The UK's EV INFRASTRUCTURE challenge

How the nation is preparing for the mass switch to zero emission cars, reports **Jonathan Manning**

ABOUT THE AUTHOR

Jonathan Manning is a freelance writer and editor. He is a former editor of *Fleet News*.

The UK Government's bold ambition to transition all new cars to electric power by 2040 (and potentially as early as 2032 dependent on the outcome of a live consultation) is at risk of being thwarted by the most basic of Catch-22 supply-demand scenarios.

Motorists want the security of a comprehensive electric vehicle (EV) charging infrastructure before switching to battery propulsion, while the companies and authorities responsible for building this infrastructure need to see significant demand in place to support their business models before they expand their recharging networks.

The number of public charge points is rising rapidly, but will require substantial further growth to serve the anticipated surge in plug-in vehicle volumes.

The Government's 2018 Road to Zero strategy set out an 'ambition' for at least 50% – and as many as 70% – of new car sales to be ultra-low emission by 2030, alongside up to 40% of new vans.

To put these goals into perspective, battery electric (BEV) and plug-in hybrid (PHEV) cars accounted for a combined market share of 6.6% in the first three months of this year. In total, ultra low emission vehicles (ULEVs) today represent just 0.5% of licensed cars on the road.

Recent triple-digit percentage growth in BEV sales may be impressive, but it is starting from a very low base and, in terms of market share, lags a long way behind Norway, the European beacon of zero emission motoring, where BEVs account for almost half of all new car sales.

THE NORWEGIAN EXAMPLE

Norway intends to ban the sale of cars with internal combustion engines (ICEs) from 2025, and has fuelled its dramatic boost in EV sales through a series of compelling financial incentives. Battery-powered cars are exempt from VAT and import duty in Norway, which makes them cheaper than petrol or diesel equivalents.

Having stimulated demand for EVs financially, the Norwegian Government turned its attention to the country's charging network, setting a goal in 2017 of having at least two fast charging stations per 50km (about 30 miles) of all main roads. The opportunity to recharge on longer journeys forms part of a campaign to persuade two-car households to switch both cars to electricity.

According to the European Commission-funded European Alternative Fuels Observatory, Norway now has 780 fast chargers per 100km of highway, compared with 127 in the UK and 41 in Germany.

The UK's significantly larger new car market renders the generosity of Norway's approach unattainable. Grants in this country are now capped at £3,000 for the purchase of an EV, placing greater emphasis on making a switch from ICE to BEV as convenient as possible for drivers.

This convenience, however, has to be delivered by a fragmented recharging infrastructure where a complex chain of power companies, distribution network operators (DNOs), engineering manufacturers and charge point owners must work together, alongside landlords, local authorities and national government, to create solutions that are as simple to access and use as the traditional petrol station.

The electric charging network is developing rapidly. Zap-Map counted 11,311 public charging locations with 31,591 chargers in April 2020, compared with 8,338 locations and 22,837 charge points a year earlier. But Ofgem's Decarbonisation Action Plan, published in February, cites the Committee on Climate Change's conclusion that by 2050, "3,500 rapid and ultra-rapid chargers near motorways and 210,000 public chargers in towns and cities will be needed, up from 30,000 public chargers of all speeds currently installed".

The Government's destination of carbon neutrality by 2050 may be clear, but the roadmap for vehicles to reach it is fiendishly complicated. The experience of Devon County Council provides an example of the multiple agencies involved in building a commercially sustainable charging network in these days of fledgling demand. The council secured European Union funding to support the installation of charge points in at least 25 car parks across the county; Highways England funding to support charge points in car parks close to main roads; and Innovate UK funding to install and operate 150 electric car charge points in partnership with Zapinamo and Gamma Energy.

This piecemeal approach is not uncommon in the public sector when seeking support for infrastructure investment.

CHARGING OPTIONS

Drivers of electric cars have three options of where to recharge their cars – home, work or public places. Of these, public charging is the most visible and therefore, arguably, the most influential – a survey by The AA in February found that a lack of public charge points was cited by 70% of motorists as their prime reason for not considering an electric car – despite it being the least likely source of charging to be used. Put bluntly, drivers expect EVs to offer the same freedom as petrol and diesel models to go where they wish, when they wish, without range anxiety.

▲ **At home, one of the ways to charge your EV**

6.6%

Combined market share of BEVs and PHEVs in first three months of 2020

Yet as recently as last November the Department for Transport (DfT) named and shamed more than 100 local authorities that had fewer than 10 public charging devices per 100,000 population, highlighting the postcode lottery of proximity to public charging.

Both financial and practical reasons are holding back the market. The Government-funded On-Street Residential Charge Point Scheme has so far supported the deployment of more than 2,000 charge points by 60 local authorities in areas where residents do not have off-street parking, but the 2020 Budget saw a cut in its grants to local authorities from £7,500 to £6,500 per charge point.

Moreover, local obstacles, such as the location of streetlamps, are holding back some authorities. In London, where street lights are immediately by the roadside, Ubitricity has successfully converted hundreds to double as EV chargers. In other cities, the location of lamp posts on the far side of a pavement from the road means charging cables would create a trip hazard.

While this type of slow roadside charging is a cost-effective way to open access to EVs for residents without a drive or garage to accommodate a charger, it's the fast and especially the ultra-rapid chargers that will facilitate longer journeys until other car manufacturers can match Tesla's impressive 300-plus mile range.

The Government has put £500 million into a Charging Infrastructure Investment Fund to support its aim of having a rapid charge point within 30 miles of every motorist. This includes a Rapid Charging Fund to "help businesses with the cost of connecting fast charge points to the electricity grid", subsidising the grid reinforcement costs that are proving to be a barrier to the installation of the fastest chargers.

"The charging fund is making a real difference in terms of getting investors up to speed with the sector," says Philippa Eddie, commercial finance specialist, Infrastructure and Projects Authority (HM Treasury and Cabinet Office). "We are trying to create a policy environment where industry will take this forward."

GRID UPGRADES

But industry is hitting buffers due to weaknesses within the UK's grid. Upgrading and reinforcing this infrastructure is prohibitively expensive in some locations, says James McKemey, head of insights at Pod Point.

"There is, arguably, an area of market failure whenever the applicant who requires an upgrade to a downstream transformer/substation on the DNO network must foot the whole bill for the new capacity provided (without it staying on their balance sheet to depreciate), despite only benefitting from a small proportion of it, while subsequent users receive the benefit of that capacity free of charge," he says.

As an indication of the levels of investment required to install chargers capable of such ultrafast speeds, Innovate UK awarded a grant of £4.86m to support the development of Gridserve's first Electric Forecourt, near Braintree in Essex, where 24 vehicles will be able to charge at once from superchargers capable of up to 350kW of charging power.

A spokesman for UK Power Networks, the DNO (Distribution Network Operator) for the east and south east of England, says the cost of the electrical infrastructure forms part of the commercial decision that customers make when they decide where, when and how many chargers they install at any given location.

"From a power distribution perspective it is important customers engage early with us to ensure we can provide the electrical infrastructure they need to power their chargers. If they engage early, we can provide the infrastructure they need in a timely manner," he says.

Infrastructure challenges have delayed BP Chargemaster's objective to roll out a network of 400 ultra-fast (150kW) chargers.

Roy Williamson, vice president of BP Advanced Mobility, says: "We've probably rolled out significantly fewer (fast chargers) than we planned, not because we didn't have the capital or the appetite or the project planning, but because we couldn't get the DNO infrastructure in place to make this happen quickly enough.

"It's not just about funding, it's about the physics of putting the infrastructure underground to make this work. We can sort out the above ground stuff and the business model, but we really need the infrastructure to be there."

Williamson cites China, where BP is involved in a partnership with the ride hailing giant Didi, as an example where, "the grid system allows for an equitable deployment of charging infrastructure and is evenly handed".

This type of arrangement is crucial for the roll-out of ultra-fast charging, with BP Chargemaster research indicating that 13 minutes is the maximum time drivers are prepared to wait while charging an EV at a public charge point.

As a rough guide, a 50kW charger takes 30 minutes to deliver enough power for 100 miles of range, a 150kW charger takes 12 minutes, and an ultra-fast 350kW charger needs only four-to-five minutes; the difference between lunch, a coffee or a comfort break while the car is plugged in.

"People want safe charging, a reasonable price and reliability, but the differentiators and the reasons new people will come into this space are around convenience and the ease of charging," says Williamson. "We want charging to be as easy as it is to refuel a car today. The economics and the accessibility of charging at home is not available for most of the population, so we are looking at fast, efficient public charging."

NATIONAL INFRASTRUCTURE

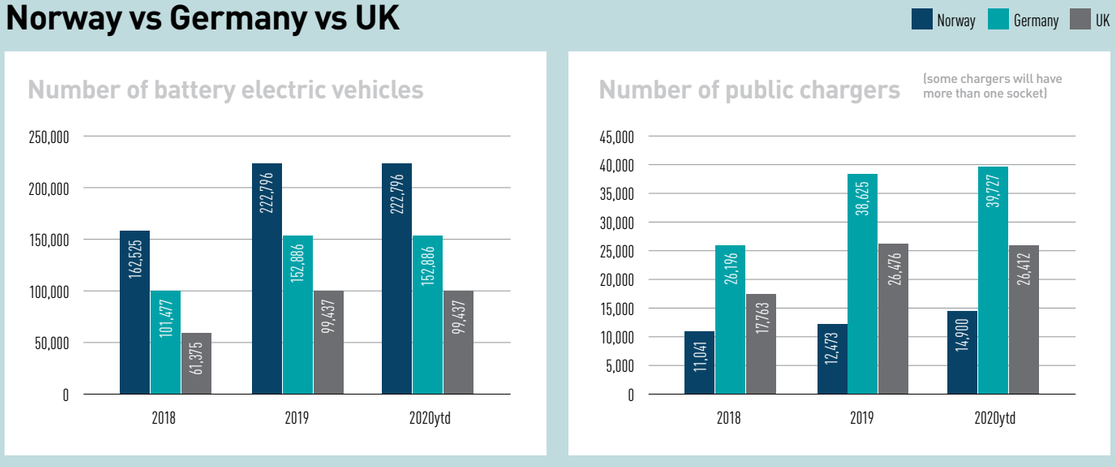
Anticipating a seismic shift in demand for public charge points, the National Infrastructure Commission (NIC) published its National Infrastructure Assessment in 2018, which urged the energy regulator Ofgem to remove barriers to connecting chargers to the network and called for local authorities to allocate 25% of their parking spaces for possible charging by 2025. The NIC is still waiting for a Government response in the yet-to-be-published National Infrastructure Strategy.

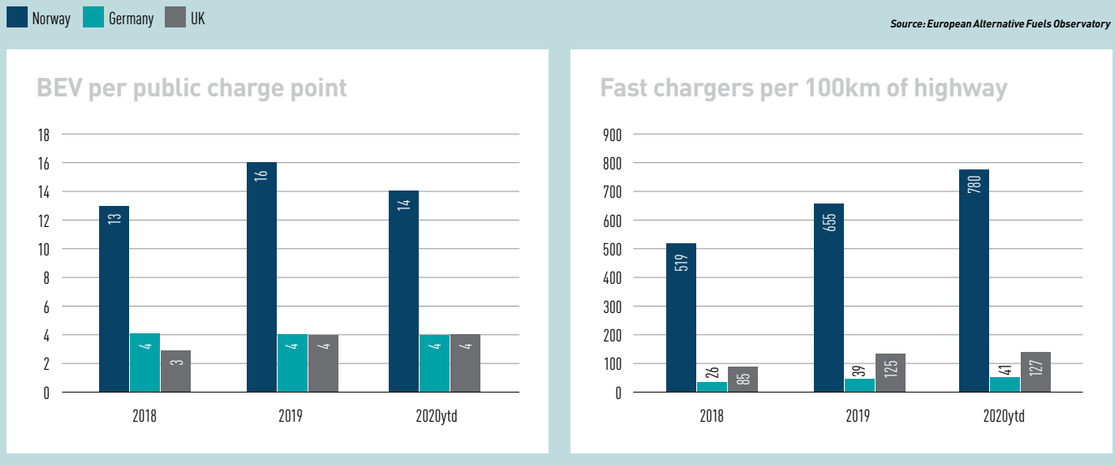
Yet despite the high profile of the public recharging network, the vast majority of drivers will plug in their cars at home or work, according to McKemey.

"In terms of energy transferred, we expect home and work charging to deliver the vast majority – we estimate it will be about 60% home, 30% work (combining employee charging and fleet/depot charging) – though work ▶▶

> **There is, arguably, an area of market failure whenever the applicant who requires an upgrade to a downstream transformer/substation on the DNO network must foot the whole bill for the new capacity provided**
>
> **JAMES McKEMEY PODPOINT**

Norway vs Germany vs UK





Source: European Alternative Fuels Observatory

CARBON NEUTRAL AND ZERO CARBON TRANSPORT FUELS

If the electrification of road transport, at least for cars and light commercial vehicles, is on a clear trajectory, environmentally-sustainable solutions for trucks, planes and shipping is proving a much greater challenge.

Put bluntly, alternative innovation and technology for these large combustion engines is not going to be available by 2050, says Shamit Gaiger, director of strategic advisory, consultancy, AECOM.

"Sustainable biofuels will be an interesting solution because if you look at jet planes we are not going to have a (zero emission) solution until 2050 and governments know that," she says. "Biofuels, in terms of cascade, will definitely go to aviation first then shipping, before rail."

▲ **Shamit Gaiger, AECOM**

Biofuels blended with fossil fuels are already in use in aviation, but accounted for only 0.01% of demand in 2018, according to the International Energy Agency. It said the use of transport biofuel consumption needs to almost triple by 2030 to play its part in the IEA's Sustainable Energy Scenario. This would represent about 9% of global transport fuel demand, compared with the 2018 level of around 3%.

The EU's Renewable Energy Directive outlines strict guidelines to ensure biofuels are genuinely sustainable. Fuels such as ethanol and bio-diesel, derived from plant-based sugars, starches and vegetable oils are, in theory, both renewable and carbon neutral (not carbon zero) and therefore a useful tool in the fight to lower greenhouse gas emissions. But engines that run on biofuels still create local air pollution and the production of the fuels risks environmentally-damaging indirect land use change. Biofuel crops are typically grown on arable farmland that was previously used to produce food or animal feed. The danger is that high carbon forests, wetlands and peatlands are then cleared to accommodate traditional farm crops, which would release CO_2 stored in trees and soil and undo any greenhouse gas savings from biofuel use.

Researchers are developing second generation ethanol, made from plant-based residues such as straw, the leaves and stalks of maize and forestry harvest residues.

Clean transport campaign group, Transport & Environment, says hydrogen is the only realistic zero-emission energy solution for aviation and shipping. It concedes, however, that green hydrogen, created through the electrolysis of water, requires vast amounts of clean electricity to produce, which is not yet available. And even when it is, this zero emission solution will still have to compete with battery power in trucks and shipping.

But in the Orkney islands, north of Scotland, a surplus of renewable electricity from wind, tidal and wave energy, beyond the capacity that local power cables can supply to the UK National Grid, is being channelled into the production of hydrogen. This is then being used to power a fuel cell to heat a local primary school and provide electricity for local ferries. The hydrogen is also powering a trial fleet of five Renault Kangoo vans equipped with a Symbio hydrogen range extender.

And in a further initiative, the UK Government has invested £2.7 million in the HyFlyer project, set up by ZeroAvia, to develop practical, zero emission flights in commercial aircraft. The project aims to achieve a 250-300 nautical mile flight on a six-seater aircraft, powered by ZeroAvia's zero-emission hydrogen powertrain and then target up to 500-mile regional flights in 10-to-20-seat fixed-wing aircraft in 2022.

◀◀ charging is still in its infancy and home charging is more dominant today," he says.

"These are simply the most convenient locations for people to charge."

The extended periods that cars are parked at both home and work mitigates the need for rapid chargers, with 7kW and 22kW chargers sufficing.

"As yet, we are not really seeing the clustering of home chargers threatening capacity at local substations," says McKemey. "However, this is inevitable and is one reason why we build smart charging capability into all of our units."

Load balancing options, which determine both the rate of charge and even the number of vehicles being charged, can overcome grid constraints and are currently the most cost-effective alternative to grid upgrades at residences and workplaces, says Frank Muehlon, head of ABB's Global E-mobility Infrastructure Solutions.

BATTERY STORAGE

Nationwide, National Grid sees no problem with the UK's ability to charge EVs.

Graeme Cooper, National Grid's project director – electric vehicles, says: "Even if the impossible happened and we all switched to EVs overnight, we think demand would only increase by around 10%. So we'd still be using less power as a nation than we did in 2002 and this is well within the range of manageable load fluctuation."

Daytime peaks of demand might create temporary issues, but a combination of load balancing and battery storage presents an opportunity to store excess electricity when there is a surplus of supply and to use this to resupply the grid at times of peak demand.

10%

projected increase in electric demand if everyone switched to EVs

It is also an effective way to support renewable energy, which is vital if EVs are to achieve maximum eco-friendliness – transplanting emissions from the exhaust pipe to a coal-fired power station defeats the point.

The National Grid reports that wind, solar and hydro power generated 26.5% of Britain's electricity last year (compared with 2.3% in 1990), but the intermittent nature of sunlight and wind conditions mean they need storage solutions to provide reliable 24/7 electricity.

This raises the prospect of vehicles themselves becoming electricity storage solutions, charging batteries at periods of low energy demand and resupplying the grid at times of peak demand.

Carl Bayliss, vice president of mobility solutions, Centrica, says the UK is moving towards a future in which cars will become an extension of the fabric of our homes and businesses.

"Most cars are stationary 95% of the time, so it makes sense to use the collective storage capacity as a mini power plant, to power our lives and support the grid," he says.

Muehlon, however, is unconvinced by the business case for vehicle-to-grid (V2G).

> When you come to a delivery fleet and vehicles used for business purposes, it's important for those vehicles to be used as much as possible and not sitting on a charger
>
> **FRANK MUEHLON ABB**

"In theory, it's very nice because you can generate aggregated loads and deliver significant value to the (power) utility," he says. "But you need a significant amount of storage capacity to do that."

The low penetration of EVs today means this storage capacity is both limited and uncertain, although the opportunity for depot-based fleets to link several vehicles to the grid simultaneously may provide an answer, even if the commercial returns available today "are not that thrilling", says Muehlon.

Moreover, "when you come to a delivery fleet and vehicles used for business purposes, it's important for those vehicles to be used as much as possible and not sitting on a charger. You need to ensure vehicle availability is high so you need a fast charge".

Muehlon also raised the unresolved technical issue of V2G doubling the number of recharge/discharge cycles for vehicle batteries, the bi-directional flow meaning that owners might exceed the number of cycles covered by manufacturer warranties.

PAYING FOR POWER

Planning how to earn revenue back from the grid seems premature, however, when paying for power seems so complicated, especially for the biggest cohort of early EV adopters, company car drivers. With pure electric company cars incurring no benefit-in-kind (BIK) tax this financial year, and only the most modest tax charge for the next two years, fleets anticipate a surge in demand for these zero emission vehicles. But resolving how employers reimburse drivers for electric business miles is a complex issue given the three potential sources of electricity – home, work and public chargers.

If drivers do not have smart chargers at home, there is no way of knowing how much power they have drawn for their car, while the official HMRC mileage reimbursement rate (AFR) of 4p per mile is insufficient to cover the cost of recharging at many public rapid chargers, says Matt Dale, head of consultancy, ALD Automotive.

"If you supercharge it will cost you more than charging at home, just as if you refuel with diesel on the motorway it will cost you more than at Tesco or Sainsbury's," he says. "But the difference is that it takes the same time to refuel with diesel, wherever you do it, whereas recharging a vehicle with a supercharger is quick and using a slower charger may be more cost-effective, but it will take longer."

Businesses will have to take a position on the productivity issues this raises.

They will also have to resolve which employees take priority at any workplace chargers, and whether the cost of this electricity is billed back to drivers. In an ideal world a single agent would measure and record all power drawn at home, work and public chargers and calculate an accurate reimbursement rate for business miles driven, but today's fragmented market is still waiting for a technology solution.

"We have customers who will pay for home chargers to be installed and others who won't. Some are paying for home and public and business charging while others are using AFRs," says Dale. "There is no hard and fast rule at the moment. It depends on the company's view – some see EVs and PHEVs as a step to reduce their carbon footprint, so they will support employees financially to achieve it."

Even the issue of public charging is fraught with complexity, with drivers forced to carry multiple RFID cards or download several apps to their phones to access charge points belonging to different networks. All new chargers have to offer 'tap and pay' via a credit card, but this still exposes drivers to huge variations in tariffs. The Ionity rapid charging network, for example, charges £0.69 per kW hour, but Audi e-tron Charging Service subscribers pay £0.28 per kWh for the same chargers.

The long-term solution is the development of 'roaming' access to charging networks, similar to mobile phones or withdrawing cash from ATMs, although drivers can still expect to pay different tariffs at different chargers, dependent on the location and speed of charge.

In February, the Electric Vehicle Energy Taskforce, convened by the Office for Low Emission Vehicles, called for industry to deliver "roaming services for a seamless EV charging experience everywhere", by the end of 2021, although it argues that "it should be left up to charge point operators to define their own commercial arrangements and preferred technical solutions to deliver this outcome".

Tanya Sinclair, policy director UK & Ireland at ChargePoint, says: "We do expect EV drivers to subscribe to one network or another, but the logical conclusion of the market is that, whatever network you subscribe to, you are able to roam between the networks with no surcharge. There needs to be complete interoperability, so whichever card you have and use, you can still access another charger in a different part of the country or another network." ST

DEFINITIONS

Slow charge 3kW to 7kW chargers requiring up to 12 hours to fully charge a BEV.

Fast charge 7kW to 22kW that can charge a BEV in three-to-four hours.

Rapid charge 50kW to 350kW chargers capable of fully charging batteries in minutes.

TURN OVER FOR THE PEER REVIEWS