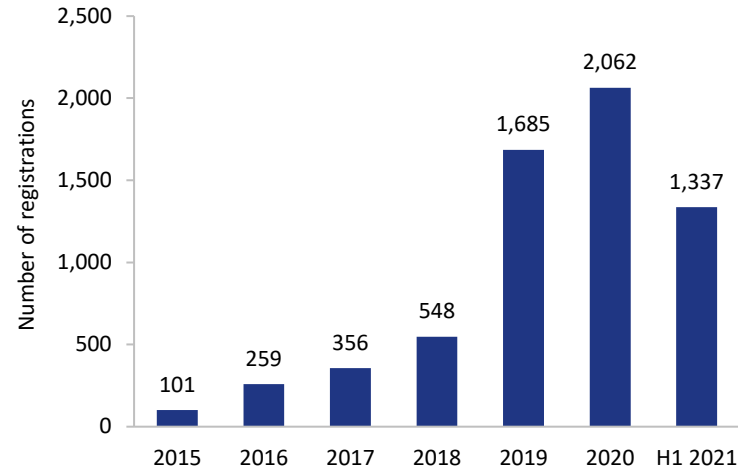


- As per BNEF estimates, electric buses account for approximately one-fifth of the total global bus fleet
- So far, the progress in this direction has been limited, in part due to the lack of adequate charging infrastructure
- China holds the largest share of electric buses in its total fleet thus, coming across as the largest e-bus market globally

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

Regional Overview of EV Adoption (3/6)

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 its e-bus fleet
- Key European countries such as Poland, France and the Netherlands are seeking replacement of their existing bus fleet with the e-buses

Share of Electric in Total Two-Wheeler Sales by Market

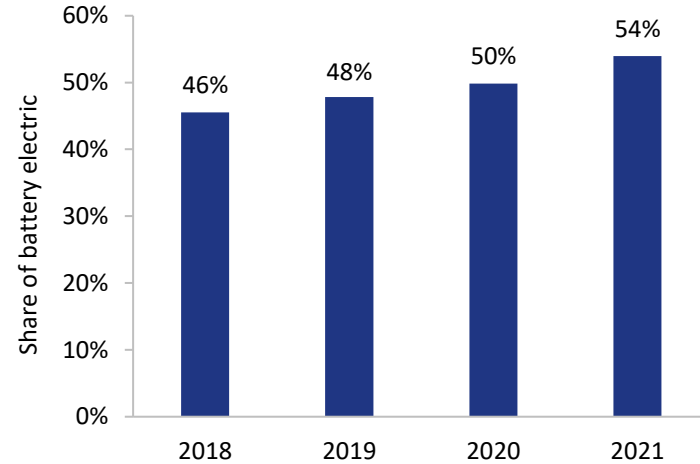
| | 2016 | 2017 | 2018 | 2019 | 2020 |
|---------------|------------|------------|------------|------------|------------|
| China | 59% | 59% | 63% | 61% | 68% |
| Vietnam | 9% | 11% | 9% | 12% | 14% |
| India | 0% | 0% | 0% | 1% | 1% |
| Taiwan | 5% | 5% | 12% | 19% | 10% |
| Europe | 1% | 2% | 4% |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

Source: BNEF

- Volume-wise, it is the EV two-wheeler and three-wheeler segments that hold the predominant share of the units sold
- About three-fourths of the global two-wheeler sales come from three countries – China, India, and Indonesia
- Electric two-wheelers and electric bicycles are 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

Regional Overview of EV Adoption (4/6)

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

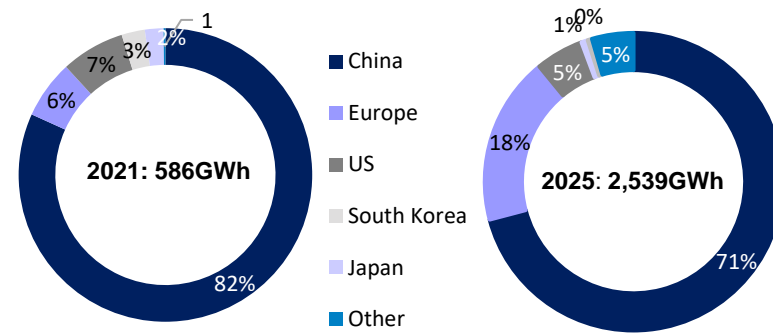


- The three-wheeler segment is a smaller market than that of two-wheelers globally
- China and India are the two major markets, both achieving high electrification levels in the segment
- Although China's three-wheeler fleet is larger than that of India, the attention is likely to shift to the Indian market as rationalisation in costs spurs a larger scale of adoption

Source: BNEF

Battery and Charging Infrastructure

Lithium Cell Manufacturing Capacity by Plant Location Region

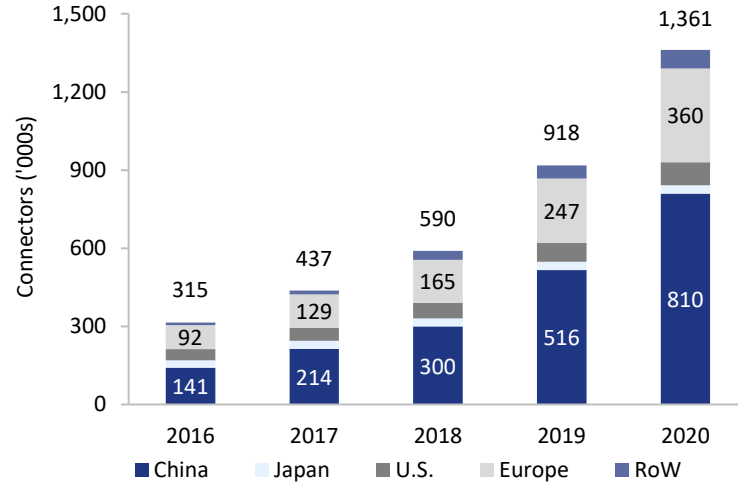


- The demand for batteries globally is predominantly driven by the EV industry, in which the passenger EVs are the most important
- BNEF estimates suggest that with ongoing facilities under development globally, the total manufacturing capacity could quadruple by 2025
- While China's market dominance is given in the battery manufacturing segment, European region is poised to massively enhance its indigenous production base.

Source: BNEF

Regional Overview of EV Adoption (5/6)

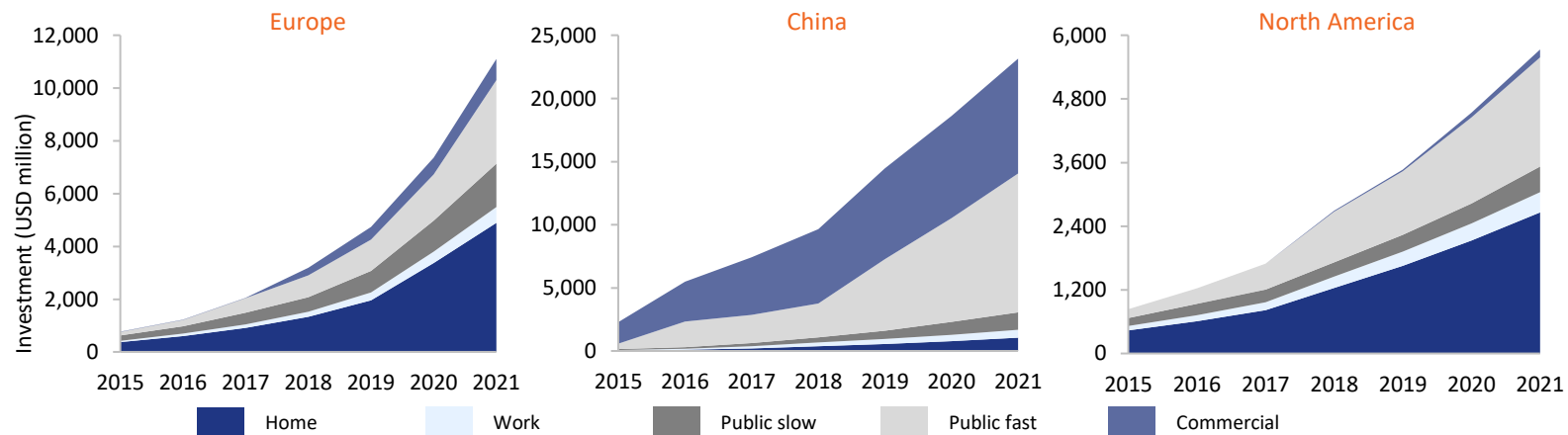
Cumulative Global Public Charging Connectors



- In the absolute capacity base, 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

Source: BNEF

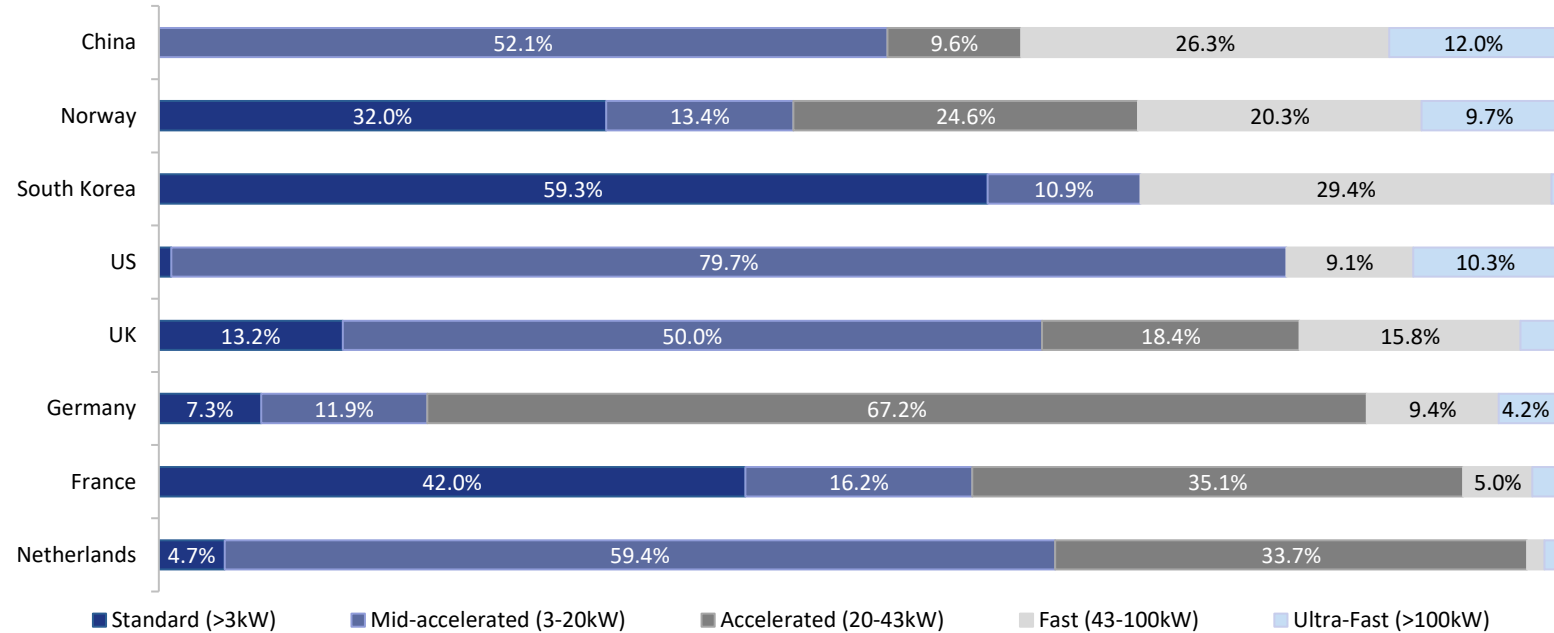
Infrastructure Investment in Key Regions across the Charging Categories



Source: BNEF

Regional Overview of EV Adoption (6/6)

Share of Public EV Charging by Speed, in Select Countries



Source: BNEF

- With the expansion in charging infrastructure, the charging points also need to be upgraded in rating
- As trend suggests, fast chargers are required to enable greater ease of use and adoption of EVs across segments
- Considering the already limited base so far in the provision of the charging infrastructure, the growth of fast chargers is restricted to mature markets
- 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

4. TRENDS & DRIVERS

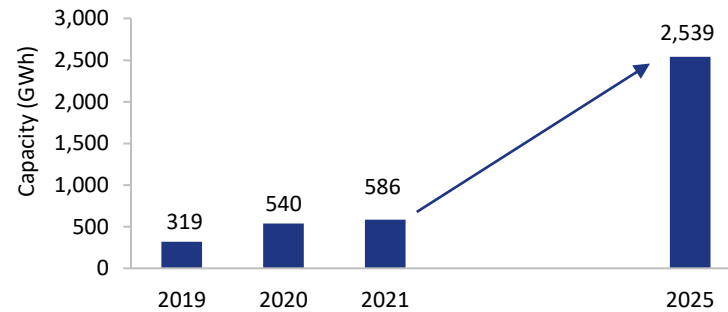
Trends & Drivers (1/6)

Introduction

- The transition to EV-based drivetrain is gaining momentum. Although, with barely 1% of the global passenger vehicle fleet by drivetrain, EVs have a long way to make a dent in this market
- Of late, deliberate policy and regulatory action have propelled the progress towards electrification. They have also pushed several automotive manufacturers, technology providers and related stakeholders to shift business orientation drastically

Battery Cost and Supply

Lithium-Ion Battery Manufacturing Capacity Trend and Projection



Source: BNEF

- The Lithium-Ion battery plays the predominant role in the entire electric vehicle ecosystem.
- Existing annual battery manufacturing capacity stands at about 586GWh in 2021 – almost double than that of in 2019.
- As per BNEF estimates the various manufacturing projects in pipeline globally, point to an expected quadrupling of the current capacity by 2025.

Global Battery Cell Manufacturing Locations and Key Players

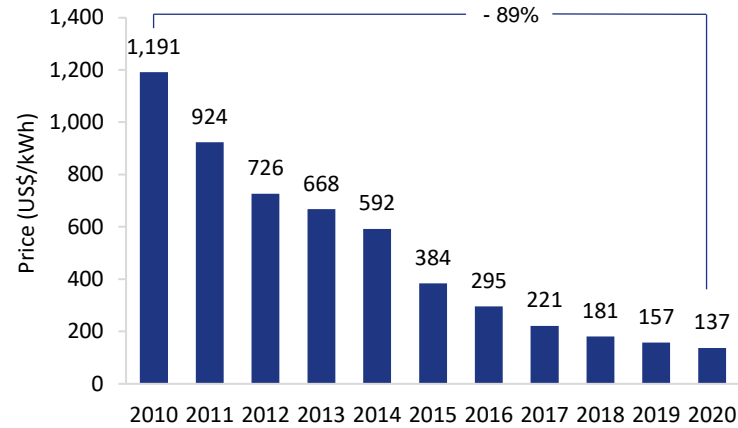


Source: KPMG and CII report on EV Landscape in India

- Globally, the battery manufacturing capacity is concentrated in selected production hubs
- China dominates over a three-quarter share of total global capacity in this regard. It has access to critical material supply and the facilities set up for the supply chain

Trends & Drivers (2/6)

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

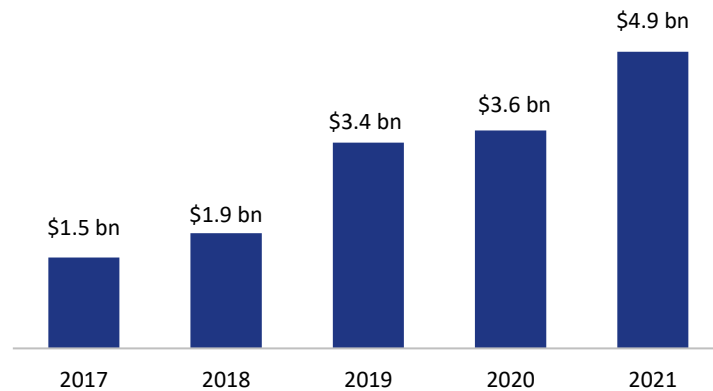


Source: BNEF

- The sharply declining trend in battery prices reinforces the competitiveness of Lithium-Ion technology over other storage options in the market
- 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

Charging Infrastructure

Trend in Public Charger Investment



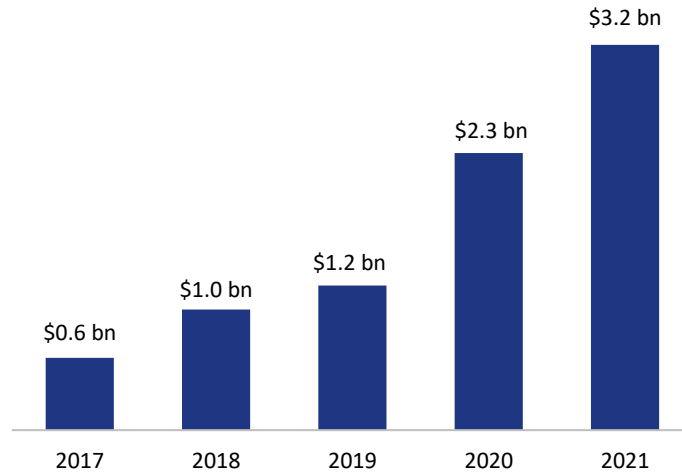
Note: Data for 2021 is an estimated one

Source: BNEF

- The charging infrastructure availability is assuming a critical role in EV adoption
- 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.

Trends & Drivers (3/6)

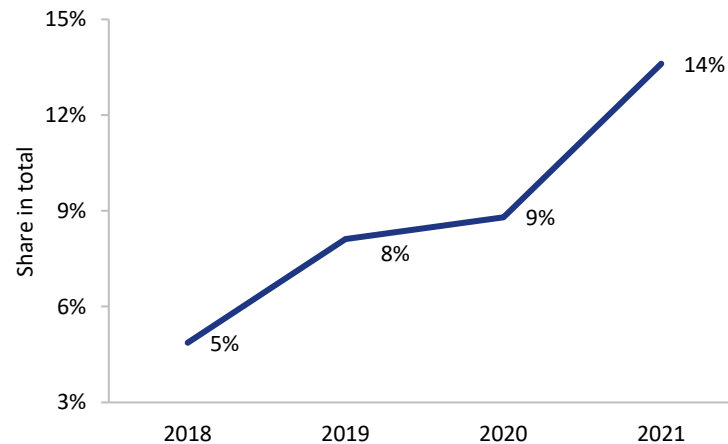
Trend in Home Charger Investment



Note: Data for 2021 is an estimated one
Source: BNEF

- In volume terms however, home charger installations outnumber those in public segment, growing four times during 2019-2021
- As per BNEF estimates, 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



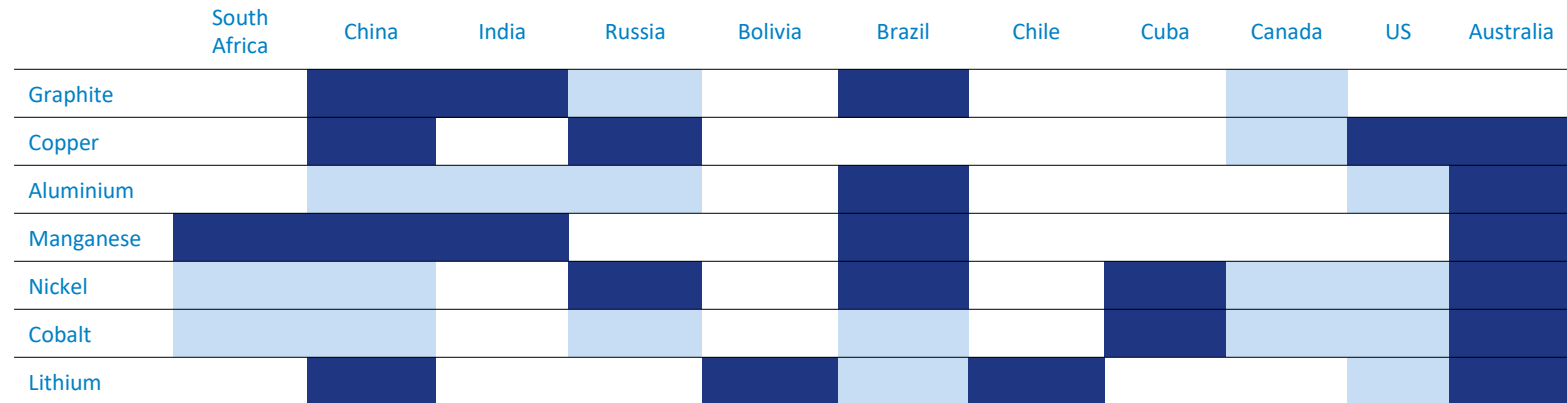
Source: BNEF

- The fast chargers constitute about 20%-40% of the annual public charger investments, even as their share in total installations averages around 20%
- The ultra-fast charging stations (rated above 100kW) installation shows a rising share, progressively taking place in urban locations such as supermarkets or on the public highways

Trends & Drivers (4/6)

Localisation

Reserves of Lithium-Ion Battery Raw Materials in Selected Countries

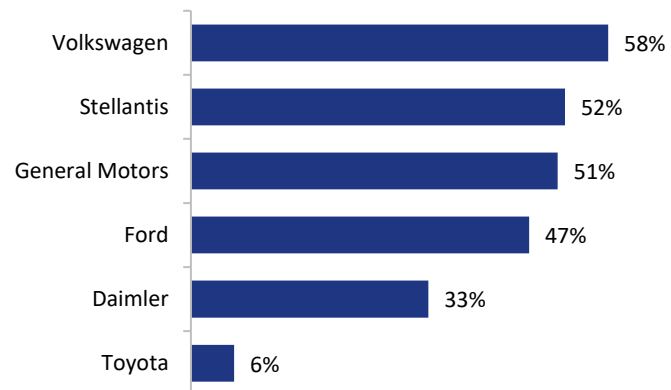


Source: KPMG report on Electric Vehicle Landscape in India

Significant proportion as a per cent of global known reserves
 Low proportion as a per cent of global known reserves

Corporate Sector's Initiatives and Commitments

Major automakers' R&D and capex commitments on EV and digital tech in 2020 (% of total)



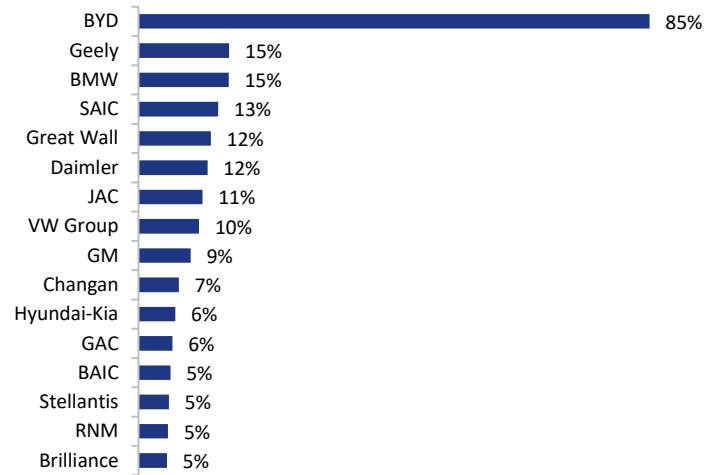
Source: BNEF

- A significant part of the progress in EV industry is driven by the corporate sector's steps, such as capital outlay towards EV research and development (R&D) and related digital technologies
- Notably, some of the biggest automakers globally have committed an accelerated capital spending plan for electrification within the next five years

Trends & Drivers (5/6)

Market Players and Competition

Share of Electric Vehicles in Automakers' Total Sales, Q3 2021

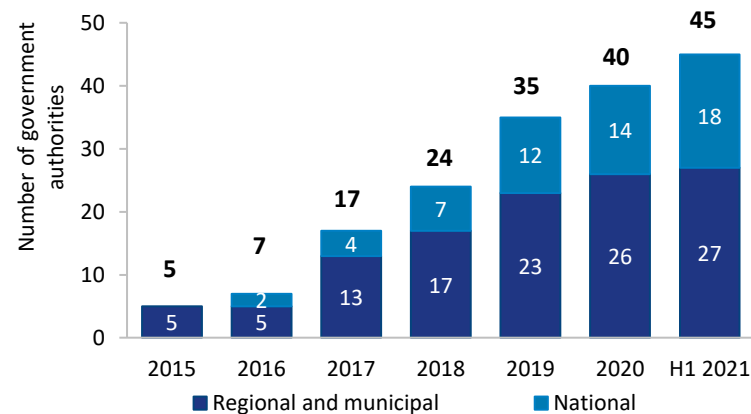


Source: BNEF

- For many automobile manufacturers, EVs are becoming a vital part of the product mix as they face pure-play EV manufacturers such as Tesla and NIO
- Chinese major BYD has emerged as among the key players in global EV marketplace with over 80% of its total sales attributed to EVs

Role of Government

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

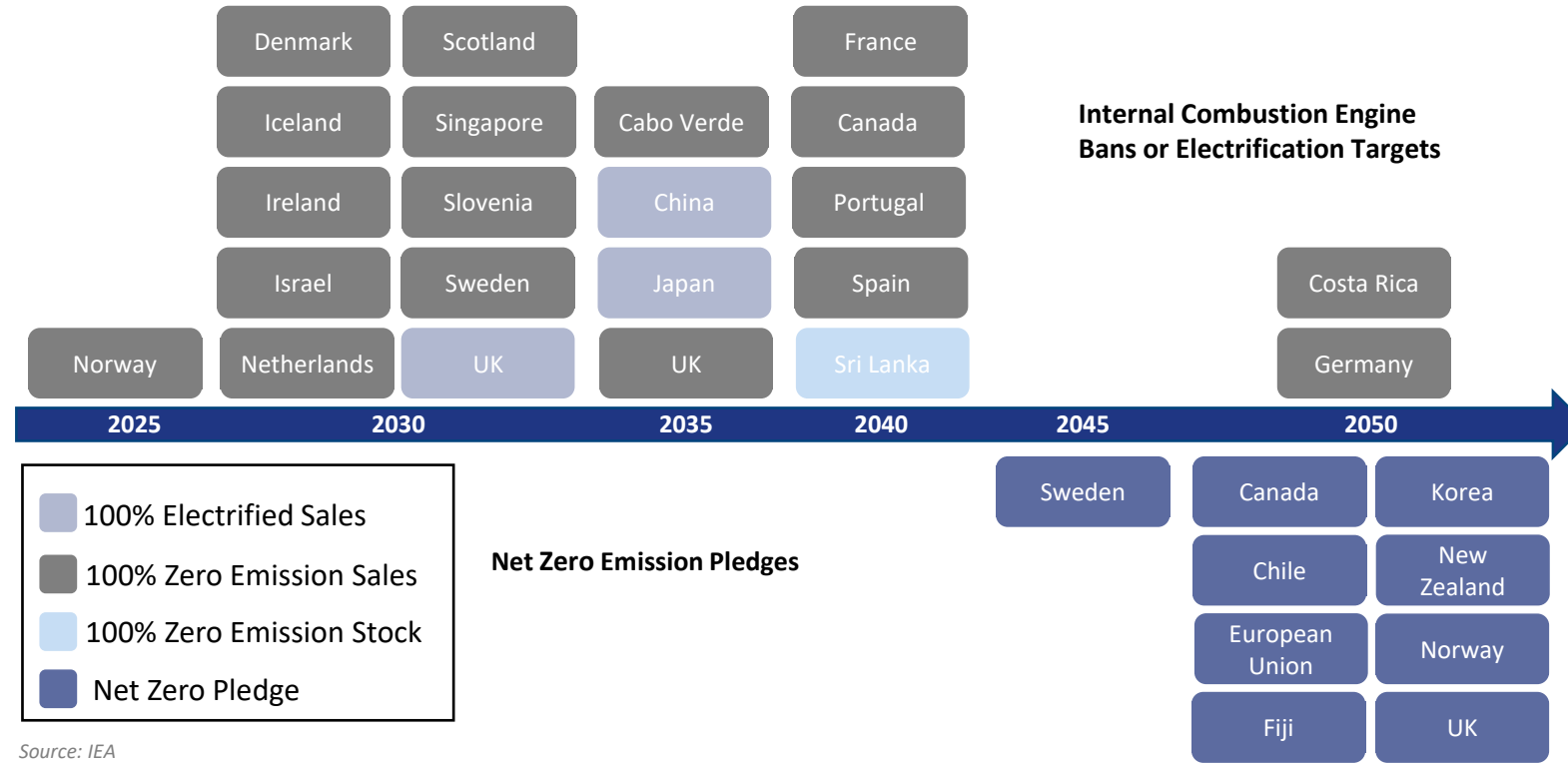


Source: BNEF

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

Trends & Drivers (6/6)

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



Source: IEA

- Globally, the growth fundamentals of EV market are being underpinned by the policy and regulations
- 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
- Nevertheless, 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

5. OUTLOOK

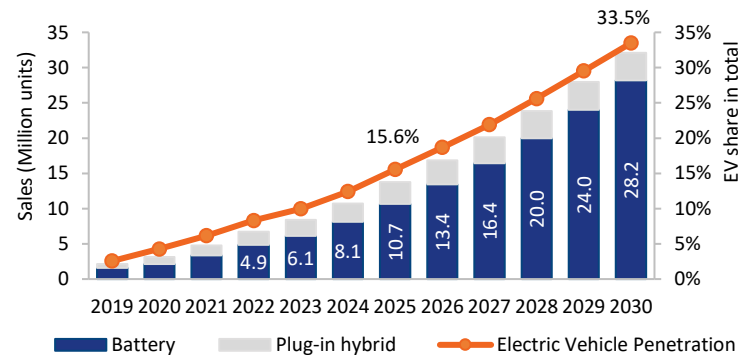
Outlook (1/6)

Introduction

- Globally, the transition to EV-based drivetrain is underway in varied pace and momentum. The leading markets, as in China and the European region, set the context of the transition to EV-based drivetrain due to the rapid growth and the predictable policy roadmap on the same
- The transition entails a significant change as this impacts the key players in the overall value chain including automotive manufacturers, municipal authorities and utilities / grid operators

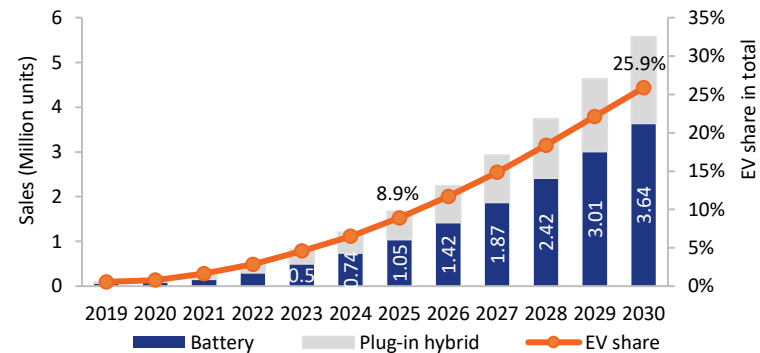
EV Adoption and Penetration

Projected Global Passenger EV Sales and Penetration



Source: BNEF

Projected Global Commercial EV Sales and Penetration



Source: BNEF

- Passenger electric vehicles' segment attracts the maximum attention in policy framework.
- The passenger EVs are likely to account for a rising share of new vehicle sales, reaching a projected one-third level by 2030, led by battery electric vehicles
- 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
- Significant share 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 (2/6)

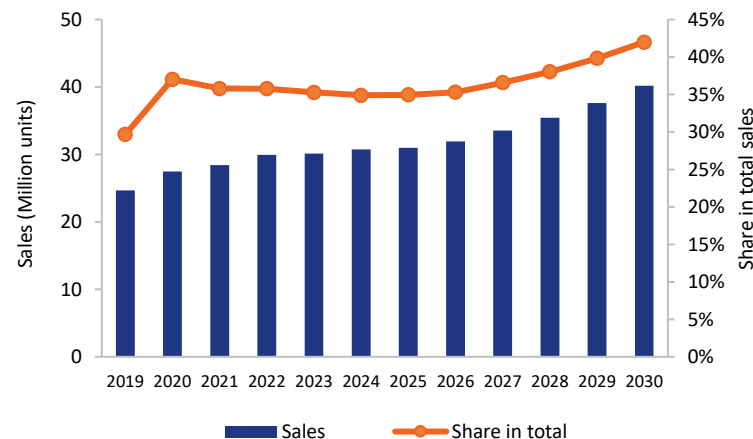
Projected Global Electric Bus Sales and Penetration



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
- The 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 Two-Wheeler Sales and Penetration



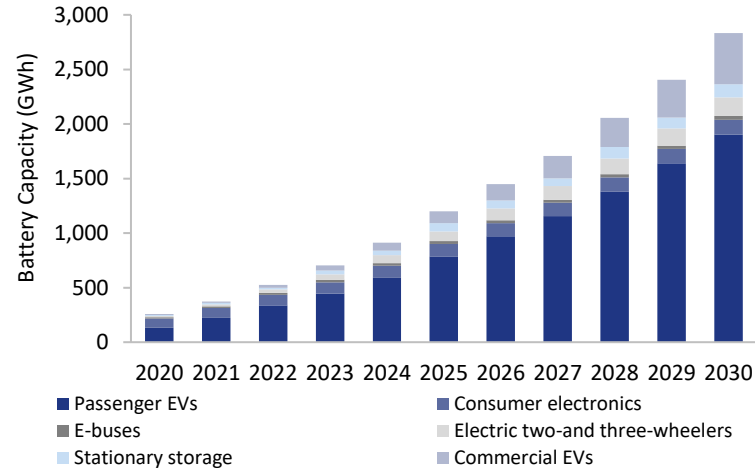
Source: BNEF

- Electric two wheelers has progressed in last couple of years
- 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
- China is the global leader in this space, while growth is expected to be driven by countries such as Taiwan, Vietnam and India in near future

Outlook (3/6)

Battery & Charging Infrastructure

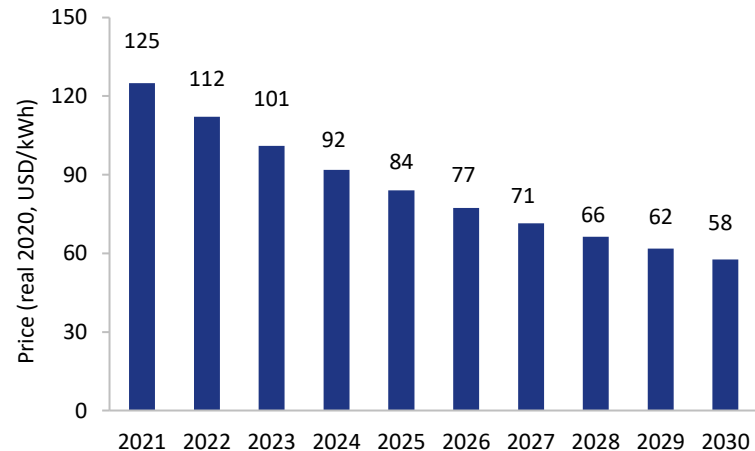
Projected Lithium-Ion Battery Demand Outlook



Source: BNEF

- As per BNEF, for Lithium-Ion batteries passenger electric vehicles accounted for over half of the total demand in 2020
- Projections, using the same source, show that electric vehicles' share in global battery demand rising to 90% by 2030

Projected Lithium-Ion Battery Pack Price

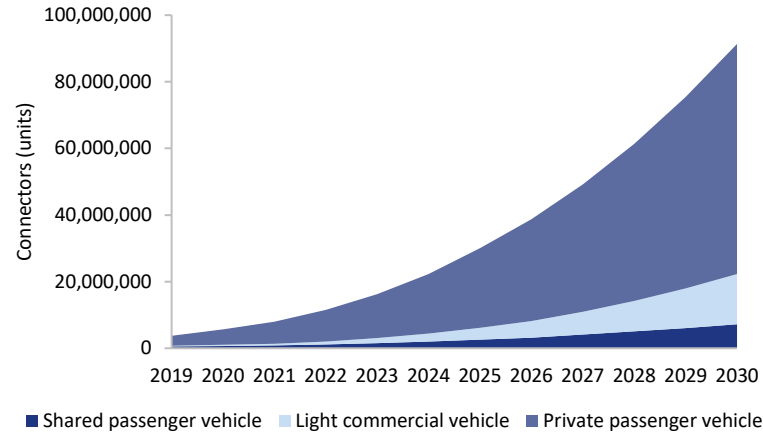


Source: BNEF

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

Outlook (4/6)

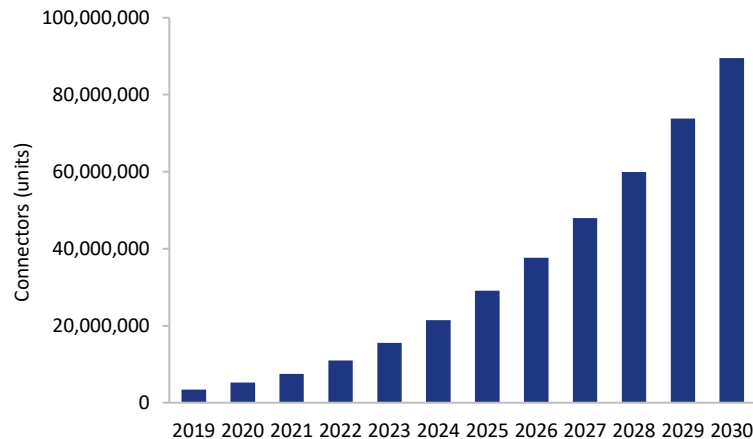
Projected Public Charging across Major Electric Vehicle Segments (no. of connectors)



- Passenger electric vehicle market holds the maximum importance for the required charging connectors
- The projected charging infrastructure requirements are largely based on the energy demand likely from the emerging electric vehicle demand across countries

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)

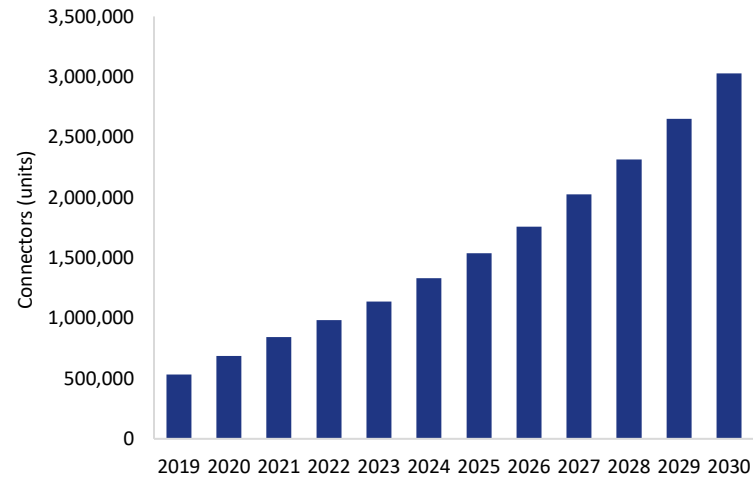


- Home charging is the largest category, accounting for 80% of share in the projected capacity.
- As BNEF projections indicate, much of the future growth will be led by the existing base of relatively slow chargers (up to 22 kW) that are amenable for AC power connections at home/office.

Source: BNEF

Outlook (5/6)

Projected Public Fast Charging Capacity (50 kW and above)

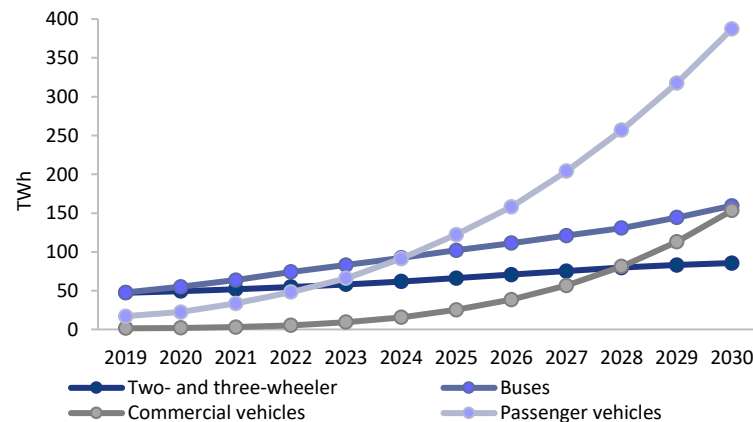


- Fast charging (50 kW and above) is gaining traction, partly with the push from EV manufacturers to enable the adoption.
- The large availability of faster charging infrastructure facilitates rise in the number of EVs per public charging connector, resulting in better utilisation levels.

Source: BNEF

Integration of EVs in Power System

Projected Electricity Demand Attributed to Electric Vehicles



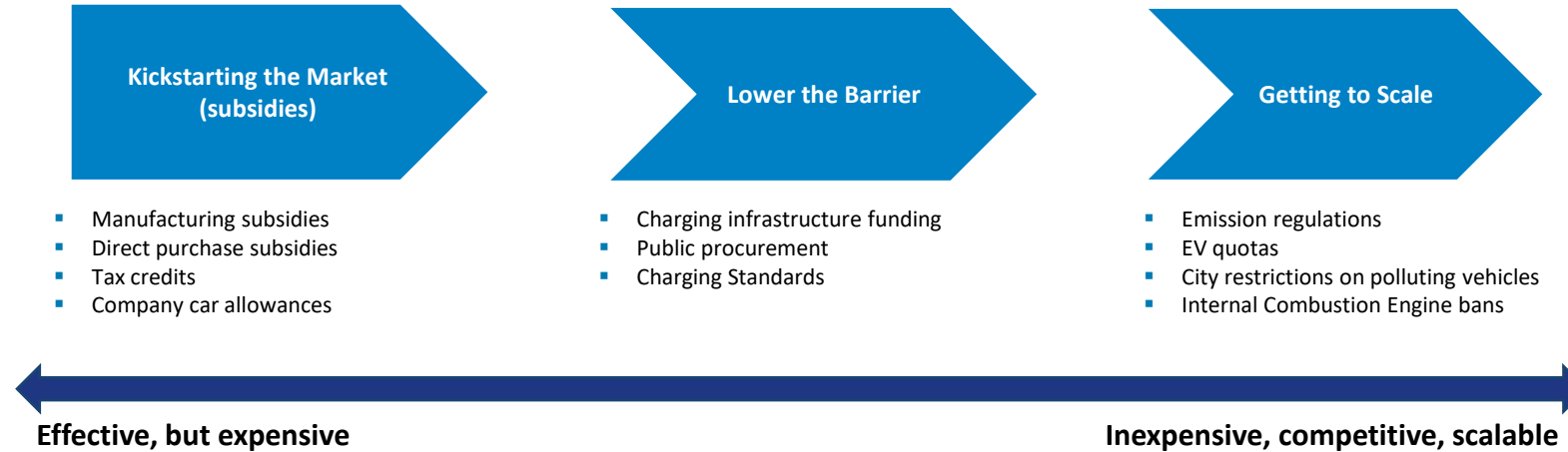
- The unprecedented rise in EV adoption will necessitate steps to balance the overall power system with which it is to be connected.
- As per BNEF projections, by 2030, the electricity demand from such vehicles could reach almost 800TWh, which showcases a small part of the total global electricity consumption and on it own is unlikely to cause any displacement.

Source: BNEF

Outlook (6/6)

Policy / Regulatory Outlook

Evolving Policy Structure for Electric Vehicle Market (BNEF)



Source: BNEF

- The policy support to boost electric vehicle penetration has been, more or less, similar across the globe
- The stages of the financial aid deployment include 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
- China, the global market leader, will be completely phasing out the passenger vehicle subsidies in 2022. Similarly, countries such as UK are planning a reduction in the purchase grants offered for passenger battery electric vehicles and vans
- The globally leading markets of China and Europe are thus progressively shifting to adoption of supply-side policies
- However, climate and energy policy targets devised by governments are expected to play important role in the respective context, driving the market equilibrium

Contact us

CleanBridge Group LLLP, CleanBridge Securities LLC and CleanBridge Advisors (UK) Ltd

Miami office: 2601 South Bayshore Drive, Suite 1130, Miami, FL 33133, United States

London office: 50 Grosvenor Hill, London W1K 3QT, United Kingdom

Tel: +1 (305) 577 - 9799 • Fax: +1 (305) 577 - 9766

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