Power sector accelerating e-mobility

Can utilities turn EVs into a grid asset?

A collaboration between

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About this report

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Power grids face a new and salient test: the oncoming mass penetration of electric vehicles (EVs). This report examines the imminent challenges and opportunities for power and utilities companies, and identifies what they can do to accelerate eMobility.

The pace of EV adoption already exceeds expectations. But the readiness of vehicles, range anxiety and the ability to charge quickly and easily are three major pain points that could, potentially, hold back the uptake of EVs and the transition to eMobility. The first two are being addressed by market forces. The third hinges on charge point operators (CPOs) securing permissions to install infrastructure, and on grid operators, which are responsible for connecting power to the charge points. The whole premise of eMobility depends, however, on a safe and resilient grid, supported by technology solutions to mitigate the impact of EVs on local networks. And, to that end, distribution system operators (DSOs) are the lynchpins in making this evolution in transport happen.

This study focuses on the anticipated surge in EV sales across Europe (the EU27, plus Norway, Switzerland and the UK) and the charging infrastructure that is required to support it. We consider different charging needs across six segments – residential (rural and urban), workplace, fleet hub, overnight stay hub and highway corridor — and examine the impact on electricity load.

We seek to articulate the scale of the challenge and the technology solutions that are either available, or under development, to minimise peak load and capture value from flexibility in EV batteries. We acknowledge the pivotal role of the customer in driving the eMobility transition and the requirement that the nascent industry collaborates and converges around customer needs.

This report is informed by experts at European energy industry body Eurelectric and its members. It is curated and augmented by EY professionals with extensive experience in energy, automotive, government and technology. It includes experiences and insights from European industry leaders in the ecosystem of supporting businesses, including automotive, utilities, fleet management, city planning and charging infrastructure. We thank them for sharing their experiences and opinions so openly with us.

Foreword

- Adoption of eMobility is not just an economic or environmental phenomenon, but a psychological one that hinges on customer acceptance.

- The pace of change is swift, but customers can both drive the transition and stop it in its tracks. EV adoption will truly accelerate when the hearts and minds of customers are won; when there is greater choice of affordable vehicles; when robust charging infrastructure allows them to charge whenever and wherever, quickly and reliably; and when the driver experience is simple and seamless, irrespective of EV type.

- The electricity grid will not collapse due to exponential growth in EVs. It will cope with the predicted 130 million EVs on the roads by 2035. But once EV penetration reaches 50% on an urban distribution network, unmanaged charging could lead to voltage deviations and affect the quality of power supply.[1]

- The eMobility ecosystem depends on widespread collaboration. Within it, power and utilities companies have a critical role in enabling eMobility acceleration. They must provide a resilient grid, underpinned by digital capabilities, to enable timely customer connections to charging infrastructure.

- An unmanaged approach to charging infrastructure risks creating major congestion. Already heavily loaded grids could become bottlenecks in eMobility rollout.

- A digital interface is essential. Smart charging will manage capacity and prevent the grid from buckling under the pressure of millions of EVs plugging in at the same time. It will use algorithms to read grid load and to shift EV demand to times when green energy is plentiful and cheap. In time, it will offset grid investment by leveraging battery capacity.

[1] https://www.researchgate.net/publication/297055070_Impacts_of_electric_vehicles_charging_on_distribution_grid.

- Getting the fundamentals right is critical. What we invest in and design today will serve us long into the future. The deployment of smart grids is foundational to giving DSOs the information they need about the grids they operate, while analysis of current and future needs will enable them to determine grid reinforcement or flexibility solutions to cater for EVs.

- Innovation at the grid level must complement and boost convenience for the customer. Failure to align these interests could increase the overall cost of investment and erode trust between EV driver and service provider, jeopardising buy-in and the overall effectiveness of future mobility.

- Policy, regulation and attractive government incentives will give the green light to new vehicles and technologies, boosting customer confidence and heightening EV demand.

- If each of these conditions aligns around the customer, a green, seamless and frictionless transition to electric is possible. In fact, it is already underway. And it is set to go even faster.

Serge Colle
EY Global Energy & Resources Leader

Kristian Ruby
Secretary General, Eurelectric

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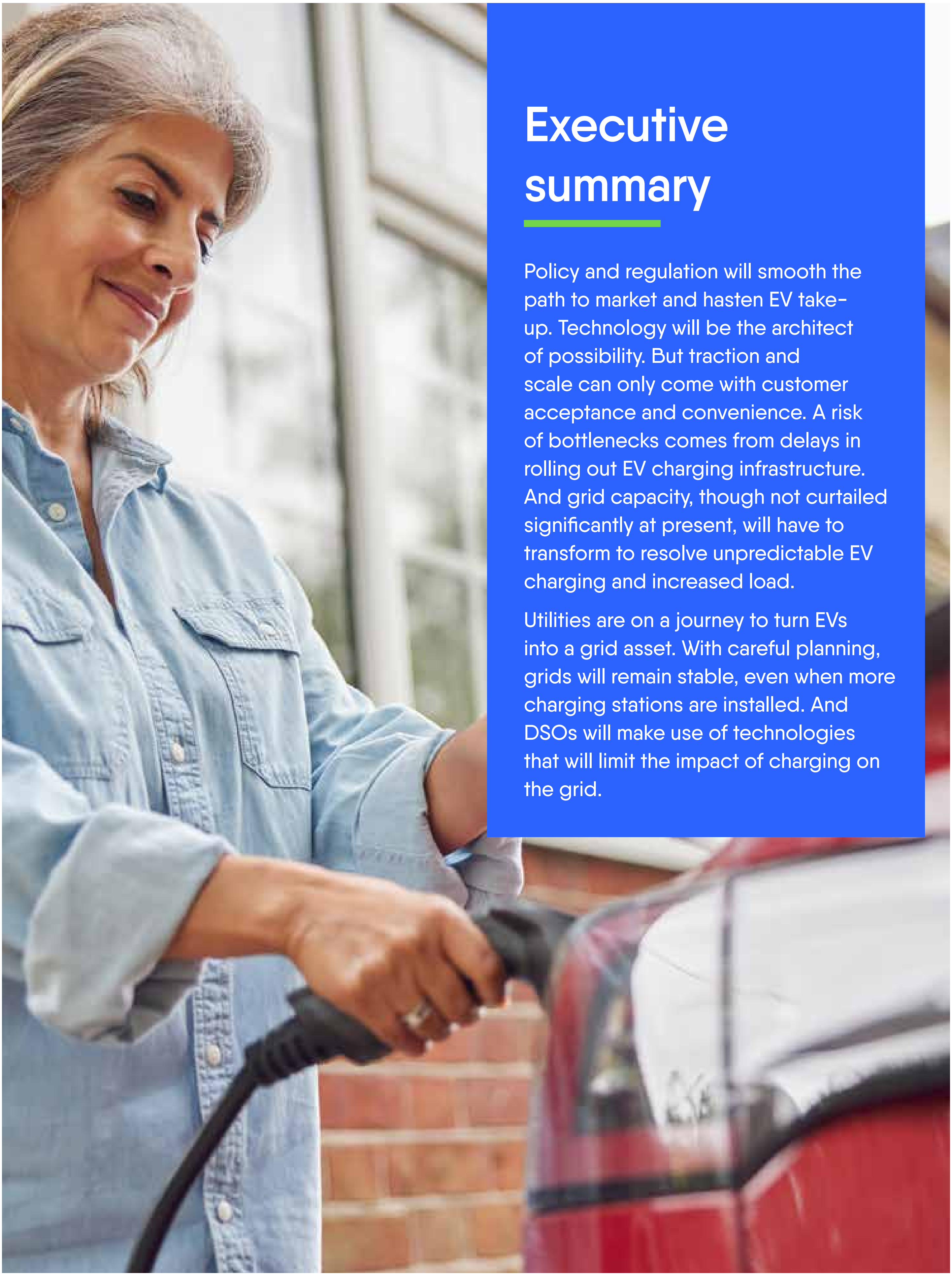

Executive summary

Policy and regulation will smooth the path to market and hasten EV take-up. Technology will be the architect of possibility. But traction and scale can only come with customer acceptance and convenience. A risk of bottlenecks comes from delays in rolling out EV charging infrastructure. And grid capacity, though not curtailed significantly at present, will have to transform to resolve unpredictable EV charging and increased load.

Utilities are on a journey to turn EVs into a grid asset. With careful planning, grids will remain stable, even when more charging stations are installed. And DSOs will make use of technologies that will limit the impact of charging on the grid.

Electric vehicles hit the road

The signs all confirm the direction of travel. eMobility is taking off faster than the most ambitious forecasts predicted. But we're not done yet. To be truly transformational and deliver the sought-after environmental and driver benefits, we need to go faster still.

Progress is being made. In 2021, one in five new vehicle registrations in Europe was electric.[2] Representing just 1% of the total 326 million vehicle parc in Europe today,[3] the EV share is expected to grow to 65 million vehicles by 2030 and double to 130 million vehicles by 2035, according to EY analysts. Though undeniably impressive, we expect governments to make more announcements that will further accelerate the pace of change. The incoming German coalition, for instance, is targeting 15 million EVs by the end of this decade, effectively banning the sale of internal combustion engine (ICE) vehicles.[4]

Several catalysts have coincided to drive this EV momentum:

- **The global climate agenda:** in November 2021, the UN Climate Change Conference (COP26) saw leading markets commit that all new car and van sales will be zero emissions by 2035, with all other markets to follow by 2040.[5] Some countries go further. The UK Government, for instance, promises that all new heavy-duty vehicles (HDVs) sold in the UK will be zero emissions by 2040.[6]
- **Automakers:** original equipment manufacturers (OEMs) are getting behind eMobility. Business models are being rewritten to accelerate electrification, and 18 of the 20 largest automakers (in terms of vehicles sold in 2020) have announced intentions to increase the number of electric models available and boost production of electric light commercial vehicles (LCVs).[7] Some OEMs plan to release new electric HDVs too.[8, 9]
- **Regulation and government incentives:** tougher carbon dioxide (CO_2) emission standards for passenger cars and LCVs are now woven into the European Commission's Fit for 55 package,[10] eliciting the switch in powertrains. At the same time, government incentives, including bonus payments, premiums and tax benefits, are sweetening customer appetite for eMobility and accelerating change.
- **Customer buy-in:** driven by their own environmental consciences, cheaper operating costs and enhanced performance over corresponding ICE vehicles, customers welcome EVs.[11] That appetite is boosted by the declining total cost of ownership (TCO) of compact and mid-sized EVs, which is now comparable with petrol and diesel cars in most European countries.[12, 13] Although EVs are more expensive today, within the next four to six years, they are expected to be cheaper than an ICE equivalent, according to research by BloombergNEF for European green group Transport & Environment.[14]
- **Trucks primed for electrification:** though fuel cell technologies are advancing, battery power makes better sense for shorter trips by smaller trucks.[15] Dramatic declines in battery prices, and improvements in energy density, support battery electric trucking too.

[2] https://www.schmidtmatthias.de/post/more-than-1-million-new-zero-emission-electric-cars-registered-in-europe-this-year.
[3] https://www.acea.auto/files/report-vehicles-in-use-europe-january-2021-1.pdf, includes cars, trucks, vans and buses.
[4] https://www.bloomberg.com/news/articles/2021-11-26/german-coalition-proposes-a-combustion-car-ban-without-saying-so.
[5] https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans.
[6] https://www.businessgreen.com/news/4040041/cop26-government-confirms-hgvs-zero-emission-2040.
[7] https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf.
[8] https://www.volvogroup.com/en/news-and-media/news/2020/nov/news-3820395.html.
[9] https://www.scania.com/group/en/home/newsroom/news/2021/Scanias-commitment-to-battery-electric-vehicles.html.
[10] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_3541.
[11] https://www.ey.com/en_gl/power-utilities/how-energy-providers-can-light-the-path.
[12] https://www.leaseplan.com/en-lu/blog/leasing/2021-car-cost-index/.
[13] https://www.volkswagenag.com/en/news/2021/07/enel-x-and-volkswagen-team-up-for-electric-mobility-in-italy.html.
[14] https://www.transportenvironment.org/discover/hitting-the-ev-inflection-point/, May 2021, Transport & Environment.
[15] https://www.greenbiz.com/article/why-future-long-haul-heavy-trucking-probably-includes-lots-hydrogen.

- **Corporate sustainability:** the fiscal advantages of transitioning passenger car fleets to electric are being felt in the LCV market too, as electric vans become increasingly cost competitive with diesel alternatives.[16] The switch to electric also sends a clear message to employees and stakeholders about a company's green intentions. The biggest companies are making public declarations. They include signing up to the EV100 initiative, run by The Climate Group, to electrify their fleets by 2030.

Though the conditions align for massive expansion in eMobility, the success of the EV market will be determined by a confluence of factors, including government legislation and the reaction of automakers to it, and evolving customer attitudes. Concerns persist about vehicle affordability, driving range and charging duration, but they will be resolved in time. The real risk is that EV uptake will accelerate faster than the ecosystem that will sustain it. And key to resolving that is a ubiquitous and reliable charging infrastructure.

The contrast between the Netherlands, the country with the most chargers (47.5 per 100 kilometres of road), and Poland, eight times bigger but with only one charging point for every 250 kilometres, is striking.

Source: https://www.acea.auto/press-release/electric-cars-10-eu-countries-do-not-have-a-single-charging-point-per-100km-of-road/.

Can charging infrastructure keep up?

Despite rapid acceleration in EV adoption, aided by improved affordability and enhanced driving range, charging infrastructure is one the biggest deterrents to uptake. A survey by The Climate Group's EV100 initiative cited lack of charging infrastructure (67%) as the most significant barrier.[17]

Our industry commentators say that duration of charging compared with refuelling at the pump, poor user experience and availability of public charging stations contribute to range anxiety and lack of confidence in the ability to charge wherever and whenever there is a need.

"In what seems like no time at all, the coincidence of vehicle availability, regulation, technology and user appetite is changing the conversation from 'if' to 'when' eMobility will become mainstream. However, if momentum is to be maintained, a huge leap in the availability of charging infrastructure is needed too.

Andrew Horstead, Global Power & Utilities Lead Analyst, EY

[16] https://www.ey.com/en_gl/energy-resources/when-does-reinventing-the-wheel-make-perfect-sense.
[17] https://www.theclimategroup.org/sites/default/files/2021-02/EV100%20Progress%20and%20Insights%20Report.pdf.

Today, there are over 374,000 public charging points in Europe.[18] But EY calculates that the predicted 130 million EVs are going to need at least 65 million chargers – 9 million of which will be public and 56 million residential – by 2035 across Europe (see figure 4). Charge points will be installed in locations that represent different driver usage needs: home; workplace or depot; at a destination where you charge for convenience while engaged in other activity, such as shopping or dining; and public, which includes on-street parking and highways.

Currently, infrastructure rollout is patchy. Ten European countries do not have a single charger per 100 kilometres of road, while the Netherlands, France, Italy, Germany and the UK account for 66% of total public charger stock.[19] This polarisation between economies risks destabilising the eMobility vision.

There are disparities at a regional level too. Rural locations tend to be underserved compared with urban areas, while a lack of off-street parking creates demand for on-street chargers in residential zones in cities.[20]

The European network of public chargers grew in 2021 by 40%.[21] It is fast, but not fast enough. Market forces will not be sufficient to deliver the pace and type of EV charging infrastructure that is needed. Europe faces three principal bottlenecks in its bid to build out infrastructure faster:

- **Permitting delays and availability and access to real estate:** local authorities often lack dedicated teams to administer the rollout of EV charge points and can take months to give CPOs permission to site infrastructure.
- **Delays in getting a grid connection:** anecdotally, some of our industry commentators reveal that CPOs in some European countries can wait up to 36 months to get a connection. Significant local bottlenecks are commonplace, especially where grid upgrades are needed to accommodate hubs of rapid and high-powered chargers. There are questions about who pays for grid connections, as well as policy options for funding public chargers.
- **Lack of interoperability between charger networks:** using a charge point is not as straightforward as filling up with fuel. Lack of interoperability, due in large part to an absence of common standards, restricts user choice about where to charge and how to pay. Meanwhile, poor reliability on some networks, and variable levels of customer service, add to driver concerns.

These bottlenecks already exist. Just imagine how they will be exacerbated when EV adoption accelerates at the predicted pace.

"By 1 January 2023, we must have connected and equipped all service areas on the highways with the power they need for fast chargers. We will be ready – the distribution network is already sized to support that level of power capacity. According to our study, we will have to spend €300mn over the next 15 years which, in the context of Enedis's €4bn annual capex, is affordable without any real difficulties.

Pierre de Firmas de Peries, Director eMobility, Enedis

"The major bottleneck to the development of charging infrastructure in Poland and Slovakia is the waiting time to get a grid connection. It usually takes two or even three years to get a connection.

Rafał Czyżewski, CEO, GreenWay Poland

[18] https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats.
[19] https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats.
[20] https://policyexchange.org.uk/wp-content/uploads/Charging-Up.pdf.
[21] https://www.transportenvironment.org/discover/co2-targets-propel-european-ev-sales/.

Can central eMobility ambition translate into local application?

Clear planning, based on anticipated EV uptake and usage, customer preferences, future living and working patterns, etc., is needed now to build a reliable and trustworthy infrastructure network that is fit for the future. However, to deliver on ambitious national strategies, EV charger deployment must accommodate and adapt to regional and local variances too. The same bottlenecks that we see at a national level translate into local hurdles, which can disrupt and delay installations.

Operating within the parameters of local policies, planning and funding constraints, city planners will need to work with DSOs as infrastructure is deployed at scale. They will acquire new skills to envision future mobility patterns and create charging landscapes fit for anticipated EV growth. That means understanding local contexts and rolling out charging infrastructure – which will inevitably change the characteristics of villages and towns – in a sympathetic way. The players should take account of population density, likely EV ownership, access to off-street parking, daily commutes, social and economic circumstances, etc., within the locality.

In this way, national ambitions for EV charger deployment can adapt to local and regional needs. Rollout may be facilitated by incentives for DSOs to speed up connections to the grid, potentially at reduced costs, and to invest in reinforcement of the network.

eMobility undoubtedly presents a once-in-a-lifetime opportunity to model the future of road transport. It means siting charging infrastructure in the right places, where it will get the highest usage, make the greatest environmental return on investment and deliver maximum convenience to the customer. But there is a complication. The more charging infrastructure we install to accommodate the massive influx in EVs, the greater the demands on the electricity grid, which will, in turn, heighten user concerns about reliability.

Electrification of major European road networks

- The proposed Alternative Fuels Infrastructure Regulation (AFIR) sets minimum distances between charge points and power output requirements along the Trans-European Transport Network (TEN-T) corridors.
- It should deliver a positive signal to freight companies and hauliers weighing up the prospects of an electric or hydrogen future.
- It will cost €115bn, according to the CEO Alliance.

Source: https://www.globalceoalliance.org/.

Thanks to the USER-CHI project, next year we will have an online tool for urban planners. The expert feeds data, based on the city characteristics, set goals, number of EVs, traffic demand for different user groups, etc., into a system, which produces a plan for the optimal deployment of charging infrastructure.

Matilde Chinellato, Project coordinator — Mobility, Eurocities

The impact of EV charging on the grid

Total electricity demand in Europe is expected to increase by around 1.8% per year by 2030 to around 3,530TWh, according to Eurelectric. The residential, commercial and industrial sectors are expected to contribute to electricity demand growth, but the strongest growth will come from transport. In this sector, EV penetration will see demand growth accelerate by 11% per year, adding 200TWh by the end of this decade.[22] The European Commission has said that further efforts will be needed to improve the level of energy savings needed to meet Europe's climate objectives.[23]

The grid, by and large, will cope with the increased demand that will accompany the transition to EVs. But it is the unpredictable fluctuations in demand, which will come from an unknown quantity of EV drivers charging simultaneously, that will potentially destabilise and disrupt its operations. The system will need, therefore, sufficient generation, storage and network capacity.

The risks from unmanaged charging

Unmanaged charging could create problems for the local grid and power quality. Rapid and unpredictable increases in demand are likely to cause fluctuations in voltage, and power losses. Upstream, the impact may translate into increased energy prices.

The scale of the impact will depend on the number of EVs, network characteristics, charging configurations, local energy storage in batteries for peak shaving to the grid and the charging features of the EVs themselves. The problem will be heightened when electric trucks get the go-ahead from the automotive industry, as grid connections will require even more power. In an unmanaged charging situation, once EV penetration reaches 50% on an urban distribution network, network voltage deviations will exceed the standard level.[24]

The challenge is exacerbated when peak EV charging periods coincide with peaks in general load. Analysis of the six most common charging use cases – residential (rural and urban), workplace, fleet hub, overnight stay hub and highway corridor – finds that peak load will increase by between 21% and 90%, and transformer utilisation will rise by 19% to 80%. In multi-unit dwellings, we expect an 86% increase in peak load, and on highway corridors, where rapid and high-powered chargers draw large amounts of electricity from the grid, a 90% increase. Transformers, in most cases, will have to operate above their rated capacity.

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EVs represent just a small part – 8% – of total grid investment needs but can be a big part of the solution. That depends, to some extent, on regulation, due to differing market rules for participation in balancing markets. It also hinges on technology innovation, given teething challenges that are typical in a developing industry. But, above all, it's about customer convenience. To become relevant to the customer, eMobility has to be simple, seamless and frictionless.

Tomas Björnsson, Head of eMobility, Vattenfall

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From an informed grid perspective, things will probably get worse before they get better. Within four or five years, it's quite likely we'll have to get the grid operator's approval to install charging stations in the Netherlands. That's a pity because, technically, it's not necessary. And it's also a pity because we knew way back in 2008 what was coming down the line in terms of electrification of transportation.

Lennart Verheijen, Head of Innovation, GreenFlux

[22] https://www.eurelectric.org/connecting-the-dots/.
[23] https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698045/EPRS_BRI(2021)698045_EN.pdf.
[24] Li, H.L., Bai, X.M., Tan, W.: https://www.researchgate.net/publication/297055070_Impacts_of_electric_vehicles_charging_on_distribution_grid. 2012 IEEE Int. Conf. on Power System Technology (POWERCON), Auckland, New Zealand, 2012, pp. 1–5

From grid liability to grid asset

DSOs have the potential to transform the liability that comes from millions of EVs charging, into an asset. They are aided by innovative demand-side management tools and technologies, which are being trialled to control the time and duration of charging and will transform the ways in which customers engage with the charging sector in the future.

Smart charging already allows EV charging to be intelligently controlled, so it takes place when the electricity network has surplus capacity, or when there is reduced demand (overnight, for instance) and electricity is cheaper. Across different charging segments, smart charging indicates savings of 7%–21% peak load. Increased awareness and greater incentives to encourage EV drivers to smart charge wherever possible, at off-peak hours and overnight, are required.

Though managed charging solutions will not resolve every scenario, they will help to mitigate the impact of thousands of EVs charging simultaneously. Until then, digitising the grid to monitor and validate performance against assumptions will be critical in understanding, anticipating and optimising customer behaviours, grid impacts and network needs, both now and long into the future.

In this context, DSOs are the critical cog in eMobility expansion. They have significant experience in energy management, gained by connecting thousands of charging points to the power system across Europe. They have a level of oversight that enables them to identify where demand is increasing from EV charging, areas of local congestion, and where to connect infrastructure to best meet customer needs. As technologies evolve, notably the deployment of smart grids and local flexibility markets, DSOs will allow the integration of market solutions to shave peak consumption, reduce congestion and improve power quality.

Cohesive eMobility planning

Unless industry, infrastructure and the supporting network of services catches up with the massive acceleration in eMobility, we are at risk of derailing the ambition.

The availability and reliability of chargers is chief among the challenges. Rollout is frustrated by operational and administrative hurdles. In turn, the impact of unmanaged charging has consequences for power quality, investment costs and driver confidence in a fully charged battery.

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> **There is much more to eMobility than the EV itself. There is a complex ecosystem of charging, energy and other connected products and services that surrounds the vehicle and its user. The automotive industry is progressing rapidly in this direction in order to ensure its customers receive the best possible user and customer experience.**
>
> Despoina Chatzikyriakou, Manager EV New Business Development, Toyota Motor Europe

Each of these components is interdependent; one cannot advance without destabilising the others.

Getting the fundamentals right is critical. The road transport system we design today should serve us long into the future. To do that, it must deliver on six priorities:

- Carefully plan distribution, digital, IT and grid infrastructure investments, allowing for expected EV uptake
- Simplify local authority approval processes for installing charging infrastructure
- Enable faster and cheaper grid connections for EV chargers

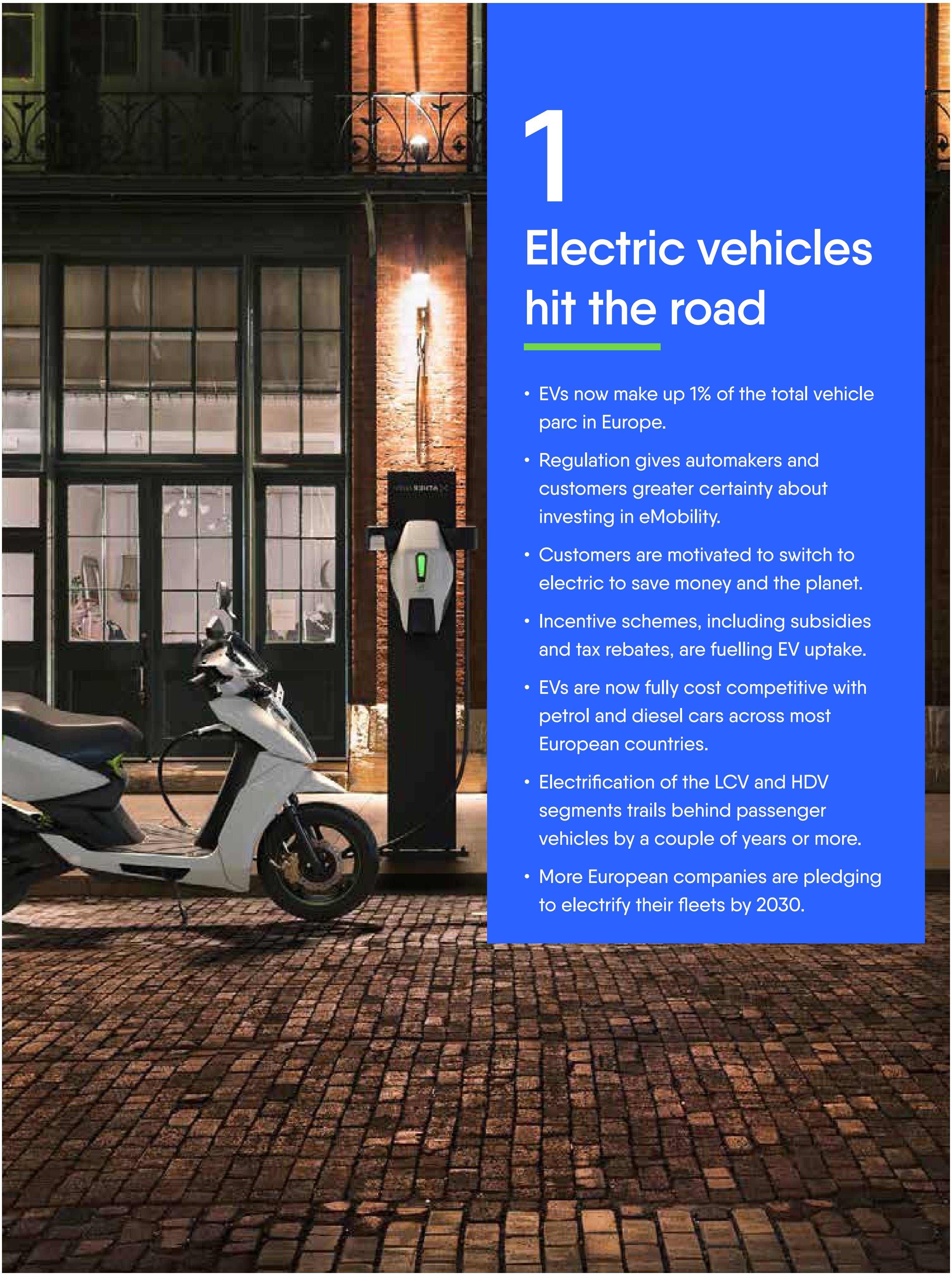
- Focus on the reliability of charging infrastructure to win customer confidence
- Ensure every publicly accessible charger in Europe is digitally connected and capable of smart charging
- Enable interoperability – any vehicle, any contract, any payment mechanism – across charger networks

As we look ahead to mainstream adoption, an ecosystem comprising municipalities, local authorities, city planners, CPOs, eMobility service providers (eMSPs), automakers and network companies has a decisive role to play in bringing together multiple components of a nascent sector to better serve the customer. Within that ecosystem, DSOs are absolutely critical. They must:

- Develop reliable forecasts for future electrification, including for transport and other sectors
- Coordinate network planning to integrate EV charging infrastructure into the electricity network, smoothly and cost-efficiently
- Achieve a better understanding of what is happening and where, by improving visibility over low- and medium-voltage networks
- Consider the skill sets, capabilities and investments needed to deliver a fully automated and harmonised customer experience to meet current and future needs
- Track real-time behaviours from the vehicle to the grid and back again
- Become more customer centric and develop innovative solutions that deliver a better EV user experience for all

Real-time data will be the critical currency. It will enable utility companies to provide information to the market on the state of the grid, so that the connected ecosystem can, in turn, steer usage and guarantee reliability for users. And, in doing so, they can transform the influx of EVs from grid liability into grid asset.

This is the vision of a fully integrated and automated future of connected eMobility.



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Electric vehicles hit the road

- EVs now make up 1% of the total vehicle parc in Europe.
- Regulation gives automakers and customers greater certainty about investing in eMobility.
- Customers are motivated to switch to electric to save money and the planet.
- Incentive schemes, including subsidies and tax rebates, are fuelling EV uptake.
- EVs are now fully cost competitive with petrol and diesel cars across most European countries.
- Electrification of the LCV and HDV segments trails behind passenger vehicles by a couple of years or more.
- More European companies are pledging to electrify their fleets by 2030.

From micro-mobility to heavy-duty fleets, the transition to electrify all road transport has begun. Here's what we know so far:

- In 2020, the size of the total vehicle parc in Europe was 326 million, of which just 1% was electric.[25] By 2035, EY analysts calculate that the total EV parc will exceed 130 million vehicles.[26]
- In 2020, EVs across Europe made up 11.5% of passenger cars sold, up from 3.5% in 2019.[27] Electric bus registrations jumped 7% compared with 2019 and now make up 4% of all new bus registrations in Europe.
- Fully electric LCV sales totalled 1.9% of new registrations, while electric HDV sales rose 23%, but market share remains well below 1%.[28, 29]
- In the first 11 months of 2021, battery-powered EV (BEV) and plug-in hybrid EV (PHEV) sales accounted for over 20% of the European vehicle market, with close to two million units sold.[30]
- Just over three-quarters (77%) of all EV sales are concentrated in six Western European countries (France, Germany, Italy, Norway, Sweden and the UK) – locations with strong policy support, vehicle choice and comparatively high income levels. More vehicles were registered in Germany in the first nine months of 2021 (478,000) than in the whole of 2020 (395,000).[31, 32] By contrast, Cyprus, Latvia and Bulgaria share just 740 registered vehicles.[33] This indicates that affordability remains a barrier to adoption.
- The Tesla Model 3 became Europe's top-selling passenger car in September 2021, the first EV to surpass ICE alternatives.[34]

"An EV range of 200 kilometres is sufficient. But sometimes it is only just sufficient. Once an affordable car can drive 300 kilometres on a single charge, that is good for consumer confidence and eMobility adoption. If, however, everyone starts driving EVs with 1,000km batteries, that will definitely change the future landscape.

Lennart Verheijen, Head of Innovation, GreenFlux

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[25] https://www.acea.auto/files/report-vehicles-in-use-europe-january-2021-1.pdf, includes cars, trucks, vans and buses.
[26] EY Mobility Lens Forecaster.
[27] https://www.acea.auto/files/20210204_PRPC_fuel_Q4_2020_FINAL.pdf.
[28] https://www.acea.auto/files/ACEA_progress_report_2021.pdf.
[29] https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf.
[30] https://www.schmidtmatthias.de/post/more-than-1-million-new-zero-emission-electric-cars-registered-in-europe-this-year.
[31] https://www.acea.auto/files/20211022_PRPC-fuel_Q3-2021_FINAL.pdf.
[32] https://www.acea.auto/files/20210204_PRPC_fuel_Q4_2020_FINAL.pdf.
[33] https://www.acea.auto/files/20211022_PRPC-fuel_Q3-2021_FINAL.pdf.
[34] https://www.best-selling-cars.com/europe/2021-september-europe-car-sales-and-market-analysis/.

Why EV sales are going up so fast

EV sales are accelerating rapidly. Several factors contribute to the continuing momentum.

Global climate agenda sets direction of travel

Greenhouse gas emissions from road transport in 2021 are projected to rebound significantly, having dropped by 12.7% in 2020 due to the steep decline in transport activity as a result of the COVID-19 pandemic.[35] They are the main cause of pollution in cities and account for more than 100,000 premature adult deaths in Europe every year.[36] Reducing emissions from transport, in parallel with the promotion of greater use of public transport and alternative modes of travel, and efforts to decarbonise the grid are top government and regulatory priorities.

And nowhere was this more evident than at COP26 in November 2021, where eMobility became one of the most talked about decarbonisation initiatives. More than 30 countries, along with 40 cities, states and regional governments, and dozens of businesses – both those that manufacture vehicles and those that operate fleets – signed a declaration. They pronounced that all new car and van sales should be zero emissions by 2035 in leading markets, with a 2040 deadline for all other markets.[37] Individual governments committed their nations to ambitious and measurable EV targets and rollout plans. Under global scrutiny, they will incentivise customers and compel stakeholders in the wider ecosystem to participate in, and deliver on, the electrification agenda.

Automakers getting behind eMobility

Over 100 EV models were available in Europe at the end of 2020, more than double 2019 levels. The electric fleet expanded to include superminis, large family cars, hatchbacks, estates, sports utility vehicles, executive models and medium-sized vans.[38]

In the next decade, global automakers are expected to spend more than half a trillion dollars on EVs and batteries, according to analysis by Reuters.[39] Numerous pledges are being made by automakers to become fully electric and bring new vehicles and choice to the market. Eighteen of the 20 largest automakers (in terms of vehicles sold in 2020) have announced their intentions to increase the number of electric models available and boost production of electric LCVs, with some announcing electrification targets by 2030.[40] Certain truckmakers, such as MAN,[41] Scania[42] and Volvo,[43] plan to release new electric HDVs too.

French carmaker Renault says that, by 2025, it will launch 10 new electric models and have the greenest mix in the European market, with EVs accounting for over 65% of sales, increasing to 90% by 2030.[44] Swedish manufacturer Volvo will phase out the sale of gasoline vehicles by 2030.[45] British automaker Jaguar Land Rover says it will sell all-electric cars in its Jaguar luxury brand from 2025.[46] Volkswagen Group announced a long-term plan for EVs to make up 50% of the group's total sales by 2030, and 100% by 2040.[47] And Daimler has split its truck and passenger car divisions into two companies primarily focused on electrification.[48]

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[35] https://www.eea.europa.eu/ims/greenhouse-gas-emissions-from-transport.
[36] https://www.euro.who.int/en/health-topics/environment-and-health/Transport-and-health/data-and-statistics/air-pollution-and-climate-change2.
[37] https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans.
[38] https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf.
[39] https://www.reuters.com/business/autos-transportation/exclusive-global-carmakers-now-target-515-billion-evs-batteries-2021-11-10/.
[40] https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf.
[41] https://press.mantruckandbus.com/corporate/man-presents-zero-emission-roadmap/.
[42] https://www.scania.com/group/en/home/newsroom/news/2021/Scanias-commitment-to-battery-electric-vehicles.html.
[43] https://www.volvogroup.com/en/news-and-media/news/2020/nov/news-3820395.html.
[44] https://en.media.renaultgroup.com/news/cp-eways-72d8-989c5.html.
[45] https://www.media.volvocars.com/global/en-gb/media/pressreleases/277409/volvo-cars-to-be-fully-electric-by-2030.
[46] https://www.ft.com/content/4a7f386b-121b-450e-936c-e7935daab089.
[47] https://www.volkswagenag.com/en/group/strategy.html.
[48] https://www.ft.com/content/64910c9a-75c4-4e7b-9ca6-2d35c009498d.

Regulation and government incentives sweeten the switch

As climate goals get more ambitious, regulations become more rigorous. Since CO_2 emission standards came into effect in Europe in 2020 for passenger cars and LCVs, the auto industry has been led down a one-way street to electrification.

Those requirements are made tougher still by the Fit for 55 package of policies to combat climate change. Introduced by the EU in July 2021, the package hikes 2030 CO_2 emissions reduction targets. For cars, it proposes a 55% reduction, up from the previously prescribed 37.5%, against a current baseline of 95 grams of emissions per kilometre travelled. For LCVs, the reduction target rises from 31% to 50%, against a baseline of 147g/km. Targets for HDVs will be set in 2022.[49, 50]

Regulatory certainty proves to customers that electrification is no fad. It is a government-backed mandate, allowing them to buy with confidence. From the automakers' perspective, the switch in powertrains is a massive shake-up, but there is regulatory certainty for them too in the planned phase-out of combustion engine sales, enabling them to promise that more EVs will hit the road.

Government incentives also sweeten the switch to EVs and help to accelerate mass adoption. They include subsidies and tax rebates for both private customers and corporates. In some countries, additional incentive schemes have been introduced to aid the short-term recovery of the automotive industry from the impacts of the COVID-19 pandemic-induced economic downturn, further boosting EV sales.[51] Twenty European countries now offer incentives, such as bonus payments or premiums, to buyers of EVs.

In France, for instance, a driver gets a bonus of up to €7,000 for purchasing a vehicle that emits 20 grams of CO_2/km or less, plus a scrappage bonus of up to €5,000 when purchasing a second-hand or new battery EV. And, for drivers living or working in a low emission zone, there is an additional €1,000 bonus. Full EVs are exempt from company car tax; privately owned EVs get a 50% to 100% reduction in registration tax.[52]

> **The EU's CO_2 emission standards push manufacturers to increase the supply of EVs. They are a clear signal to transition away from internal combustion engines. And that, in turn, is giving corporate buyers certainty. They can commit to electric knowing that the future supply will be there.**
>
> Dominic Phinn, Senior Policy Manager, The Climate Group/EV100

[49] https://www.europarl.europa.eu/legislative-train/theme-a-european-green-deal/file-co2-emission-standards-for-cars-and-vans-post-euro6vi-emission-standards.

[50] https://ec.europa.eu/clima/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/co2-emission-performance-standards-cars-and-vans_en.

[51] https://iea.blob.core.windows.net/assets/ed5f4484-f556-4110-8c5c-4ede8bcba637/GlobalEVOutlook2021.pdf.

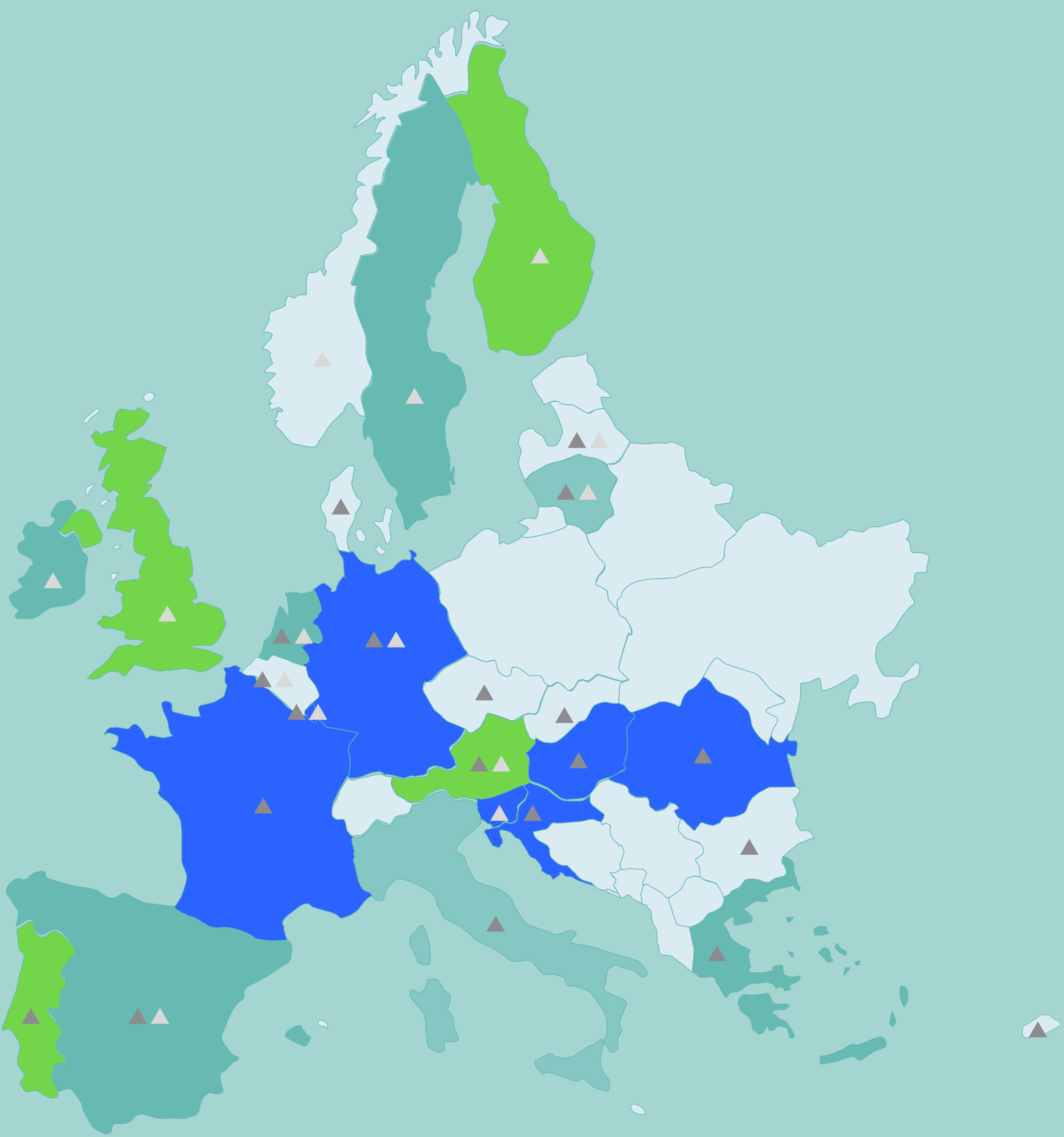
[52] https://blog.wallbox.com/en/ev-and-ev-charger-incentives-in-europe-a-complete-guide-for-businesses-and-individuals/.

Norway is one of the most progressive economies for EV adoption – in fact, 12% of its vehicle stock is now fully electric[53] – but it does not offer many purchase subsidies. Instead, there is no purchase tax or VAT on EVs until the end of 2022; road tax is reduced by between 75% and 90% for fully electric and plug-in hybrids; and there is a 50% discount on company car tax for fully electric and plug-in hybrids.[54]

> **From the beginning, there was no VAT on EVs in Norway; EV drivers got free parking and free toll road passage; in Oslo, they could use the bus lane. Early adopters bought EVs in order to commute in an economically wise and convenient way, while doing something good for the environment. The incentives compensate for any hassle with charging.**
>
> Oskar Svedenstedt, Chief Commercial Officer, Recharge

[53] https://www.ssb.no/en/transport-og-reiseliv/landtransport/statistikk/bilparken.
[54] https://blog.wallbox.com/en/ev-and-ev-charger-incentives-in-europe-a-complete-guide-for-businesses-and-individuals/.

Figure 1: Monetary EV vehicle in Europe



▲ Tax exemption
△ Tax benefit
No purchase incentive
<€4,000
>€4,000–<€7,000
>€7,000–<€10,000

Note:
Illustrative only. Details correct as of end 2021. For full details on electric vehicle tax benefits and purchase incentives visit: https://www.acea.auto/files/Electric_vehicles-Tax_benefits_purchase_incentives_European_Union_2021.pdf.

Of the 10 European countries that do not provide EV purchase incentives, 6 are in Eastern Europe: Bulgaria, Czech Republic, Estonia, Latvia, Poland and Slovakia. However, Hungary offers a €7,350 purchase incentive for electric cars costing up to €32,000 – it drops to €1,500 for vehicles priced between €32,000 and €44,000. Romania has introduced a €1,250 car scrappage scheme and €10,000 purchase incentive for new BEVs. In Slovenia, a €7,500 purchase incentive is available for BEVs, and €4,500 for fully electric vans and PHEVs (cars and vans).[55]

EV desirability and driver choice

Customer awareness of the risks of climate change means their purchasing decisions are influenced increasingly by sustainability concerns. In fact, research by EY among 34,000 global consumers found a significant interest in adopting new energy products and services when the benefits align around saving money, time and the planet. Just under half of those surveyed were willing to pay a premium for sustainability.[56]

The environmental benefits of plugging in rather than filling up, plus greater vehicle choice and cost reductions, are primary drivers for EV uptake. A survey by LeasePlan reveals that compact and mid-sized EVs are now fully cost competitive with petrol and diesel cars across most European countries. Where EVs are not yet cost competitive, the price gap has narrowed significantly. By the mid-2020s, if the trend continues, EVs are likely to reach cost competitiveness in every country surveyed, including Eastern European markets, such as Romania and Poland. LeasePlan's analysis compares the TCO of cars, including fuel or energy, depreciation, taxes, insurance and maintenance, in 22 European countries.[57]

"

Uber will provide access to resources valued at US$800mn (€715mn) to help drivers to use electric vehicles by 2025 ... The countries and cities in which we are successful are those that have very conducive policies to help us electrify. They either enable electrification activities, or they tax, or they make it more difficult and costly to put non-EVs on the roads.

Matthieu Campion, Head of Electrification Operations, Uber

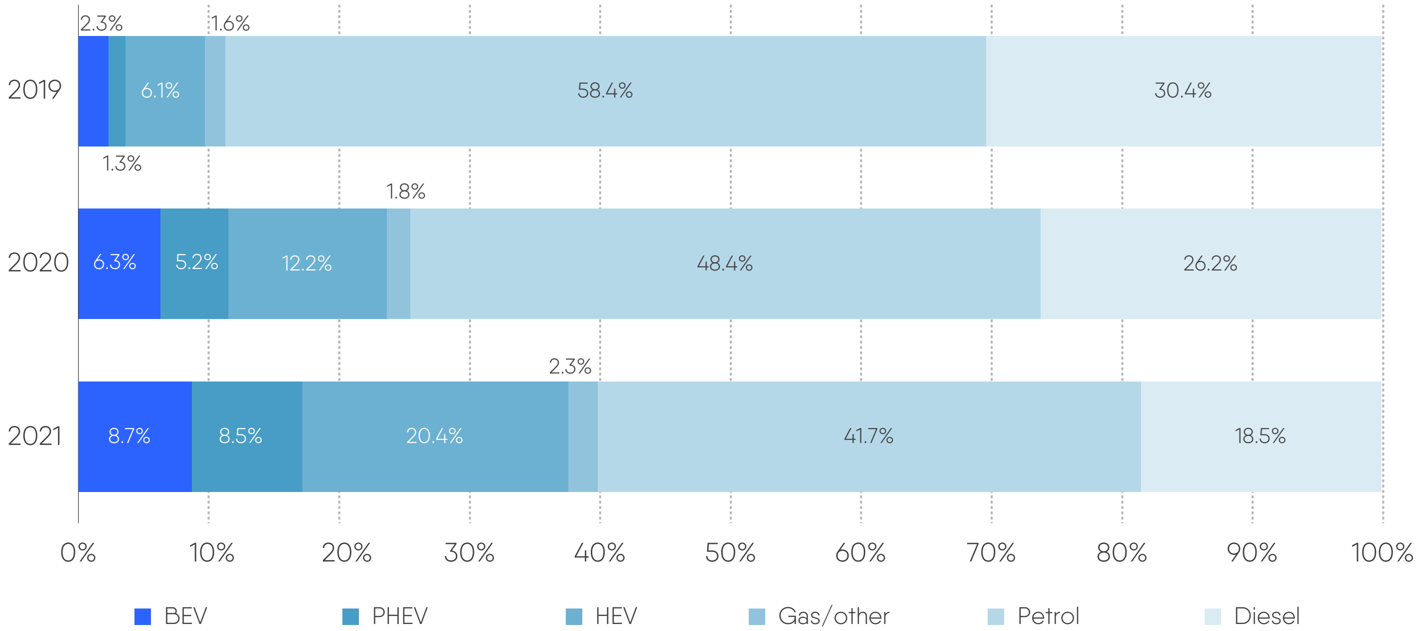
"

Six years ago in Norway, you could lease an EV with a 10-mile range or you could buy a Tesla. Instead of these extremes, there are now all sorts of cars with different ranges in between, which I think has been the tipping point for continued growth in the EV market in Norway.

Stian Bjørhei, CEO, Elaway

[55] https://www.acea.auto/files/Electric_vehicles-Tax_benefits_purchase_incentives_European_Union_2021.pdf.
[56] https://www.ey.com/en_gl/power-utilities/how-energy-providers-can-light-the-path.
[57] https://www.leaseplan.com/en-lu/blog/leasing/2021-car-cost-index/.

Figure 2: Annual vehicle market share by fuel in Europe (2021, Q1–Q3)



Europe = EU27 + Norway + Switzerland + UK
2021 data shown, Q1–Q3

BEV – Battery electric vehicle
HEV – Hybrid electric vehicle
PHEV – Plug-in hybrid electric vehicle

Source: https://www.acea.auto/files/20211022_PRPC-fuel_Q3-2021_FINAL.pdf.

EV battery facts

- EVs can take between 30 minutes and 12 hours to charge.
- A typical EV (60kWh battery) takes about eight hours to charge from empty to full on a typical residential 7kW charging point. A 50kW fast charger delivers a full charge within 30 minutes.
- In the past 10 years, the cost of battery packs has declined by over 98% to US$132/kWh (€122).
- The battery market in Europe is gaining traction, with an estimated 600GWh annual production capacity across a range of manufacturers.
- Several large-scale battery gigafactory projects are under construction:
  - A Nissan and Envision partnership is investing £1bn (€1.17bn) in an EV manufacturing hub in Sunderland in the UK, with a 2024 battery production date.
  - Volkswagen is to build six gigafactories with total capacity of 240GWh in Europe by 2030.

Source: https://pod-point.com/guides/driver/how-long-to-charge-an-electric-car.
Source: https://about.bnef.com/blog/battery-pack-prices-fall-to-an-average-of-132-kwh-but-rising-commodity-prices-start-to-bite/.
Souce: https://www.orovel.net/insights/li-on-battery-gigafactories-in-europe-january-2021.
Source: https://slocat.net/e-mobility/.

LCVs and HDVs getting up to speed

Electrification of the LCV and HDV segments trails behind passenger vehicles by a couple of years or more. But most automakers have started to offer full electric drivetrains, with around 20 different LCV models available at the beginning of 2021.[58]

Take-up will come, as we have already seen with the electric passenger vehicle segment, once supply chains, technology and choice catch up. To that end, clearer policy direction and expanded zero-carbon city initiatives will provide impetus. They will further entice investment in vehicle manufacturing and charging infrastructure on the scale needed to harness the true potential of electric trucks.

At the bigger end of the spectrum, battery electric and fuel cell technologies are advancing, and for shorter trips or smaller trucks, battery electric trucks already make far better sense than hydrogen fuel cell counterparts.[59] Regulation is also making an impact. The CO_2 emissions standards for HDVs will be reviewed in 2022, with a 30% reduction likely to increase to 32.5% by 2030. Some businesses are going further. An alliance of EU truckmakers is pledging to phase out diesel trucks by 2040, a decade earlier than originally planned. Daimler, Scania, Man, Volvo, Daf, Iveco and Ford have committed to transition to zero-emission vehicles based on battery and hydrogen technologies and clean fuels.[60]

However, the industry leaders who contributed to and informed this report have lingering concerns about how quickly HDVs will transition to electric. Their concerns include:

- Higher upfront capital costs
- The need for high-performance batteries for long-range and heavy-duty applications
- Scarcity of highway fast-charging infrastructure, though 250kW and 900kW capacity chargers are now being tested
- Regulation of the eHDV sector
- Harmonisation of standards and communication protocols

"Once drivers experience an electric truck or an electric bus, there is no way back. It does require an adaptation of habits but, for bus and truck drivers, the silence and comfort of electric driving are so high. Being in a noisy environment all day long has an impact on your life that you cannot ignore.

Philippe Vangeel, Secretary-General, European Association for Electromobility, Avere

"Given that around 30% of HDVs are not currently covered by the existing CO2 standards, expanding the requirement to all HDV categories will automatically increase its parameters.

Michelangelo Aveta, eMobility Lead, Eurelectric

[58] https://www.dataforce.de/en/news/zero-emission-delivery/.
[59] https://www.greenbiz.com/article/why-future-long-haul-heavy-trucking-probably-includes-lots-hydrogen.
[60] https://www.ft.com/content/7d49589b-ff50-444d-8eef-b8abe5691f91.

Accelerating fleet electrification

Momentum continues to grow for electrification of fleet vehicles, notably company cars, as identified in *When does reinventing the wheel make perfect sense?*, a study by EY and Eurelectric.[61] And for electric delivery vans, the economic business case is improving too, with the TCO already lower than diesel in some jurisdictions. That gap will widen.

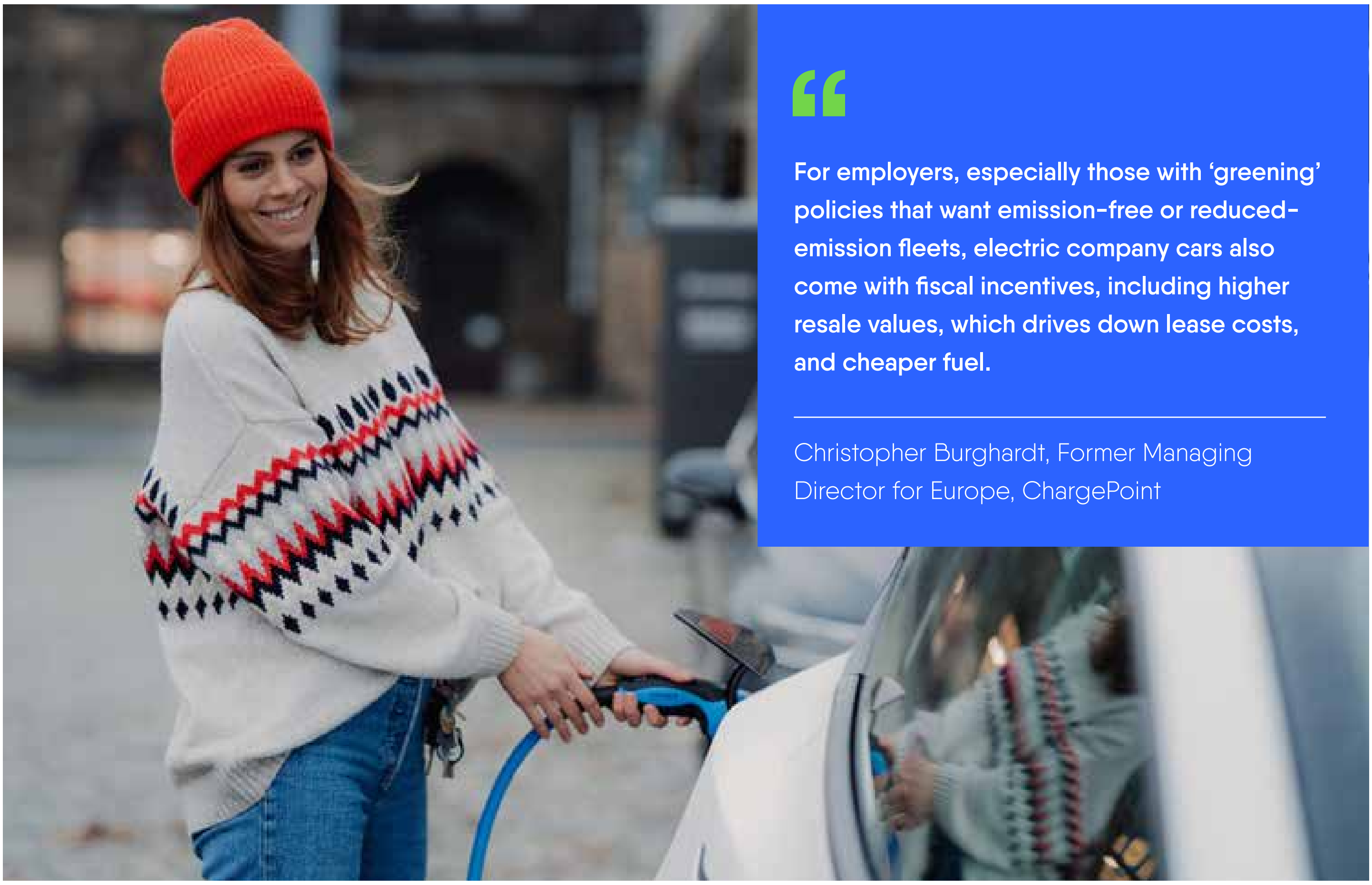
Already, we see companies making large-scale commitments to the climate agenda with demonstrable actions. A total of 120 leading global companies, including 66 in Europe, have signed up to The Climate Group's EV100[62] initiative. They have committed to electrify their vehicle fleets by 2030 and to report publicly on their progress against targets. Collectively, they surpassed 5.4 million vehicles in 2021. Moreover, European membership has grown by 15 companies compared with 2020, illustrating the uptick in climate pledges.

Going the distance in EVs

In conversations with utility companies, automakers, city planners, fleet managers and CPOs, there is an overwhelming sense of confidence that EVs will go the distance and that players will converge around making the transition happen.

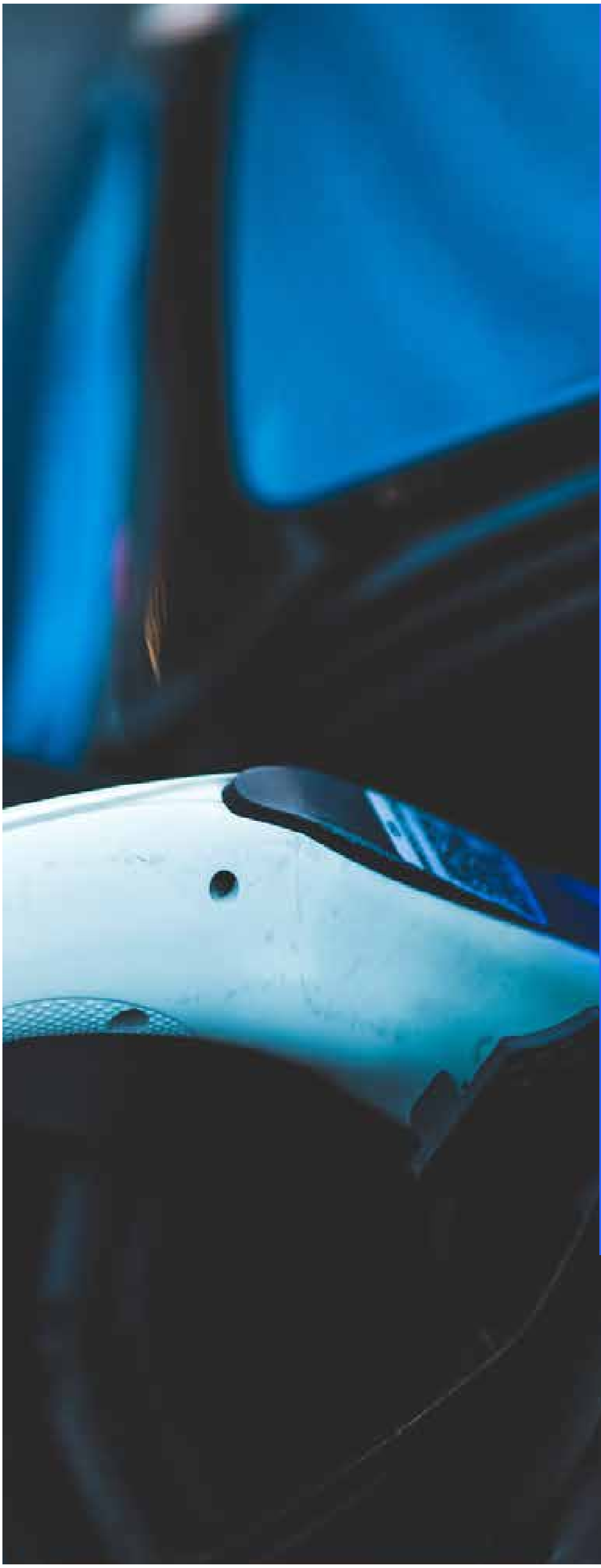
The European Commission has defined a structure for reform, with a top-to-bottom policy for 100% reduction in CO2 from cars by 2035, effectively banning the sale of new petrol and diesel vehicles. EV parity with ICE vehicles, in terms of price and performance, is either already here, or on its way, at least in the passenger car segment. Together, these conditions converge towards an electric future.

And that brings us to the issue of charging infrastructure. Given the rapid pace of EV rollout, will charging infrastructure be the logjam that disrupts the transition? Can it and will it keep up?



> **For employers, especially those with 'greening' policies that want emission-free or reduced-emission fleets, electric company cars also come with fiscal incentives, including higher resale values, which drives down lease costs, and cheaper fuel.**
>
> Christopher Burghardt, Former Managing Director for Europe, ChargePoint

[61] https://www.ey.com/en_gl/energy-resources/when-does-reinventing-the-wheel-make-perfect-sense.
[62] https://www.theclimategroup.org/ev100.



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Can charging infrastructure keep up?

- EY estimates that around 13 million chargers need to be installed in Europe by 2025, rising to 32 million by 2030 and 65 million by 2035.
- Eighty-five percent of chargers are expected to be residential, 6% in the workplace, 4% public chargers and 5% at destinations.
- The investment will be significant. €115bn cumulative investment is needed between 2022 and 2035.
- Fast and superfast chargers will make up less than 2% of the total number of chargers, but account for around 25% of the investment.
- The geographic divide is evident. Ten countries will account for around 70% of total charger stock in Europe in 2035.

While progress is being made on the vehicle front, the deployment of public charging infrastructure, which is as vital to EVs as the fuel pump is to ICE vehicles, is paramount. What is more, very few charge points today are suitable for fast charging. It is not a huge problem while vehicle numbers are comparatively low. But it will be.

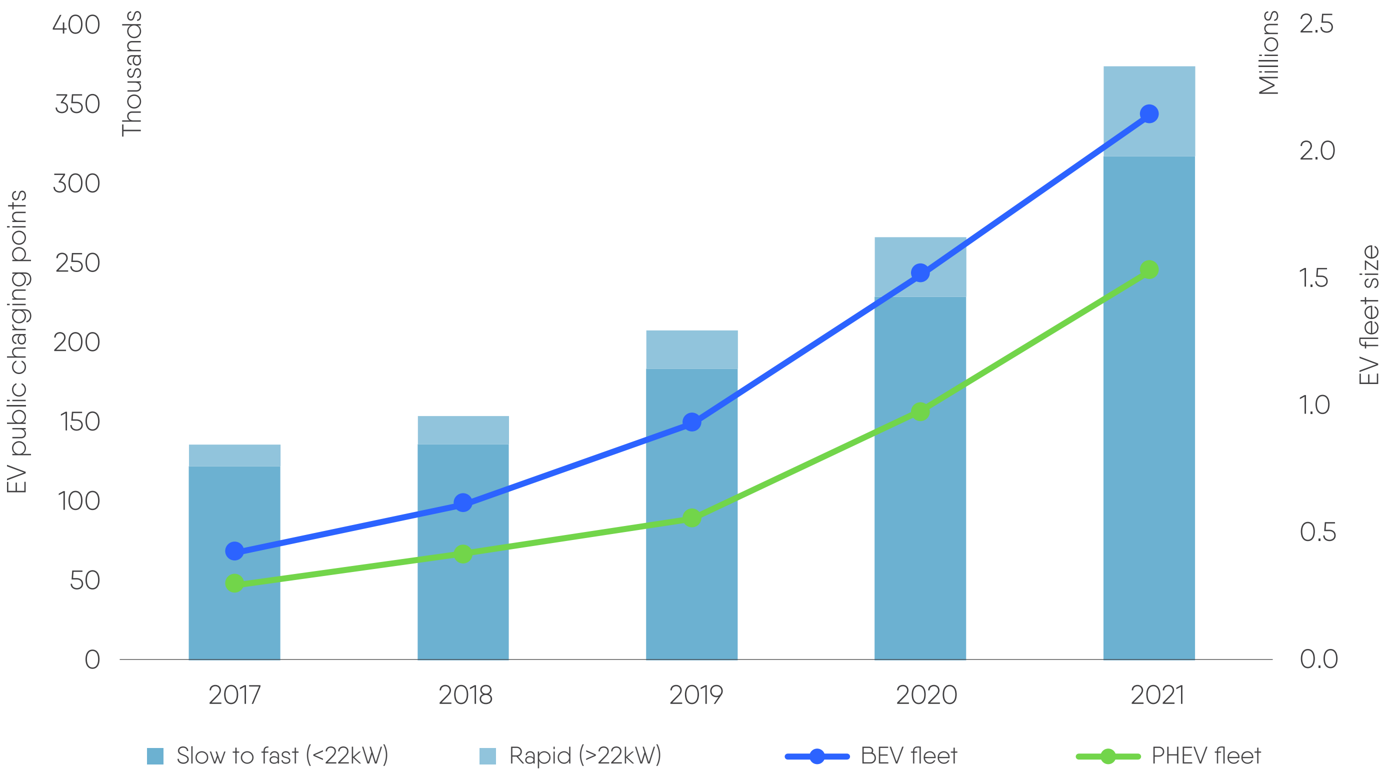
"It's not good to fully charge a battery, yet people feel uncomfortable if their car is less than 100% charged every time they drive it. When they park at home, they charge immediately; when they park at work, they charge immediately; so we end up with double peaks. It's an education thing.

Christian Lechner, Project Manager, EVN AG

How much charging infrastructure do we really need?

Currently, according to the European Alternative Fuels Observatory (EAFO), there are around 374,000 public charge points in Europe: a mixture of slow and fast (22kW or under) and rapid (over 22kW). The latter account for just 12% of the total.[63]

Figure 3: EV public charge point growth in Europe



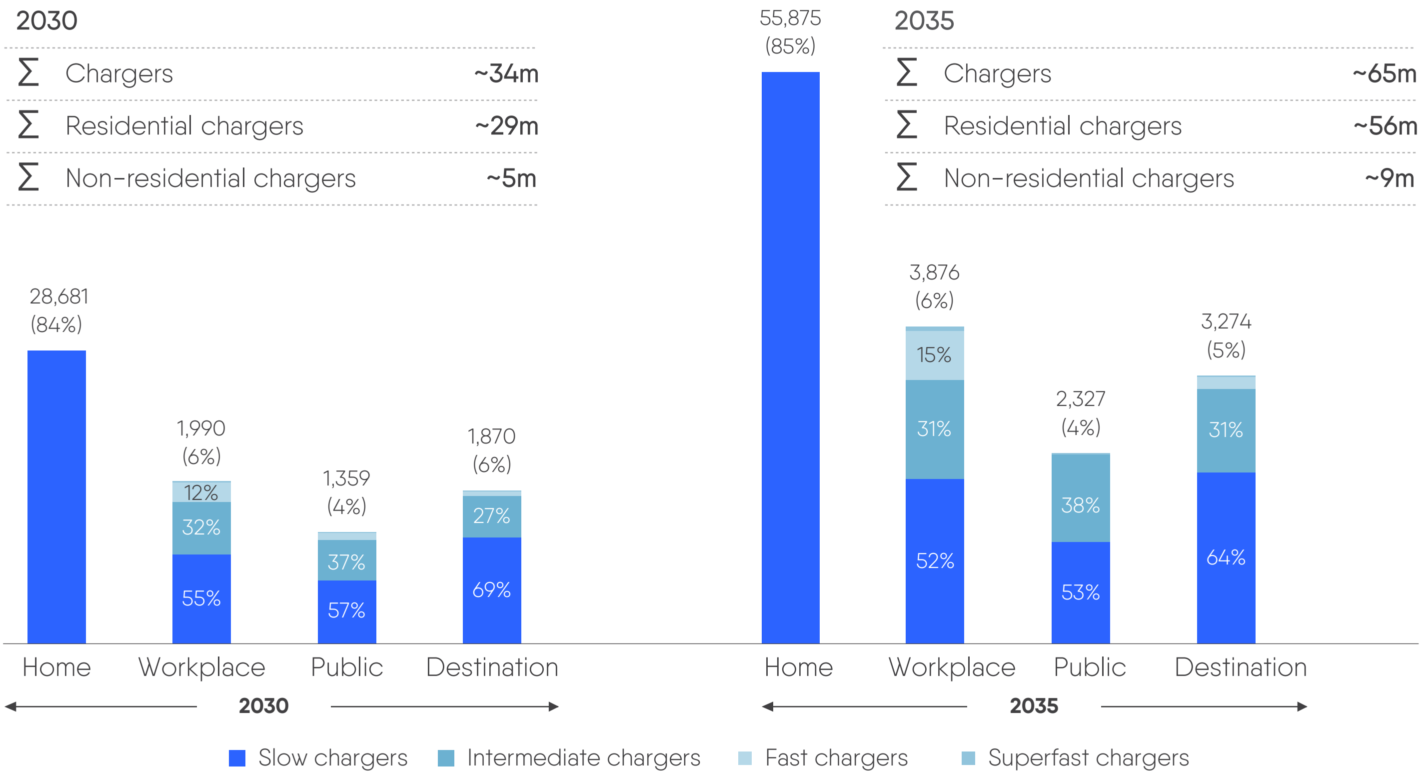
Source: European Alternative Fuels Observatory.

[63] https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats.

If, as EY analysts predict, 130 million EVs hit the road by 2035, how many chargers do we need to make them accessible to everyone?

Using an artificial intelligence-based tool to analyse changing market inputs, EY modelled likely scenarios for the future eMobility landscape.[64] Four charging locations – home, workplace, public (on-street and highways) and destination – were validated by industry leaders during our research and informed our assumptions on drivers' charging behaviours. We calculate that 34 million chargers will be needed by 2030, 29 million of which will be residential, to accommodate 60 million EVs. That almost doubles to 65 million chargers by 2035, of which 56 million will be residential, to accommodate 130 million EVs.

Figure 4: Charging stock by charging location and charger type



(n%) – indicates share of respective year's charger stock

Source: EY analysis, November 2021.

[64] EY Mobility Lens Forecaster.

Where to plug

Where EV drivers want to charge will determine the number of chargers needed. Our industry commentators agree that the most convenient, cheapest and preferred location to charge EVs is at home. This is supported by a UK National Audit Office study, which found that charging at home is 59%–78% cheaper than charging in public.[65] But nearby residential streets and local car parks are essential for overnight charging for households without access to off-street parking. The preference for home charging is followed by the workplace and any other location where charging is the secondary activity.

EV charging will become as automatic as putting your phone on charge when you can, or just because you can. There might not be a specific need to charge, but there is an opportunity, which will be taken, especially if it is free. This is far removed from the concept of going purposefully to a fuel station to fill up with diesel or petrol, although for rapid and high-powered charging on longer journeys, charging hubs will continue to fulfil that purpose.

EY analysts estimate that in 2035, roughly 85% of charging will be done at home, 6% in the workplace, 5% at the destination (semi-public charging) and 4% on public highway corridors. These numbers are validated anecdotally by our industry commentators.

These four broad location types can be split further across six distinct segments. Each has differing demands, considerations and charger types:

- **Residential rural:** for those with off-street parking, charging on a driveway or in a garage will provide the most convenient and cost-efficient charging option. A slow (3.3kW or 7kW) charge point is installed and connected to the home electricity supply. It has one of the highest flexibility potentials due to extended dwell times, enabled by smart charging and battery storage. For those without access to off-street parking, charging will be on the street, via kerbside connected chargers, or in local car parks.

The future will be about opportunity charging. In Belgium, supermarkets have smart chargers; and also in Germany, they are installing normal power chargers. It's a bit like taking the opportunity to charge up your mobile phone at work because you're going out in the evening. That's the way to go with EVs.

Philippe Vangeel, Secretary-General, European Association for Electromobility, Avere

Only 3% of charging will be done at the gas station in future. Most of the charging will be done at home, at work, in parking lots.

Doron Frenkel, Founder and CEO, Driivz

[65] https://www.nao.org.uk/wp-content/uploads/2021/02/Reducing-Carbon-Emissions-from-cars.pdf.

- **Residential urban (condominium or multi-unit dwelling):** unlike residential customers with off-street parking, EV drivers in multi-unit dwellings do not tend to have the option to install charging infrastructure independently. They require agreement from the landlord.

Typically, chargers will be slow (7kW), but few buildings are designed to support charging stations or increased load. Installing charging stations can be expensive. Parking spaces are often assigned, but tenants change, and new occupants may, or may not, have an EV. There is also the issue of metering and paying for the electricity used to charge EVs in multi-unit dwellings. Challenges such as these must be resolved equitably, but with a long-term perspective on eMobility trends.

However, as with residential charging, long vehicle dwell times provide opportunities for smart charging and peak shaving. Forthcoming revisions to European legislation will address the 'right to plug' and seek to tackle some of the challenges associated with residential urban charging.

- **Workplace:** charging at workplace car parks, mainly for use by employees, is often offered free as a perk and provides an alternative to charging at home. Chargers are typically slow or fast (up to 22kW). Vehicles will be stationary for extended periods, so vehicle charging can be optimised and integrated, potentially, into energy building management schemes. Workplace parking offers flexibility by, for instance, maximising the use of solar energy. However, workplace profiles vary. Depending on the nature of the business, electricity availability problems can arise during unique peak periods of usage.

- **Fleet hub:** LCV and HDV depots are the typical start and destination points in drivers' journeys. They offer facilities for last-mile logistics and unmanned overnight vehicle parking for local nine-to-five operations. Chargers will be fast (22kW to 50kW). Installing high-power charging infrastructure at depots will need significant investment and must be planned carefully. However, it offers energy optimisation potential on account of long dwell times during the off-peak period.

- **Overnight stay hub:** different charging solutions are needed for different vehicle types, but chargers are typically fast (50kW to 100kW). Dwell times will be high, up to around eight hours. And investment costs will be high because fast chargers are required to accommodate large charging requirements, primarily for trucks. Depending on the dwell time, hubs offer the best use case for grids, since most of the charging will be done at night during the off-peak period. Hubs also offer the potential to optimise the energy network and pair with on-site solar and behind-the-meter energy storage.

- **Highway corridor:** at highway service stations, drivers will be able to top up their charge en route. Chargers will be a mixture of fast and superfast (70kW to 350kW), and drivers will pay a premium for the convenience of charging quickly so that they can continue their journeys.

> **EDF, to be frank, is very careful before investing in the fast-charging business. It is very difficult to forecast the volumes of traffic that will go to fast-charging stations. We don't know whether people will be prepared to pay for it. They are used to paying almost nothing at home or at work. Are they prepared to pay tens of euros for a fast-charger?**
>
> Olivier Dubois, Head of eMobility, EDF

But highways are doubly challenged. They have high-power charging needs, which create the greatest grid impact, so investment costs will be high, and grid upgrades will be needed. But limited EV dwell time also restricts opportunities for managed charging. Co-locating solar and on-site behind-the-meter storage solutions would give EV drivers access to charging from renewable power.

For the heavy goods industry, there are more complex demands. Electrification of eHDVs must be enabled along the major European arteries – including the TEN-T corridor – and hubs, which the CEO Alliance, a cross-industry CEO alliance of 12 companies, estimates will cost in the region of €115bn by 2030.[66] The investment is needed to deploy an estimated 400,000 chargers to cater for an estimated eHDV fleet of 820,000 vehicles. The European Automobile Manufacturers' Association (ACEA) believes between 40,000 and 50,000 DC 350kW and >500kW public and destination chargers will be needed across Europe by 2030.[67] In addition, investment is needed in advanced grid management technologies and charging platforms to manage charge point activities and changes in energy demand.[68]

The European Commission, in its Alternative Fuels Infrastructure Regulation, provides what Michelangelo Aveta at Eurelectric describes as "the single biggest guarantee that eMobility will go ahead," with its requirement for distance-based charging points (at 60-kilometre intervals, down from 80 kilometres) along the TEN-T core network. Additionally, it sets power output requirements: 1400kW charging output for HDVs and 300kW power output for cars and vans by 2025, increasing to 3,500kW and 600kW respectively in 2030. This configuration is designed to maximise usage of the charging facilities, without draining the network.

The UK Government has set out its vision for a rapid charging network across England's motorways and A roads to meet future charging demand from EVs ahead of need. A £950mn (€1.1bn) rapid charging fund was announced to support private investment at strategic sites where electrical connection is expensive and commercially non-viable. UK government policy is to have at least 6 rapid chargers at motorway service areas by 2023, with 10 to 12 charge points at larger sites. The long-term plan includes 6,000 rapid chargers on the strategic road network by 2035.

Source: https://www.gov.uk/government/publications/government-vision-for-the-rapid-chargepoint-network-in-england/government-vision-for-the-rapid-chargepoint-network-in-england.

[66] The CEO Alliance is an alliance of 12 CEOs from technology, software, manufacturing, automotive, energy, telecommunication, mining and metals, to develop a 'zero-carbon future' and 'a more resilient Europe'. Members include ABB, AkzoNobel, Enel, E.ON, Ericsson, H2 Green Steel, Iberdrola, Philips, SAP, Scania, Schneider Electric and Volkswagen.

[67] https://www.acea.auto/publication/position-paper-heavy-duty-vehicles-charging-and-refuelling-infrastructure-requirements/.

[68] https://ec.europa.eu/energy/sites/default/files/documents/swd2021_307_en_autre_document_travail_service_part5_v2.pdf.

Figure 5: European Commission rules on emissions and power outputs by vehicle type

Legislative initiative	Rules			
CO_2 emissions standards for new cars and vans	55% **Cars** GHG emissions reductions by **2030** and **100%** by **2035**		50% **Vans** GHG emissions reductions by **2030** and **100%** by **2035**	
Alternative fuels infrastructure regulation	TEN-T core networks		TEN-T comprehensive networks	
	2025	2030	2030	2035
Cars and vans	**300kW** power output/**60km**	**600kW** power output/**60km**	**300kW** power output/**60km**	**600kW** power output/**60km**
HDVs	**1400kW** power output/**60km**	**3500kW** power output/**60km**	**1400kW** power output/**100km**	**3500kW** power output/**100km**
Hydrogen vehicles		Every **150km** and in every urban node for **LDVs** and **HDVs**		

Source: Proposal for a regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council.

The bill for EV infrastructure

There are three main types of EV charger, which come in at different costs:

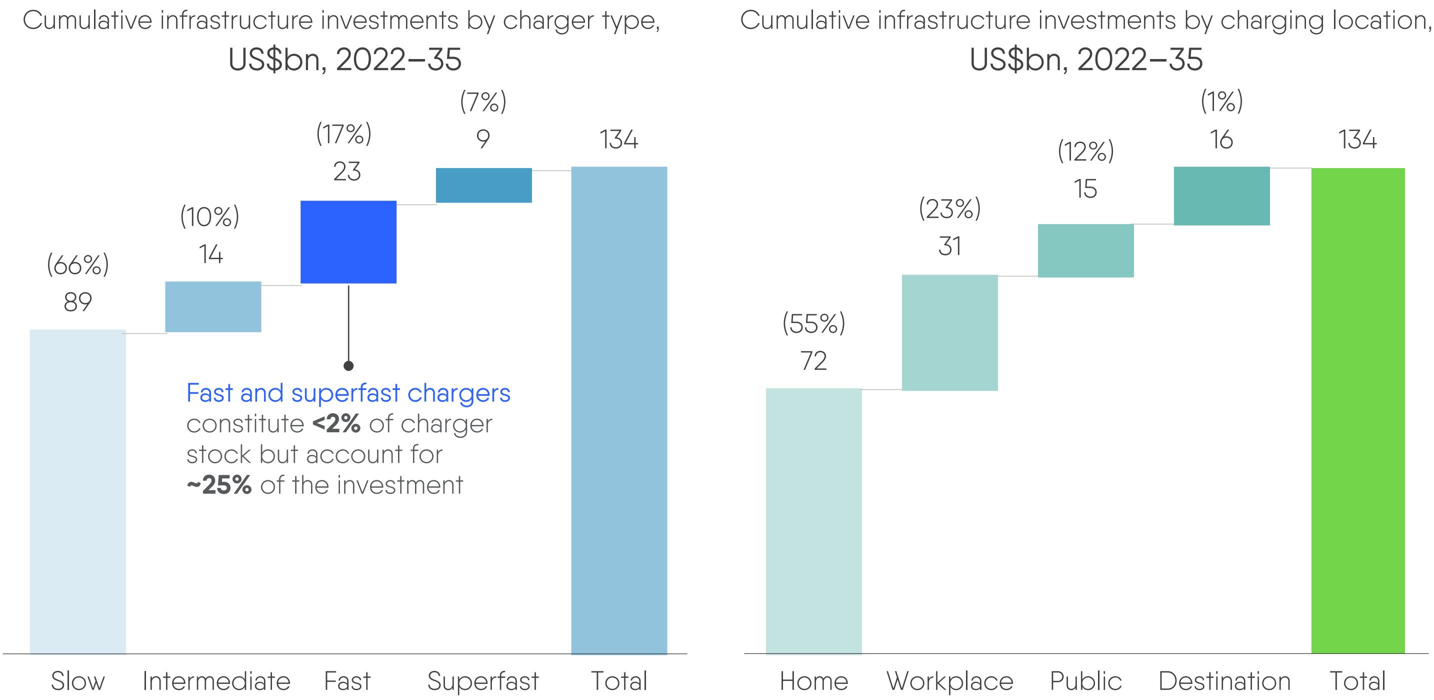
- Level 1 standard AC charging – typically 3kW to 7kW, used in slow or overnight home charging, costing between €700 and €900
- Level 2 fast AC charging – between 10kW and 22kW, used in various 'destination' locations, costing between €900 and €3,000
- DC rapid or high-powered charging – between 50kW and 350kW, commonly used in public charging stations such as highway corridors, costing anywhere between €25,000 for a 50kW rapid charger and €125,000 for a 350kW high-powered charger

Costs are influenced by the positioning and number of chargers, plus network connection fees, labour, materials, permits, taxes and utility upgrades.

With an estimated 65 million chargers needed by 2035, EY calculates an infrastructure investment bill of €115bn, which will be funded by a combination of public and private sources.

In the period from 2022 to 2035, fast and superfast chargers, which will represent less than 2% of the total charger stock, will account for around 25% of total investment.

Figure 6: Charging infrastructure investment needs by charger type and charger location



Source: EY analysis, November 2021.

Source: https://www.gov.uk/government/publications/workplace-charging-scheme-minimum-technical-specification/minimum-technical-specification-workplace-charging-scheme-wcs.

Source: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf.

Source: https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/energy/ey-accelerating-fleet-electrification-in-europe-02022021-final.pdf.

Geographic divide

Of course, numbers only tell part of the story. Where the charge points are sited is another matter entirely. Geographic distribution, at present, is patchy and polarised.

ACEA warns "a two-track infrastructure rollout is developing along the dividing lines between wealthier member states in Western Europe and countries with a lower gross domestic product."[69] Currently, 66% of all charge points are concentrated in just five European countries – France, Germany, Italy, the Netherlands and the UK.

The Netherlands maintains its position as a worldwide leader in eMobility, with the highest density of EVs and charge points per 100 kilometres. It has 93,100 public charge points, the equivalent of 4 EVs per charge point, compared with 60,698 in Germany, where the EV to charge point ratio is 18:1. In the UK, the ratio is marginally better at 15:1.[70] Due to limited off-street parking, EV drivers in the Netherlands tend to rely on public rather than private charging stations, which are mostly free to use. Installation of new public charging stations is free too. The Dutch Government will, on request, install a public charge point close to EV drivers' homes if one is not already available nearby.[71]

Meanwhile, 10 European countries do not have a single charge point per 100 kilometres of road.[72] Cyprus, Malta and Lithuania have just 353 charge points between them.

Looking towards the end of this decade, polarisation will continue. EY calculates that the UK, Germany, France, Italy, the Netherlands and Spain will account for around 60% of total charger stock. By 2035, Sweden, Poland, Portugal and Denmark will come into the fold and, together, the 10 countries will account for 70% of Europe's charger stock.

Clearly, other countries, particularly those in Eastern Europe, need to catch up fast if eMobility is to deliver the optimal impact on decarbonisation.

Countries with most public charge points (2021 data)

93,100
Netherlands

60,698
Germany

42,345
UK

28,601
France

23,753
Sweden

Countries with fewest public charge points (2021 data)

72
Cyprus

97
Malta

184
Lithuania

358
Latvia

401
Estonia

Source: https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats.

[69] https://www.acea.auto/press-release/risk-of-two-track-europe-for-e-mobility-with-sharp-divisions-in-roll-out-of-chargers-auto-industry-warns/.
[70] https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats.
[71] https://www.ampeco.com/blog/ev-and-ev-charging-incentives-in-the-netherlands/.
[72] https://www.acea.auto/files/ACEA_progress_report_2021.pdf.

Charging bottlenecks

So far in 2021, the European public charger network has jumped by 36% compared with 2020.[73] Yet multiple hurdles obstruct infrastructure rollout, impede the user experience and slow EV adoption. In contributing to this report, industry leaders reveal the scale of the challenge:

- **Permitting delays:** CPOs cite lead times of many months to get permission from local authorities to install public charging infrastructure. Local authorities have wide-ranging statutory responsibilities, including housing, social care, education and transport, and many lack dedicated teams to administer the rollout of EV chargers.
- **Access to real estate:** the installation of EV chargers requires access to real estate across highway corridors, dense urban areas and rural locations. Judicious planning is needed so that chargers are sited where usage will be maximised and where electrical grid capacity is either available or can be accommodated. Rising land prices create additional cost challenges, while physical and safety constraints present problems too.
- **Connection delays:** CPOs say it can take between 3 and 36 months to get chargers connected to the grid.
- **Funding:** for hubs of rapid and high-powered chargers, the need for substantial grid upgrades can present a considerable and costly challenge. Lack of clarity over who pays for grid connections and reinforcements to enable millions of EVs to charge is heightened by a lack of incentives for DSOs to prioritise EV connections. The infrastructure business case is worsened where tenants (both commercial and residential) are not the landlords. It adds complexity and can result in disputes over responsibilities for costs.
- **Making charging pay:** on average, the payback period for investment in public charging infrastructure is 10+ years. CPOs may choose to pay for periodic grid upgrades to meet rising EV demand. Or they may invest in a large grid connection ahead of demand, which is likely to be less costly. Either way, the business case for strategic investment in grid connections must be planned carefully if it is to support predicted EV growth.[74]

Getting a grid connection is very often a lengthy procedure. That is not to put the burden onto DSOs, because we know they have a lot to integrate in terms of decentralised generation capacity and renewables, etc., but it slows down the path of infrastructure installation. The procedures can be administratively complex and are certainly not harmonised.

Christelle Verstraeten, Head of EU policy, ChargePoint

We need to make it easier to get build permit and grid connections for public benefit. When asking for additional grid connections, we are in same queue as everyone else.

Oskar Svedenstedt, Chief Commercial Officer, Recharge

We've built our systems to manage with whatever power is available to us. If we don't have enough power from the grid, we add renewables, we add batteries. If there is limited power on site, we decide how much each vehicle needs to ensure they are all charged on time.

Doron Frenkel, Founder and CEO, Driivz

[73] https://www.transportenvironment.org/discover/co2-targets-propel-european-ev-sales/.
[74] https://www.ey.com/en_uk/power-utilities/how-to-make-ev-charging-pay.

- **Interoperability:** lack of standardisation in communication protocols means the interface between charger, vehicle and the grid is not universal. That restricts useability, can limit charger availability and may hinder innovation around payments and charging station energy management.
- **One size does not fit all:** vehicles need different charging solutions to accommodate the size and type of battery and the charging preferences of EV drivers. Understanding preferred locations and durations of vehicle charging is integral to ensuring that the right infrastructure is installed in the right locations.
- **Availability:** lack of visibility over the performance of assets means chargers may be offline or not functioning, frustrating drivers and slowing EV adoption. Predictive maintenance, enabled by data science and real-time diagnostics, is critical for guaranteeing charger availability.

These bottlenecks already exist today. But just imagine how exacerbated they will become once EV adoption accelerates at the predicted pace.

Poor cash flow and returns are jeopardising the case for investment in public charging infrastructure. EY research finds that a typical charging station, with two slow and two fast chargers, will take five years to yield positive cash flow. Our analysis shows that the payback periods for charging infrastructure investments are longer than 10 years.

Thierry Mortier, EY Global Digital & Innovation Lead for Energy

Technological barriers are giving way to more bureaucratic and administrative barriers in the delivery of a charge point service.

Dominic Phinn, Senior Policy Manager,
The Climate Group/EV100

Buildings are going up in the Netherlands, but they can't open because it takes three years to get a grid connection. There is not enough capacity. On the other hand, the market for stationary batteries is booming, because that's the only way to connect a large building to a small grid connection.

Lennart Verheijen, Head of Innovation, GreenFlux

Can central eMobility ambition translate into local application?

As petrol and diesel vehicles are phased out, public electric chargers will become indispensable street furniture. And they will change, inevitably, the characteristics of villages, towns and cities.

It is important, however, that big-picture European and national mandates on decarbonisation and the climate are not imposed on local authorities. Installation of infrastructure must not become target based. Instead, it should be needs based and attune with local circumstances. Mobility, in a day-to-day context, is largely defined by proximity to services – schools, shops, leisure activities, etc. – within a local community. Charger installation, therefore, must be governed by population density, likely future EV ownership, access to off-street parking, average daily commutes, topography, economic and social characteristics, etc. Future social mobility trends, including public transport, cycling and walking, should be considered too.

The COVID-19 pandemic gave us a glimpse of what life could be like with reduced pollution from transport, and it has shifted the human response in relation to our environment. So, preservation of green spaces, cleaner air and local identity must sit comfortably alongside eMobility. City and town planners are striving to create a trade-off between the two tensions. They promote alternative forms of transport, such as shared mobility, electric bikes and electric buses, and encourage street pedestrianisation and safer cycle lanes.

Not all homes can install chargers

- In Ireland, 20% of homes do not have driveways.
- In the Netherlands, 70% do not have driveways.
- In the UK, one-third does not have driveways.
- One in six rural homes do not have off-street parking.
- Sixty percent of urban homes do not have off-street parking.

Source: https://www.current-news.co.uk/news/ukpn-records-42-increase-in-ev-chargepoints.

A UK government report identified that the UK needs approximately 400,000 public charge points by 2030. However, it also finds that the increase in EVs is outpacing growth in public charging infrastructure. There are currently 10 EVs per charger in the UK, similar to Belgium and Ireland. That rises to four EVs per public charger in the Netherlands.

Source: https://publications.parliament.uk/pa/cm5802/cmselect/cmtrans/27/2706.html.

A convergence between COVID-19 pandemic recovery plans and the Green Deal accelerated eMobility uptake.

Christelle Verstraeten, Head of EU policy, ChargePoint

Ultra-low emission zones, use of EVs in bus lanes, toll-free driving, etc., sit among the arsenal of tools available to local authorities to spur the switch to electric. London, for instance, has accelerated its plans for a zero-emissions electric bus fleet from 2037 to 2034.[75] In the traffic-choked streets of Paris, where just 3 in 10 residents own a car, the Mayor is pushing ahead with plans to remove 70,000 surface parking spaces, in favour of underground parking, to encourage more eco-friendly travel.[76]

For the future good

There is no template solution for eMobility and charging. But what we have right now is a unique opportunity to remodel road transport for the future good of the environment and humankind. In much the same way as first-generation electricity grids impacted 100 years ago, the infrastructure decisions we make today will continue to impact decades down the line. Situating chargers in locations where they deliver maximum customer convenience and greatest environmental influence, as well as financial returns that will keep investors investing, is a global imperative.

So, charging infrastructure will become a fact of life. But it must work with, rather than frustrate, users. It should deliver enhanced interoperability that enables them to charge, pay and roam across networks and geographies as they have always done, but in a cleaner and more sustainable way. That, however, is subject to the robustness of the electricity grid.

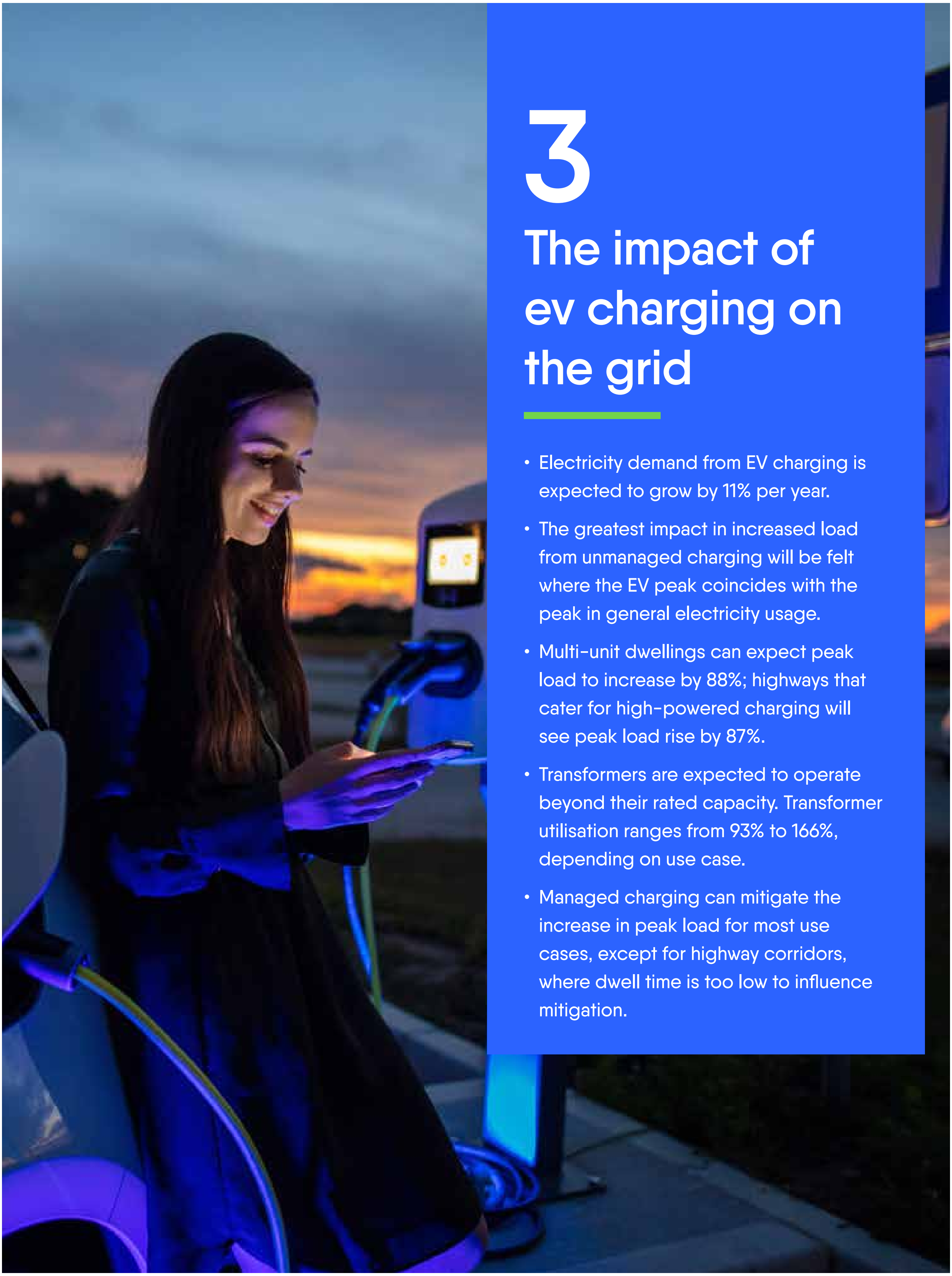
The charging infrastructure approach in London is to take land use, and its impacts on the future of the city, into account. They don't choose locations simply based on cost or existing grid capacity. The idea is to take responsibility for how charging infrastructure will reshape the face of the city's livelihood. Stepping out of forcing mechanisms, which have driven urban development to date, the regulator is assessing ten sites for suitability, based on environmental, social and economic benefits and impact. Realising that an ongoing impact evaluation will be needed, there is a public-private collaboration for generating information about EV charging hotspots.

Maya Ben Dror, Practice Manager, Automotive and New Mobility, World Economic Forum

Cities in the Netherlands manage the trade-off between public space and promotion of cleaner vehicles because the different levels of governance talk to one another. That means deployment of charging infrastructure happens smoothly and the national plan does not disrupt the local mobility plan.

Thomas Lymes, Policy Advisor – Project Coordinator Mobility, Eurocities

[75] https://www.london.gov.uk/press-releases/mayoral/mayor-host-zero-emission-bus-summit-at-city-hall.
[76] https://www.weforum.org/agenda/2020/12/paris-parking-spaces-greenery-cities/.



3

The impact of ev charging on the grid

- Electricity demand from EV charging is expected to grow by 11% per year.
- The greatest impact in increased load from unmanaged charging will be felt where the EV peak coincides with the peak in general electricity usage.
- Multi-unit dwellings can expect peak load to increase by 88%; highways that cater for high-powered charging will see peak load rise by 87%.
- Transformers are expected to operate beyond their rated capacity. Transformer utilisation ranges from 93% to 166%, depending on use case.
- Managed charging can mitigate the increase in peak load for most use cases, except for highway corridors, where dwell time is too low to influence mitigation.

Total electricity demand in Europe is expected to increase by around 1.8% per year by 2030 to around 3,530TWh, according to Eurelectric. The residential, commercial and industrial sectors will contribute to electricity demand growth, but the strongest growth will come from transport. In this sector, EV penetration will see electricity demand growth accelerate by 11% per year, adding 200TWh by the end of this decade.[77]

Currently, electricity demand growth is partly offset by energy efficiency measures. However, now that the EU has set an objective of a minimum 55% reduction in greenhouse gas (GHG) emissions by 2030, significant investment will be needed to accelerate and deepen the level of energy savings if Europe is to meet that challenge.[78]

For all the scaremongering about the grid not being able to handle the influx of EVs, the reality is that it can cope. The destabilising impact will come, however, when thousands or even millions of EVs attempt to charge simultaneously. The more vehicles that connect to conventional electrical networks, the greater the risk to the adequacy and secure operation of the electricity system, as well as to the quality of power supply. In the UK, the Government has announced a draft law that will limit the use of home or workplace EV chargers for up to nine hours a day to avoid overloading the national electricity grid.[79] Charging EVs can cause voltage drops, voltage fluctuations and power losses.[80]

When the number of EVs increases, total load demand increases and voltage decreases, steadily but simultaneously. Under an unmanaged charging scenario, a high penetration of EVs could violate voltage boundaries and disrupt the security of the power network. Studies show that once EV penetration reaches 50%, network voltage deviations go beyond the standard level.[81]

A 'fit-and-forget' approach to charger connections can exacerbate congestion problems in already heavily loaded grids. It can increase low-voltage problems in predominantly radial networks and increase peak load and energy losses. Potentially, it will lead to large load imbalances between phases in low voltage networks. The problem is accentuated where peak load periods coincide with EV charging periods.[82]

Upstream, generation and transmission systems could also experience problems due to grid loading at the distribution system level. They include unpredictability of power flows, lack of installed and operational reserve, and changes in marginal generating units, which could have a consequential impact on energy prices.

UK Power Networks says a single 50kW rapid charger uses the same amount of power as a block of 25 apartments.

Source: https://www.current-news.co.uk/news/ukpn-records-42-increase-in-ev-chargepoints.

An anticipated 1.9 million EVs in the Netherlands by 2030 could add around 6TWh of electrical energy per year.

Source: https://www.elaad.nl/uploads/files/Smart-Charging-Guide/Smart_Charging_Guide_EN_single_page.pdf

[77] https://www.eurelectric.org/connecting-the-dots/.
[78] https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698045/EPRS_BRI(2021)698045_EN.pdf.
[79] https://insideevs.com/news/537120/ev-chargers-switched-off-uk/.
[80] https://ietresearch.onlinelibrary.wiley.com/doi/10.1049/iet-est.2018.5023.
[81] Li, H.L., Bai, X.M., Tan, W.: 'https://www.researchgate.net/publication/297055070_Impacts_of_electric_vehicles_charging_on_distribution_grid'. 2012 IEEE Int. Conf. on Power System Technology (POWERCON), Auckland, New Zealand, 2012, pp. 1–5.
[82] Anestis G. Anastasiadisa*, Georgios P. Kondylisb , Apostolos Polyzakisc , Georgios Vokas: 'https://www.sciencedirect.com/science/article/pii/S1876610218311925".

Where will unmanaged charging make the biggest impact?

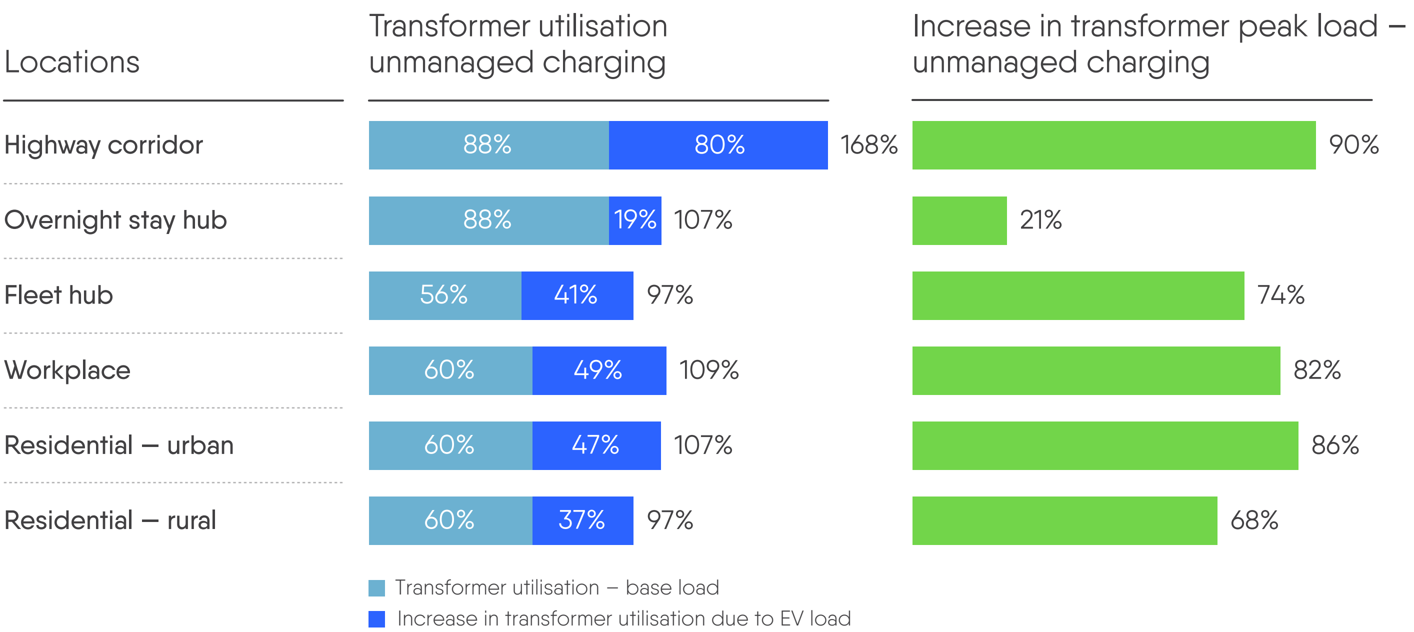
EY analysis considered the six most common charging use cases, as identified in our conversations with industry:

1. Residential (rural)
2. Residential (urban)
3. Workplace
4. Fleet hub
5. Overnight stay hub
6. Highway corridor

We factored in likely EV adoption, as well as the number of chargers and types in use. Based on estimated average daily distances travelled by electric cars, buses, vans and trucks in 2035, we calculated the likely draw on the electricity grid. Across our six use cases, in all instances, peak load will increase by 21%–90% and transformer utilisation will rise by 19%–80%. Two further observations stood out:

- The greater the coincidence in usage patterns, the greater the impact on peak demand. So, for residential urban charging, where the peak in EV charging coincides with the daily electricity usage peak, the impact on peak demand is greatest.
- Impact is positively correlated to charging speed. So a single 350kW charger can adversely increase peak demand beyond manageable limits, compared with multiple 7kW slow chargers operating in, for example, a home or workplace context.

Figure 7: Impact of unmanaged charging across six use cases



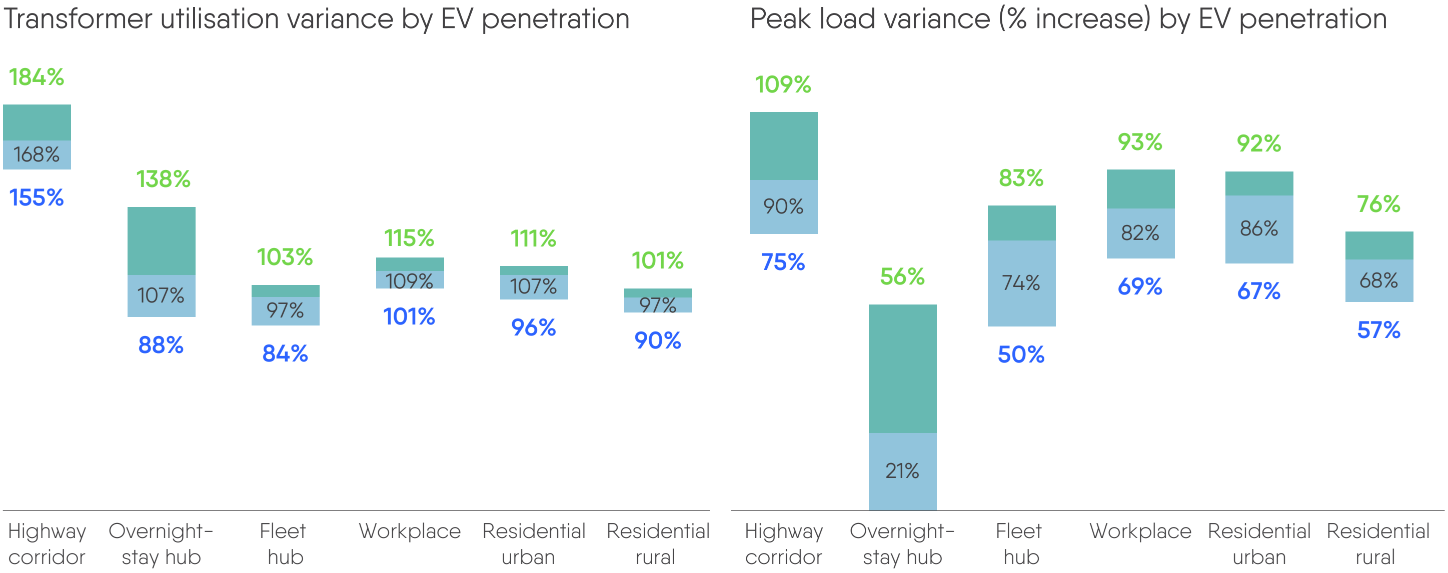
Notes:
1. Transformer utilisation: ratio of peak load to transformer-rated capacity.
2. Increase in peak load: measures increase compared with the base-case.

Source: EY analysis, November 2021.[83]

[83] EYs grid impact analysis is conducted using WRI's EV simulator tool. This analysis is illustrative and is conducted for six presumptive transformers located in a utility's service territory. The analysis is not carried out for any specific utility or service territory. The analysis factors in several assumptions around vehicle attributes, user driving and charger behaviour, and charger attributes sourced using secondary research, expert input and analysis. Evaluation of the impact of managed charging on peak demand is based on assumptions around vehicles participating in managed charging, parking duration and managed to charge power limits. These assumptions are based on secondary research, expert input and analysis.

If demand is not managed, the problems will perpetuate. Figure 8 illustrates the impact of increased electricity demand, in different EV-penetration scenarios, on peak load across the six use cases.

Figure 8: Impact of unmanaged charging across six use cases



EV penetration scenarios – share of total vehicle parc

Vehicle type/scenarios	Low	Base	High
M&HCVs – trucks and buses	4%	6%	8%
Light vehicles – cars and vans	27%	32%	37%

KEY

Low penetration
Base case
High penetration

Δ between base case and high penetration case

Δ between base case and low penetration case

Source: EY analysis, November 2021.[82]

Highway corridors, where energy consumption from high-powered, rapid charging of passenger cars, LCVs and HDVs is unpredictable, rank highest. They effect a 90% increase on peak load where EV charging and high general electricity usage coincide. They are followed closely by multi-unit dwellings in residential urban settings. Charging at this location contributes to an 86% increase in peak load. Workplace charging sees an 82% increase in peak load. The least impacted use cases are fleet hubs, residential rural and overnight stay hubs, at 74%, 68% and 21% respectively.

We expect transformers, in four of the six use cases, to be overloaded and to operate beyond their rated capacity. The exceptions are the fleet hub and residential rural use cases. For the others, transformer utilisation rates will vary by setting: residential urban (107%), overnight stay hubs (107%), workplace (109%) and highways (168%).

“

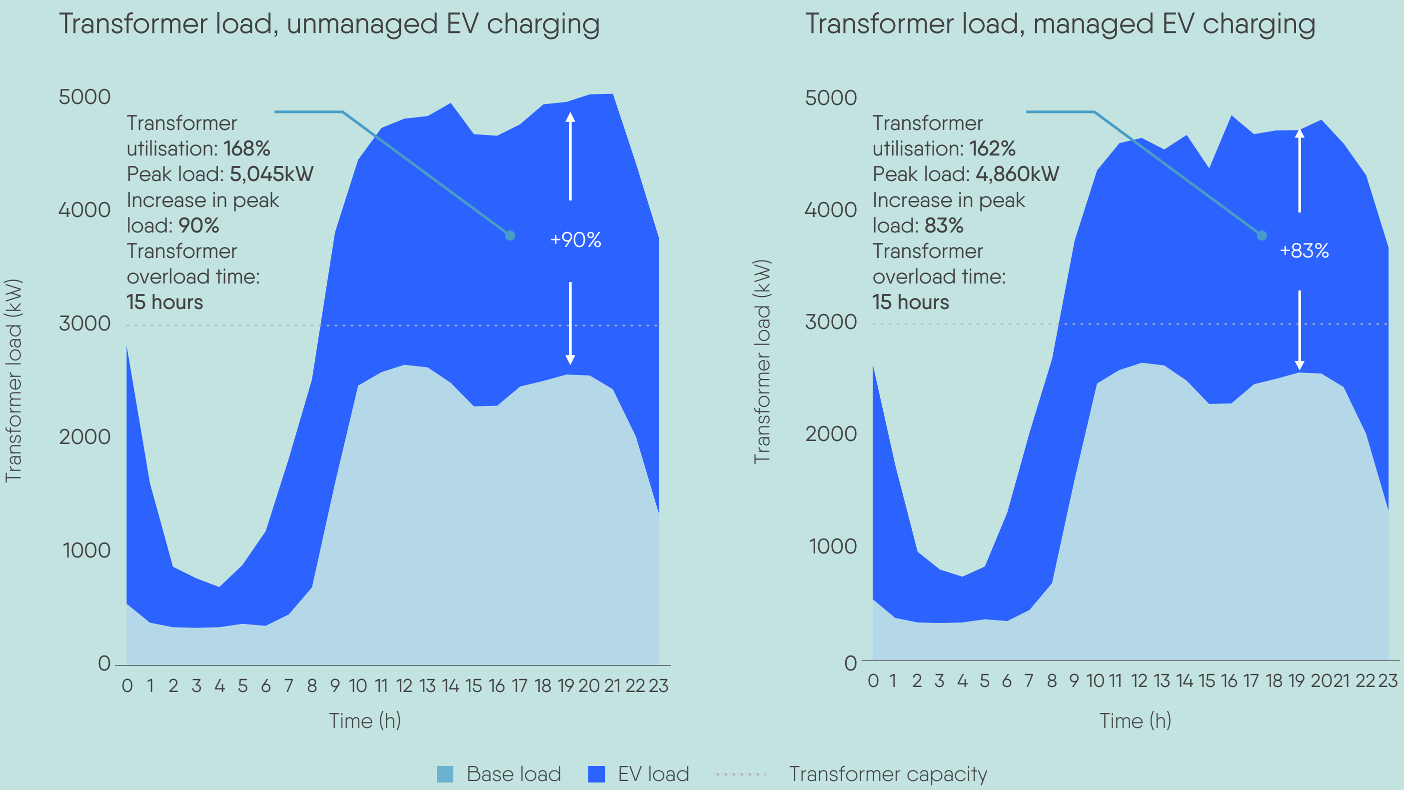
Avoiding constraints in the system will require the combined management of supply, grid and demand-side assets, as well as policies and measures that give consumers the appropriate market signals for consumption.

Gonçalo Castelo Branco, Director of Smart Mobility, EDP

The risk of unmanaged demand

Highway corridor use case

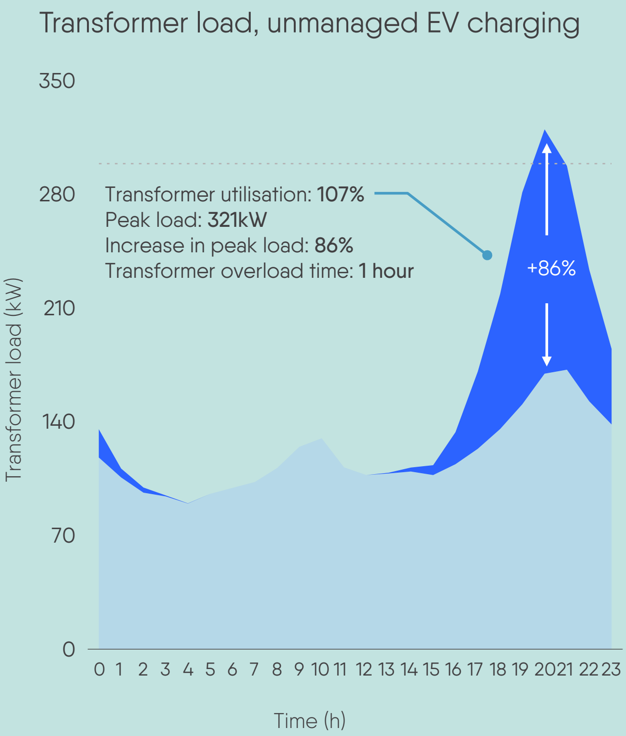
In 2035, on the main European highways, electricity grid infrastructure is being tested. Historically, there has been no significant demand for electricity along the main road networks, but eHDVs are now pulling into service stations to use superfast 350kW or >500kW chargers. LCVs and EVs are topping up with enough electricity to complete their journeys. Load is unpredictable throughout the day. Connections to the grid are expensive. Moreover, the grid must manage a high-capacity, short-duration charging load, with limited options to control peaks given the brevity of dwell time.

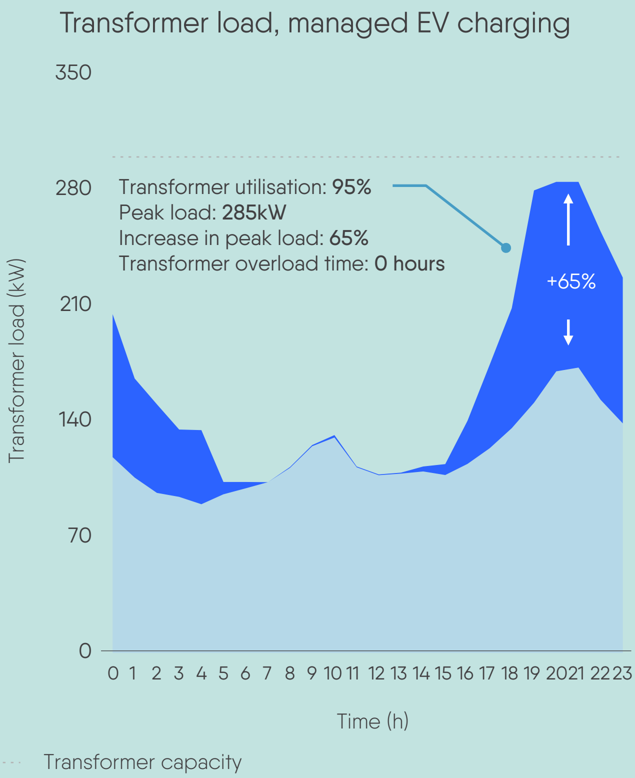


Residential – urban use case – multi-unit dwelling

In 2035, a five-storey building is home to 15 families in the centre of a European commuter town. At around 6:00 p.m. every day, people return home from work and plug in their EVs to charge. Families begin to unwind. Appliances go on in the kitchen; laptops fire up; the TV is on in the living room.

And the same thing goes on in the next residential building, and the next, and the next. Within a few hours, electricity consumption begins to peak. The local transformer trips. The grid struggles to cope with this unpredictable and highly concentrated charging activity.





How unmanaged charging is impacting local grid resilience

Some countries are better equipped than others to cope with unmanaged charging. In the Netherlands, where the grid system is built to meet peak demand of around 270TWh, capacity is more than adequate to charge 1.9 million EVs by 2030, so long as they don't all go on charge at the same time.

In Hamburg, a DSO found that electrification of 9% (60,000) of the city's total private vehicle fleet would create bottlenecks in 15% of the feeders in the distribution network. Reinforcement of the local grid, at the cost of at least €20mn, is needed.[84]

> Everyone is talking about what 2035 will look like. You can't predict with accuracy unless you put in a system to monitor decisions and validate assumptions. That means digitising the entire system to have eyes and ears on the ground.
>
> Paul Micallef, EY Global Digital Grid Leader

In France and Norway, where electric has long been the principal power source for heating, the impact of eMobility appears negligible. They have enough capacity. Grid investment costs for eMobility come in at around just 1% of capex. Grid and network companies are not daunted by the anticipated future load from EVs. In fact, they see opportunity in their ability to shift the peak with managed-charging solutions. They need digital capabilities to capture and interrogate data accumulated over extended periods, which will accurately inform their future grid investment decisions.

EY's Renewable Energy Country Attractiveness Index reveals that Eastern Europe is trailing in its development of green energy infrastructure compared with Western Europe.[85] A 'coal curtain' has gone up between east and west that is largely a consequence of affordability[86] and will impact decarbonisation initiatives. Reduced industrial output and lower per capita incomes mean reduced energy consumption, while tariffs fail to recover costs fully. This translates into underinvestment in grid infrastructure. Unmanaged charging of relatively large EV loads at a distribution level could easily exacerbate issues with reliability.[87]

From grid liability to grid asset – solutions to EV charging

Infrastructure reinforcement might seem an obvious answer to managing the impact of EV charging on distribution grids, but it may not be the most efficient solution. And, of course, the unpredictable EV burden is not the only challenge for grid operators, which are also dealing with the introduction of heat pumps and the electrification of buildings and industry.

Proactive measures and investments are needed if the grid is to juggle each of its demands effectively and enable Europe's transition to net zero. A clear view of the current state of the grid across geographical areas is essential. It provides a baseline against which to assess EV uptake, heat

[84] https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/May/IRENA_Innovation_Outlook_EV_smart_charging_2019.pdf.
[85] https://www.ey.com/en_ao/news/2021/10/conditions-are-ripe-for-rapid-growth-in-renewables-generation-inadequate-grid-investments-may-be-a-major-challenge.
[86] https://www.renewableenergyworld.com/blog/the-coal-curtain-why-eastern-europe-will-be-slower-to-adopt-renewable-energy/#gref.
[87] https://energypost.eu/accelerating-electromobility-in-east-europe-a-how-to-guide-part-1/.

pump installations, etc., track energy variances by location and inform decisions relating to energy expansion.

Our analysis and interviews with leading industry commentators identified the most encouraging technology solutions, at differing stages of maturity, that could mitigate challenges associated with unmanaged EV charging:

- Managed charging:
  - Supplier-managed smart charging, via a local smart charger; an energy management system, such as an advanced distribution management system (ADMS) and a distributed energy resource management system (DERMS); peak-to-peak voltage (PPV) or charging management system (CMS)
  - User-managed smart charging via time of use (ToU) tariff
- Solar distributed generation and storage co-location
- Smart grid investments (e.g., smart wires)
- Wireless charging

We think in terms of opportunities for new and innovative system services to support our ramping reserve provision. Electric vehicles are on the demand side but, if they can provide generation, that's fine too. As long as they give us dynamic capability.

David McGowan, Team Lead Future Networks, EirGrid Group

In order to manage the increasing demand for electricity that will come from eMobility, it will be required to invest in digitisation and innovation to turn distribution networks into smart grids: the exploitation of real-time energy flow data combined with artificial intelligence technologies will empower advanced monitoring and efficient network management.

Fabio Giammanco, Head of Network Analysis and Solutions Optimization, Enel

Supplier-managed smart charging

Smart charging means controlled charging of EVs in a way that allows charging power to be increased and decreased as needed. It works by connecting EVs to a charger that provides, via a data connection, information about the cheapest time to charge. Charging follows the load-demand curve, so EVs are charged during low-demand hours. The lower the grid load, the more EV charging takes place, in what is commonly described as 'valley filling'. Charging at the optimal period is enabled automatically rather than physically. The energy flow goes in one direction only, from the grid to the vehicle.

In time, as smart charging technologies become more sophisticated, vehicle-to-grid (V2G) solutions will allow power that is stored in EVs to be pushed back to the grid, or to a building such as a home, office or factory, to balance energy production and consumption. EVs participating in V2G services will help to boost the efficiency, reliability and stability of the grid through flexibility services such as load balancing, peak shaving, regulation of frequency and the provision of support for the incorporation of renewable energy.

Renewable energy, such as wind and solar, is intermittent. But with V2G, there will be no need to curtail the generation of cheap and clean energy when there is more wind or sunshine than turbines or photovoltaics can handle. Instead, renewable generation will be stored in EV batteries and discharged at times of peak demand when availability is reduced. The driver may be compensated for the 'loan' of stored energy to the grid.

In this way, the vehicle becomes a battery on wheels and can function as a flexibility asset for the grid. For now, however, issues persist, including:

- Regular cycling, which could increase the rate of degradation of the EV's battery life[88]
- Customer buy-in to the concept, not least due to data ownership concerns
- Fiscal compensation for sharing stored energy with the grid

[88] https://chargedevs.com/newswire/new-study-v2g-may-not-degrade-ev-battery-life-it-might-actually-extend-it/.

Electric vehicles are not isolated elements but part of a bigger system when connected to the grid. For TSOs and DSOs, having more real-time data about these moveable assets – where they travel, where they charge, the state of charge and their capability to provide flexibility to the system – is critical. In the future, charging will be facilitated thanks to real-time pricing signals, renewable availability and possible congestions.

Manuel Gálvez, Group EU Affairs, Elia Group

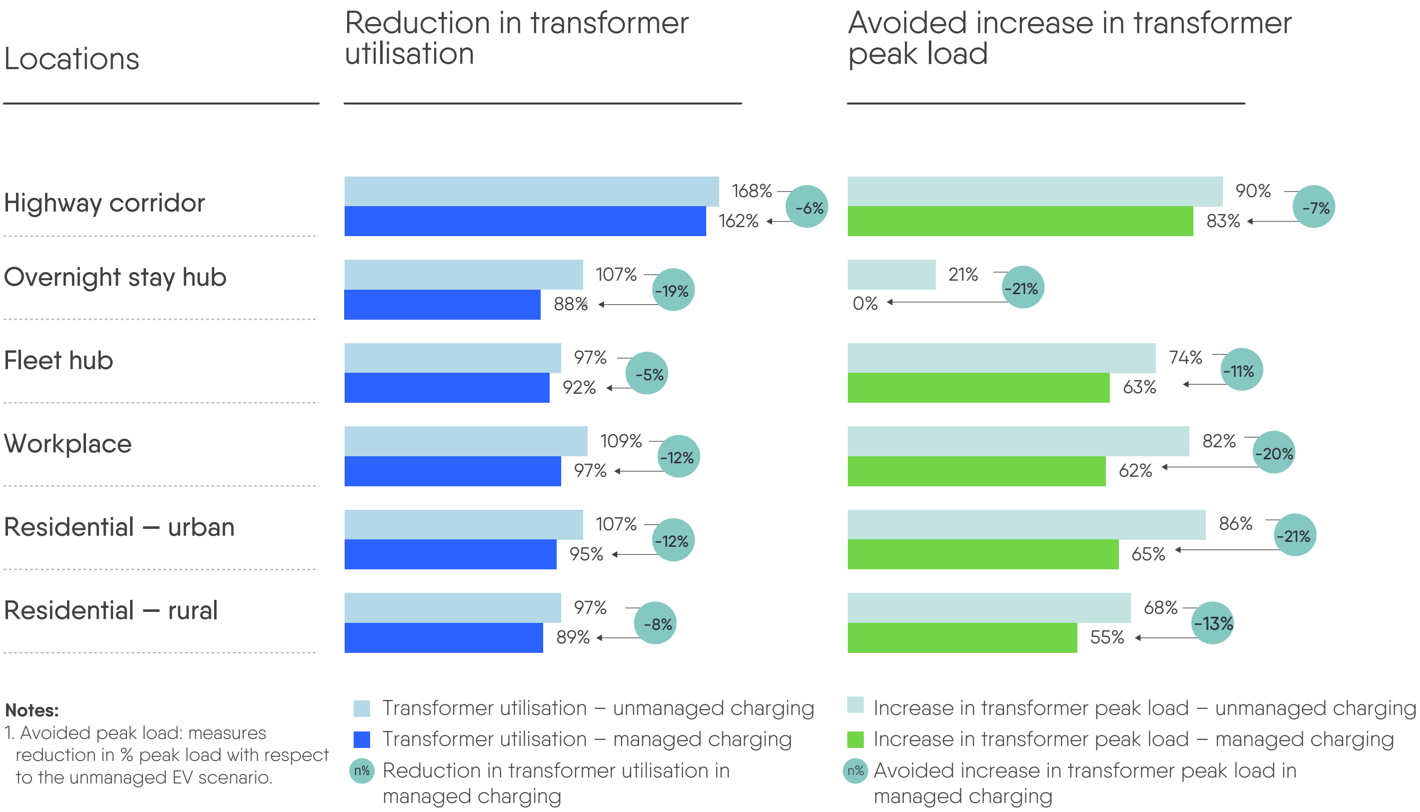
I don't think the capacity of the grid will be exceeded in France, not even as more charging stations are installed as we can limit the impact from charging with solutions such as smart charging and vehicle to grid technology.

Eléonore Bon, Electric Mobility Director, ENGIE

When you get into vehicle-to-grid technologies, you get customer scepticism from a battery degradation perspective. But, if the conversation is about optimising – plugging the vehicle in for 10 hours and charging for six hours at the lowest energy price or scaling down charging from 11kW to 5kW for two hours when there is greatest congestion – there is limited driver reluctance because, intuitively, this does not harm the battery.

Tomas Björnsson, Head of eMobility, Vattenfall

Figure 9: Impact of managed charging across six use cases



Notes:
1. Avoided peak load: measures reduction in % peak load with respect to the unmanaged EV scenario.

Source: EY analysis, November 2021.

Across five of our six use cases, where we identified potential risk, supplier-managed charging has the potential to save 11% to 21% of peak load.[89] Figure 9 shows the largest reduction in peak load in the residential urban and overnight stay hub use cases at 21% each, while charging at the workplace, residential rural and fleet hubs see peak loads drop by 20%, 13% and 11% respectively.

The exception is the highway, where there is reduced scope to introduce managed charging. Vehicle dwell time is extremely low, and charging is rapid and high-powered, making it unlikely to respond to mitigation measures. Peak load on highways is reduced by just 7%. For this use case, alternative solutions must be sought, such as co-location of solar and behind-the-meter battery storage solutions.

User-managed charging

User-managed charging helps to balance a power supply that is now more diverse, decentralised and intermittent, due to the influx of distributed energy resources (DERs) and renewables. This is effectively coordinated EV charging and requires either the customer or a central operator to control charging in response to a price signal, according to available grid capacity. This can be done through local ToU tariffs, which incentivise the customer to charge when it is cheaper, and outside peak periods. It allows not only effective usage of the power grid system but can also diminish costs for both the utility and customer.

[89] EY analysis, November 2021

Customers can decide how and when to react to price signals and can adjust consumption during specific time intervals. In the UK, Good Energy, a 100% renewable energy supplier, has launched two new ToU tariffs to support EV drivers. It offers two overnight off-peak periods when drivers can charge their EVs at a cheaper rate. In trials, these were used by 98% of customers.[90]

The ability to delay or direct charging could bring better balance to the energy system and limit the need for expensive network upgrades. Investment savings can be passed on to customers via cheaper electricity tariffs or rewards. Furthermore, EV drivers can set their charging preferences remotely, using apps, without having to manually connect and disconnect their vehicles.

Solar distributed generation and storage co-location

For use cases where grid supply is insufficient for fast and superfast charging, such as highway corridor service stations, energy storage systems could provide an answer. The systems store energy during periods of low demand for use when there is heightened demand for rapid and high-power charging. Stored energy acts as a 'filler' until increased power is available directly from the grid.

Integrated solar energy storage solutions are also being considered. Electricity generated via the solar panel system is held in the battery storage system and leveraged to charge on-site EVs. It reduces the charging station's dependency on the local grid for around 1,000 of the total 8,600 hours per year.

Utilities see this solar-plus-storage combination as a solution to the challenges of demand and high electricity prices during peak hours. When solar generation is high during the daytime, electricity can be stored. When demand and prices are high, usually peaking in the evening, this stored energy can be released. In some cases, a battery storage system may be used to store low-cost electricity from the grid.

In 2020, battery developer and manufacturer Northvolt deployed its first public battery energy storage system at an EV charging station in Västerås, Sweden. The battery system, operated by Swedish energy provider Mälarenergi, provides power output up to 220kW and a usable energy capacity of 320kWh. The battery system functions as a buffer between the electricity grid and the EV charging station to enable peak shaving and load levelling. Peak shaving helps utilities to meet demand without relying on peaking generators, which are viewed, increasingly, as a costly and inefficient way to compensate for new demands from EV charging. The battery system aims to reduce peaks in electricity demand at the charging station by more than 80%, lessening the impact of EV charging on the local electricity network.[91]

The current electricity markets need adaptation if consumers and appliances are to participate. We are trialling two solutions which will open competition behind the meter. The first is a real-time price signal which will allow consumers, EVs or smart appliances to determine the best time to charge and, in doing so, contribute to balancing the grid and gaining some value from it. The second is the 'exchange of energy blocks'. These 15-minute energy blocks can be exchanged between any party. For example, the energy blocks relating to charging a company EV can be isolated on the home bill and charged directly to another party.

Michaël Piron, Consumer Centricity – Program Manager, Elia Group

Similarly, in the Netherlands, Shell is trialling a battery-backed ultrafast-charging system at a filling station. Two 175kW chargers will draw on a 300kW/hour or 360kW/hour battery system. The battery is optimised to charge

[90] https://group.goodenergy.co.uk/reporting-and-news-centre/press-release-news/press-release-details/2021/Good-Energy-launches-new-time-of-use-tariff-for-electric-vehicle-drivers/default.aspx.
[91] https://northvolt.com/articles/rocklunda-nov2020/.

when renewable production is high, keeping both prices and carbon content low. Shell, through its acquisition of Greenlots and NewMotion software, will manage the battery system, which is provided by Alfen. When it is not helping to ease grid stress from EV charging, it will make money by participating in a virtual power plant via the Greenlots FlexCharge platform.[92, 93]

German utility E.ON and automaker Volkswagen launched a fast charger with an integrated storage battery in September 2021. The E.ON Drive Booster does not draw its power directly from the grid, but has its own integrated battery storage system. A normal power connection, together with an internal battery, can charge two EVS simultaneously with up to 150kW. It takes around 15 minutes to charge the cars with enough power to travel 200 kilometres.[94]

EV charging supported by storage is also being installed by GRIDSERVE as part of its Electric Forecourt® initiative. It combines the two technologies with solar to provide EV charging at competitive prices. Stationary energy storage to support EV charging could reach a global installed capacity of 1,900MW by the end of 2029. [95]

Smart wires

A common challenge for grid operators is constantly changing power flows, which can lead to unequally loaded circuits.

Technologies are being developed to actively balance power flows on transmission lines. They work by pushing power from overloaded lines and pulling power onto underutilised lines. The technology[96] can be integrated with an electricity system operator's supervisory control and data acquisition platform to monitor the grid from a control room. It can be used to support EV charging by freeing up congested capacity on the network.

In the UK, National Grid Electricity Transmission (NGET) says the technology can unlock 1.5GW of network capacity.[97] It is being used on five circuits at three of NGET's substation sites in the North of England, making 500MW of new network capacity available at each location. This technology helps to resolve constraints, enables greater integration of renewable energy and reduces the need for new infrastructure.

Wireless charging

The European market for the wireless charging of EVs was valued at €3.6bn in 2020 and is expected to reach €15bn by 2026.[98]

It includes innovative technologies, such as in-road or in-depot wireless charging, to address the challenges of charging station availability and time spent charging. A transmitting pad, installed on the ground and connected to the grid, links to the receiving pad on the underside of the EV via a magnetic field. Wireless signals are sent between the vehicle and the charging system to both initiate and stop charging. This means that vehicles can charge opportunistically during scheduled stops, reducing the number of chargers that an operator needs to install at specific charger hubs. Vehicles can top up throughout the day, boosting battery range.

The concept of the wireless EV road is being explored. EVs are charged by pads or coils under the road surface using magnetic induction. Although this does not fully charge EVs, it increases range and relieves driver anxiety. Among the companies trialling the technology is Finnish utility Fortum. Partnering with Momentum Dynamics and the Municipal Government of Oslo, it will install wireless charging stations for electric taxis. Charging plates in roads will connect to energy receivers in EV taxis, allowing a charge of up to 75kW.[99]

Momentum Dynamics has developed software to automatically identify vehicles equipped with energy receivers and regulate the sale of power. When used for large commercial vehicles, where rapid charging is often important, the system can recharge a vehicle using

[92] https://www.shell.com/energy-and-innovation/new-energies/new-energies-media-releases/shell-trials-forecourt-battery-power-storage-system-as-it-ramps-up-ev-ambitions.html.
[93] https://greenlots.com/greenlots-enables-shell-recharge-battery-power-storage-system/.
[94] https://www.volkswagenag.com/en/news/2021/09/e-on-and-volkswagen-launch-fast-charger-with-storage-battery.html.
[95] https://www.energy-storage.news/guidehouse-energy-storage-to-support-electric-vehicle-charging-could-reach-1900mw-by-2029/.
[96] https://www.electranet.com.au/wp-content/uploads/ritt/2016/11/Smart-Wires-submission.pdf.
[97] https://www.powerinfotoday.com/thermal/national-grid-electricity-transmission-uses-smart-wires-technology/.
[98] https://www.mordorintelligence.com/industry-reports/europe-wireless-charging-market-industry.
[99] https://sustainabilitymag.com/smart-cities/oslos-electric-taxis-be-charged-using-wireless-technology?page=1.

lower voltage systems (240V) much more rapidly than a comparable plug-in charger.[100]

Another wireless charging innovation comes from BMW. It undertook pilots in Germany and the US to test wireless charging on its 530e plug-in-hybrid sedans. A ground pad, with a secondary pad fixed to the underside of the vehicle, allows the contactless transfer of energy over a distance of three inches. The system has a charging power of 3.2kW and will fully charge a 530e PHEV in three and a half hours.[101]

Each of these potential demand-side management solutions creates synergies between the smart grid and EVs. In turn, they:

- Reduce the need for massive grid investment
- Enable operational flexibility, shifting a centrally operated power system to a decentralised paradigm, populated by autonomous smart participants
- Allow EV drivers, operating as part of a decentralised and regulated model, to provide balancing capacity to the power system and be properly remunerated

The critical role of DSOs in EV integration

DSOs are part of a smart EV value chain that includes charging infrastructure providers, responsible amongst other things for the building and operating charging station and managing the power supply and grid effect, and eMSPs that focus on everything from battery management to roaming, infrastructure and vehicle services. In this value chain, DSOs are critical to ongoing eMobility development. They are responsible for planning grid development, managing distribution grids, billing and connecting chargers. They must undertake deep analysis of EV driver-usage patterns, and locations of homes and businesses, if they are to match chargers to user needs and increase facilities.

Their level of insight allows DSOs to assess the impact made by the addition of EVs and chargers and to anticipate future grid investment and development at different connection points.[102] It equips them, moreover, to define the specifications for smart operations on the grid. Crucially, the evolution in V2G technologies, which will see EVs participate in and influence grid flexibility, must be optimised locally by DSOs. Where bidirectional power flows are enabled, EVs will become storage units, discharging power from vehicle batteries to the grid.

To support the transition to eMobility, and enable the broader energy transition, DSOs must navigate challenges across several key areas:

- **Smart grid planning:** monitoring the grid to anticipate future use, design and investment needs; fulfilment of actual grid needs in the medium and long term, and guaranteeing cost efficiency in grid updates and the best use of existing assets.
- **Active system management:** implementing smart technologies (automated, real-time, interoperable and interactive technologies that optimise the operation of consumer devices and appliances) for communication and metering purposes, and which consider the grid status and operation.
- **Security, efficiency and reliability:** increasing the application and implementation of control technologies, cybersecurity and digital information for grid stability, as well as improved data management and security.
- **DER management and renewables integration:** providing real-time situational awareness and control over behind-the-meter DERs to enable grid services.
- **Technology and data:** integrating and deploying peak-shaving technologies and high-tech electricity storage, including BEVs and PHEVs, as well as thermal storage systems.
- **Flexibility:** incorporating and developing local flexibility markets, demand response programmes and energy-efficiency resources, including control options and timely information for consumers.
- **Smart asset management:** developing advanced asset management strategies, tools and methods that focus on monitoring the condition of assets and risk mitigation.

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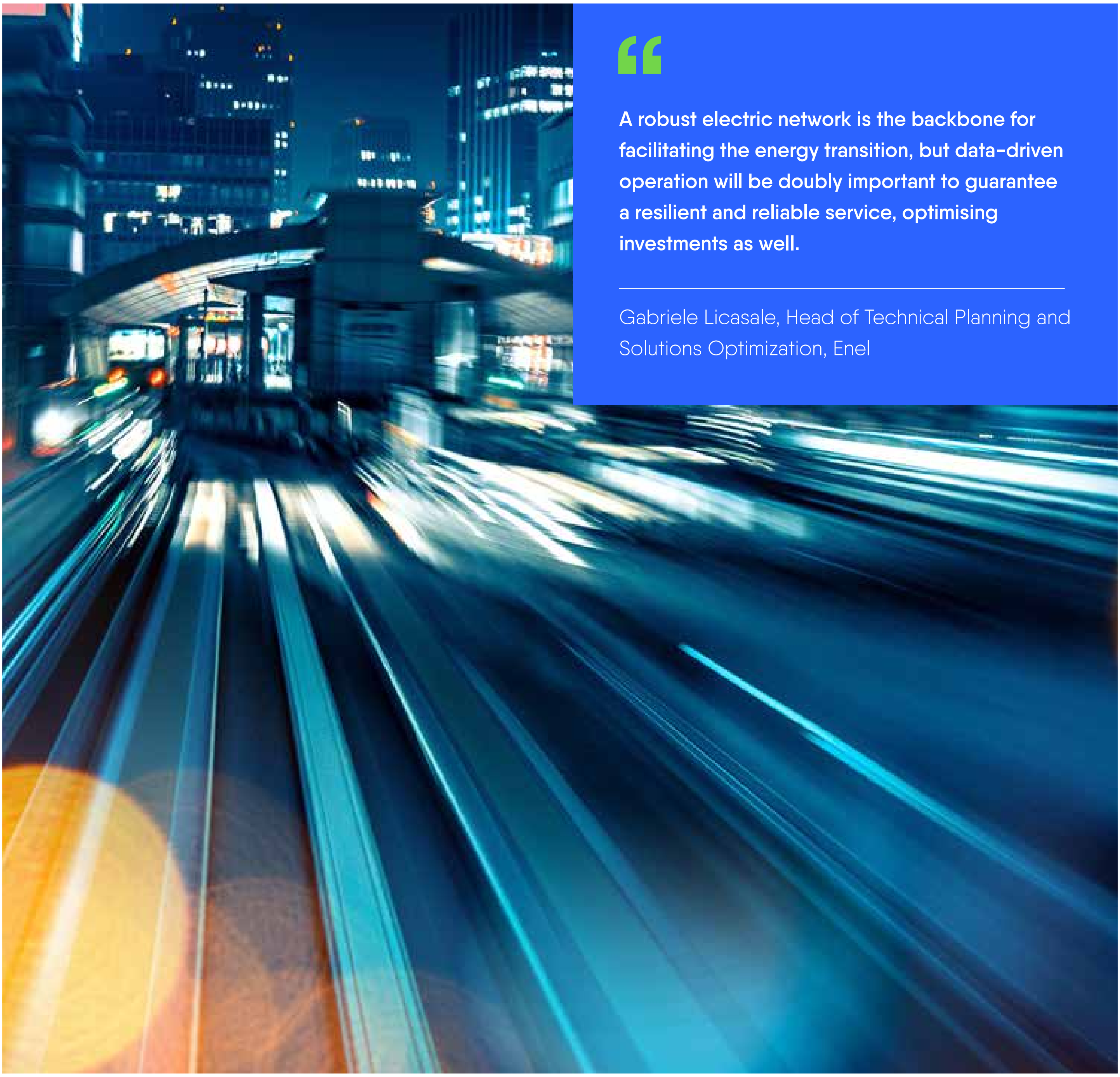
[100] https://momentumdynamics.com/.
[101] https://electriccarsreport.com/2020/01/bmw-530e-inductive-charging-pilot-program-named-2020-green-car-technology-of-the-year/.
[102] https://cdn.eurelectric.org/media/5275/debunking_the_myth_of_the_grid_as_a_barrier_to_e-mobility_-_final-2021-030-0145-01-e-h-2DEE801C.pdf.

A dynamic and agile system for facilitating clean energy growth requires robust collaboration, as well as a joined-up approach to policy and regulation, that incentivises and rewards innovation. DSOs must take stakeholders on the same journey by raising their awareness, delivering transparency and offering choice, to accelerate the transition. They have a social obligation to deliver the best environmental outcomes, at the lowest possible cost, by investing in the right locations, at the right time, while avoiding the risk of stranded assets. It is essential, therefore, that in collaboration with the TSO, DSOs are included in the development process and planning phase for the deployment of EV charging infrastructure as early as possible, if they are to bring valuable cost and time efficiencies.[103]



A robust electric network is the backbone for facilitating the energy transition, but data-driven operation will be doubly important to guarantee a resilient and reliable service, optimising investments as well.

Gabriele Licasale, Head of Technical Planning and Solutions Optimization, Enel

[103] https://cdn.eurelectric.org/media/5275/debunking_the_myth_of_the_grid_as_a_barrier_to_e-mobility_-_final-2021-030-0145-01-e-h-2DEE801C.pdf.

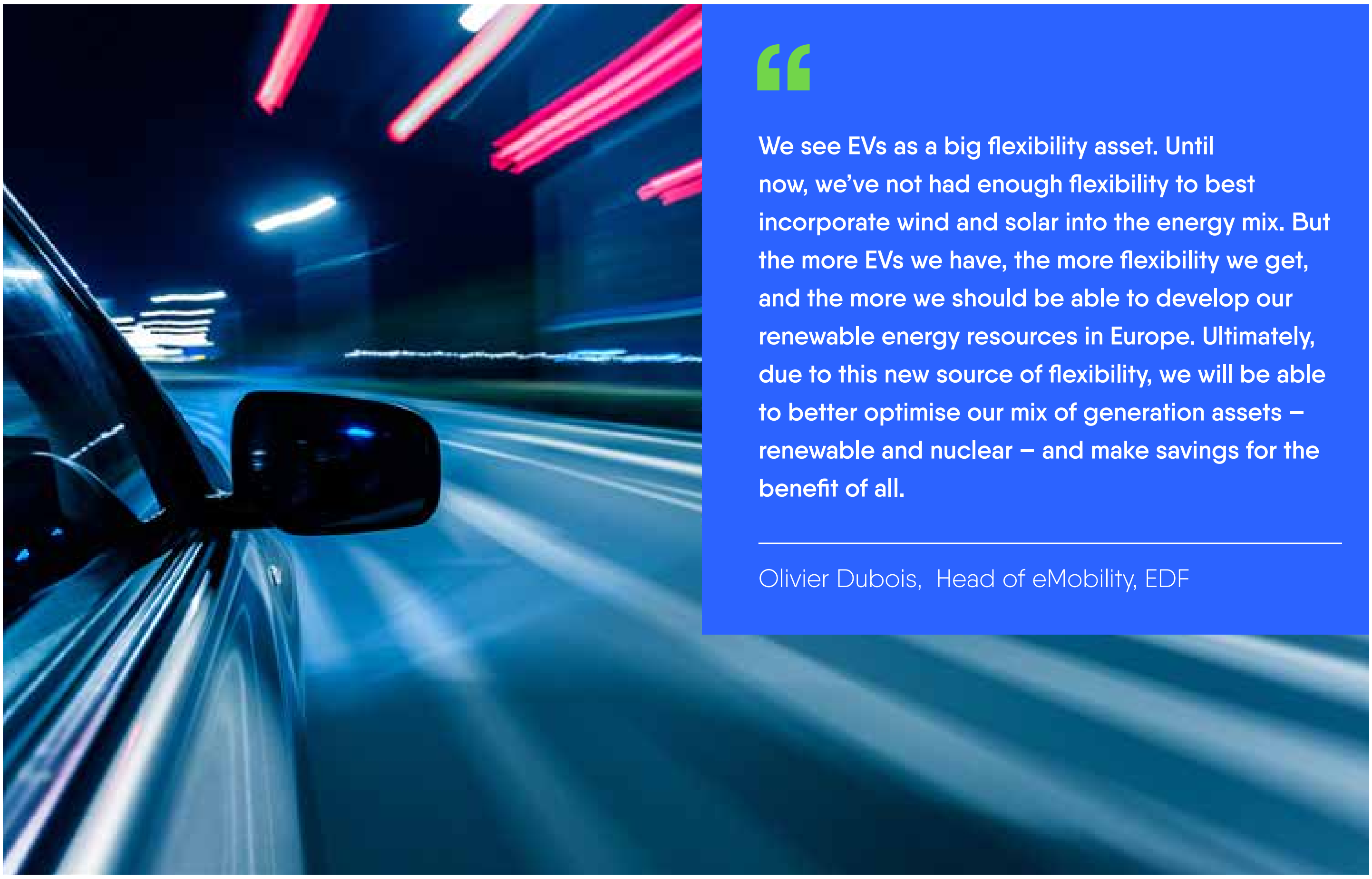
Reinforcing Europe's distribution grid

Europe's distribution grids are the backbone of the digital and energy transition. They are the nucleus for the expansion of electrification and capacity. They sit at the junction of multiple connections of DERs and renewables flowing into the electricity system. And, ultimately, they will enable the creation of new services, enhance business models for flexibility and demand management, and deliver new capabilities to all grid users.

However, as the momentum for EVs gathers pace, planning the power system for electrification is a massive undertaking. Efforts must focus on designing a system that can handle load from managed EV charging while guaranteeing supply security. It must consider network connections of EV chargers – especially high-powered EV chargers that require expensive grid connection upgrades – at specific locations.

But EVs are not the only innovation pushing up overall electricity consumption and peak demand. They are joined by the wider use of heat pumps and electrolysers for green hydrogen production.[104] Together, they underline the case for more efficient power usage, grid modernisation and the urgent need to expand renewables.

Ultimately, delivery of an increasingly decarbonised, decentralised and digitised European power system will come with a hefty bill. Between 2020 and 2030, investment of between €375bn and €425bn is needed in distribution grids, according to Eurelectric. Only 8% of grid investment – €25bn–€35bn – will be targeted at eMobility and the integration of EV charging infrastructure. Most of the spend will be on high-powered EV chargers. It is comparatively small in the context of the costs of modernising the distribution grid and electrifying buildings and industry, but more investment is expected in the years to come.[105]



> **We see EVs as a big flexibility asset. Until now, we've not had enough flexibility to best incorporate wind and solar into the energy mix. But the more EVs we have, the more flexibility we get, and the more we should be able to develop our renewable energy resources in Europe. Ultimately, due to this new source of flexibility, we will be able to better optimise our mix of generation assets – renewable and nuclear – and make savings for the benefit of all.**
>
> Olivier Dubois, Head of eMobility, EDF

[104] https://cdn.eurelectric.org/media/5275/debunking_the_myth_of_the_grid_as_a_barrier_to_e-mobility_-_final-2021-030-0145-01-e-h-2DEE801C.pdf.
[105] https://www.eurelectric.org/connecting-the-dots/.

4

Cohesive eMobility planning

- If eMobility is to deliver on environmental goals, it must engage with an ecosystem of enablers in supporting disciplines.
- Data capture and analysis will inform the evolving business and investment case for the grid for decades to come. It will ensure that future action is essential and targeted, and benefits operators, users and the environment.
- Regulation will protect operators and businesses, govern new technologies, enable prosumers to participate in the energy system and support the transition to net zero.
- A cohesive response to eMobility will underpin a market expected to be worth around €150bn[106] by the end of the decade.

[106] https://www.globenewswire.com/news-release/2021/02/23/2180650/0/en/European-Electric-Vehicle-Market-worth-143-08-Billion-by-2027-Allied-Market-Research.html.

eMobiity has gone from ambition to reality in just a few years. We are seeing exponential growth in EV demand and impending price and performance parity with ICE vehicles. But the EV is just one part of the unfolding story. Its success, and indeed the success of the decarbonisation of road transport, rests on an ecosystem of related parties that cooperate to find solutions for the global good. These solutions are not just for now, but for decades to come, and are part of a cohesive and functional response to best serve customers, communities, industry, commerce and the planet.

Collaboration, integration and cohesion

Sandwiched into multiple layers are the platforms, systems, processes and technologies that enable eMobility. The EV sits on top. Each layer has a unique and crucial function. They are not especially visible, at least not to the customer, but are integral to the functioning of the vehicle and the connected environment in which it operates. Collaboration, integration and cohesion across these various layers promote interoperability and unlock value.

In the top layer are enabling technologies. They have the potential to deliver better performance and uncover new market value streams. They sit closest to the customer and effect change or responses. They include, but are not limited to:

- Spatial planning tools that deliver a strategic view of energy and mobility management across real estate
- Future electricity distribution and planning, based on emerging needs
- Smart grid modernisation and automation
- Demand response
- Metering
- Payments and peer-to-peer roaming
- Apps that give availability information on charging infrastructure and user-reported updates

The next layer is data and supporting platforms. Data will be the critical currency in the eMobility ecosystem. But it also needs to be the common currency. Data outputs from, for example, metering or grid automation allow us to track, monitor, record and take remedial action. Data allows us to

We are developing our eMobility business, aiming to cover all of the EV customer touchpoints. We are looking at a whole range of solutions with both our established partners and beyond.

Despoina Chatzikyriakou, Manager EV New Business Development, Toyota Motor Europe

We want to partner with the EV ecosystem and connect with automakers to enhance the customer experience. Together, we can promise our customers a better vehicle, less pollution and an energy bill that is significantly lower than diesel or petrol at the pump. And it all comes in a very simple process that is designed to make our customers' lives easier.

Olivier Dubois, Head of eMobility, EDF

In the end, you always need data. If you do not have enough data, you cannot manage super flexibility at the low voltage level.

Dr. Xiaohu Tao, Vice President, Business Innovation and Digitalization, Energy Networks, E.ON SE optimise, monetise and maximise the customer experience through tailored charging and billing plans and services, and add incentives that encourage customer loyalty.

To be truly effective, however, cohesive data sharing must be accompanied by common platforms and governance that respect data privacy and cybersecurity protocols. At the same time, systems should be able to talk with one another across interfaces and use data to extract greater efficiencies and drive innovations, such as V2G and wireless charging technologies. Common data standards and cross-ecosystem agreements between parties will deliver, for example, the interoperability – and simplicity – of being able to access any charge point network, to charge and pay.

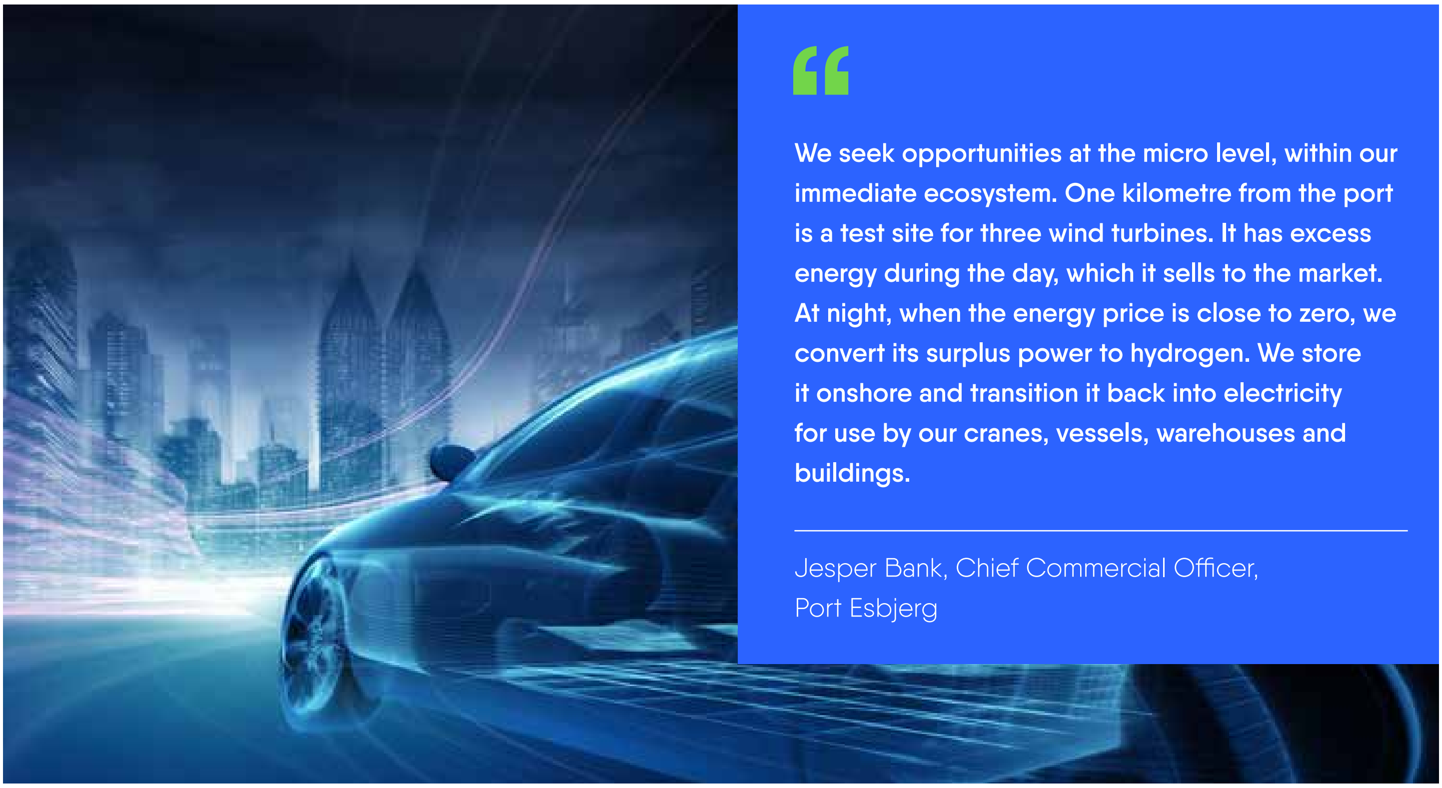
Consistent data capture will reveal hotspots and emerging criticalities in grid infrastructure and supply. It will enable energy networks both to understand the impact of eMobility and to plan not only for today but long into the future.

The next layer down comprises digital intelligence and analytics – the tools that enable modelling, predictions and optimisation, and help to shape current and future eMobility concepts and solutions. It includes monitoring charging infrastructure and using tools to investigate, track and resolve issues quickly. In time, self-healing capabilities, which fix issues automatically before they impact grid operations, will enhance the customer experience.

Lastly, the regulatory layer provides the mechanisms that both protect and benefit customers and the businesses operating within the ecosystem. Regulation governs V2G and other solutions and allows, for instance, localised flexibility markets to function. It enables the prosumer to perform as an essential cog in the energy system and to be compensated for integrating renewable energy sources to balance the grid.

These functional layers are sandwiched between the external pillars of the eMobility framework. They include grid technologies, energy management systems and smart meters, and are designed to improve localised energy demand and supply, and to increase grid capacity to absorb, offset and store more renewable generation.

Each layer helps to support the massive value that exists in the EV market – expected to be worth more than €150bn[107] by the end of the decade – and the huge societal gains that will accompany reductions in emissions from road transport and the pursuit of climate neutrality.



We seek opportunities at the micro level, within our immediate ecosystem. One kilometre from the port is a test site for three wind turbines. It has excess energy during the day, which it sells to the market. At night, when the energy price is close to zero, we convert its surplus power to hydrogen. We store it onshore and transition it back into electricity for use by our cranes, vessels, warehouses and buildings.

Jesper Bank, Chief Commercial Officer, Port Esbjerg

[107] https://www.globenewswire.com/news-release/2021/02/23/2180650/0/en/European-Electric-Vehicle-Market-worth-143-08-Billion-by-2027-Allied-Market-Research.html.

Getting the fundamentals right for successful eMobility

Getting the fundamentals of eMobility right is critical. As vehicle rollout races ahead, the supporting components – the infrastructure, grid, technology and regulation – must keep pace, otherwise the vision and ambition are in jeopardy.

The availability and reliability of chargers is the biggest hurdle. Their rollout is frustrated by operational and administrative barriers. Meanwhile, the impact of unmanaged charging has consequences for power quality, investment costs and driver confidence in a fully charged battery. To be truly successful, the road transport system we design today should serve us long into the future. To achieve longevity, we must:

- Carefully plan distribution, digital, IT and grid infrastructure investments, allowing for expected EV uptake
- Simplify local authority approval processes for installing charging infrastructure
- Enable faster and cheaper grid connections for EV chargers
- Focus on the reliability of charging infrastructure to win customer confidence
- Ensure every publicly accessible charger in Europe is digitally connected and capable of smart charging
- Enable interoperability – any vehicle, any contract, any payment mechanism – across charger networks

As EVs become mainstream, focus will switch to the ecosystem of municipalities, local authorities, city planners, CPOs, automakers and network companies that make the user experience better. They will become commodities in the driver's journey from A to B on an adequate charge. Within that ecosystem, DSOs are a critical cog, integral to putting EVs on the road, while keeping the lights on.

DSOs are charged with developing reliable forecasts for future electrification, which include transport and other sectors. They must integrate EV charging infrastructure into the electricity network, smoothly and cost-efficiently. To achieve that, they need:

- A better understanding of what is happening and where, by improving visibility over low- and medium-voltage networks
- The right skill sets, capabilities and investments to deliver a fully automated and harmonised customer experience to promote EV take-up
- An ability to track real-time behaviours from the vehicle to the grid and back again, to optimise the economics and performance of each

Together, an extension of DSO skill sets and better execution of their responsibilities will deliver enhanced customer centricity and more innovative solutions to create a better EV user experience for all.

The end of the beginning

Much of the piloting has been done. With global backing for the decarbonisation of transport declared at COP26, we are on a one-way, fast-moving track to electrification. We are at the end of the beginning of the experiment, and we are now living the EV reality.

Partnerships and collaborations are working through the challenges. Players are sharing what they know, and drawing on experiences in prior transformations, including the integration of over 600GW of renewable generation across Europe. The collective goal is to unlock and optimise the future of eMobility.

Where hurdles and bottlenecks exist, coordination of efforts across participating entities will speed up decision-making and implementation, and conquer matters as diverse as interoperability and bureaucracy that can hold up progress.

This is the end of the beginning of a fast-moving evolution in transport, backed by multiple catalysts for change. And it is already happening, whether we are ready or not.

“

Sustainability is a team sport. The entire ecosystem has an obligation to accelerate the transition.

Matthieu Campion, Head of Electrification Operations, Uber