

BENORI

**China:
The undisputed leader
of the global EV market**



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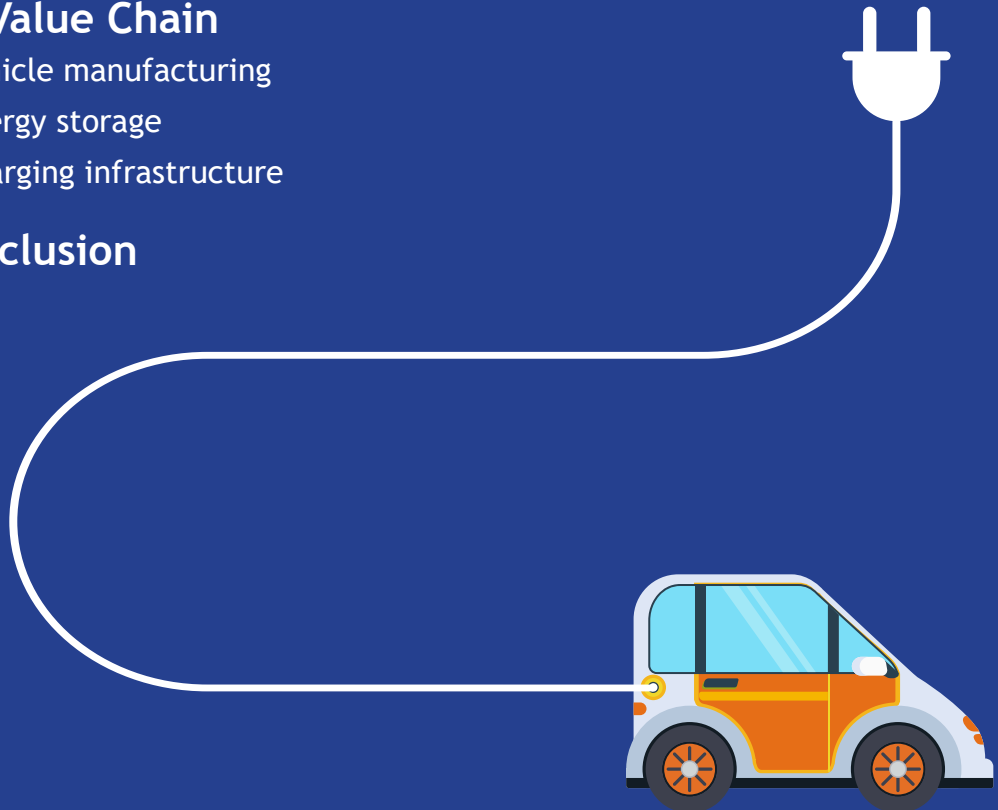
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Executive Summary

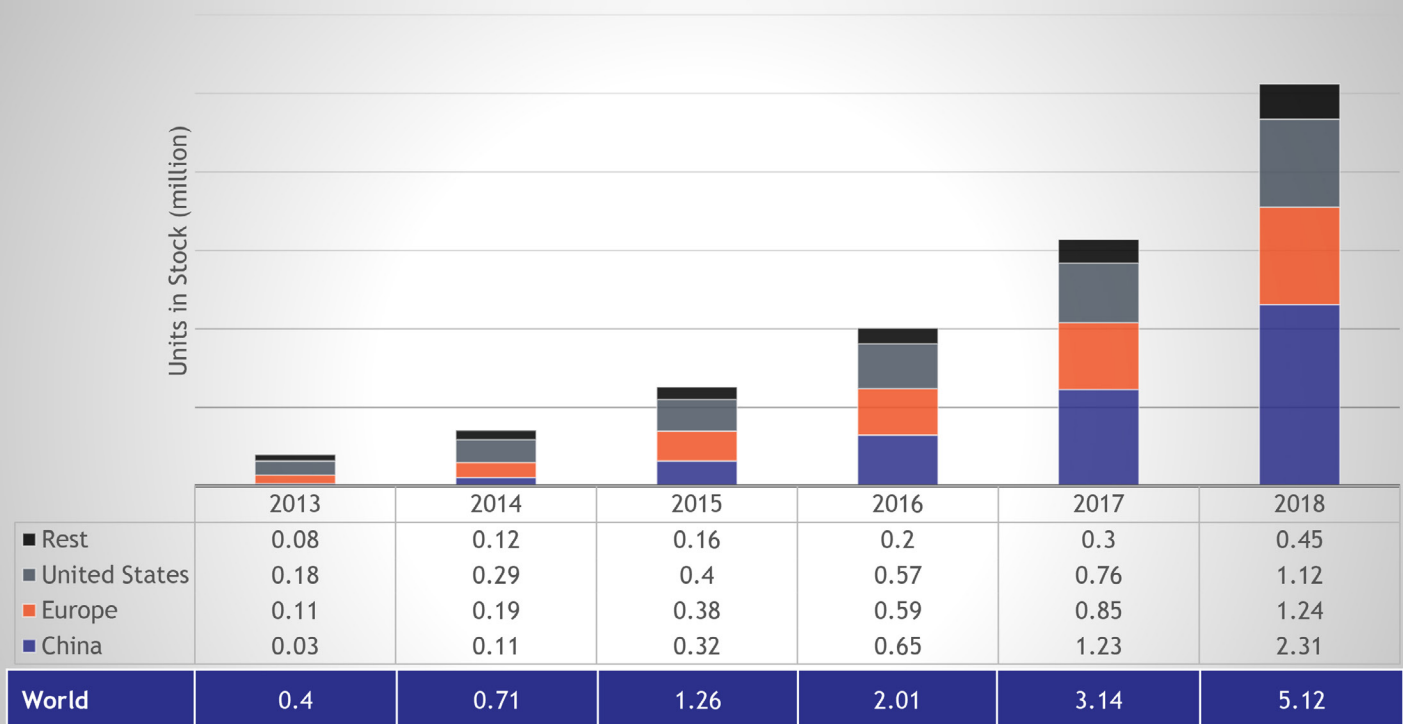
Rise of Electric Vehicles (EVs) across the globe

Excessive Greenhouse Gas (GHG) emissions from conventional internal combustion engine (ICE) vehicles have resulted in a worldwide environmental consciousness. The global commitment for combating climate change has encouraged the demand for smart mobility and hence has supported a rapid growth for **Electric Vehicles (EVs)**.

The global stock of EVs (BEVs + PHEVs)¹ has risen manifold in the last decade, surpassing 5 million units in 2018, a 63% increase over the 2017 number. In 2016, China emerged as the global leader in the EV market surpassing the performance of the US market. As of 2018, the country has successfully sustained its position in terms of both, EV units in stock and total units sold.

In terms of the market stakeholders, several power corporations, charging point operators, charging hardware manufacturers and other players are being acquired by utilities and major energy companies. Global OEM giants and electricity storage manufacturers are also increasing investments or collaborating to boost product innovation, showing confidence in the promising future of the EV industry.

Global EV deployment in selected countries (2013-2018)



Source: IEA

■ China ■ Europe ■ United States ■ Rest

¹ BEVs (Battery Electric Vehicles) are powered by electricity completely; PHEVs (Plug-in Hybrid Electric Vehicles) are powered by both electricity and fuel. Another segment, HEVs (Hybrid Electric Vehicles) were not covered under the study as they combine the electric propulsion system with the internal combustion engine (ICE) system, which due to GHG emissions are not categorized as NEVs, hence not relevant for this paper.

China - The undisputed leader of the EV market

China has become the world's largest electric car market over the past decade due to various government initiatives and supportive policy framework. In 2018, with about 2.3 million units (BEVs + PHEVs) in circulation, China contributed the lion's share (45%) to the global EV fleet, followed by Europe (24%) and the US (22%). Of the total EV units on Chinese roads, 77% were BEVs and the rest were PHEVs.

China's EV market in 2018 saw a growth of about 85% over the previous year. Proving the country's supremacy in the NEV¹ industry, this figure was significantly higher than the industry average for the year. The year also marked China's NEV share in the automotive market reaching an all-time high of 4.2%. The country's administration and regulatory authorities have played a critical role in laying the groundwork for this exponential growth.

Chinese government is accelerating the EV adoption rate in the domestic market through various investment, incentive and policy measures. It has expressed intentions to completely ban ICE vehicles in the future, which will lead to greater penetration of EVs in the country. In fact, the Government has initiated studies to identify a possible timeline for exiting from fossil fuel cars altogether.

Surge in the global EV sales, penetration in the domestic market and advances in technology have led to major drops in the costs of EV manufacturing, storage systems and charging infrastructure. Market estimates for 2020-2025 indicate a significant drop in the prices of battery electric vehicles (BEVs), nearing cost parity with ICE vehicles.

Having pledged its support to the EV30@30 campaign i.e. reaching a 30% market share for EVs by 2030, the government is focusing at scaling the EV sector growth. It is targeting the annual sales of NEVs to reach 2 million units in 2020 and up to 7 million units by 2025.

¹ NEVs (New Energy Vehicles) include plug-in hybrids, battery-only electric vehicles and those powered by hydrogen fuel cells.

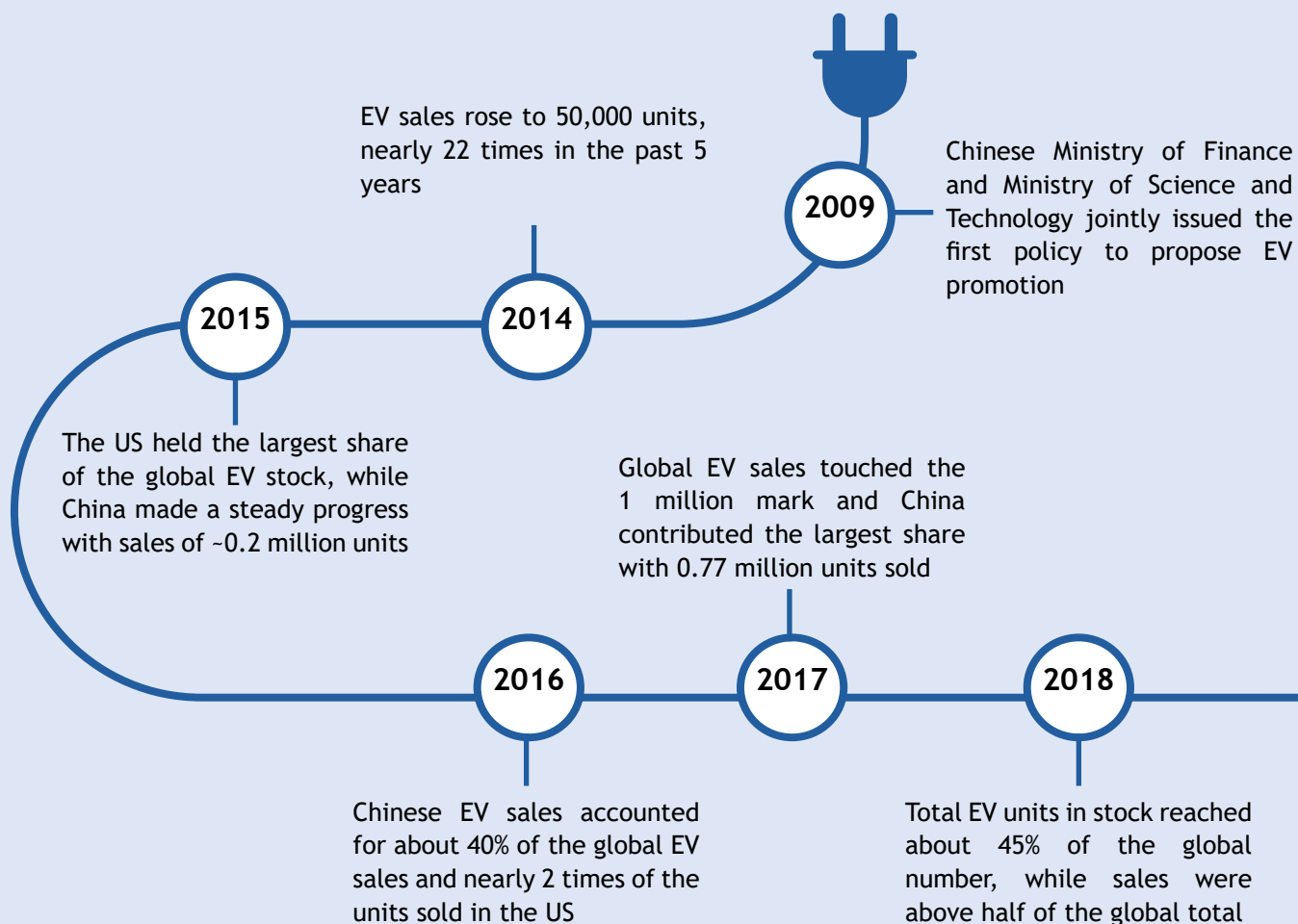


EV Growth in China

Journey along the past decade

What began as a policy change by the government in the year 2009, helped establish an ever-growing industry in China within less than a decade. Starting with EV sales of about a few thousand units in 2009, the country outdid the US to become the new leader of the global market in 2016. **In 2016, China had about one-third of the world's electric cars in stock and closed over 40% of global EV sales, which was more than twice the units that US sold.**

With a continuous rise in demand-supply, advanced manufacturing infrastructure, leading technological capabilities and a reassuring regulatory scaffold, China has effectively sustained its position as the undisputed EV market leader. **In 2018, the country sold nearly 1.1 million units and had 2.3 million units in total - almost half of the global electric car stock.**



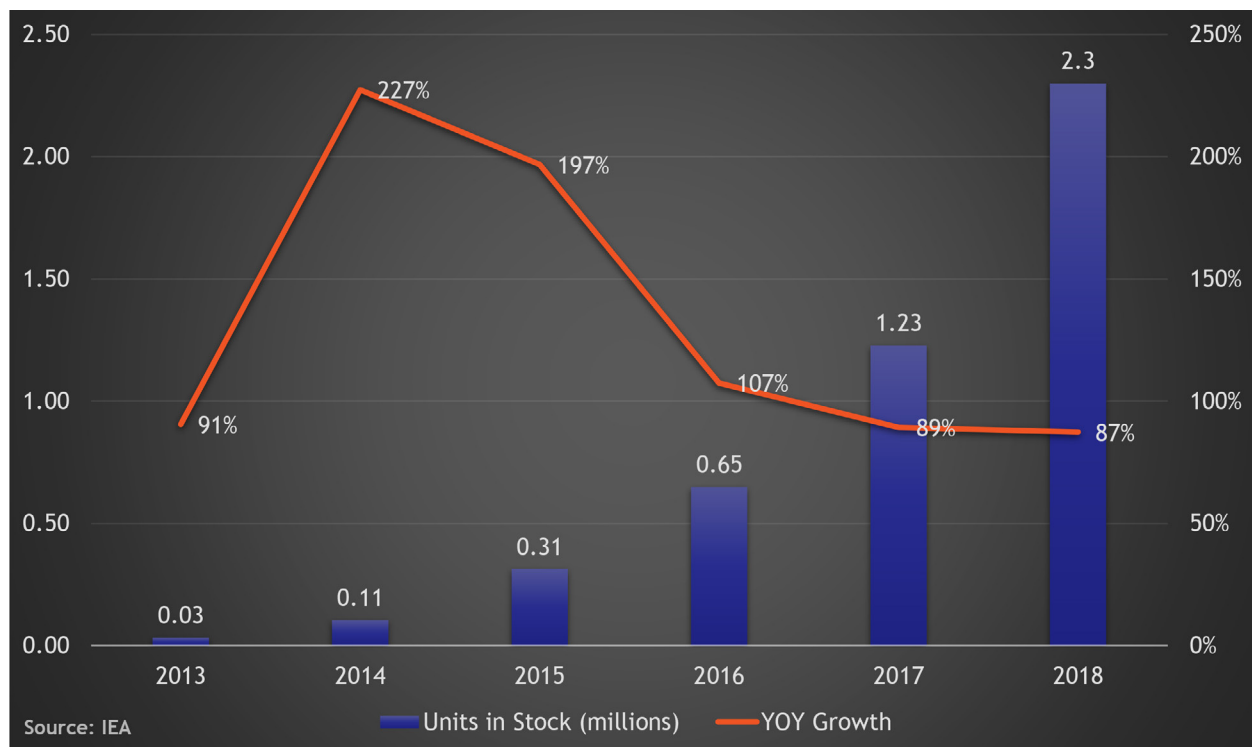
Current market update

In 2018, China registered a year-on-year (YOY) growth of about 85% in the EV market, which was significantly higher than the industry average for the year. The market share of new electric cars in the country additionally rose and exceeded 4.2% in 2018. In absolute terms also, the country outdid its top competitors - Europe and the US - for both categories, EV units in stock and units sold.

EV units in stock (circulation):

In 2017, around 40% of the global electric car fleet was in China when the number of electric cars on Chinese roads went beyond 1 million for the first time. In 2018, the country increased its share in the global EV fleet to about 45%. The number of units in stock almost doubled from 2017 figures to reach 2.3 million units. This is much greater than the units held by Europe or the US separately in 2018.

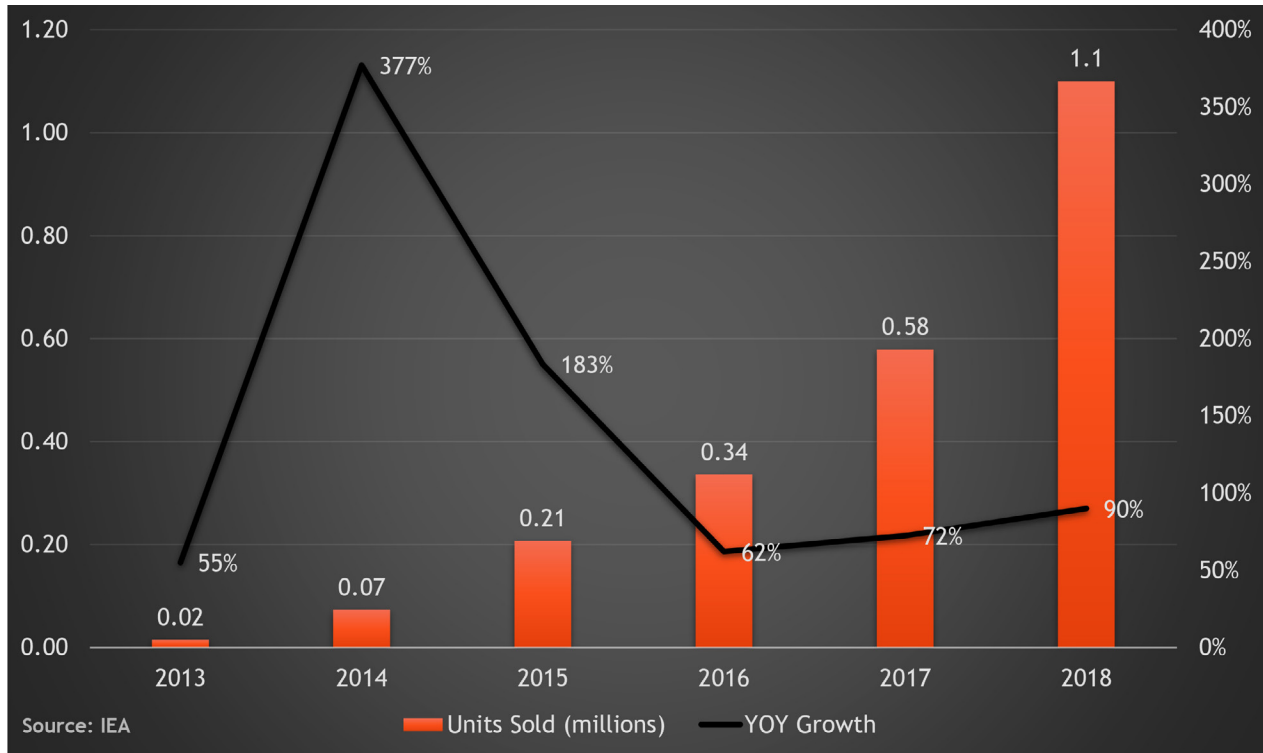
Electric car stock (BEV+PHEV) and YOY growth (2013-18)



EV units sold:

In the year 2017, about 0.58 million units of electric cars were sold in China, which was more than half of the EV sales globally. In 2018, the country remained the top contributor to global EV sales with a 51% share. **Having sold 1.1 million units in the year, China's EV market is now about thrice the size of the European and US markets each.**

Electric car sales (BEV+PHEV) and YOY growth (2013-18)



Top market segments

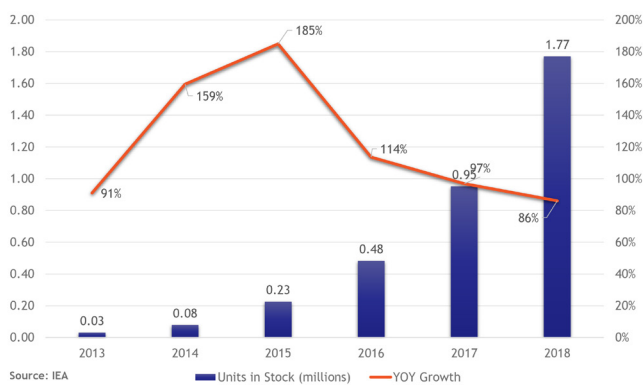
Battery Electric Vehicles (BEVs):

2017 marked a historic year for the Chinese BEVs, with units in circulation reaching close to a million, the highest in the global BEV market. In 2018, at 1.77 million units the country accounted for almost 54% of the global BEV stock which was 3.29 million units.

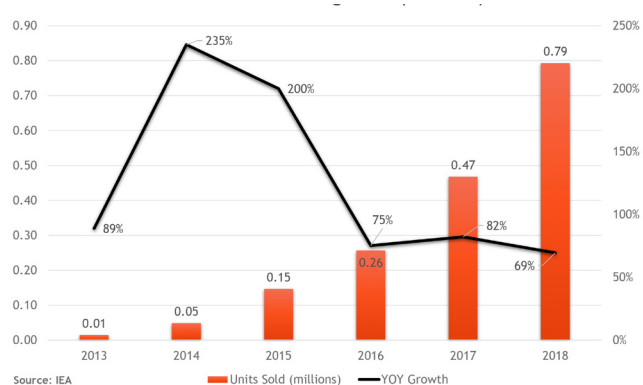
The total number of BEVs in circulation in China have continuously seen an upward trend over the past decade. **In fact, one third of the electric cars in the world today are Chinese BEVs.** However, in terms of the year-on-year growth, China’s stock of BEVs has witnessed a decline since 2015 and hit a record low of 86% in 2018.

Despite a slower YOY growth over the last couple of years, the number of Chinese BEVs sold has continuously increased, reaching about 0.79 million in 2018.

BEV Stock and YOY Growth (2013-18)



BEV Sales and YOY Growth (2013-18)

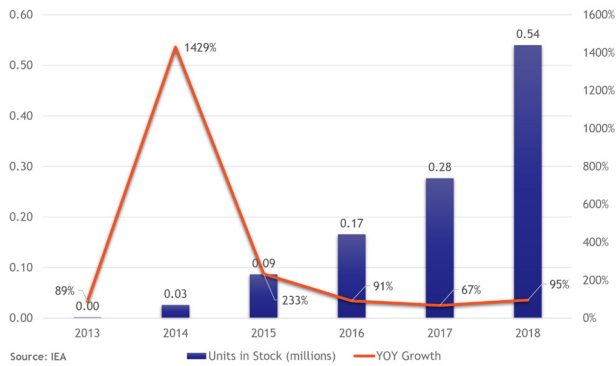


Plug-In Hybrid Electric Vehicle (PHEV):

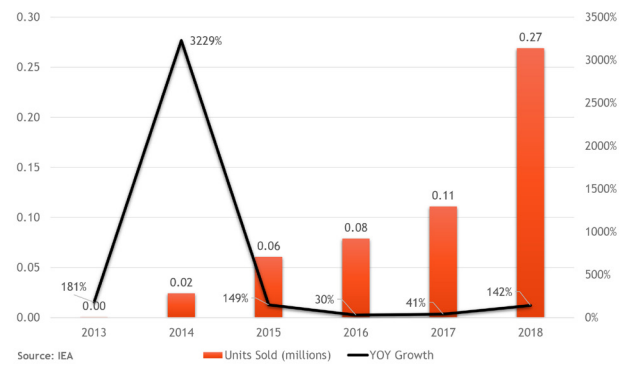
2018 saw a record number of the Chinese PHEVs in stock, almost twice the number seen in 2017. Today, one out of ten EVs in global circulation is a PHEV located in China. At 0.54 million units, the PHEVs on China's roads constituted about 23% of the country's electric car fleet.

In 2012, PHEV sales in China witnessed a sharp fall to about 26,000 units from 32,000 in 2011, registering an all-time low YOY variance of -19%. However, with an increase in production, the sales of PHEVs skyrocketed in 2014. Since then, the PHEV segment sales in the Chinese market have been growing at a fast pace, even though the yearly growth rate has significantly dropped. In 2018, at 0.27 million units the market made more than double the sales in the segment that were made in the previous year.

PHEV Stock and YOY Growth (2013-18)



PHEV Sales and YOY Growth (2013-18)

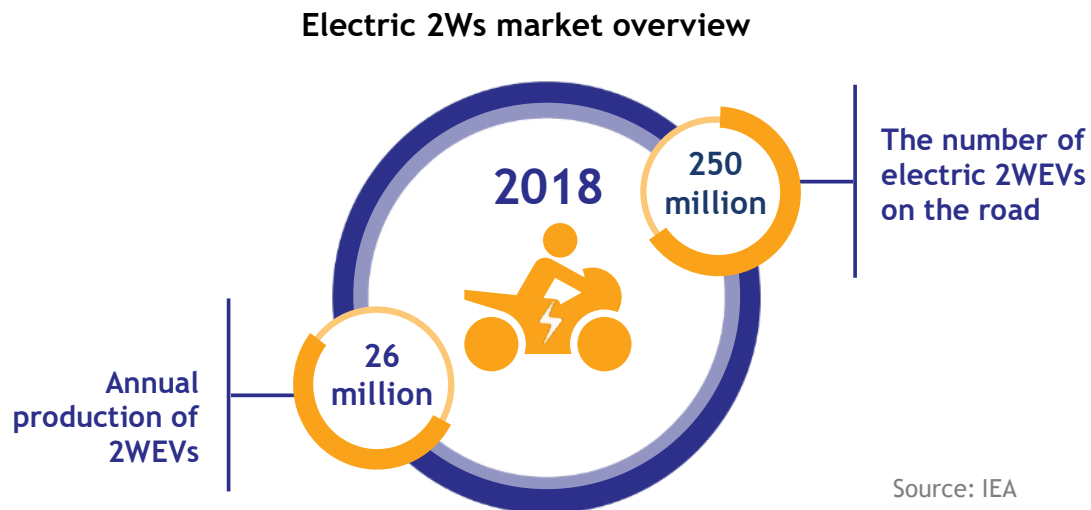


Two-Wheeler Electric Vehicle (2WEV):

Owing to low costs and ease of operability in traffic congestion, two-wheelers have been popular, especially in highly populated countries like China. Earlier, two-wheelers were mostly powered by ICEs or fuelled by gasoline. In the recent years however, China - just like various other geographies - has seen a very significant surge in the number of two-wheelers powered by electricity.

China produced 26 million units of electric two-wheelers in 2018, retaining its position as the global market leader in the segment. Today the country's market for electric two-wheelers is hundreds of times larger than anywhere else in the world. **Nearly one third of the global motorised two-wheelers, which is about 800 million units, is in circulation on Chinese roads.**

Nearly 67% of the 2WEVs in the Chinese stock use 0.5-0.8 kilowatt-hour (kWh) batteries and cover around 50 km at low speed (typically 20-25 km per hour max speed).



What drives China's 2WEV market growth?



Reclassification as bicycles: In 1999, the Chinese government designated certain 2WEVs as bicycles, enabling travel in bicycle lanes and exemption from registration and driving license requisites.



Restrictions on ownership: Many cities severely restricted the ownership of gasoline motorcycles and their use near urban hubs.



Low costs as compared to ICE: Chinese 2WEVs are characterised by costs which are lower than those of an ICE scooter, primarily because of relatively simple manufacturing processes and limited battery requirements.

Growth Accelerators for EVs in China

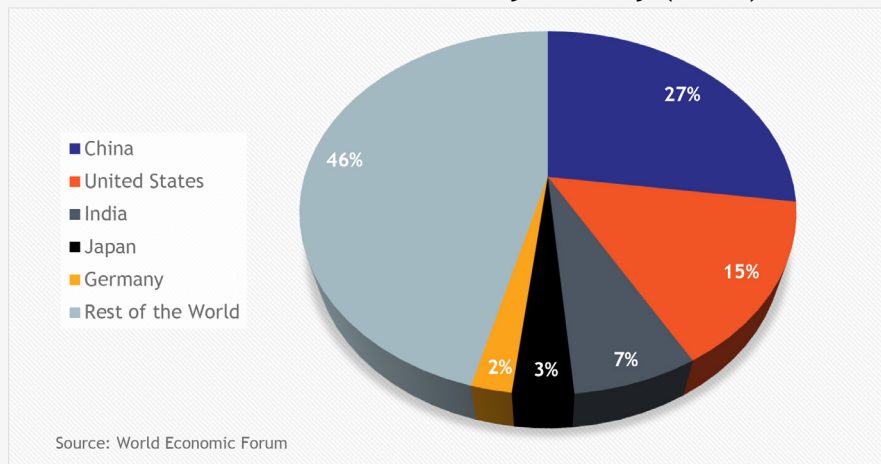
Rising environmental concern

Alarming GHG emission levels:

Based on the 2017 greenhouse gas (GHG) emission statistics by World Economic Forum, Asia is a big contributor to global warming through GHG emissions in large volumes. China accounts for almost a quarter of global GHG emissions, making it the most polluted country in the world.

Over the years, China's share in the global CO₂ emissions has been on the rise, which is attributable to its growing economic and industrial power. Rising consumption, growing demand for goods/services and increasing car ownership and transportation in the country, has led to an alarming level of CO₂ emissions.

Share of CO₂ emissions by country (2017)



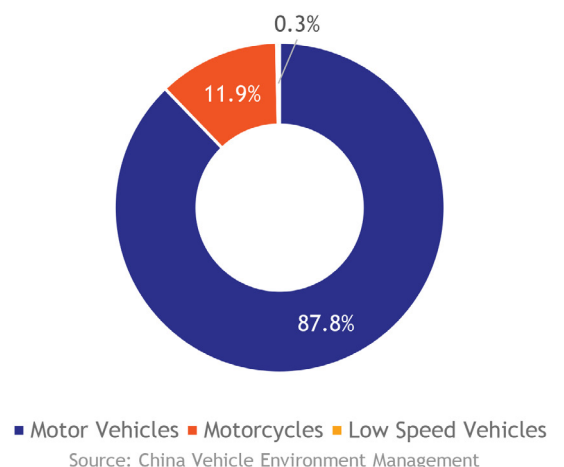
Increasing vehicular pollution:

Though growing industrialisation and electricity generation through fossil fuels are the key contributors to the country's CO₂ emissions, studies have shown that motor vehicles also have a huge role. The rising number of vehicles on roads, particularly in the tier-I cities such as Beijing, Shanghai and Shenzhen, has been adding to the concern.

Under the Paris Climate Agreement, China has committed to reduce its carbon intensity by 2030, effectively to 60-65% of its 2005 emission levels. As part of this commitment, the country is working on implementing the electric vehicle initiative (EVI) vigorously.

EVs are being encouraged as part of the initiative to combat environmental pollution. In addition, over the past years, the administrative authorities for many tier-I cities have already placed auto sales restrictions to cap the urban vehicle population growth.

CO₂ emissions by vehicle sector in China (2017)



Supportive government policies

New Energy Vehicle (NEV) credits mandate:

Government initiatives and transitions in policies have primarily helped in promoting the adoption of electric vehicles in China at a rapid scale. In 2009, the government introduced several policies including subsidies, incentives and quotas for vehicle manufacturers and tax exemptions for the development of the EV sector.



Restrictions on ICE vehicle licences in major cities:

Major cities in China such as Beijing, Shanghai, Guangzhou, Shenzhen and Tianjin, have faced severe traffic congestion and high air pollution levels over the past few years. City-wide policies favouring EVs license plates have been important not just for the EV motorisation but also in lowering the carbon emissions in these cities.

Administration from these cities have been able to limit the number of car plates issued to ICE vehicles each year. In 2016, 2.7 million people registered for a license plate in Beijing, of which only 90,000 were allotted for ICE vehicles through a lottery or auction process. This number dropped to just 40,000 in 2018.

According to Frost & Sullivan, by 2025, over 17 Chinese cities will impose such restrictions on the number of car plates issued annually for ICE vehicles. The auto market in these cities will create a huge unmet demand for car ownership which presents a lucrative opportunity for the EV sector.

Tier-I cities	Avg. probability of obtaining car plate (%)	No. of applicants (2017)
Beijing	0.12	2,839,000
Shanghai	4.49	228,000
Guangzhou	1.46	586,000
Shenzhen	0.81	909,000
Tianjin	0.78	866,000
Hangzhou	0.92	679,000
Total		6,107,000

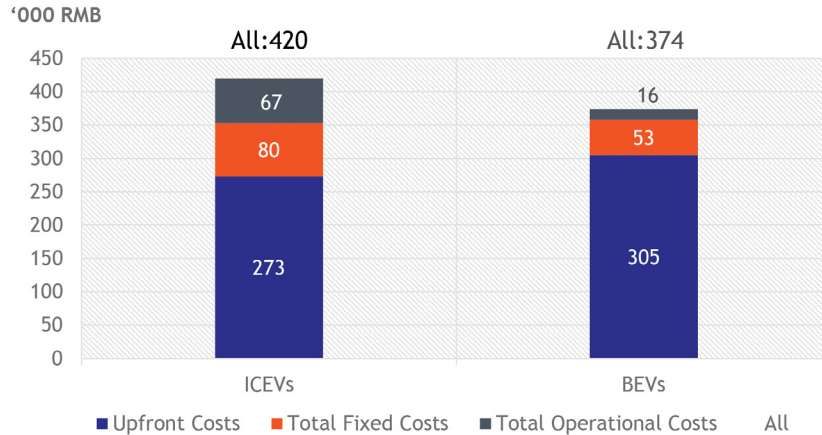
*FCEVs (Fuel cell electric vehicles) are powered by hydrogen and produce no GHG emissions—they only emit water vapor and warm air.

Economic benefits to buyers

Competitive cost of ownership:

From the perspective of total cost of ownership, BEV owners enjoy significant running cost advantages. ICE vehicles may appear to be cheaper with a lower upfront purchase price, but the fixed and operational costs make them costlier than BEVs. According to Frost & Sullivan, BEVs’ battery charging cost is approximately 75% lower than fuel cost for ICE cars. Also, the repair and maintenance costs are significantly lower for BEVs due to their simpler structure and lower maintenance frequency.

Cost of ownership for BEVs and ICEVs over 6 years



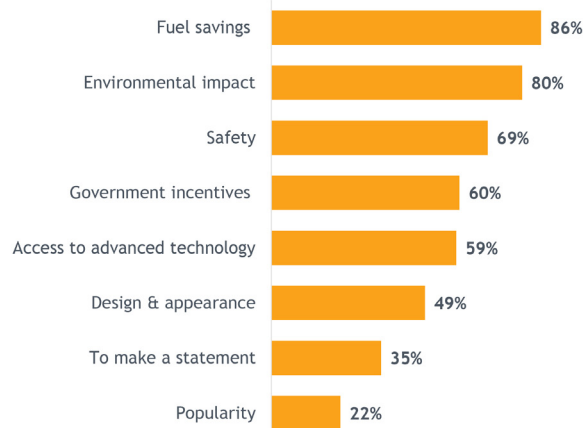
Source: Frost & Sullivan

Additionally, the continuous decline in the costs of lithium-ion (Li-ion) batteries will bring the operational costs of BEVs further down in the coming years. Within the last decade, the average cost of Li-ion batteries has already fallen almost seven times from about US\$ 1,200/kWh in 2010 to nearly \$175/kWh in 2018. Improvements in battery technology, coupled with economies of scale by battery suppliers will continue to reduce battery costs. According to Frost & Sullivan, this cost is expected to further decrease to around \$150/kWh by 2022.

Higher fuel savings:

Studies on the factors impacting the buying decisions of Chinese EV users have revealed that most consumers prefer EVs due to huge cost savings on fuel - one of the key reasons that has positively influenced the country’s EV market.

Factors impacting buying decision



EV Value Chain

Vehicle manufacturing

China has about 487 EV makers based in the country. As much as 98% of the passenger EV market is captured by established, domestic auto companies. With product innovation and mutually beneficial collaborations at the core of their business strategy, these players continue to lead the market despite the entry of several new players.

To fulfil their environmental goals, Chinese government bodies are providing aid worth millions of dollars to EV makers. This has appealed to several new brands who are looking to bank the opportunity. In July 2018, for instance, the US-based EV manufacturing giant, Tesla closed a deal with Chinese authorities to build a new plant in Shanghai.

Leading domestic playezrs	Leading foreign players
 BYD - Build Your Dreams Co. Ltd.	 Tesla, Inc.
 SAIC - Shanghai Automotive Industry Corporation	 Volkswagen Group
 Geely - Zhejiang Geely Holding Group	 Nissan Motor Co. Ltd.
 BAIC - Beijing Automotive Industry Holding Co. Ltd.	 Go Further Ford Motor Company
 Chery Automobile Co. Ltd.	 General Motors Company

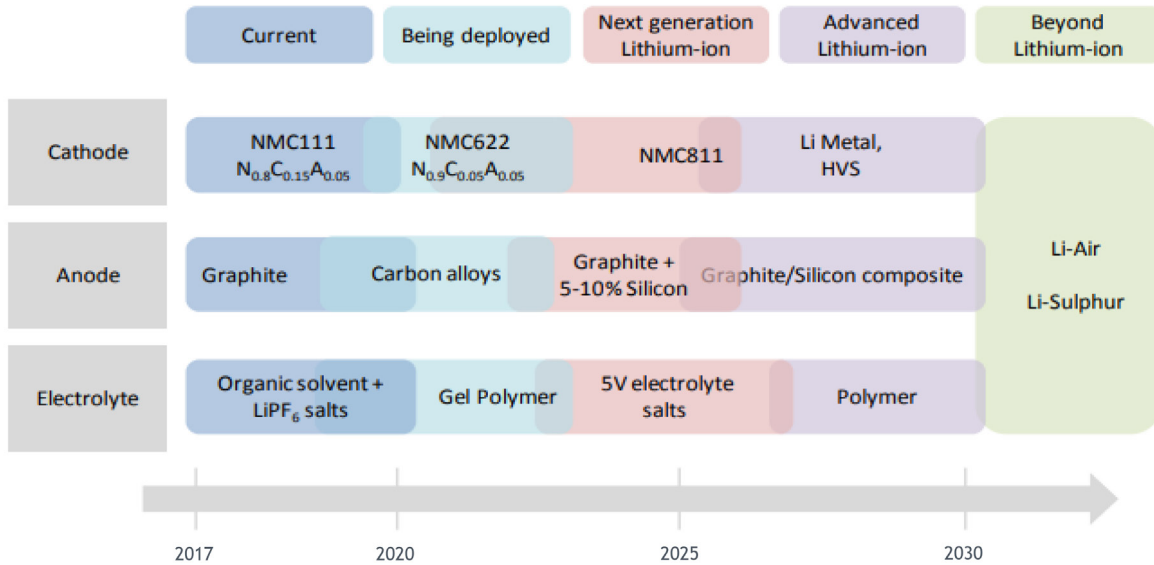
Energy storage

Battery technology:

Due to a huge demand for batteries in consumer electronics, the technology for battery storage has seen a boost in the recent past. Given the consistent reduction in its costs and improving performance, Li-ion is expected to remain the battery technology of choice for the next decade.

The next generation of Li-ion batteries entering mass production around 2025 will have low cobalt content and high energy density. During 2025-30, technologies that promise significantly higher energy densities (advanced Li-ion) are expected to begin entering the market. Other technology options are likely to become available after 2030.

Future of EV storage technology

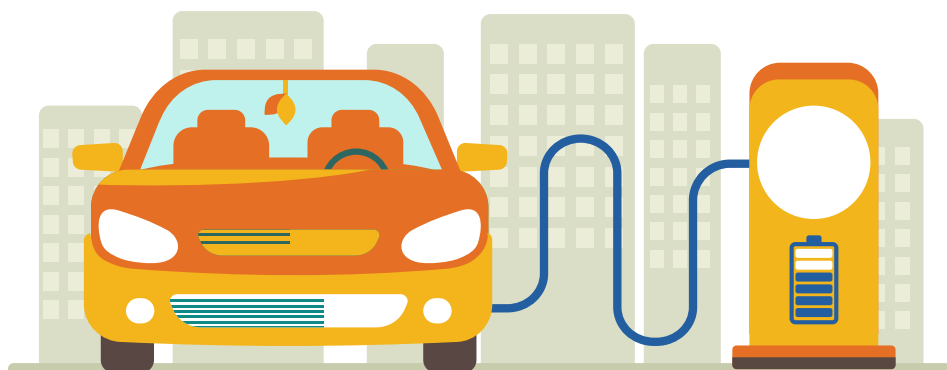
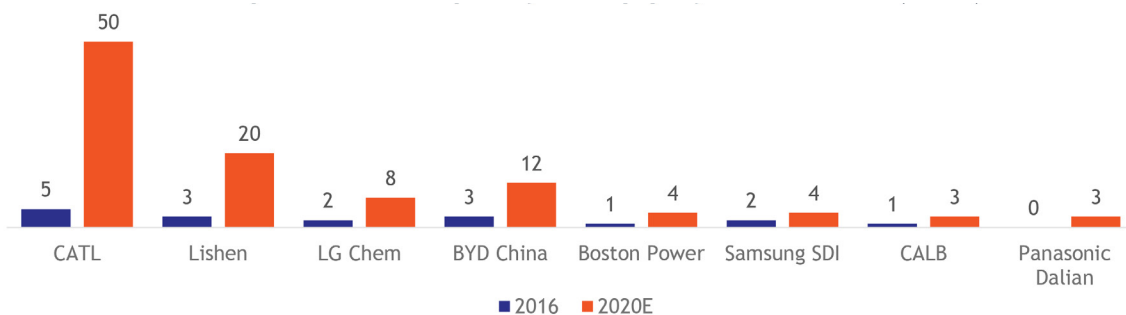


Leading battery manufacturers:

China’s regulatory framework promotes consolidation among battery manufacturers, encouraging players who offer batteries with the best performance. Additionally, investments in battery production is notably increasing from both domestic and foreign companies, such as BYD and CATL (Chinese); LG Chem, Samsung SDI, SK Innovation (Korean) and Panasonic (Japanese).

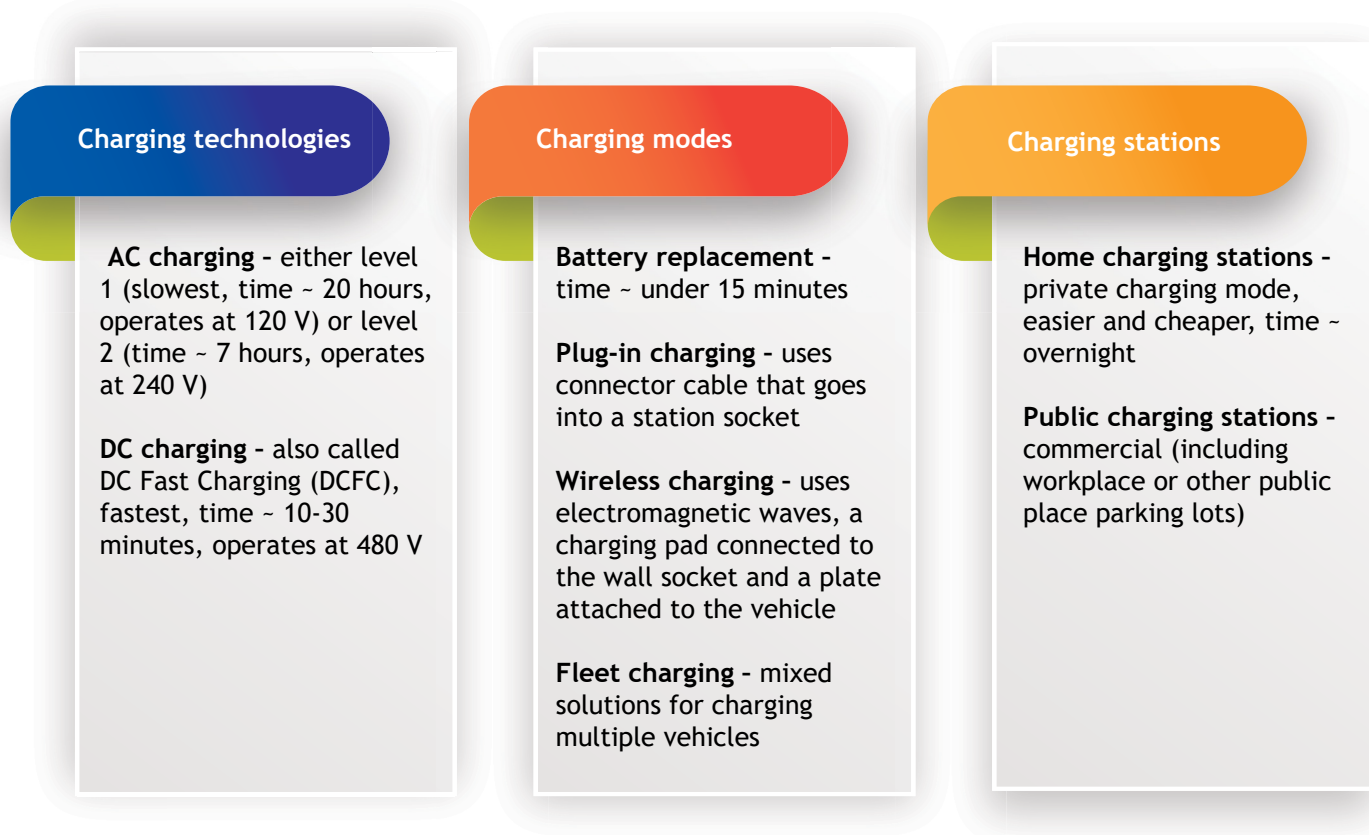
In 2018, China’s domestic company, CATL was the segment leader. Among the big foreign brands which have expanded into the Chinese market are - South Korea’s LG Chem, which opened a battery factory in Nanjing in 2015 and Samsung SDI, which opened a plant in Xian in 2016. However, in 2017, the government began pressuring auto makers to use locally made batteries, which has led to limited growth for foreign battery producers.

Li-ion production capacity of top players in China (GWh)



Charging infrastructure

Charging models:



Home charging is used relatively less in China, since the country has very few single-family homes. Therefore, public charging will grow over time, projected to cover 55-60% of the demand by 2020 and about 80% by 2030. However, the present charging infrastructure is undergoing some major challenges.

Most of the present charging stations are either distributed charging piles or individual slow/medium speed chargers. Majority of these charging piles have high vacancy rates and charging speed is generally low at the stations, resulting in long wait time for users.

If the operating power of the station is raised to higher voltages for faster charging facilities, there are risks of physical harm to users or their vehicles. Both public and private charging operators are, however, working on reinforcing more robust safety features to deal with the issue.

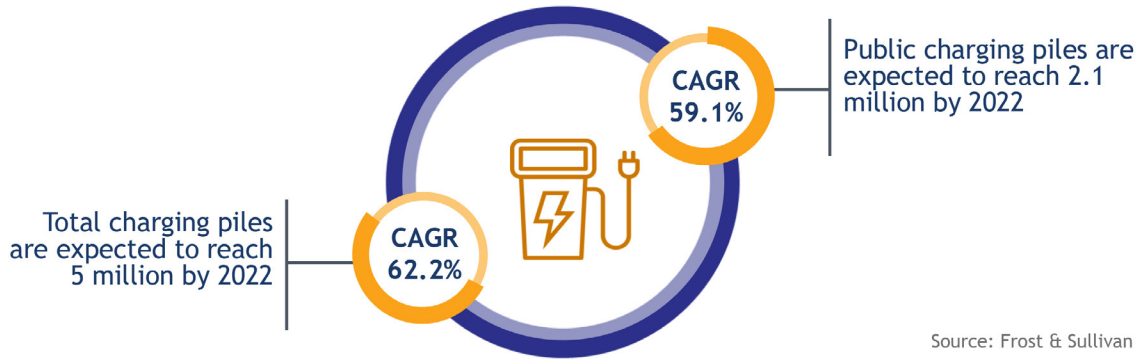
China's charging network:

In 2018, 80% of the global electricity demand for EVs came from China. For managing this ever-increasing demand, China plans to build 120,000 centralised, public charging/battery swap stations for electric cars by 2020.

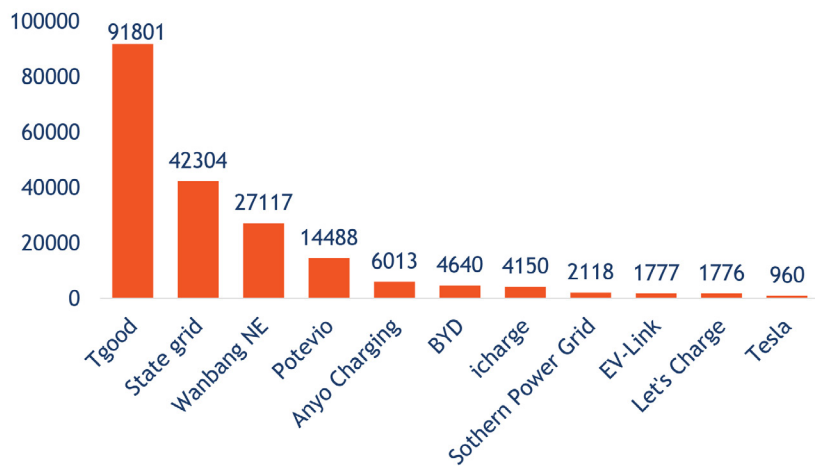
The State Grid Corporation of China, the world's largest utility also aims to distribute 4.8 million charging piles by 2020. During 2018, the Corporation successfully installed more than 6,000 charging stations with more than 57,000 charging points along nearly 25% of the country's highway network.

China is among the major global economies which have ramped up their ambition to install fast charging facilities along highways. In fact, the year 2018 saw the number of publicly accessible, fast chargers rise to 150,000 globally, 78% of which are deployed in China.

China's charging network growth



Charging pile operators in China



Conclusion

In the recent years the global EV industry has bloomed, pushing margins on vehicle range, power, style, profitability, accessibility and affordability. With increasing competition among top players in the industry, this growth is expected to intensify further in the coming years.

More than 101 EV models are expected to launch in 2020 alone and with more international players entering the market every year, this figure is expected to reach around 400 by 2023. Major developments in terms of innovation in Li-ion battery technology, better regulatory enforcements and heavy investments will continue adding to the sector's development.

China's commitment to reach 30% market share for NEVs by 2030 through the EV 30@30 initiative will be the primary growth propeller. In fact, if this policy framework comes into enforcement, the country is expected to increase the share of EVs in new vehicle sales to up to 70% (including two-wheelers) by 2030.

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info@benoriknowledge.com

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