Charging forward:
Creating a world class UK charging network

TRANSPORT & ENVIRONMENT

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Executive Summary

The shift to electric cars in the UK is accelerating with more than 1 in 10 sales in 2020 [1]. Only new cars with a significant electric range can be sold in the UK from 2030 and only zero emission vehicles from 2035. The shift to an entire fleet of BEVs will not be complete until around 2050, but creating a UK-wide, convenient, affordable charging network is a key part of the delivery plan and this briefing and supporting study detail a roadmap to create a world-class charging network.

Much of the criticism of the lack of public charging infrastructure in the UK is ill informed. There is one charge point for every 9 battery electric cars on the road today, sufficient for the number of chargeable cars on the road. Just 1% of EV drivers want to go back to a combustion engine car [2]. But tackling the poor perception of the UK charging network requires: tackling the postcode lottery in the availability of charging; addressing the poor reliability of some networks; and making it easier to access charging points. After 2025 there will need to be a rapid and sustained increase in charging points and it is essential to create the conditions to ensure the network can grow with the number of BEVs expected on the road.

Figure A illustrates the number of charging devices to charge cars in the UK depending upon the mix of Slow (3-5 kW), Fast (7-22 kW) and Rapid (>50 kW) chargers installed. The numbers of charge points needed are lower than recent estimates by the Climate Change Committee and most other studies. This is because the approach assesses how many public charging devices will be needed to support the EV fleet and does not take into account that a more extensive network may be needed to persuade some non-EV drivers to make the switch to electric. About about two-thirds of UK homes have off street parking [3] and EVs charged at home will typically only use the public charging network on long journeys. Half of all drivers use their car so little they typically only need to fully charge their car twice a month [4] and should be able to make use of chargers located at their destination in car parks and Rapid Chargers on longer trips. Less than 1 in 20 cars need, on average, to be fully charged twice a week or more and would benefit from a kerbside charger near their home. The number of chargers needed in the future is partially dependent upon the future share of PHEVs that require a much more extensive charging network to be used widely on their batteries due to the short electric range and slow charging speed of these vehicles.

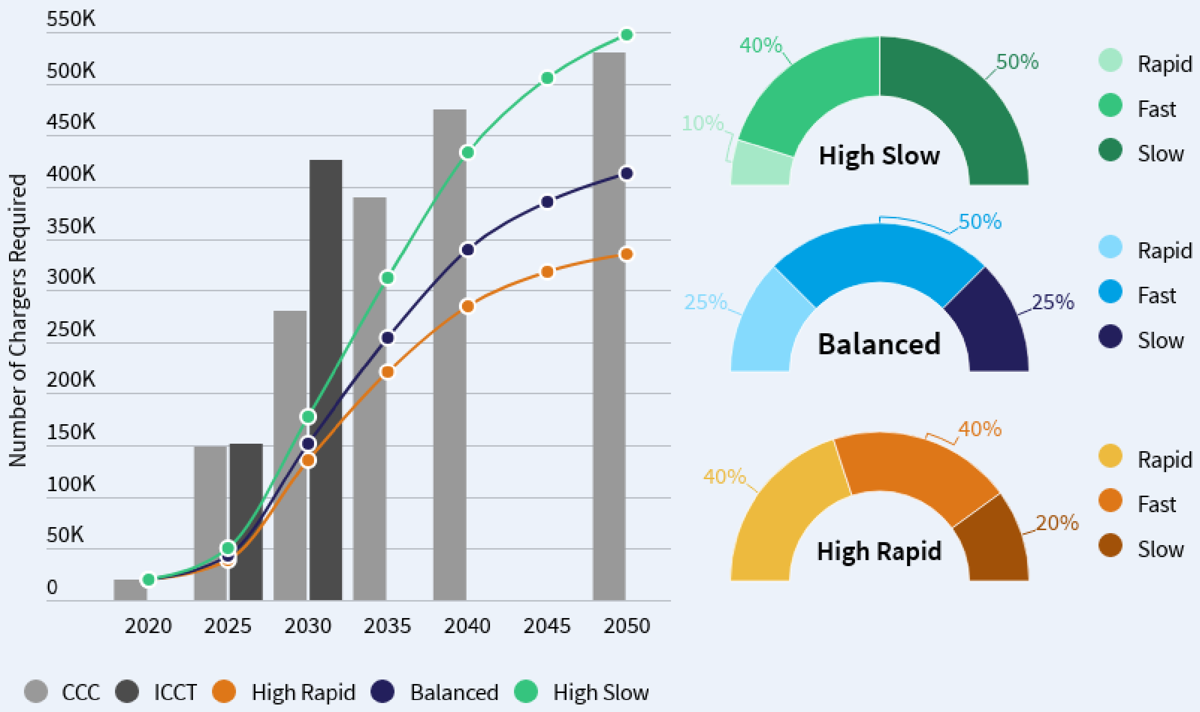

Figure A: Required number of charging devices for High Slow, Balanced and High Rapid charging network scenarios.

To create a world class charging network the role of government must now change from one of stimulating innovation and providing investment to an enabler of an extensive, high quality network. The need for a green recovery from the pandemic and huge benefits of transport electrification justify continuing public investment. However, it is unrealistic and unnecessary for the government to bankroll the transition.

The next step to develop the UK network must be to level up the availability of charging in local authorities throughout the UK. Between 18 and 29,000 additional charge points need to be installed by 2025 to ensure adequate coverage of charging through the UK and these need to be focused on those authorities with limited current provision. A supporting online map illustrates the progress of individual local authorities in the UK installing charging compared to the number of EV registrations and the number of chargers that are likely to be needed by 2025. A regional analysis (Figure B) shows London is closest to having a charge point network adequate for its needs in 2025 (although there are some parts of London with a surplus of charging devices and others with a shortage). The South East, South West, East and North West are the regions where the most chargers need to be installed by 2025 to level up provision throughout the UK.

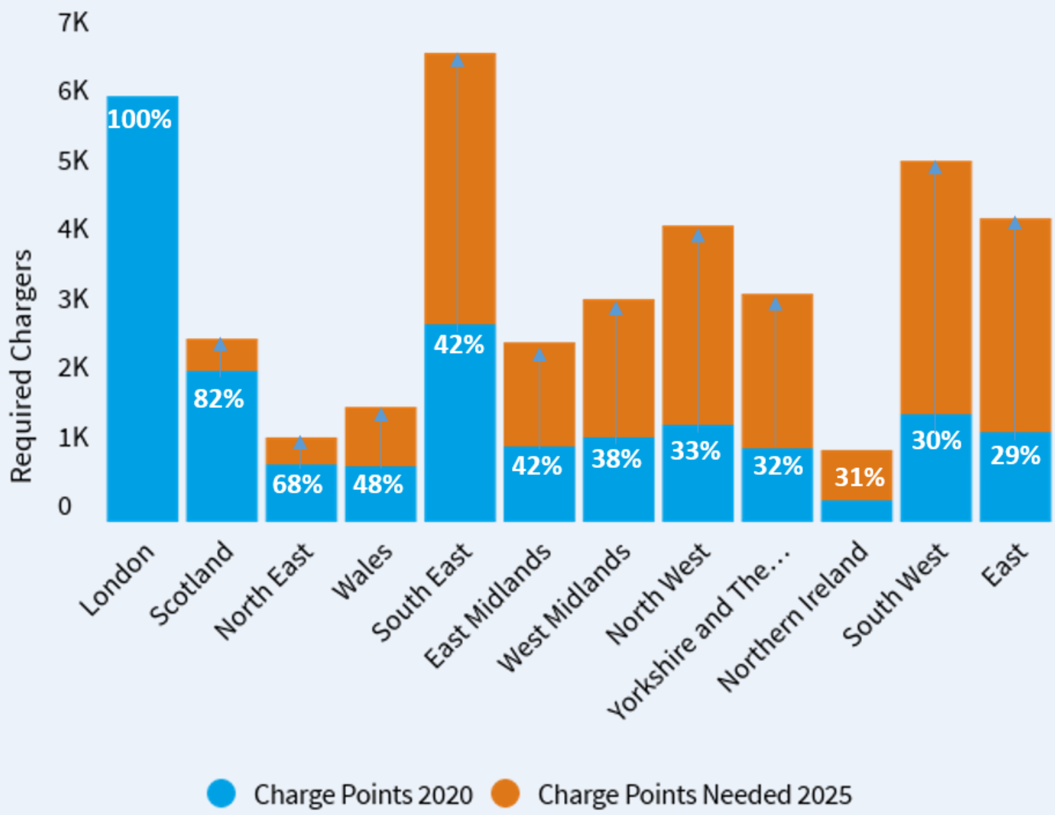

Figure B: Required number of charging devices in 2025 compared to current installations

At current rates of installing charge points the UK will have installed sufficient devices by 2025 but all local authorities need to make progress as at present, most have not allocated the resources needed to ensure an adequate supply of charge points in their area. Local authorities should therefore be given the responsibility to ensure there is adequate charging provision and a "right to charge" for all BEV drivers. Central Government funds should be allocated for "Charging Officers" to help deliver the roll out. OZEV should develop guidance and tools for local authorities to ensure a consistent approach to charging whilst recognising local circumstances will lead to variations of approach and charger density.

The government should also require charge point operators to ensure: every EV charging point is accessible to all vehicles; streamline the process by which EV drivers access the charging network;

require all publicly available charge points to be registered on a dynamic, publicly available national charge point registry; mandate minimum levels of maintenance and repair and customer support; and that there is transparent pricing. It should also allow renewable electricity supplied to EVs to count towards the Renewable Transport Fuels Obligation (RTFO) thereby providing an additional revenue stream for chargepoint operators.

The government must also develop a strategic solution to the high cost of grid connections for chargepoint operators and other private businesses. In the short term the Rapid Charging Fund should be directed exclusively at offsetting high grid connection costs but this only provides a temporary, sticking plaster solution. A long-term solution is needed to meet the costs of grid upgrades with the costs shared between charging installers, electricity bill payers and the Treasury. This will be particularly important once electric trucks are in more widespread use.

After 2025 the rate of installation of charge points will need to approximately double to match the increasing number of EVs. Regulations, reform of the buildings regulations and updated planning guidance should be introduced to increase the supply of charge points. There should be a legal requirement for an increasing share of changing places to be installed in car parking spaces including communal car parks in residential properties, at workplaces, at retail and leisure facilities, stations and other car parking locations.

Existing government charging support schemes including the: Electric Vehicle Homecharge Scheme; and Workplace Charging Scheme and Ultra Low Emission Taxi Infrastructure Scheme should be phased out once regulations have been strengthened with the costs of charging partially offset by supportive tax breaks. To be fair to less affluent drivers without off street parking, the cost premium for charging at public sites should be reduced by levying a 5% VAT rate to costs of using a public charge point to match that for domestic customers.

Creating a world class charging network will ensure this does not present a barrier to the phase out of sales of new cars and vans with engines. The vast majority of the investment will come from the private sector but national and local governments have a key role in steering the development of the network to produce outcomes that meet drivers needs, ensure good coverage nationwide does not place excessive demands on electricity supply infrastructure and support the transition to renewable energy.

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1. Charging in the UK today

The transition from internal combustion engine cars to battery electric vehicles (BEVs) is accelerating in the UK. In 2020, sales of electric cars (BEVs and plug-in hybrids - PHEVs) leapt to more than 1 in 10 sales from 1 in 33 sales in 2019 [1]. Driven by new UK regulations [5], sales are expected to grow further in 2021. The Government has announced only new cars with a significant electric range can be sold from 2030 and only zero emission vehicles from 2035 [6].

The shift to an entire fleet of BEVs cars and vans, will not be complete until around 2050, but the speed of transition, and resulting CO2 savings, will be largely dependent upon how quickly the share of new sales grows in coming years. Early adopters of BEVs have predominantly had off street parking enabling easy home charging and have been willing to tolerate the adequate but incomplete, unreliable and user unfriendly charging system that currently operates in the UK. But as the share of new EVs sold grows and new cars trickle down into the second hand market more drivers without access to off street parking will begin considering EVs and most will only choose to switch if charging is at least as convenient and easy and filling up is today. A rapid shift to BEVs therefore requires a comprehensive and easy to use charging network.

Much of the criticism of the lack of public charging infrastructure in the UK is either ill informed or malicious. Zap-Map statistics show there are currently 40 thousand connectors on 23 thousand devices in 15 thousand locations across the UK and the network is growing by around 850 connectors a month [7]. With approximately 450 thousand EVs (BEVs plus PHEVs) on the UK's roads [8] this equates to an adequate 1 device for every 20 EVs (9 BEVs). A recent survey found just 1% of EV drivers wanted to go back to a combustion engine car with 90% saying they would not [2]. This suggests the perception of the UK charging network amongst non users is worse than the experience of EV drivers. Perception amongst prospective EV owners is however crucial in purchase decisions.

Many chargers have low utilisation but the density of public charging is also highly variable throughout the UK. Data from the Department for Transport [9] shows on average there are 29 charging devices for every 100,000 population with the lowest density in Fenland (2) and highest in the City of London (370). Even within London the density of chargers varies widely with the lowest Havering (5) being amongst the lowest in the UK. Whilst some variation is to be expected the disparities highlight coverage is far from complete even for the relatively small number of cars currently in the UK's fleet. Figure 1 illustrates the wide variability in charging density per 1000 cars.

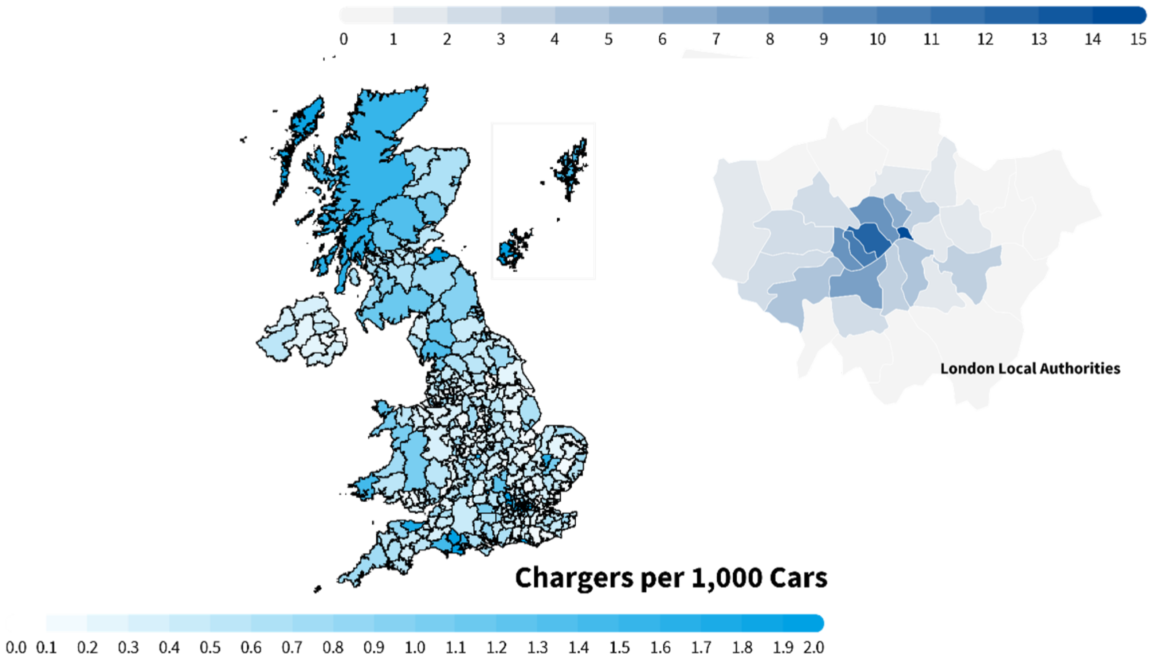

Figure 1: Variability of charging density across the UK, as of 4/1/2021 [9]**.**

A recent Zap-Map survey [2] of EV driver satisfaction with UK charging networks similarly shows wide disparities. Tesla topped the ranking (with a score of 4.8); InstaVolt second (4.4) and Osprey third (4.1). But the Electric Highway network of Ecotricity scored only 2.0. Charge your Car scored only 2.6 with network reliability a particular concern. Source London also scored poorly (2.7) with pricing and availability of local facilities noted as areas of concern.

This report examines what is needed for the adequate charging available in most of the UK to both expand and become exemplary. Section 2 of this report considers the rate at which the public charging infrastructure needs to expand including the impact of PHEVs on the charging network and how different charging strategies affect the size of the network required. Section 3 considers the key barriers to the expansion and improvement of charging in the UK and solutions to these based upon consultancy undertaken by Cenex for T&E UK. Section 4 draws conclusions and makes recommendations directed mainly at the Office for Zero Emission Vehicles (OZEV).

2. Future Charging Needs

2.1 Approach

A range of studies have estimated the UK's future charging needs with widely differing estimates [10]. For this paper future charging needs have been modelled by estimating future charging demand on the public charging network and then examining the charging capacity of different charger types to calculate the number of charging points of different types required. The approach is described in Appendix A and illustrated in Figure 2, below. The approach estimates the number of charging devices needed assuming a reasonable utilisation rate. It does not take into account that some prospective EV drivers may perceive they need a much more dense network of chargers before they are willing to make the shift to an EV.

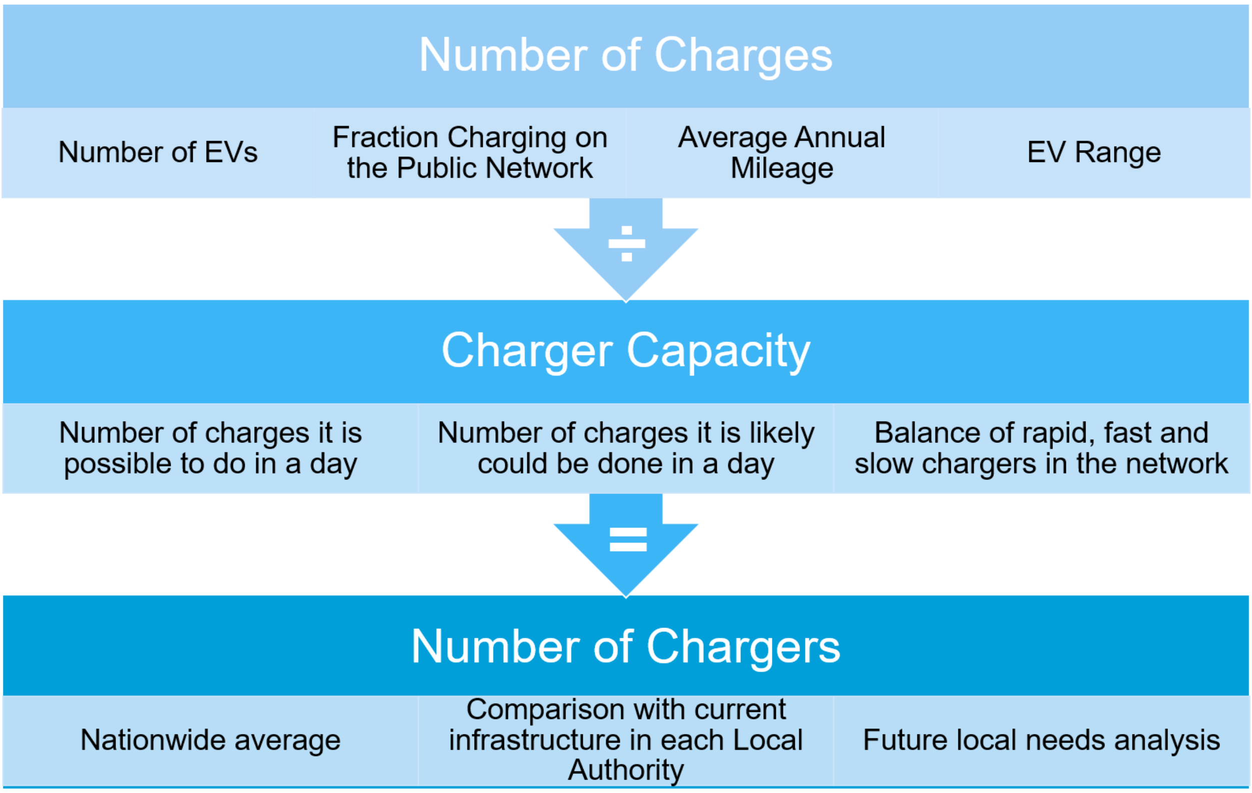

Figure 2: Schematic representation of methodology for estimating minimum adequate charging infrastructure.

Using typical average mileage of cars in the UK and average ranges for BEVs and PHEVs the number of full charges per year using the public charging network was calculated. It was assumed that BEV and PHEV owners with off street parking will overwhelmingly charge at home, supplemented by occasional charging at fast chargers on the motorway network during longer trips. The public charging network is therefore only used frequently by the half or less of drivers who park on the road [3] and do not have access to a home charger. The calculation assumes a steady increase in sales of

BEVs and PHEVs until 2035, after which only BEVs are sold. Once home charging has been accounted for, the remaining charging demand was allocated to the public network in a given year. A similar process was applied to the charging demand from PHEVS.

In practice drivers will very rarely entirely deplete the battery before recharging and most charging events are likely to be a partial charge. However, this does not significantly impact on the total number of chargers required as this analysis does not include full utilisation of chargers and a partial charge will be quicker, vacating the charger for another vehicle to use.

Three types of chargers were assumed to deliver the required charging:

- **Slow chargers** (3 - 5kW), located kerbside close to people's homes, at workplaces, stations and some other locations where cars are parked for a significant duration. These place the least demands on the electricity grid and in the case of kerbside chargers provide an important offpeak overnight demand for the increasing share of renewable generation supplying the UK grid.
- **Fast chargers** (7 - 22kW), charge the EV in car parks such as at retail centres, leisure facilities etc. where the car may be parked for an hour or more. It is assumed the output of the charger is suitable for a full charge to be delivered during the duration the car is parked at the destination.
- **Rapid Chargers** (>50kW), deliver a quick charge in 30 to 45 minutes. These are located at service stations on the trunk road network and in urban areas to supplement slow and fast charging.

The utilisation rates and charge times used for these charger types used in the calculations of required charges and chargers are detailed in Appendix A.

2.2. Numbers of Charges

Figure 3 shows the growth in the number of full charges at public sites that are expected to 2050 including upper and lower band estimates. Uncertainty arises in particular from: the estimated future range of electric cars, utility factor of PHEVs and the proportion of home charging, as detailed in Appendix A. The share of public charging is estimated to be between 33% and 49% of all charging - illustrating the majority of EVs will infrequently use the public network. About 50% of privately owned homes have off street parking, as do a further 17% of those that are rented [3]. Installing home charging in rented property and flats is not as simple as in privately owned houses but usually simpler, more convenient and cheaper than public charging and maximising the deployment of chargers in rented properties and communal residential car parks is therefore highly desirable.

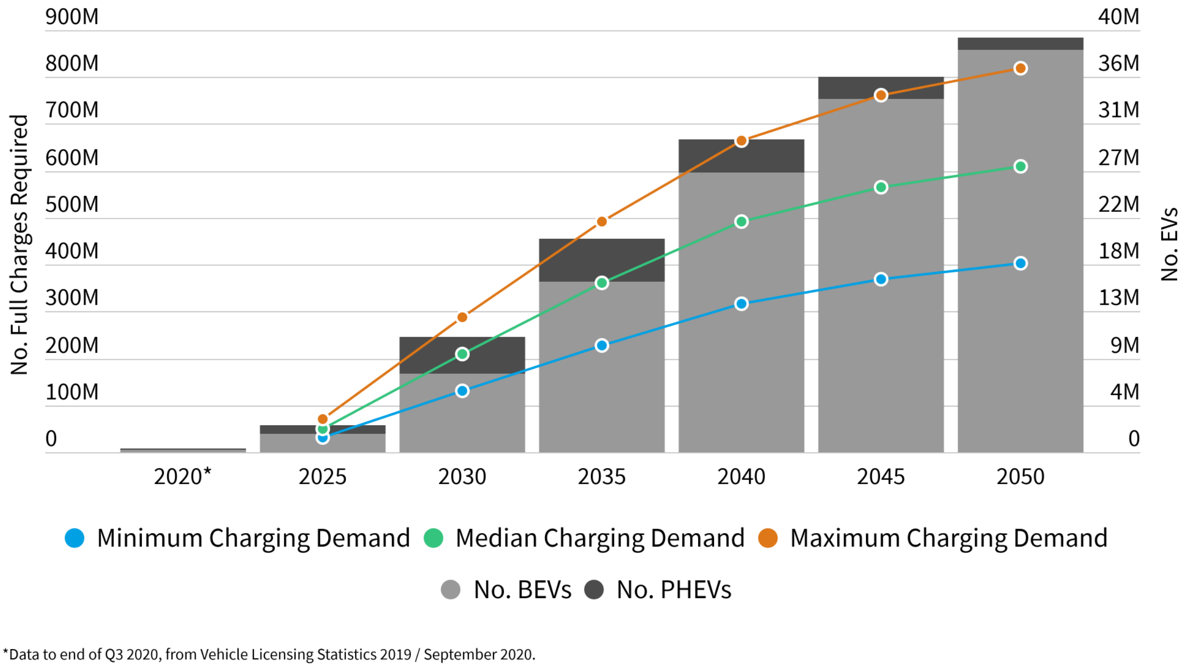

Figure 3: Required number of full charges to 2050 (assumptions are detailed in Appendix A). The estimate for 2020 is based on the Vehicle Licensing Statistics from September 2020 [11]**.**

The number of BEVs and PHEVs in the car fleet has been calculated using T&E's in-house EUTRM fleet model. In the central scenario sales of BEVs reach 69% in 2030 and PHEVs 31%. The appendix details other assumptions.

In 2025, we estimate a requirement of 50.5 million full charges per year on the public network in the median scenario. Of these 23.7 million are for PHEVs and 21.2 million for daily BEVs charging with the remainder rapid motorway charges (5.6 million). The annual total number of full charges for the central estimate rises to 209 million by 2030 (range 130 - 289 million) and 610 million by 2050 (range 401 - 818 million).

Figure 3 illustrates there is a large increase in the number of public charges between 2025 and 2030 (about 4 times) with charges then doubling between 2030 and 2035 and doubling again from 2035 to 2050. This illustrates it will be essential to ready the market for a large increase in chargers after 2025.

The data also illustrates that a relatively small share of PHEVs creates a relatively high number of charges (assuming a high utility factor in the order of 45%). This is because PHEVs have a small battery requiring daily charging - unlike most BEVs and can only be charged using low power.

2.3. Numbers of Chargers

Different charger locations and types have different advantages and limitations as summarised in Table 1. A balance is therefore needed between the different charging options and the Office of Zero Emission Vehicles (OZEV) through policy choices can steer the market towards different outcomes it seeks to achieve. Local factors will also influence the optimal balance of charge points and local authorities therefore also need to be provided with the resources, and develop the expertise, to steer an appropriate balance of charging types within their local area.

Table 1: Description of charger types.

Charger type	Advantages	Disadvantages
Slow domestic	Low cost, simple installation with owned homes	Only available to drivers with offstree parking unless charge point is made accessible for public use
Slow, kerbside	Convenient, charge at home, helps grid balancing	Local charger may be occupied when needed; poor business case - currently needs subsidy; addition street furniture and cables
Slow, workplace	Convenient when working & low cost	Only usually accessible for employees during working hours; charging during the day not at time when demand lowest; office buildings frequently not owned increasing installation complexity
Fast, retail and leisure	Integrates charging into daily activities	Higher cost; may involve expensive groundworks; can add to peak load on grid often unavailable at night
Rapid, urban hub	Car recharged quickly	Special trip to charge usually required; expensive; often high grid connection costs; will add to peak load on grid unless hub equipped with on-site batteries
Rapid, highway	Car recharged quickly and during routine stops	Expensive; often high grid connection costs; will add somewhat to peak load on grid

To illustrate how different factors influence the number of chargers needed in the future, T&E has created 3 scenarios and an upper, medium and lower case for each. The three scenarios are:

1. **High Rapid** - in which there is a high share of charging at rapid urban hubs and speed of charging is prioritised (Assumes chargers are distributed between: Rapid chargers - 40%, Fast - 40%, Slow - 20%)
2. **High Slow** - in which there is a high share of charging at slow chargers located at kerbside locations at home and at work. In this case charging is optimised to reduce impacts on the electricity supply (Rapid - 10%, Fast - 40%, Slow - 50%)
3. **Balanced** - in which destination charging accounts for half all charging and the remainder split between fast and slow charging. This is intended to be agile, with a balance of expensive but convenient rapid and fast destination charging and slower, lower capacity work and kerbside chargers. (Rapid - 25%, Fast - 50%, Slow - 25%).

The three scenarios are illustrative and designed to show the range in the total number of chargers required. There will be a theoretical maximum number of charges that a given charger can do in a year, determined by its power rating, and a more realistic estimate of how much a charger can realistically be used (utilisation rate). The higher powered the charger, the more EVs it could theoretically charge in a year and therefore the fewer chargers required to satisfy demand. Figure 4 illustrates the number of chargers needed for each scenario. More details of the assumptions behind these estimates are in Appendix A.

Utilisation rates are highly uncertain and are likely to change in the future as the charging network matures. Maintaining a good utilisation rate is essential. Anecdotal information suggests very low utilisation rates for many charge points in the UK at present. With too many chargers and low utilisation return on investment will be insufficient and charging companies will be at best only marginally profitable. This is likely to lead in the long term to a poorer service for drivers and high costs per charge. However, with too few chargers utilisation rates will be good but drivers will struggle to find a convenient public charge point of the type they need. This is likely to lead to negative media coverage that will discourage new drivers buying an BEV until 2035 (when they will be required to). Growing the number of chargers at the right speed is therefore essential.

T&E has selected utilisation rates that are higher than most sites currently achieve in the UK but which are not unduly optimistic based upon discussions with stakeholders.

Charger type	**Full charges per day**			
	Theoretical maximum	**Maximum assumed**	**Average assumed**	**Minimum assumed**
Slow kerbside	3	2	1.5	1
Slow workplace (5 days / 7 per week)	2.1	1.1	1	0.7
Fast destination	6	2	1.5	1
Rapid hub	32	10	8	6

Table 2: Assumed utilisation rates

To calculate the required number of chargers for 2025, a similar approach was used but which included a more detailed analysis of the current charging provision at a local authority level across the UK and scaling this to ensure there is adequate charging in all local authorities throughout the UK.

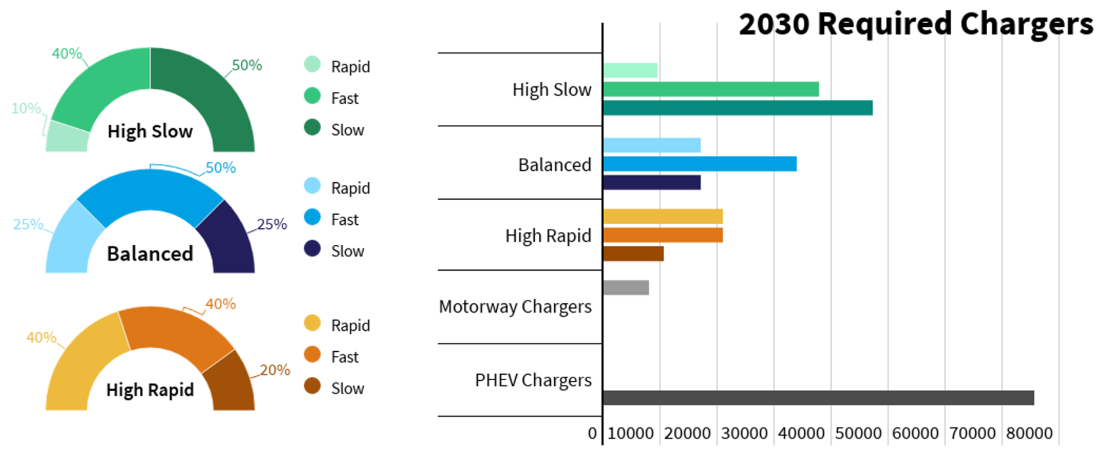

Figure 4. Required chargers by charging speed in 2030 for each charging network scenario. It's assumed that all motorway charging uses rapid chargers, and all PHEV charging uses slow chargers.

The number of chargers includes rapid chargers stationed at motorway services and slow charges to meet the charging needs of PHEVs that use the public network. The estimated range in the number of chargers required stems from uncertainty in charger utilisation rates.

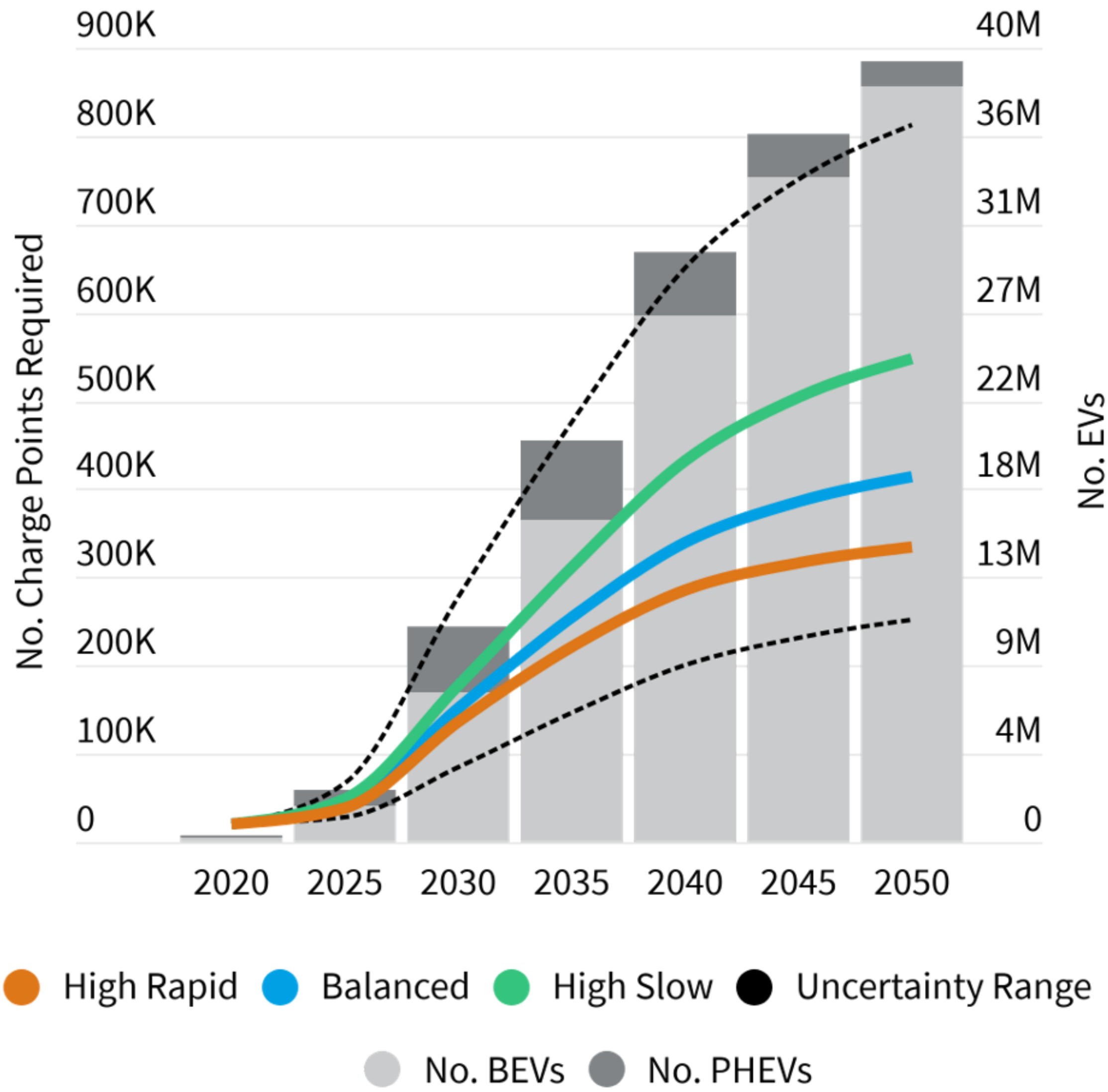

Figure 5: **Number of charge points required in the UK for alternative charger scenarios from 2020** [9]

Additional Charging Devices[1]	High share of Rapid chargers	Balanced	High share of Slow chargers
2020-2025 total	**25,300**	**26,000**	**32,000**
Rapid	3,300	2,300	400
Fast / Slow[2]	22,000	23,700	31,400
Monthly Installation Rate	380	460	600
2025- 2030 total	**96,800**	**108,300**	**128,000**
Rapid	21,800	18,800	13,200
Fast	15,600	25,300	28,200
Slow	59,400	64,200	86,700
Monthly Installation Rate	1,600	1,800	2,100

Table 3: Estimated minimum required growth in chargers over the 5 year periods 2020-2025 and 2025-2030[3]. As of 1 Jan 2021, there were 20,775 charging points in the UK with almost 36,600 connectors[4].

2.4. Comparison with other studies

A comparison of the number of chargers with previous studies by the CCC and T&E indicates that less charging infrastructure may be required than has been previously suggested. This is to be expected given the focus on sufficiency in this work. For skeptical new car buyers to choose an EV for the first time it may be necessary to install more chargers than is actually needed - although this will lead to a lower utilisation rate.

[1] For the purpose of these calculations it has been assumed each device can only charge 1 EV at the same time.
[2] Data on the number of fast and slow chargers in each Local Authority in 2020 was not available, making only a rapid / other analysis possible.
[3] As noted by ZapMap and the Electric Vehicle Charging Statistics based on the ZapMap data, many charging stations have one or more connections capable of charging an EV. However, it is not well known how many of these could charge multiple vehicles simultaneously. T&E has followed OZEV's decision to count the number of charging devices in 2020; this is likely an underestimate of true charging capacity. In subsequent years, 'charging points' implies the number of connections capable of independently charging an EV.
[4] Zapmap, "EV Charging Stats 2021", Feb 5 2021. Retrieved from: https://www.zap-map.com/statistics/

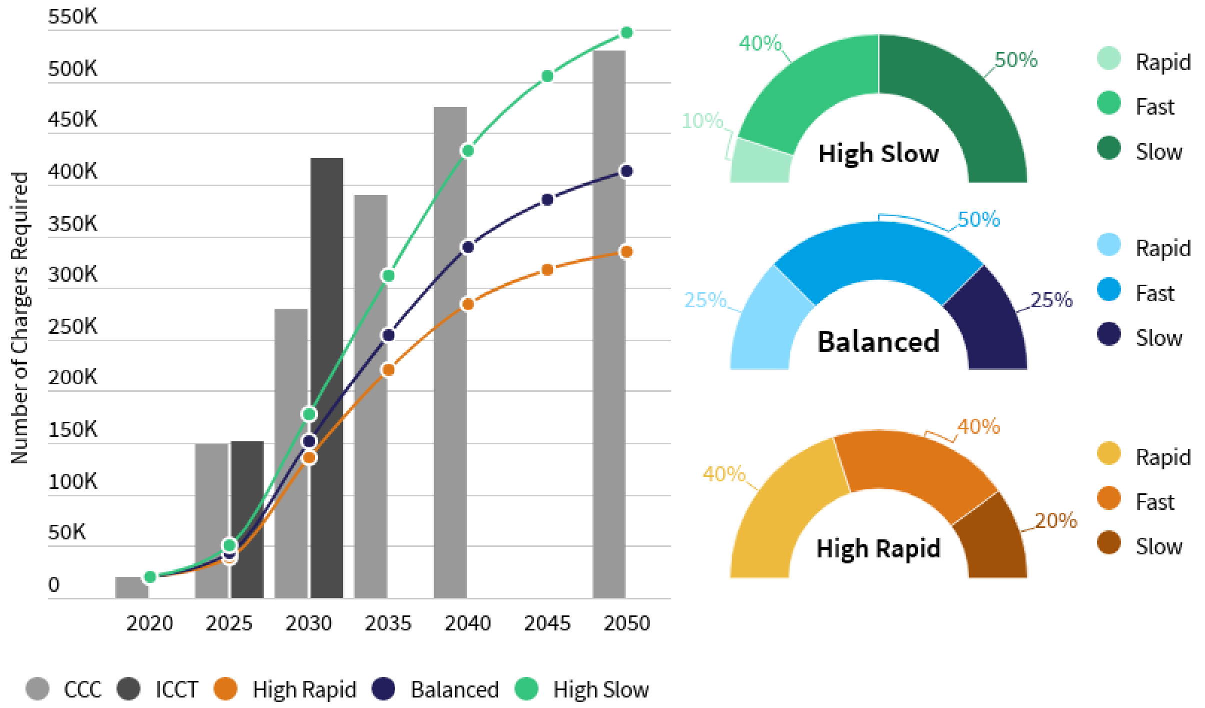

Figure 6: Comparison of estimates of required number of charging points with that made by the CCC in 'The sixth carbon budget' [12] **and by the ICCT in their "70% Electric share in 2030" scenario** [13].

2.5. Impact of PHEVs

The approach taken allowed the impact of a large share of PHEVs on the required charging network to be tested. The impact of high shares of PHEVs compared to BEVs on the charging network depends upon the extent to which PHEVs are driven using their battery and electric motor (utility factor). At present real world data shows [14] that privately owned PHEVs have a utility factor of 37% and company cars just 20%. But if PHEVs are to have a significant role in decarbonising cars and vans a much higher utility function is needed. To calculate the impact of a higher or lower share of PHEVs on the required charging network three scenarios assuming a low, median and high fleet share were modelled.

- Low PHEV Scenario: PHEVs are 12% of 2030 sales and there are 1.4 million PHEVs in the 2030 UK fleet.
- Median PHEV Scenario: PHEVs are 31% of 2030 sales and there are 3.4 million in the fleet.
- High PHEV Scenario: PHEVs are 50% of 2030 sales and there are 5.5 million in 2030.

Other assumptions are detailed in Appendix 1. Figure 6 shows the effect on the charging network of different uptake scenarios for PHEVs. As PHEVs can currently only use slower chargers, each additional PHEV disproportionately increases the number of charge points required compared to a BEV. If there are high PHEV sales until 2035, these significantly increase the amount of public charging needed. High sales volumes of low range, low utility factor PHEVs that cannot fast charge pressurise the charging network without corresponding gains in decarbonisation and electric miles driven. If high sales of PHEVs continue until the 2035 phase out, rather than decreasing more rapidly and being displaced by BEV sales. In 2030, the UK will need a third more chargers (34% more devices are needed in the high PHEV scenario vs the low). However, once PHEVs leave the fleet after sales end in 2035, the UK could be left with more kerbside charging than is necessary, having wasted investment on meeting PHEV charging needs. In 2035:

- For the Low PHEV scenario the total required number of chargers is 231,000
- For the Medium PHEV scenario the required number of chargers is 255,000
- For the High PHEV scenario, the required number of chargers is 288,000

The difference between the low and high scenarios is therefore 25% in 2035.

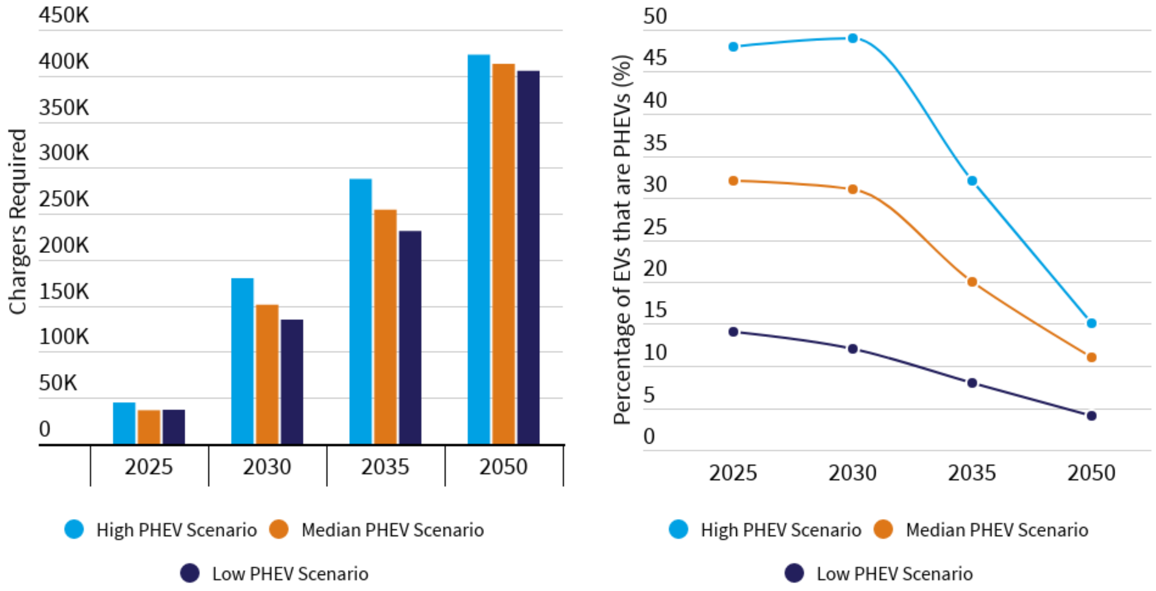

Figure 7: Effect of increased PHEV numbers on charging infrastructure network.

2.6. Levelling up charging provision across the UK

To assess the number of charge points required by 2025 T&E undertook a more detailed analysis which took account of the uneven distribution of charge points throughout the UK as was illustrated in Figure 1. On average there are 20 EVs (BEVs plus PHEVs) for every charging point in the UK. But the distribution of charging is highly variable. From now until 2025 the focus of government should be levelling up to ensure adequate charging in every local authority throughout the UK. To achieve this T&E estimates it will be necessary to deploy an additional 22,000 charging devices throughout the UK to ensure there is adequate coverage in all areas. An estimated 87% of areas have more chargers than they are estimated to need in 2021; just 12% of local authorities have adequate charging for 2025.

Figure 8 illustrates the number of new charging devices that need to be installed in each UK local authority. The calculation assumes the distribution of EV sales across the UK in 2020 and 2025 remains the same and that sales follow the same S-based uptake curve in all areas. This is a reasonable assumption since the share of EVs sold remains fairly small. It is also assumed that the charging network follows the 'Balanced' scenario in terms of proportions of chargers of different speeds.

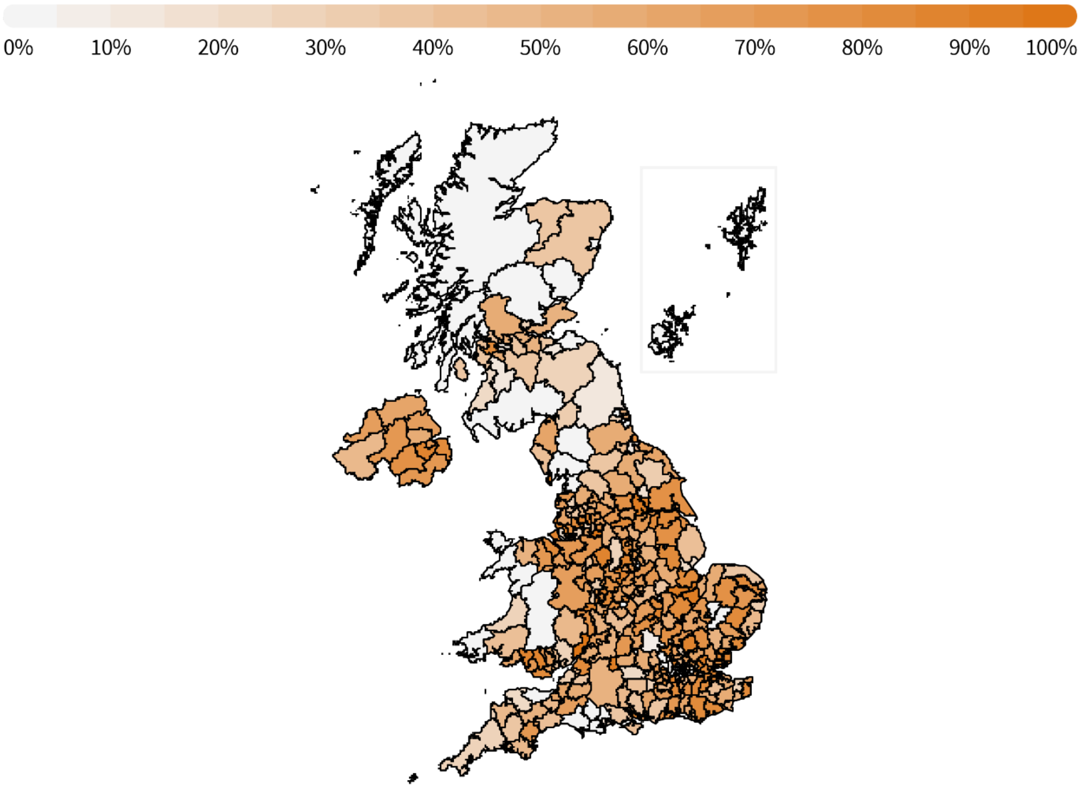

Figure 8: Percentage increase in charging points required by 2025 to meet anticipated demand, by Local Authority.

The analysis examines the number of charge points needed to meet the requirements of local residents. Some local authorities may attract a large number of visitors and therefore may require more charging to meet their needs. Other authorities may attract a large number of commuters driving into their area that also need additional charge points. Local considerations are important and local authorities should be given a far greater role and resources to ensure there is sufficient charging provision. Finally, it is possible that the number of EVs registered in a specific local authority may be disproportionately influenced by the presence of a major leasing company located in that authority, for example Peterborough. This emphasises the importance of local assessments of charging needs. The analysis nevertheless provides an illustration of where additional charging is particularly needed in the UK before 2025. Table 3 illustrates at a local authority level those that appear to have the best charging networks for their charging needs in 2025; and the authorities that need to install the most chargers to meet their needs in 2025.

Local Authorities requiring no additional charge point installations by 2025	Local authorities requiring the most additional charge point installations by 2025
Westminster	Stockport
Wandsworth	Leeds
Kensington and Chelsea	Slough
Hammersmith and Fulham	Swindon*
Camden	Peterborough*
Richmond upon Thames	Birmingham
Southwark	Milton Keynes*
Brighton and Hove	Forest of Dean
Lambeth	South Gloucestershire
Islington	Solihull

*Data may be influenced by the presence of large leasing companies.

Table 3. Local authorities (LAs) with the most and least installations are needed to ensure the charging network is adequate in 2025.

Table 4, below, compiles the local analysis to give a regional analysis of the parts of the UK where the greatest number of chargers are required. It clearly shows London to be by far the most advanced region in terms of having the charging network needed for the number of EVs expected on the road in 2025. In contrast the East, South West, Northern Ireland, Yorkshire and Humber and the North West have particularly poor coverage given the number of EVs currently registered and expected to be bought in these regions in the next few years.

Region	Chargers Installed 4/1/2021	Additional Chargers Needed by 2025	Percentage of required chargers by 2025 already installed
East	1,300	3,100	29%
East Midlands	1,100	1,500	42%
London	6,200	1,100	100%
North East	800	400	68%
North West	1400	2,900	33%
Northern Ireland	300	700	31%
Scotland	2,200	500	82%
South East	2,900	4,000	42%
South West	1,600	3,700	30%
Wales	800	900	48%
West Midlands	1,200	2,000	38%
Yorkshire and The Humber	1,100	2,200	32%

Table 4. Regional analysis of the levelling up of charging networks needed by 2025.

3. Creating a world class charging network

Section 1 highlighted there are wide disparities in both the adequacy of charging available across the UK and usability of charging networks. Whilst the installation of new charging and improving the user experience are both primarily the responsibility of private companies, government intervention and funding can play an important role to strengthen the charging network. This section addresses the barriers to creating a world class charging network and how these can be resolved.

3.1. Strengthening local government responsibilities and capabilities

Local authorities play an important role in facilitating the roll-out of charging infrastructure particularly slow kerbside chargers and those located in council owned or operated car parks. Local authorities can also specify a requirement for charging as part of planning conditions. Some authorities have supported the role out of extensive local networks including in: some London boroughs (City of London, Westminster, Hammersmith and Fulham, Kensington and Chelsea and Wandsworth), Dundee, Nottingham, Oxford and Coventry. Other authorities such as: Fenland, Castle Point, Selby, Barrow-in-Furness, Brentwood, Gravesham, Harlow, Havering and Rhondda Cynon Taf have made minimal progress to date with 5 or less chargers installed per 100 thousand people. The Secretary of State for Transport has said: "Your postcode should play no part in how easy it is to use an electric car ..." [15] But clearly it is and will continue to be whilst local authorities have neither a statutory responsibility to facilitate the roll out of charging points or the resources to do so.

Establishing a new statutory responsibility for local authorities to facilitate the roll out of charging points is essential and this must also clarify the specific responsibilities of different levels of local government and require cooperation between neighbouring authorities to create a seamless network for EV drivers. Encouraging action at a regional level will also reduce the costs of the roll-out. To date, much of OZEV's On-street Residential Chargepoint Scheme has been spent on installing infrastructure in off-street car parks in part due to a lack of engagement from borough and district councils. But many authorities lack the staff to make use of the fund - so new dedicated resources for the roll out of charging is needed in all local councils complemented by the development of guidance and provision of training and an online help-service to ensure a consistently high quality of charging throughout the UK. Having dedicated resources, and operating as part of larger regional networks, may also discourage authorities from attempting to use charging as a significant new revenue stream rather than only seeking to cover their costs. The business case, particularly for kerbside charging, is already weak and can be uncommercial if the local authority tries to excessively profit from newly deployed charging points.

3.2. Tackling the high cost of grid connections for fast charging

The high cost of grid connections, particularly for high-power charging, is a significant barrier to the roll out of fast charging along highways, fast charging stations in urban areas and, in the future, depot and distribution centre charging for trucks and vans. For EVs to complement increasingly renewable grids as much charging as possible should be undertaken at home at night or at work during the day. Where Rapid Urban changing hubs are deployed these need battery backup storage to avoid creating peak energy demands. However, for most car drivers routinely using Rapid charging will make EV use expensive but some Rapid charging will be needed in highway locations for longer trips and in major urban centres for taxis, delivery drivers and for car drivers that urgently need to charge.

Upgrading the electricity grid can double the costs of the rapid charger installation. The Rapid Charging Fund provides a potential solution and should be focused exclusively on helping to cover a portion of the grid connection costs where these are high. Channeling funds through Ofgem to Distribution Network Operators seems the best use of these funds. However, the Rapid Charging Fund can only provide a sticking plaster solution and a long-term structural plan to tackle the high grid connection costs for EV charging is needed that should also tackle the inability of network operators to invest in grid capacity ahead of need. Without this, electricity network upgrades will continue to be undertaken several times in the same location. Ofgem recently finalised its price controls for electricity transmission for 2021-26 (RIIO-2) which included £11 billion of upfront funding. The equivalent system of price controls for electricity distribution network companies will begin in April 2023 and as part of this the high costs for grid connections for charging and other green projects need to be addressed.

Another limitation of the current system is that there is no freely accessible means for EV charging network operators to understand and plan around the existing local constraints of the UK's electricity network. At present, once a new potential site has been identified the DNO must be contacted to obtain a budget estimate to establish the connection point to install EV charging infrastructure at each site. But network connection costs vary widely depending on the proximity to existing electrical supply and whether there is capacity at this site and this will not be known until budget estimates are received from the DNO creating delays and adding costs. This system of trial-and-error is inefficient imposing costs and significantly slowing the rollout process. Some DNOs, such as Western Power Distribution, provide an online EV Capacity Map that provides a substation-level view of locations that are more or less likely to have capacity for EV charging sites. Most DNOs only offer freely-available grid capacity data at the primary substation level, which is of much more limited use for EV charging infrastructure network planning. All DNO's should be required to provide similar tools to the EV Capacity Map.

3.3. Improving the user experience

3.3.1. Roaming

In the UK there are more than 50 different private charging networks and no single and simple way to access all the different networks. There is also only one, privately operated, information source covering most EV charging points (ZapMap). In England, EV drivers have a wide choice of charge point operators but to access the sites need to register with a range of network providers, navigate widely differing pricing structures and experience highly variable performance from network operators. In Scotland, ChargePlace Scotland, operates a national EV charging network that is owned and has been developed by the Scottish Government. There are now 1500 charge points in the network that approximates to 27 for every 100 thousand people, similar to the 29 currently in England. There are advantages and disadvantages to both publicly and privately owned and operated networks and both systems can provide EV drivers with an excellent service.

All EV drivers want is affordable, convenient and reliable public charge points. Whilst the proliferation of charging networks in England has undoubtedly encouraged innovation, it has also created enormous complexity for drivers. As electric cars become mainstream, charging, particularly in England, must be simplified and networks become as interoperable as filling stations and as reliable. If not, the diversity of operators and approaches is likely to become an increasing barrier to future EV uptake.

One clear area for improvement is to enable easy roaming between networks. The Alternative Fuels Infrastructure Regulations (2017) must be reviewed by October 2022 and OZEV should use the opportunity to consider whether the current rules are being met and if they are fit for purpose. The regulations state that "*the ability for any person to recharge an electric vehicle without entering into a pre-existing contract with an electricity supplier to, or infrastructure operator of, that recharging point*". But many operators require registrations through apps to use charging sites that in turn require signing terms and conditions - it is questionable whether most UK charge point operators are compliant with the regulation. The government has provided ample time for charge point operators to develop their own solutions to improve interoperability which they have failed to adequately do.

The government consultation on *The consumer experience at public chargepoints* [16] is a step in the right direction with many construction proposals. Regulation is needed to:

1. Make every EV charging point accessible for all EV users
2. Streamline the process by which EV drivers access charging network
3. Enable card payment at all chargepoints
4. Require all public available charge points to be registered on a dynamic, publicly available national charge point registry
5. Mandate minimum levels of maintenance and repair and customer support
6. Providing a consistent basis for indicating costs.

EVs are becoming mainstream and the substantial investment risks for early charge point operators have been eliminated and will in coming years be replaced by a healthy and reliable income stream. The market needs to work for its customers and the government must now prioritise the needs of EV drivers over those of charge point operators to create a world class charging system whilst maintaining a healthy environment for future investment.

3.3.2. Open data access

Another limitation of current systems is that there is no open dataset of live chargepoint information. Zap-Map provides an excellent system for EV drivers but live data is not provided by all networks, meaning that data is not updated in real time. As a private service the information held by Zap-Map is not openly available. The OZEV needs to develop the National Charge Point Register (NCR) to accept live data (by equipping it with an Input Access Point Interface) and mandate charge point operators to provide the information. This should include future booking capabilities in the future. An upgrade to the system should be completed by the end of 2022 at the latest.

3.3.3. Improving charging at motorway service areas

Ecotricity has the dubious honour of operating the UK's worst charging network according to EV drivers [2]. Its network of more than 300 charge points is mainly located at the motorway service areas. A recent survey by EV drivers by Zapmap were particularly critical of reliability and ease of use with respondents commenting that the units are old, poorly maintained, and frequently out of service with inadequate out of hours support. Exclusivity agreements have prevented other charge point operators from installing equipment at most motorway service areas and created a virtual monopoly that is being exploited through high charges and poor service. The launch of the Competition and Market Authority (CMA) investigation into the electric vehicle charging sector in the UK is an important opportunity. T&E urges the CMA to develop proposals which:

- Require the creation of a dynamic open access database of EV charge points
- Address the market failure at motorway service areas
- Require increased price transparency
- Enhance interoperability between charge point networks
- Enable booking of chargers in advance.

3.3.4. Pricing

Pricing transparency is another area of concern with different networks operating entirely different charging structures. This includes: different rates for: members and non-members; for using an app or paying by card; for time; for connecting; for the power of charge delivery. In the future charges may also vary with time of day. With so many permutations for payment it is difficult for a regular user of public chargers to know what is their optimum charging approach. For non-EV drivers the array of options may actively discourage them to purchase an EV. With greater open access to data it is likely tools comparing pricing options will become available and T&E sees this as a key to assisting EV drivers choose the optum package for their use pattern. OZEV should also develop a legal definition of price transparency with stakeholders and build this into future regulation.

3.4. Home charging for all

3.4.1. Requiring charging in rented and leasehold properties

T&E estimates that around 12% [3] of homes in the UK with off street parking are rented or have parking owned by the freeholder and for these properties installation of home recharging points can present a major challenge and / or cost. This represents a valuable charging potential that could significantly reduce the need for more expensive public charging. However, to install charging the consent of the owner or freeholder is required and with rented or leasehold properties and communal car parks there are a number of additional complexities that complicate installing charge points. The recent change [17] to the Electric Vehicle Homecharge Scheme to extend access to the rented and leasehold sector is a step in the right direction whilst the decision to end the scheme for private homes from April 2022 also targets limited resources towards the sectors this is most needed. The extension of the Workplace Charging Scheme to small to medium enterprises and the charity sector, will also enable small accommodation businesses, such as B&Bs to access support and enable easier charging for those making overnight stops.

A legal obligation on property owners to install an increasing number of charge points where there is dedicated parking provision would cut through the complexity and ensure that overnight charging is possible where parking is provided. The cost of the charge point would, overtime, be covered through use fees and if it is not possible to power the chargepoint from a specific domestic electricity supply then a commercial charge point company could install and manage the equipment. In early years the ratio of charge points to parking spaces would be low but would need to increase over time.

3.4.2. Strengthening planning requirements

At present there is no requirement for property developers to be required to install home charging for new build properties even where off street parking is provided. Some local authorities have introduced planning requirements such as the London Plan, which includes a requirement for newly-developed car parks to include charge points in 20% of parking bays. However, planning authorities are often willing to ignore such policies in order to secure investments in major new buildings.

The UK Government consulted [18]on reform of the English Building Regulations in 2019 and proposed that:

- Every new residential building (and building undergoing material change of use) with an associated car parking space should have a charge point installed.
- Every residential building undergoing major renovation with more than 10 car parking spaces shall have cable routes for electric vehicle charge points in every car parking space.

- For new non-residential buildings (including those undergoing major refurbishment) - with more than 10 car parking spaces to have one charge point and cable routes for an electric vehicle chargepoint for one in five spaces.
- For existing non-residential buildings - there shall be a requirement for at least one chargepoint where there are 20 car parking spaces, from 2025.

There is a pressing need to complete the review of responses and implement the changes that should be strengthened in line with bringing forward the phase out date for cars and vans with engines from 2040 to 2030. Specifically, the requirements to install cabling should apply irrespective of the number of car parking spaces and to communal car parks in both residential and non-residential buildings.

3.5. Including electricity in the Renewable Transport Fuels Obligation (RTFO)

The RTFO is a key policy to require the supply of renewable fuels in transport. Fossil fuel suppliers for vehicles are obligated to supply renewable fuels in transport (this year 9.6%). The Obligation is met through earning Renewable Transport Fuel Certificates (RTFCs) and is mainly achieved through the supply of biofuels. The government is consulting on proposals to raise RTFO targets to increase CO2 savings. However, it continues to omit electricity used to charge electric vehicles to count towards achieving the targets even though hydrogen or Renewable Fuels of Non Biological Origin (RFNBOs like e-kerosene) made from renewable electricity are allowed.

In the EU, the supply of renewable electricity counts alongside biofuels towards targets set under the RED II. Liquid renewable transport fuels and renewable electricity are also both credited through the California Low Carbon Fuel Standard. Tackling this anomaly provide an additional incentive towards the shift to electric cars by providing an additional revenue stream for supplies or charge points (or possibly vehicles).

Although electricity for transport is currently excluded from the RTFO, historically, suppliers of electricity were allowed to claim credits under the Greenhouse Gas (GHG) Regulations credit mechanism which ended in 2020. The GHG regs defined the electricity supplier as the owner of the electricity at the point that it is metered, linking to the Electricity Act 1989 to do this. In practice, this meant that to be a claimant of electricity under the GHG Regulations a company had to be a registered electricity supplier with Ofgem. Only the renewable part of the electricity was rewarded and assessed based on each supplier's annual 'Fuel Mix Disclosure' to Ofgem.

There are several issues to resolve in order to include renewable electricity used in cars but none are insummontable:

1. **What renewable electricity should count towards RTFCs?** T&E favours using the grid average renewable content of electricity. Data are readily available that could be applied by the RTFO administrator without requiring any further evidence from the claiming entity. Whilst we recognise this doesn't send a signal to the market that electricity for EVs should

ideally be renewable, 37.0% of the UK electricity mix in 2019/20 was renewable and between 60% and 100% of UK power will be renewable by 2030.

2. **Which entity should be eligible to claim reward?** T&E favours allowing the charge point operator (where there is a separate entity owning the charge point, which is usually the case for non-domestic charging). Providing support to charge point operators maximises the likelihood the credit will increase the supply of charge points.
3. **How to reward electricity use within the Energy Act?** T&E considers definitions in the Energy Act are sufficiently broad to allow the inclusion of electricity into the RTFO. The Energy Act states that a renewable transport fuel is a liquid, solid or gas. In doing so, the intention of the Act was to allow the broadest scope of renewable energy vectors to be included. Furthermore a charged battery is a form of solid fuel.

Including renewable electricity for charging EVs within the RTFO will support the roll out of charging and should be allowed.

4. Conclusions

EV charging in the UK is at a key stage of its development. It has expanded to provide an adequate network for the early EV adopters and through government support and early high risk investment overcome the chicken and egg dilemma to support the first electric cars. But the network must continue to expand as the number of EVs on the road grows; coverage must improve; and charging must become much simpler and more reliable. Government has a key role in creating the world class network that is needed for the UK to end the sale of conventional cars with engines by 2030. But the role of the government must change from facilitating innovation and incentivising early adopters to becoming an effective market enabler and regulator. This will inevitably include phasing out or redirecting some of the support currently being provided to focus resources where they can have greatest impact.

The employment opportunities created by a green economic recovery and the benefits of a shift away from powering transport with oil justify the government continuing to invest in the transition to electric cars. However, it is unrealistic and unnecessary for the public sector to bankroll the shift - particularly with the economic crisis created by the pandemic severely impacting public finances. Financing of the transition needs to move away from increasingly expensive grants and capital funding for charge points towards providing tax breaks for companies installing charge points and revenue funding for local authorities to enable them to employ staff that will be responsible for the roll out of charging within their local area and put in place the contracts and licences to enable this to happen.

The large proportion of UK homes with off street parking (around two-thirds) and increasing range of EVs means most BEV users will only need a full charge once or twice a week. Less than one in 20 drivers need to charge every day. T&E estimates that by 2025 the UK will only need between 18 and 29 thousand additional charge points depending upon the mix of Rapid, Fast and Slow chargers. This compares to 23 thousand devices currently deployed. If there is a high share of PHEVs the amount of charging required increases by around 23% (rising to 33% by 2030) as these cars have smaller batteries and in most instances cannot Fast or Rapid charge. The estimates of required charging are less than other studies including those of the Climate Change Committee [12] and T&E [19] (that used a different methodology and less UK specific assumptions). Our results estimate the level of public charging needed to service EVs expected on the road that do not have access to off street home charging plus those taking longer trips.

The increase in charging between now and 2025 should focus on addressing the postcode lottery of public charging that currently exists through a levelling up process to ensure every local authority has sufficient distributed charging across its area. This will help to address the unfairly negative perception of charging in the UK. A supporting online map illustrates the progress of individual local authorities in the UK installing charging compared to the number of EV registrations and the number of chargers that are likely to be needed by 2025. The regional analysis shows London is closest to having a charge point network adequate for its needs in 2025 and the South East, South West, East and North West are the regions where the most chargers need to be installed by 2025.

There are more than sufficient private sector charge point operators keen to install charging - but particularly beyond 2025, there is likely to be a lack of sites willing to pay for the chargers given the very large increase in charge points that is required. Between 2025 and 2030 the number of additional charge points is estimated to be 108,000. Instead of using public funding to support the purchase of workplace and other charging, the government should introduce regulations to require owners of private car parks (charged for or free) to install an increasing proportion of charge points in parking spaces they provide. At present around 1% of the cars on the road are electric, as this share grows so must the number of chargers. T&E analysis shows the importance of destination charging and regulating parking providers is the way to ensure these points are deployed. To help car park operators to meet the costs, tax breaks should be offered to help offset the costs. Enhanced Capital Allowances are available for the cost of charge points but not the electrical and groundworks needed to install the equipment. Extending the costs that can be claimed would help businesses offset their costs that could also charge for the use of the charger.

The recent changes to the Electric Vehicle Homecharge Scheme to extend this to the rental and leasehold sector is a positive development. But in the medium term regulations should also be introduced requiring charge points to be installed by landlords of rented properties where off-street parking is provided (and there is a request from the tenant); and for all new homes and those undergoing major rebuilding works where there is off-street parking. Home charging is by far the most convenient and cheapest way to charge.

The Government through Project Rapid has identified the need to strengthen the charging network alongside major roads and this money should be focused on tackling the high costs of grid connections. But a long-term solution needs to be found to reduce costs of grid connections for all project developers wanting to install chargers. The solution will need increased government funding of DNO's to strengthen local grids possibly supported by small increases in electricity bills for all users.

Existing government schemes including the: Electric Vehicle Homecharge Scheme; and Workplace Charging Scheme and Ultra Low Emission Taxi Infrastructure Scheme should be phased out once regulations and/or supportive tax breaks have been introduced. However, the On-street Residential Chargepoint Scheme may need to continue for longer. Analysis by Cenex for T&E indicates that the business case for kerbside charging is presently weak. In addition, a recent survey by Centrica [20] found authorities typically only planned to install an additional 35 kerbside chargers by 2025, less than is needed in many local authority areas. To help balance electricity grids, and provide confidence to prospective EV drivers that they will be able to charge, kerbside charging must become an important part of the charging mix. The £20 million recently allocated for this purpose is helpful but the costs of kerbside charging need to be reduced. Further R&D to help optimise and reduce the cost of kerbside charging points could be beneficial along with utilising cheaper green financing. One innovative option would be to utilise the system similar to that of contracts for difference to as a means to progressively reduce the subsidy to kerbside chargers. Bidders to deploy kerbside chargers would indicate the level of subsidy required with the most competitive bids receiving a subsidy as opposed to a fixed grant. OLEV should explore options for such a scheme that should reduce the level of subsidy needed over time.

There is also an inequality between EV drivers charging at home with a 5% domestic VAT rate and the 20% charged for using a public charger. Charging a lower VAT rate for public charging would lower the additional costs of charging for, typically less affluent EV owners that park on the road.

There is also an anomaly in the RTFO that allows renewable electricity used to make hydrogen for transport to be eligible for RTFCs, but electricity used in battery electric cars is not. Closing this gap would provide an additional revenue stream for charge point operators and should be addressed in the reform of the RTFO.

This briefing paper provides a roadmap for a world call charging network in the UK. It shows by stimulating investment through regulation and managing the market it is possible to roll out the charging needed for the fleet of increasingly electric vehicles. It will be a challenge but one which can be achieved if the government moves away from capital investments towards supporting local authorities to manage the local roll out of charge points and regulating the emerging market to ensure customers receive high quality services.

Further information

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Appendix A: Modelling Assumptions

The charging infrastructure model was developed to estimate the number of public charging stations the UK needs to meet forecasted EV charging demand. The method and data sources used are described in Figure 9 and Equation 1, below.

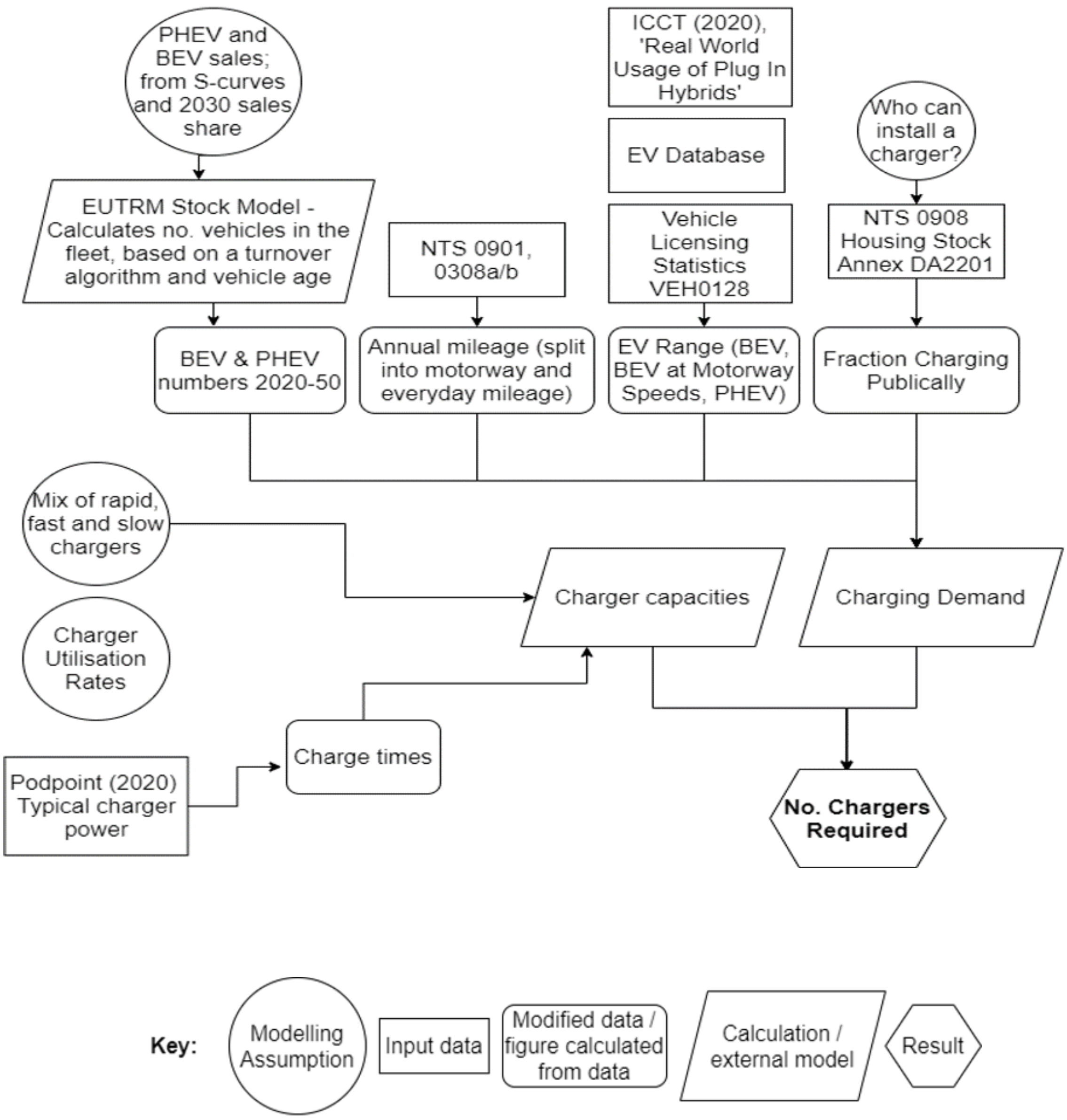

Figure 9. Flowchart of calculation steps, inputs and data sources

Data from the National Travel Survey (NTS) [4]on annual mileage and average trip length is combined with an estimate of the percentage of future EV drivers who will have access to home charging (from the English Housing Survey [3]) to estimate a yearly charging need per EV.

When divided by an average EV range based on real world data (from EV Database [21]) and weighted to model popularity (Vehicle Licensing Statistics [11]), this gives the average no. chargers per year per EV.

EV sales estimates are used in T&E's EUTRM fleet turnover algorithm to calculate the estimated no. BEVs and PHEVs on the UK's roads in a given year through to 2050. For a median uptake scenario where: BEVs achieve 69% and PHEVs 31% of total sales in 2030; EV adoption follows a standard S-curve; total UK fleet size is tied to GDP and fleet turnover based on an average vehicle lifespan of 15 years before exiting the fleet - the EV numbers shown in Figure 10 in a given year were assumed.

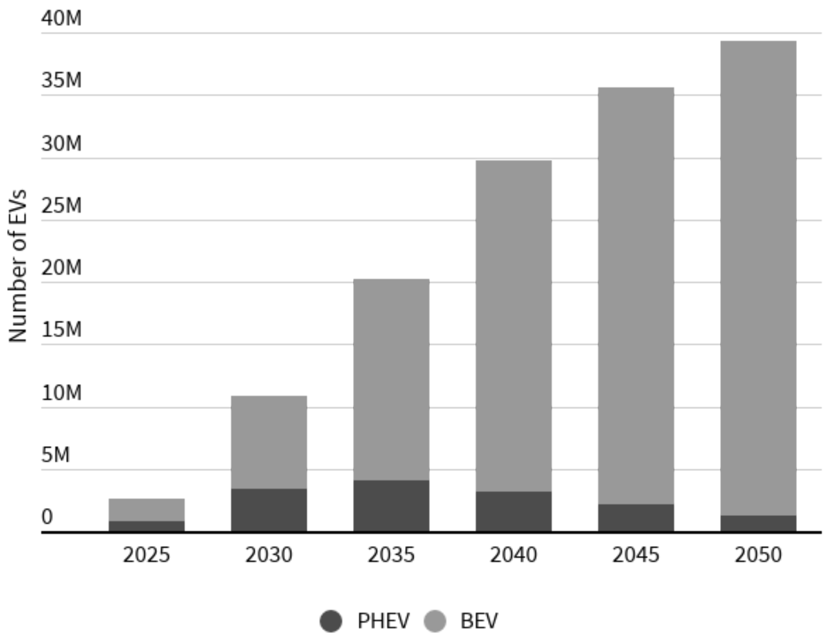

Figure 10: PHEV and BEV fleet size for a median EV uptake scenario (2030 sales 69% BEV, 31% PHEV).

From the number of EVs on the UK's roads, the number of charges required in a year can be calculated. The three scenarios used represent a minimum, median and maximum charging demand.

Table A-1. Assumptions made in each of the charging demand scenarios.

	High Charging Demand	Median Charging Demand	Low Charging Demand
%age of EV drivers with home charging	51%	55%	67%
EV Range (miles)	200	250	300
PHEV Range (miles)	38	75	50
Charges / PHEV / year	40.8	28.5	16.2
Motorway charges / BEV / year	3.9	3.1	2.6
Charges / BEV / year	16.2	12.0	7.4

The number of chargers needed to meet the charging demand depends on the balance of rapid, fast and slow chargers, charger utilisation rates and charger capacities. Charger capacity is the number of charges a given charger can do in a year. There will be a theoretical maximum, determined by the charger power, and a realistic estimate based on assumptions of how much a charger can realistically be used. For instance, a rapid charger could theoretically charge >11000 EVs a year, if in constant 24h use, but was assumed to be unlikely to achieve many more than 2000 in reality.

The higher powered the charger, the higher its theoretical charging capacity and therefore the fewer chargers needed to satisfy a given charging demand. The three scenarios used represent different balances between the number of charges on Rapid, Fast and Slow chargers. The proportion of chargers of each type for the different scenarios is shown in the table below; this is the number of charge points and not on a basis of energy delivered or number of charges.

Table A-2. Assumed charger utilisation rates.

Charger utilisation	**Maximum**	**Median**	**Minimum**	
Rapid	31%	25%	19%	
Fast	33%	25%	17%	
Slow (Kerbside)	66%	50%	33%	
Slow (Workplace) *only operate 5 days in 7	50%*	47%*	33%*	
PHEV	50%	44%	38%	
Charges / day	**Maximum**	**Median**	**Minimum**	***THEORETICAL MAXIMUM NO. CHARGES / DAY***
Rapid	10	6	8	*32*
Fast	2	1	1.5	*6*
Slow (Kerbside)	2	1	1.5	*3*
Slow (Workplace) *only operate 5 days in 7	1.07*	0.71*	1.00*	*2.14**
PHEV	4	3	3.5	*8*

The ratio of different types of chargers, their theoretical capacity and estimated utilisations give an average charger capacity for each of the High Rapid, Balanced and High Slow scenarios. The number of chargers required in a given year is then simply the charging demand in a given year, divided by the average charger capacity; this process is summarised in the equation below.

Equation 1. Estimation of charging demand and corresponding sufficient charging infrastructure.

$$\textbf{No. Chargers Needed} = No.BEVs \times \left\{ \frac{\frac{m_{MW}}{R_{BEV-HS}}}{C_R \times U_R} + \frac{\left({(m_E \times PCF)}/{R_{BEV}} \right)}{C_{av} \times U_{av}} \right\} + No.PHEVs \times \left\{ \frac{\left[\frac{(m_{tot} \times PCF \times UF)}{R_{PH}} \right]}{C_{PH} \times U_{PH}} \right\}$$

$$m_{MW} = fraction\ of\ annual\ mileage\ on\ long\ distance\ trips\ likely\ to\ be\ on\ a\ motorway$$

$$R_{BEV-HS} = BEV\ Range\ at\ motorway\ speeds$$

$$C_R = Annual\ rapid\ charger\ capacity$$

$$U_R = Rapid\ charger\ utilisation\ rate$$

$$m_E = fraction\ of\ annual\ mileage\ on\ shorter\ trips$$

$$PCF = fraction\ of\ EV\ drivers\ without\ home\ charging$$

$$R_{BEV} = Average\ BEV\ Range$$

$$C_{av} = Average\ charger\ capacity$$

$$U_{av} = Average\ charger\ utilisation$$

$$m_{tot} = Average\ annual\ mileage$$

$$UF = PHEV\ Utility\ Factor = Share\ of\ miles\ driven\ electrically$$

$$R_{PH} = PHEV\ Range$$

$$C_{PH} = PHEV\ charger\ capacity$$

$$U_{PH} = PHEV\ charger\ utilisation$$

Following this, to understand the impact the number of PHEVs has on charging networks, three more scenarios where PHEVs had a low, median and high fleet share were modelled. A median charger utilisation rate and the ‘Deer’ charger balance scenario was used in this calculation.

Table A-3. PHEV Scenarios.

	PHEV Share of Sales 2030	No. PHEVs 2030
Low PHEV Scenario	12%	1.7 million
Median PHEV Scenario	31%	4.0 million
High PHEVs Scenario	50%	6.5 million

The table below shows the input data values and assumptions that were constant in the scenarios described above.

Table A-4. Underlying assumptions for all scenarios.

	Value	Source
Average annual mileage (non-motorway)	6,640 miles	NTS Table 0901 [4]
Average annual mileage (motorway)	783 miles	NTS Table 0308 [4]
BEV Range (miles)	250	EV Database [21]
BEV Range at higher speeds (miles)	230	EV Database [21]
PHEV Range (miles)	50	ICCT [14]
Rapid charger capacity(>50kW)	11,680 BEVs / year	Podpoint [22]
Fast charger capacity (7-22kW)	2,190 BEVs / year	Podpoint [22]
Slow charger capacity (3-5kW)	1,095 BEVs / year	Podpoint [22]

PHEV charger capacity (3-5kW)	2,920 BEVs / year	Podpoint [22]

Both charging infrastructure and EV drivers are not evenly distributed throughout the UK. Different areas will require more or less charging infrastructure through to 2025, depending on where they currently are in the EV adoption process.

To make a more accurate estimate of the charge points needed in each LA in 2025, an adjustment to account for current and projected EV numbers was made. Current numbers of EVs in each local authority were compared to the EV proportions assumed in the S-curve of EV uptake used for the national modelling. The number of chargers required in each LA was that required five years ahead of this current position on the uptake curve. The overall number of chargers needed in the UK did not vary significantly, but this approach highlighted those local authorities which will require significant investment and those that are ahead of the curve. This process and the data sources used are shown in Figure 11, below.

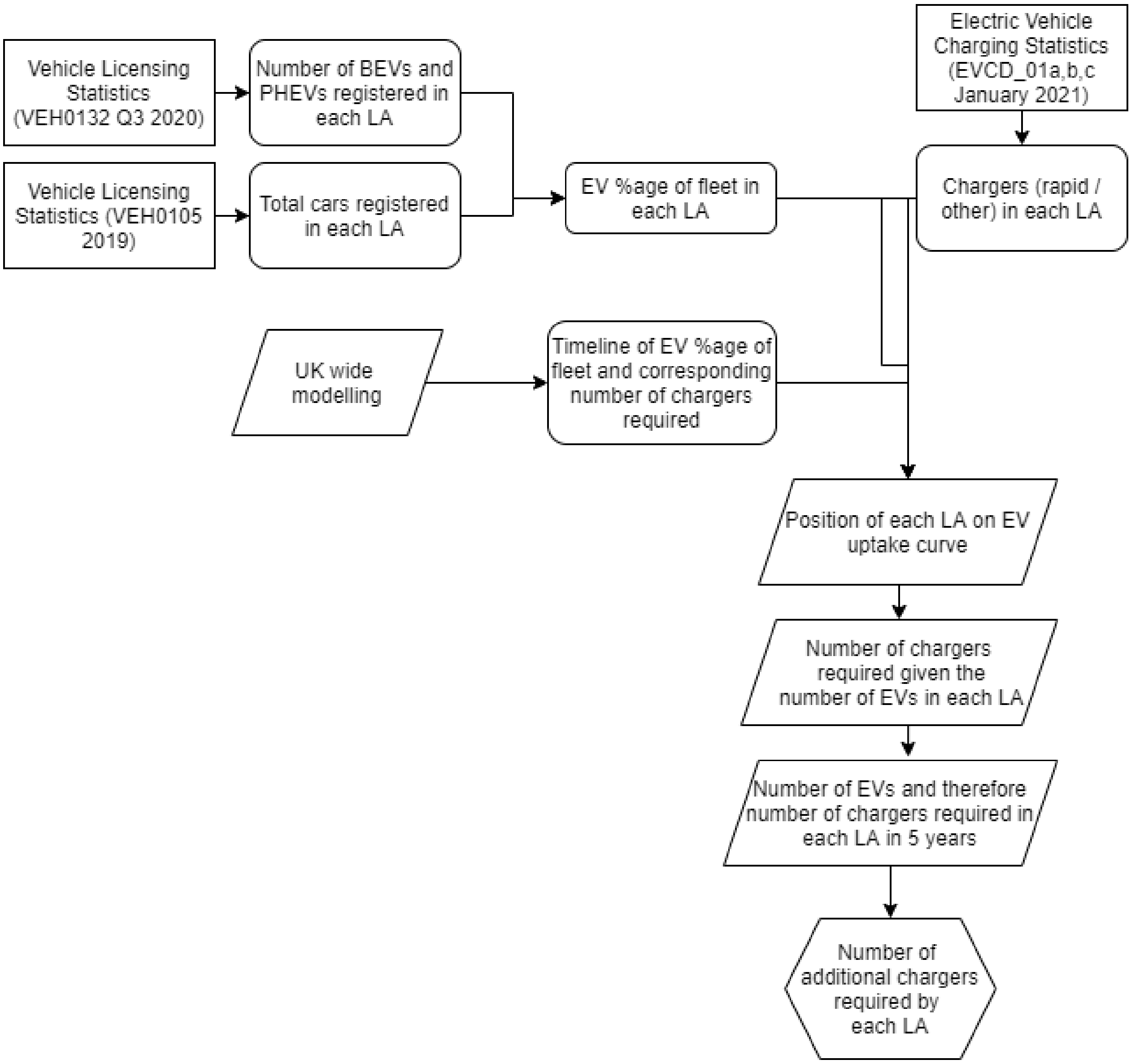

Figure 11: Process Schematic for the Local Authority adjustment.

Endnotes

1. UK new car registration data, UK car market - SMMT. (2016, August 18). Retrieved April 13, 2021, from https://www.smmt.co.uk/vehicle-data/car-registrations/
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