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INTERVIEW

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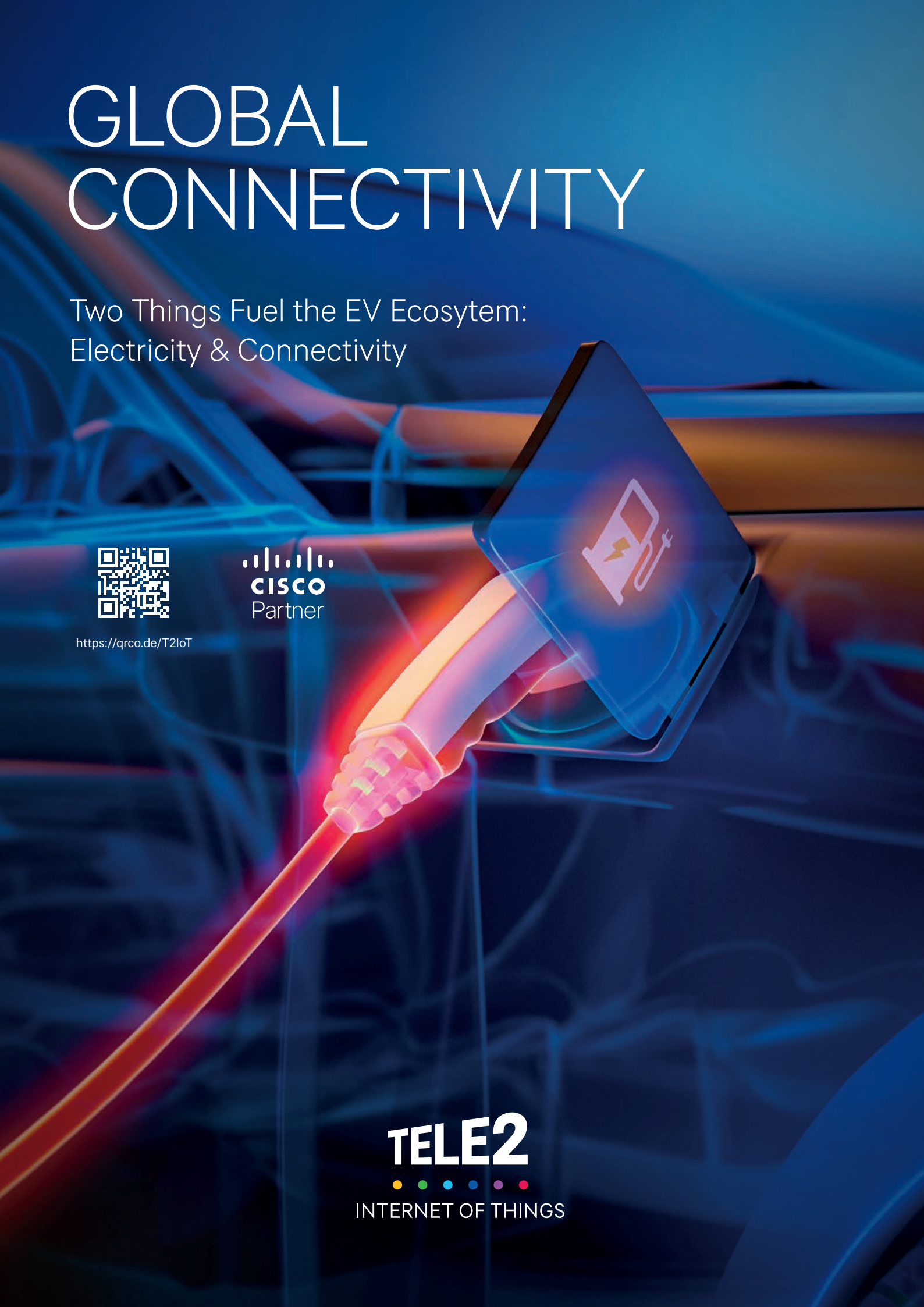
GLOBAL CONNECTIVITY

Two Things Fuel the EV Ecosytem: Electricity & Connectivity



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The IoT Now CEO Guide to the EV ecosystem 2022

IN THIS ISSUE

Cellular connectivity powers the EV ecosystem into the fast lane of user adoption

Electric vehicles (EVs) have come a long way since the cumbersome quadricycles that dotted city streets at the dawn of this millennium. Range anxiety, comfort and ease of charging are all being addressed by a wave of innovation as lawmakers across the world mandate the move to EVs. Cyril Deschanel, the managing director of Tele2 IoT, tells George Malim, the managing editor of IoT Now, why cellular connectivity is the critical enabling technology that is bringing together the vehicles, the charging infrastructure and added value applications and services to create the EV charging ecosystem that is on the cusp of dominating personal transport

Cellular connectivity is one of the key enablers of EV charging because of this huge increase in charging points

George Malim: How do you see the electric vehicle ecosystem developing and in what ways will it align with adjacent sectors?

Cyril Deschanel: The EV ecosystem is growing quickly. Everyone thinks only about cars but it's also trucks, boats, ride sharing and two-wheelers, so this is a much bigger area than just cars. You therefore need the full infrastructure for all vehicles to charge but also to be able to remotely control charging. The more charging points there are, the greater need for them to be controlled remotely.

The ecosystem is composed of two main parts, the vehicles and the charging infrastructure, both of which have added value services on top. If you go to charge your car, for example, you currently have to wait for between 25 minutes and two hours depending on your vehicle and how quickly it charges. This presents an opportunity for digital signage and advertising such as for the best burger available within a ten-minute walk.

All this added value lies on top of the ecosystem and includes the payment terminals. If you're connected you can have a lot of additional revenue and richer customer experiences – if you're not, you can't.

There are currently about 380,000 charging points in Europe and the European Commission estimates that, by 2030, we will need three-to-four million more. That, excluding household charging points, is ten times more than we have today and presents a huge challenge for scaling-up in time to meet targets for the end of selling combustion-engine vehicles.

Cellular connectivity is one of the key enablers of EV charging because of this huge increase in charging points. You can't physically place humans at every charging point, so you have to manage and perform maintenance remotely in order reduce costs. This is where IoT is important and **Tele2 IoT** has many examples of how to reduce cost with remotely controlled installations.

The goal is to have to send people only when they need to address very large problems. A cellular connection enables EV charging operators to determine the cause of the problem, troubleshoot and often fix it but there are also opportunities to move from corrective to preventive to predictive maintenance by communicating information over the connection.

GM: EV charging sites will be connected to power grid infrastructure so why isn't fixed fibre connectivity a viable option?

CD: Of course, you can get fibre everywhere, but it will be expensive, complex and too slow to meet the urgency the market faces. Planning, compliance and installation will not be fast enough for fibre to be viable. If you were bringing charging to Route 66 in the US, there would be thousands of charging stations to connect and each one would require a contract, a work order, local government permissions and someone to dig a hole to run the cable. The same would be true for parking slots that offer charging in European city centres. I don't know of a single EV charging operator that is not using cellular connectivity.

If you consider EVs, cars such as **Tesla** and all other electric cars are connected with cellular ▶

technology. In addition, our customer ride-sharing provider **Voi** has 100% of its scooters connected. Mobile operators like us have deployed 2G, 3G, 4G and 5G so why not use it?

GM: There's a lot of excitement in IoT about the speed and low latency of 5G connectivity but do EV use cases really need this?

CD: 4G is enough for most of the applications. 4G has enough capacity, coverage and good latency and you don't need a lot of data to run a charging point effectively. When 5G is rolled out internationally, with roaming agreements in place so you can move your trucks from one country to another, 5G will be more suitable and bring some benefits to some apps but in the meantime 4G meets the sector's needs. All our customers use 4G and the whole ecosystem uses 4G. ▶

Cyril Deschanel

We need a more universal solution for when you move from one country to another than having to download an app for each country you pass through

GM: Moving between countries is an important point that is particularly relevant in Europe but also in other parts of the globe where vehicles routinely move between countries multiple times a day. How are the challenges of this being addressed?

CD: This plays directly into the strength of our core business which is providing global managed connectivity. We provide a single rate for the EU27 countries to all customers, so they pay the same in Finland, the UK and Italy. Obviously, this simplifies the life of end customers, and they can drive their connectivity however they want to use our self-service platform. We have one rate plan in the US as well.

Roaming is not only about connectivity, it's also about payment and other services and this highlights that the EV market is fragmented, whether that's the car maker, the fuel retail chains, the charging point operators, the electricity companies or anyone else at the heart of the ecosystem. There is no specific answer but the experience needs to become more cohesive for customers so they can have the convenience of being able to use the charging point that best suits their needs at any given time.

We need a more universal solution for when you move from one country to another than having to download an app for each country you pass through. This is being addressed by companies such as our customer **Virta**, a Finnish company that has created a cloud-based platform that brings together companies who own and operate charging stations, as well as services for companies who want to provide mobile apps for drivers and want to handle payments and money flows. Virta's digital platform connects all of these hundreds and thousands of companies together so that EV drivers can charge their cars anywhere, whether that's in Europe or around the globe, connecting charging station operators to hundreds of thousands of EV drivers.

This type of end-to-end system is vital for the development of the market because it brings everything together for the charging operator and the customer. It encompasses everything from discovering the charger, to pricing and cross-border payments. The only thing Virta doesn't cover is the physical installation of the charging station.

GM: We've talked about public charging points but what about home chargers, do they need connectivity?

CD: The greatest investment in EVs is being made by the car makers, the second largest is in the charging infrastructure and the third is the power grid, which has to invest a lot. There are already a lot of individual charging points that are connected as well as those owned by home service providers. These companies need to know that the charging point is working, and cellular technology is a great enabler here. For these to be connected to the grid as well is important so usage information can be communicated. This will ▶

become increasingly essential as the grid tries to manage peaks and troughs in demand alongside the variable power generation of home-based renewables such as solar and wind. EVs entering the mainstream will move substantial power consumption to the home and grids need to be prepared for this new profile of demand.

A recent report from **McKinsey** has reported that US$0.2bn has been invested in public EV charging infrastructure but this will need to reach US$3.4bn in 2030 to serve the market's needs. For grid companies, US$2.6bn has been invested but US$42.1bn of investment is required by 2030 to ensure readiness of grids for EV charging.

GM: Why is Tele2 IoT well-positioned to serve the EV market?

CD: It is the ability to handle scale and the connectivity expertise that we have that makes us strong in this market. With more than nine years of experience serving EVs so we are confident that we understand the market's needs and that we have the ability to meet those. We have proved this with more than 20 players in Europe and we have the commercial flexibility that this market needs.

We are now in the top 8 European providers in the IoT connectivity space overall because we have the right platform, the right commercial flexibility and, of course, we're competitive. On top of this, our people differentiate us from the competition. We have 75 dedicated IoT experts that offer 24/7 technical support. Not every mobile network operator offers that with a dedicated IoT expert.

This expertise is important. Imagine you're a charging point operator and one of your most popular charging points has a technical issue. You don't want to speak to a call centre agent who normally handles consumer or B2B queries. You need an IoT expert who understands how important uptime is to your business and knows how to address the problem quickly.

In Europe, we are very strong in the security and healthcare markets where our connectivity powers mission critical applications. EV charging is also mission critical and having secure, robust connectivity is essential. If a slew of charging stations go down because you've been hacked, cars will be stuck on the street but we know the connectivity is secure because it is built-in to our network and IoT platforms and we go end-to-end. We also have an integration with **Equinix** which provides interconnectivity with the main cloud providers.

GM: As a Nordic mobile network operator is it an advantage to be based in one of the world's earliest EV adopter regions?

CD: There's no doubt that the Nordics and Northern Europe lead in innovation and new technology adoption and the EV ecosystem starts with our adoption. Norway, for example has reached the point where 80% of new vehicle sales are EVs and from 2025 it will be mandatory not to sell internal combustion engine vehicles. We are a company in the Nordics where adoption is high, and this gives us a step up. We know the ecosystem isn't just about charging stations and we understand how cellular plays into the broader market.

Our customer **Elonroad**, for example, has developed conductive charging infrastructure that is embedded in the road. This means EVs can charge where they park or even when they are running, and no cables are needed. Pilot projects are underway in a number of places, including in Helsingborg Port in Sweden as well as in France.

CityQ, also a customer, sells its electrified cargo bike that has been designed for urban movement, including city deliveries and for tradespeople. The Norwegian company's vehicles deliver 60% faster than delivery vans and cut emissions by 90% in comparison to diesel vans and could solve huge urban challenges.

Finally, let's not forget that EVs are not only road vehicles. We also have customers that make electric boats. **Candela** makes advanced electric speedboats that feature hydrofoils for greater efficiency. The range of the Candela Seven is 50 nautical miles at 20 knots, which is a world record for an electric boat. Also in Sweden, **X-Shore** has created the Eelex 8000 electric boat which uses battery technology and at speeds of less than six knots is totally silent.

It's clear that a lot of innovation comes out of the Nordics as well as from every other point of the globe. Although the EV journey started ten years ago, legislation is accelerating it into the fast lane of user adoption. Technology advances are making it practical and appealing, and our job is to provide the connectivity that powers the ecosystem, justifying the investment in infrastructure that is needed and enabling the experiences that users want. ■

We're now in the top eight European providers because we have the right platform, the right commercial flexibility and, of course, we're competitive

www.tele2iot.com

EV stakeholders charge towards an electric vehicle opportunity

Antony Savvas highlights the growing pains charging networks face as they try to ramp up to have sufficient capacity to make our electric dreams a reality

EV charging demands costly, dedicated power infrastructure to enable fast charging at public charging locations, while private charging potentially puts unfamiliar strains on the electricity grid. The increased adoption of renewables at users' homes will help to level out some of the spikes in generation and consumption via the adoption of efficient home batteries, but the need to fast charge at public charging poles in order to complete long journeys demands that intelligence and connectivity are embedded into the charging point.

How we charge EVs for those without off-street parking and who can't charge at work remains a big question

This intelligence is essential to optimise charging performance and to enable variable pricing, so charging station owners can generate a return on their investment. This information will also be useful to drivers, as they search for compatible chargers that are available when and where they need them.

Being able to communicate is therefore fundamental to charger performance. For example, knowing that you could charge a vehicle to 80% of its capacity in 30 minutes for a fixed price, rather than waiting 50 minutes to reach 100%, could be valuable for many users and enable optimised utilisation of the charger. The connectivity can also be used to support payment, infotainment and other services at the charging site, and wireless - predominately cellular connectivity - looks cost-effective and simple to deploy in contrast to running fibre to every charger.

Scaling up to meet growing demand

When it comes to being ready for massive uptake, Rollo Home, head of product at **Ordnance Survey**, says: "For charging on the move, it's essential that charging infrastructure is fairly and intelligently distributed, taking into account the requirements of rural and urban areas. In short, we cannot have not spots.

"To ensure an equitable roll-out of EV infrastructure, we need to ensure all stakeholders involved in creating this infrastructure have access to data that provides a coherent national picture of requirements," he adds. "If left to individual market players, we will get pockets of priority areas and likely not spots developing. Stakeholders must coordinate and governments must be able to identify when and where intervention is necessary."

Home says combining geospatial data with datasets that provide deeper contextual information around potential charging sites, from environmental impact to accessibility, potential energy demand and projected frequency of use, will help to establish the optimal national infrastructure. When it comes to energy supply, increased investment in renewable sources is essential, he adds, as "powering the transition to a greener future through fossil fuels would be a clear contradiction".

On the challenges to growth, James McKemey, head of policy and public affairs at EV charger provider **Pod Point**, says: "It's clear that certain parts of the charging ecosystem are developing more fluently than others. We believe the vast majority of charging will be done at home or at work. Scaling this private provision presents its own challenges, but success so far makes us confident we can keep pace. However, the development of en route charging facilities, particularly at motorway services and other sites near to strategic road networks, is currently lagging behind."

McKemey adds: "How we charge EVs for those without off-street parking and who can't charge at work remains a big question, with a mix of solutions required: on-street charging, overnight local hub charging, ubiquitous destination charging or high-powered hub charging, all of which will need to scale."

Leon Wong, EV business development manager at **Pilot Group**, says: "Investment in public charging points closer to homes is vital to cater for those in cities who do not have access to off-street parking. These points need to provide the fastest charging possible. Rapid or ultra-rapid DC charging can provide between 50kW and 350kW and charge a car in around 40 minutes. Fast AC charging offers an output of 3.6kW and 22kW, with average charging times of between four and six hours. A key focus of introducing off-street parking charging should see a solid mix of both AC and DC points, so the infrastructure caters for all. AC charging is cheaper than DC, better for the longevity of a battery, and more cost efficient to install." ▶

Naturally, says Wong, EV drivers will install home chargers where possible, and workplaces are putting in infrastructure to help. But it is necessary for governments to support local authorities on solutions for off-street parking, he adds.

Tim Evans, CEO of **3ti Energy Hubs** in the UK, warns: "Government guidance indicates an optimal EV-to-charge point ratio of 10:1. The UK is currently at 52:1, and the situation is getting worse."

"Predictably, perhaps, rapid and ultra-rapid charge point networks, capable of charging EVs at rates of 50-350 kW/hr, have been lauded by many in the EV world as the holy grail of charging," he adds. "It's almost as if the petrolheads have embraced EVs by becoming charge rate heads."

Also, "unsurprisingly", says Evans, the industry has focused on trying to replicate the petrol filling station model with an EV clone. "Encouraging customers to fill up rapidly on their way to and from work, whilst stopping to spend money in the forecourt supermarket franchise, is what the industry currently does best. Replicating this model for EVs though requires significant investment in infrastructure, leaving EV drivers charging their cars on expensive, carbon-intensive electricity, much of which is being generated by burning fossil fuel."

He says we shouldn't be asking how many rapid charge points are required to service growing EV demand, but what is the most sustainable method of supporting EV drivers.

Evans maintains the most cost- and carbon-efficient EV charging is done at home, but that in the UK, for instance, for around 50% of households this is not an option. Workplace and destination charging, where cars park for a minimum of two to three hours, represents a considerable opportunity. "Helping EV drivers move away from a traditional stop to refuel mindset to a recharge where you stop approach is key."

3ti has developed Papilio3, a pop-up mini solar car park and EV charging hub. It aims to have a network of up to 50 units in operation in the next 12 months.

Paul Loustalan is a partner at **Reddie & Grose**, a firm of UK and European patent and trademark attorneys. He says of standards: "One of the biggest factors will be the standardisation of both the physical charging connectors and of the charging protocols. This could be decided by government policy, by consumer demand or by consortiums of major OEMs choosing to standardise their products."

"But without standardisation, it is likely that resistance to installing charging infrastructure will persist," he adds. "It is difficult to obtain agreements on standardisation between competing OEMs, as there are clear incentives for OEMs to lock their customers into proprietary systems, with the **Tesla** model a prime example of this. This is where government policy could intervene, and minimum technical requirements in the guise of a formal standard will mitigate some challenges."

Why 5G?

Cyril Deschanel, managing director at **Tele2 IoT**, says of the need for 5G: "In all fairness, 4G is sufficient for most EV use cases at the moment. The main challenge is overall quality of service within coverage areas. This is especially important for charging on-the-go, since many current locations were not prioritised by mobile network operators previously, due to less population density. 5G provides a solution to the problem through improved latency and bandwidth."

Deschanel adds: "There are digital signage and e-commerce opportunities that can create more revenue streams for EV ecosystem players. If more interactive data is to be transferred to and from charging stations, 5G will add value."

Paul McHugh, UK area director at **Cradlepoint**, adds: "Laying fibre cables to new sites is costly, time-consuming and often requires maintenance, with engineers having to travel to locations. Cellular connectivity can be set up by plugging in a router, and multiple routers across different sites can be remotely managed and kept up-to-date using software updates."

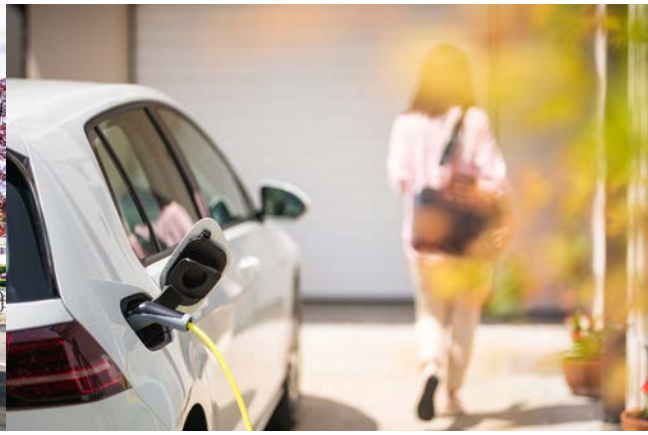
"5G connectivity is also better at supporting the deployment of IoT devices, which can lead to more benefits to drivers, from supporting smart charging to keeping people informed about the availability of chargers to manage queues," he says. "In addition, 5G provides network slicing control, with firms able to ensure enough bandwidth is available to quickly process payment transactions, whilst supporting other processes such as machine-to-machine communications and complimentary Wi-Fi."

Nick Earle, CEO of cellular connectivity provider ▶

Tim Evans
3ti Energy Hubs

Paul Loustalan
Reddie & Grose

3ti has developed Papilio3, a pop-up mini solar car park and EV charging hub



Nick Earle
Eseye

Martin Kochman
Hitachi Vantara

National grids will, of course, need to be upgraded in line with the implementation of EV infrastructure, but some estimates of the potential demand are greatly exaggerated

Eseye, confirms the need for reliable, high-speed connectivity: "High-speed and reliable connectivity have become integral to EV charge point operations, including the payment process, software updates and user analytics. Any individual charge point must communicate with back-end IT systems and be able to exchange this data in real-time. Charge points also aspire to run for a decade or more with minimal human intervention, requiring high-speed connectivity to monitor and manage them remotely."

Earle adds: "EV charging operators can meet any challenge by deploying a flexible and future-proof cellular connectivity solution, such as eSIM technology, coupled with a next-gen IoT connectivity management platform. This enables charge points to switch mobile networks seamlessly to take advantage of the best available coverage and radio access type, whether it's 4G or 5G, for complete network redundancy."

Breaking the gridlock

Ordnance Survey's Home says of power grid needs: "National grids will, of course, need to be upgraded in line with the implementation of EV infrastructure, but some estimates of the potential demand are greatly exaggerated. Such assumptions are often based on the maximum requirement, which would entail every EV owner charging their vehicle on the same day and at the same time.

"This is clearly never going to be the case, but it does raise an important point about how we ensure there is adequate capacity for times when demand is high," he says. "Vehicle-to-grid (V2G) technology allows EV users to push surplus energy back to the grid and earn money in doing so, so investment in this technology is one potential solution to manage some of the increase in demand."

David Hall, the vice president of power systems at **Schneider Electric** UK & Ireland, says: "EV chargers have to be installed in vast quantities, and evenly geographically. But we need to ensure that the right infrastructure is in place to manage this usage spike," he says. "Harnessing a smarter grid will help create network efficiencies and avoid pressures caused by an increase in electricity usage, in a cost-effective and resilient way. Smart grids, operating independently from larger grids, and with the ability of being able to store and reserve energy, have the potential to enable efficient EV charging with user contingencies."

Contactless charging

And how about contactless charging? Deschanel at Tele2 IoT says: "We already have customers that are producing contactless charging solutions, such as **Elonroad**. Authentication is a key component of these. Vehicles that use charging infrastructure on the fly need to authenticate themselves, initiate payment and keep staying authenticated during the charging duration. SIM cards bring encryption end-to-end, and further IoT security technologies around cloud interconnect can be enabled to secure the communication."

"Wireless charging has the potential to become an essential factor in the future of EVs," says Martin Kochman, vice president and head of customers and industries at **Hitachi Vantara**. "Through its nature, wireless charging is more user friendly, simplifying the charging process with pre-installed receivers fitted to the EV, autonomously communicating with the charging pad, whether installed in the pavement or charging bay. Drivers could also simply drive over a charging pad, with the EV charging automatically, like a mobile phone charging wirelessly. However, wireless EV charging is still a relatively new technology, meaning it is still expensive to install."

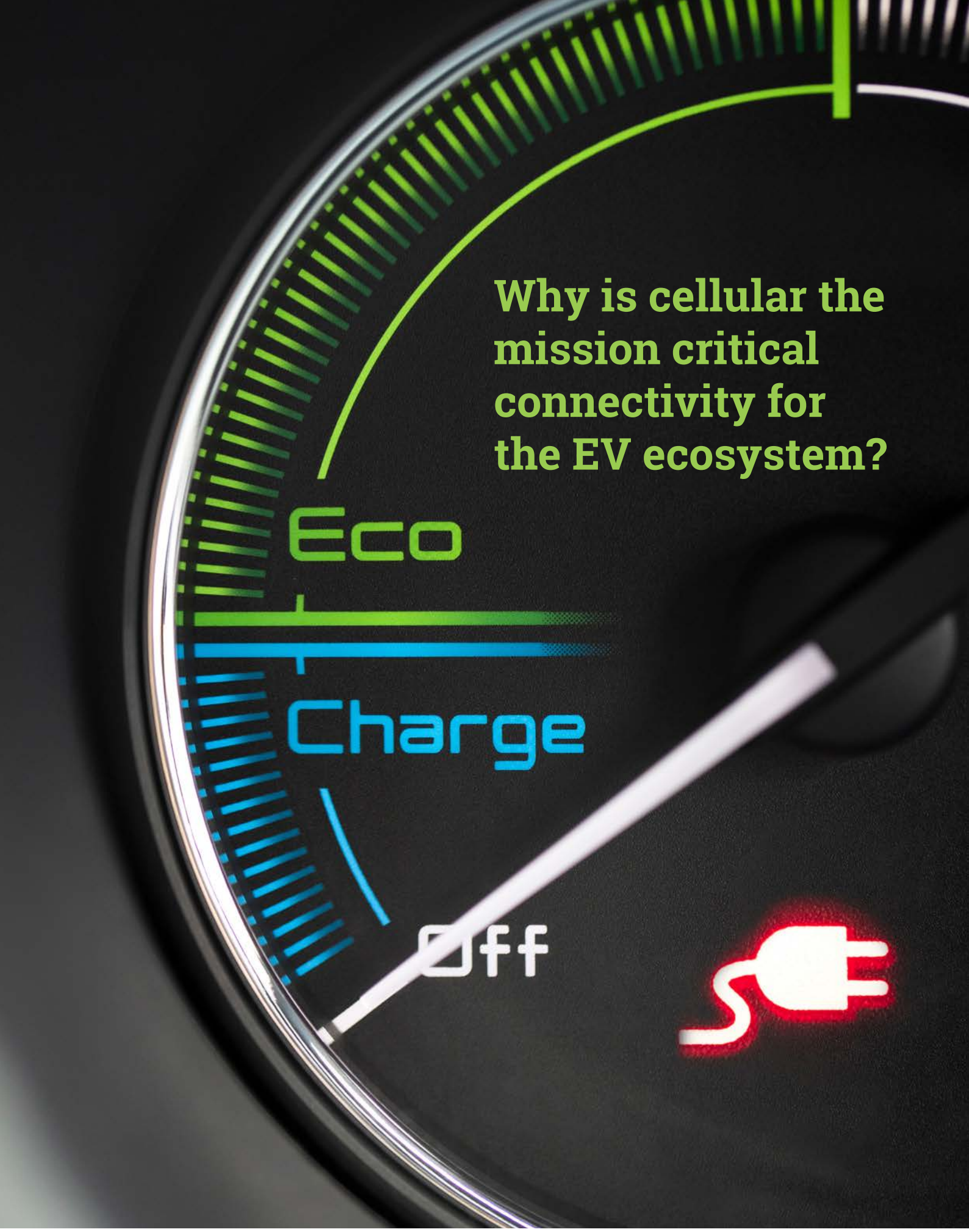
Apps and services

Home at Ordnance Survey says of apps and services: "Many app developers are motivated by sustainability, and the ecosystem around EVs offers compelling opportunities to build a greener future. Users should also not have to worry about who the operator of a charging unit is, so payment solutions that provide users with a single account to charge against, across all providers, are essential."

Home adds that accessibility is also a huge issue for some, as charging locations may not accommodate disabled EV users. The location of charging stations might also be a problem for others, who may not feel safe waiting for their vehicle to charge in a dimly-lit area at night if they are alone. "These are the kinds of challenges EV users face, which can be addressed through applications and dynamic safety and accessibility features that improve their experience," he explains.

Deschanel says of extra services: "Charging locations could be equipped with last mile delivery boxes. Travellers who know they will pass the location can have orders delivered to the spot. For instance, you forgot to buy a present to the wedding you are invited to. You could purchase one online and get it delivered to the charging station where you know for sure you will have a pit stop at. It could even be delivered by a drone."

While there are still challenges to the rapidly evolving EV charging industry, the obstacles are not insurmountable. ■



Why is cellular the mission critical connectivity for the EV ecosystem?

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Why is cellular the mission critical connectivity for the EV ecosystem?

Introduction

Electrification of vehicles goes way beyond plug-in cars and encompasses, ships, trucks and a range of ride-sharing and local delivery vehicles that are set to transform transportation. To realize this efficient, more environmentally friendly world, the enabling technologies need to be put in place and optimised. Both the power grid and charging infrastructure need billions of dollars of investment so electric vehicle (EV) charging demands can be accommodated by the power infrastructure and so the experience is attractive to users of all types. With internal combustion engines (ICE) already starting to be phased out in various global markets, the pressure is on for all those involved in the electric vehicle ecosystem to build charging points and ensure grids can cope with the changed demand profile that EVs bring

Connectivity has an essential role to play in this mission critical market. The data that the grid and parking providers need so they can optimise performance has to be communicated and connections are vital to enable users to find, operate and pay for their use of public charging sites.

The challenges are not only about public charging. In many markets, the bulk of charging will happen at users' homes and service providers and charging device makers addressing this market need connectivity as well in order to communicate with the grid and perform preventative and predictive maintenance. Don't forget that ultimately, millions of vehicles will result in a need for millions of charging points so frequent human interaction will not be viable.

As EVs enter the mainstream, IoT is poised to demonstrate the strength and depth of the value it can add. Robust, secure, comprehensively available connectivity is a critical technology here because it supports charging and goes further by enabling a wider ecosystem that adds value and richness to user experiences.

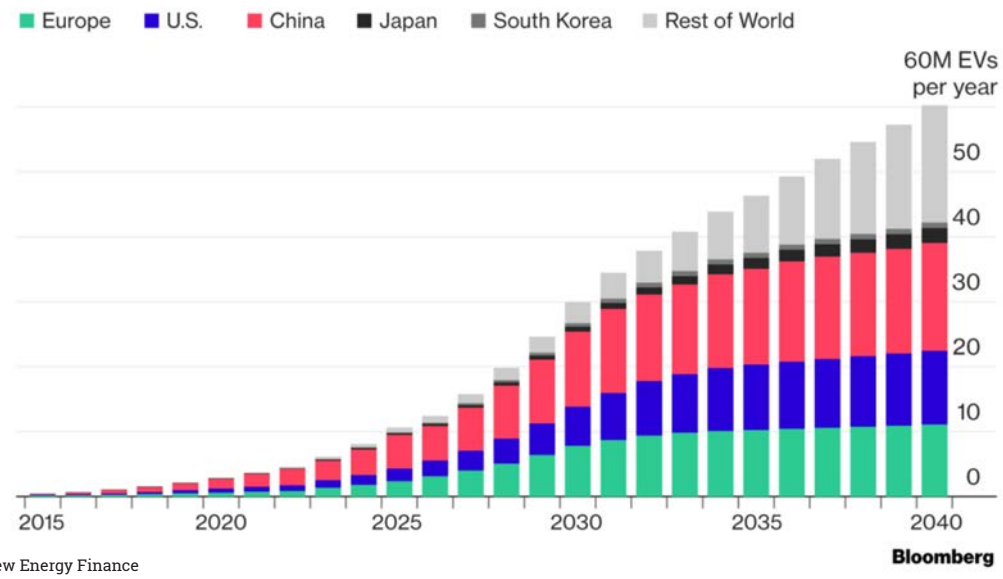
From the roads in your town it's clear to see the EV revolution has already arrived. Just a few years ago, simply seeing an electric car was cause for comment but now, routinely, there are battery-powered electric vehicles, ride-sharing scooters, electric bikes and other two-wheelers, plus a growing range of electric, local delivery vehicles. The days of there being a handful of hybrids are long gone and the pandemic, with its lower emphasis on regular commuting, has helped to make EVs viable alternative to ICE vehicles.

This adoption is clear to see although there remains a substantial distance left to travel. Pandemic supply chain woes aside, EVs are not just another vehicle, they demand new infrastructure that cannot be served by the existing ICE fuelling infrastructure and this demands sustained investment in the power grid and the charging network. Without this, cars will grind to a halt and streets will be blocked.

Large-scale efforts are underway according to analyst firm **Berg Insight**, which reports that the installed base of charging points is set to hit 22.8 million globally in 2025. The firm expects 1.8 million EV charging points to be shipped to Europe and North America in 2025 with the total in these two regions reaching 7.9 million a year in 2025[1].

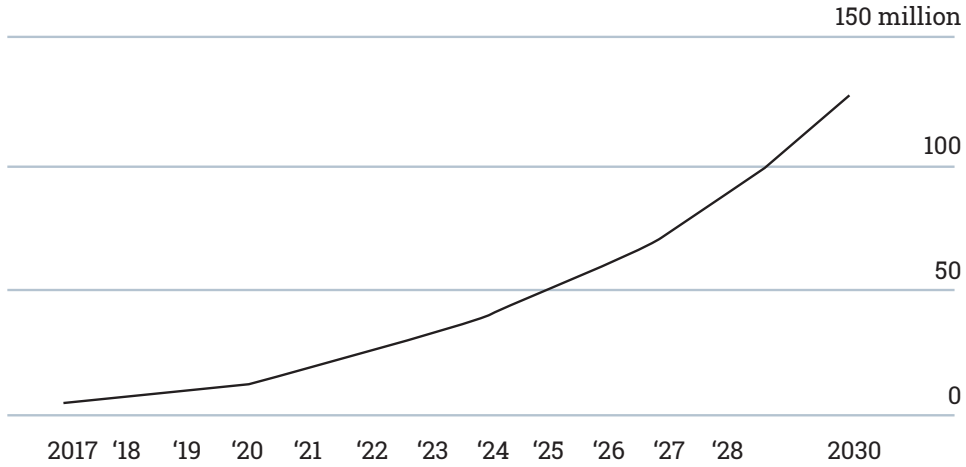
This projected uptake reflects a steep increase in the number of electric cars being sold globally and **BloombergNEF** estimates that more than 5.6 million EVs were sold worldwide in 2021, in spite of pandemic-related supply chain constraints. That's an 83% higher rate of ▶

1 https://www.berginsight.com/the-number-of-connected-ev-charging-points-in-europe-and-north-america-to-reach-79-million-by-2025



Source: Bloomberg New Energy Finance

Figure 1: Global electric car revolution set to take off



Source: IEA

Figure 2: The global fleet of electric vehicles is set to soar

sales than in 2020 and an increase more than 168% over 2019 sales, the firm reports[2].

In Europe, the adoption of domestic charging takes some of the pressure off the public charger roll-out but few EV owners will charge exclusively at home. **IHS Markit** forecasts that the cumulative deployment of EV charging stations will increase at 24% CAGR during the 2020-30 period. By 2030, about 20 million houses within Europe are expected to be equipped with domestic charging stations, while public or semi-public charging station deployments will increase eight-fold on 2020[3].

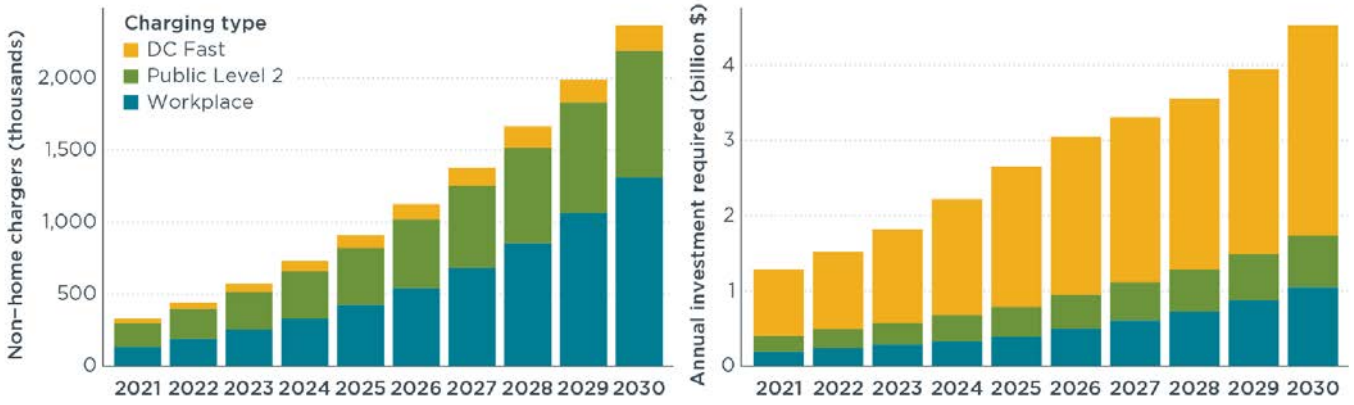
The tide has turned away from ICE and more than two-thirds of residents in Oslo, Norway own an EV, heading the world in terms of EVs per capita according to management consultancy **McKinsey**[4]. With European nations aiming to ban sales of new ICE vehicles by 2035 at the latest, the direction of travel is set for an electric future[5]. McKinsey estimates that EVs will make up 75% of European new car sales by 2030 and the electric vehicle market in general is growing with increased sales of two and three-wheeled vehicles in addition to four-wheeled cars.

Appetite is not only driven by the Nordic markets. Electric cars accounted for 17% of Europe's car sales in 2021, according to the **International Energy Agency**[6]. The largest market in Europe by volume of EVs sold is Germany, where electric cars accounted for 25% of new cars sold in 2021. Other countries with larger EV market shares include Norway (86%), Iceland (72%), Sweden (43%) and the Netherlands (30%), followed by France (19%), Italy (9%) and Spain (8%).

The race is on

As adoption of EVs continues to grow, so will demand for charging both at homes and workplaces and at remote locations. This places significant pressure on vehicle-makers, electricity companies, the traditional fuel forecourt industry and a new breed of property ▶

2 https://about.bnef.com/blog/electric-vehicle-sales-headed-for-five-and-a-half-million-in-2021-as-automakers-target-40-million-per-year-by-2030/
3 https://ihsmarkit.com/research-analysis/ev-charging-infrastructure-report-and-forecast.html
4 https://www.mckinsey.com/business-functions/operations/our-insights/shaping-the-future-of-fast-charging-ev-infrastructure
5 https://www.euractiv.com/section/transport/news/eu-countries-approve-end-to-combustion-engine-sales-by-2035/
6 https://www.iea.org/reports/global-ev-outlook-2022/trends-in-electric-light-duty-vehicles



Source: ICCT (2021)

Figure 3: Charging infrastructure (left) and the associated investment (right) needed to support US electric vehicle market through to 2030

companies, charging service providers and application providers. These companies are in a battle to secure the best sites, roll-out charging points to these and ensure their sites have maximised utilisation.

With charging taking from 20 minutes to two hours or more depending on the state of charge and the availability of fast charging, an ecosystem is developing around public charging that encompasses not only charging but value-added services such as advertising, infotainment and entertainment. These are all important for making the EV experience attractive and for monetising charging sites.

With annual investment in EV charging away from homes in the US set to exceed US$4 billion in 2030 according to **the International Council on Clean Transportation**, efficiency in deployment and operation is necessary to optimise expenditure. Additional revenues that can be generated beyond the fees for charging itself will make the business case more attractive and help increase the number of charging points that can be deployed.

Connectivity is a prerequisite for this because it enables both remote maintenance, management and charging and because the connectivity is the enabler for a large number of commercial opportunities. Public charging points are a unique environment because they boast a captive audience. Being able to push offers that are relevant to that location such as restaurant, retail or entertainment options is valuable and appealing and the connectivity can enable advertising of these or downloads of specific content.

The need is set to continue to grow as EVs become mainstream and people look to charge on longer journeys and even plan their charging stops around local attractions. The charging industry is maturing rapidly in terms of site selection, deployment speed and management efficiency and it relies on connectivity to gather data, ensure charging point uptime, enable convenient charging and help easy discovery of available charging locations.

Wherever EVs roam

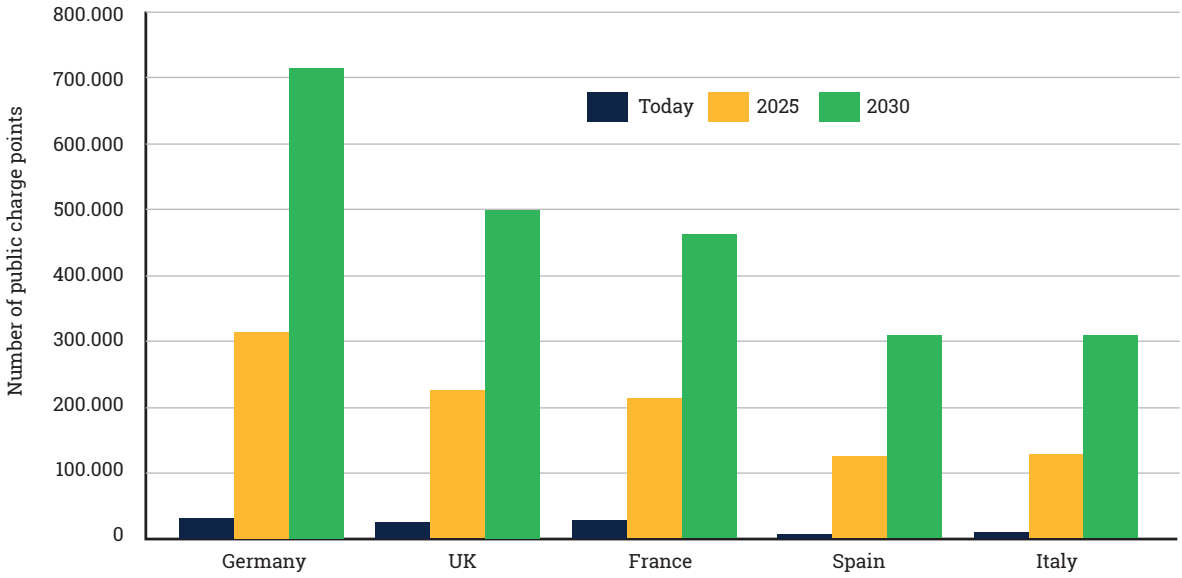
In regions, such as Europe, in which multiple countries border each other and are traversed each day multiple times by various vehicles this fragmented ecosystem needs to be managed to provide a cohesive experience. App providers have emerged to handle this so users don't have to download multiple EV charging apps for every country they visit and to make the experience streamlined and more appealing. Users need to be able to roam freely and have the capability to access the best charging fit for their needs.

For some, this might mean the nearest fast charger but for others that might mean a slower charger in a popular location with lots of amenities. Connectivity enables those preferences to be communicated and the closest match to be selected.

Wireless leads the charge

Wireless connectivity is widely adopted for public EV charging points even though it may seem obvious that fixed line connections could be run to terminals at the same time as the power itself. There are many reasons why fixed fibre connectivity has not been adopted by the public charging sector. Fibre connections are complex to deploy, require rights of way, permission from local authorities and the cables themselves to be embedded into the ground. Inevitably gaining permission, digging the cable channels and then scheduling the works alongside power and other installations adds cost and causes delay.

Large car parks at highway service areas or at a new breed of charging plazas are seldom being networked by cables because 4G provides a robust, secure, globally adopted, cost-effective connectivity method that is easily able to support the needs of EV charging now and into the future. Ultimately, 5G could be used but today there is no necessity to adopt the technology because EV apps don't need the low latency and high speed of 5G. In addition, 5G roaming has not been fully addressed and coverage remains incomplete. In the mid-term it will not be a significant challenge to upgrade 4G-enabled ▶



Source: Transport & Environment. (2020)

Figure 4: Projected need for public charging infrastructure in Europe's largest car markets

chargers to support 5G so, when the business case emerges, it will be relatively simple to upgrade to 5G.

The reality of already-existing wireless connectivity to support EV charging makes it attractive to charging point operators but the current, still low rates of charger utilisation mean there is a long ROI period associated with the EV charging business. After more than ten years in operation, the EV market is only now entering its growth phase and charging service providers are conflicted between investing to meet the mass needs of the coming five years while still needing to operate profitably as demand builds.

The maturity of the cellular industry means it is able to accommodate flexible commercial models that enable providers to pay in line with growth and adapt their connectivity commitments as their business demands. This flexibility is an important element of de-risking the build-out of charging infrastructure and one that the specialised, global IoT operators, including **Tele2 IoT**, are able to support.

Conclusion

As innovation continues to improve charging capabilities and experiences, we expect to see a simplified ecosystem in which EV users can discover, locate, use and pay for charging regardless of the vehicle they drive and the charging companies they have relationships with. This unification of the ecosystem will be enabled by ubiquitous, global cellular connectivity, which provides the cost-effective, secure means of transmitting customer, service provider, vehicle and power grid data.

All of these organisations need to share data safely, apportion revenue fairly and operate efficiently. Standardising on the already-proven 4G cellular technology provides a constant in a charging ecosystem of apparently limitless variables. As new innovations see EV charging enabled without contact between vehicles or even for vehicles on the move, it's apparent that choice is going to become far wider for those needing to charge their EVs.

Options extend from battery swapping centres to fast charging options. Customers will be able to tailor a charging option to fit their needs. An off-peak time on a slow charger at an unpopular site will be cheaper than a fast charger at peak time at an over-subscribed charger. Users will balance their needs accordingly and rely on 4G to keep themselves informed of what's available, reserve a slot, pay for it and then receive useful content from the site owner. ■

Elonroad pioneers electrified roads for charging on the move

Sometimes inspiration strikes in the most unusual way – and for Elonroad founder Dan Zethraeus, inspiration came from the snow and slush that gather along the highway's median strip during winter. Zethraeus, a former film director, was commuting between his home in Lund, Sweden to his office in Malmö, and as early as 2012 he wanted to buy an EV – but the cost was prohibitive at the time, and because he lived in an apartment, the charging infrastructure just wasn't there

"Stationary charging stations will not be enough when we become a fully electric vehicle society"

Zethraeus's idea was that plus and minus posts, not in parallel with one another but instead one after another, could solve EV charging challenges. To confirm his hypothesis, Zethraeus built a prototype using his children's Lego.

"As Dan was driving to work every day, he thought to himself 'What if there was something there that could charge my car' – a bit like the car racing tracks he played with when he was a kid," explains Karin Ebbinghaus, the chief executive of **Elonroad**. "We have Lund Technical University right in our backyard, so Dan contacted a professor to discuss his idea. The professor thought there was potential but pointed out that if conductive rails were above ground level, it might be a bit like having a speedbump on a highway, which could make them unpleasant for drivers."

Zethraeus went to a lumber yard and cut a piece of wood to mimic exactly what the rail would look like, then took the professor to a racetrack and drove over the mock-up rail at various speeds – and he did it with a full coffee cup in the cup holder of the car. When the professor saw how little disturbance there was, he was convinced.

New technology requires new solutions and new mindsets – and one of the biggest challenges for Elonroad was getting people to understand the concept. After the first prototype was built, Zethraeus took part in numerous conferences, trying to explain the concept and how it fulfills a real need in the EV ecosystem, where you would no longer have to follow the traditional 'fuel up at the gas station' model to keep your EV charged.

"Stationary charging stations will not be enough when we become a fully electric vehicle society," explains Ebbinghaus. "They will be part of the larger ecosystem of charging options. And if we look at rural areas, the Elonroad solution will have very positive implications: when you're in a city or town, you usually have quite a few charging options, but out in the countryside there aren't as many, so having charging rails on the roads outside the cities will solve a lot of problems in a very simple way."

And as urban populations continue to grow, cities have to ask themselves if they want to take up more space for parking where an EV could be charged? Or would it be better to use existing infrastructure, such as roads?

"In a city, there are so many use cases that can share the same infrastructure and solution," says Ebbinghaus. "So, if you put a network of charging lanes, you can charge anything from cars and buses, to taxis and last mile vehicles. You wouldn't have to build as many pantographs for buses or charging stations for cars – it's suboptimising the charging infrastructure because you are using one solution to solve the challenges faced by many user groups."

Elonroad's electrified road solution can also be a boon for large, long-distance trucks, where battery size is a challenge, as is the amount of time to charge the large batteries that would today be needed to power a large vehicle. In fact, the Swedish government has large trucks as a use case, due to the difficulty in electrifying them. Elonroad would enable them to be charged while they're operating.

Connecting Elonroad with Tele2 IoT

On a practical level, a device is placed in the car that connects to the conductive rail in the road. There is both a digital and physical connection called a pickup, and there is also an antenna that sends an encrypted signal identifying the vehicle and unlocking the power distribution. The driver is in control of whether or not energy is being picked up, and can set parameters, such as setting when the battery should be charged, among other ▶

Elonroad's in-road charging

things. That signal also enables payments, which can be pay-per-use or via a subscription.

"The system also knows how much effect we have in the grid at any moment, which means we can then distribute it to whomever needs it the most. We will know in real-time how many users need charging," explains Ebbinghaus. "We have a lot of sensors in the road, and we have a lot of processing power to have the safety to unlock the power system. It's the IoT sensors that allow us to unlock the energy strip in real time. Right now, we're using 4G, but 5G is going to be even better, both for real-time and for lower latency."

Elonroad's embedded IoT sensors are able to gather data on more than just charging – they can also gather data on things like moisture, air quality, temperature, ice and snow – in other words, Elonroad's solution can make the road smart and gather information that can benefit different stakeholders – and that's not limited to drivers. Real-time and historical data can be used by municipalities to gauge what is happening in the moment, such as if a road needs to be sanded because it's covered in ice. That information and data can also help with long-term planning of repair work, upgrades to roads and identifying problem areas, such as: Where is it getting icy? Is water rising? Where is wear and tear most dire? So, while this is a solution for EV charging, its applications are much wider.

As the technology evolves and more innovative ideas come to the fore, electrification will no longer operate in small hubs. Instead, these will cluster and merge as the ecosystem matures – and electrified roads will play a big part in this.

Karin Ebbinghaus, Elonroad

Seamless multinational EV roaming is the Virta reality

With the massive increase in sales of electric vehicles (EVs) the global infrastructure supporting EV charging stations must scale up rapidly. What is also developing is the software needed to run these charging stations – and Finland's Virta is supporting both users and suppliers while creating a global industry standard

Essentially, our business model services both the consumer and the provider

Virta doesn't do hardware or get involved with installing EV charging stations. What it does is develop systems that are compatible with the hardware or charging station being installed. The company's cloud-based platform includes everything needed to build a charging business, from charging infrastructure management to end customer services and smart energy management solutions. It is an end-to-end solution for EV charging, providing services for companies who own and operate charging stations, as well as services for companies who want to provide mobile apps for drivers and want to handle payments and money flows.

Virta's digital platform connects all of these hundreds and thousands of companies together so that EV drivers can charge their cars anywhere, anytime. But different companies in different countries use different kinds of hardware – and this is where Virta's solution really shines.

"There are a lot of different charging station models around the world," explains Jussi Ahtikari, the chief technology officer of Virta. "Our solution is compatible with more than 200 of them and we're growing that number all the time. This is critical, since there is a clear market need for an open platform that works with all kinds of hardware and all across the globe."

Virta has several different customer profiles: the first is companies that own the charging stations. Virta provides management software that is connected to the charging station and allows the company to process payments, troubleshoot, see what needs maintenance, and get an overview of usage so they can optimise accordingly.

The second group is EV drivers. Virta provides payment solutions and a mobile app that allows the user to see all available charging stations from all the different companies in the Virta network. ▶

"Essentially, our business model services both the consumer and the provider. This is very different from other companies working in this space, who are often involved in both software and hardware," says Ahtikari. "When your solution has both hardware and software you can get locked in, unable to easily change to a different software solution or buy new hardware from another company."

Virta's open solution allows customers to use whatever hardware they want and even have ten different models, offering much needed flexibility while avoiding the headaches of lock-in effects.

Think local, act global

When you're working with global payment solutions, there are a number challenges that need to be addressed. Mobile payment systems can sound simple, but in reality, they can be quite complex, particularly when you're talking about cross-border payments.

"A few years ago, I drove my EV to Sweden and had difficulties charging because to use the local charging solution I had to download an app, register, then wait for verification to arrive at my home – where I wasn't at. It just didn't work smoothly," explains Ahtikari. "There are also local regulations and other challenges, such as which currency the payment will be in and who gets the taxes. In the end it's a complicated issue."

Virta offers EV drivers the entire Virta network, where you need just one account to access EV charging stations, location maps, and other features in any of the countries Virta operates in.

Charging stations using Virta's solution are equipped with **Tele2 IoT** SIM cards, but this wasn't always the case. When Virta first started offering its solution in 2014, it worked with a local Finnish telco, connecting around 30 charging stations. "We noticed pretty quickly that as our operations expanded into more and more countries, we needed a better connectivity solution," says Ahtikari. "We didn't want to negotiate with individual operators every time we entered a new country, so we needed a telecoms operator that could offer global connectivity, as well as roaming. Roaming is important to us – we need to ensure that if a network is down or otherwise not available, we can quickly connect to another. If we don't have a connection, we're losing business. Tele2 IoT has the right agreements with operators across the globe."

Because Virta operates globally, it needed an easy way to make and manage different configurations of its deployment. The answer? 2CONTROL (**Cisco**'s IoT Control Center), which allows Virta to easily adjust rate plans and communication plans for different use cases and different markets.

"We need an easy way to deploy SIM cards used in new charging stations and to manage the SIM cards in the stations which are already deployed, as well as follow, analyse and solve different problems," explains Ahtikari. "2CONTROL provides good functionality to manage big numbers of SIM cards in an easy way. Also, automation makes life a lot easier, because managing hundreds of thousands of SIM cards and IoT devices can be really difficult. 2CONTROL allows us to focus on our own business, and not waste time managing the difficulties of connectivity of our devices."

When Virta was founded in 2013, the company had just three employees. Today, it has more than 200 people on staff and was recently named Europe's fastest growing EV charging company by the **Financial Times**. The growth is the result of adjusting.

"What we at Virta are doing today is very different from what we were doing even a year ago," says Ahtikari. "Operating in a swiftly evolving market means we need to respond to changes quickly and make sure we're providing our customers with what they need both now and what they'll need going forward. Our solution does just that."

Virta is already operating in nearly every European country and has begun expanding quickly outside of Europe, recently opening its first office in Singapore as it grows into Asia.

"Our competitors tend to focus on particular areas, taking one angle," says Ahtikari. "That might be a charging app, but no charging stations, or they might have a platform to manage charging stations but don't have a payment solution. The big strength with our solution is that you don't need to build your own solution as an individual by buying from a bunch of different companies – you get a really good, well-working solution from us, which is very much out of the box, plug-and-play." ■

What we at Virta are doing today is very different from what we were doing even a year ago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