Special edition

Magazine from EBV Elektronik and Avnet Abacus

TQ + focus

EV CHARGING

SUCCESS FACTOR FOR A
SUSTAINABLE MOBILITY AND
ENERGY TRANSITION

73

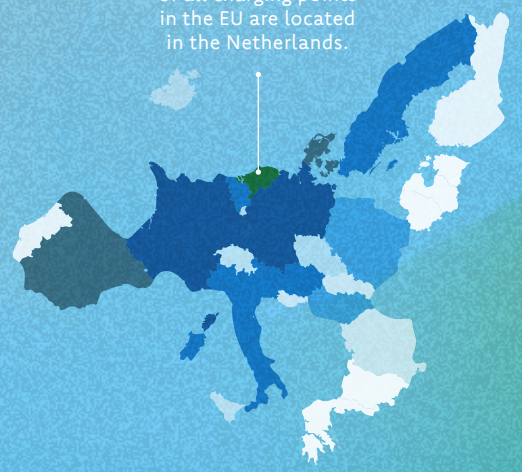
public charging points per

100,000

inhabitans in the EU

29.4 %

of all charging points in the EU are located in the Netherlands.



0 0.6 1.5 2.5 5.5 10.5 25.5 60 90

Number of charging points in thousands

Source: ACEA/P3 analysis

A mixed picture across the EU

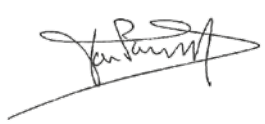
At the end of 2021, there were more than 330,000 public charging stations in the EU. The distribution of these across the continent, however, reveals a strong divide between Central and Eastern European countries, and Western European countries. For example, a large country such as Romania (which is around six times the size of the Netherlands) has only 0.4 per cent of all charging points in the EU. The Netherlands – the country with the largest charging infrastructure – has almost 1,600 times more charging points than the country with the smallest infrastructure (Cyprus with just 57 charging points). In fact, the Netherlands alone has the same number of charging points as 23 member states combined.

MORE POWER FOR ELECTROMOBILITY

Electromobility is picking up pace in Europe: according to the European Automobile Manufacturers' Association (ACEA), 878,000 new electric vehicles were registered in 2021 – up from 539,000 the previous year. It is anticipated that 100 per cent of all newly registered cars will be electric in Europe from 2035. However, this increase in demand also requires the charging infrastructure to expand alongside – preferably as quickly as possible. Despite the fact that the number of charging points in the EU has increased significantly over the last five years (+180 per cent), the total number lags far behind the number that is actually needed. A recent study from the ACEA shows that, by 2030, up to 6.8 million public charging points will be required in order to achieve the CO_2 reduction target of 55 per cent for cars – which means that, in less than ten years, the number of charging points needs to increase more than 22-fold. It is a huge market that offers great opportunities for companies who manufacture and sell charging solutions. The market researchers at Fortune Business Insights are expecting the global market for charging stations to increase from 17.59 billion US dollars in 2021 to 111.90 billion US dollars in 2028. But it is not just the charging hardware which is crucial to success in this market; the manufacturers at the forefront will be those with the best software for energy management and "bidirectional" charging. Furthermore, charging point manufacturers can generate extra income with the data collected from energy management in conjunction with local and national power grids. According to business consultants at Roland Berger, these types of additional services alone will be worth six billion US dollars in 2030. All of this does not just present fantastic opportunities for the providers of such charging solutions, but also for the electronic components industry. Because no charging point or charging station would work without power electronics, connectivity solutions or charging controllers. At EBV Elektronik and Avnet Abacus, we support manufacturers with everything they need for their charging solutions – starting from the right hardware and software modules, to the necessary charging cables and plugs, right up to specific cloud solutions. The time-to-market can be reduced significantly with this end-to-end solution, providing the best starting point to secure a share in the market of this rapidly expanding industry.

Rudy Van Parijs, President Avnet Abacus and Thomas Staudinger, President EBV Elektronik

In this special edition, you can find out more about the technology and market for charging solutions – we hope you enjoy reading it!



Rudy Van Parijs
President Avnet Abacus

Thomas Staudinger
President EBV Elektronik

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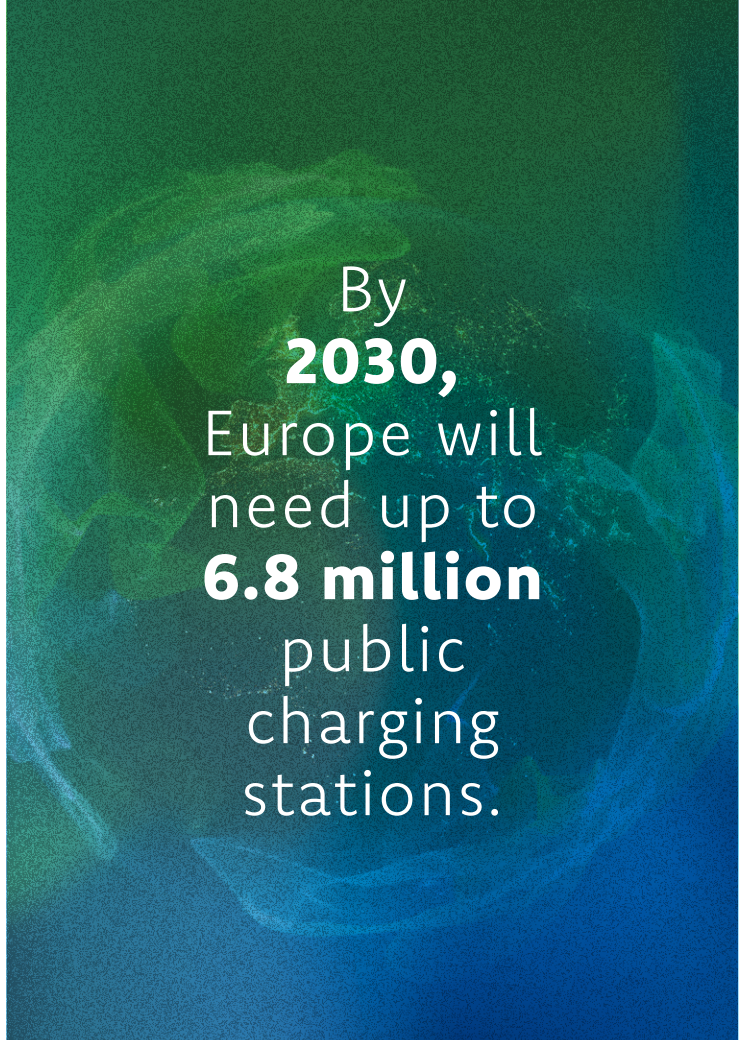
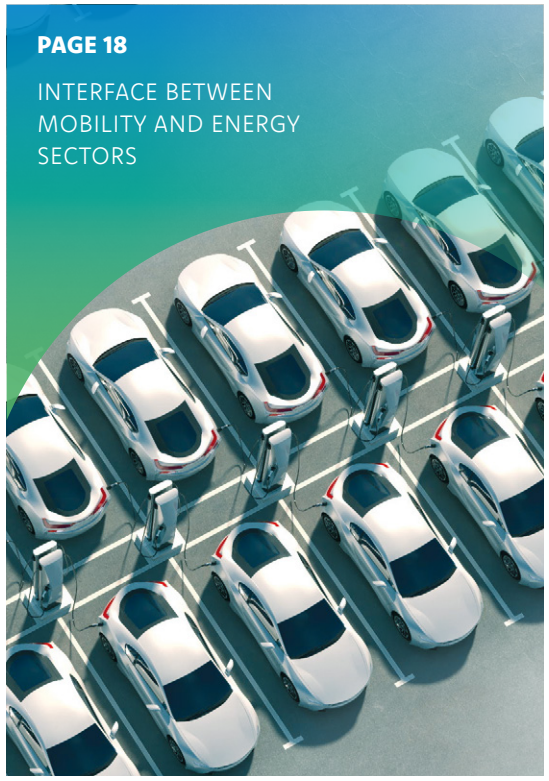


TECHNOLOGY



MARKET REQUIREMENTS

Charging is becoming as easy as refuelling

VISIONS & VIEWS

Electrification can be found in all transport sectors

CHARGING SOLUTIONS ARE THE COMMON LINK BETWEEN THE MOBILITY AND ENERGY REVOLUTIONS

Modern charging stations are much more than just a socket for electric cars. With integrated energy management and bidirectional charging, they help to keep the electricity grid stable, improve the integration of renewable energy, and create additional revenue streams for energy companies and homeowners.

Electrification of the mobility sector is an important factor in achieving the European Union's CO_2 reduction targets. "As an industry, we have the right vehicle technology readily available," says Oliver Zipse, Chairman of the Board of Management of the BMW Group and President of the European Automobile Manufacturers' Association (ACEA). "Making sure that enough Europeans buy these vehicles over the coming years largely depends on how quickly and widely infrastructure is rolled out across the entire EU." Bruce Douglas, Director of Business Development & Communications at Eurelectric, is confident, however: "By 2035, there will be 135 million e-vehicles on European roads, recharging at 65 million charging stations. 56 million of these stations will be in people's homes."

SMART CHARGING

The prerequisite for smart charging at home is a home energy management system. This gets to know all the requirements of the various electrical consumers, so it can manage their power supply in a smart way. The potential of this becomes even greater when combined with bidirectional charging: the electric cars can feed electricity they do not need into the customer's home grid, and in the future they will also be able to provide this power to stabilise the power grid.

INTERFACE BETWEEN MOBILITY AND ENERGY SECTORS

"We want to make the batteries in our electric cars usable as flexible, mobile storage units in the energy market. Storage facilities are absolutely essential in order to expand the share of renewable energies. What's more, this can make charging much more affordable for customers because they can feed their own electricity into the public grid," explains Elke Temme, CEO of Elli, a provider of energy and charging solutions. This vehicle-to-grid technology can help to decarbonise the transport sector, keep the electricity grid stable, improve the integration of renewable energy, and provide additional revenue streams for energy companies and car owners.

CHARGED IN FIVE MINUTES

Charging stations at home or at work are being supplemented by publicly accessible charging infrastructure. The focus here is on making them as easy as possible to use. The market launch of Plug & Charge represents a major push for quality in this respect – the vehicle identifies itself securely at corresponding charging stations in line with the ISO 15118 standard and automatically starts the charging process. When it comes to public charging points, the charging performance is even more important than convenience; after all, long stops to recharge a vehicle on long-distance trips need to be avoided. A game-changer could be increasing the use of 800-volt architectures – these allow the vehicle battery to be charged in up to ten minutes.

14,000

charging points would need to be installed every week in the EU to achieve the planned 55 per cent CO_2 reduction for passenger cars by 2030.

Source: ACEA

A WIN FOR THE ELECTRICITY GRID

Interview with Bruce Douglas, Director of Business Development and Communications at Eurelectric

Bruce Douglas is regarded as an experienced economist and has over 20 years of experience in promoting renewable energy and electrification. His mission is to electrify everything that can be electrified with clean and renewable energy. He is currently pursuing this goal as Director of Business Development and Communications at Eurelectric, the association representing the interests of the European electricity industry.

"Energy management must be implemented across all levels."

YOU ARE A PROVEN EXPERT ON RENEWABLE ENERGY SYSTEMS, BUT EURELECTRIC ALSO REPRESENTS ENERGY PRODUCERS BASED ON COAL AND NUCLEAR POWER. A CONTRADICTION?

B. D.: The energy system in Europe and around the world is, of course, not only based on renewable energy. Although renewable energies have grown considerably in recent years and will continue to grow, there are, of course, other technologies in the mix – fossil fuels like gas and coal, and nuclear energy. In fact, 25 per cent of electricity currently comes from nuclear power. Many countries are also considering investing in new nuclear power plants. But it is precisely this interaction of circumstances and challenge that interests me. And, of course, how we can promote and accelerate the energy transition.

YOU YOURSELF DRIVE AN ELECTRIC CAR. WHERE AND HOW DO YOU CHARGE IT?

B. D.: Yes, in my family we actually have two electric cars and I recently bought myself an electric bike. Many years ago, I was among the first to buy an electric car. Back then it was difficult to find a charging station, but nowadays I easily charge at home using the photovoltaic system on our roof.

UNTIL RECENTLY, THE AUTOMOTIVE AND ELECTRICITY INDUSTRIES HAD VERY LITTLE TO DO WITH EACH OTHER. BUT IN THE CONTEXT OF E-MOBILITY, THE TWO NEED TO TALK TO ONE ANOTHER – HOW CAN THAT BE ACHIEVED?

B. D.: It's a paradigm shift – for the transport sector as well as the energy sector. That's why Eurelectric started an initiative called E-Vision a few years ago. The goal is to bring the sectors closer together, that is to say the car manufacturers, the charging infrastructure and the energy sector. ▶

“Energy management is critical for putting electrification into practice.”

WHAT IMPACT WILL THE MASSIVE INCREASE IN ELECTRIC VEHICLES IN EUROPE HAVE ON THE ELECTRICITY GRID?

B. D.: We estimate that the electricity generation capacity will have to increase by 10 to 11 per cent by 2030, but the growth in EVs may also be a win for the electricity grid and could be helpful in grid operations. However, that will require some investment in the electricity grid.

IN ADDITION TO THE MOBILITY SECTOR, THERE ARE OTHER SECTORS THAT ARE EXPECTED TO BE ELECTRIFIED – THE HEATING SECTOR FOR EXAMPLE. WILL ELECTRIC CARS BE COMPETING WITH HEAT PUMPS IN THE FUTURE?

B. D.: In the future, heat pumps will be a dominant form of heating. We don’t see any problem with this. The increasing electricity demand can be managed through increased use of renewable energy, system management and greater investment in the grid infrastructure. We also believe there are close correlations between the demand-side elements, and this means that the charging of an electric vehicle or operation of a heat pump can be linked with the supply available in the electricity grid.

IN THE FUTURE, FAST-CHARGING STATIONS WILL PUT FURTHER STRAIN ON THE GRID WITH THEIR CONSTANTLY INCREASING CHARGING CAPACITIES. WHAT WILL THAT MEAN?

B. D.: Currently, around 90 per cent of all charging processes are private. High-capacity fast charging will still only make up a small, albeit important, part of the market in the future. The problem with these fast-charging stations is the unpredictability of their usage, that is to say when and what power is required. Attempts are being made to estimate this using calculations. What’s more, fast-charging stations should not only be easily accessible from motorways, but should also be close to renewable energy generation centres or connecting to the grid should be easy. This means that lots of planning and system management is necessary.

HOW COULD THE ENERGY SECTOR BENEFIT FROM E-MOBILITY?

B. D.: We’re talking about 100 million “mobile” batteries. The capacity of these batteries will be used, on average, only 5 per cent of the time. The other 95 per cent can therefore be used in intelligent ways to support the electricity grid. This would require a connection between the vehicle and the grid – the so-called vehicle-to-grid – although it is not yet commercially available. It comes at additional costs, but in the coming years these costs will be offset by the added value offered by this technology. With an energy management system, batteries could therefore be used for peak load usage. So, instead of switching on a gas turbine, energy could be drawn from the car batteries.

YOU’VE MENTIONED ENERGY MANAGEMENT. HOW IMPORTANT IS THAT?

B. D.: Energy management is critical for putting electrification into practice. It must be implemented across all levels, meaning for the energy company, consumer and charging station – and that requires an intelligent and integrated approach.

AND FINALLY: WILL ELECTROMOBILITY REALLY CATCH ON? OR DO WE STILL NEED A PLAN B?

B. D.: The question is not if, but when. My personal mission is to speed this up with clean and renewable energy. However, walking and cycling are just as important, especially in cities. Substantial investment in public transport, walking and cycling infrastructure is needed in order to complement the e-mobility revolution.

Listen to the full interview in our podcast “Passion for Technology”: ebv.com/podcast

10.5

million

is the forecasted number of electric vehicles in Europe by 2030.

Source: EY/Eurelectric

+10 %

is the required increase in power generation capacity in Europe by 2030.

Source: Eurelectric

THE FOUNDATIONS FOR **ELECTROMOBILITY**

Global sales of electric cars more than doubled in 2021, with the total number now at around 16.5 million – triple the number compared to 2018. During the same period, the number of public charging points tripled to approx. 1.8 million. The current momentum in electric car sales can only be maintained if a greater proportion of the population acquires access to convenient, affordable charging infrastructure – to both public and private charging stations.

Electric vehicle energy requirements
Annual energy requirement for electric vehicles in the EU-27

8 TWh
in 2021

128 TWh
in 2030

Source: ChargeUp Europe/P3 analysis

High demand requires high investment
Investment in the charging infrastructure will increase from

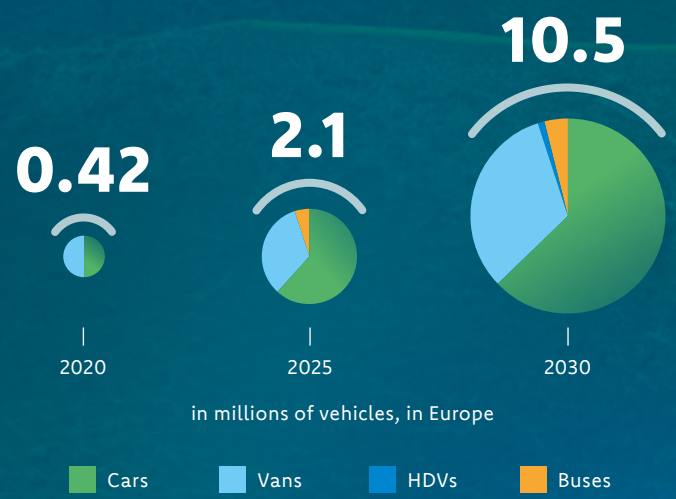
5 billion
euros in 2021 to more than

15 billion
euros in 2030.

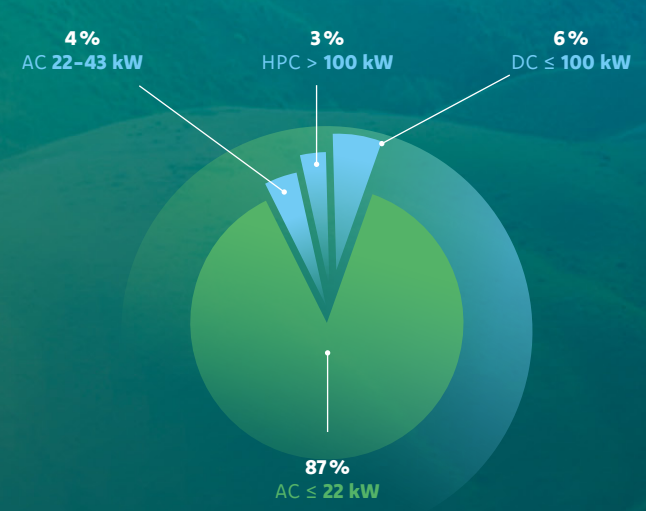
Source: ChargeUp Europe/P3 analysis

The electric vehicle market is booming

Source: eurelectric/EV



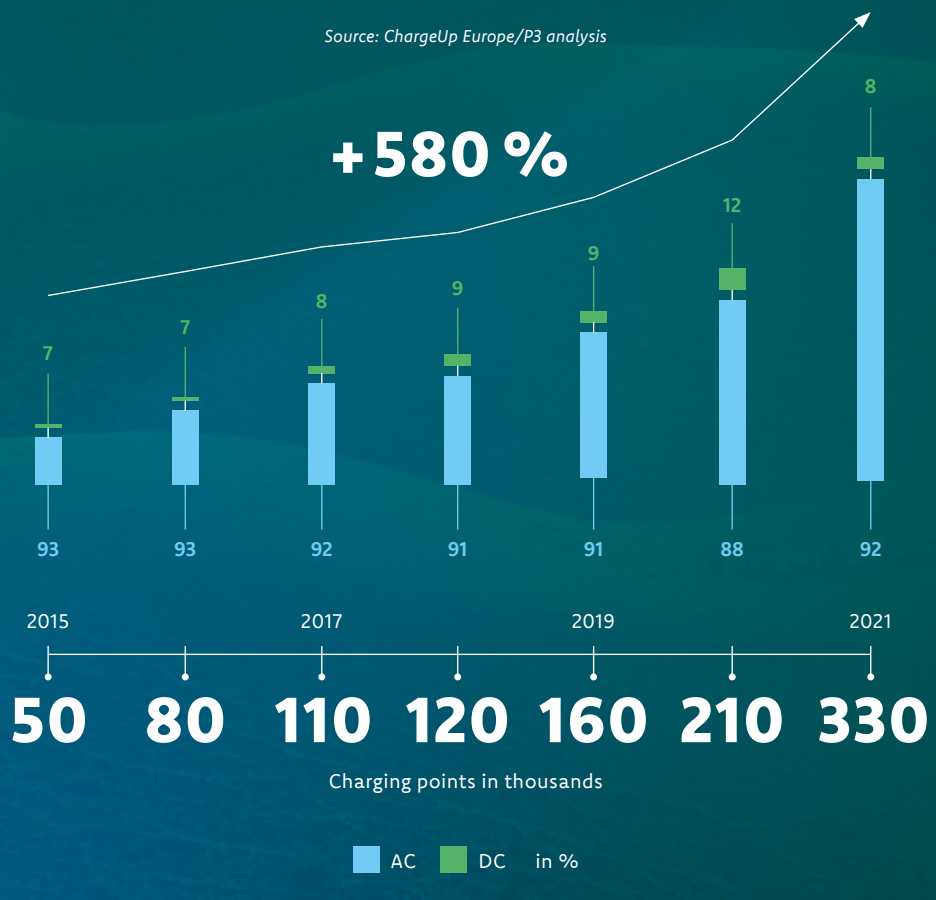
Public charging infrastructure in the EU-27 by type



Source: ChargeUp Europe/P3 analysis

Exponential growth
The stock of charging infrastructure is increasing at the same rate as the number of electric vehicles. Since 2015, the number of public charging stations alone has increased six-fold, and yet this only makes up a small part of the total charging market.

Source: ChargeUp Europe/P3 analysis



65

million

charging points needed in Europe
by 2035

Source: EY

MARKET REQUIREMENTS

The boom in electric vehicles requires a rapid expansion in charging infrastructure. At the same time, expectations around user comfort, safety and, above all, charging speed are also increasing.

TIPPING POINT IN ELECTRIC MOBILITY

Electric vehicles are conquering the mass market. More and more people are being won over by the many advantages they offer. But to keep up this enthusiasm, sufficient charging options must be created.

In their sustainable and smart mobility strategy published in 2020, the EU Commission set the milestone of at least 30 million emission-free vehicles by 2030 and the target of a largely zero-emission vehicle fleet by 2050.

ELECTRIC VEHICLES ARE IN GREATER DEMAND THAN EVER BEFORE

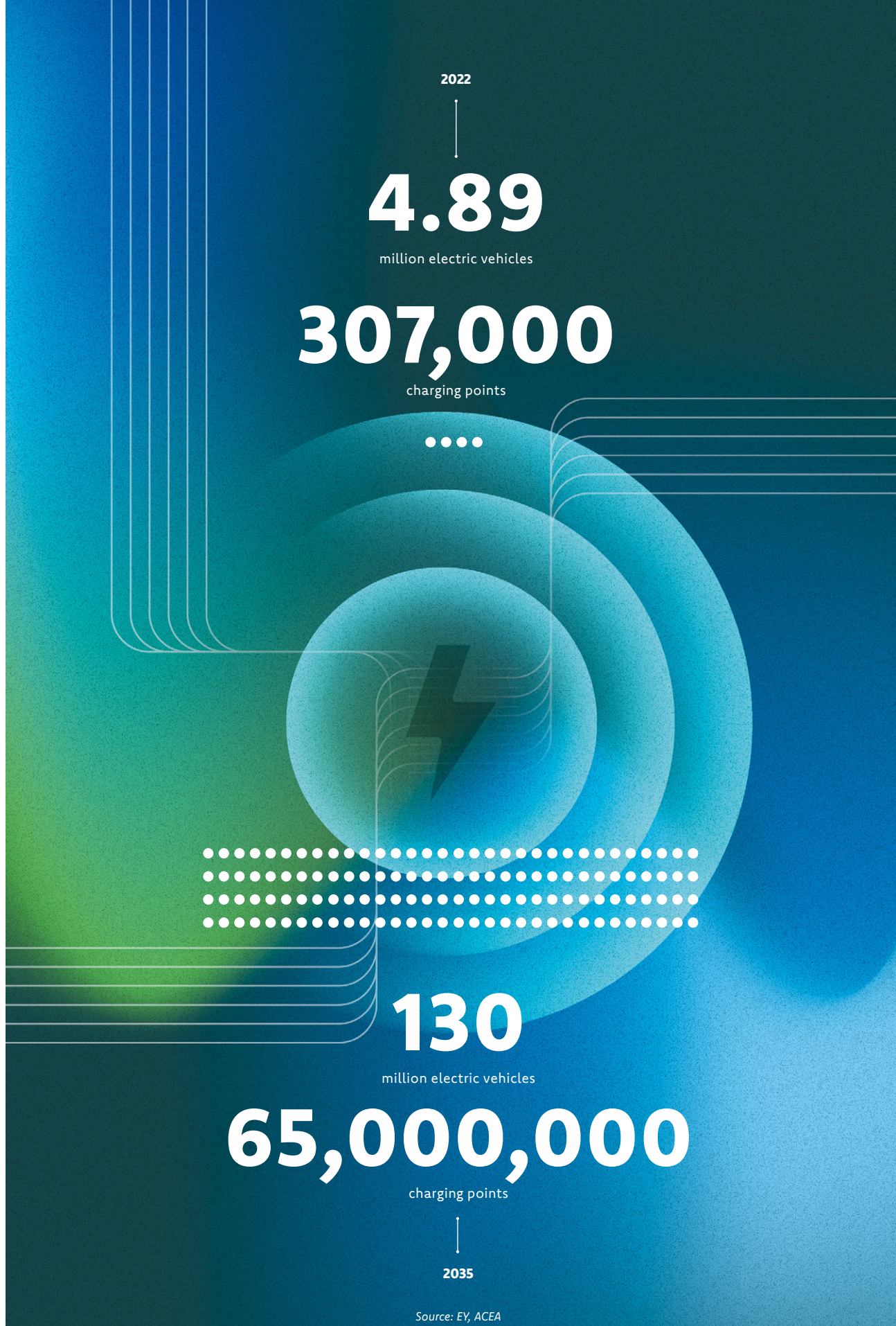
Whilst initially these figures may have seemed unrealistic, the latest EY Mobility Consumer Index removes all doubt. Randy Miller, EY Global Advanced Manufacturing & Mobility Leader says: "These findings truly mark a tipping point in the global car-buying market. For the first time since EY teams have been collecting this data, more than 50% of consumers across the globe indicate that they want an EV. The speed of this change has also been eye-opening, with a rise of 22 percentage points in just two years." While today electric vehicles comprise only 1.5 per cent of the total European fleet of 326 million vehicles, analysts at EY predict that the amount will increase to 65 million vehicles by 2030, and double to 130 million by 2035.

PLAYING CATCH-UP WITH THE EXPANSION OF CHARGING INFRASTRUCTURE

Enric Asunción, Co-Founder and Chief Executive Officer of charger and energy management provider Wallbox, says: "Mass market adoption of electric vehicles is here, and with this comes a need for significant expansion of charging infrastructure, starting in the home. At Wallbox, we believe that ubiquitous access to affordable, efficient, and optimised EV charging is a critical part of the transition to electric vehicles." EY has calculated that by 2035, at least 65 million charging points will be required across Europe – nine million public and 56 million private. According to car manufacturer association ACEA, the number of charging points installed in Europe is currently 307,000, which shows how much catching up there is to do.

CHARGING AS EASY AS REFUELLING

Justin Kolbe, Director of Market Strategy for Power and Industrial Automation at Henkel, has commented on the need for consumer-friendly access to charging devices: "Charging needs to be as convenient as refuelling at the pump," he says. Henkel provides special materials for chargers. These offer robust operating performance, a long service life of the components, and protection against tough conditions and use. "Consumers, while all-in on the benefits of EVs, will only maintain this enthusiasm if the ability to use them – for short or long journeys – is made simple and reliable. Expanding the charging infrastructure cost-effectively with reliable systems is key."



CARS AS THE NEW POWER-BANKS

The first electric cars can already feed electricity back into the grid when needed. Bidirectional charging transforms the charging infrastructure into the interface between the mobility and energy sectors.

As electromobility advances, the intelligent integration of charging infrastructure into the power grids becomes increasingly important. Take Amsterdam, for example: more and more residents are driving electric vehicles, meaning the urban electricity grid is already under considerable pressure.

In the summer of 2022, the energy company Vattenfall therefore joined forces with the university, an energy company and other stakeholders to run a pilot project testing a new concept for smart charging. This concept involves system software monitoring how much power is required at the connected charging stations and ensuring that the charging speed during the day varies according to the number of vehicles that are charging simultaneously. "This means that when few cars are charging, the charging stations provide more power to each car than when several cars want to charge," says Tim Hoogvliet, Product Owner Smart Charging at InCharge Netherlands. "With this technology, we can deal more efficiently with the available power and make optimal use of the existing electricity grid capacity. As a result, more charging points can be placed at a location connected to the same local electricity grid." ▶

REWARDING BEHAVIOUR THAT HELPS THE NETWORK

In Germany, such charging stations fall under the term "controllable consumer equipment" and they are defined in Section 14a of the German Energy Industry Act (EnWG). By enabling charging points to be controlled by the energy company, operators of charging infrastructure can contribute to a stable power supply and the change in energy policy. This subsequently pays off in terms of price, as the electricity costs can be reduced significantly as a result of lower network charges. "With volatile renewable energy, grid operators either have to expand the power grid, which is cost-intensive, or use tools such as controllable consumer equipment to organize the power supply more intelligently. The fundamental concept behind EnWG Section 14a is that costs for operators will be lower if they act in a grid-optimized way," explains Marcus Fendt, Managing Director of The Mobility House. The technology company has launched a smart charging and energy management system called Chargepilot for this purpose.

AVOIDING PEAK LOADS ON THE GRID

According to an analysis by EY, the peak load on the electricity grid will increase between 21 and 90 per cent due to electric vehicle charging. If this load is not managed, it can very quickly lead to network overload. The solution is to use smart systems that communicate with one another. For example, electric car drivers can receive information about which services can be accessed at which rates even before they drive to the charging station. Conversely, the energy company can know in advance what performance and capacity are needed at what time.

A SOLUTION TO MAKE THE GRID MORE FLEXIBLE

Bidirectional charging vehicles go one step further. In this case, the battery of an electric vehicle can be both charged and discharged. Cars usually stay parked for about 95 per cent of their life. These idle times, combined with the storage capacity of the batteries, turn e-vehicles into an attractive solution to make the electricity grid more flexible. With this concept, each e-vehicle becomes a micro-storage unit connected to the electricity grid that can provide a wide range of services to the system. The technology that makes this possible is called V2G or "vehicle-to-grid". The bidirectional communication between electric vehicles and charging points is regulated by the international standard ISO 15118. Among other things, it governs the "Plug & Charge" function. This allows vehicle users to charge directly at a charging station without needing to identify themselves via a charging card or app. In addition, the V2G energy flow and associated energy management can also be enabled and controlled.

"With green power, we can transform mobility in a targeted way, something which also applies to building management and heat supplies."

Kurt Sigl, Bundesverband eMobilität

Smart-charging solutions enable fleet operators such as local public transport companies to integrate their trucks or buses into the international electricity market as decentralized energy resources. The prerequisite for this is energy management of the e-fleet so that battery data, charging status and charging options of all e-vehicles in the fleet are constantly recorded. This opens up completely new sources of revenue and savings for a company with respect to its e-vehicle fleet. Examples include short-term grid balancing and the provision of battery capacity. Savings or additional revenue of thousands to tens of thousands of euros per year can certainly be realised in this way, depending on the scope and usage.

"The potential of this symbiosis between the changes in energy policy and the mobility sector is enormous," says Kurt Sigl, President of industry association Bundesverband eMobilität, with confidence. "With green power, we can transform mobility in a targeted way, something which also applies to building management and heat supplies."

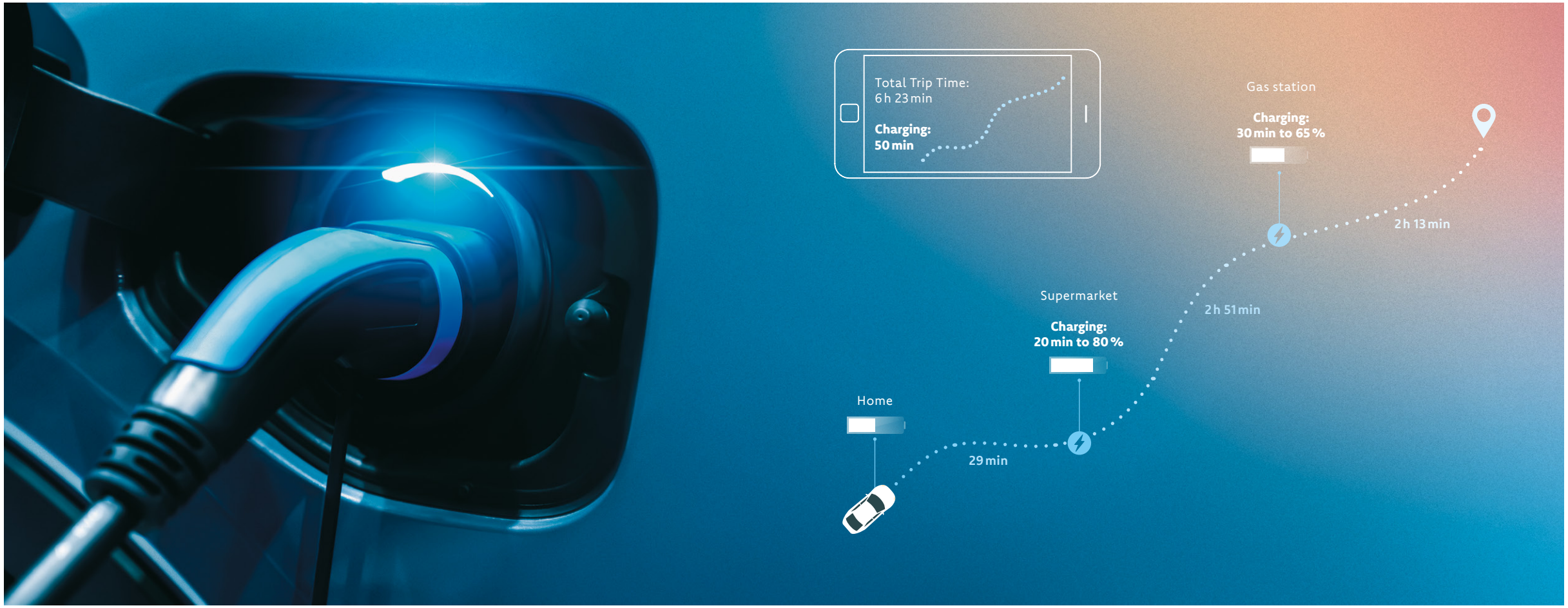
QUALITY OF SERVICE **AS A KEY** TO SUCCESS

In order to ensure electromobility solutions are widely accepted, it is not only important that sufficient charging stations are available, but also that the charging process itself is as simple as possible. There are various requirements to take into account here.

Drivers of electric vehicles don't actually ask for much when it comes to the charging process: they are simply looking for a user experience that is comparable to refuelling with petrol or diesel. In other words, they want to be able to freely choose their fuel (or charging) station operator, not have to wait at all or only for a short while, and have a range of payment options to choose from.

APPS AS A CONCIERGE

The first step towards achieving this level of service are apps that provide a range of digital services to help drivers when charging their electric vehicle. For example, they enable drivers to filter for suitable charging stations based on criteria like plug type, charging speed, operator and type of access. The FordPass app is one such app – it lets drivers of electric vehicles configure charging plans and warnings at home and makes it simple to prepare their vehicle before setting off. One important feature of Ford's app is a tool that simplifies journey planning by taking into account the vehicle's current state of charge and locating charging stations along the route. ▶



FREE CHOICE OF CHARGING STATION

However, an app does not solve the problem of drivers being restricted to a single charging station operator. The aim should be that drivers can access as many charging stations as possible with a single customer account. This is referred to as "roaming", like with mobile telephony, which means that drivers of electric cars can charge anywhere without any issues, regardless of what route they are taking. However, this development is still only getting started. Bilateral roaming in particular is currently proving popular – this is when two market players agree that their customers can use each other's network. While this type of peer-to-peer roaming agreement opens up access to more charging stations, it still doesn't enable drivers to choose any one they like. This would only be possible with open roaming, which would require the use of generally accepted protocols and interoperability standards for charging. These do not exist yet for electric vehicles on the European market.

However, major roaming platforms do currently exist. The largest of them all is currently Hubject, which provides access to more than 400,000 charging points in Europe, the USA and Japan. "The quality of service of public charging stations is becoming a crucial success factor in adopting electric vehicles. The market needs reliable, accessible and available charging stations, so we can convince more people to switch to an emission-free form of mobility in the future," says Christian Hahn, CEO of Hubject.

SIMPLY PLUG IN AND YOU'RE READY

Another method that makes it easier to charge electric vehicles – particularly when it comes to roaming – is the Plug & Charge function. This technology provides a simple means of authentication for drivers of electric vehicles at the charging station. Simply connect the electric vehicle to the charging station and the vehicle and station will exchange the relevant data via the charging cable. The charging process then starts completely automatically. "If we want more people to switch over to e-mobility, it will be crucial to ensure charging stations are easy to use – and the Plug & Charge function is a major step towards achieving this. Even if the technology is still in its infancy, it nonetheless gives our customers the best possible seamless charging experience today," says Jörg Reimann, CEO of Digital Charging Solutions. The company develops charging solutions for car manufacturers and fleet operators.

SIMPLER PAYMENTS

It is not only the charging network that is highly fragmented – the payment infrastructure for electric vehicles varies greatly as well. "Uniform standards and secure, open payment systems are therefore important in order to increase acceptance among consumers and ensure the long-term success of e-mobility," says David Klemm, Vice President of Business Development at Mastercard. The basis for this is open-loop technology that enables an operator of charging stations to accept all common payment methods.

Of course, things would be even easier if the electric car itself acted as your wallet or purse. E-Wallet technology would make this possible, as it turns the actual vehicle into a trusted data source. With this approach, it can autonomously execute secure transactions between customers, vehicles and other infrastructure. For example, the electric car could automatically make the payment at the charging point or independently sell power from the battery to an electricity provider. So we can see that, in future, it might even be simpler and more convenient to charge your electric vehicle than it is to refuel a non-electric vehicle.

"In order to increase the acceptance of the switch to e-mobility, ease of use at the charging station is crucial."

Jörg Reimann, CEO Digital Charging Solutions

ARE CHARGING STATIONS **A NEW TARGET FOR HACKERS?**

The increasing connectivity of electric vehicles, charging stations and power grids is opening the door to a myriad of possibilities. However, it also entails an inherent cyber-security risk.

Last year, British company Pen Test Partners uncovered a number of serious cyber-security vulnerabilities in different chargers and public charging networks. For example, some charging solutions allowed cyber-attacks that could have led to accounts on millions of smart chargers being hijacked. Moreover, several charger platforms had API authorisation issues, allowing accounts to be taken over and chargers to be controlled remotely. The company also highlighted the risk of the electricity grid becoming unstable if a large number of chargers were to be switched on and off synchronously. "The technology is advancing swiftly and there is a growing need to focus on the cyber security of electric vehicles", says Timothy Zeilman, Vice President of HSB, part of Munich Re. "With the rush to make the switch to electric cars and trucks, owners and the EV industry should step up their efforts to protect vehicles and charging infrastructure from cyber-attacks."

CONSIDERING THE SYSTEM AS A WHOLE

However, according to Juice Technology (a manufacturer of charging solutions for electric vehicles), all the market players involved – i.e. energy companies and manufacturers of charging stations and cars – have so far only tended to focus on the security of their part of the ecosystem. As such, it is crucial to keep the system as a whole in mind. Ultimately, the entire infrastructure is a target for attacks. "A lot of vending machines are better protected than charging stations," said Thomas R. Köhler, cyber-security and data protection expert and member of the Board of Directors of Juice Technology. "The possibilities for cyber-attacks are many and varied, and not very complex, either. An attacker can cull or manipulate data in poorly secured electronics, and thereby take control of the system and misuse it for all kinds of criminal activities."

"A lot of vending machines are better protected than charging stations."

Thomas R. Köhler, cyber-security and data protection expert and member of the Board of Directors of Juice Technology

THE RISK CAN BE REDUCED

Researchers at the Concordia Institute for Information Systems Engineering in Canada also found vulnerabilities in charging stations, some of which were major. The researchers recommend a range of risk mitigation measures that manufacturers could take. However, the ease and efficiency with which each solution can be implemented depends on how complex the vulnerability is, explains Tony Nasr, the lead author of the study: "Each vulnerability has its own case and requires a proper level of sophistication to resolve." Chadi Assi, a professor at the Concordia Institute for Information Systems Engineering and the paper's supervising author, adds: "We are about to see an exponential rise in EVs on the road. But without secure charging infrastructure, customers will be reluctant to commit to electric cars."

PASSION FOR TECHNOLOGY

Listen to our podcast "Passion for Technology" for the latest technology trends and to understand what all these technical terms that shape our lives actually mean. Allow our guests and their passion for technology to inspire you.

The power of three — Shortening time to market — Building fast-charging infrastructure — Major trends

EV CHARGING³

THE POWER OF THREE

www.ev-chargi.ng

3,750,000

watts

maximum charging capacity of the Megawatt Charging System

Source: CharIN

TECHNOLOGY

Although the majority of charging processes will still have a low charging capacity in the future, fast charging is currently the focus of technological development, as it is only with this that long-haul journeys in an electric vehicle and the electrification of HGV traffic are practical and feasible.

COMPONENTS OF A **CHARGING STATION**

A variety of electronic and electromechanical components are required to implement a charging station – from simple plug connectors, sensors and protective elements such as fuses and overvoltage protection to various software solutions. However, the five most important assemblies are the charging controller, the human-machine interface, modules for connectivity, the power electronics and finally the charging cable with charging plug. When selecting suitable components, a number of questions must be clarified before actually designing a charging station. A few example questions are shown below.

WHAT STANDARDS DO THE CHARGING CABLE AND PLUG SYSTEM HAVE TO MEET?

Power is transmitted between the electric vehicle and charging station via a suitable charging cable and a corresponding charging plug.

- In which region is the charging station to be set up (type 1 or type 2 charging cable, type 2 charging plug, CSS, Combo, CHAdeMO, etc.)?
- Is AC or DC used for charging?
- What power is used for charging?

WHAT FUNCTIONS IS THE CHARGING CONTROLLER EXPECTED TO HAVE?

The charging controller controls and monitors the entire charging process. It communicates with the electric vehicle to be charged, regulates parameters such as charging current, and optionally performs additional tasks.

- Is direct current or alternating current used for charging?
- Is communication between the vehicle and charging station to be carried out using pulse width modulation (PWM) or bidirectionally as per ISO 15118 with power-line communication?
- Is the charging station to provide the “Plug & Charge” function?
- Is use of or connection to cloud services planned?
- What type of electricity meter is to be installed – an external one via the IMD interface or an internal one?

WHAT POWER IS TO BE USED FOR CHARGING?

The power unit is responsible for actually converting the electrical energy from the grid. The power unit defines the charging capacity available (7 kW, 11 kW, 22 kW, 50 kW, 400 kW, etc.) and therefore also the possible charging speed.

- What voltage level is required at the output (400 V, 600 V, 800 V, etc.)?
- Which semiconductor device is preferred (module or discrete):
  - MOSFET Si: most common circuit breaker in DC chargers with a power of up to 75 kW, high efficiency with fast switching applications and a good price/performance ratio
  - IGBT: suited for inexpensive DC chargers where efficiency and space requirements are not a factor
  - SiC: high efficiency and low space requirements – therefore mainly used in DC chargers with an output of more than 100 kW

WHAT ARE THE REQUIREMENTS OF THE HUMAN-MACHINE INTERFACE (HMI)?

The charging station is operated and the charging process, for example, initiated and paid for by the user via the human-machine interface.

- LEDs
- NFC for payment purposes
- Chip card reader
- Security and protection against tampering
- Touch LCD control panel

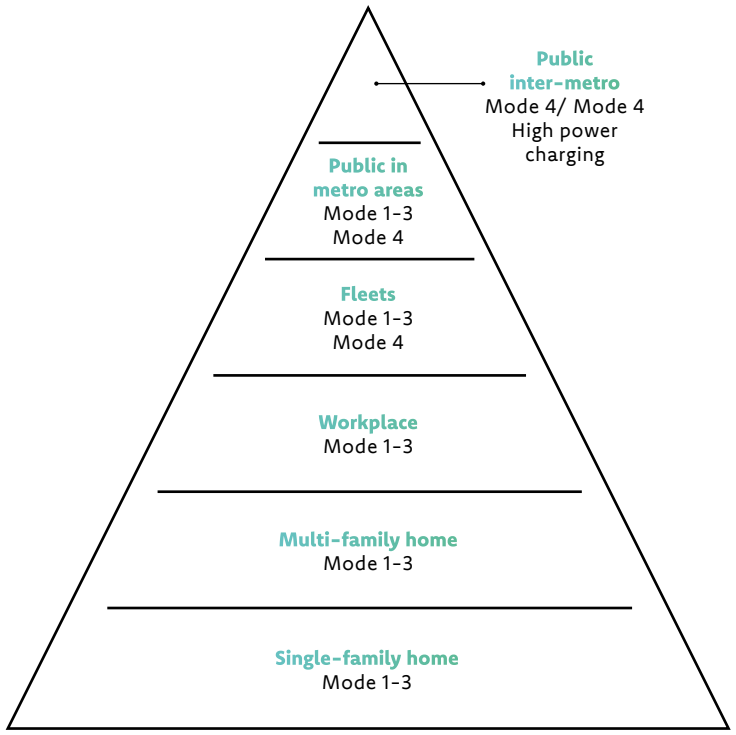
WHAT TYPE OF WIRELESS OR CABLE-BASED CONNECTIVITY IS REQUIRED?

Communication modules enable the charging station to be networked and a connection to be established with higher-level management and backend systems. One important task here is protecting against cyber attacks.

- MODBUS, MBUS, RS485, etc.
- 2G, 4G, 5G mobile communication, NBIoT, Cat-M, etc.
- Wi-Fi, sub-GHZ, Lora, WiSUN, etc.
- PLC/RF narrow band hybrid module

THE VARIOUS TYPES OF CHARGING SYSTEMS

Different technologies are available to charge electric vehicles. The main thing that distinguishes them is their power output – and thus the time it takes to charge the battery.



The location where the vehicle is being charged and the time available determine which charging mode to use.

Different types of charging systems are available to charge electric vehicles. In wired (or conductive) charging systems that use alternating current, the power from the AC grid is first transferred to the vehicle. The vehicle has a built-in charger that converts the alternating current into the direct current required by the battery. Higher power outputs can be achieved by charging the vehicle with direct current. With this method, the charger is integrated into a charging station.

For wired charging of electric vehicles (including pedelecs, e-bikes, etc.), four different charging modes are available, which are set out in DIN EN IEC 61851-1.

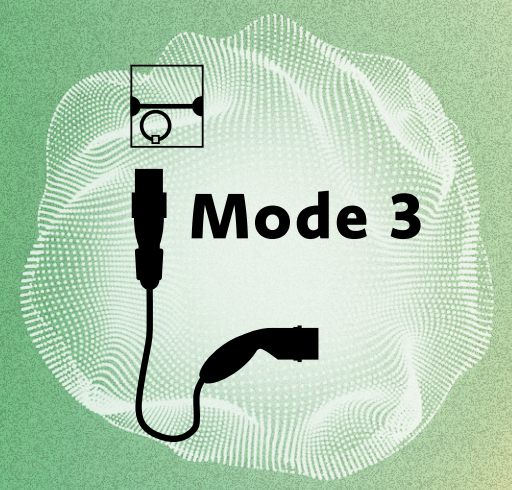
Mode 1

(prohibited for passenger cars in Europe)

Power	AC
Connection	domestic or industrial power socket
Communication	none
Safety measures	none (residual current device installed domestically)
Single-phase power	max. 16 A, 3.7 kW
Three-phase power	max. 16 A, 11 kW

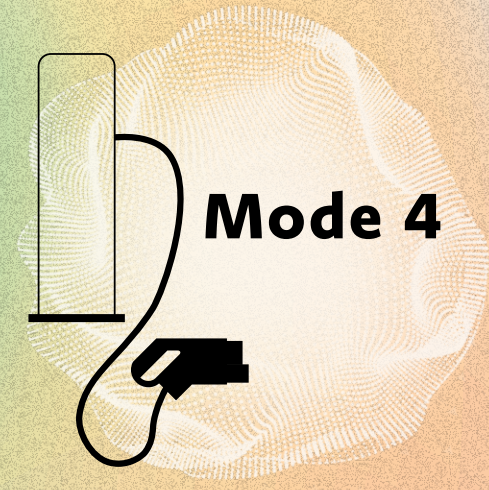
Mode 2

Power	AC
Connection	domestic or industrial power socket
Communication	PWM signal (pulse width modulation)
Safety measures	integrated in the cable (In cable control and protection device, IC-CPD)
Single-phase power	max. 16 A, 3.7 kW
Three-phase power	max. 32 A, 22 kW



Mode 3

Power	AC
Connection	charging station (upright stand, wallbox)
Communication	PWM signal
Safety measures	integrated in the charging station
Single-phase power	max. 16 A, 3.7 kW
Three-phase power	max. 63 A, 43.6 kW



Mode 4

Power	DC
Connection	charging station
Communication	communication according to ISO 15118 using power-line communication (PLC) and the TCP/IP protocol
Safety measures	integrated in the charging station
Charging power	max. 500 A (High Power Charging), 350 kW

MORE EFFICIENT **CURRENT CONVERSION**

Supplying vehicle batteries with the correct current is essential for charging stations, and it is the job of inverters to take care of this. New technologies are enabling better efficiency, not just with regard to losses, but also design complexity.

"SiC is considered the enabler to provide good efficiency, and a supply of 1,200 V devices is feasible. With more 800 V EVs coming, SiC is expected to grow quickly."

Poshun Chiu, Technology & Market Analyst, Compound Semiconductors & Emerging Materials at Yole

Inverters are a central component of every charging solution. Minimising charging time while simultaneously optimising system efficiency is a main focus when designing inverters for chargers.

HYBRID INVERTERS USE MAINS AND SOLAR ENERGY

When charging the vehicle at home or at work, people normally want to use power from a photovoltaic system on the roof. This is a topic for inverter technology: SolarEdge has developed the world's first inverter with an integrated e-charge controller which combines photovoltaic systems and charging electric vehicles in one single piece of hardware. The system allows the simultaneous use of mains power (= alternating current) and solar power (=direct current). As the powers are combined downstream of the circuit breaker, the charging speeds can exceed the in-built limits of the circuit breaker. This means that homeowners with a single-phase inverter can charge their electric car up to 2.5 times faster than with a traditional charger. Moreover, system costs are reduced because the costs for the installation of a stand-alone charger and inverter are eliminated.

STRAIGHT TO THE MEDIUM-VOLTAGE GRID

Modern inverter technology can also play a role in reducing the number of required components in the field of DC fast-charging technology. Solid-state transformers (SST) are one example of this. They are composed of silicon-carbide-based power electronic transformer stages which allow greater flexibility in controlling power distribution networks. Depending on requirements, they make seamless AC-DC and DC-AC conversions possible. When used in charging stations, they can charge various types of vehicle battery with different voltage and performance levels. In particular, SST technology makes direct connection to the medium-voltage grid of the energy supplier possible, without any additional equipment for energy conversion and the associated commissioning.

MORE EFFICIENCY WITH SILICON CARBIDE

Another important trend for inverter technology is the transition to silicon carbide semiconductors. They offer an array of advantages in comparison to traditional power semiconductors made from silicon. They enable faster switching speeds, lower inductance and capacities, all of which results in smaller component sizes. With this, smaller chargers can be built that work at a higher efficiency and require less cooling than their silicon equivalents. This means that it is possible to design simpler charging systems, while still delivering higher charging efficiency and reliability than silicon alternatives.

CONSISTENT **COMMUNICATION**

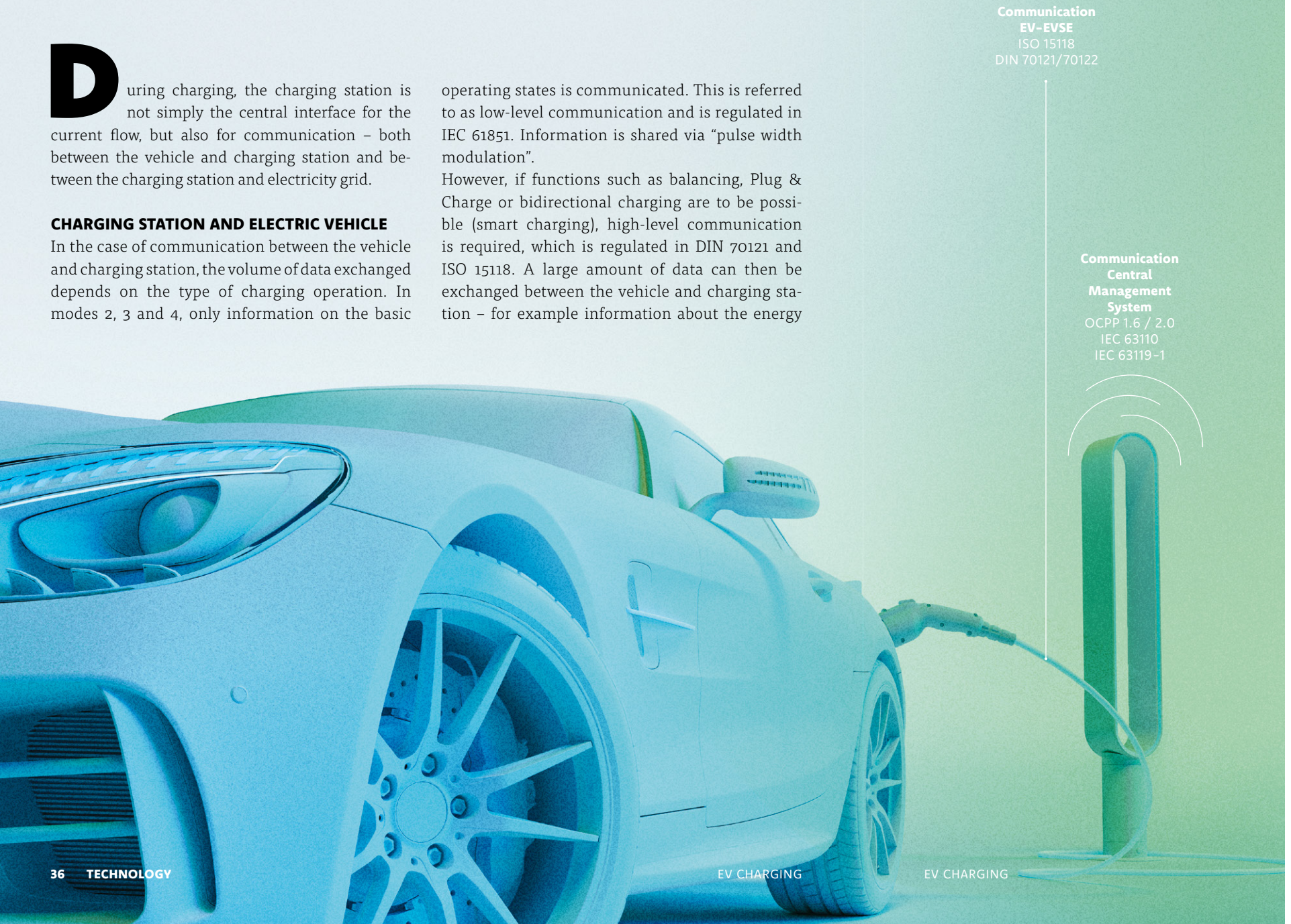
When an electric vehicle is integrated into the electricity grid during charging, this doesn't just result in more intelligent charging, but also enables a wide range of additional services. A smooth flow of information between the vehicle, charging station and the grid is required for this.

During charging, the charging station is not simply the central interface for the current flow, but also for communication – both between the vehicle and charging station and between the charging station and electricity grid.

CHARGING STATION AND ELECTRIC VEHICLE

In the case of communication between the vehicle and charging station, the volume of data exchanged depends on the type of charging operation. In modes 2, 3 and 4, only information on the basic operating states is communicated. This is referred to as low-level communication and is regulated in IEC 61851. Information is shared via "pulse width modulation".

However, if functions such as balancing, Plug & Charge or bidirectional charging are to be possible (smart charging), high-level communication is required, which is regulated in DIN 70121 and ISO 15118. A large amount of data can then be exchanged between the vehicle and charging station – for example information about the energy demand, the planned charging duration or information concerning the price and billing. For charging stations as per the "Combined Charging System" (CSS) standard, power-line communication (PLC) is implemented on the basis of IP-based protocols. For charging stations as per the DC GB/T or DC CHAdeMO standard, communication is carried out via CAN bus (Controller Area Network), which is widespread in the automotive industry.



"The charging station is the communication hub between the vehicle and the electricity grid."

CHARGING STATION AND ELECTRICITY GRID

There are also special protocols for vehicle-to-grid communication between the charging station and the market participants on the grid side such as charging station operators, distribution grid operators, billing service providers, roaming networks and measuring site operators. This includes the Open Charge Point Protocol (OCPP) developed by the Open Charge Alliance. It enables communication between a charging station and a billing/management system, i.e. the backend. The IEC 63110 series of standards is an additional standard for communicating with the backend. In addition to just the communication protocol, the standard also defines the interface from the charging station to the backend. It therefore covers management of charging stations as well as all other associated infrastructure. The Open Smart Charging Protocol (OSCP) was also developed by the Open Charge Alliance. It supports communication between the charging point and energy management systems. The OSCP was originally developed to provide charging station operators with predictions about the local capacity available, in order for them to adapt the electric vehicle charging profiles. The IEC 63119 series of standards regulates the information exchange for roaming, i.e. the use of various charging networks.

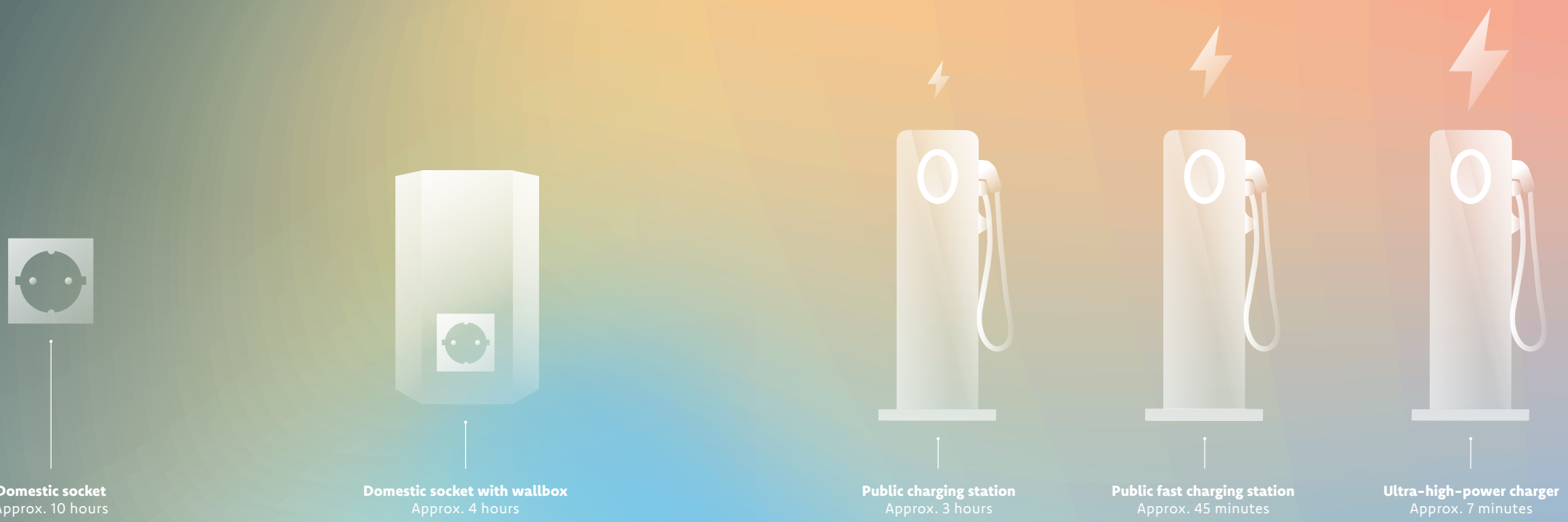
EV CHARGING

EV CHARGING

ACCELERATING **ELECTRO-MOBILITY**

To ensure that even more people make the transition to electric driving in the future, charging has to be as fast and convenient as possible. Long breaks to charge the vehicle are not acceptable, particularly in long-distance transport. Fast-charging stations mean charging can be completed in just a few minutes.

Fast chargers "are key to travel around corridors in the European Union," says Philippe Vangeel, Secretary General of AVERE (The European Association for Electromobility), the European association that promotes electromobility and sustainable transport across Europe. Similar to traditional refuelling, fast chargers allow people to recharge electric vehicle batteries in just a few minutes. This makes fast chargers a basic requirement for convenient long-distance travel. ▸



Charging times compared: from domestic sockets to ultra-high-power chargers

CHARGING CAPACITY IS GROWING

The number of extremely fast-charging points of 150 kilowatts and above, i.e. "high-power chargers" (HPC) is actually growing disproportionately: for example, there were more than twice as many of them in Germany in 2021 compared to the previous year according to the German Association of Energy and Water Industries (BDEW). "Huge technological leaps are still being made when it comes to the charging power of vehicles and charging stations," explains Kerstin Andreae, Chair of the BDEW Executive Board. "Until a few years ago, vehicles could generally be charged with a maximum power of 50 kilowatts; the number of vehicle models with a charging power of 100 kilowatts and above has been growing steadily since 2019 and we are seeing a trend towards 150 kilowatts. This represents a tripling of the charging power within just a few years …"

HEADING INTO THE MEGAWATT RANGE

This is not only thanks to technological advancements in charging points, but also due to improvements in vehicle battery technology. New materials and, in particular, sophisticated thermal and battery management allow higher charging currents, without having a significant impact on the battery life. This means that charging outputs of 350 kilowatts are already possible; the first charging stations with a charging output of one megawatt are currently being launched onto the market. However, these types of high-performance charging stations are designed more for charging trucks rather than cars – and in future for charging aircraft and boats. CharIN, which advocates for the standardisation of electric vehicles, has developed a fast-charging plug for heavy-duty commercial vehicles especially for ultra-fast charging solutions – the Megawatt Charging System. It is designed for a maximum current of 3,000 amperes at up to 1,250 volts, which results in a potential peak output of 3,750 kilowatts.

MODIFIED CHARGING STATION ARCHITECTURE

These types of charging outputs have to be reflected in the design of charging stations: minimising the cooling required, providing a high power density and reducing the system size and cost. For example, liquid-cooled lines are required to prevent charging cables and plugs from overheating. This means that the charging cables can still be thin and are therefore easy to handle when connecting the charging station and vehicle. High-power charging stations also work with output voltages above 500 volts. These are the kinds of voltages that generally only trained experts are allowed to handle. Plug connections must therefore be able to withstand high loads and also adhere to safety protocols that permit laypersons to handle them.

REDUCING LOSSES

At the same time, the charging station must be equipped with efficient power electronics that reduce losses during charging as much as possible. This is because even an efficiency rate of 97 per cent means 9,000 watts of power are lost during a charge with 300 kilowatts. By way of comparison, the average connection power of an oven is 3,000 to 4,000 watts. Cooling is therefore required in the case of a high power density. Whilst air cooling is currently standard, the next generation of charging systems use liquid cooling. Silicon carbide and gallium nitride represent a great leap forward in terms of efficiency and reducing the amount of power lost in the power electronics, as they enable an efficiency rate of 98.5 per cent or more.

PREVENTING GRID LOAD

Besides the "insides" of the charging station, fast-charging stations also present challenges for the electricity grid: firstly, the costs for the corresponding grid connection power would be considerable, and it is not available everywhere. And secondly, the high charging outputs place significant strain on the grid and result in strong fluctuations. This is why fast-charging stations are increasingly being connected to fixed buffer storage that can compensate for a lower connection power. ADS-TEC Energy is one company that offers this type of system. Its battery buffer is charged around the clock with a low grid power. It then uses this charge to boost the available power from the electricity grid in order to provide charging outputs of up to 320 kilowatts. Thomas Speidel, Founder and CEO of ADS-TEC Energy says: "With our battery-buffered ultra-fast charging stations, charging can be carried out in just a few minutes almost anywhere, even in grids with limited grid connection power."

2.3

billion USD
value of the global market
for fast-charging systems in 2027

Source: Emergen Research

KEEP COOL

Charging cables and plugs are used to physically connect the charging station to the electric vehicle. However, fast charging using several hundred kilowatts of power is now placing particular requirements on cables and plugs.

The number of charging stations and electric vehicles is rapidly increasing, meaning that ever more charging cables are required. Connections for charging operation types mode 1 and mode 2 dominate the market in terms of numbers used. Mode 1 charging cables, which are simply connected to a domestic plug socket and do not have any protective devices, are used in Europe to charge e-bikes, for example. Mode 2 charging cables are currently the most common type of charging used for electric vehicles. Various versions of these cables are currently available and are supplied by OEMs together with the vehicle. However, the mode 4 segment will experience the highest growth rate in future – as the demand for DC fast chargers in particular is currently increasing all across the world.

DC charging is the fastest charging method. Thanks to high charging currents of up to 500 amperes, it can be used to charge a fully discharged vehicle to 80 per cent in just a few minutes. However, the faster an electric vehicle is charged, the greater the need for heat regulation. This is because a high charging current generates a substantial amount of heat due to the internal resistance in the cable and plug. According to the VDE-AR-E 2623-5-3 directive and the IEC TS 62196-3-1 standard, charging plugs and cables must not be more than 50 kelvins warmer than the ambient air during charging.

The market for electric vehicle charging cables is expected to grow from

513

million USD
in 2022

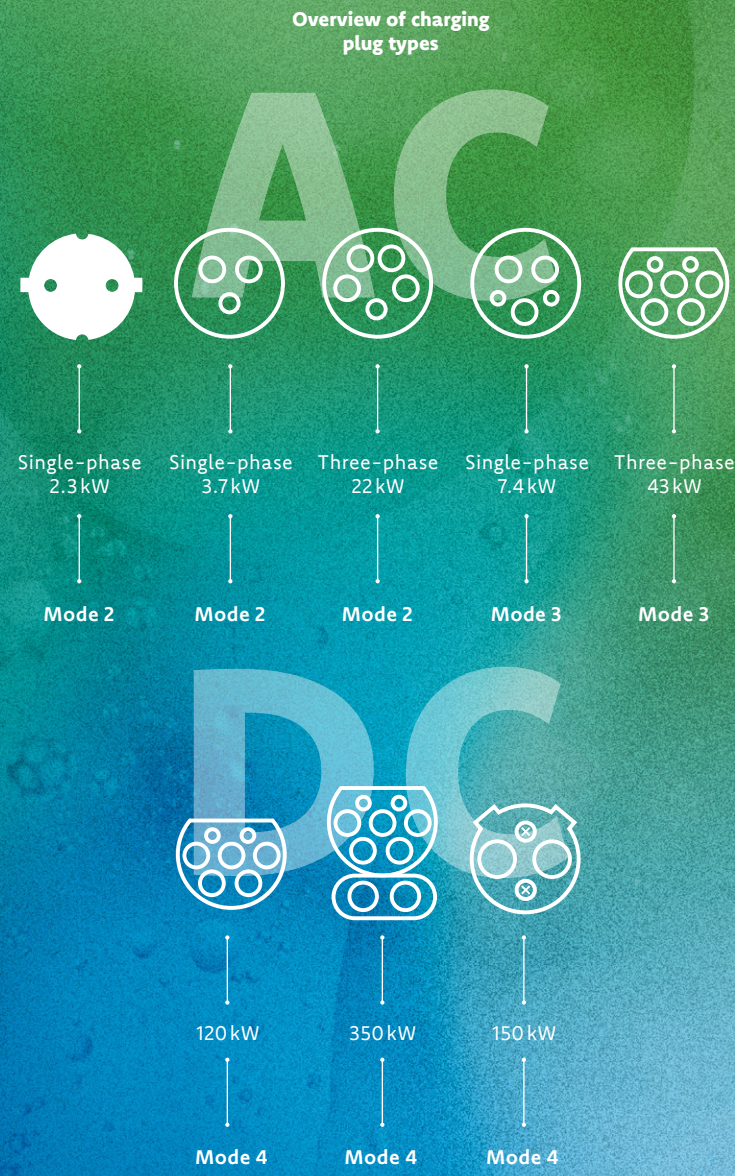
to

3,551

million USD
in 2028.

Source: The Insight Partners

Cables with a larger diameter could be the answer, although they would be heavy and bulky. Manufacturers of fast-charging stations are therefore using liquid-cooled charging cables, in which special coolant flows from the cooling unit via the cable to the plug and back again. This means the charging cables can be made thinner and lighter and the cable's weight is reduced by around 40 per cent compared to an uncooled cable. The latest technology is phase change cooling: Ford has been working with Purdue University to develop a system in which the liquid is vaporized in a closed system, cooled to liquefy it again, and then passed through the cable ones more. Charging cables are said to be able to handle more than 2,400 amps with this system. Furthermore, highly sensitive temperature sensors on the power contacts of the charging plug and in the charging cable ensure safety during charging, and can be used to control the cooling intensity in a needs-based and efficient manner. Integrated position and shock sensors provide information about the current condition of the charging plug, and a leak sensor also monitors whether any coolant is leaking. If this sensor data is monitored via an integrated CAN bus interface, this enables predictive maintenance that is in line with the level of wear.



Source: home & smart

CHARGING SOLUTIONS FROM A ONE STOP SHOP

Sarah Ghaemi, Director of Technical Development at Avnet Abacus, Bevan Braude, Business Development Manager at Avnet Embedded, and Andrej Orel, Director of Market Segment City and Infrastructure at EBV Elektronik, report on the cooperation of their three companies which could significantly reduce the development time for new charging solutions.

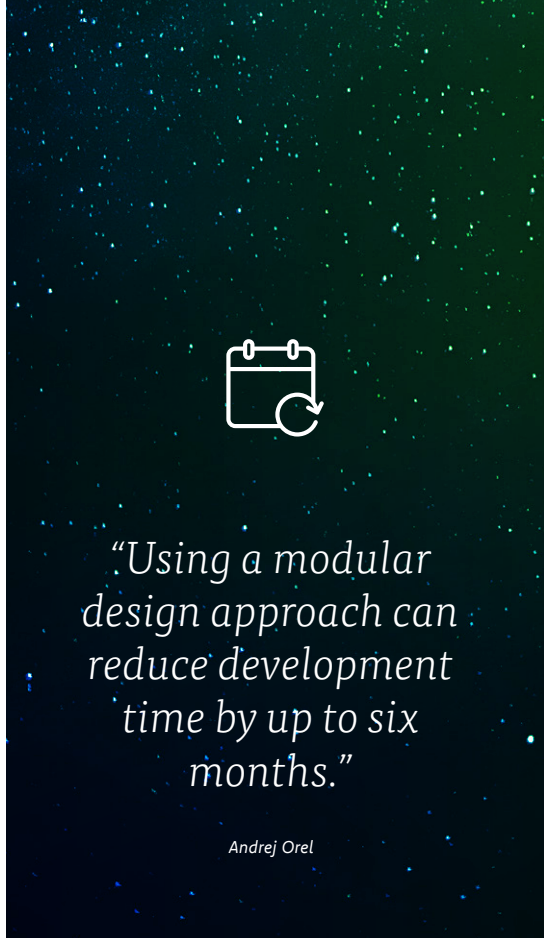
Sarah

Ghaemi

Electric vehicle charging infrastructure must be rapidly expanded for the e-mobility of tomorrow to be a success. Policy-makers and manufacturers must make sure that the number of charging facilities keeps up with the market's exponentially growing demand. However, designing a new charging solution is complex and a development timeframe of up to two years is not uncommon. The Quintessence spoke with three experts on how to make the design process easier: Sarah Ghaemi is Director of Technical Development at Avnet Abacus, Bevan Braude Business Development Manager at Avnet Embedded and finally Andrej Orel, Director of Market Segment City and Infrastructure at EBV Elektronik. All three companies are part of the Avnet Group and have combined their expertise in order to support manufacturers during the development of charging solutions.

SARAH, WHAT DO YOU SEE AS THE MOST IMPORTANT MARKET TRENDS FOR CHARGING TECHNOLOGY AT PRESENT?

Sarah Ghaemi: I see three fundamental areas: first there is the growth of charging capacity, as more and more charging stations with megawatt capacities are coming into operation. Secondly, wireless charging is emerging as a trend – what is especially exciting about this is the capacity to charge while the vehicle is moving. The third trend is the protocols that allow a vehicle to communicate with the electricity grid. ▶



Andrej

Orel

BEVAN, WHAT DO YOU THINK ARE THE MOST IMPORTANT TECHNOLOGIES WITH REGARD TO FUTURE CHARGING INFRASTRUCTURE SOLUTIONS?
Bevan Braude: Artificial intelligence – when integrated into the charging station, it enables a wealth of additional services. This creates added value not just for the operators but also for the end users. That includes, for example, aspects of security or remote monitoring combined with technologies like facial recognition, vehicle recognition and also current monitoring for recovering energy back into the system.

WHAT DO YOU SEE AS THE GREATEST CHALLENGE WHEN IT COMES TO EXPANDING CHARGING INFRASTRUCTURE FAST ENOUGH TO MEET CURRENT DEMANDS?
Andrej Orel: The greatest challenge is the stability of the power grid, especially in relation to integrating renewable energy sources and decentralised systems. The second problem is the insufficient charging infrastructure in rural areas. And then a solution has to be found for everyone to be able to charge at home, even for those who don't have a garage or their own parking space.

CHARGING STATION DESIGNERS HAVE TO JUGGLE VARIOUS CONSIDERATIONS. NO WONDER, THEN, THAT DEVELOPMENT CAN TAKE UP TO TWO YEARS. WHAT OPTIONS DO MANUFACTURERS HAVE TO REDUCE THE TIME TO MARKET?
Andrej Orel: There are several possibilities. The easiest, of course, is to use a white label option, but with that you are dependent on the original developer and you lose the momentum with regard to future upgrades. We recommend a modular or semi-modular approach where the customer can assemble a charging station out of various modules – for example, charging controller with software, embedded performance level, HMI with integrated payment and billing functions and so on and so forth. This can easily shave three to six months off the development time.

IN ORDER TO ACHIEVE THAT, EBV, AVNET ABACUS AND AVNET EMBEDDED ARE WORKING TOGETHER UNDER THE MOTTO "THE POWER OF THREE". WHAT EXACTLY DO YOU MEAN BY THIS?
Bevan Braude: We all have different skills and capabilities within our eco-systems. Together we support manufacturers in bringing their products to market faster. That includes not only hardware but also software, IP, electromechanics and connection technology. Several heads are always better than one. Therefore, we can work together on new technologies and find solutions for some of the challenges we have already mentioned – from mains power, software issues and connectivity to the necessary certifications.

WHAT MAKES THIS COOPERATION SO SPECIAL?
Sarah Ghaemi: Together we are providing an end-to-end solution, so it's not just about components and modules. Together we can also provide services for manufacturers such as hardware, firmware or software development. Our customers can store their charging solutions in the cloud via our platform and therefore use innovative cloud services. Together we provide everything that is needed for charging solutions – a one-stop shop.

This interview is an extract from the EBV podcast "Passion for Technology". Here Sarah Ghaemi, Bevan Braude and Andrej Orel talk in detail about charging technology trends and explain the advantages of the "Power of Three" campaign from Avnet Abacus, Avnet Embedded and EBV Elektronik for charging technology manufacturers.
www.ev-chargi.ng

Bevan

Braude

THE EV CHARGING DESIGN BOOK

Across four volumes, this guide will cover the critical functionality and requirements of EV charging stations, including power, control, communications, and software and integration.

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EV CHARGING³

THE POWER OF THREE

www.ev-chargi.ng

18

billion

US dollars venture capital in 2021 for e-mobility start-ups

Source: PitchBook

VISION & VIEWS

Electrification affects more than just cars. From scooters and aircraft to cargo ships, everything in the future will run on electricity. Innovative solutions are being developed around the world – from integration into the electricity grid and charging while driving to completely new vehicles.

INNOVATIVE ALTERNATIVES

Using a charging cable to charge an electric vehicle is standard today. Yet there are developments that could make the charging process even easier or even replace conductive charging entirely.

Besides the electrification of vehicles, fully automated driving is a big trend when it comes to future mobility solutions. So how should vehicles be charged when they no longer have a driver? The solution could be charging robots. Hence the development by Continental Engineering Services, together with Volterio, of a fully automatic charging solution which consists of a unit on the underbody of the vehicle and another on the garage floor. As soon as the car is parked, the two components connect through a smart automatic system.

Ford has also designed a prototype of a robotic charging station. It is operated by the person behind the wheel from within the electric vehicle via their smartphone. The focus here is on people with disabilities or limited mobility. Once the system is activated, the station cover slides open and the charging arm extends towards the inlet with the help of a tiny camera.

TRANSFERRING POWER WIRELESSLY

So why even create a physical contact point for power transfer? Today smartphones can also be charged wirelessly. In fact, initial solutions for charging electric vehicle batteries inductively already exist. For example, a project team at the University of Duisburg-Essen has installed an inductive charging system for electric taxis at Cologne central station. A charging strip has been installed underground, running underneath the taxi rank. The counterpart is attached to the underbody of the EV. When the two systems detect each other, charging can begin.

Inductive charging is even more exciting when it takes place while driving. In the "Arena del Futuro", Stellantis tested a dynamic inductive charging system for electric vehicles. In this system, conductor loops are laid under the tarmac and the energy is transferred directly to cars, lorries and buses, without the vehicles having to stop at a charging station to charge their batteries. The results show that a battery-powered electric vehicle is able to drive at typical motorway speeds without depleting the energy stored in its battery.

FULLY AUTOMATED BATTERY SWAPPING

Instead of charging the battery while it is in the vehicle, battery swapping technology could offer an alternative. With this technology, batteries would be recharged slowly, which extends their lifespan – and for EV drivers this removes waiting times at the charging station. This technology is already widespread, especially in China. By the end of 2021, the EV manufacturer NIO had already opened 700 battery swapping stations in China and successfully carried out over 5.3 million battery swaps. By 2025 the company wants to put into operation 1,000 such stations outside of China as well.

In fully automated stations, vehicle batteries can be swapped for fully charged ones in a matter of minutes.

CHARGING ON LAND, WATER AND EVEN FOR AIR TRAFFIC

Almost everyone drives a car; it is the cornerstone of private transport. So it is no wonder that cars are what many think of first when it comes to the topic of electromobility. But the electrification of transport goes much further – it starts with e-scooters and extends to aeroplanes and ships. As a result, all these applications place their own particular demands on charging technology.

Electromobility starts small: more and more people are using e-bikes, e-cargo bikes, e-kick scooters or larger e-scooters. Even these require charging infrastructure that meets their demands. For example, swappable batteries can be exchanged at intelligent battery swapping stations. One such example is Swobbee, the first Europe-wide cross-manufacturer swapping system for small electric vehicle batteries. It takes less than a minute to equip a vehicle with a freshly charged replaceable battery. Ongineer is taking another approach: together with the e-scooter manufacturer Zeus, the company has launched the world's first wireless charging station onto the market, where the e-scooter can be safely parked, charged and automatically locked at the nearest station at the end of the ride – thus incidentally also effectively solving the issue of chaotically parked e-scooters.

1,000 KILOWATTS FOR HGVS

Electromobility was long seen as not economically viable for long-haul HGVs, but megawatt charging will be opening up new possibilities from 2025. The first global project in the field of megawatt charging is "Hochleistungs-Laden (high performance charging)", HoLa for short. High-performance charging points with Megawatt Charging Systems (MCS), which have a charging capacity of almost 1,000 kilowatts, are being set up along the A2 motorway in Germany. Vehicles – particularly those in long-haul transport – can easily cover ranges of 600 to 800 kilometres per day with this technology. The first battery-powered HGVs are already on the market or will be going into operation in the coming years. ▶

"E-mobility spans all traffic and transport sectors – and requires a variety of adapted charging solutions."

MOBILE CHARGING STATIONS FOR CONSTRUCTION EQUIPMENT

It is not only lorries that are going to be electrified; in the future, agricultural and construction equipment will also be emission-free. There is a unique issue here in that the job sites do not tend to have a charging station. It is for this reason that Deutz has developed a mobile fast-charging station. It is housed within a robust 10-foot container and can easily be transported to where it is needed. A mobile buffer battery with a fast-charging station enables a charging capacity of up to 150 kilowatts. This means that construction equipment or tractors can be quickly recharged during a lunch break.

ELECTRIC WITHOUT OVERHEAD LINES

The railways are also eager for emission-free trains. This is no problem for the routes with overhead lines, but there are numerous stretches which are not electrified. These gaps can be overcome by the use of battery-powered traction units: these work by drawing power to charge the lithium-ion batteries from the overhead lines when the train is on an electrified route section. When there is no external mains power, the trains use the energy from the charged batteries. Ranges of 60 to 90 kilometres are therefore currently possible. In order to increase this range, Stadtwerke Tübingen, together with Furrer+Frey, developed the world's first fast-charging station for trains. This station can charge battery-powered trains with outputs of up to 1.2 megawatts per train unit. What was so special about this triumph is that an electricity grid with a frequency of 16.7 hertz is used in the railway electrification system. Yet the power electronics of a modern battery-powered train can also cope with a regular electricity grid which is normally 50 hertz, meaning the charging station can be directly connected to the grid on site.

CHARGING AT ANCHOR

The electrification of ships brings with it new demand for high-performance charging infrastructure. There are as many solutions to this as there are applications for ships, and they vary from the use of autonomous telescopic charging via loader crane to manual charging stations. These can be used to charge ferries such as the Norwegian ship Bastø Electric, the world's largest purely electric ferry, which charges every time it comes to shore. The fast-charging system provides a charging capacity of nine megawatts. In order to make longer distances possible, Maersk Supply Service has initiated the offshore ship charging project, Stillstrom. This uses a charging buoy in an offshore wind farm which electric service vessels can use to charge overnight using green electricity.

MEGAWATT FOR AIR TAXIS

The aviation industry is also working on electric motors. The majority of electric aircraft are used for short haul flights. ABB E-mobility and Lilium, for example, are developing charging infrastructure for the regional high-speed flight network which Lilium will be launching from 2025. The charging stations are designed so that the batteries can be fully charged in 30 minutes and in 15 minutes they can reach a charge of 80 per cent. This is another example of where the Megawatt Charging System is set to be used.

A TECHNOLOGY OF THE FUTURE, WITH A LONG HISTORY

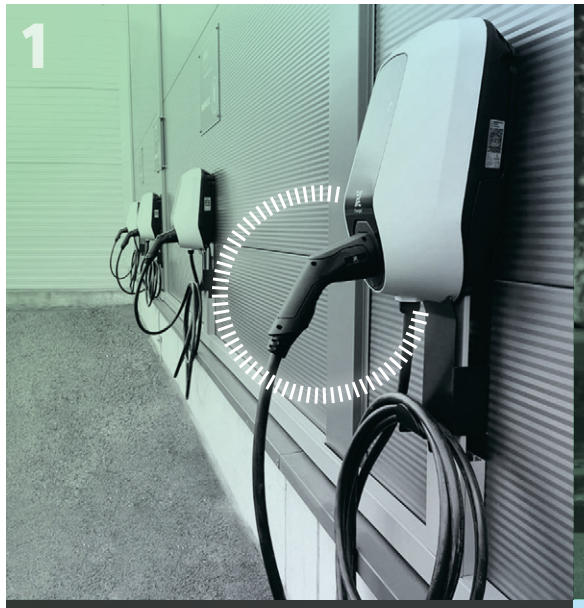
Electric vehicles are shaping the mobility of the future, but they are not as new as you might think. Their history stretches as far back as the 19th century. For a short while, electric cars dominated road traffic much more than petrol cars.

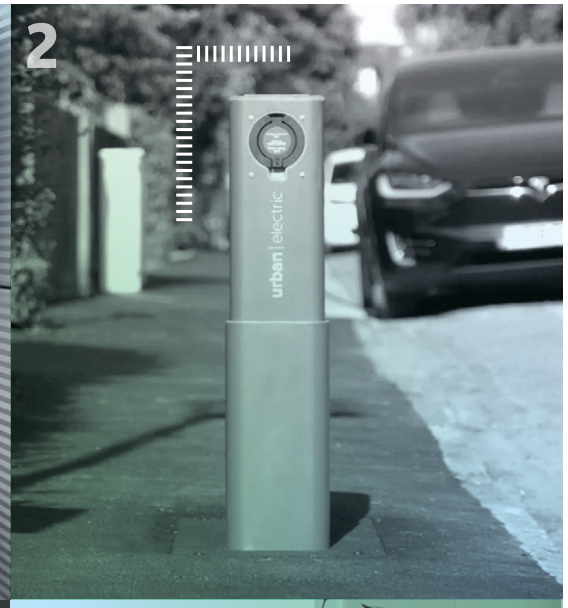
Five years before the first Benz motorcar was on the road in 1886, the first proper electric vehicle was already being driven: for the first International Exposition of Electricity in Paris in 1881, Frenchman Gustave Trouvé built a tricycle powered by electricity. It managed a top speed of twelve km/h and had a range of 26 kilometres. This was the beginning of a real boom in development – in many countries electric vehicles were suddenly being built.

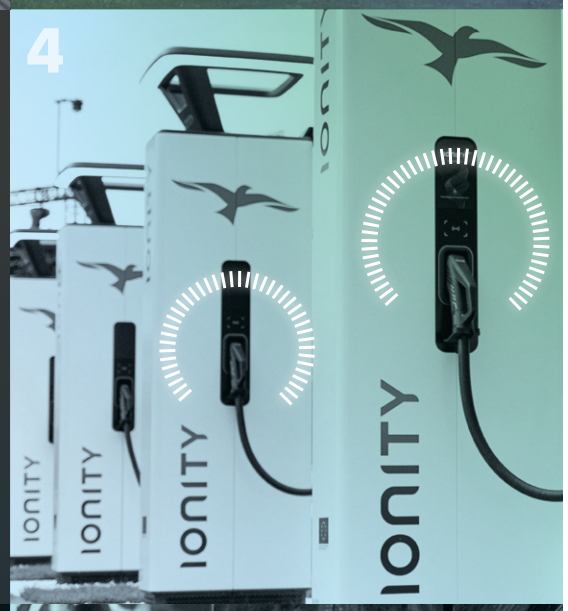
What was probably the first real electric passenger vehicle with four wheels was developed in Germany in 1888. The vehicle from the Maschinenfabrik A. Flocken in Coburg may have still looked more like a carriage, but it was already capable of going 15 km/h, had pneumatic tyres and electric headlights. Just eleven years later, the Belgian racing driver Camille became the first to go 100 km/h: equipped with two 25-kW electric motors, the torpedo-shaped racing car achieved a speed of 105.88 km/h. Battery technology was also developing alongside this, and ranges of over 100 km were not uncommon at the time.

This marked the start of a veritable boom in electric vehicles: at the start of the 20th century, there were over 60,000 battery-powered cars in the USA alone. Their market share was 38 per cent, significantly higher than that of petrol vehicles (22 per cent). At the time, electric vehicles were being produced by every industrialised nation, and by 1939 there were 565 brands worldwide building electric cars.

It was first in 1911 that petrol vehicles began to replace electric ones, as it was at that time that the American Charles Kettering invented an electric starter motor for the petrol engine. This meant that petrol vehicles no longer had to be cranked up (something which required a great deal of effort), and so they became suitable for everyday life. Since petrol vehicles were faster and cheaper and fuel became more readily available wherever it was needed, vehicles with internal combustion engines ultimately overtook electric cars.







INNOVATIVE CHARGING SOLUTIONS

The boost in innovation for electric vehicles and battery systems has also led to innovations in charging technology. Fast-charging stations and the associated infrastructure are some of the most important requirements for electric vehicle users. It is not only the large companies asserting their position in the market. From mobile charging stations to intelligent software solutions – even young start-ups are developing technologies which are changing the market.

1
Multi-socket for charging

ChargeX have developed the Aqueduct system which allows up to ten charging points to be installed from just one grid connection – in contrast to conventional methods which only allow one charging point per supply line. Thanks to the innovative mounting concept, installation of a smart charge module with up to 22-kW charging capacity takes less than 60 seconds. Using the charging current distribution app, it is possible to carry out needs-based charging.

www.chargex.de

2
Pop-up charging station

The UEone from Urban Electric Networks is the world's first pop-up charging station, and it solves the charging problem faced by 50 per cent of drivers in cities who park on the street at night. The charging stations automatically sink into the ground once the charging cable is disconnected. In this way, the streetscape is affected as little as possible and the stations are protected from vandalism. With a charging capacity of 7 kW they enable intelligent overnight charging.

www.urbanelectric.london

3
Software for charging stations

eMabler has developed a SaaS API platform which enables power companies or charging station manufacturers to quickly and easily include electric vehicle charging infrastructure in their other business systems, e.g. in mobile applications, existing customer platforms and payment solutions. With just a mobile app, drivers of electric cars can seamlessly use charging stations from various operators and billing takes place via a central point.

www.emabler.com

4
Network for long distance journeys

Along European motorways, Ionity is building and operating a high-power charging network with a charging capacity of up to 350 kW along European motorways. During stopovers, electric vehicle drivers can benefit from high charging speeds when using the European charging standard CCS. Every charging park has four charging stations on average. 100 per cent renewable energy is provided at every charging station.

www.ionity.eu

5
Off-grid charging

Constructing new on-grid chargers is often a difficult, lengthy and cost-intensive process. L-Charge offers an alternative: the company is building charging stations that are independent of the power grid and they are building three models: fixed, mobile and floating. The solutions are equipped with generators which generate electricity from hydrogen or LNG. The stations enable ultra-fast charging – going from 0 to 80 per cent in 15 to 25 minutes.

www.l-charge.net

6
Making charging easy

Easee has developed an intelligent charger which offers not only a cloud connection free of charge but also a free eSIM, automatic updates and extra services. The system impresses in many aspects that are not just important today, but will be essential in the future, as well. These include the automatic load and phase balancing between charging stations and other consumers and the integration of photovoltaic systems, billing systems, flexible tariff systems and smart home systems.

www.easee.com

GLOSSARY

AC
Alternating current

BACKEND
Administration interface for data input by charging station operators

BIDIRECTIONAL CHARGING
The electric vehicle can be recharged with electricity but it can also return energy from its battery to the grid

CCS (COMBINED CHARGING SYSTEM)
International charging standard for electric vehicles for charging with direct current

CHADEMO (CHARGE DE MOVE)
Charging standard for Japanese car manufacturers

DC
Direct current

EROAMING
EV users have access to charging stations from various providers. This requires an exchange of data between various charging infrastructure operators and mobility providers

EVCC (ELECTRIC VEHICLE CHARGE CONTROLLER)
Charging station control unit that communicates with the vehicle in accordance with IEC 61851-1 mode 3 and controls the energy flow to the vehicle

HMI (HUMAN MACHINE INTERFACE)
Interface which a human can use to monitor and control a machine, e.g. LEDs, plain text display, buttons, switches, key switches, apps, etc.

ICCB (IN-CABLE CONTROL BOX)
Control box which integrates the charging cable and controls and monitors charging of the electric vehicle

CONDUCTIVE CHARGING
Wired charging

CHARGING POINT
Connection point at the charging station to charge the vehicle. A charging station can have one or more charging points

CHARGING CAPACITY
The current available for a charging process (in watts)

OCPP
Universal application protocol which standardises communication between charging stations for electric cars and a central management system

PLC (POWER LINE COMMUNICATION)
Transfer of data over a power cable

VEHICLE-TO-GRID (V2G)
Use of battery storage of an electric vehicle for the purpose of feeding energy back into the grid. This requires communication between the vehicle/charging station and the electricity grid

MEET THE **TEAM**

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is Senior Marketing Communications Specialist at EBV Elektronik. She used her communications expertise to help bring the magazine to fruition.

INFO-POINT

ASSOCIATIONS & INITIATIVES

Platform for collaboration in the field of electromobility focused on the CHAdeMO DC charging protocol.
www.chademo.com

AVERE (The European Association for Electromobility) promotes electromobility and sustainable transport across Europe.
www.avere.org

The Open Charge Alliance develops communication protocols and related standards in electric vehicle charging infrastructure.
www.openchargealliance.org

The ChargeUp Europe industry association aims to drive the development and deployment of high-quality charging infrastructure in Europe.
www.chargeupeurope.eu

The CharIN association works to promote interoperability based on the Combined Charging System (CCS) as a global standard.
www.charin.global

FAIRS & CONGRESSES

Power2Drive Europe, Munich, Germany
www.powertodrive.de

Fully charged live, Amsterdam, Netherlands
www.fullycharged.live/eu

MOVE, London, United Kingdom
www.terrapinn.com/exhibition/move/index.stm

BLOGS & JOURNALS

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Date: 10/2022.

For the first time
in history, the
automotive world
is dictating
the tempo to the
energy sector.
We now need balance
in both sectors.