Driving change in the auto industry

On the road towards securing a viable EV charging infrastructure network in Europe

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The transport sector is an important contributor to greenhouse gas emissions in the UK and Europe. It is therefore essential to decarbonise the transport sector to meet national and international emission reduction targets aimed at combatting climate change. The transition from petrol and diesel fuelled vehicles to electric vehicles ("**EVs**") has an important role to play in meeting these targets.

Whilst it is not yet clear how fast the transition to EVs will be, what is clear is that the growing fleet of EVs will require significant investment in electric charging infrastructure, particularly on or near motorways and other major roads as well as in towns and cities, not least given that as of the summer of 2018, there were only around **17,400 public charging points in the UK**.

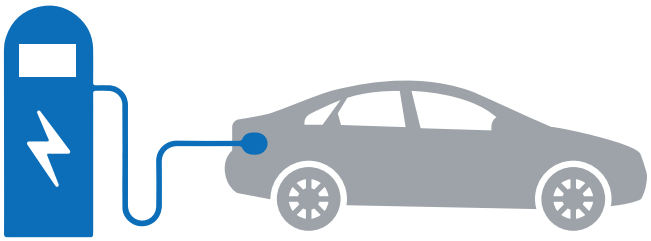
This new charging infrastructure will also need to be sufficiently homogenous (both in terms of compatibility to different makes of EV and methods of payment) in order to maximise the benefits and continue to encourage and support the move towards EVs.

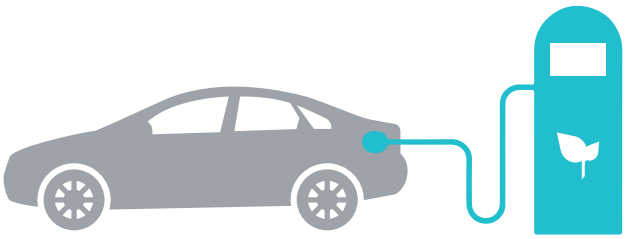
Without confidence in the availability of a reliable, cost-effective and quick recharge the transition of the majority of drivers to EVs will be slow. However, the scale of the EV charging infrastructure required to deliver this is presently unclear and is subject to change, in particular as battery density improves.

In this article Roddy Martin and Silke Goldberg look at recent developments in relation to this significant infrastructure roll out and at some of the challenges faced.

AS OF SUMMER 2018

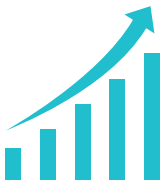
There were about **155,000 EVs** on British roads





Whilst this is a small number in the context of nearly **30 MILLION** Hydrocarbon-powered cars

there is currently a steady growth of **EVs**



with around 4,500 additional vehicles being registered each month in the UK

The UK Government's objective to halve **non-EV sales** by **2030** and providing that by **2050** nearly all cars and vans should be **zero emission** vehicles gives an additional push to this growing market.

On the road towards more charging points: where can I charge my vehicle?

There are currently around **150,000 EV charging points across Europe**, with a heavy bias towards the Netherlands, then Germany and France, the UK and Norway.

Confused market commentary often compares the number of charging points with the fact that there are around 90,000 petrol stations across Europe. This misses at least four important points:

- **Points v Stations**: A larger petrol station will have 8-10 separate pumps, so the direct comparator would be more like 150,000 v 750,000;
- **Urban v Network & AC v DC**: A considerable majority of these 150,000 charging points to date are in urban areas and therefore the number of charging points on the European major road and motorway network compared to petrol pumps is considerably lower. Moreover, charging points differ in a number ways (see Compatibility below for more detail), including the speed with which they can charge an EV battery and, although growing (and with the UK currently in the lead), the number of all fast charge DC charging points only represents about 15% of the total across Europe and these are what will be required in order to develop a complete en-route charging infrastructure for high volumes of EVs in order to provide the level of assurance to drivers (including commercial drivers) that they are likely to seek;
- **Home charging**: On the other side of the equation is the fact that a large majority of charging is and will continue be done at or near the home (for reason of cost as well as convenience) and therefore the footprint for the EV charging infrastructure can be and will be different to that for hydrocarbon-fuelled vehicles;
- **EV battery capability is evolving**: A fuel tank has a fixed capacity and the installed engine a maximum level of fuel efficiency whereas EV batteries are evolving both in respect of their power density: the speed with which a battery can be charged and whether a battery is suitable for ultra-fast charging and their energy density: how much electricity can be stored per unit volume or mass of the battery. As EV battery technology develops this will have an important influence on the scale and shape of the charging infrastructure required to support the EVs.

Considerable investment is likely to be needed to establish ultra-fast charging points on major roads and motorways, as well as making in-town charging widely available; however, for reasons alluded to above, the absolute scale of the investment necessary is still unclear. Whilst there have been some suggestions of a need for between 2 million and 3 million charging points in Europe, this is highly dependent on a range of developing and evolving factors, including driver habits. Whilst under-investment will delay the growth of EVs on our roads, over-investment or investment in superseded technology or which is located in the wrong places will hurt the investors.

The likely premise is that those that can will mainly recharge at home overnight and those that cannot charge at home will use local AC charging points on an occasional basis or rely on provision being made at or near their workplace and some (particularly urban) drivers will gradually shift towards shared-use mobility models.

Studies have estimated that there are about 5 EVs on the road per public charging point (the EU Commission recommends 10 EVs per charging point). By 2020, it has been estimated, there will be about 220,000 charging points available at a ratio of 10:1 and of these, about 1,000 will be ultra-fast (eg Ionity, Ultra-e, Mega-e 150-350 kW) charging sites. It has been estimated that if all current plans for ultra-fast chargers are implemented, there will be one such station every 58km on the EU's core network of motorways by 2020. The capacity of the charging points is likely to be limited to 150 kW, with upgrades to 350 kW only coming on-stream once new EV models and charging standards are updated to cope with the higher charge.

The current price of these ultra-fast chargers (presently reputed to be in the region of US$200k for a 350kW charger) and the scale of the investment required will mean that these are likely to be largely confined to motorways, other major highways and possibly out-of-town shopping centres. As the charging point footprint improves across Europe, ensuring high levels of reliability and mutual compatibility of these charging points will be of utmost importance – see **Compatibility** and **Paying for EV charging** below.

The changing face of the petrol station forecourt

The oil majors: Total, BP, Esso, Shell and ENI currently dominate Western European petrol stations and are responding to the move to EVs by investing in EV charging points.

Shell were one of the first to make a significant move in Autumn 2017 with the acquisition of NewMotion which gave them 30,000 charging points across Western Europe (and beyond petrol station forecourts), alongside their own roll-out programme.

BP followed suit in the Summer of 2018 with the acquisition of Chargemaster (on which deal HSF co-advised BP) which gave BP the capability to design and build charging points, a number of established relationships with OEMs and the largest network of 6,500 charging points in the UK (around one-third of the total). Prior to this, BP had invested in mobile EV charger developer FreeWire Technologies.

Both Shell and BP plan to develop more fast and ultrafast (150kW and above) charging points, but due to the costs (see above), the roll-out is likely to be in the hundreds not thousands for the foreseeable future.

Across the Channel, French energy major EDF (which has 5,000 charging points through its Sodetrel unit) has recently said that it aspires to have a 30% share of the EV charging market by 2022. According to EDF, this would represent, some 75,000 charging stations across France, the UK, Italy and Belgium. Noting that 75,000 charging points is 50% of the current number of charging points across Europe, these are very ambitious plans. Total is also involved, acquiring France's G2mobility a provider of EV charging solutions in September 2018 which manages almost 10,000 charging points.

In addition to Tesla's own-brand charging network, both Porsche and Ionity (a joint venture between BMW, Daimler, Ford and VW) have announced plans for a small number of ultra-fast charging stations or electronic pit-stops. Away from the forecourt, VW and Tesco announced a joint venture on 30 November 2018 to install around 2,500 charging bays with Pod Point chargers at up to 600 Tesco stores over the next three years. 95% of which are expected to be standard 7kW fast charges with the remainder being rapid 50kW chargers with electricity priced at a "market rate".

The car manufacturers have a clear vested interest in seeking to ensure that the early adopters of pure EV models have the support of a fast and reliable charging infrastructure, which is why a number of OEMs are participating in charging infrastructure initiatives and joint ventures. However, we anticipate that this participation is more likely focused on the promotion of their own EVs and ensuring growth in the EV market, rather than any long-term plan by OEMs to become the providers of the EV charging infrastructure for mass-market EV use.

Battery swapping stations as alternatives to charging points?

Battery swapping stations, where a fully charged battery is swapped into the car for the depleted battery without the driver necessarily having to even leave the vehicle, have occasionally been promoted as alternatives to EV charging points. However, the high costs and greater infrastructure and labour requirements of such facilities have meant such swapping stations have struggled to get traction with a couple of high-profile failures in this space, including Better Place. Issues around the ownership of the battery unit, a fundamental part of the vehicle, only serve to complicate this method. Tesla itself has now largely abandoned its plans for this method of recharging.

Compatibility

If you find a charging point, there is still a chance you will not be able to use it.

Different EVs require different chargers, and, as yet, there is no universal fast single car-charging adaptor that allows you to plug in anywhere – unless you are prepared to rely on the charger that often comes with the EV as the basic charging kit and which can be plugged into a standard three-pin domestic socket.

The charging market is still very much in the hands of the companies which install them. There are currently around 30 major players in

Europe and many of them operate locally, meaning that there is little to no interoperability nationwide.

Commercial or corporate chargers can look quite different depending on the manufacturer and by which network they are installed, with charging speed being the key differentiator. It is similar to how mobile phone chargers were before the 2009 agreement to rally around the European Commission's USB standards – wasteful and non-consumer-friendly.

In Europe the Combined Charger System (**"CCS"**) is the dominant open and universal standard, but the Japanese (incompatible) competitor, the CHAdeMo quick charging DC standard, is almost as prevalent in Europe at least to date, and then there is Tesla's standalone proprietary supercharge system. As things stand this means there is a doubling-up of charging points in certain places which is highly inefficient.

The EU Directive on the Deployment of Alternative Fuels (2014/94/EU, the "**EU Directive**") establishes a common framework of measures for the deployment of alternative fuels infrastructure in the EU. Amongst other provisions, it sets out standards for the design and use of alternative fuel points, including EV charging points. The EU Directive obliges Member States to introduce national policy frameworks for the development of infrastructure for alternative fuel including EV charging points and to develop measures to promote the deployment of alternative fuels infrastructure in public transport services, and designate areas which are to be equipped with recharging points for the public.

This standardisation is welcome and very necessary and should ultimately result in full interoperability of charging stations (for example, AC normal and high power compatible with Type 2 connectors and DC high power compatible with Combo 2 connectors), as well as minimum technical standards for the connectors.

However, setting minimum technical standards is not the same as universal standardisation and therefore compatibility issues arise unless the OEMs and the EV charging operators work together closely.

Paying for EV charging

In order to promote EVs, some EV charging companies, OEMs and some cities have offered public charging points free of charge. For owners of some of its models, Tesla also offers a network of free fast-charging points across Europe. It is clear that the free EV charging facilities are intended to offer an incentive for (prospective) owners of EVs. It is likely that once EVs have become a mainstream feature on our roads, this incentive will disappear.

Apart from the few free charging points, and those where cash or card payments are possible, charging systems as diverse as the EV charging points themselves have emerged.

The smart card system in which drivers can be identified via a smart card and are charged for the power they offtake at charging points seems to be gaining in popularity, although given the different EV charging systems, this payment regime may require users to have smart cards from different operators to ensure they can access sufficient charging points.

In another payment system known as 'plug and charge', electricity suppliers register specific EVs and issue a digital ID to each registered EV. Once registered, EVs will be recognised and drivers charged without the need for a card.

Multiple payment systems are not user-friendly and may well be another obstacle to the expansion of EVs not only in the UK, but also in Europe. Ideally, the payment systems

Automated and Electric Vehicles Act 2018

The UK Automated and Electric Vehicles Act 2018 (the "**Act**") aims at providing a legal framework for both the automated and EV sector. Having entered into force in July 2018, it is intended to enable consumers in the UK to benefit from improvements in transport technology. The Act makes provision for (1) the creation of a new liability scheme for insurers in relation to automated vehicles https://www.herbertsmithfreehills.com/our-expertise/services/connected-and-autonomous-vehicles, and (2) the creation of regulations relating to the installation and operation of charging points and hydrogen refuelling points for EVs.

In general, the Act is effectively enabling legislation granting the Secretary of State to make further regulations as described below. Given the nature of the Act, the legal regime developing pursuant to it is likely to remain fluid for some time to come so that EV industry participants will need to keep an eye on any emerging new obligations.

Regulations which can be made under the Act include those which:

- require operators of publicly accessible charge points and hydrogen refuelling stations and networks to ensure consumers can use them without the need to utilise many different methods of access, such as smart phone, SMS text, subscription and card payment;
- specify minimum standards of design and functionality to secure physical interoperability between electric and hydrogen vehicles and charge points;
- require the minimum provision of charge points and hydrogen refuelling stations at motorway service areas and large fuel retailers;
- require operators to provide open data in an open source format on the geographical location and live availability of charging and refuelling infrastructure and services; and
- require infrastructure installed for the purposes of charging EVs to have 'smart' functionality that enables them to receive, understand and respond to signals sent by energy system participants (eg DNOs, energy companies, the National Grid as TSO or other third parties) for the purposes of balancing energy supply and demand.

According to the UK Department of Transport, a timetable has yet to be set for the introduction of above regulations. However, in a paper by Ofgem on smart electricity systems published in October 2018, it has been suggested that Government will consult by early 2019 on the introduction of secondary legislation to set standards for smart EV chargepoints, when Parliamentary time allows.

would be simplified so that EV users can seamlessly charge and pay at any given location. Several initiatives are trying to achieve this, for example:

- hubject, a platform founded in 2012 with now 300 partner companies from a cross section of companies from the energy, technology and automotive industry connecting charging infrastructures in Europe through a business and IT platform aimed at providing simple access to charging stations; and
- NewMotion, the Shell-owned platform which has been operational since 2009 and is now available in 28 countries.

These, and other platforms, aim to make a maximum of charging points available for all EV users by forming consortia of charging infrastructure providers and facilitating 'eRoaming'. eRoaming, a concept borrowed from the mobile phone sector, aims to get rid of the need for multiple smart cards and is in line with the requirements of the EU Directive (see above) which mandates ad-hoc access to charging stations at 'reasonable, easily and clearly comparable, transparent and non-discriminatory' prices.

In the UK, the EU Directive has been implemented by the 'Alternative Fuels Infrastructure Regulations 2017 (SI 2017 No. 897, the **"UK Regulation"**). In relation to EV charging points, the UK Regulation provides that EV charging operators have to ensure that charging points for which an operator is responsible must:

- incorporate intelligent metering systems to a specific standard; and
- provide ad hoc access to any person wishing to recharge their EV without that person having to enter into a pre-existing contract with an electricity supplier to, or infrastructure operator of, that recharging point.

Home charging: Tariffs and impact on the electricity grid

Whilst en-route charging is an important aspect for EV drivers, the majority of EV drivers who are able to are likely to charge regularly at home, which brings its own issues both in terms of tariffs as well as the impact on the electricity grid (the **"Grid"**).

Charging a large number of EVs will invariably cause strain on the existing grid infrastructure. Particularly, if, as the international energy agency predicts, the global EV market could reach between 9 million and 20 million EVs by 2020 and between 40 million and 70 million EVs by 2025. Even at the lower end of the estimate, nine million EVs could require up to 8GW of extra power generation if drivers charge them when they like (for context, a good-sized CCGT power turbine or large off-shore windfarm is likely to have an installed capacity of around 500MW).

EVs will not only consume more electricity, they will also cause spikes in electricity demand which could put significant strain on the Grid and could potentially affect Grid stability. Some industry participants have also suggested that EV recharging could place strain on local electricity substations – commentators suggest that in terms of grid demand, each EV is the equivalent of three residential houses – and it is likely that a number of these substations will need reinforcing, especially in areas where they are already nearing their capacity.

Building on work undertaken by the Energy Networks Association about the impact of EVs on the Grid, Ofgem has recently published

an analysis of the impact of EV charging on typical household electricity demand across five scenarios, taking into consideration different charging speeds and different times of the day https://www.ofgem.gov.uk/system/files/docs/2018/07/ofg1086_future_insights_series_5_document_master_v5.pdf. The analysis showed that where flexible charging was used, at least 60% more EVs could charge using the existing Grid without needing to upgrade network infrastructure (both in terms of additional power stations and additional transmission infrastructure).

Flexible charging does this by allowing EVs to be charged when energy prices are lowest, for example when wind and solar power is generating lots of electricity or when there is less demand across the system.

To make flexible charging work, EV owners would need to use so called 'time of use' tariffs available through smart meters which would charge less for electricity outside of peak times.

Energy companies such as E.On and Scottish Power are starting to pursue related initiatives. In particular, Scottish Power recently announced an EV package through Arnold Clark where, alongside the purchase or lease of an EV, the driver would get a charge point at home from Wallbox on a 100% renewable electricity tariff from Scottish Power. The idea being that, ultimately, its smart meter functionality would facilitate flexible charging.

However, as of today, such flexible charging systems do not yet exist and Ofgem has set out proposals to put reforms in place between 2022 and 2023, including incentives for customers to charge their EVs at the most efficient time to free-up existing grid capacity.

In turn, this would allow new generators, including businesses or other organisations which want to generate their own power on-site (including potentially via the EDF/ Nuvve collaboration mentioned below), to get connected to the grid more quickly. In addition to flexible charging, localised distributed generation, in particular from renewable energy sources, may to some extent be able take the pressure of the Grid in areas with a lot of additional EV charging points being installed.

EVs: Giving back to the Grid?

Another important initiative underway is the development of the use of the capability to store electricity within the EV batteries themselves. Such electricity could be used to reduce business or domestic electricity consumption during peak periods or be sent back into the Grid via suitably enabled EV charging infrastructure when needed.

For instance, ChargePoint is currently working with Green Charge Networks (majority owned by Engie) to provide its EV charging infrastructure with energy storage capabilities and EDF recently announced a partnership with Nuvve whereby EDF business customers would be offered the supply of one of Nuvve's vehicle to grid (**"V2G"**) chargers to facilitate storage and re-use of stored electricity in fleets of EVs.

However, in some cases, allowing the EV battery to function as a flexible storage provider to the Grid may breach the terms of the relevant manufacturer's warranty, leaving the EV owner exposed.

In order for EVs to be part of the solution, rather than the problem, for the challenges to Grid capacity, a future proof, well thought-out regulatory regime is needed and quickly.

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