

/ EV CHARGING:
THE FOURTH TRANSPORT INFRASTRUCTURE



/ TABLE OF CONTENTS

Introduction	3
Vertical integration in the EV charging market	4
The changing shape of energy	9
The future of EV charging	10
Conclusion	12

/INTRODUCTION

All nations are moving away from internal combustion and toward electric drivetrains. To meet their own targets, the installation of an EV charging infrastructure must at least keep pace with the increase in demand.



Transport infrastructures are shaped by commerce. Demand for coal supported the expansion of canal systems. These eventually gave way to railroads, which were mostly supplanted by road vehicles for all kinds of freight. In each case, private investment provided the seed, but public interest soon overtook development, governance and often ownership.

The strategic importance of transport infrastructure is apparent. Nations rely on infrastructures to operate. When that infrastructure becomes so strategically important, governments have no choice but to take a keen interest.

The similarities between road vehicles powered by combustion engines and those powered electrically are superficial. The form, fit and function of vehicles isn't changing. The intention behind this familiarity is to ease transition. The differences under the hood are much bigger, but the real transition is taking place outside the vehicle.

The dynamics behind supplying fuel for internal combustion engines and supplying electricity for electric vehicles are fundamentally different. Service stations are independently operated by companies that are small, medium, large, and multinational giants. Consumers are guaranteed compatibility by standards governing the production and distribution of fuel. The market sets the price, of course.

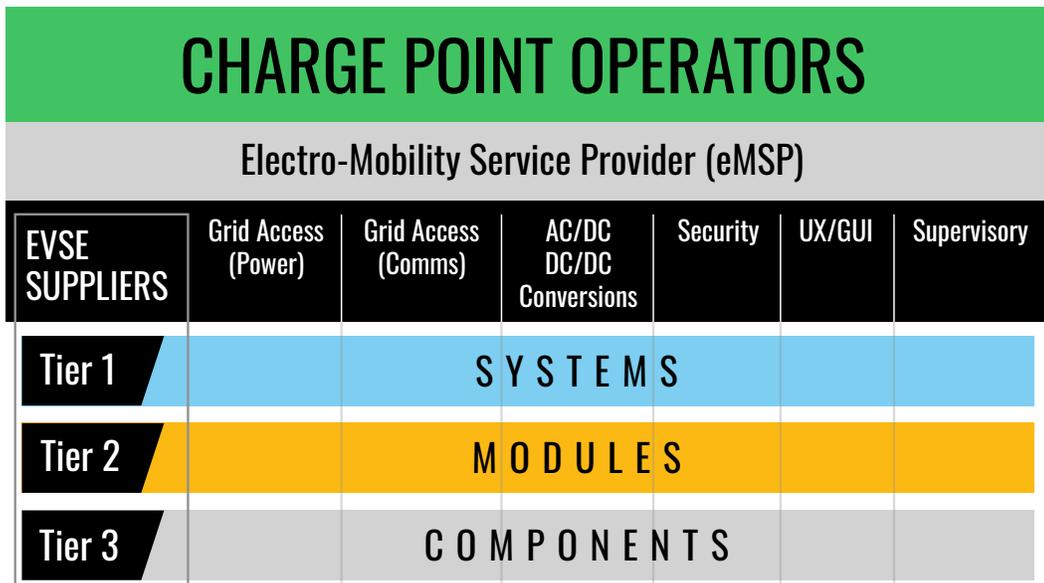
Relatively speaking, the production of oil-based fuel is addressed through a virtually unlimited number of manufacturers, who buy and refine the base material. For EVs, the base material is not so openly available. There is no comparable margin in its refinement and distribution. Instead, there are new value-added steps between its production and its consumption.

This creates a different type of open competition in the supply chain, which may ultimately force a new kind of governance across the global EV charging infrastructure. Today, many governments already acknowledge the importance of an EV charging infrastructure and are issuing financial incentives to spur its growth. The details and ownership of the equipment installed under such incentives will inevitably vary by region.

In the immediate future, private enterprises are addressing the challenges and opportunities of building an EV charging infrastructure. This is creating something of a landgrab for those wishing to stake a claim on both the physical real estate needed for the charging stations and the available market it services.

VERTICAL INTEGRATION IN THE EV CHARGING MARKET

There are significant and obvious differences in the supply chains for ICE fuel and electricity. This has created opportunity for new businesses to emerge, and existing suppliers to diversify into supplying the EV market. These opportunities are expected to persist and expand as the world transitions to e-mobility.



The EV charging infrastructure sector pivots around the Electric Vehicle Supply Equipment (EVSE) manufacturers, supported by the system, module, and component suppliers (Source: Avnet)

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A vertically integrated EV charging sector incorporates multiple tiers, supported by industry standards that attempt to encourage compatibility without impeding competition. Within the vertical structure there are discrete functions, some of which are outlined in the diagram above. The following provides a brief explanation of the vertical layers and functions included

- **Charge Point Operator (CPO):** A CPO manages the point of delivery. This may include owning the location, the equipment or both. Equally it may provide a 'Charging as a Service' solution. Essentially, the CPO is the public face of the infrastructure.
- **Electro-Mobility Service Provider (eMSP):** While a CPO may operate a network of charge points, an electro-mobility service provider will enable consumers to use networks operated by multiple, different CPOs as simply as possible. With a growing number of CPOs, both large and

small, making it easier for consumers to use as many of them as possible with just one account is seen as enabling.

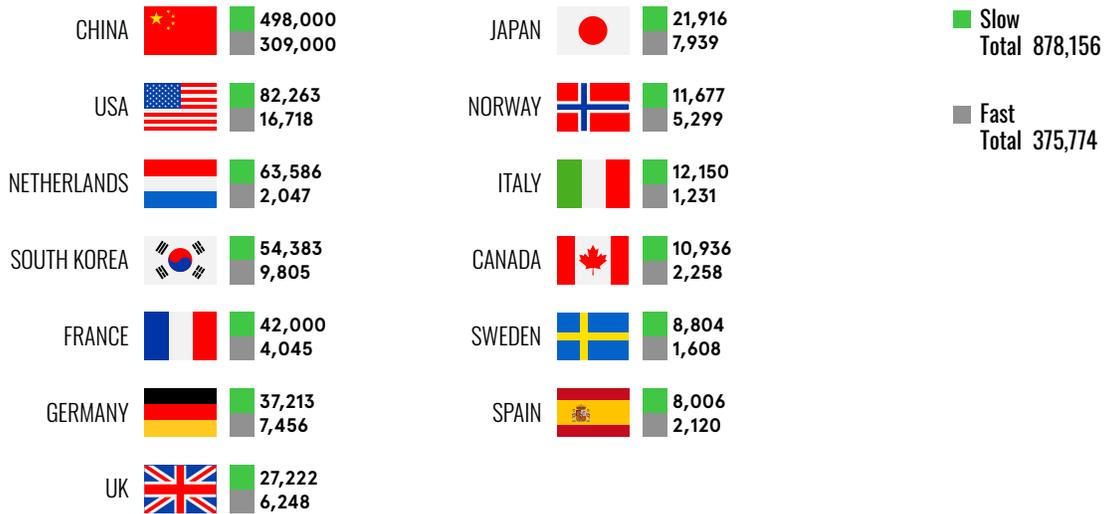
- **Electric Vehicle Supply Equipment (EVSE):** This is where the grid really meets the vehicle. Designing, manufacturing, and delivering the charge point equipment is the purpose of the EVSE supplier.
- **Tier 1 – Systems:** In this context, a system would be everything inside the box, comprising hardware and software. The system integration would be provided by the system provider, who may or may not be the EVSE supplier.
- **Tier 2 – Modules:** Most systems today use modules at some level. A module, or sub-system, would be provided by a specialist manufacturer focused on that function. This might be the power conversion, payment system or user interface, for example. The system provider would take care of the integration of modules.
- **Tier 3 – Components:** At the board level, all systems and modules rely on components. This is where the semiconductor, connector and embedded software suppliers live. They may also, but not necessarily, provide modules based on their own components, with some level of pre-integration.



Data by Statista show approximately 880,000 public slow chargers in operation around the world in 2020. Around 375,000 fast chargers were in operation.

Worldwide public charge points in 2020

(Data: Statista)





"THE ACCELERATION OF THE EV VEHICLE MARKET IN THE AMERICAS IS EXPLOSIVE."

— JASON SKOCZEN,
Sales Director, Transportation and Lighting,
Avnet Americas

As a global company, Avnet has regional subject matter experts (SMEs) working with customers in every layer of the EV sector model. Each provides support for manufacturers working in the EV charging infrastructure. The SMEs and their teams are actively working with customers developing new solutions, forging new partnerships, and accelerating the move to fully electric mobility.

Avnet Americas' Sales Director for Lighting and Transportation, Jason Skoczen, explained he is seeing emergence in this area, with companies addressing every layer in the model. This includes module designers, integrators and OEMs designing their own charging stations.

"The acceleration of the EV vehicle market in the Americas is 'explosive'," Skoczen said. But the infrastructure is significantly lagging in its ability to support this growth:

"There needs accelerated focus on the development of not only the charging stations themselves, but the locations, availability, and the user experience when plugging in on long-distance trips."

Skoczen feels there is strong support for this acceleration, something Avnet is geared up to enable. "Avnet can support this growth. We provide hardware development and connectivity. We also have partnerships with third party vendors to support the installation of charging stations."

According to Skoczen, there is growing demand for charging stations to support all types of mobility: "We see the need for charging stations to support fleet vehicles, motorcycles and even the commercial, construction and agricultural vehicle (CAV) market."



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"THE EU WILL NEED AT LEAST 6 MILLION NEW CHARGE POINTS IN OPERATION BY 2030."

— THOMAS FOJ,
Director, Vertical Markets, Avnet Silica

According to Thomas Foj, Avnet Silica's Director Vertical Markets, EV charging is one of the fastest growing sub-segments in our industry: "The European EV market will reach \$32 billion USD in 2027," Foj said "Today, the market is just \$6 billion. The EV charging infrastructure market is expected to grow at more than 30% compound annual growth rate (CAGR) through to 2030."

Not surprisingly, Foj characterizes the market as very dynamic. "The European Union has launched the program 'Fit for 55', which means 55% less greenhouse gas emissions by 2030. This requires a minimum of 60% penetration of fully or partially electric vehicles by 2030. To service that level of penetration, we need at least 6 million new chargers in operation by 2030."

Tobias Nakel is the Sales Director for Avnet Abacus for the Central European region which includes Germany, Austria and Switzerland. Nakel has seen fast growth in the EV market, helped by local government subsidies. He notes: "The aim of the German government is to have 1 million public charge points available by 2030. This compares to around 50,000 available today."

Nakel recognizes that the market is fragmented. "We do see that the big Tier 1 automotive electronics manufacturers are heavily engaged in this field, as well as multinational industrial companies. But it is very fragmented, with a lot of mid-sized 'hidden champions' bringing innovative solutions."

This creates an opportunity, particularly for smaller companies with differentiating or disruptive approaches.

"There are huge subsidies from the local governments. The German government is planning to invest €3 billion by 2030 into the extension of the public charging network," he said.

Avnet's teams are strongly engaged with customers looking to enter or expand share of the EV charging infrastructure market. "Our teams are bringing all their knowledge at the component level to these customers," Nakel said.

From the EV charger distribution data shown above, China is leading the world in charging infrastructure deployment. Tom Wang, Avnet's Sales Director for China, confirmed he is seeing rapid deployment of EV charging sites in the country, with roughly 50% annual increase over the last three years. This fast growth is leading to a vast network: "The charging infrastructure has been extended to all corners of the country, even in the remote countryside," Wang said.

Wang explained that the network is growing at a rate of around 30,000 new charging sites per month. "The EV to charger ratio is currently around 3:1," said Wang. "The momentum for expansion is coming from the continuous growth in overall EV car manufacture and adoption in China."

In addition to manufacture buy-in, part of the momentum for growth in the Chinese EV charging infrastructure is coming from new infrastructure construction. This is attracting investment from around the country and the world. "Even some web companies are entering the market, to make it 'smart' and digitized," Wang explained.

"THE GERMAN GOVERNMENT IS PLANNING TO INVEST €3 BILLION BY 2030 INTO THE EXTENSION OF THE PUBLIC CHARGING NETWORK."

— TOBIAS NAKEL,
Sales Director, Avnet Abacus, Central Europe





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Wang expects the 50% annual growth to continue for several years. His team is helping customers get to that rapidly growing market quickly, while also being price-competitive.

Tobias Nakel added: "From an Avnet Abacus point of view, we can offer a huge variety of components to these customers. This includes the components visible to the end-customer, such as charging cables and display solutions, down to the components on the board." This covers power relays and current sensors, as well as embedded communications and customized software for IoT solutions.

In India, the EV market looks very different. Sambit Sengupta is Avnet's Associate Director SPM & FAE, Asia. "India has just started working on the EV charging market," Sengupta said. "It is still early days, with a lot of learning and un-learning going on."

India is unique in this respect. The first EVs in the region were three-wheeled vehicles known as "autos" or "tuk-tuks". These were the first to change to an electric drivetrain, but

India is now deeply invested in two-wheeled e-mobility. The two-wheeled vehicles are almost all personally owned and charged at home. The three-wheeled vehicles are used for last-mile transport and make use of exchangeable batteries.

"The charging market is very much concentrated on servicing individuals with AC-DC chargers," Sengupta said. "There is also a strong push for concepts such as Battery as a Service coming from companies including Bounce Infinity, Hero Electric and Gogoro."

Despite the momentum behind two-wheeled e-mobility in India, Sengupta sees the EV market growing. "All top OEMs, whether two- or four-wheeled, have launched or announced their plans for EV models." This is generating a lot of interest around battery management systems and motor control solutions. "Avnet has a lot of expertise in supporting these customers. We are leveraging our internal knowledge base in terms of reference designs and supplier product knowledge," Sengupta added.



"THERE IS STRONG SUPPORT FOR CONCEPTS SUCH AS BATTERY-AS-A-SERVICE."

— SAMBIT SENGUPTA,
Associate Director SPM & FAE, Asia

/ THE CHANGING SHAPE OF ENERGY



"GOVERNMENTS FROM INDIVIDUAL COUNTRIES, PRIVATE SECTOR AND EUROPEAN UNION PARLIAMENT ARE ALL PUSHING FOR NET-ZERO."

— HARVEY WILSON,
Avnet Silica systems engineer

The cost of conventional forms of energy is susceptible to change. There is a global appetite to move away from dependency on fossil fuel for reasons that include economic and environmental. The motivation to move to new forms of energy derived from renewable sources has never been stronger. These factors are conflating to change the shape of the global energy landscape in general. A move to e-mobility is very much part of that strategy.

Avnet's Andrej Orel is director of vertical segment city infrastructure for EBV Elektronik. He sees activity across the EU to accelerate the move to alternative and renewable energy sources. "The EV charging infrastructure will be one of the fastest growing segments within energy transition in the coming years," Orel said. "This will pull other energy segments, like the smart grid, in the same direction."

The new energy sector is attracting the attention of companies and organizations not traditionally interested in this area, at least not at this level. We can expect new providers to emerge with familiar names, but not necessarily associated with energy distribution.

According to Orel, any company entering this market needs to focus on the "charging event," as this is where the opportunity to differentiate lies. "Avnet and EBV are driven by demand creation. We have a great team of technical experts from power stages down to connectivity. We represent key vendors in this sector, including ST Microelectronics, NXP, Infineon, onsemi, Renesas and others."



"THE EV CHARGING INFRASTRUCTURE WILL BE ONE OF THE FASTEST GROWING SEGMENTS WITHIN ENERGY TRANSITION IN THE COMING YEARS."

— ANDREJ OREL,
Director, vertical segment city infrastructure,
EBV Elektronik

One way to accelerate time to market is to use a modular approach, with Avnet Embedded's System on Module (SOM) portfolio or working with one of Avnet's partners. This includes IotEcha, which offers certified software packages compliant to ISO 15118, Open Charge Point Protocol (OCPP) and more. Orel and his team have worked with customers to develop entry level AC chargers and premium chargers with vehicle-to-grid (V2G) capability.

Harvey Wilson, Avnet Silica systems engineer working in EMEA, is also seeing strong regional support for the development of the global EV charging infrastructure. "Governments from individual countries, private sector and European Union parliament are all pushing for net zero," Wilson said. "Companies see new opportunities to grow business, governments see opportunities to move away from fossil fuel dependency and being less reliant on other countries for energy security."

"The UK government recently announced an extra £1.6 billion to extend the EV charging infrastructure," Wilson said. This will see the number of charge points reach 300,000 by 2030, which will be five times more than the number of fuel pumps in the UK.

This increased ratio of electric vehicles to charge points indicates one of the inescapable and fundamental changes that consumers must accept. The time it takes to charge a vehicle will, at least for the near future, always be longer than it takes to refuel an internal combustion engine vehicle.

/ THE FUTURE OF EV CHARGING



Should we be building an infrastructure to suit the new EV paradigm, as LinkedIn TOP Voice for EV and CharIN brand ambassador, Roger Atkins, believes?

Connect with Roger Atkins: [LinkedIn](#)

The momentum behind expansion of the EV charging infrastructure is clear and expected to build, worldwide, until the end of the decade. This could be seen as a bubble but, in fact, it is more significant than any short-lived growth spurt.

The reality is that e-mobility is here to stay. That signifies that the way we convert electrons to motion will mature. We are, some believe, entering a new paradigm in mobility, which goes further than the convenience of charging out-of-home.

Roger Atkins is a brand ambassador for CharIN, the non-profit organization behind the Combined Charging System (CCS) specification. The main features of the CCS specification include the charging process, safety, user authentication, payment authorization and load balancing.

As well as being the UK brand ambassador for CharIN, Atkins is a LinkedIn TOP Voice for EV and the founder of Electric Vehicles Outlook Ltd. Atkins has been involved with the electric vehicle industry for around 20 years and regularly meets with other CharIN brand ambassadors to discuss the industry.

He noted that when the internal combustion engine emerged some 130 years ago, fuel was purchased in shops, just like any other consumable. The development of fuelling stations came after the start of vehicle mass-production. Consequently, the automotive industry had no ownership of the network of stations and, even today, there are many large retailers, but none with the name of a car manufacturer.

Atkins feels the automotive industry may not be quite so eager to relinquish control of the EV charging infrastructure. This is already apparent in the form of Tesla's charge points. Today, the companies that make the energy are in the strongest position to own its distribution but that, too, is not happening. This may be because the paradigm is about to shift.

According to Atkins, the big picture is complex. Car ownership figures vary across the world. In India, the figure for motorization per thousand people is about 22%. In the U.S. it is around 90%, which indicates that some people own more than one vehicle. There is no expectation that this gap in the figure for motorization per thousand people globally will shrink. But e-mobility itself is huge.

"What if EVs are just a step towards the real paradigm shift, which is about autonomous vehicles?" Atkins said. He refers to the concept of shared ownership allowing more people access to e-mobility. Utilization of an autonomous shared asset would redefine what an EV charging infrastructure needs to look like in the longer term.

Atkins went further, saying: "Mass ownership of cars is a mistake." He believes we should be building an infrastructure that suits the new paradigm. This includes shared ownership but also the use of (autonomous) electric heavy goods and commercial vehicles. "There will also be a market for luxury, privately owned vehicles," Atkins added.

"There is a herd of elephants in the room," said Atkins, in reference to these three points. The requirements from EV charge points will be different for each: autonomous and shared ownership, commercial, and private luxury.

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This might include, as Atkins believes, “de-gridding” the energy used. Atkins described battery swap as a fascinating area that has been around since before the internal combustion engine. This isn’t just about convenience; it’s about using distributed micro-grids to generate clean energy and store it until it’s needed. EV batteries would provide the storage and a way of utilizing the energy. It would take pressure off the grid and provide load balancing.

As well as battery swap, Atkins sees wireless charging as being equally important. This would enable vehicles to charge as they travel, or recharge small amounts of energy when they stop at traffic lights, intersections, or drop-off points. This is now referred to as static wireless charging. The

technology needed to support dynamic wireless charging is also being developed. Dynamic charging works as the vehicle is in motion.

Static and dynamic wireless charging can use both inductive and capacitive technologies. It is an active area of interest for many automotive manufacturers. For autonomous vehicles, wireless charging seems essential. The topic of dynamic wireless charging, which requires no human assistance, will no doubt become more important as we near Level 5 autonomy.



/CONCLUSION

Whatever shape the EV landscape eventually takes, there is little doubt that the next decade will see rapid and continued expansion of the EV charging infrastructure. Its need goes beyond a trend for e-mobility; there is a fundamental global shift away from internal combustion engines. This shift must be supported.

Beyond 2030 we may see needs change, based on the emergence of autonomous vehicles. That emergence seems inevitable, given the amount of interest and investment going into autonomy. The EV charging infrastructure will need to adapt to this new paradigm while still, in the meantime, serving the immediate need for out-of-home charge points.

Consolidation doesn't always come to fragmented markets, but what is apparent is that the EV charging infrastructure is embracing fragmentation to accelerate growth. This creates opportunity and Avnet is here to help its customers seize that opportunity.

Connect with Avnet's Subject Matter Experts!

- Thomas Foj: [LinkedIn](#)
- Tobias Nakel: [LinkedIn](#)
- Harvey Wilson: [LinkedIn](#)





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