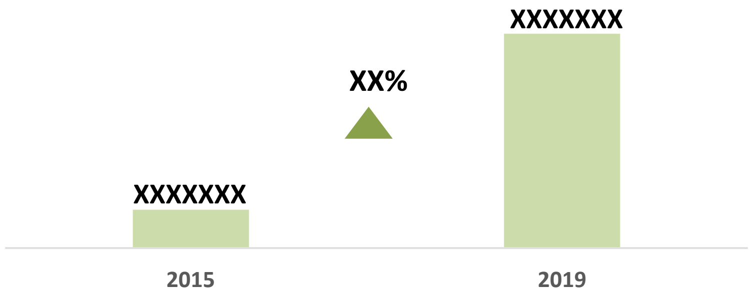
EV Charging Infrastructure: Current State and Regulations in Key Markets

June 2020

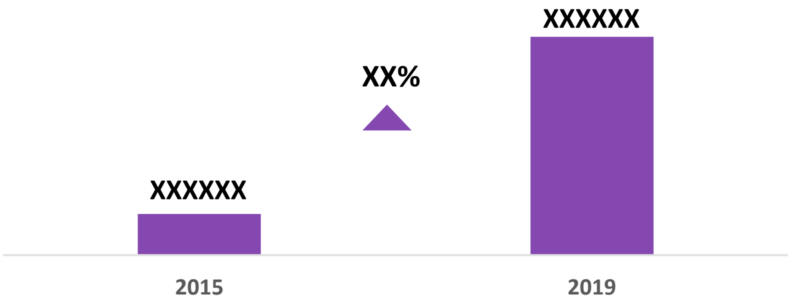
The EV market and public charging infrastructure (1/2)

- The global electric vehicle (EV) market has witnessed tremendous growth over the last five years, registering a CAGR of XX, with the EV fleet exceeding XX million in 2019. At the end of 2019, over two-thirds of the EV fleet were battery electric vehicles (BEVs) while the remaining were plug-in hybrid electric vehicles (PHEVs). The share of BEVs in total EVs has increased from XX in 2015 to XX in 2019.
- The public charging infrastructure sector has witnessed a similar growth, with the number charging points increasing at a CAGR of almost XX and reaching close to XX million at the end of 2019. Of these, XX were normal charging points and XX were fast charging points. Normal charging infrastructure includes Level 1 and Level 2 AC chargers, and fast charging includes direct current fast chargers (DCFCs) and some Type 2 AC points in a few countries.

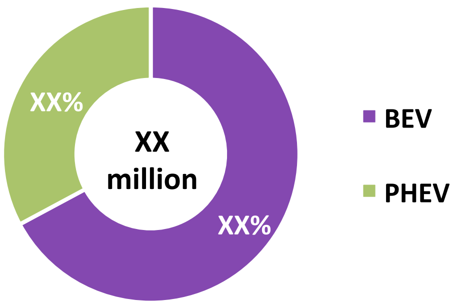
Growth in global EV fleet, 2015–19



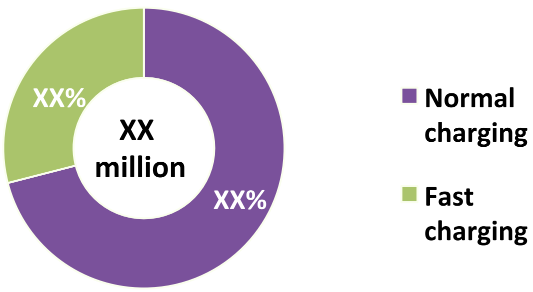
Growth in global public charging points, 2015–19



Global EV fleet in 2019 by type (%)



Global public charging points in 2019 by type (%)



The EV market and public charging infrastructure (2/2)

- China is the largest EV market in the world. Six key Asia Pacific countries accounted for a share of XX% in the global EV fleet at the end of 2019, followed by Europe (14 countries) with a XX% share, and North America (Canada and US) with a share of XX%.
- The Asia Pacific region, led by China, accounts for almost XX% of the installed public charging points around the globe. It is followed by Europe (XX%) and North America (XX%).
- Access to the public charging infrastructure varies across countries, ranging between XXX plug-in EVs per public charging point, indicating the great disparity in regional performance as well as the market opportunity that could be tapped.

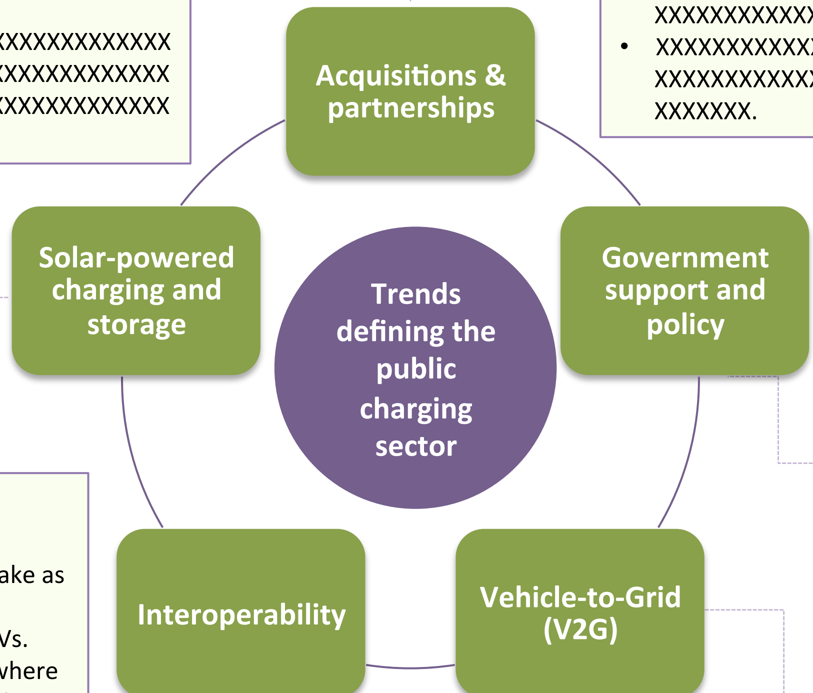
Access to public charging infrastructure in key markets

Country	EVs per public charging point	Fast charging points per 100 km highway
US	XX	-
China	XX	X
Japan	10	15
France	X	XX
Germany	X	XX
Italy	X	XX
Netherlands	X	XX
Norway	24	–
United Kingdom	XX	XXX

Global EV fleet in 2019 by region (%)

Global charging points in 2019 by region (%)

Emerging trends in the charging infrastructure sector



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- Policy support will be needed to boost the EV and charging infrastructure industry, at least in the short run, till the industry has enough customer volumes where it can take off on its own.
- Recently, countries like Germany and France announced economic stimulus packages to support the EV industry.

- Interoperability is inevitable for facilitating e-roaming.
- This, in turn, is critical for EV uptake as it will allay range anxieties and hesitance of consumers to buy EVs.
- Already the central hub model, where the platform providers typically charge a fee to the CPOs for the customer-facing apps to recover their costs, is becoming popular in Europe.
- Several CPOs have also signed bilateral interoperability agreements to open up their networks for each other's customers.

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Expected growth in key markets

- By 2030, the US is expected to have an EV fleet of XX million and XX million public chargers.
- China will continue to lead the world and embark on making ambitious addition of XX million EVs and XX million public charging points by 2030. The top six European countries (the UK, Germany, France, Italy, Norway, and the Netherlands) will collectively account for XX% of the total EVs and XX% of the total public charging points installed across the region in 2030.

Country	EV fleet 2019	EV fleet 2030	CAGR 2019–30	Public charging points, 2019	Public charging points, 2030	CAGR 2019–30
	XXXXXXX	XXXXXXXX	XX%	XXXXX	XXXXXX	XX%
	XXXXXXX	XXXXXXXX	XX%	XXXXXX	XXXXXXXX	XX%
	XXXXX	XXXXXXX	XX%	XXX	XXXXXX	XX%
	XXXXXX	XXXXXXX	XX%	XXXXX	XXXXXX	XX%
	XXXXXX	XXXXXXX	XX%	XXXXX	XXXXXX	XX%
	XXXXXX	XXXXXXX	XX%	XXXXX	XXXXXX	XX%
	XXXXX	XXXXXXX	XX%	XXXX	XXXXXX	XX%
	XXXXXX	XXXXXXX	XX%	XXXXX	XXXXXX	XX%
	384,066	1,970,000	16.0%	13,763	197,188	27.4%
	XXXXXX	XXXXXXXX	XX%	XXXXX	XXXXXX	XX%

Acquisitions to strengthen future market positions

- The EV charging industry is at a nascent stage but offers huge growth potential. It has caught the attention of big corporates and start-ups alike, and many companies are investing in partnerships and acquisitions to secure their positions in this rapidly evolving industry.
- The industry has seen a spate of acquisitions by new entrants trying to get a foothold and by incumbents to expand their markets. Most of these deals reflect the harsh reality faced by oil and gas majors to diversify away from their traditional businesses as the world transitions towards a low carbon economy.
- Many players have also started to integrate themselves along the value chain to acquire capabilities to build a competitive value proposition and stay ahead in the business.

Key recent acquisitions in the e-mobility sector

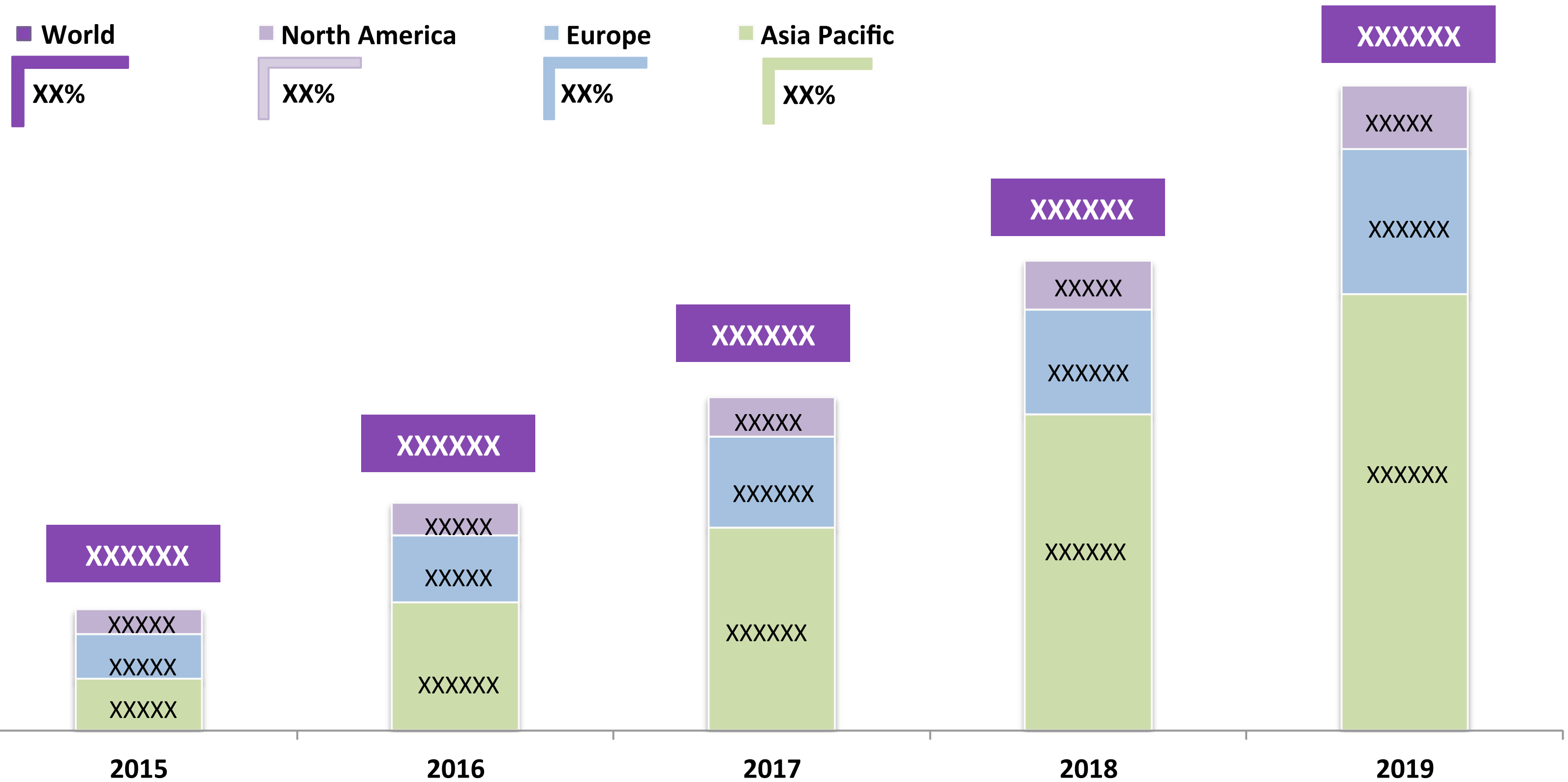
Acquiring firm	Acquired firm	Year	Description
XX	XXXXXXXX	XXXXXXXX XXXX	XXXXXXXXXXXXXXXXXXXXXXXX
XX XXXXX	XXXX	XXXXXXX XXXX	XXXXXXXXXX
XXXX	XXXXXXX	XXXXXXXX XXXX	XXXXXXXXXX XX XXXXXXXX
XXXX	XXXXXXXXX	XXXXXXX XXXX	XXXXXXXXXX
XX	XXXXXXXXXX	XXXXXXX XXXX	XXXX XXXXX XXXXXXXX
XXXXXXXXXXXX XXX	XXXXXXXXXX	XXXXXXX XXXX	XXXXXXXXXXXXXXXXXX
Total	G2mobility	September 2018	Acquisition
XXXXXX	XXX XXXXX	XXXX XXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXX
XX	XXXXXXXXXXX	XXXX XXXX	XXXXXXXXXXXXXXXXXX
XXXXXXXX	XXXXXX	XXXX XXXX	XXXXXXXX
XXXXXXXXXX	XXXXXXXX	XXXX XXXX	XXXXXXXX
XXXXX	XXXXXXXXX	XXXX XXXX	XXXXXXXX
XXX	XXXXXXX	XXXX XXXX	XXXXXXXX XXXXXXXXXXXX
XXXXX	XXXXX	XXXX XXXX	XXXXXXXX
XXXXXXX	XXXXXXXX	XXXX XXXX	XXXXXXXXXXXXXXXXXXXX

Source: Media reports, Global Transmission Research

Growth in the global public charging infrastructure (2/2)

- As mentioned before, the Asia Pacific region leads in the development of the public charging infrastructure. China and Japan have an extensive network of public chargers and are targeting for further expansion.

Growth in the global public charging infrastructure by region, 2015–19



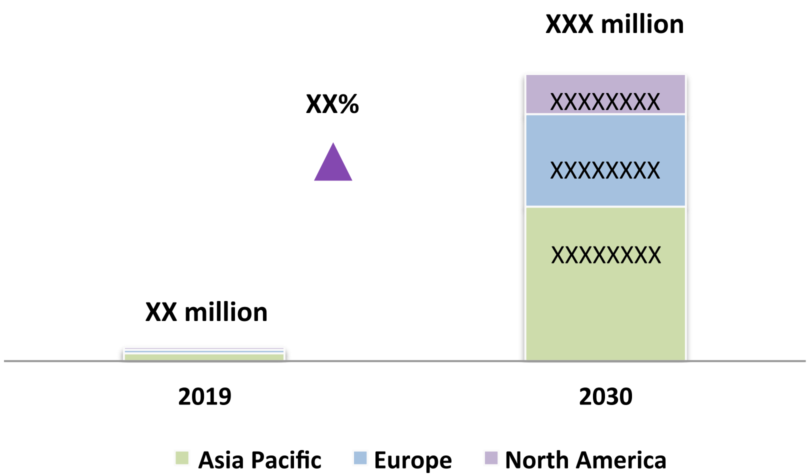
Note: Growth is expressed in compound annual growth rate (CAGR); North America includes only US and Canada, Asia Pacific includes Australia, China, India, Japan, Singapore and South Korea and Europe includes 14 countries.
Source: Global Transmission Research

Expected global growth in EVs and charging infrastructure

- The total EV fleet in 22 key markets is expected to grow at a CAGR of XX% to reach XXX million by 2030 from an estimated XX million in 2019.
- About XX million public charging points would be needed to cater to the expected EV fleet by 2030, up from XX million public charging points in 2019. This represents a CAGR of XX%.
- By 2030, the Asia Pacific region, mostly China, India and South Korea, will lead this growth and the region will account for about XX% of the EV fleet and about XX% of the number of public charging points installed across the world. This will be followed by Europe, which will account for XX% of EVs and XX% of public charging points, and North America with XX% of EVs and X% of public charging points.

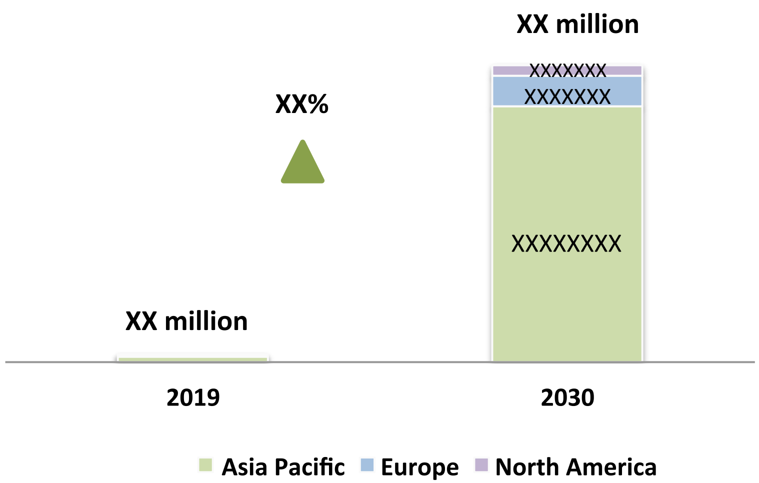
Expected growth in global EV fleet

Region	2019	2030
Asia Pacific	XXXXXXX	XXXXXXXX
Europe	XXXXXXX	XXXXXXXX
North America	XXXXXXX	XXXXXXXX
Total	XXXXXXX	XXXXXXXXX



Expected growth in global public charging infrastructure

Region	2019	2030
Asia Pacific	XXXXXX	XXXXXXXX
Europe	XXXXXX	XXXXXXX
North America	XXXXX	XXXXXXX
Total	XXXXXX	XXXXXXXX



Policy and regulatory developments – North America

- The US is the third-largest market for EVs in terms of sales in the world and it is poised to grow exponentially as electrification of transportation picks up momentum with the right incentives in place.
- Recognising that this is largely dependent on a robust EV charging network, the federal government and several states have drafted supportive legislation and regulations to ensure that the needed public charging infrastructure is developed.

- At the federal level, the Further Consolidated Appropriations Act of 2020 reinstated the alternative fuel infrastructure tax credit until the end of 2020. The Electric CARS Act of 2019 proposes to extend tax incentives until 2029. Several bills have been introduced in Congress to provide more incentives for EVs and to expand charging infrastructure along the federal highways.
- Among the states, California was the pioneer in establishing a zero-emission vehicle (ZEV) mandate program. Following this, eleven other states have adopted ZEV programs mandating automakers to offer a certain percentage of their production as clean vehicles. California is also one of the ten original signatories of the ZEV Memorandum of Understanding (ZEV MOU), a signed agreement to incentivise the purchase or lease of 3.3 million EVs by 2025 and provide incentives to ensure that charging infrastructure is developed. The other nine signatories to this MoU are Connecticut, Maryland, Massachusetts, Maine, New Jersey, New York, Oregon, Rhode Island, and Vermont.
- California's latest Clean transportation Program commits over USD384 million until 2023 for the development of charging infrastructure, clean technologies, and ZEV manufacturing capabilities.
- New York has also recently announced ambitious clean energy programs. Recently, the New York Public Service Commission proposed the "Make-Ready" program will run until 2025 to support the development of the electricity grid for the expansion of the charging infrastructure.

- Canada has set ambitious federal targets for ZEVs to reach 30% of light-duty vehicle sales per year by 2030 and 100% by 2040. To achieve this, the federal government offers financial incentives for purchases of EVs and setting up EV charging infrastructure.
- The federal government in its 2019 Budget announced funding of CAD130 million over five years (2019-2024) to deploy a network of EV charging points among other things.
- At the provincial level, British Columbia (BC) and Quebec also provide incentives for the purchase of EVs and for installing chargers for individuals, multi-family units, and at workplaces.

Fastned

Key information

Headquarters	• XXXXXXXX, XXXXXXXXXXX
Ownership	• XXXXXXXXXXX
Infrastructure	• Launched its first charging station in 2013 along a Dutch highway. Uses ABB chargers at its stations. • Now owns and operates 114 charging stations, of which 105 are fast chargers of 175 kW (and can charge up to 350 kW). It has been successful in setting up about 34% more EV charging stations in 2019, compared with 2018.
Key markets	• XXXXXXXXXXX : XXXXXXXXX • XXXX: XX XXXXX XXXXX • XXXXXXX: XX XXXXXX XXXXXX
2019 Revenue*	• EUR4.5 million
Plans and targets	• XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Recent developments

2018

- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

2019

- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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2020

- XXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXX
- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

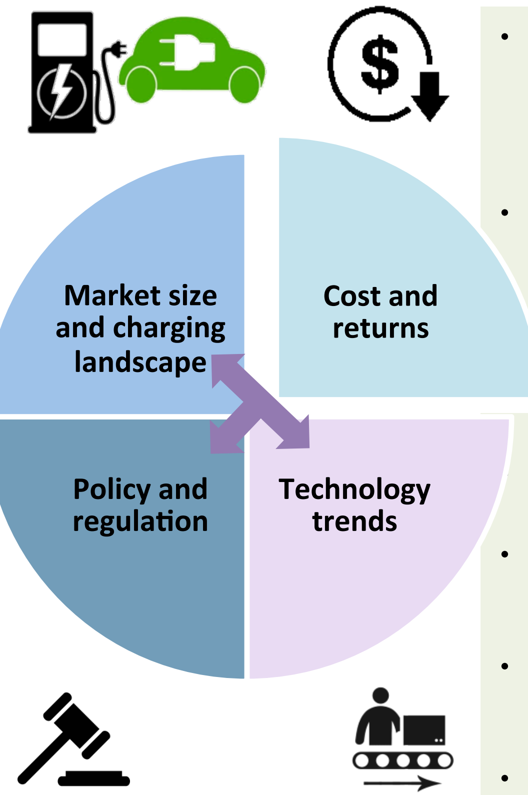
Note: *denotes revenue for charging segment of Fastned.

Overview of the EV market in the UK

- The UK's EV industry is small compared with its well-established automobile sector. In 2019, XXXXX EVs were sold. The UK's automobile industry witnessed sales amounting to XX million units in 2019. Despite this, the industry promises huge potential.
- The growth drivers for increasing EV adoption can be understood in terms of socio-economic factors, government push towards zero carbon emissions, increasing investments, policy support and a growing ecosystem.

- The UK has witnessed a huge expansion in the EV charging network. The sector is highly competitive with several national and international players.
- The government initiatives and a ban on sale of petrol and diesel vehicles by 2040 (at the latest) are expected to further increase EV sales and will, thus, create a need for a huge expansion in the charging network.

- Automated and Electric Vehicles Act 2018 aims to improve the uptake of EV charging infrastructure.
- Road to Zero strategy (2018) lists measures to establish UK's leadership in zero emission vehicles and for all new cars to be zero emission by 2040.
- The government is considering to move the proposed date for the ban on the sale of ICE vehicles from 2040 to 2035.
- Several local councils have formulated guidelines for EV charging infrastructure procurement and development in their local development plans.
- As per Ofgem, charge point operators (CPO) typically do not need a supply licence.



- EVs are not projected to reach price parity with ICE vehicles until the mid-2020s. The CCC assessment of the Road to Zero Strategy states that financial support for the higher upfront costs of EVs will be required beyond 2020.
- The government offers several fiscal and non-fiscal incentives to support the uptake of EVs.

Expansion of the charging infrastructure has also been dependent upon the government's support.

The past few years have seen increased investment in fast and rapid charging points.

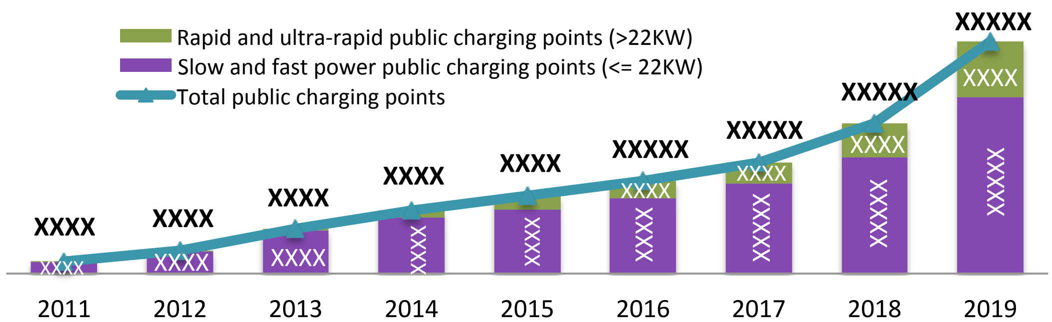
- High powered charging (up to 350 kW) developed in response to increased battery sizes is expected to gain popularity in the near future.
- The government is promoting smart charging – the Electric Vehicles (Smart Charge Points) Regulations 2020 is under preparation.
- Various trials are underway to test the V2G technology.

Note: ICE – Internal combustion engine; CCC–Committee on Climate Change; CCS–combined charging system; Ofgem–Office of Gas and Electricity Markets
Source: Global Transmission Research

Overview of the charging infrastructure

- The UK has a good density of charging points with around XX vehicles per charging point (2019) and around XXX fast public charging points per 100 km of highway.
- In the UK, slow chargers are defined up to 3 kW AC (which take 6-12 hours to fully charge BEVs); fast chargers have 7-22 kW AC power outputs (3.4 hours to fully charge BEVs) and rapid AC chargers are rated at 43 kW while rapid DC chargers at 50 kW (30 minutes to charge BEVs to 80%). Ultra rapid chargers comprise DC chargers with a rating of over 100 kW.

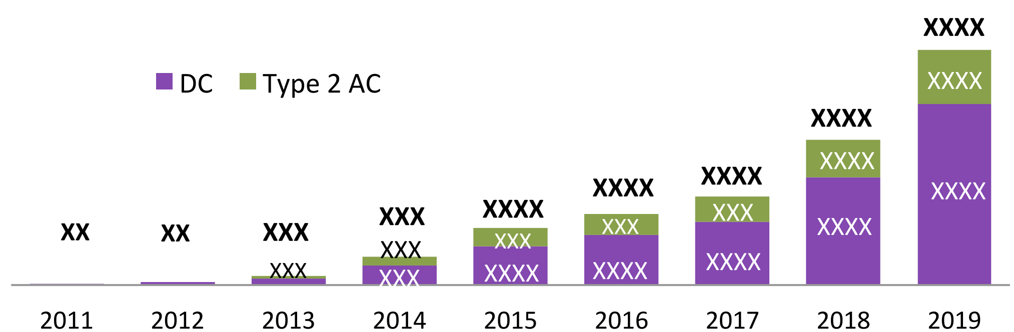
Growth in EV charging infrastructure



- In 2019, the number of charging points neared the XXXXX mark.
- The total number of charging points has grown at a CAGR of XX% since 2015.
- Majority of the public charging infrastructure at around XX% comprises of normal charging points while the remaining are fast charging points.
- Normal charging points grew at a CAGR of XX% since 2011 and fast charging points grew at XX%.

- At the end of 2019, the UK had XXXX fast charging points.
- This includes XXXX Type 2 AC points and XXXX DC charging points. The latter includes CCS charging points, CHAdeMO points and Tesla Superchargers.
- DC fast charging points have grown from only XX in 2011 to XXXX in 2019. There were around XXX ultra rapid (≥100 kW) charging points in 2019.

Growth in EV fast charging infrastructure



Note: CCS- combined charging system; CCS chargers include CCS Combo DC fast chargers which are multi-standard chargers with both CHAdeMO and/or 3-phase AC type 2 sockets.
Source: ZapMap; Global Transmission Research

Policy and regulations (3/5)

Models for EV charging infrastructure

- The **own and operate model** is the main type of contract. Under this, the parties are given the right to install and operate charging stations in public spaces at no cost to government agencies.
- Various national frameworks, compliant with UK/EU legislation, are available to simplify charge point procurement for public bodies. The main examples are the ESPO Framework (636 – Vehicle Charging Infrastructure) and the Crown Commercial Service Traffic Management Technology 2 (Lot 10 Sustainable Transport Infrastructure). The ESPO Framework allows both the purchase and lease of charge points.
- **Private sector match-funding:** To date, most central government grant schemes for charging infrastructure cover 75% of the eligible capital costs. The remaining 25% can be covered by the local authority but in some cases, EV charge point operators have provided this match-funding.
- **Concession frameworks:** Through a concession contract, the operational costs and risks are shared, in part or completely, with a charge point provider. Local authorities who have taken this approach include Nottingham City Council and Oxford City Council.
- Some charge point operators are approaching local authorities in England with the offer of free charging infrastructure, while some operators are developing the leasing business model. Some operators are targeting workplaces and fleets while others are beginning to work with local authorities.

Fiscal and non-fiscal incentives

- To achieve the ambitions set out in the Road to Zero strategy, the government is investing nearly GBP1.5 billion between April 2015 and March 2021, with grants available for plug-in vehicles and schemes to support charge point infrastructure.
- **Purchase grant:** OLEV administers the Plug-in Car Grant, under which buyers receive a grant of up to a maximum of GBP3,500 on purchase of a new electric car. Over the first seven years since the introduction of grant in 2011, GBP0.5 billion was disbursed. The grant does not support PHEVs since October 2018. Also, the grant amount per car has also come down from the previous GBP4,500. The grant is currently available until the end of 2020.
- **Ownership tax benefits:** Pure electric vehicles costing less than GBP40,000 are exempt from the vehicle excise duty (annual road tax).
- **Company tax benefits:** Businesses that buy EVs can write down 100% of the purchase price against their corporation tax liability. Plug-in electric vehicles emitting less than 50g/km of CO_2 have their company car tax set at 16% in 2019-20. In 2020/2021 zero emission, 100% electric cars will pay no tax, only 1% in 2021/2022 and 2% in 2022/2023.
- Businesses that install charging infrastructure can access tax benefits through a **100% first-year allowance (FYA)** for expenditure incurred on electric vehicle charging equipment.

Local and regional EV incentives for individuals and businesses

- **Scotland:** The Scottish Government offers an interest-free loan to support drivers switching to an EV or hybrid car. Loans of up to GBP35,000 to cover the cost of purchasing a new electric/hybrid vehicle, repaid over a period of 6 years, under the Low Carbon Transport Loan Fund. Under the fund, interest-free loan of up to GBP120,000 with a six year repayment period (Funding is capped at GBP35,000 per electric car/ van; GBP50,000 per electric HGV; and GBP10,000 per electric motorbike/ scooter and other sustainable transport measures).
- **Northern Ireland:** A maximum grant of EUR5,000 is available for private EVs, and a maximum grant of EUR3,800 for those bought commercially.
- **London:** EVs and PHEVs are exempt from London's Congestion Charge scheme until 2025.
- **Others:** Incentives such as free parking are decided at the local level

Charging infrastructure forecast

- According to the XXXXXXXXXX XXXXXXXXXXXXXX XXXXX.
- Under XXXXXX, the number is expected to reach XX million and XXXXXX public charging points by 2025 and XX million EVs and XXXXXX public charging points by 2030.
- Furthermore, according to the National Grid's *Future Energy Scenarios– Community renewable scenario*, UK is estimated to have a fleet of around XX million EVs by 2030. This will be accompanied by an overall charging requirement of XXXXX GWh by 2030.
- By 2030, the UK government has plans to install XXXX ultra-rapid chargers across the UK's motorway stations and highways.

Public charging points

	2020	2025	2030
EVs	XX million EVs	XX million EVs	XX million EVs
Public charging points	XXXXX	XXXXXX	XXXXXX

By 2030:
DC ultra-rapid chargers: XXXX

National mobility goals

Climate and energy goals for the transport sector

- The government's Road to Zero strategy largely relies on replacing petrol and diesel vehicles with low and zero emission EVs. To do so it set the ambition that by 2050 almost every car and van will be zero emission. It has since moved its planned date for ending the sale of petrol and diesel vehicles from 2040 to 2035 and is seeking views on this measure till May 2020.
- The Scottish government has gone further pledging to phase out new petrol and diesel vehicles across Scotland by 2032.

Note: The forecast numbers are based on government targets for DC ultra-rapid chargers and Road2zero scenario published by EU Federation of Transport and Environment.
Source: National Grid; EU Federation of Transport and Environment; Global Transmission Research

Charging tariffs and pricing (2/2)

- In UK there are several pubic charging networks owned by different operators that charge differently. In addition to the costs per kWh, consumers have to pay separately to the charge card provider for using the charge card. This is usually an amount per charging session or it can also be a monthly/ annual fixed amount.

Tariffs of key public charging networks

Public charging network	Cost per charge (GBP per kWh)	Membership charges
		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Polar network*	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXX
–Polar plus	XXXXXXXXXXXXX	XXXX
–Polar Instant	XXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
–Polar Contactless	XXXXXXXXXXXXX	XXXX
Charge Your Car Network	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXX
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
GeniePoint Network	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXX
Source London network		
–Full (For 22 kW/ 7 and 3kW units)	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXX
–Flexi (For 22 kW/ 7 and 3kW units)	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXX
–PAYG (For 22 kW/ 7 and 3kW units)	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXX
Pod Point	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
ecarNI network	XXXX – XXXXXXXXXXX	XXXX
InstaVolt network	XXX	-
Engenie network	XXX	-
Ubitricity network	XXX	XXXXXXXXXXXXX
Tesla		
–Supercharger network	XXX	-
–Destination network	XXXX	-
ChargePlace Scotland	XXXX	XXXXXXXXXXXXXXXXXXX
	XXX	XXXXXXXXXXXX
ESB EV Solutions	XXX	XXXXXXXXXXXXXXXXX
Ionity network	XXX	-

Note: *-Indicates cost for ultra-rapid charging stations
Source: ZapMap; Global Transmission Research