STIFEL | IRIS

INTELLIGENCE • RESEARCH • INSIGHTS • SERVICE

EXPLORING THE FAST GROWING EV CHARGING MARKET

A key building block of the energy transition

CONTENT

While the past five years have witnessed the gradual ramp-up in electric vehicles (EV), we now see EV charging as the hottest segment of mobility today. Whether private or public, slow or fast, electric car owners depend on charging infrastructure deployment. To answer this unmet need, European and domestic regulations have established different measures, notably subsidies and ICE-restriction deadlines, in order to stimulate the charging ecosystem. In this context and following multiple company contacts, we focus on the three main segments composing EV charging: original equipment manufacturers (OEMs), charging point operators (CPOs) and e- Mobility service providers (e-MSPs). Indeed, the hardware and software aspects will be key for adoption, use and maintenance of charging points. We have also identified what we consider could be the next technological disruptions in the EV charging market: smart charging, data aggregators and next-gen batteries (li-ion, solid state, li-sulphur). These innovations will indeed allow new business models such as vehicle-to-grid (V2G) and vehicle-to-home (V2H).

A BOOMING **EV MARKET**

SECTION 1

FROM **ICE** TO **EVS**

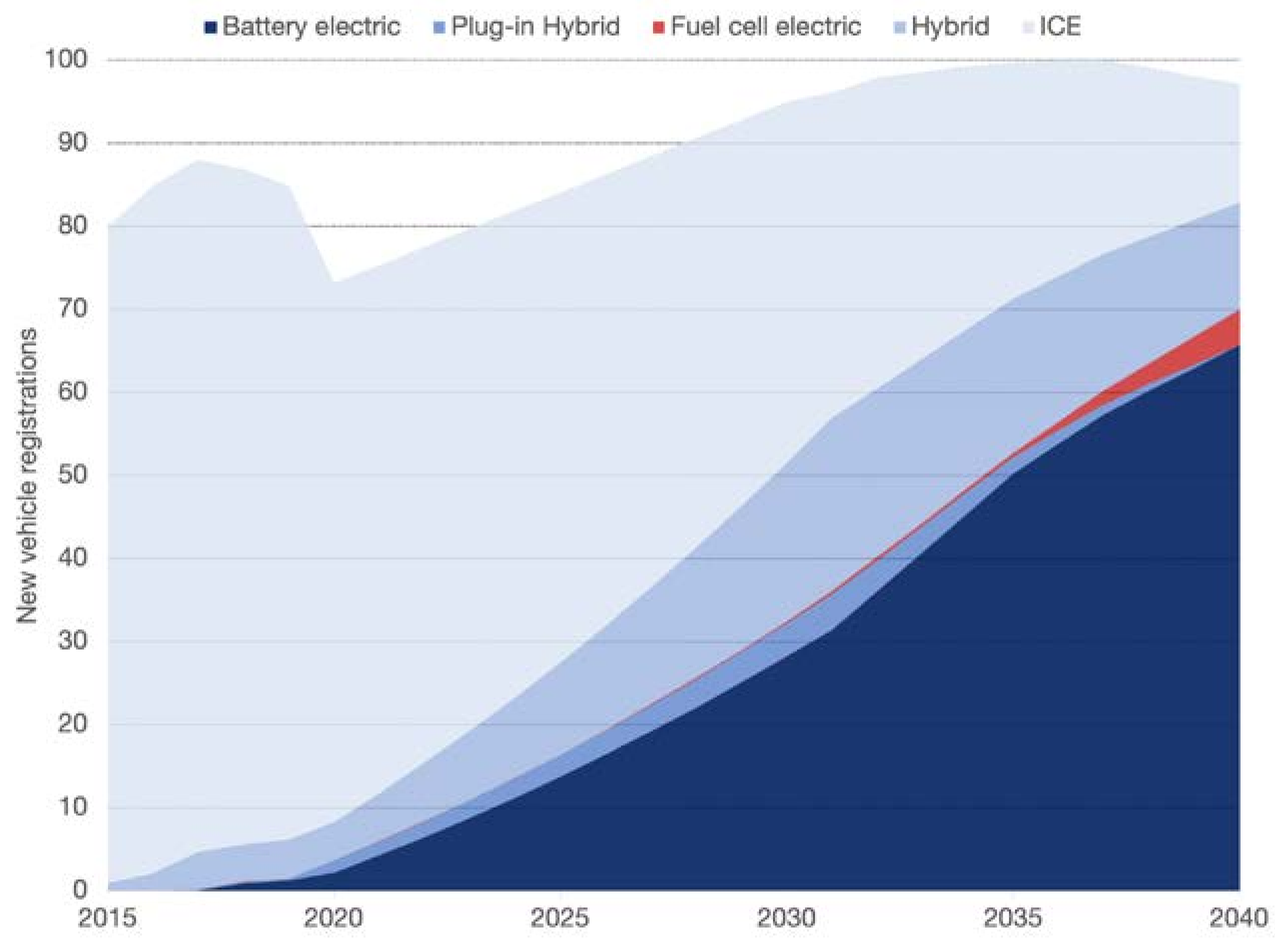
Massive EV rollout

Although many different models, brands or types of light vehicle exist, two distinct categories lead the market:

- Internal combustion engine vehicles, referring to engines relying on the combustion of a fuel (ICE), and
- Electric vehicles (EV), which include any kind of cars partially or fully powered by electricity.

While the share of EV in the overall vehicle fleet remains low today, it is set to rise massively in coming years. According to the IEA, 2.6m EVs were sold in Europe in 2021 (27% of total registrations) while an overall fleet of 60m is expected in 2030 in view of numerous government initiatives and OEM adaptation. This trend could result in EVs accounting for more than half of new passenger vehicle sales in 2035.

FIG. 1: IN 2035, >50% OF NEW PASSENGER VEHICLES SOLD WILL BE ELECTRIC



Source: Stifel, Springer Nature Limited*

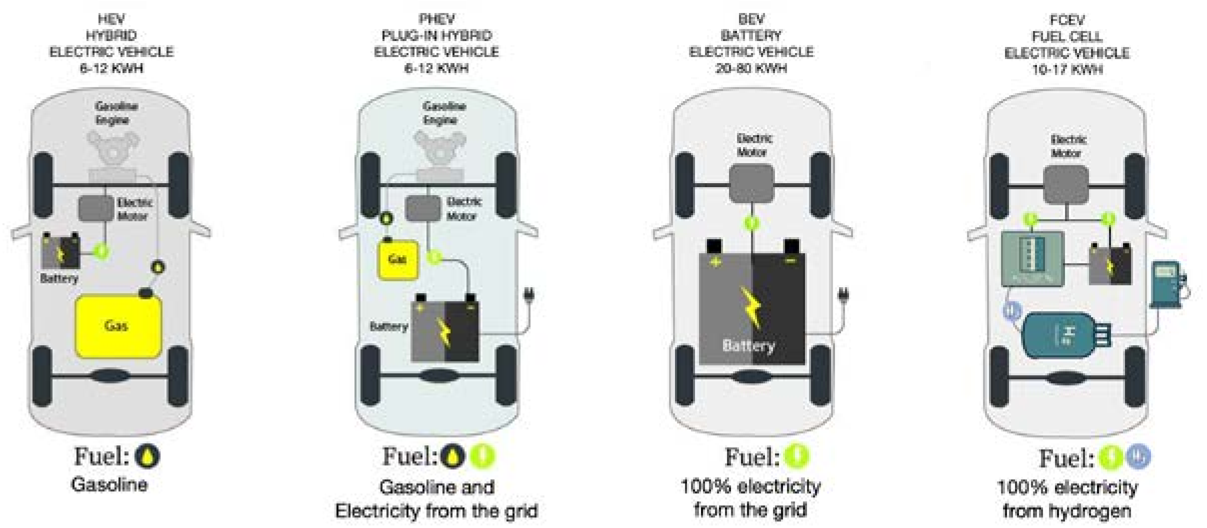
ICE engines are disappearing

As already stated, EVs are cars partially or fully powered by electricity. There are three major types of EV:

- Hybrid electric vehicles (HEVs): these vehicles include both an electric engine and a petrol-powered ICE. Most of these cannot be plugged in and instead, batteries are refuelled both by the petrol engine and a regenerative braking tool while driving. Plug-In Hybrid EVs (PHEC) are a sub-segment of hybrid EVs: they are similar to a hybrid, but with a larger battery and electric engine. These vehicles are generally powered both by an ICE and an electric motor but provide a charging port for their batteries. They tend to have a larger all-electric range than traditional HEVs.
- Battery electric vehicles: this type of vehicle corresponds to pure zero emission electric vehicles and uses a rechargeable battery as a power source to run an electric motor. Most BEVs are capable of fast charging and L2 charging at a dedicated charging station or @ home on L1 charging.
- Fuel cell electric vehicles: this is the most early-stage type of electric vehicle. Instead of using a rechargeable battery, it uses a different technology with fuel cells generating electricity through a reaction between hydrogen and oxygen. These vehicles are able to address long-range end-markets (autonomy is 60% higher than BEV), take less time to refuel and offer a good alternative to rail network electrification.

In all, every EV has an electric engine running the vehicle, either alone or in conjunction with a petrol or diesel-powered ICE. Even though all of these vehicles use electricity, only BEV and FCEV are zero emission EVs.

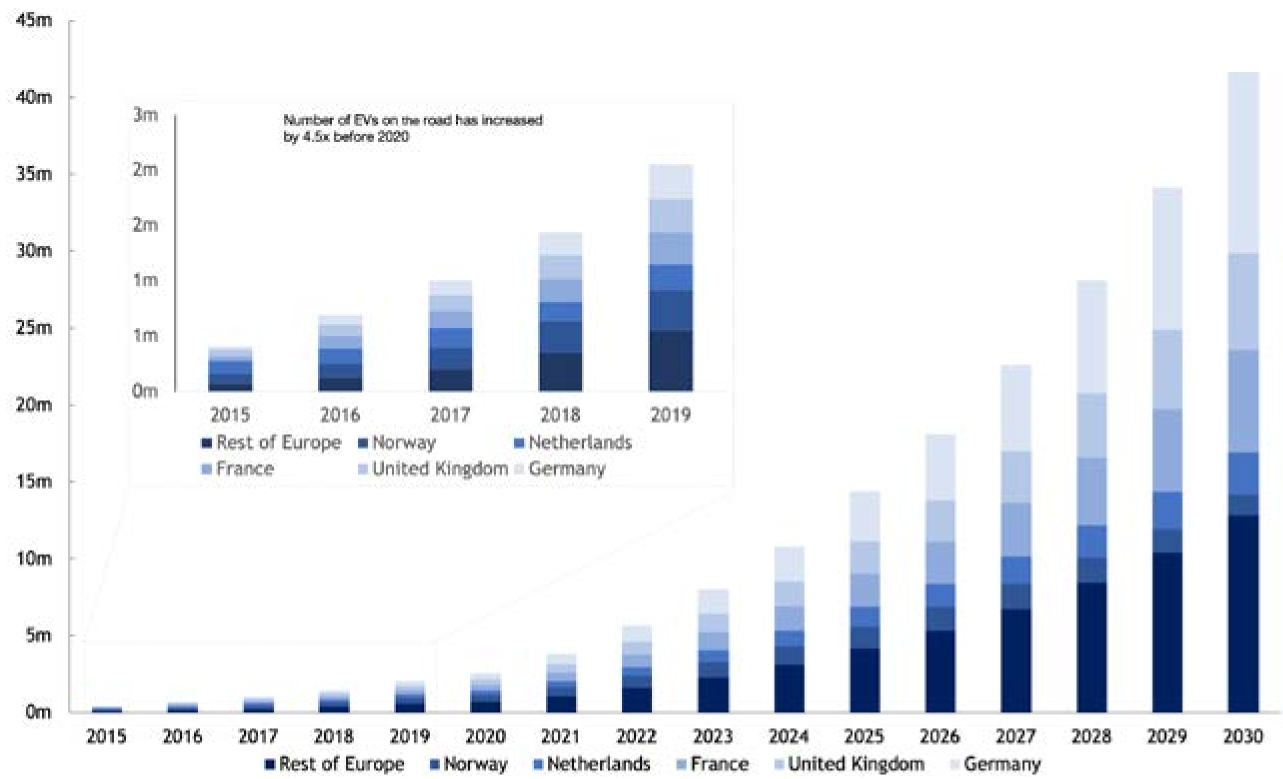
FIG. 2: DIFFERENT EV ARCHITECTURE



*Source: Stifel**

Hybrids are an effective transitional technology for limiting passenger fleet carbon emissions, but are gradually becoming a dying breed as LCEV and HDEV manufacturers are set to favour BEV and FCEV. Indeed, HEVs incur weight and cost barriers over the long term but are highly efficient in reducing GHG emissions in an urban environment given low-range journeys.

FIG. 3: MORE THAN 40M EVS IN CIRCULATION IN EUROPE BY 2030



Source: Stifel, ACEA, Delta-EE*

FIG. 4: DIFFERENT EV TECHNOLOGIES AND PROPERTIES

	Battery Electric	Fuel Cell Electric	Hybrid Electric	Plug-In Hybrid	Extended Range Electric
Power source	Battery stacks, 100% electric	H_2 Fuel, 100% electric	Primarily gasoline	Gasoline and batteries	Gasoline and batteries
ICE-generator included	✘	✘	✔	✔	✔
Grid connected	✔	✘	✘	✔	✔
Emissions	None	💧	0-125g CO_2/km	0-125g CO_2/km	0-125g CO_2/km
All-electric mode	✔	✔	✔	✔	✔
Regenerative braking	✔	✔	✔	✔	✔
All-electric autonomy	150-600km	More than 450km	0-50km	0-80km	20-80km
Battery capacity	16-100kWh	10-17kWh	0.65-1.8kWh	4.4-34kWh	Up to 32kWh
Price range	€25-150k	€50-100k	€25-180k	€25-180k	€35-85k
Examples of available models	Fiat 500e - Taycan Turbo S	Hyundai ix35 - BMW iX5	Toyota Yaris Hybrid - Porsche Cayenne Turbo S e-Hybrid	Hyundai Ioniq PiH - Porsche Cayenne Turbo S e-Hybrid	BMW iX3 - Karma GS6 e-Rev

*Source: Stifel**

THE EV MARKET IS BENEFITING **FROM MULTIPLE DRIVERS**

European regulations are clearly stimulating EV adoption

Reduced GHG emissions from transport, as well as greater usage of public and alternative transport or initiatives to decarbonise the grid are key government and regulatory priorities. COP26 in November 2021, for example, made clear that e-Mobility had become one of the most promoted decarbonisation initiatives.

With all new cars and van sales expected to be zero-emission in leading markets as of 2035, and a 2040 deadline for any other markets, governments have committed to ambitious tangible EV roll-out targets.

The drive to zero campaign aims to bring governments and leading industry stakeholders together to collaboratively develop policies, programmes and actions that can support the rapid manufacture and deployment of zero-emission lightweight vehicles. We have compiled the main programmes/policies established over the past years:

Europe

- AFID: Coordinate alternative fuel infrastructure development, EU countries to develop national policy frameworks (NPFs) for developing "an appropriate number" of refuelling and recharging points by 2020 and 2025.
- Fit for 55: Scheme to reach the 55% GHG emission reduction target by 2030 vs 1990. Upward target revisions regarding energy taxation and AFID. New credit mechanism to boost renewable electricity use in transport with specific smart charging and V2G requirements for private stations, higher CO2 emission standards for new vehicles and a shorter timeline for adoption.
- European green deal: Governments have pledged to be the first continent to reach carbon neutrality with estimates pointing to one million public recharging stations required by 2025, serving 13 million LEVs.
- EV30@30: Ambition of the Clean Energy Ministry's Electric Vehicles Initiative (EVI), setting a target to reach a 30% sales share for EVs by 2030

France

- Mobility Orientation Law (L'OM): Non-residential (residential) with >10 parking spaces must pre-equip* 20% (100%) of the car park (*pre-equipment: installation of conduits for the cables and power supply devices required for the installation of charging points. This is not the actual installation of the charging stations, but a preparation step for the installation of charging stations). 5% of pre- existing tertiary car parks must be fully equipped with charging stations.
- Advenir Law (Renewed until 2025): This law targets the financing of 125k charging points by 2025, 75% of public charging connection costs subsidised, up to EUR25k paid for DC charging point equipment, sliding scale rates (30% up to EUR960 excl. tax) for private parking lots

Germany

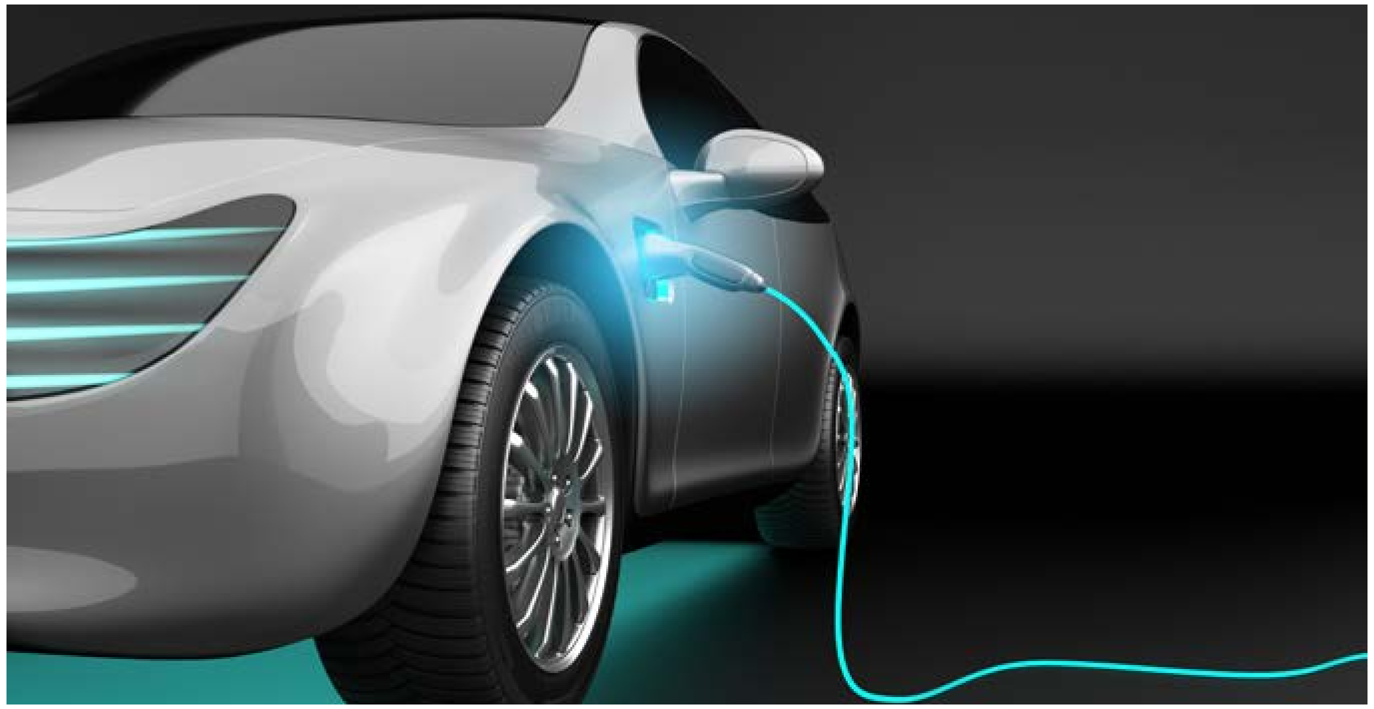
- Electromobility funding guideline (runs until 2025-end, part of the Mobility and Fuel Strategy [MKS]): together with the national control centre of charging infrastructure, which coordinates and controls activities related to the expansion of Germany's charging infrastructure, the target is for 15m EVs on Germany's roads by 2030, and more than EUR550m allocated (~50% of the programme).
- Combining the Home Ownership Modernisation and Building Electromobility Infrastructure Acts (2020), ministerial support promotes purchase and installation of charging stations for EVs with EUR900/charging points (50/50 between hardware and installation costs). Due to high demand, the funding volume of the programme was gradually increased from the original EUR200m to a total of EUR800m and represents ~900k chargers throughout the country. About half of these is related to homeowners installing chargers even if they do not yet possess an EV. We see this as highly positive for future EV adoption as residential EV charger owners are already open to an e-Mobility switch.
- Fast Charging Act (August 2021): This targets the installation of 1,000 fast charging locations with up to EUR2bn planned accordingly. Up to 2025, an additional EUR500m is available to develop publicly accessible charging infrastructure for EVs.

United Kingdom

- Starting in 2022, building regulations are evolving to ensure the provision of charging points throughout the UK. Before that, there were no country wide regulations for EV charging development, but cities and local authorities (London Plan, Edinburgh Design Guide etc) had to build their own. From now on, (1) every new home with associated parking must have an EV charger, (2) residential buildings with more than 10 parking spaces undergoing a major renovation must have at least one EV charger per dwelling with associated parking, (3) all new or renovated non-residential buildings with more than 10 parking spaces must meet a 20% EV charging equipment rate.

FIG. 5: MAIN REGULATORY MILESTONES IN EUROPE SINCE 2014

*Source: Stifel**



Pipelines at the main OEMs suggest numerous new EV models

OEMs are joining the fray and rearranging their production to further accelerate in electrification. Almost 18 out of the 20 largest automakers in terms of vehicles sold in 2020 announced intentions to boost their production of EVs with concrete milestones to reach in 2025 or 2030. Communication by OEMs on their future sales of EV is now aligned with the most aggressive IEA scenario (Sustainable Development Scenario). Their product ranges are to be adapted to transform all the current segments to electric. The Volkswagen Group has announced no less than 75 new models by 2025. The roll-out of incentive policies and/or restrictive regulations on thermal vehicles will be also key factors for growth in electric mobility.

FIG. 6: SAMPLE OF OEM PIPELINES OVER 2021-2030

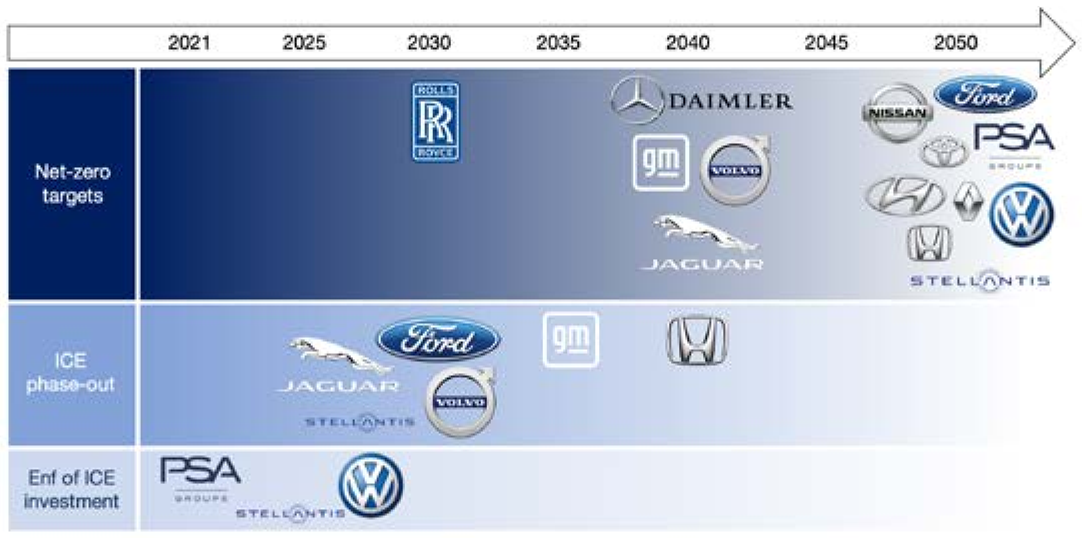
Original equipment manufacturer	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BMW Group			25		25%					10
BAIC Group	2				1.3					50%
Chengan Automobile					33					
Daimler Group		10			25%					50%
Dongfeng Motor Co	1	30%	1		1				1	1
First Automobile Works Group (FAW)					40%					60%
Ford		40				00%				
General Motors Group (GM)			22		30	1				1
Honda										40%
Hyundai-Kia Group					29 1					
Mazda		1								5%
Renault-Nissan-Mitsubishi		20 20%								
Maruti Suzuki	1									15
SAIC					30%					30
Stellantis					38%* 31%**					70%* 35%**
Toyota Group	1				15					>1
Volkswagen Group			1		75 20%				26	70%* 50%**
Volvo (Geely Group)	1	1	1	1	50%					00%

New EV models (number) | Electric sales (%) | Annual sales (m) | Cumulatives sales (m)

* European market only ** Chinese and US markets only

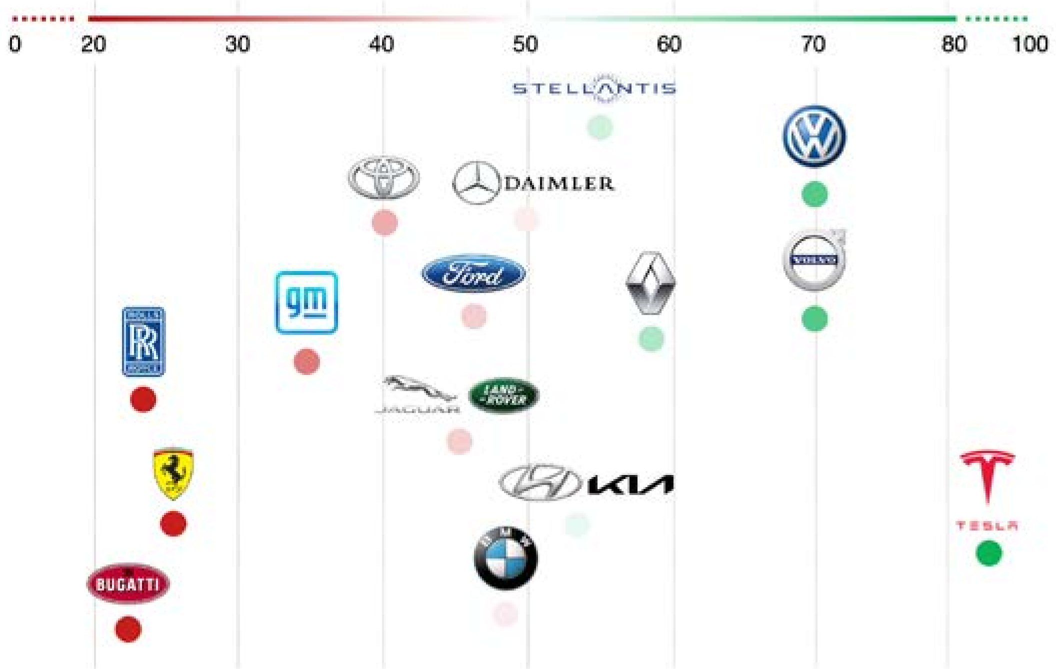
Source: Stifel, IEA*

FIG. 7: OEM NET-ZERO EMISSION TARGETS



Source: Stifel, BloombergNEF, Company reports*

FIG. 8: CARMAKER EV READINESS INDEX



Source: Stifel, BloombergNEF*

Tesla changed the image of EVs by setting the focus on high performance and aesthetic appeal. Looking back, EVs were no new concept. The first one was built in 1828 and its idea survived across decades. Tesla revived public interest by showcasing that there was actually huge demand for EVs given that people were actually able to pre-order and wait for years on the basis of a prototype unveiling. They switched constructor focus to mass public perception with sporty, performance and experience-oriented EV development where software skills are making the difference.

Tesla has also played an active role in raising awareness about the roll-out of EVs. Indeed, the group made an important move by releasing its battery technology to the public in June 2014, pledging to step up development of the battery ecosystem. Since then, it has continued to unveil improvements in the battery technology to deliver cheaper, cleaner battery cells with higher energy density and longevity. Here, solid-state batteries are one of the main catalysts. Gogoro, a light electric vehicle company, already unveiled swappable battery prototype using this technology.

Growth in the stock of electric vehicles will also be encouraged by technological progress in terms of storage capacity and autonomy.

Capacity should continue to rise to reach average autonomy of 350-400km. This implies having batteries of 70-80kWh, vs. around 40-75kWh with an average of 55kWh at present (variable depending on the markets, electric vehicles in the US have batteries with higher capacity). For example, a Tesla Model 3 has a battery of 75kWh and offers theoretical autonomy of around 500km. A Renault Zoe has a battery of 41kWH and autonomy of around 250km.

FIG. 9: TESLA IS LEADING THE LIGHT EV MARKET AS OF AUGUST 2021

Rank	Manufacturer	EV model	Average units sold per year	Average units sold per hour
#1	Tesla	Model 3	215,000	25
#2	Wuling	Hongguang Mini EV	125,925	14
#3	Tesla	Model Y	100,000	11
#4	Nissan	Leaf	85,988	10
#5	BAIC	EU-Series	65,333	8
#6	Volkswagen	ID.3	54,495	6
#7	SAIC	Baojun E-series EV	53,877	6
#8	Hyundai	Kona Electric	52,184	6
#9	Audi	e-tron	47,324	5
#10	Renault	Zoe	35,599	5

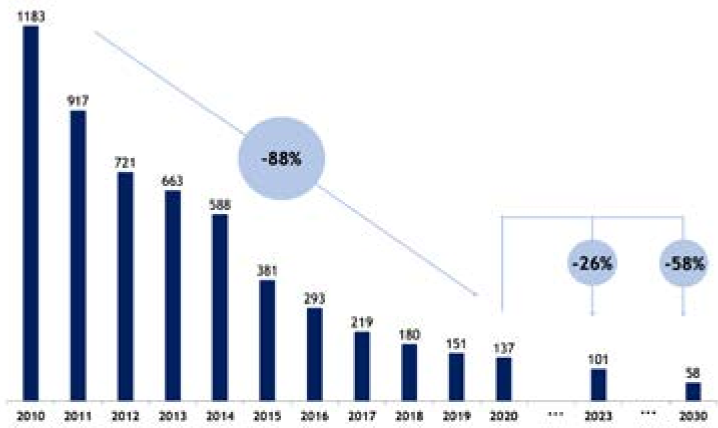
Source: Stifel, Statista*

Ongoing cost reductions

EV adoption is set to be aided by the gradual decline in production costs. Indeed, the cost of a battery pack, which still accounts for lion's share of overall costs for an EV, is set to decrease over coming years. Battery costs have already decreased by 88% over the past 10 years to USD137/kWh in 2020 (USD132/kWh in 2021 and USD135/kWh expected in 2022 due to supply chain disruptions, and higher raw materials costs) on the back of advancements in cell chemistry and manufacturing as well as increased competition.

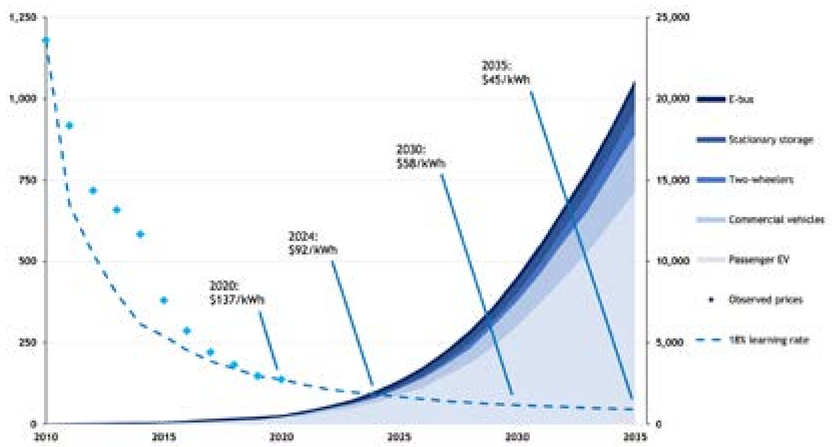
The forthcoming industrial ramp-up should enable an additional production cost decline making EVs more competitive with ICE. Li-batteries indeed represent 35-50% of the total cost of an EV. According to BloombergNEF, EVs become cost competitive with ICE at ~USD150/kWh.

FIG. 10: LITHIUM-ION BATTERY PRICE IN USD/KWH OVER 2010-30E



*Source: Stifel**

FIG. 11: LITHIUM-ION BATTERY PACK PRICE AND DEMAND OUTLOOK OVER 2010-35



Source: Stifel, BloombergNEF*

Several large-scale battery giga-factory projects are under construction:

- a Nissan and Envision partnership of more than EUR1bn on an EV manufacturing hub in the UK, with a battery production start as of 2024
- Volkswagen is to build six giga-factories with total capacity of 240GWh in Europe by 2030, but has already announced an additional EUR1-2bn to produce EV engines by 2026.

More and more industrial players are announcing their plans in Europe, with 38 giga- factory projects as of May 2021, 17 of which gave secured funding for USD30bn and a 800GWh battery manufacturing capacity representing around 14-16% market share in 2030. An further USD17bn is required for the other projects, which could boost manufacturing capabilities to 460MWh of batteries by 2025 and 1150GWh in 2030, self- covering close to 90% of EV production needs for the same year.

The decline in battery production costs is also set to be the most important factor for growth in electric vehicles. In 10 years, the lithium-ion battery prices were divided by almost 10, from USD1,183/kWh to less than USD140/kWh (-88%) and the trend is expected to continue. Prices could reach the USD100/kWh mark by 2023 (previously forecast for 2024 and already reached for the VW ID3) and around USD60/kWh by 2030. Economies of scale ought to participate in the cost reduction. Today, the majority of plants have production capacity of 3-8GWh/year, but some plants exist with capacity of more than 20GWh/year, while others are being built.

FIG. 12: EUROPEAN GIGA-FACTORY PROJECTS SCHEDULED OUT TO 2040

Source: Stifel, CIC energiGUNE*

BUT HURDLES **REMAIN IN PLACE**

Ongoing regulatory efforts and targets are driving a fast revolution. While this is true looking at the numbers announced, many hurdles remain in place and are challenging to implement. Moreover, the adoption of e-Mobility is not just an economic or environmental phenomenon, but a psychological one that is highly reliant on customer acceptance. Technology will again be the architect of possibilities. EV traction and scalability can only be derived from customer convenience apart from many other environmental and economic aspects. Bottleneck risks are set to stem from delays in rolling out EV charging infrastructure, grid capacity and the number of EV models available. The pace of change is swift, but customers can both drive the transition or stop it where it in its tracks.

Wherever and whenever supporting infrastructure

The limited availability of public charging infrastructures is one of the biggest headwinds to the widespread adoption of electric cars, not to mention the lack of adequate business and financing models for these operators. Because more and more electric cars are entering the market, fed by government subsidies, the willingness to go-green, and an improved technical and operational performance, the need to gradually develop a quick, robust and reliable charging network assumes primary importance.

Disruptive performance comes at a cost

High upfront costs and lower autonomy than ICE vehicles undermine customer buy-in momentum. Customers welcome EVs because of their own environmental consciences, lower operating costs, and improved performance over similar ICE vehicles. Lowering total cost of ownership (TCO) of compact and mid-sized EVs, which is currently comparable to petrol and diesel cars in most European nations, is fuelling this appetite. Still in the early stages of its adoption curve, the industry has yet to reap economies of scale and efficiency gains along its manufacturing and research process with batteries accounting for around 35-40% of total costs per vehicle. According to Shell, even though 80% of potential customers acknowledge their interest in EVs, they also cite high purchase costs as the biggest barrier for owning an electric vehicle and 50% even stated they would not buy an EV because of its purchase price.

Very mixed autonomy and charging duration levels are also key components in customer experience.

EVs can take between 30 minutes and 8-12 hours to charge for increasing but volatile average autonomy. While a typical EV (60kWh battery) takes about eight hours to charge from empty to full on a typical residential 7kW charging point, a 50kW fast charger delivers a full charge within 30 minutes. In addition, a vehicle's autonomy is subject to driver habits and the global environment exposure.

Customers education to avoid misconceptions

A lack of consumer knowledge and false perceptions are clear difficulties encountered by EV manufacturers. In the past, these have misled customers to a point where misbeliefs emerged such as range and price anxiety (even if the average price to range fell steadily between FY10 and FY19 from USD435/km to USD110/km), and the idea that EVs could be costly to maintain and repair (no regular tune-ups, fewer moving parts, one speed transmission). Fears also concern the low battery lifecycle (Nissan Leaf ~75% capacity after 150k km/Tesla ~90% capacity after 250k km) or power grid unsuitability (Navigant Research estimated that 10m EVs could be added to the system without having to build any power plants considering that EVs are charged at night during off-peak period).

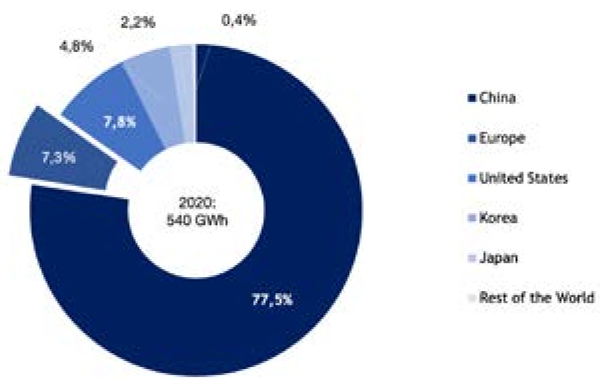
Growth sustainability

The potential long-term effects of the Covid-19 pandemic and the ongoing war in Ukraine, notably regarding supply chain disruptions, could harm the ability of the entire ecosystem to sustain the pace at which the EV revolution is taking off. Raw materials such as nickel, manganese and cobalt are part of this challenge given that they are by far the largest components of Li-batteries. Even if batteries can now be recycled at 95%, nickel output is highly dependent on the development of new mines. Indeed, recycled input will come from ageing EVs (ex: Model 3 since 2017), but the first massive wave will probably occur when vehicles hit the 10-year-old threshold (i.e. 2025-2027). Therefore, the scarcity of nickel has propelled EV manufacturers such as Tesla to become technical partners in new openings, so that they could secure part of their raw material supply.

Direct supply chain pressurising

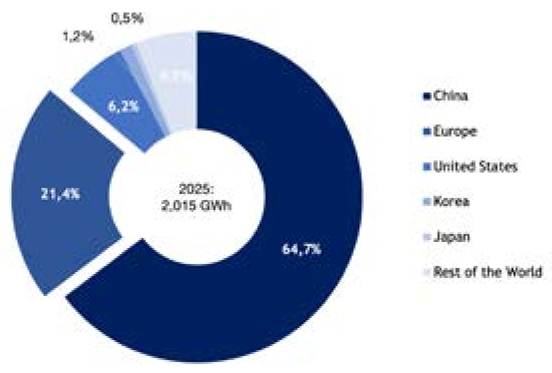
The entire supply chain from lithium mining, to battery production, and car manufacturing, must be carefully calibrated and coordinated to meet rising EV demand. According to a recent Benchmark Mineral Intelligence report, global lithium-ion production capacity could exceed 6 TWh in FY30 based on current investment scheme announcements made by battery manufacturers. The actual global battery market stands at 600GWh annual production/year vs typical EV battery 60KWh which means actual annual EV production capacity is at 10m/year and that the investment pipeline could bring it at around 100m/year FY30. Additional investments must be made to adjust for a 70% average global capacity utilisation taking into account maintenance and rising demand for batteries in energy storage systems.

FIG. 13: GLOBAL BATTERY MANUFACTURING CAPACITY IN 2020



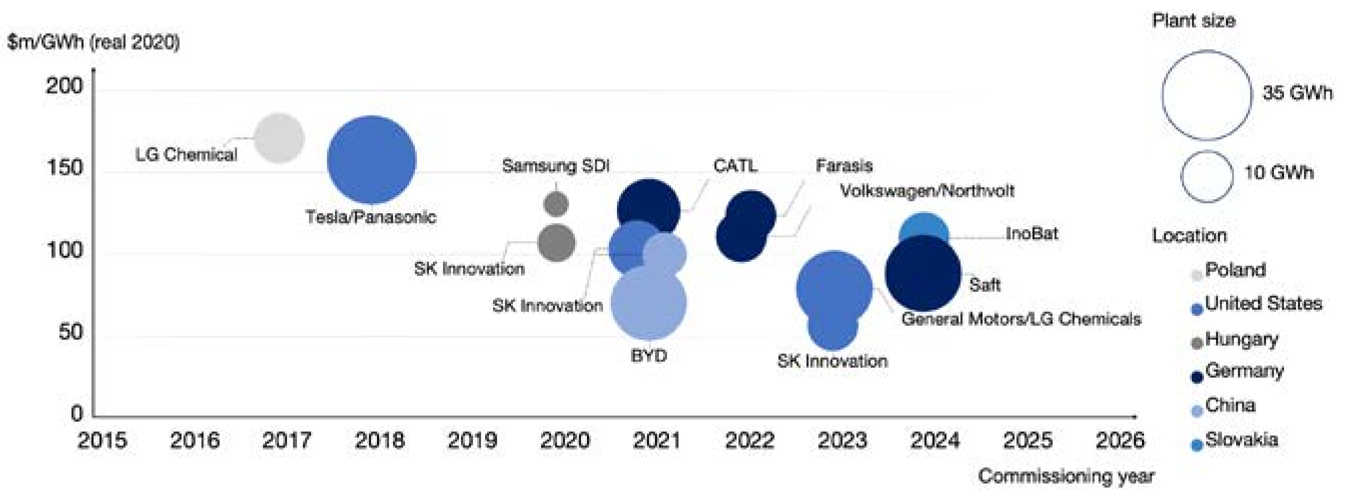
Source: Stifel, BloombergNEF*

FIG. 14: GLOBAL BATTERY MANUFACTURING CAPACITY BY 2025



Source: Stifel, BloombergNEF*

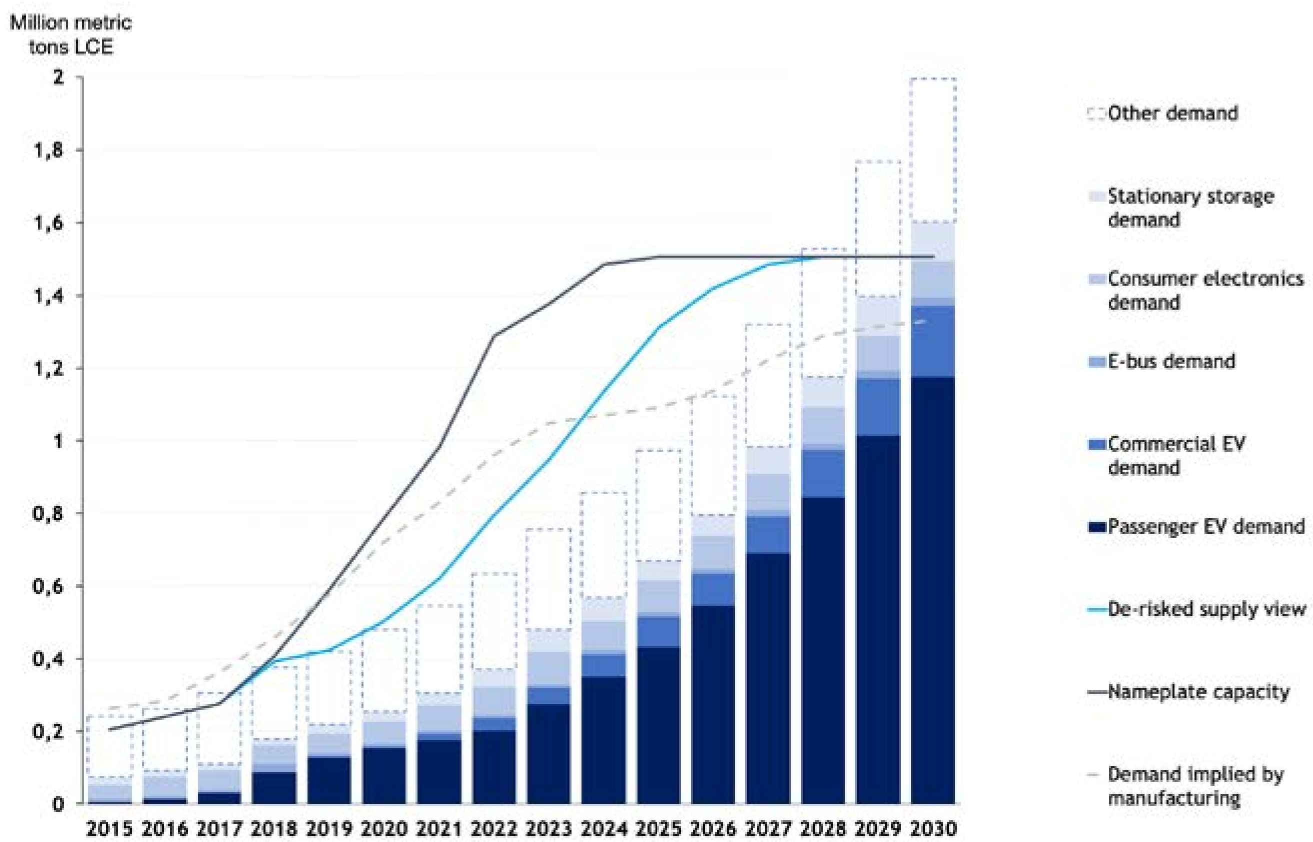
FIG. 15: GREENFIELD BATTERY MANUFACTURING CAPEX



Source: Stifel, BloombergNEF, public reports*

Lithium raw material mining and supply will have to expand to these 6TWh battery production worldwide and deliver ~3.8m tonnes of Lithium Carbonate Equivalent from 485k tonnes (vs 452k demand) in 2021. Based on current supply forecast, lithium demand will begin to outstrip supply as of 2022 and the imbalance will grow rapidly in the absence of further mining development. Elon Musk even added lithium to his list of raw materials concerns saying that it was a fundamental limiting factor for EV adoption worldwide. Production is expected to expand by 25% a year with conventional supply balancing the industry in 2030 but according to McKinsey, by then, three new technologies called Direct Lithium Extraction, Direct Lithium to Product and Direct Shipping Ore will both mitigate short-term undersupply risks and boost initiatives in the future.

FIG. 16: GLOBAL LITHIUM SUPPLY AND DEMAND FORECASTS USING DIFFERENT METHODOLOGIES



Source: Stifel, BloombergNEF, Avicenne*

Looking at the global fleet structure in 2021, we can derive that around 0.6% of the car fleet is actually electrified, with only 5% market share. China and Europe lead the transition with 1-2% of their fleet and around 20% of new sales in electric vehicles in 2021. Still, if we compare this to innovation diffusion schemes, we know that we are close to the early-adopter stage in Europe and on track to catch the early-majority in the EV adoption cycle, compared to one step before at a global level.

Considering investments announced in manufacturing capabilities we know that the ramp-up will allow for around a 20% EV fleet in Europe in 2030 and more than 60% market share for the same year. Steepening 2019-21 numbers confirm an accelerating pace in the adoption trend. As such, the market seems ready for a take-off with 2030 potentially starting to bite the late-majority in terms of new EV registrations. 2025-35 is increasingly becoming the key decade to address the broad e-Mobility switch and ecosystem development. Additionally, since the average retention period for passenger vehicles in Europe is gradually decreasing, reaching seven years in 2021, and the European fleet averages 12 years across all vehicle types, there is room for further renewal acceleration and this could further increase the switch to EVs.

INFRASTRUCTURE ROLL OUT **IS THE KEY BUILDING BLOCK**

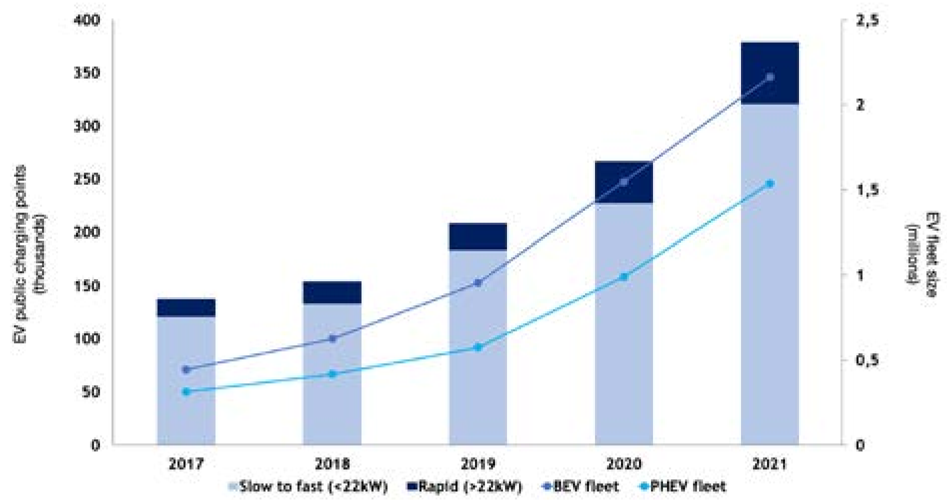
SECTION 2

HOW MANY CHARGING POINTS **DO WE NEED**?

Deployment of an extensive charging infrastructure in line with EV roll-out is key to switching to alternative fuels over coming decades. European policies aim to make EV charging as easy as filling up a conventional vehicle, paving the way for easy traveling across the EU.

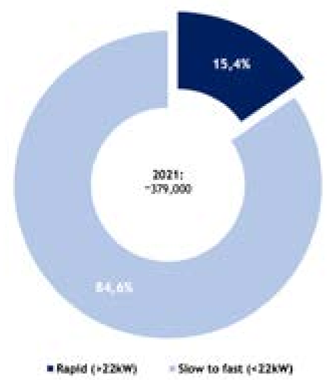
According to the European Alternative Fuels Observatory, there were approximately 374,000 public charge points in Europe at end-2021, including slow/fast (0-22 kW) and rapid/ultra-rapid charging modes (22kW-350kW).

FIG. 17: EV PUBLIC CHARGING POINT GROWTH IN EUROPE OVER 2017-21 (IN # OF UNITS)



Source: Stifel, European Alternative Fuels Observatory*

FIG. 18: CHARGING POINTS SPLIT BETWEEN AC AND DC IN EUROPE IN 2022 (# OF UNITS)



*Source: Stifel**

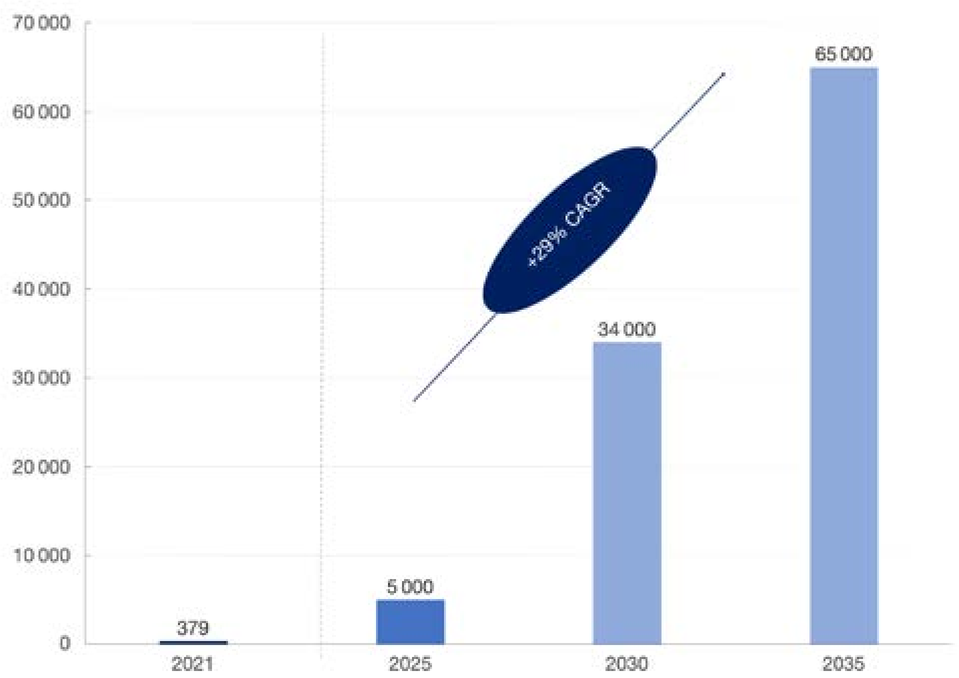
Numerous projections have been made by experts regarding the number of EVs in circulation in 2030 or 2035. According to the IEA, the number of EVs could reach between 137 million and 220 million units in 2030.

However, these numbers seem too aggressive to us. As stated in the previous section, based on lithium-ion giga-factory capacities in Europe over the next 10 years, we forecast 100-110m EVs circulating in 2030, which is consistent with the expectations of several experts.

Indeed, according to Ernst & Young, the total EV parc is set to exceed 130 million vehicles. We can therefore derive consistent EV charging point forecasts for the next decade.

With 130 million EVs circulating by 2035, 65 million charging points will be needed at least (assuming a ratio of 2 EVs / CP).

FIG. 19: EXPECTED NUMBER OF CHARGING POINTS REQUIRED IN EUROPE OVER 2025-35 (IN # OF UNITS)



Source: Stifel, EY, European Alternative Fuels Observatory*

An extended offer of chargers

EV's autonomy is lower (c.380 km averaged over 10 EV passenger cars currently on the market) than that of conventional vehicles. Therefore, they need to be charged more frequently. Moreover, the charging time is not homogenous since it depends on the vehicle's battery and charging point capacity.

Basically, there are four types of charger: slow and normal (home, workplace, supermarkets etc.); fast and ultra-fast (motorways and main road networks).

FIG. 20: CHARGING SPEED AVAILABLE IN EUROPE IN 2022

Charger speed and type	Power rating	Approximated time to charge*
Slow *(single-phase AC charger)*	3-7kW	7-16 hours
Normal *(three-phase AC charger)*	11-22kW	2-4 hours
Fast *(DC charger)*	50-100kW	30-40 minutes
Ultra-fast *(DC charger)*	>100kW	<20 minutes

*Also depends on the battery capacity and other variables

Source: Stifel, European court of auditors as of December 2021*

In terms of cost, each category of charger comes at a different price:

- Standard AC charging (typically 3kW to 7kW) ranges from EUR700 to EUR900.
- Rapid AC chargers (from 10 kW to 22kW) cost between EUR900 and EUR3000.
- DC fast chargers (between 43kW and 53kW) start at EUR25,000.
- Ultra-fast chargers (350 kW) usually cost EUR125,000.

With distinct types of use:

- Standard AC charging: slow, usually overnight charging.
- Rapid AC charging: used in various destination locations (i.e. places where people might spend a few hours like workspaces, restaurants, hotels, supermarkets etc).
- DC fast chargers: commonly used in public charging stations such as motorway corridors.
- Ultra-fast chargers: generally reserved to motorway corridors or specific hubs.

Standardisation would ease the customer experience

Enabling interoperability in the e-Mobility ecosystem is currently one of the key headwinds. All charging points, contracts, payment mechanisms and vehicles will need to embed interoperable technologies in order to scale at the same pace.

Data collection and interpretation is key, but so is hardware and software to smooth both the customer and operator experience. Data and power flows require interoperable communication protocols from charger interface to plug inlets and payment systems, or battery and energy management system information exchanges.

Industry standards and protocols are evolving fast such as the OCPP (open charge point protocol), OCPI (open charge point interface), OCSP (open smart charging protocol), and more recently ISO 15118 (V2G, bidirectional charging protocol).

Moreover, to date, not all battery electric vehicles and plug-in hybrid electric vehicles can recharge at every recharging point in the world. That is because the EV recharging connector and vehicle inlets vary across geographies and models.
In the European Union, recharging points are classified into two main categories, based on their power output and speed. Category 1 is recharging via AC, while Category 2 is recharging via DC.

FIG. 21: CHARGING POINTS CATEGORY BASED ON AFIR PROPOSAL

Category	Sub-category	Maximum power output (P)	Definition
Category 1 (AC)	Slow AC charging point *(single phase)*	P < 7.4kW	Normal power charging point
	Medium-speed AC charging point *(triple phase)*	7.4kW ≤ P ≤ 22kW	Normal power charging point
	Fast AC charging point *(triple phase)*	P ≥ 22kW	High power charging point
Category 2 (DC)	Slow DC charging point	P < 50kW	High power charging point
	Fast DC charging point	50kW ≤ P ≤ 150kW	High power charging point
	Level 1 Ultra-fast DC charging point	150kW ≤ P ≤ 350kW	High power charging point
	Level 2 Ultra-fast DC charging point	P ≥ 350kW	High power charging point

Source: Stifel, European Alternative Fuels Observatory*

In the EU for example, the AFID requires that all the charging points are equipped at least with socket outlets or Type 2 vehicle connectors, Mennekes (for AC normal and high- power recharging points) and connectors of the combined charging system, CCS/Combo 2 (for DC high power recharging points).

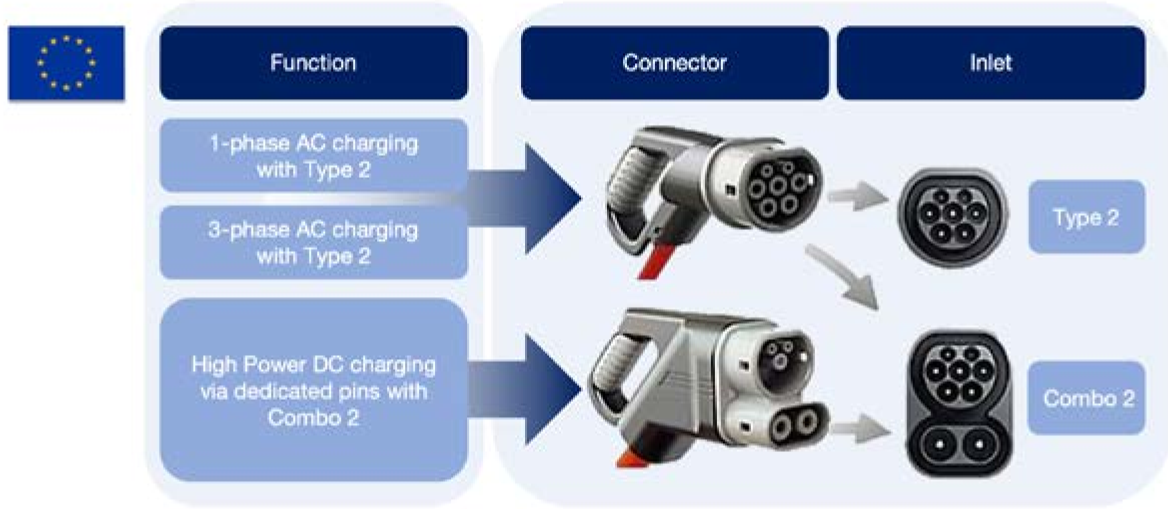
European regulations do not ban the addition of other connectors to a recharging point. While prior to the adoption of AFID, a number of recharging points with AC connectors other than Type 2 were deployed in the EU, the prescription of the Type 2 standard through the European directive put an end to this.

Regarding DC charging, while 50kW recharging points were usually equipped with an additional CHAdeMO connector, more and more providers of high-power recharging points choose to equip their stations with CCS/Combo 2 connectors only.

Below, an overview of the main types of standards, for the rest of the world:

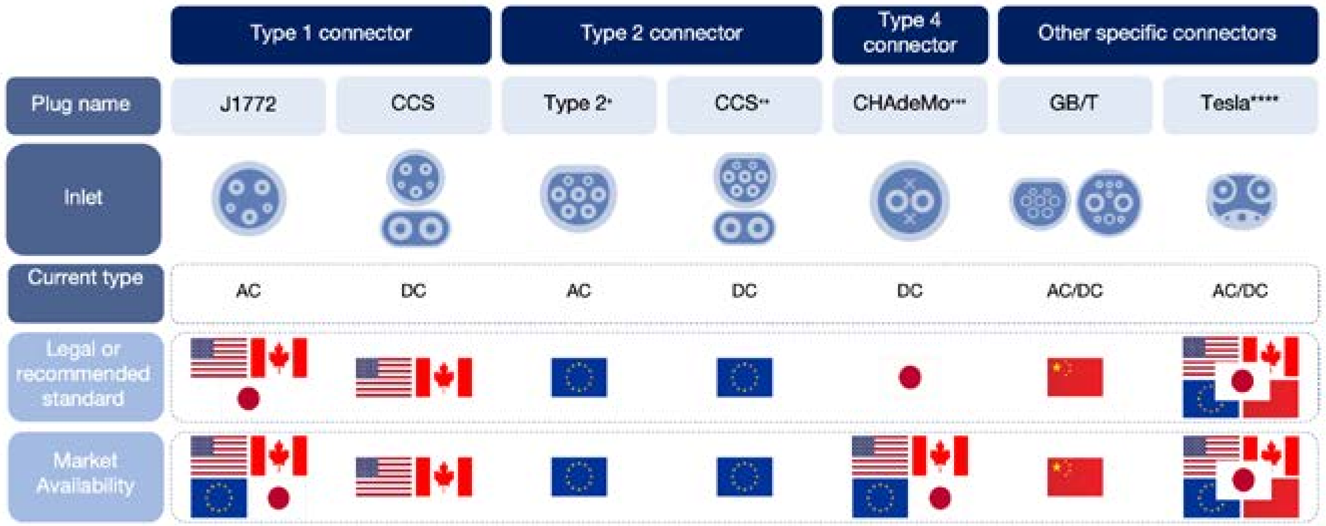
- SAE J1772 and J3068 (North America, Japan).
- CHAdeMO (Japan).
- T esla (all markets except EU).
- GB/T 20234.2 and 20234.3 (China).

FIG. 22: TYPES OF EV CHARGING PLUGS (CONNECTORS)



Source: Stifel, European Alternative Fuels Observatory*

FIG. 23: EV CHARGING PLUGS BY GEOGRAPHY



* AFID Annex II requires AC charging stations to be equipped at least with socket outlets of Type 2 EV connectors for interoperability purposes.

** AFID Annex II requires high power DC charging stations to be equipped at least with "Combo 2" (CCS2). It is the charging standard on recent EV models such as BMW I3/iX3, Fiat 500e, Mercedes EQC, Jaguar I-Pace, Audi e-Tron, Volkswagen e-Golf/ID.3, Tesla Model 3 and Porsche Taycan.

*** Used in Japan and in Europe (France requires all fast-charging points to include a CHAdeMo connector by the end of 2024. It is the charging standard on EV models such as Citroën Berlingo Electric/C-Zero, Kia Soul, Mitsubishi Outlander PHEV/iMiEV, Nissan eNV-200/Leaf and Peugeot iOn.

**** Tesla's vehicles can charge on other connectors such as Type 2.

Source: Stifel, European Alternative Fuels Observatory*

WHERE WILL
THE CP BE LOCATED?

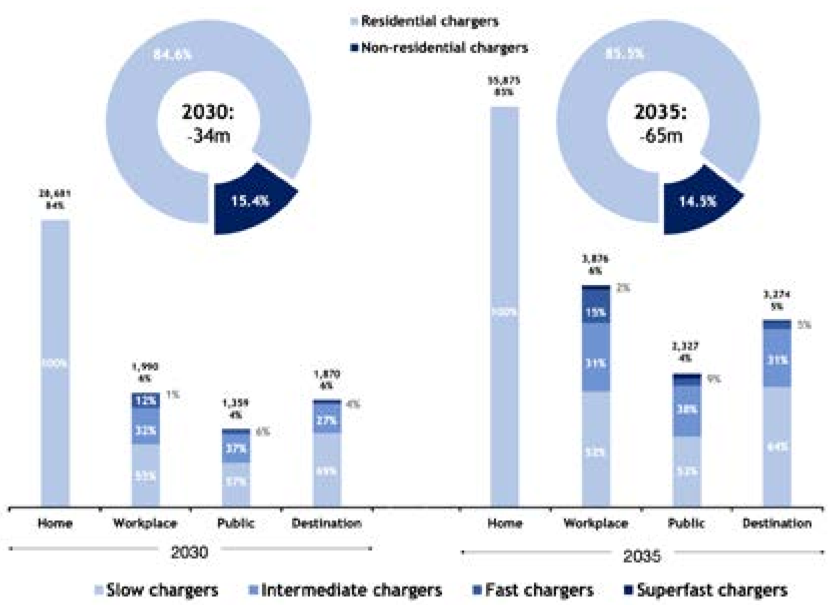
Bearing in mind that cars are parked for 95% of time, one of the main assumptions is that people will charge their car where they live. Consequently, four charging locations are usually highlighted:
- Home.
- Workplace.
- Public (on streets & motorways).
- Destination (supermarkets, restaurants, charging hubs, etc).`

According to our industry contacts, the most preferred location to charge EVs in the future is at home, mainly for the following reasons:
- It is cheaper than public charging (by 59-78% according to the UK National Audit Office).
- It allows overnight charging.

the EVnetwork

Founded in 2017, EVN is a leading independent EV charging infrastructure development company. EVN's mission is to address the challenges faced by both landlords and charge point operators in rolling out a network of rapid and ultra-fast EV chargers and charging infrastructure in the UK. EVN has carefully selected and secured the very best sites in the UK, seizing first-mover advantage in what has become an increasingly competitive UK market. Through strong relationships with high quality landlords and charge point operators, EVN has become a distinguished player in the EV charging market able to provide its partners with fully funded bespoke technology and service solutions. The company is looking to expand its offering in other key geographies.

FIG. 24: CHARGING LOCATION EXPECTED IN 2030 AND 2035



Source: Stifel, EY*

55 ELECTRIC CHARGING

First created under the name Plus de Bornes in 2013, Electric 55 Charging is the first private operator of charging stations in France. Retrofitting adept, the company is not only able to install its own equipment and software but also to update and take over the operation of old Autolib' network charging stations. Most of its efforts are concentrated on the software side of the business, with scalable network supervision and maintenance solutions.

BORNE RECHARGE SERVICE

BRS has been an e-Mobility market player since 2012, acting as charging point operator and service provider. It equips, operates and provides recharging services for electric vehicles to all its private and professional customers, whether in apartments, individual houses or private/public organisation car parks. Established for 10 years, BRS benefits from the support of a network of approximately 90 qualified installers throughout France.

These four locations can be broken down into six distinct segments, each embedding their own specific features:
- Residential rural: 3.3-7kW, connected to the home electricity supply, high flexibility due to extended dwell times (off-street parking = available parking spaces for vehicles within an enclosed car park or garage, car parks may be owned by a municipality, government organisations or privately owned).
- Residential urban: no option to install the charging unit independently, with the need for agreement from the landlord; 7kW, few buildings are designed to support charging stations, installing charging stations can be expensive, parking spaces are often assigned but tenants change and new occupants may or may not have EV. There is also an issue of metering and paying for the electricity used to charge EVs. Opportunities for smart charging.
- Workplace: for employee use, offered free as a perk and providing an alternative to charging at home (slow or fast up to 22kW), flexibility, can work with solar energy .
- Fleet hub: designed for commercial vehicles (cab, LCV and HDV) generally requiring overnight parking. As such, these hubs are designed to perform both logistics and nine-to-five operations in order to ensure most of the fleet is up and running on daylights. Chargers are usually fast (> more than 22 kW) thus requiring significant investments, but long dwell times during off-peak periods offer high potential for energy consumption optimisation.
- Overnight stay hubs: this set-up requires important investments and primarily targets HDVs, but it can be equipped with various types of chargers (50-300 kW) in order to address a broader range of vehicles. With mostly long dwell times (more than 4 hours), hubs again offer potential to reduce pressure on the grid when optimizing off-peak solicitation.
- Motorway corridors: highway service stations equipped with fast (50-70 kW) and ultra-fast (more than 150 kW) charging points in order to allow car/truck drivers to top up their vehicle autonomy very quickly. As such, drivers can keep on with their journeys after having paid a charging fee.

FIG. 25: DIFFERENT CHARGER USES DEPENDING ON POWER AND LOCATION

	Private charging		Public charging		
	Home charging	Fleet charging	Semi-public charging	Public AC charging	Public DC-/HPC charging
	Charging in single, residential and/or dwelling houses homes. These stations are usually equipped with overnight, low power charging points.	Fleet charging consists of charging during working hours or at the workplace. Charging infrastructure is dedicated, and thus installed in a private parking spaces.	Destination charging i.e. supermarkets, restaurants, hotels and leisure facilities. Hybrid models integrate DC/HPC charging in semi-public charging stations to increase CP frequentation	AC charging with both fees and spreads at the roadside in urban areas. In the first place, these charging stations were mostly publicly owned	DC and HPC charging in public areas mainly corresponds to highways, main traffic axes and metropolitan areas with high traffic volumes
	• Private customers on their own or rented parking spaces • Business car owners requiring billing tools	• Employees in which company car drivers • Fleet vehicles • Customers and guests	• Opportunity charging for private customers • Regular charging possibility if no charging station available at home	• Private customers looking for convenience charging • Lantern parking • Car sharing fleets	• Long distance charging for roaming private and business customers • Last resort, urgent charging

Source: Stifel, P3 France*

AC over DC ?

After looking at different sector research reports (consulting companies, European commission, specialised press) devoted to EV charging and speaking to multiple companies, we derive a consensus related to the AC/DC split.

Indeed, what we usually observe is that AC (slow charging) should represent more than 95% of all the installed base of charging points by 2030, mainly located in cities (residential, workplace, supermarkets, streets etc.). Therefore, according to many experts, DC chargers will represent a 2-10% share, primarily located on motorways, in place of current petrol station locations.

The reasons explaining these expert forecasts rely on multiple pillars:

• Grid capacity is higher in the intercity corridors than in city centres; consequently, DC chargers are easier to install at the peripheries and need less CAPEX than in urban places where additional grid updates (substation transformers) are required to allow the delivery of 100-300 kW power.

• EV users will not be keen to pay charging fees when they can charge for free at their home or at work.

• Since EV charging will mainly be done on AC charging points, EV users will change their behaviour and take advantage of the charging point located at their destination: at home, at work, at supermarkets or restaurants.

• Finally, the market is already crowded with major players like Ionity or Tesla clearly focusing exclusively on DC charging, which could prevent new players from penetrating the market.

All these points explain why EY for example anticipates that DC charging will represent 2% of the installed base of charging points but will require 25-35% of all CAPEX related to charging infrastructure in Europe by 2030.

However, our view is not that categorical.

Indeed, we note that taxi drivers and buses are at the forefront of EV adoption. Working exclusively in urban environments on a 12-15h/day basis, slow charging is not optimal at all.

• Plus, CPOs could be more willing to operate DC charging stations despite higher CAPEX: with an average of 10-20min stay per charge, volumes are far higher than an AC charging station. Since CAPEX is massively subsidised by local governments, returns can be more appealing from a CPO perspective.

• Finally, only CPOs can provide fast charging stations meaning they will not compete with individuals installing their own chargers.

For this reason, we start to see locations like supermarkets or restaurants (destination locations) initially targeted by AC charging CPOs, now equipped with DC stations.

Schneider Electric

According to Mike Doucleff, Head of Schneider Electric e-Mobility, “once the cost of batteries is progressively going to USD100/kWh capacity, this is where price parity will take place and where real growth comes into play. EV drivers will charge when they stop, they won’t stop specifically to charge their vehicles”. Still, “for the passenger segment, the majority of charging demand will be on the connection of a building/home, ie. residential charging”. There are roughly three factors driving demand for slow charging stations and explaining Schneider’s focus on low/medium voltage appliances (AC/DC metering, microgrid, layer softwares, EMS & smart grid solutions):

- the range of mass market increases to 500-600km/charge while a typical driver drives 1500km/month,
- residential charging is 20-50% cheaper than when charging in transit (DC charging) because you leverage smart charging, energy management systems and thus reduce charge peaks
- residential charging is more convenient, and 50% drivers will only charge at home.

FREEWIRE

FreeWire Technologies is a turnkey provider of battery-integrated ultrafast charging solutions. The Boost Charger is unique in that it benefits from proprietary battery technology, internally developed power electronics and software, solving grid infrastructure limitations by using the existing power available on a site.

According to Michael Beer, CFO at FreeWire Technologies, “while Europe has already reached a tipping point in terms of EV adoption, the North American market is benefiting from a number of governmental tailwinds and a host of incentive programs, driving EV sales and investment in associated charging infrastructure. Charging, regardless of technology, is at the core of the e-Mobility revolution, but the strain on the grid today is a huge concern. Unfortunately, slow charging rarely makes sense in the public (outside of office parks or a handful of select locations). As a result, we developed a product that offers ultrafast charging capability in convenient locations, while minimizing the need for utility upgrades and/or new on-site heavy grid infrastructure.”

Examples of EV charging partnerships in order to attract and convert EV drivers into customers are ranging from McDonald’s to Carrefour and other big names. Hundreds of McDonald’s restaurant are now equipped or will be equipped by Nuon with Vattenfall fast chargers and they have also partnered with Endesa X throughout Spain since 2019. At the same time, Carrefour Energies partners with Allego and Driveco to equip its hypermarket and supermarket network with 5,000 medium and fast charging stations by 2025.

In the end, fast charging could be deployed more widely than currently expected. Especially in urban places, despite the massive grid updates required. French company Electra, mainly focused on urban/peri urban fast charging, is a good example.

ALFEN POWER TO ADAPT

Founded in 1937 as the J. van Alfen factory dedicated to high and low voltage equipment in the Netherlands, Alfen became an international organisation focused on products and projects closely involved with electric energy.

In the early years, the company mainly manufactured switching equipment but since 2008, it has been active in the EV charging space. Alfen grew to become an international and diversified player commercialising smart grid solutions (hardware and software), energy storage (based on batteries) and charge points for electric vehicles (EVs). On the back of its deep expertise, Alfen focuses on destination charging (home, semi-public and public segment) with 5 base models. The company is the only player in the energy sector that is positioned simultaneously in the substation, microgrid, energy storage and EV charging station businesses.

This unique positioning also contributes to market share gains since every single contract can lead to cross-selling opportunities and cost synergies. As such, Alfen has delivered close to 320,000 charge points across Europe up until Q122 and has doubled its charging business year-on-year for 3 consecutive years in a row (2018-2021).

ELECTRA

Electra is a fast/ultrafast charging point operator, founded in 2021 with the aim of accelerating the energy transition by providing EV drivers a fast-charging network. The group has already signed contracts with Indigo, AccorInvest and Chopard over the last year. The company aims to operate more than 1,500 charging stations with 8,000 charging points in urban/suburban areas first in France and then in Europe by 2030. While the hardware part is key, what creates value for the consumer is the embedded software so that the network is well maintained, always up and running and data is processed, enabling continuous learning.

According to the company, public charging will represent 40-50% of the market in terms of energy delivered, of which 70-80% in fast charge. Charging stations will gradually become more commoditised and more profitable.

Alpitronic, an Italian company created in 2009 and based in South Tyrol, is one of the leading DC charging point providers in Europe. Since 2017, they have been offering innovative and cost-efficient products with state-of-the-art technological content as well as the ability to master the entire development and production process, from design to integration and production. With their Hypercharger solution, they not only have one of the most sought-after products on the European market but are also "setting European standards in the field of fast charging technology" said Philipp Senoner, co-founder and managing director of Alpitronic.

In June 2022, together with Scania and CharIn at the EVS 35, they simulated a megawatt charging process based on MCS adapted solution, enabling trucks and buses to charge electrified heavy-duty vehicles within a reasonable time. Based on CCS, they demonstrated that the device is already capable of supplying charging power of more than 350kW and above 1MW.

FIG. 26: MEGAWATT CHARGING SYSTEM ON AN ALPITRONIC CHARGER

Uneven deployment and geographic divide

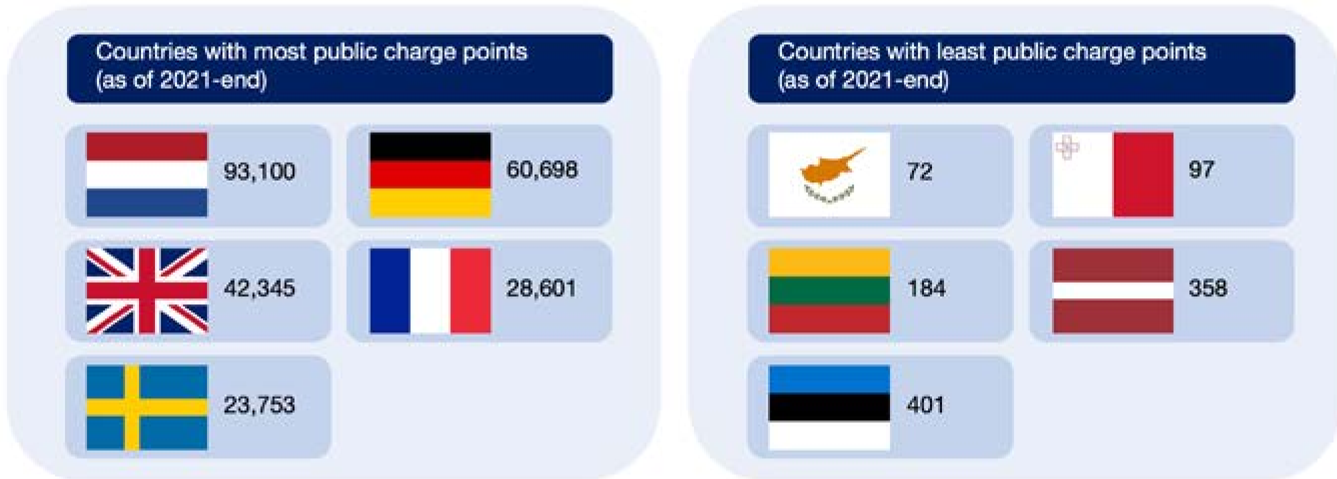
A look at the current numbers indicates that geographic distribution of charging points is fairly polarised in Western Europe. At present, 66% of all charging points are concentrated in just five European countries: France, Germany, Italy, the Netherlands and the UK.

The Netherlands is known for its position as worldwide leader in e-Mobility with the highest density of EVs and charge points per 100 km. In terms of ratios EV/CP, disparity is also important:

- Four EVs per CP in the Netherlands.
- 15 EVs per CP in the UK.
- 18 EVs per CP in Germany.

This polarisation is likely to continue according to EY: the UK, Germany, France, Italy, the Netherlands and Spain should account for around 60% of total charger stock by 2030. By 2035, adding Sweden, Portugal, Denmark and Poland, 10 countries will account for 70% of Europe's charger stock. As such, Eastern European countries will have to quickly catch-up to meet zero emission targets.

FIG. 27: GEOGRAPHIC SPLIT IN # OF UNITS



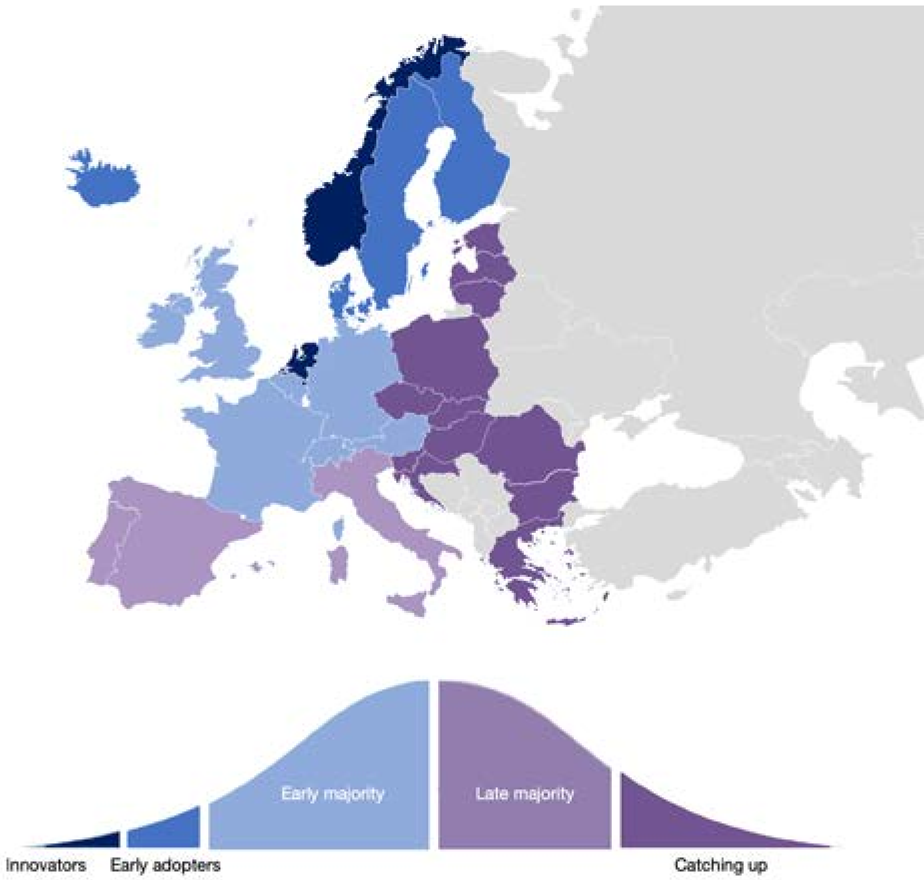
*Source: EeFO, Stifel**

Compleo is a German pure-play technology provider of AC and DC charging solutions for EVs in different public and semi-public, fleet and employee charging applications.

Since 2009, Compleo has shipped more than 50,000 EV chargers to 15 countries in Europe even if most of them are installed in its home market, i.e. Germany. As a "one-stop-shop", Compleo enables charging-as-a-service. Indeed, it addresses both hardware and software along with services ranging from planning and project management to maintenance and troubleshooting. Acting as a consolidator, Compleo actively pursues an M&A strategy in order to strengthen its portfolio on every vertical and remain a leading player for the energy transition of the mobility sector.

FIG. 28: COMPLEO'S TAILORED SOLUTIONS ENABLED DEUTSCHE POST DHL TO INSTALL 2,200 CHARGING POINTS THROUGHOUT GERMANY SINCE 2018

FIG. 29: EARLY ADOPTERS ARE IN WESTERN EUROPE

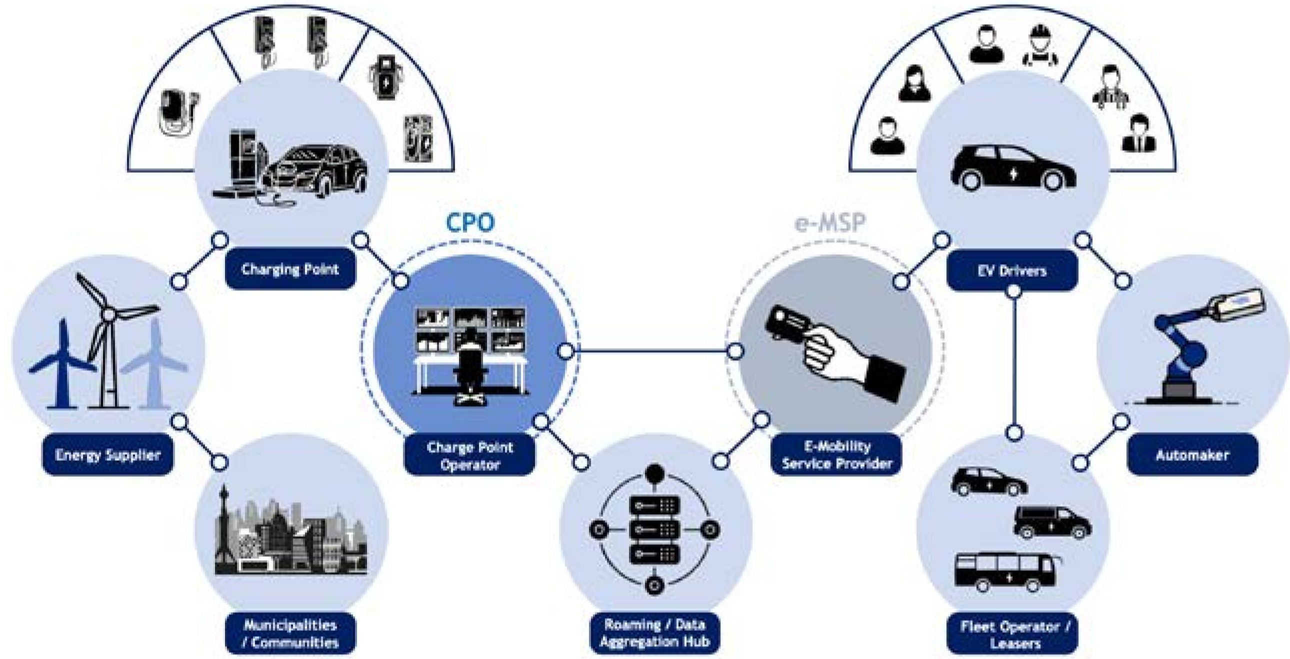


Source: Stifel, BloombergNEF*

MAIN BUSINESS MODELS AND **INDUSTRY PLAYERS**

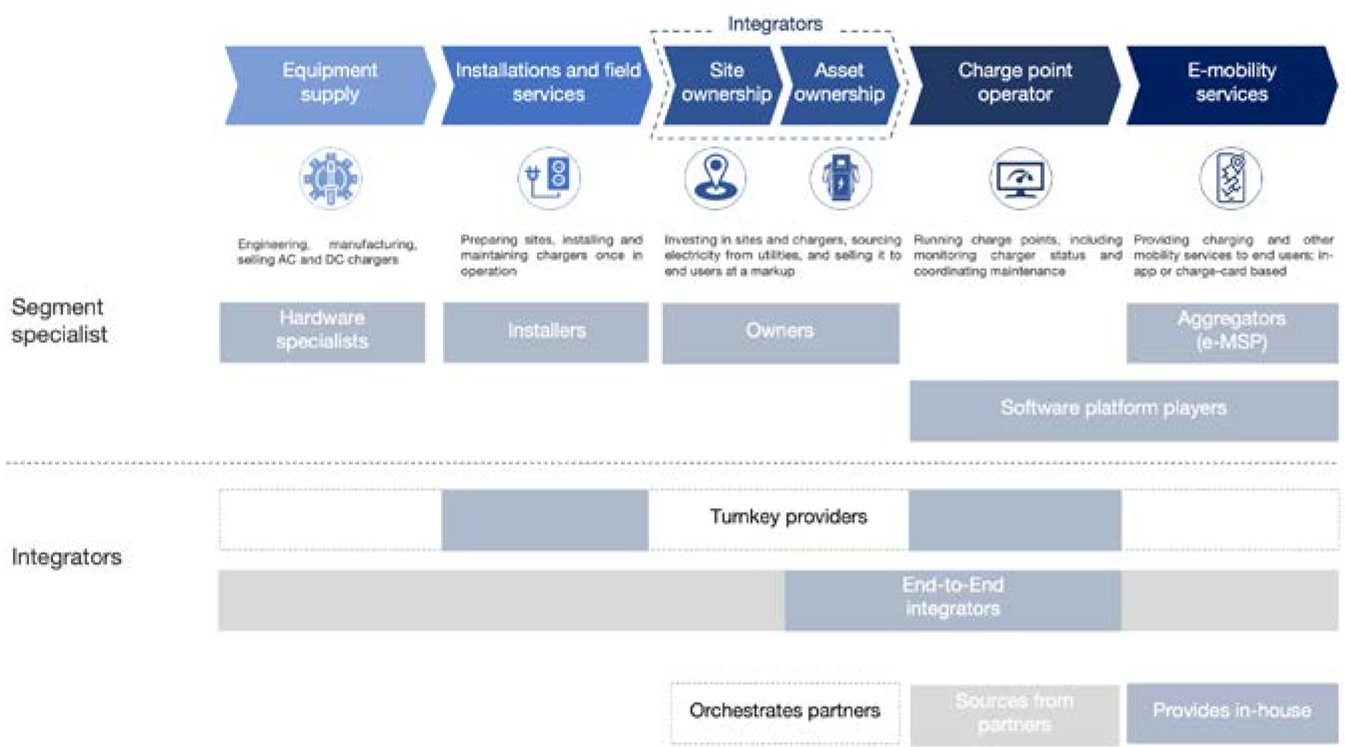
As shown previously, decarbonisation trends and the acceleration in the pace of adoption are shedding a lot more light on the EV industry thus generating new business opportunities. Since the ecosystem is nascent, the balance between its players is tending to change fast, although its architecture can be set out as shown in Fig 31. In the end, the ecosystem is aimed at reducing total cost of ownership and developing third-party applications.

FIG. 30: WHO ARE THE PLAYERS AND WHAT ARE THEIR SCOPES?



Sources: Stifel, EAOB*

FIG. 31: ECOSYSTEM VALUE CHAIN

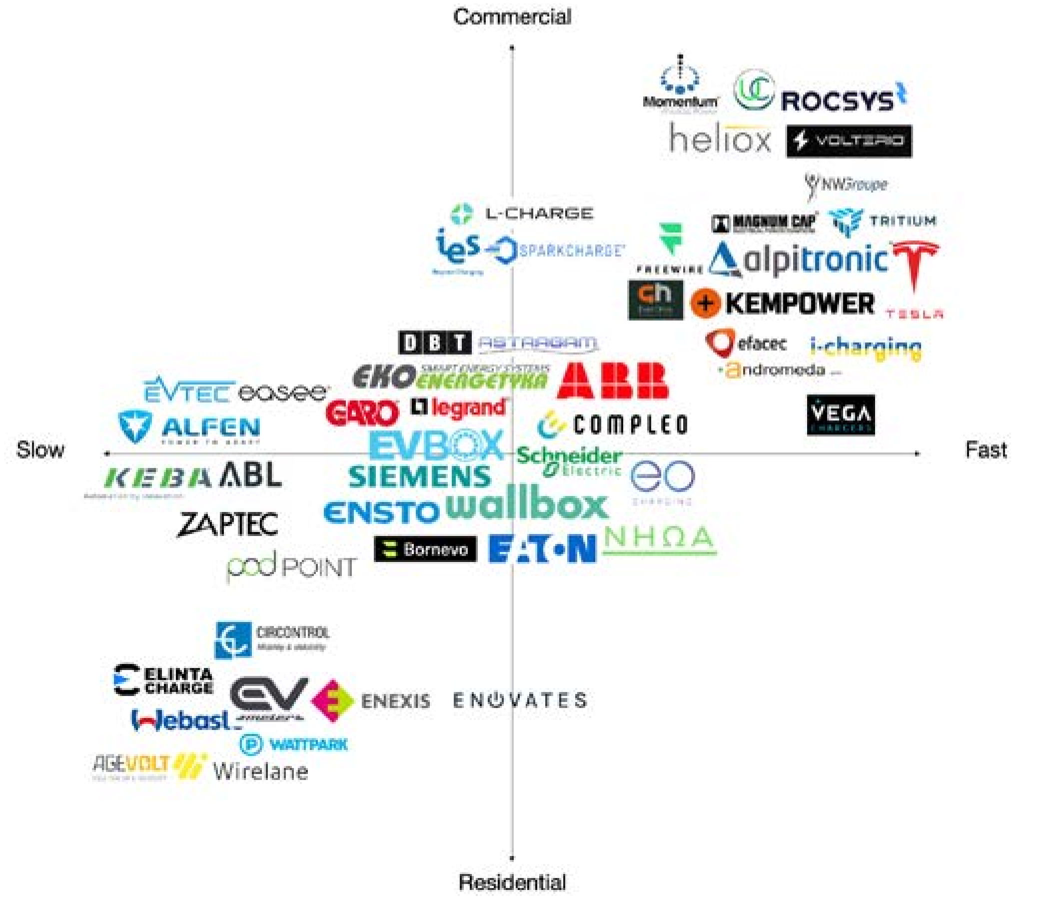


Sources: BCG, Stifel*

Original Equipment Manufacturers

OEMs primarily supply EV charging station hardware, i.e. the charging terminal. Between the manufacturers, there are three majors differentiators. The first one is power capacity, either targeting slow or fast charging application demands. This one drives the second one relating either to residential or commercial demand for charging power. Last but not least is software, which will probably differentiate winners from losers over the longer-term with software solutions helping extract the most value from available infrastructure.

FIG. 32: MAIN OEM PLAYERS IN EUROPE



Sources: Stifel*

Charging Point Operator

A charge point operator (CPO) consists of a company operating a pool of charging points. Both Charge Point Operators and Charge Point Owners are generally referred to as CPOs but their roles are slightly different. Operators can also be owners of the charging infrastructure and the opposite is also true, but it is easier to follow the below definition:

- Charge point owners own a charging infrastructure.
- Charge point operators provide owners with a secured connection to e-MSPs and have access to their customers' data.

CPOs ensure EV charging network tridem i.e. 24/7 availability, operationality and stability, which implicitly means a CPO has to be able to perform remote/on-site maintenance and diagnostics, set and update its kWh prices and finally manage, lever and value customer' POI data. This is why CPOs can create a lot of value by providing smart charging features to EMSPs. CPOs are network builders given that scalability also falls into their perimeter. This cannot in any way take them away from the fact that they are pure technology and data-driven players in that they need to integrate smart energy management systems, bidirectional charging capabilities, V2G technology and provide smooth applications for their end-customers.

FIG. 33: MAIN CPO PLAYERS IN EUROPE

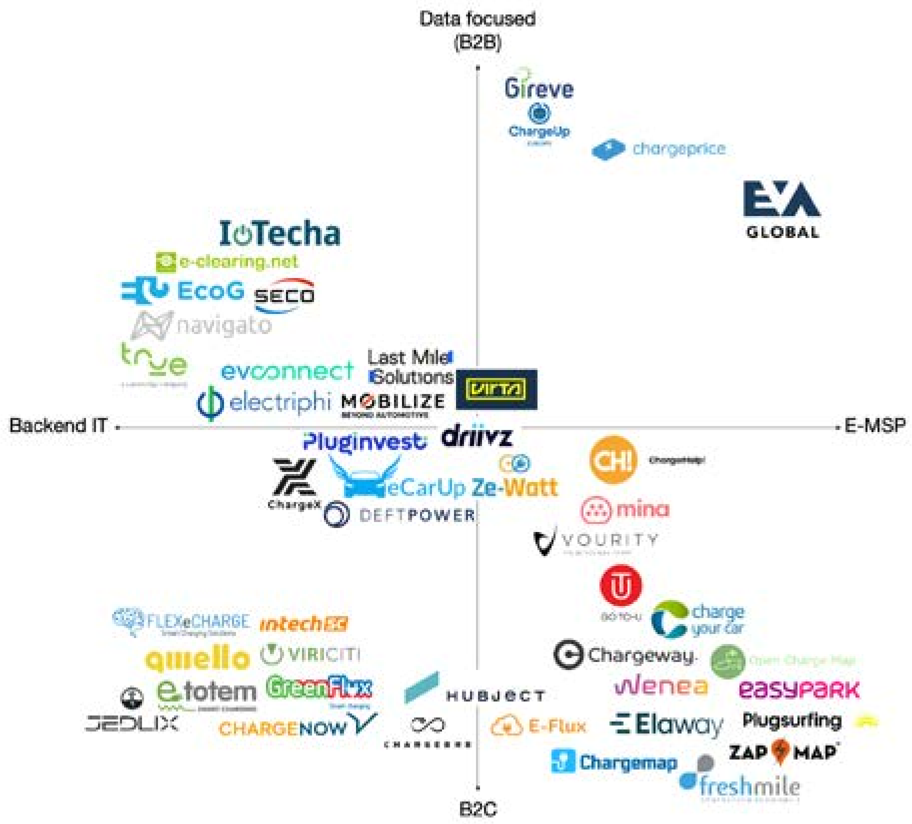
*Sources: Stifel**

e-Mobility Service Provider

E-MSPs and CPOs are two key components of the e-Mobility ecosystem. Indeed, they are crucial and interdependent elements for a charging network to bear fruit and contribute to EV driving expansion. They bring the most value when taken together because they both install and manage EV charging stations.

E-MSPs are companies offering EV charging services to EV drivers. An e-MSP primarily creates value for EV drivers because they help them find charging stations and offer both frictionless charging experience with different payment methods. These companies are software and data-driven. In parallel with rising needs for scalability, e-MSPs are rapidly shifting to provide access to third-party charging networks through roaming solutions. Indeed, while CPOs can develop their own mapping solutions, it is more difficult to have enough roaming partners without diluting their user base while looking at opening their network to EV drivers initially registered to other charging networks.

FIG. 34: MAIN E-MSP PAYERS IN EUROPE



*Sources: Stifel**

HOW MUCH OF AN **OPPORTUNITY** COULD IT BE?

We have tried to assess the size of the European charging market in euro terms. While the exact number of charging points expected varies substantially from one source to another, we have decided to stick with EY market estimates (34 million charging points in 2030) which we consider the most realistic. However, targeting a number of charging points is not enough to clearly define the market since the price spread between slow and fast charging is very wide. From our company contacts (including fast charging OEMs and CPOs), we estimate that 95% of charging points could be devoted to slow charging (3-22 kW) in 2030, with the remainder concerning fast charging.

From these numbers, we estimate an OEM market size: assuming respective ASPs of EUR1,500/unit and EUR30,000/unit for slow and fast charging points, we derive a EUR48bn market opportunity for slow charge, while the fast charge could reach more than EUR50bn.

Regarding CPOs, determining the addressable market is tougher since different business models could be established. Some CPOs could indeed generate revenues through a rental fee while others could be paid via a charging fee based on a spread indexed to electricity prices (either secured or not with PPAs). We tried to assess the CPO opportunity based on McKinsey's estimate, "EVs are poised to command on average more than 5 percent of electricity demand in 2030 in Europe". Going a bit further, public and private charging revenue could be quite well balanced, with most public charging concerning fast chargers over the longer term. Thus, fast and ultrafast charge could represent 30-40% of EV power demand. For example in 2019, France consumed about 473TWh. In 2030, EV electricity demand could therefore represent close to 20-24TWh, and imply 6-9TWh in fast charge demand. This corresponds to a French market estimated at EUR10-12bn in 2030 and EUR3.5-5bn in fast charging revenues (respectively based on EUR0.5/kWh vs the average normalised European electricity price of EUR0.25/kWh).

WHAT COULD BE THE NEXT **MAJOR TECHNOLOGICAL MARKET DISRUPTIONS?**

SECTION 3

SOFTWARES

Autonomous driving & 5G

ACES is the abbreviation for Autonomous, Connected, Electric and Shared vehicles established by the Center for Automotive Research. This trend is gradually disrupting all sectors of the economy. Actually, data flows enabled by 5G and progress made on AI/robotization are paving the way for level-5 autonomous vehicles relying on machine-learning algorithms, that should facilitate the development of a fully interconnected road transportation system. Moreover, quantum computing is expected to significantly disrupt the electric vehicle industry resulting in higher battery ranges and new product launches with 5G-capable cars. Finally, the rise of 5G could help broaden the market for shared mobility, including idle car monetisation and autonomous fleet operators with sophisticated route-optimisation solutions. The promise of ACES trends will require significant investment in new capabilities, such as network infrastructure, data- management platforms and edge-computing power, where OEMs will need to position and share the pie thus creating a new ecosystem.

e-MSP

This is all about customer experience. E-Mobility services will help EV drivers develop smooth ubiquity, ensuring they can find available cars or charging stations anywhere, at any time they want. This is where car-sharing, EV charging software and applications developers will come into place. The software side comes as a facilitator for the end-consumer-facing interface, providing friendly app-based functionalities from monitoring and remote diagnosis of the charging network to payment running/billing and harmonisation processes or energy management systems. Since a large and dense network of charge points is a key factor of success in the EV revolution (along with quality, ease of use and service reliability), the data aggregation application comes into play. This is again about providing a convenient and seamless customer experience to boost EV adoption while the EV charging infrastructure is in its infancy. Network interoperability is key as it allows for agnostic technology to ramp-up and progressively upgrade itself alongside innovation and EV-driver demand, thereby providing a smooth experience and addressing both roaming and scalability issues.

Chargeprice, created in 2019, is an electric mobility data and market intelligence provider for EV drivers, charging point operators, corporates and organisations. These are focused on supplying accurate charging price data, industry insights and customised reports such that CPOs can increase their network revenue and customers can find the best price for their charging session throughout Europe.

Time2Plug is a French e-MSP and CPO founded in 2022. Supported by TotalEnergies, the company provides access to turnkey and personalised EV charging solutions. Facing the high number of charging stations and embedded software available on the market, they are able to identify and advise their customers on the best suited solutions. Acting as a CPO, it manage sand maintains these charging points if this binds well with their customers' requirements.

According to François Hussenot, co-founder of Time2Plug, once equipped with charging stations and with a little inertia at the start, individuals and corporates will see their electricity bills double. This will increase traction for energy efficiency and we will see a sharp take-off in smart/green home/charging solutions.

Zap-Map is the UK's leading app and digital platform enabling EV drivers to search for charge points, plan their journeys and pay on partnering networks. With 97% of public charge points mapped in the UK representing 70 CPOs and around 70% of charge points showing live availability status, Zap-Map attracts more than 220,000 daily users. Most of their revenue comes from data monetisation as network mapping acts as an entry-level product.

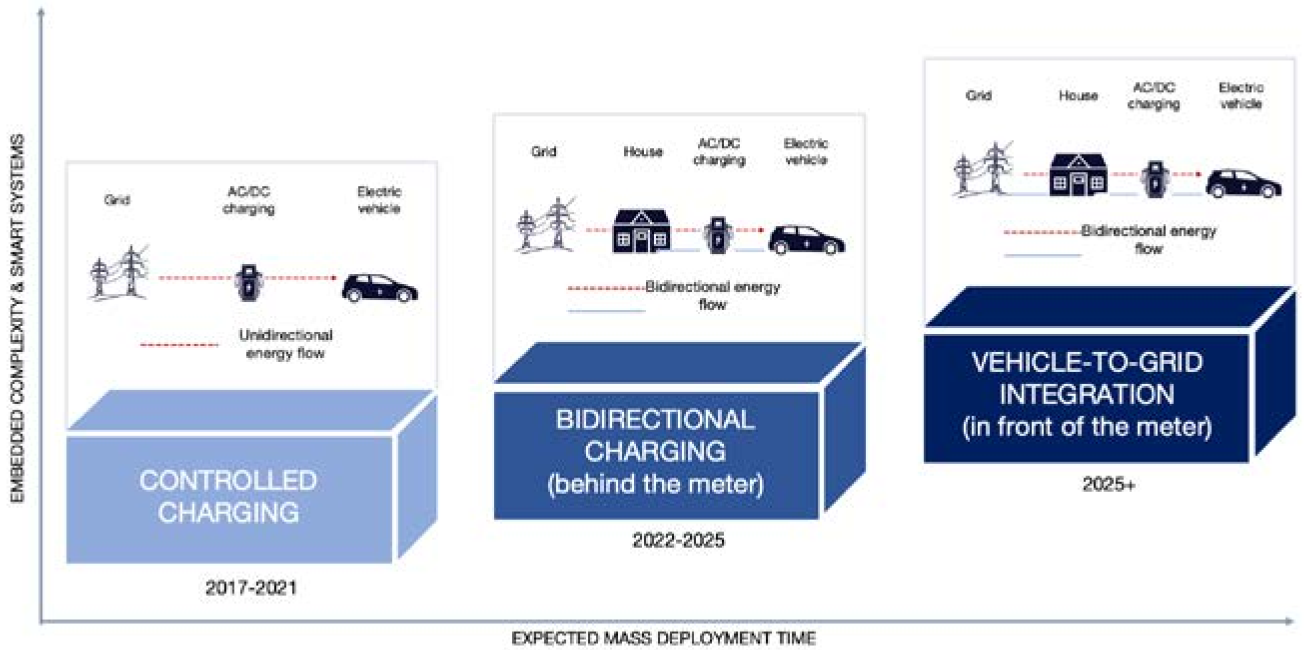
According to Richard Bourne, CEO of Zap-Map and in view of CPO development, this is all about finding the right locations, since each and every CPO has its own use-case (work, destination, parking etc). This is where e-MSP comes into play with a huge amount of raw data and analytics resources helping CPOs identify the right place and add value to their network.

In terms of the number of charging stations, slow solution OEMs are far ahead, but looking at the amount of energy delivered and growing charging demand, fast charging will be a key part of the mix. Indeed, early adopters were predominantly charging @home but as long as EV adoption is scaling up, on-street/community charging will become highly sensitive because most of the population does not have a private parking space.

SMART **CHARGING**

The smart charging perimeter sweeps different forms of managed and optimised EV charging methods, both optimising electricity demand and enabling grid expansion or simply savings on bills. From a top-down to a bottom-up energy management system, this will be a three-phased revolution with ongoing experimental projects in each future phase.

FIG. 35: SMART CHARGING OUTLOOK



Source: Stifel, Improved*

Controlled charging

Controlled charging offers static and dynamic control of the energy flow related to electric vehicle charging in order to optimise loads, avoid peak demand and thus lower electricity costs. Already available, these technologies and services are rapidly evolving and increasingly upgrading their technological contents as the number of EVs on the market increases. As previously developed, EV adoption requires a kind of cost-optimised deployment for the charging infrastructure to accompany the pace at which the transition occurs. In this respect, controlled charging will allow both for a lower number of charging stations and reloading costs. Because the system is a closed one, there are weaker interactions between the grid, EVs and charging points regarding energy management and optimisation.

FIG. 36: CONTROLLED CHARGING TECHNOLOGIES

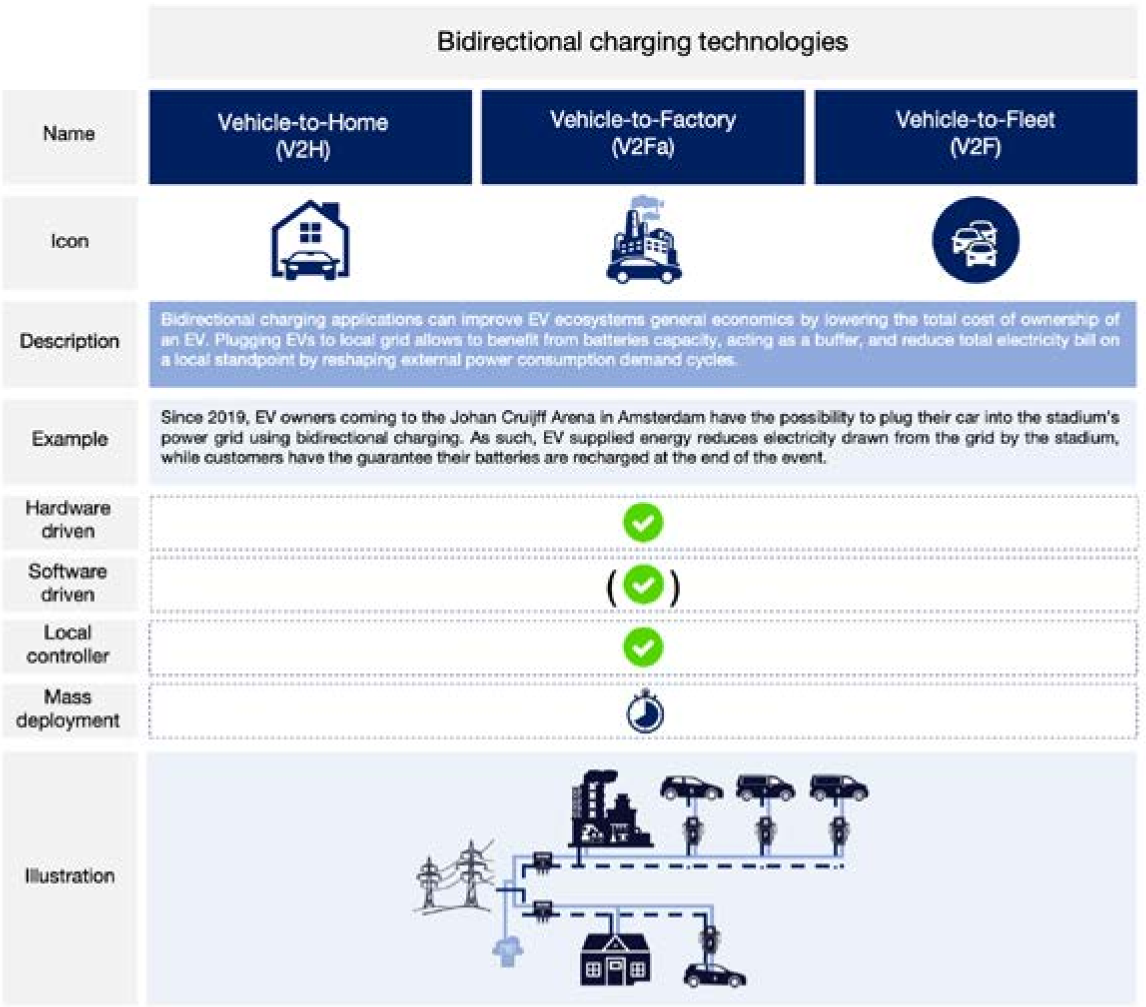
	Controlled charging technologies			
Name	Power Management	Intelligent Power Management	Local Load Management	Optimized Charging
Icon				
Description	Power limitation on each charging point not to exceed load limitations. Available load is manually managed according to the number of vehicles plugged but isn't optimized.	Dynamic distribution of the available load between charge points directly managed by an external controller running different algorithms, from first-2-come first-2-serve to privileged charging methods.	Microgrid power management between charging stations and other consumers on a local basis in order to balance power demand. As such, charging stations demand reduction can offset the ramp-up of production demand.	Using algorithms and data API, charging sessions can be optimized both on time, costs and self-consumption either from solar PV or home storage. Settings ensure charging takes place at low price but with high renewable share on the grid.
Hardware driven	✓	(✓)	✗	✗
Software driven	(✓)	(✓)	✓	✓
Local controller	✗	✓	✓	✓
Mass deployment				
Illustration				
Business Model	In controlled charging business, the model is built around existing infrastructure and often bundled with regular operations as an add-on. Charging-as-a-service and leasing solutions are increasing both on AC and DC/HPC charging. Main benefits are cost saving potentials from peak shaving.			

Source: Stifel, Improved*

Bidirectional charging

Using bidirectional charging, EVs cannot only be charged but also feed electricity back to microgrid applications such as houses, factories or fleets in order to optimise the overall consumption schemes on a local basis (behind the meter) as private solar PV would support electric consumption for a house. Thus, bidirectional charging is designed to buffer peaking demand or high temporary energy costs. EVs are seen as an additional storage facility that can be used both to optimise costs and store renewable energy for later consumption which decreases a plant's environmental footprint. Still in a pilot status, mass-market adoption will only be seen with widespread adoption of EVs able to charge bidirectionally with enhanced battery lifecycles. Europe's ISO 15118 and OCPP standardisation efforts are paving the way for a significant uptick by 2025 and 2030.

FIG. 37: BIDIRECTIONAL CHARGING TECHNOLOGIES

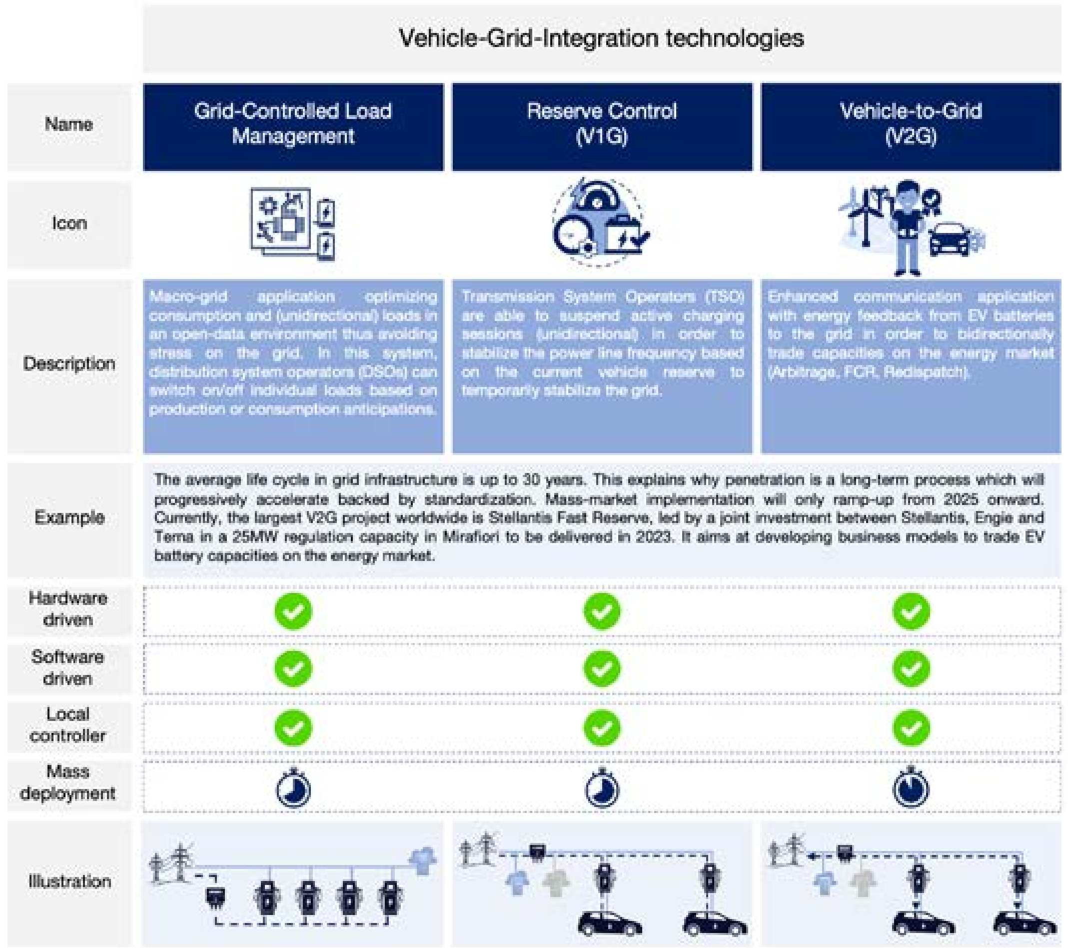


Source: Stifel, Improved*

V2G – All inclusive

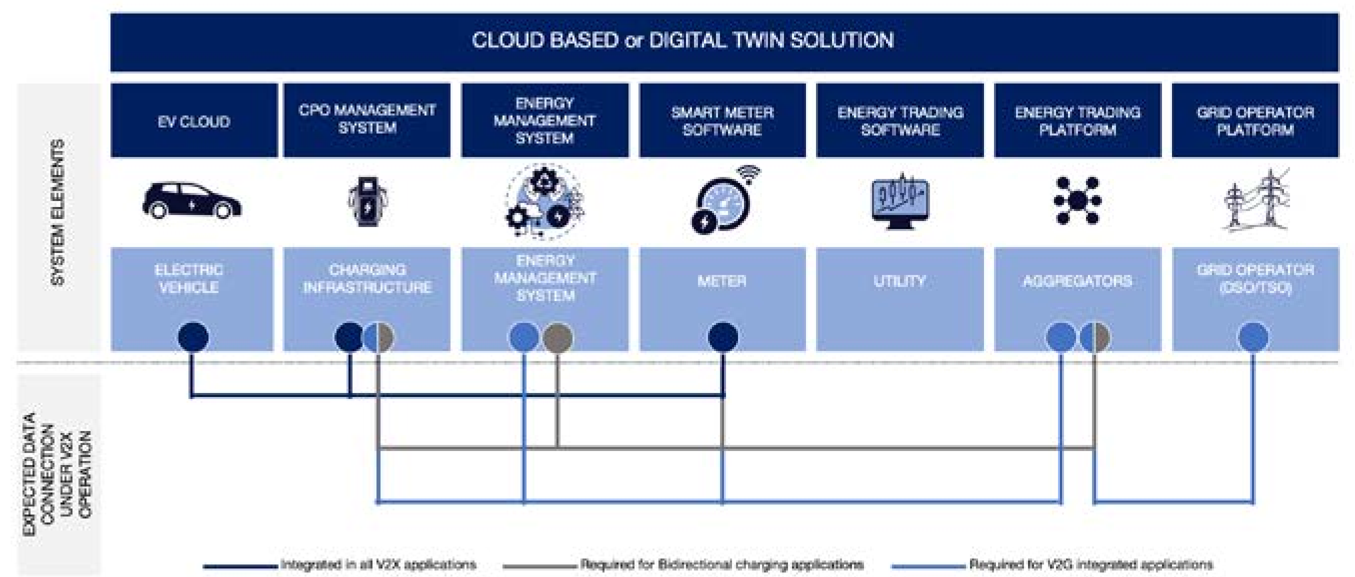
This is where we are headed to according to professionals, but not in the near future. Vehicle Grid Integration will enable constant information and power exchange between pooled EVs and the grid. Most of the services require specific smart meter devices. The most advanced services are centred around Vehicle-to-Grid (V2G) services, where EV BSMs permanently communicate with grid management systems so that power can be fed back into the grid to balance the system and re-dispatch energy by arbitrating on where it is mostly required. Smart charging requires the involvement and active empowerment of substantially different stakeholders from different segments across the value chain, thus creating conflicts of interest. As such, behind this technological breakthrough potential, the key factor for success to enable future smart charging services and Vehicle- Grid-Integration are standardised communication protocols, smart meter roll-out with transparency policies and deployment of bidirectional charging infrastructure.

FIG. 38: V2G INTEGRATION TECHNOLOGIES



Source: Stifel, Improved*

FIG. 39: MOVING PARTS AND RELATIONSHIPS ENABLING V2G

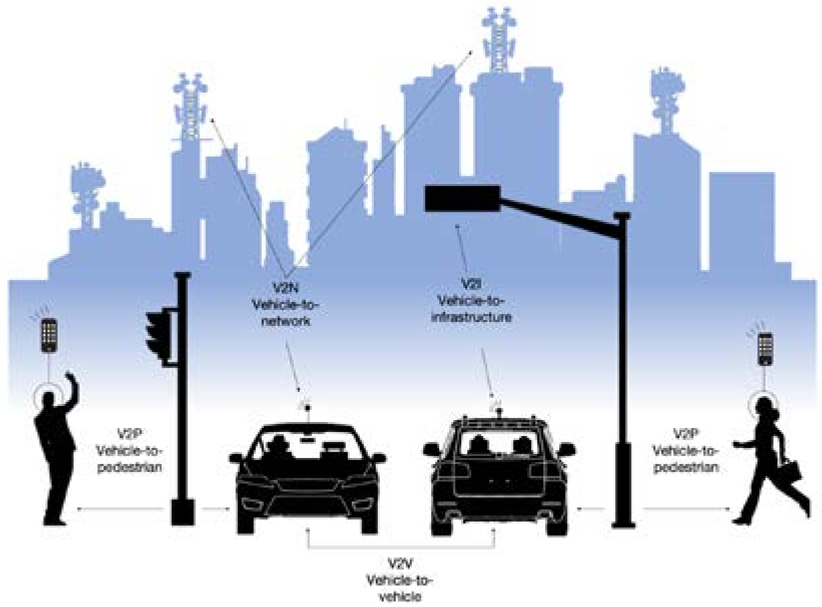


Source: Stifel, Improved*

V2X

An extension of 5G is that cars are likely to communicate with each other and motorway/toll road infrastructure to prevent over accident and warn about poor driving conditions. With autonomous driving and remote-control R&D, cars will require ubiquitous and reliable networks. This kind of network is not available at the moment, even in South Korea which is known to be the most technologically and electronically advanced economy, but data collection, transmission and analysis is clearly driving extensive and fast adoption. This kind of network-based communication will then allow EVs to use cellular networks to communicate with nearby vehicles, pedestrians, and the infrastructure thus enabling autonomous charging solutions. Indeed, EVs will also benefit from wireless power directly from the ground or from antennas. Indeed, a recent US Navy experience demonstrated the successful wireless powering of 1.6kWh via microwave beaming.

FIG. 40: V2X POTENTIALITY



Source: Stifel, McKinsey*

BATTERIES, THE ROOT **OF EV DEVELOPMENT**

Battery technologies are emerging as a key differentiator among electric vehicle projects. Most EV powertrains achieve efficiency in excess of 95% which explains why improvements in battery tech offer the greatest potential both for range and performance gains.

Battery-as-a-service (BaaS), favouring customer's purse

Based on the observation that 35-40% of the overall cost of a BEV and one of the main barriers to large-scale adoption concerns batteries, car manufacturers are now offering customers the option to lower acquisition costs by purchasing their EV without the battery and then renting or swapping them.

Battery-renting corresponds to paying a monthly rental fee based either on the expected number of kilometres covered annually or irrespectively of the distance travelled, whereas battery-swapping simply refers to proposing a sufficient internal/partnership- based infrastructure to allow customers to swap their batteries when emptied.

Wireless charging

Wireless charging technology has both clear commercial and consumer experience opportunities but could also help address some accessibility challenges associated with charging an EV. This approach allows EVs to charge by simply parking over a ground pad. Energy is then provided either from a magnetic resonance system in the ground or from antennas. The technology is particularly attractive for fleet vehicles like taxis, with the promise of minimising the time spent charging and thus optimising uptime.

With standards now in place since 2020 (Society of Automotive Engineers) and 94% grid- to-battery efficiency, interest is set to grow and developments could gain momentum. Indeed, a project in Nottingham with nine electric taxis is currently participating in a wireless charging trial funded by the Office for Zero Emission Vehicles (OZEV) and a growing number of companies now propose their own solutions (WiTricity, Wave, Hevo Inc, Plugless Power In the US, or Groupe Delachaux with Conductix Wampfler in France).

Sodium-ion batteries and ultracapacitors

These modules rely on power technologies which, compared to traditional batteries, both have greater power density along with a faster response time for highly efficient charging and discharging. At the same time, ultracapacitor hybridation helps reduce high transient loads on the battery which ultimately improves vehicle life.

Fast charge enabled batteries using sodium-ion technology have extremely low self- discharge, memory effects and high tolerance to overcharge/thermal runaway. Indeed, Li-ion cells can runaway to 500-600°C when heated to 50-80°C and provoke critical failures on other cells, whereas sodium-ion can go up to 250°C with no issues.

Overall, these batteries are not only safer and more reliable, but their cathode/anode require no scarce metals, thereby drastically reducing both environmental and supply chain concerns.

Like sodium-ion batteries, ultracapacitors are better than lithium batteries as a power source but are worse for energy storing. Therefore, these types of modules are found in KERS (Kinetic Energy Recovery System), leveraging the large amount of power they can absorb when the vehicle slows down to then throw the power back into the engines when needed, thereby helping to save 20-60% of fuel/electricity consumption. Technology relevancy is even more efficient when applied to heavy mobility applications (HDVs & FCEVs, aircrafts etc.) or EV/fast charging buffers.

TIAMAT

Tiamat designs, develops, and manufactures sodium-ion batteries for mobility and stationary energy storage. The company takes an opposite stance to solutions already on the market, using a well-patented and technology/research-centric approach to propose stable chemistry for simple, safe, fast, and high-performing battery solutions. With strategic partners such as Plastic Omnium and Startec, Tiamat delivers batteries with >5,000 charging cycles, 5-6kW/kg power density which are able to charge in less than five minutes.

Tiamat's technology could be key for industrial players as shown by Reliance's takeover of Faradion for GBP100m in January 2022. According to Faradion, the total cost of ownership for sodium-ion is already comparable to lead-acid batteries, and the technology delivers on par performance with lithium-ion phosphate batteries.

Solid-state and Li-S batteries

Solid-state batteries completely shifted the technological paradigm. Modern lithium batteries use ionic conductivity in a liquid electrolyte allowing ions to move from one electrode to another. In all solid-state batteries, liquid electrolytes are replaced by a solid compound which enables ions to migrate within its physical state. Worldwide research has enabled families of solid electrolytes with high ionic conductivity either to be discovered or directly polymerised. The main developments have been made with regards to polymers and inorganic compounds aiming at physico-chemical synergies such as processability, stability, conductivity, always bearing in mind the technological scalability.

The advantages of solid-state batteries are extremely broad, ranging from an increase in energy density to delivering good performances under low temperatures and finally, the icing on the cake, a fundamental safety improvement both at the cell and the battery levels (inflammable). At the same time, this technological breakthrough will also open the path for broader use of innovative, high-voltage and high-capacity materials, thus enabling denser and lighter batteries with reduced self-discharge.

Lithium-sulphur batteries are lighter and cheaper than lithium-ion and could be the next generation of power cells used in electric cars or mobile phones. Contrary to LiB where lithium ions act as host structures during charge and discharge, lithium-sulphur reaction occurs without any host structures and relies on a bacteria-derived biological reaction. Indeed, lithium anode is progressively consumed and sulphur is transformed into a variety of chemical compounds during the discharge process while the inverse process takes place during charging.

The advantages of lithium-sulphur relate to its light-active material profile theoretically allowing for extremely high energy density (about 4x that of lithium-ion batteries), which makes a good fit for heavy-duty applications, notably for the aviation and space industries (even if safety remains an issue). Favoured lithium-sulphur technologies are based on solid-state electrolytes thus overcoming drawbacks from liquid based Li-S (limited life, high self-discharge...) and are supplementary to solid-state batteries because of their superior energy density (30% higher).

FIG. 41: ENERGY AND POWER STORAGE TECHNOLOGIES DASHBOARD

	Sodium-Ion	New Lithium-Ion	Lithium-Air	Sodium-Sulfur	Lithium-Sulfur	Lithium Silicon	Solid-State	Ultracapacitor
Energy density								
Power density								
Nominal voltage				-				
Overcharge tolerance				-		-		
Self-discharge	None		-			-		None
Memory effects			-	-		-		None
Life cycle								
Environmental toxicity								
Technological maturity								
Expected marketability	2020+	2020+	2027+	2015+	2025+	2025+	2026+	2022+
Applications	EV, Replace lead acid in large-scale and advanced energy storage systems	Power backup, EV powering, solar power/storage, mobile devices	EV powering, medical and mobility, large scale & emergency storage	Load leveling, standby power, power stabilizer from renewables	Electric buses, trucks, trains, large-scale energy storage devices	Industrial and backup power systems, emergency systems, EV and microgrids	EV, medical & manufacturing applications, aerospace	Embedded apps, energy saving, heavy vehicle/long range vehicle

*Source: Stifel**

RECENT **TRANSACTIONS**

SECTION 4

GROWING INTEREST FROM BOTH PRIVATE AND PUBLIC INVESTORS

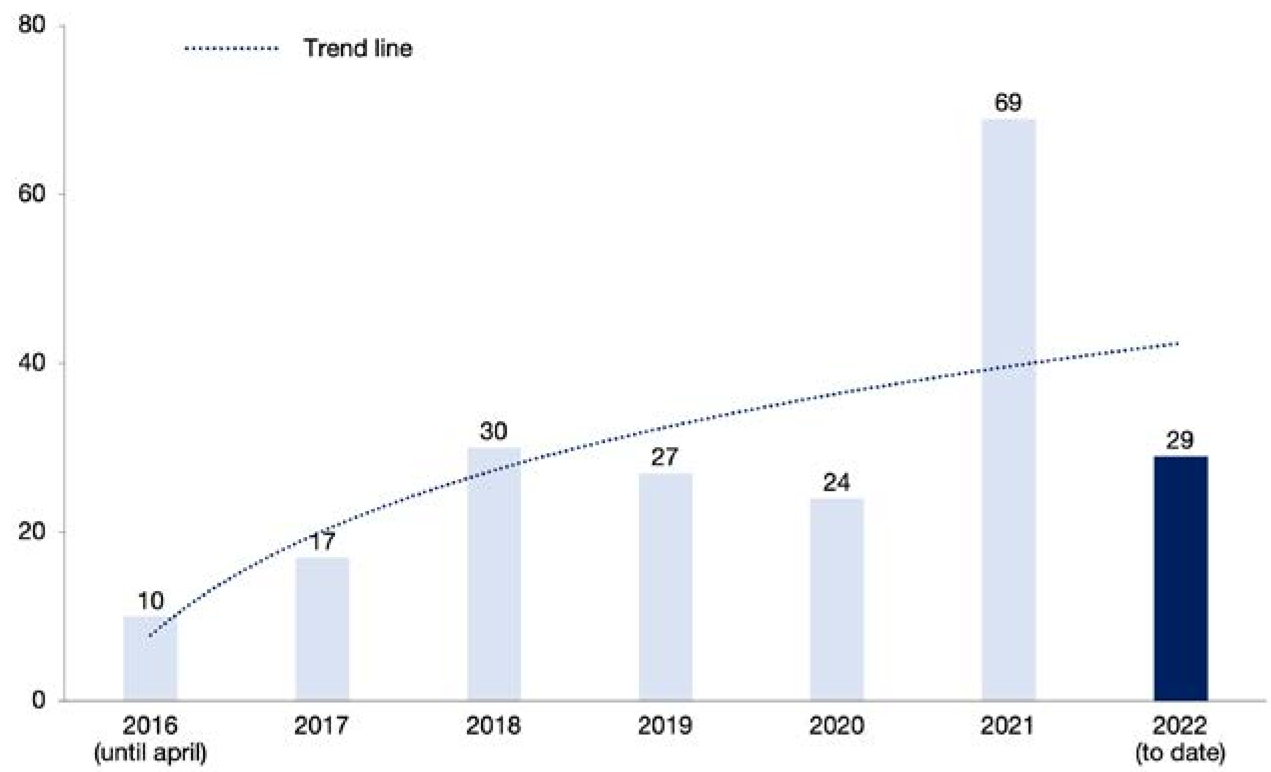
Investment activity in the EV charging ecosystem has multiplied globally by three to four times since 2016. A look at the number of transactions shows that activity skyrocketed in 2021, boosted both by the macro environment and mounting interest in EVs.

From the transaction value perspective, we derive that OEM deals are generally larger deals than for other players in the sector. CPOs are growing but remain quite fragmented with lots of local or regional operators, thereby leaving room for future consolidation.

Software and e-MSP represent smaller amounts as they are more nascent in the ecosystem, but they will drive EV charging expansion and mass market adoption. From our discussions with OEMs and operators, we see a lot more room for consolidation on the charging point installers side. For example, current fibre installers could be looking for their next growth opportunities. This business requires certifications that can either be developed internally or stem from acquisitions.

The following charts show past transactions in the smart charging ecosystem since the end of 2020:

FIG. 42: NUMBER OF TRANSACTIONS FROM APRIL 2016 TO JUNE 2022



Source: Stifel, MergerMarket*

FIG. 43: TRANSACTIONS FROM JANUARY 2021 TO JUNE 2022 (1/3)

Appendix: EV and Smart Charging Past Transactions

Date	Target/Investee	Country	Description	Acquirer/Investor	Deal type	Financing Round / M&A rationale
Jun-22		FR	Operator of fast/ultrafast charging stations looking at both innercity and intercity applications	RGREEN, EURAZEO, RIVE, rena, CHOPARD, SNCF	PP	Series B
Jun-22	NWGroupe	FR	Turnkey provider of both battery containers (JBox®) and fast charger solutions (IECharge®) allowing to increase energy management efficiency and depressurize the grid	RGREEN INVEST	PP	Asset Financing
Jun-22	evconnect	US	Cloud-based software platform to manage EV charging services	Schneider Electric	M&A	Platform
Jun-22	SemaConnect	US	Largest open-platform, fully integrated provider of EV charging solutions in North America for commercial, residential, and fleet applications	blink	M&A	Platform
Jun-22	RECHARGE	FI	Public EV charging network in the Nordics, primarily in Norway	Infracapital	M&A	PE Growth/Expansion
May-22	Numocity	IND	Digital solutions provider for electric mobility and EV charging infrastructure, battery swapping and smart grid integration	ABB	M&A	Acquisition
May-22	CHARGELAB	CAN	Developer of electric vehicle charging software designed to accelerate and commercialize electric mobility	ABB, Maple, Highline Beta	PP	Series A
Apr-22	Endesa Movilidad Electrica	SP	Spain based provider of electric mobility management services	enel x	M&A	Acquisition
Apr-22	SWTCH	CAN	Provider of electric vehicle (EV) charging and energy management solutions	LANDMARK, ALIGNED, PACIFICREACH	PP	Series A
Apr-22	FREEWIRE	US	Manufacturer of mobile and battery-integrated EV chargers	BlackRock, bp	PP	Series D
Apr-22	EB CHARGING	UK	Leading provider of EV charging and sustainable energy solutions and technologies	blink	M&A	Bolt-on
Mar-22	NWG CHARGING	DE	Contrutor and Operator of charging infrastructure in the real estate sector	Shell Recharge	M&A	Bolt-on
Mar-22	EverCharge	US	Smart Electric Vehicle charging stations provider for fleets, apartments and condos	SK	M&A	Bolt-on
Mar-22	eranovum	SP	Charging station installer and set-uper in Spain	KEYSTONE	M&A	PE Growth/Expansion
Feb-22	ev.energy	UK	EV charging software provider	ARCTERN	PP	Series B
Feb-22	INSTAVOLT	UK	EV public fast charging CPO	EQT	M&A	PE Growth/Expansion
Feb-22	greenway	POL	EV charging stations OEM	HELIOS, GENERATION	M&A	PE Growth/Expansion
Feb-22	driivz	IL	Cloud-based EV charging management platform	VONTIER	M&A	Platform
Jan-22	InCharge	US	Electric vehicle charging infrastructure solutions provider to commercial fleet	ABB	M&A	Bolt-on
Jan-22	Easelink	DE	Connection system developer to automate and accelerate EV charging process	SET Ventures, EnBW, LECT	PP	Series B
Jan-22	MONTA	DNK	Platform for EV owners to charge seemless both at home and when away. SaaS, Mobile App, Payment.	CREANDUM	PP	Series C
Jan-22	elmtronics	UK	UK's largest independent supplier and installer of electric vehicle charging equipment	mer	M&A	Bolt-on
Dec-21	driivz	IL	Cloud-based EV charging management platform	GILBARCO VEEDER-ROOT	M&A	Bolt-on
Dec-21	Qmerit	US	Specialized agnostic platform, the preferred partner to orchestrate the installation of electric vehicle charging systems and stations	Schneider Electric	M&A	Platform

Source: Stifel, MergerMarket*

FIG. 44: TRANSACTIONS FROM JANUARY 2021 TO JUNE 2022 (2/3)

Dec-21	PLUGIT	FI	Provider of EV charging infrastructure	DIF Capital Partners	M&A	PE Growth/Expansion
Dec-21	AMPLY	US	Developer of charging management software	bp	M&A	Technology
Nov-21	IONITY	DE	Operator and owner of high-power charging network for Evs	BlackRock	PP	JV
Nov-21	EnBW	DE	Charging station technology	HEIDELBERG	PP	Asset Financing
Nov-21	JEDLIX	NL	Smart charging back-end provider		PP	Series C
Nov-21	SPARK	CN	Provider of an on-demand EV charging network	HYPERCHARGE	M&A	Merger/Acquisition
Nov-21	pod POINT	UK	Asset-light CPO focused on home and semi-public segments	Undisclosed	IPO	IPO
Nov-21	qwello	DE	EV charging hardware developer and operator	Tiger	PP	PE Growth/Expansion
Oct-21	Cargacoches	ES	Electric vehicle charging points installer and manager in Spain	acciona	M&A	Bolt-on
Oct-21	xeal	US	Developer of a smart electric vehicle charging system	ARCTERN, LFC VENTURES, ALIGN, HUNT	PP	Series A
Oct-21	innogy	DE	Hardware and software products provider for electric mobility	COMPLEO	M&A	Bolt-on
Oct-21	EASYGO	IL	EV charging point operator	RUBICON, DUNPORT, Air Core	PP	PE Growth/Expansion
Oct-21	FERMATA ENERGY	US	Developer of V2G bidirectional chargers	Undisclosed	PP	Series C
Oct-21	EXPONENT ENERGY	IN	Manufacturer of electric vehicles batteries	3ONE4 CAPITAL	PP	Seed
Oct-21	wallbox	ES	Designer and manufacturer of AC, DC and V2G chargers	CATHAY, KENSINGTON, Janus Henderson	SPAC	PIPE
Oct-21	wallbox	ES	Designer and manufacturer of AC, DC and V2G chargers	KENSINGTON	SPAC	Reverse Merger
Sep-21	ampUp	US	P2P charging network (charging back-end software)	POWERHOUSE	PP	Series A
Aug-21	ampUp	US	P2P charging network (charging back-end software)	GOODYEAR	PP	Seed
Aug-21	eo	UK	Designer and manufacturer of smart electric vehicle chargers	FIRSTRESERVE	M&A	Reverse Merger
Aug-21	VIRICITI	NL	Developer of an online fleet management platform	chargepoint	M&A	Platform
Aug-21		UK	EV charging stations manufacturers and hardware agnostic cloud based charge point management software for fleets developer	FIRSTRESERVE	SPAC	Acquisition
Aug-21	Wirelane	DE	Asset-light CPO focused on home and semi-public slow charging	ABACON CAPITAL	PP	Series C
Aug-21	FERMATA ENERGY	US	Developer of V2G bidirectional chargers	WATERLAND	PP	PE Growth/Expansion
Aug-21	BEPOWER	IT	Public EV charging network + services	eni gas e luce	M&A	Platform
Aug-21	PRETTL electronics	DE	Developer of public charging park solution for electric vehicles	Ideanomics	M&A	Bolt-on
Jul-21	ecotap	NL	Manufacturer and provider of AC and DC chargers up to 180kWh	legrand	M&A	Bolt-on
Jul-21	allego	NL	Operator of a public charging network	Landis+Gyr, ECP, meridiam	SPAC	PIPE
Jul-21	allego	NL	Operator of a public charging network	Spartan Acquisition Corp. III	SPAC	Reverse Merger

Source: Stifel, MergerMarket*

FIG. 45: TRANSACTIONS FROM JANUARY 2021 TO JUNE 2022 (3/3)

Jul-21	has·to·be eMobility	US	E-mobility software	chargepoint	M&A	Technology
Jul-21	EVgo	US	Operator of public fast-charging stations	Climate Real Impact Solutions	SPAC	Reverse Merger
Jun-21	Electrada	US	Turnkey EV charging infrastructure solution for electric vehicles	Unknown bidder	-	-
Jun-21	char.gy	UK	Provider of smart EV charge points utilising existing street infrastructure	zouk	PP	PE Growth/Expansion
Jun-21	IoTecha	US	Provider of integrated software and hardware solutions to the EV charging infrastructure	bp	PP	Series C
Jun-21	GreenFlux	NL	B2B focused CPO	DKV	M&A	Platform
May-21	Connected Kerb	UK	Provider of smart EV charging solutions	Undisclosed	PP	Series A
May-21	Tritium	AU	DC an d HPC hardware solutions provider	DCRD	SPAC	Reverse Merger
Apr-21	wallbe	DE	Provider of EV charging solutions to private, sem-public and public areas	Compleo	M&A	Platform
Apr-21	ETREL	SI	Manufacturer of interactive charging stations	Landis+Gyr	M&A	Platform
Apr-21	Virta	FI	Back-end provider for EV charging Management	ENEOS Innovation Partners, Helen Ventures, [illegible] Capital	PP	Series C
Apr-21	enelion	PL	Manufacturer of electric car chargers	PGNiG	PP	Series C
Mar-21	Spirii	DK	Provider of smart EV charging solutions	Nordic Alpha Partners	PP	Early
Mar-21	The Mobility House	DE	Smart Charging and Energy Management Solutions provider	Mercure Investment	PP	Series C
Mar-21	Nuvve	US	Developer of grid-integrated vehicle platform (V2G)	Newborn Acquisition Corp	SPAC	SPAC Acquisition
Mar-21	[illegible]	SE	Developer of hardware and smart AC charging stations	Swedbank Robur	PP	PE Growth/Expansion
Mar-21	driivz	IL	Cloud-based EV charging management platform	[illegible]	PP	Series B
Feb-21	Last Mile Solutions	NL	Operator of EV charging & smart energy management platform	EW Eurowag	PP	Platform
Feb-21	ROLEC	UK	Manufacturer of smart AC and DC rapid chargers	Soliptech	M&A	Platform
Feb-21	MobilityPlus	BE	Provider of smart, green charging stations	Concentra	PP	Angel
Feb-21	ampUp	US	P2P charging network (charging back-end software)	TechNexus, Tsingyuan Ventures, [illegible]	PP	Seed
Feb-21	volta	US	EV charging for commerce-centric EV charging networks	Tortoise Acquisition Corp II	SPAC	Reverse Merger
Feb-21	wallbox	ES	Designer and manufacturer of AC, DC and V2G chargers	Iberdrola, Seaya Ventures, Cathay, Wind	PP	Series C
Jan-21	FREEWIRE	US	Manufacturer of mobile and battery-integrated EV chargers	[illegible], bp, trirec, Alumni Ventures, Blue Bear	PP	Series C
Jan-21	ubitricity	DE	Asset-light CPO offering smart charging solutions	Shell	M&A	Platform
Jan-21	volta	US	EV charging for commerce-centric EV charging networks	Energize	PP	PE Growth/Expansion

Source: Stifel, MergerMarket*

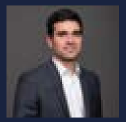
In recent months, whether public, semi-public or private, EV charging has become hugely important in energy transition schemes. From start-ups to SMEs and long-established companies, entrepreneurs have gradually built a flourishing ecosystem to answer ongoing and future challenges, both for EV drivers and for the grid.

The number of available charging points must meet and then evolve proportionally to the acceleration in passenger vehicle electrification throughout Europe. E-Mobility has reshuffled older paradigms and now opens a world of opportunities and technological improvements. Anticipating future developments in an open-data environment and planning infrastructure projects with seasoned partners accordingly are key to assimilating EVs in our society. Indeed, in addition to the development of demand-based infrastructure, detailed planning regarding grid requirements, site selection, hardware and software selection, data accessibility and government support, all contribute to the smooth roll-out of European charging infrastructure.

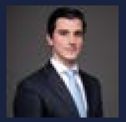
As Keynes said, «Difficulties don't lie so much in the development of new ideas, but more in escaping old ones». It seems likely that the most promising European companies will drive and attract interest either from outgrowing pure players, or from diversified players seeking to add EV charging capabilities to their offering. Real growth has just started and is merely accentuating, but consolidation is not far from beginning.

STIFEL | IRIS

WHITE PAPER **AUTHORS**



PAUL DE FROMENT
Managing Director
Paris
paul.defroment@stifel.com



THOMAS MORDELLE
Associate
Paris
thomas.mordelle@stifel.com

RECENT **TRANSACTIONS**

LEGAL **DISCLAIMER**

INDEPENDENCE OF RESEARCH

BASIS OF PRESENTATION

STIFEL | IRIS

INTELLIGENCE • RESEARCH • INSIGHTS • SERVICE

FRANKFURT, GERMANY Stifel Europe AG Kennedyallee 76 60596 Frankfurt am Main **T: +49 69 788080**	**LONDON, UNITED KINGDOM** Stifel Nicolaus Europe Limited 150 Cheapside London, EC2V 6ET **T: +44 20 7710 7600**	**PARIS, FRANCE** Bryan Garnier Securities SAS 26 avenue des Champs-Elysées 75008 Paris **T: +33 1 56 68 75 00**	**PARIS, FRANCE** Stifel Europe AG – Paris Branch 80 Avenue de la Grande Armée 75017 Paris **T: +33 1 7098 3940**
FRANKFURT, GERMANY Stifel Europe Advisory GmbH Bockenheimer Landstrasse 24 60323 Frankfurt am Main **T: +49 69 247 4140**	**MUNICH, GERMANY** Stifel Europe AG – Munich Branch Maffeistrasse 4 80333 Munich **T: +49 89 9992 9820** **T: +49 89 2154 6000**	**MUNICH, GERMANY** Stifel Europe GmbH Königinstraße 9 80539 Munich **T: +49 89 242 262 11**	**MILAN, ITALY** Stifel Europe AG – Milan Branch Via Privata Maria Teresa, 8 20123 Milan **T: +39 02 85465761**
OSLO, NORWAY Bryan Garnier & Co AS Haakon VIIs Gate 1, 2nd Floor 0161 Oslo Postbox: 0117 Oslo **T: +47 908 45 025**	**ZURICH, SWITZERLAND** Stifel Schweiz AG Tessinerplatz 7 8002 Zurich **T: +41 43 888 6100**	**GENEVA, SWITZERLAND** Stifel Schweiz AG – Geneva Office Place de la Fusterie 12 1204 Geneva **T: +41 22 994 0610**	

Stifel Nicolaus Europe Limited | Authorized and regulated by the Financial Conduct Authority | Member LSE | www.stifeleurope.com