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EV:Ready Methodology Note

EV:READY METHODOLOGY NOTE

DRAFT

Report contents

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Introduction

DISCLAIMER

The EV tool is based on propensity modelling and cannot be relied upon as a forecasting tool for financial investment

The decisions made using the outputs need to allow for the uncertainty inherent in the approach.

The tool cannot be relied on directly for predicting the use of EV charge points (individually or collectively) or the associated revenue stream.

WHY FOCUS ON EV FORECASTING?

It is widely recognised that to achieve the UK's target of being net zero by 2050 (as set out in the Climate Change Act 2008), more needs to be done to decarbonise the transport sector.

A key pathway to achieving this is the shift from petrol and diesel vehicles to:

- Less polluting active (walking and cycling) and public transport modes where possible, and
- Ultra-low and zero emission vehicles where vehicle trips will continue to be made.

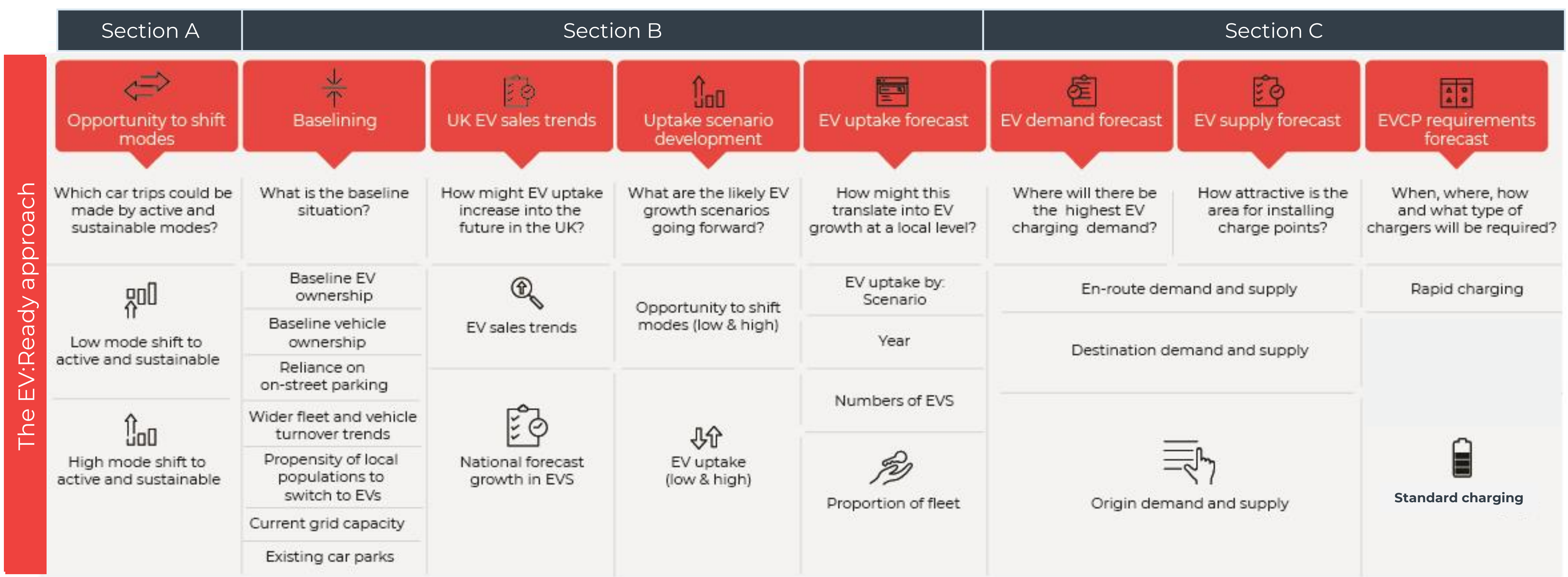
The purpose of this report is to describe the methodology used by WSP's EV:Ready tool.

EV:READY APPROACH AND METHODOLOGY

The report is structured as follows:

- **Section A – Opportunity to shift modes.** Before thinking about likely EV uptake, it is worth understanding which existing car trips could be made by active and sustainable modes (walking, cycling and public transport).
- **Section B – Electric vehicles forecasting methodology.** Sets out the projected growth in electric vehicles up to 2050.
- **Section C – Electric vehicle charge points forecasting methodology.** Sets out the requirement for electric vehicle charge points, including private/public investment split up to 2030.

The following sections of this report provides further detail on each process.



PART A

Opportunity to Shift Modes

Opportunity to Shift Modes

OVERVIEW

Before thinking about likely EV uptake, it is worth understanding which existing car trips could be made by active and sustainable modes (walking, cycling and public transport).

Using transport model trip matrices and data from Google Maps, the origins and destinations of trips within a set study area are analysed to understand which trips could be:

- Walked (based on travel time)
- Cycled (based on travel time)
- Completed by public transport (based on a travel time comparison with car)

From this analysis, two scenarios have been developed:

- **Scenario 1: High mode shift** – which has ambitious thresholds for trips to be made by sustainable modes – two miles for walking, five miles for cycling (which aligns to Gear Change), and 2.4x or less slower for public transport (when compared to driving).
- **Scenario 2: Lower mode shift** – which has a more conservative set of journey time limits for trips to be made by sustainable modes – one mile for walking, three miles for cycling, and 1.5x slower for public transport (when compared to driving).

Further detail in the scenarios is presented within Table A1.

THE PROCESS

Opportunity to shift modes uses data from a range of sources to quantify the opportunity for current car trips to be shifted to sustainable modes. These sources include:

- **Modelling outputs,** recording the origins, destinations and daily trip numbers of car journeys across the study area
- **Google Maps data,** giving the distance, duration and route shape for a sample of these modelled outputs.
- **Government travel statistics and other research**, which gives insight into how far people would be willing to travel by different modes.

A transport model is used to obtain daily trip numbers by origin and destination (O-D pairs) in a single modelled year.

From here, a sample is taken of the O-D pairs with the highest trip numbers to collect Google Maps data. This is because there are often many pairs with such small trip numbers that it would be unfeasible to test all pairs.

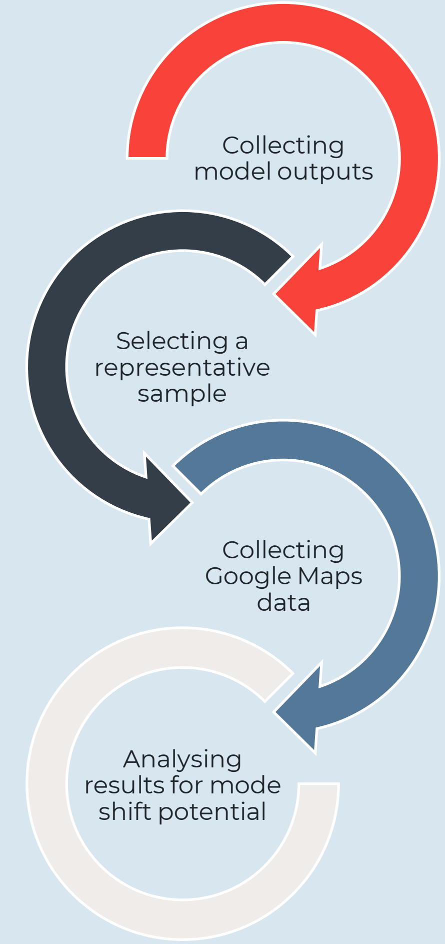
The results from Google Maps are then analysed and compared against the travel time thresholds for each mode and each of the two scenarios described previously . This gives a figure for the proportion of driving trips which could shift to public and active modes.

Vehicle kilometres and carbon emissions as a result of both scenarios is also calculated using the journey distance which Google Maps provides and UK government conversion factors. This shows the outcome of possible mode shift in the context of decarbonisation.

Table A1 Opportunity to shift modes scenarios

Scenario	Walk	Cycle	Public Transport
Scenario 1 (high mode shift)	Under: 2 miles 3.2km **40 mins**	Under: 5 miles 8km **30 mins**	Less than **2.4x** slower
Scenario 2 (lower mode shift)	Under: 1 mile 1.6km **20 mins**	Under: 3 miles 4.8km **15 mins**	Less than **1.5x** slower

Figure A1 The opportunity to shift modes process



Opportunity to Shift Modes

OUTPUTS

Opportunity to Shift Modes provides the following outputs:

- Proportion of baseline car trips which could be shifted to walking, cycling and public transport (Figure A2)
- Proportion of baseline vehicle kilometres travelled (VKT) which could be shifted to walking, cycling and public transport (Figure A3)
- Proportion of baseline CO_2e emissions which could be reduced by shifting modes to walking, cycling and public transport (Figure A4).

Additional outputs can be generated from the data gathered, including:

- Maps showing the percentage shift towards sustainable modes across the study area
- Maps showing the mode shift opportunity for each mode individually
- Comparison between Public Transport and driving time to measure competitive of PT.
- Maps showing routes which are unable to be made by Public Transport.

Caveats

While this approach is data-driven and based on evidence as much as possible, it should only be viewed as a high-level picture of mode shift opportunity.

While trip distance is a major factor in choice of mode, other factors are not considered by this approach, including peoples' propensity and attitudes to shift modes; their ability to walk and cycle; their ownership of a bike; the quality of infrastructure and Public Transport services; and aspects such as safety and comfort which people may value when they select transport modes.

Figure A2 Mode shift potential by number of trips (Transport East)

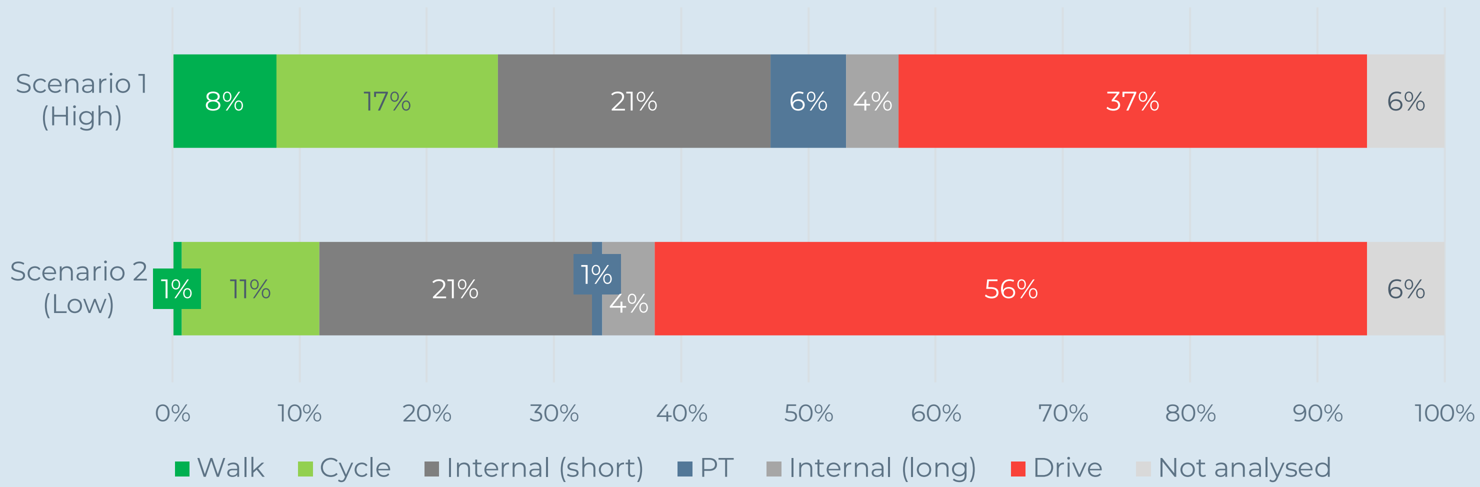


Figure A3 Mode shift potential by kilometres travelled (Transport East)

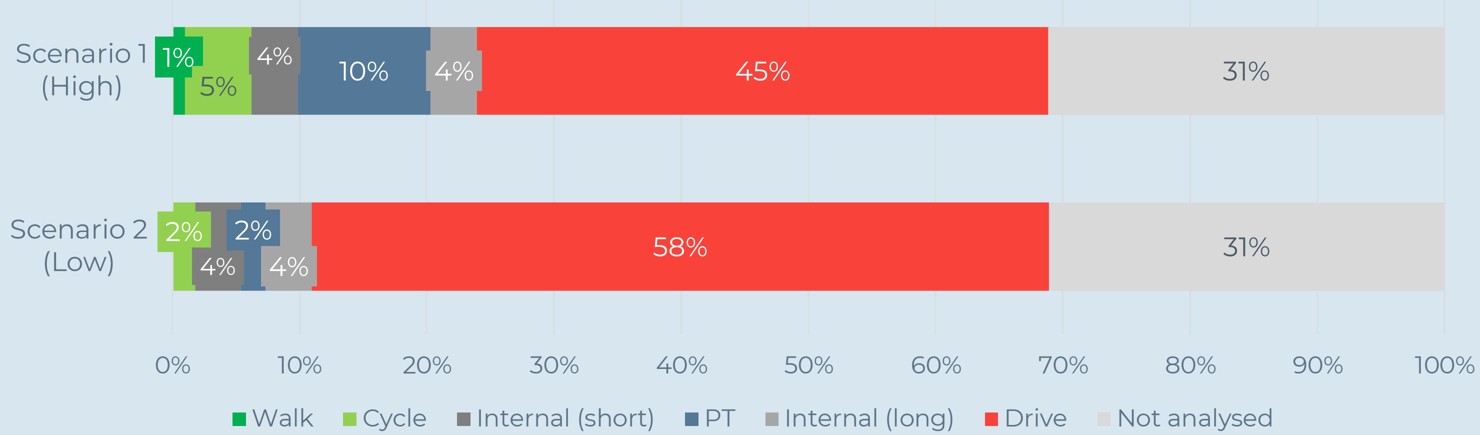
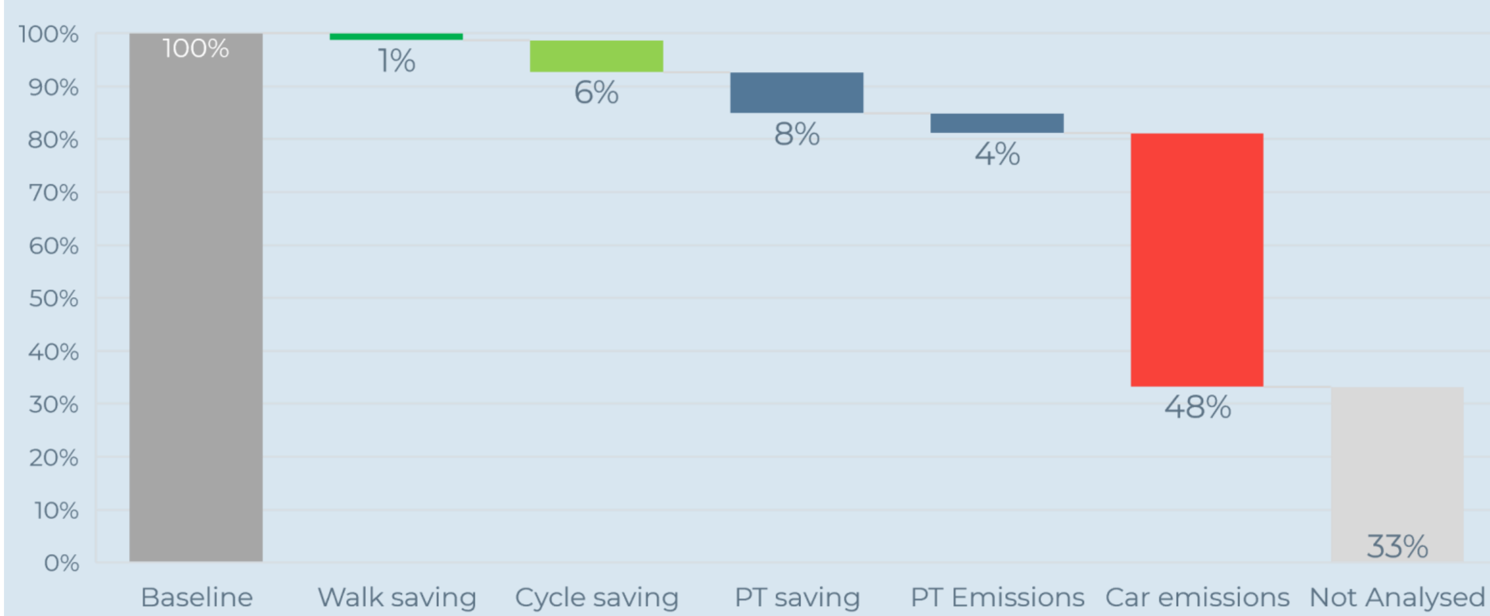


Figure A4 Carbon emissions and savings (Transport East Scenario 1)



PART B

EV Uptake Forecasting

EV Uptake Forecasting

OVERVIEW

WSP's in-house EV:Ready tool is used to derive forecasts for future electric vehicle (EV) uptake, the approach of which is summarised in Figure B1 overleaf. This section focuses on the following steps of the process:

- **Baselining:** what is the baseline situation?
- **UK EV sale trends:** how might EV uptake increase into the future?
- **Uptake scenario development:** what are the likely EV growth scenarios going forward?
- **EV uptake forecast:** how might this translate into EV growth at a local level?

EV:Ready enables sophisticated EV uptake forecasting and scenario testing. It generates granular forecasts at a neighbourhood level, accounting for highly localised spatial variations in the key determinants of EV uptake rates, including:

- Consumer profiles
- Socio-demographics
- Availability of off-street parking
- Vehicle ownership
- Vehicle sales and turnover rates, and
- Vehicle ownership trends.

This tool has been successfully applied within a range of public authorities and private organisations across the UK.

Examples of clients are presented in Table B1.

Table B1: EV:Ready clients

Westminster County Council	North Yorkshire County Council	Lincolnshire County Council
Midlands Connect	West of England Combined Authority	Norfolk County Council
City of London Corporation	Central Bedfordshire Council	West Berkshire Council
Devon County Council	Somerset County Council	Peninsula
Suffolk County Council	South Gloucestershire Council	Bicester Village

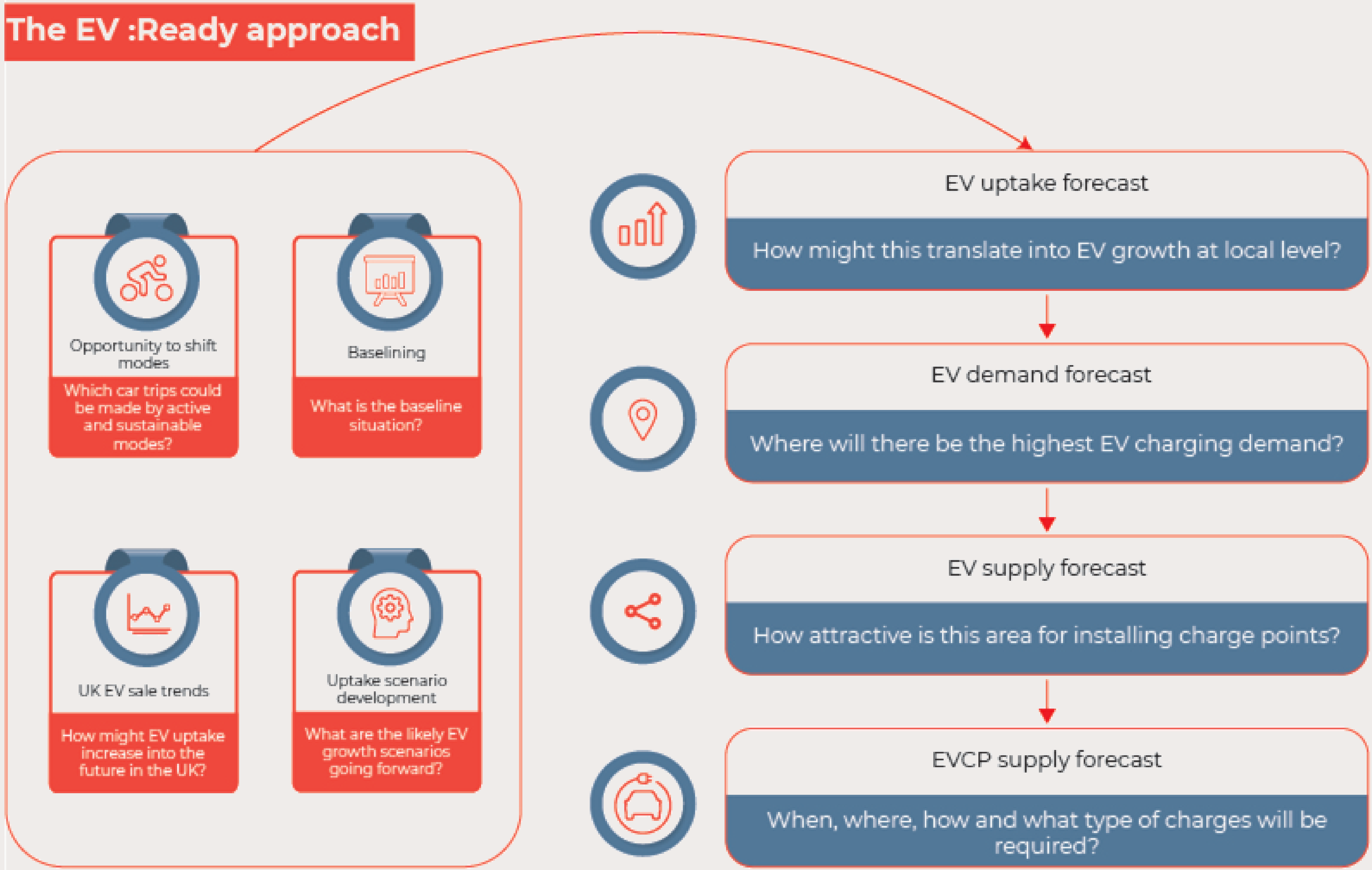


Figure B1: The EV:Ready approach

EV Uptake Forecasting

NATIONAL EV SALES TRENDS AND FORECAST GROWTH

A comprehensive review of available literature and other key determining factors for uptake has been undertaken with a range of industry forecasts being assembled and reviewed. These include:

- Bloomberg New Energy Finance (NEF 2022)
- DfT WebTAG and Common Analytical Scenarios (CAS 2022)
- National Grid Future Energy Scenarios (FES 2022)
- Various articles published by the Society of Motor Manufacturers and Traders (SMMT)
- International Energy Agency (IEA) Global EV outlook 2022
- International Council on Clean Transportation (ICCT) UK charging gap report (2020)
- Deloitte EV sales trends report (2022)

The forecast uptake of EVs varies significantly, and in many cases each source is referring to a slightly different scenario. Some are closely aligned to targets for reducing emissions and predicated on a sustained supportive policy environment, whilst others reflect market assessments. Several of the forecasts are for sales of total EVs or mileage splits, rather than as a share of total vehicles, which would then require some interpretation to be translated into comparable figures. Many also only report figures for Europe, which presents a large source of uncertainty due to the fact that the UK has a much higher rate of EV ownership in comparison to most of Europe. A few other sources of data were examined, however in many cases there was a lack of clarity in the methodology used to draw their conclusions, and so it was decided these forecasts would not be considered.

Considering that using the other sources examined would only provide more uncertainty in results, the National Grid FES 2022 databook was determined to be the most relevant and comprehensive source for determining a UK based uptake forecast, with a clear indication of how forecasts were made.

Weightings have been derived by examining each of the assumptions in the FES 2022 scenarios, considering their relevance in the market today and forecasted uptake rates until 2050. The scenarios and their included assumptions are given in Table B2.

Table B3 overleaf shows a summary of the weightings given to each of the FES scenarios for WSP's low and high uptake scenarios.

Table B2: FES scenario assumptions

	Assumptions
Leading the Way	• Consumer pull and policy support accelerates private EV adoption. • High demand for autonomous shared mobility and public transport in urban areas. • Vehicle 2 Grid (V2G) is pushed as part of enabling more renewable generation, accelerating engagement. • Charging in the future happens similarly to today, with innovation enabling consumers without access to off-street parking to slow charge overnight. • Stable government and regulatory policy/legislation for decarbonisation in transport, with decisions made in the early 2020s • Clear effective policy/pricing on carbon by early 2020s creating clarity for zero carbon technologies • Very high carbon tax
Consumer Transformation	• Consumer pull accelerates private EV adoption. • More consumer demand for both autonomous vehicles and public transport. • Buses and HGVs are predominantly electric. • Consumers are highly engaged in smart charging and V2G. • Charging predominately happens at home. • Stable government and regulatory policy/legislation for electrification in transport, with decisions made in the mid 2020s • Clear effective policy/pricing on carbon by mid 2020s - creating clarity for zero carbon technologies • High carbon tax
System Transformation	• Consumer resistance and other barriers slow the uptake of EVs. • Low growth in public transport due to a lack of consumer willingness for modal shift. • Lower consumer engagement in smart charging and V2G is a niche technology. • Charging at home is limited by a lack of viable solution for those without off-street parking. • Stable government and regulatory policy/legislation for hydrogen in transport, with decisions made in the mid 2020s • Clear effective policy/pricing on carbon by mid 2020s - creating clarity for zero carbon technologies • High carbon tax
Falling Short	• ULEV uptake requires further policy support to accelerate. • Growth in public transport is lower than other Net-Zero scenarios due to lower consumer willingness for modal shift. • Consumers are more engaged in Smart Charging however adoption of V2G is slowed, by concerns over battery degradation for example. • More rapid and fast public charging is demanded from consumers. • Current policy support with some enhancement assumed. • Unpopular, difficult, uncertain or expensive decisions delayed or not taken at all. • Low carbon tax

EV Uptake Forecasting

NATIONAL EV SALES TRENDS AND FORECAST GROWTH

The *Leading the Way* and *Consumer Transformation* forecasts are both very optimistic in their assumptions compared to the other two forecasts and show very similar uptake curves. As such, it was decided that for WSP's high uptake scenario, some weighting should be given to the *System Transformation* scenario to reflect uncertainty around government targets being met and the level of public engagement required to achieve those targets.

For the low scenario, the assigned weightings differ over the forecast period, to provide an appropriate balance between optimistic and pessimistic assumptions made in the three FES scenarios that predict the lowest uptake rates. Part of the rationale behind the higher weighting given to *Consumer Transformation* at the start of the time period was due to recent volatility in oil prices which could promote consumer appeal for EVs in the short term. The higher weighting for the two most pessimistic FES scenarios in WSP's low uptake scenario reflects the expectation that consumer engagement is more limited in this case.

The resulting weighting system for the two scenarios is presented in Table B3 and a graphical representation is shown in Figure B3.

Based on the preceding analysis, the weighted average forecast of EV uptake at a macro level (UK-wide) is estimated to range from between **22%** of the total vehicle fleet by 2030 in a low range forecast, to **32%** in a high-range forecast. This is shown in Table B4.

The synthesised forecast uptake curves are presented in Figure B4 overleaf. It should be noted that there is a drop in fleet share in the high forecast scenario due to the weighting given to the System Transformation FES scenario, which assumes that there will be a small fleet share allocated to hydrogen vehicles in the final years of the forecast.

Table B3: Weighting FES EV forecasts for low and high uptake scenario

Future Energy Scenario	EV:Ready weighting	
	High EV uptake	Low EV uptake
Leading the Way	35%	0%
Consumer Transformation	35%	40% to 0%
System Transformation	30%	30% to 50%
Falling Short	0%	30% to 50%

Figure B3: Graphical weighting FES EV forecasts for low uptake scenario

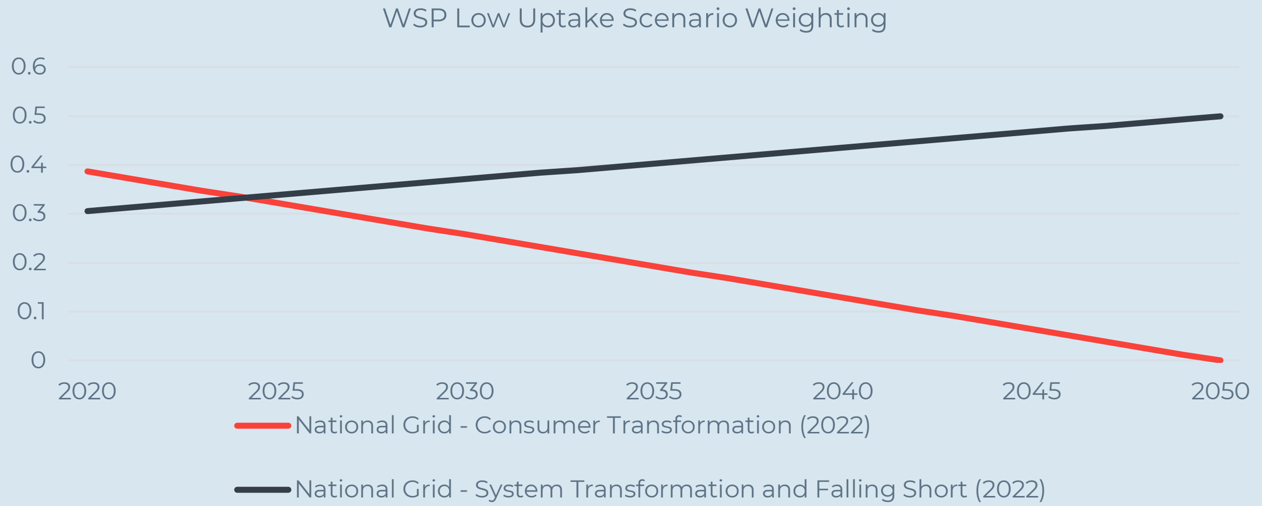


Table B4: Macro level forecast EV uptake by 2030 (as % of total fleet)

Unweighted average of FES forecasts	27%
Low-range forecast	22%
High-range forecast	32%

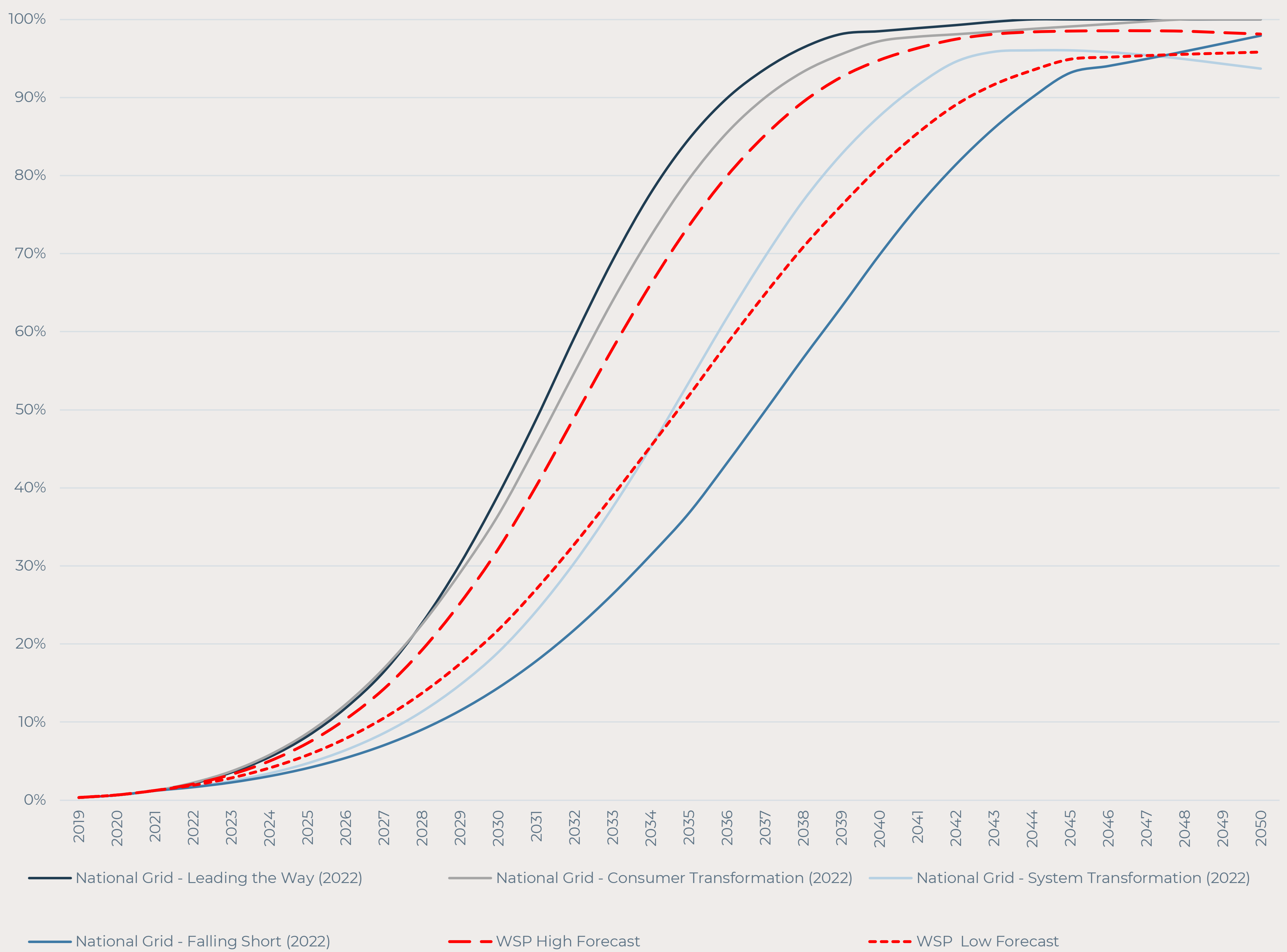


Figure B4: Comparison of FES scenarios to low and high forecasts

EV Uptake Forecasting

ACCOUNTING FOR LOCAL FACTORS

To provide more granular and area specific forecasts, the EV:Ready tool uses a variety of datasets from the Department for Transport (DfT), national EV related growth forecasts, and Experian Mosaic Data to provide population propensities as well as population demographic information for the study area.

Several DfT datasets are used to understand the number of vehicles and EVs already in service in the chosen local authority. These datasets are outlined in Table B5.

Experian Mosaic, including ONS and DVLA data, is used to understand the population demographics for the local authority, summarised in Table B6.

Using the datasets in the tables opposite, a number of local factors are considered in determining localised variations in EV uptake, these include:

- Baseline EV ownership and sales trends
- Reliance on on-street parking
- Vehicle ownership
- Wider fleet and vehicle turnover trends, and
- Propensity of local populations to switch to an EV – based on socio demographics and consumer attitudes

Table B5: Department for Transport inputs

Dataset Name	Description	Source	Update frequency
VEH0101	Total number of licences vehicles in Great Britain	DfT	Quarterly
VEH0130	Total number of registered Ultra-Low Emission Vehicles (ULEV) in the UK	DfT	Quarterly
VEH0132	ULEV vehicles registered for each LA in the UK	DfT	Quarterly

Table B6: Experian Mosaic, ONS and DVLA inputs

Dataset Name	Description	Source	Update frequency
Household numbers	Provides the number of households per postcode	Census, Royal Mail Postcode Address File (PAF), ONS	Annually
Postcode Mosaic group	Each postcode in the UK is assigned a Mosaic type, which provides demographic details on the population	Experian	Annually
On-street parking	Provides an estimate of the % of households with a driveway within a postcode	Experian	Annually
EV propensity	Likelihood of a person to buy an EV in the base year, when compared with a fossil fuel car, compared to the national average. This is presented by postcode	Experian	Annually
Average vehicle age	The average age of vehicles in a given postcode, compared with the national average	DVLA	Annually
Average vehicle ownership	Likelihood of a person within a given postcode owning a car compared to the national average	DVLA	Annually

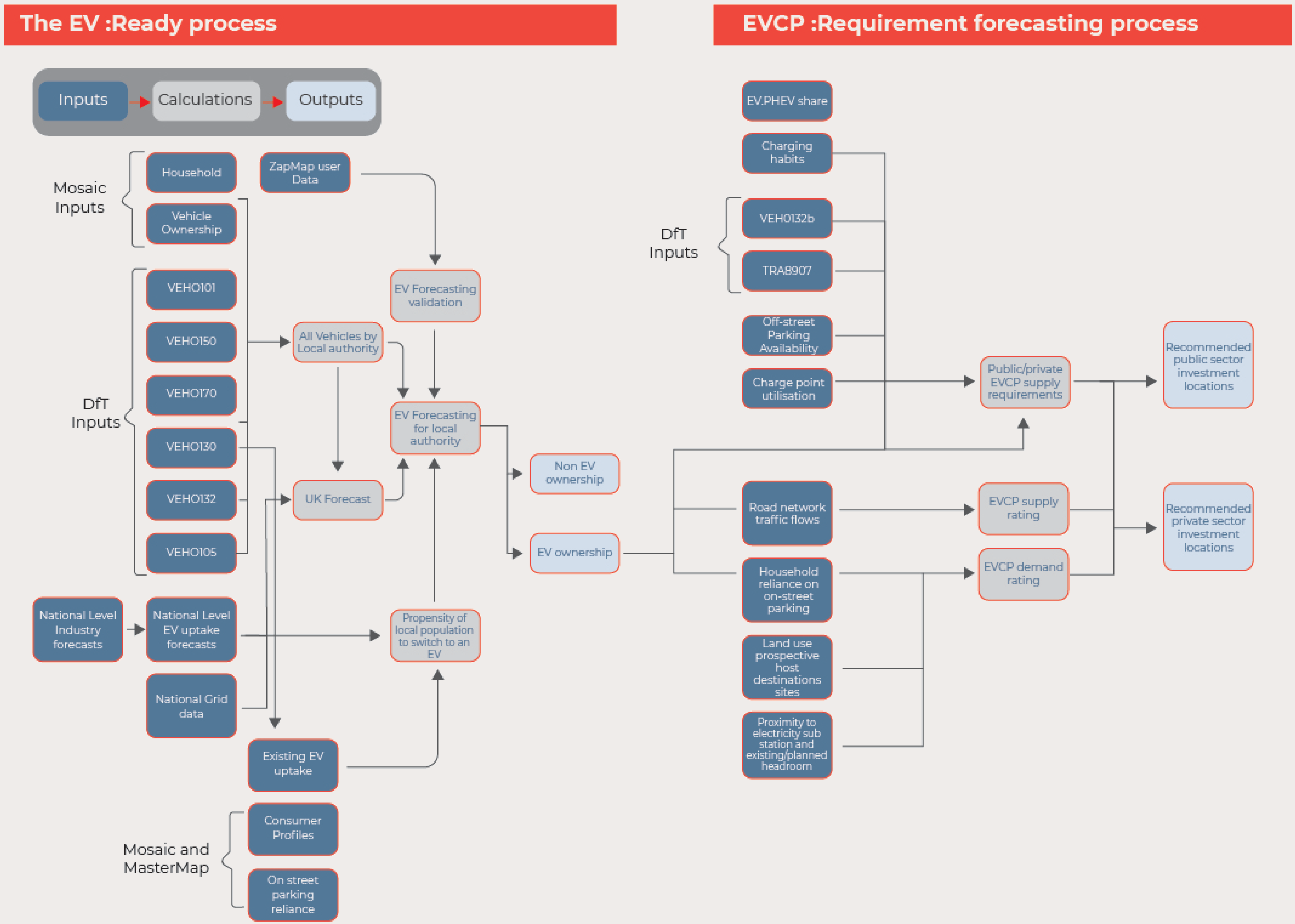


Figure B2: The EV:Ready process

EV Uptake Forecasting

BASELINE EV OWNERSHIP AND SALES TRENDS

Baseline data published on a quarterly and annual basis by DfT data provides the initial EV registrations and EV shares for the study area. The latest sales data is reviewed alongside other near-term trends in year-on-year sales growth.

However, it is not sufficient to use the DfT data at smaller scales without accounting for possible distortions introduced by company registered EVs.

These distortions can be caused when large numbers of EVs appear to be based in the local authority their business registered them in, while the true distribution is similar to that of other private vehicles across the region.

To account for this, the company vehicles are redistributed across the UK with the same distribution as the private vehicles. For some data it was also necessary to redistribute vehicles separately by type as the proportion of the total vehicles these types made up differed greatly between company and private data. For instance, buses and coaches made up a much smaller proportion of the private vehicles than they did of the company vehicles.

RELIANCE ON ON-STREET PARKING

A further important factor is the extent to which areas have access to off-street parking, or are reliant on on-street parking.

At present, 93% of EVs are estimated to have access to home charging by NextGreenCar in the Committee on Climate Change's 'Plugging the Gap' (2018) study, despite between 20-40% of vehicles nationally having no such access to off-street parking. The detrimental impact of a lack of off-street parking is, however, expected to lessen over time as EV ranges increase, recharging times shorten, and public infrastructure improves.

The likelihood of an area having access to off-street parking is determined based on the typical property types of the predominant Mosaic group at a postcode level, and assumes that terraced dwellings and converted flats would be reliant on on-street parking.

All other housing types, such as detached dwellings, semi-detached dwellings and purpose-built flats, are assumed to have dedicated off-street parking and therefore not reliant on on-street parking. It should be noted however, that car ownership is much lower amongst households without off-street parking.

An on-street parking deflator is applied to reflect the impact on EV sales if a household does not have access to a driveway. This forecast is then applied to the EV sales profile by comparing the estimated proportion of households with a driveway and factoring this by the average number of houses with a driveway, relative to the national mean.

The degree of reliance on on-street parking, and the negative impacts to EV uptake, is expected to reduce over time as access to public charging infrastructure, battery range and consumer awareness improves.

VEHICLE OWNERSHIP

Vehicle ownership is based on ONS data within Mosaic, which provides estimates by household.

The vehicle ownership by household factors are scaled to ensure the combined estimate for vehicle ownership across all households in the study area, to ensure they match the DfT data for the base year. This allows the proportion of vehicles owned by each Mosaic type to be calculated.

WIDER FLEET AND VEHICLE TURNOVER TRENDS

In order to forecast the number of EVs it is also necessary to assess current and future vehicle fleet sizes, vehicle replacement rates, range of ages at which vehicles are scrapped and the average vehicle age when scrapped.

The macro level forecasts are translated into year-on-year EV sales growth rates, and a sales profile representing the percentage of EVs amongst new vehicle sales, and tracks the number of vehicles in circulation. This method models some limitations of the real world which can prevent incorrect forecasts being produced. For example, if a scenario required that the overall annual vehicle sales rate to exceed the forecasts based on the current replacement rate and levels of annual sales.

EV Uptake Forecasting

PROPENSITY OF LOCAL POPULATIONS TO SWITCH TO AN EV

The differing attitudes and socio-demographic circumstances of local populations were analysed to identify their likely propensity for registering (purchase or lease) an electric vehicle, using the 2019-2020 version of Experian's Mosaic UK. This includes a wealth of richly detailed demographic data for the whole of the UK, detailed to full postcode level as well as property and tenure information, economic indicators and census data. As well as earnings, demographics and lifestyles, the data accounts for technology adoption and attitudes to environmental issues, as well as likelihood to buy a new vehicle and have vehicle, and hybrid vehicle ownership (derived from DVLA data).

Mosaic classifies the entire UK population into one of 66 consumer groups, based on the above data, as summarised in Figures B5 and B6. Each postcode in the UK is assigned one of 66 Mosaic types by Experian. Each Mosaic group has a separate propensity for each of the metrics described in the inputs section. We identified a selection of 10 key indices amongst the Mosaic data reflecting traits in early EV adopters, which in turn provide a statistical measure of variation across a representative group of individual data points.

The base year EV propensity, or the likelihood a person of a given Mosaic type will buy an EV compared to a fossil fuel vehicle, is created from a weighted average of a selection of Mosaic propensities, reflecting characteristics such as their attitudes to new technology, income and likelihood to purchase a new vehicle.

The propensity assessments are validated against data purchased from ZapMap of anonymised EV registrations to a postcode level, for a sample size of 1,000. The distribution of EVs across the Mosaic groups associated with these postcodes was assessed to inform key input parameters to the model.

As EVs reach price parity with conventional vehicles, and public acceptance of the vehicles increases, the difference in EV purchase propensities between Mosaic types is expected to decay exponentially. In the long term converge of the national average, as EVs become the norm, a decay rate is applied to the differing propensities over the forecast period.

Figure B5: Experian Mosaic consumer profiles and differing demographic / lifestyle types

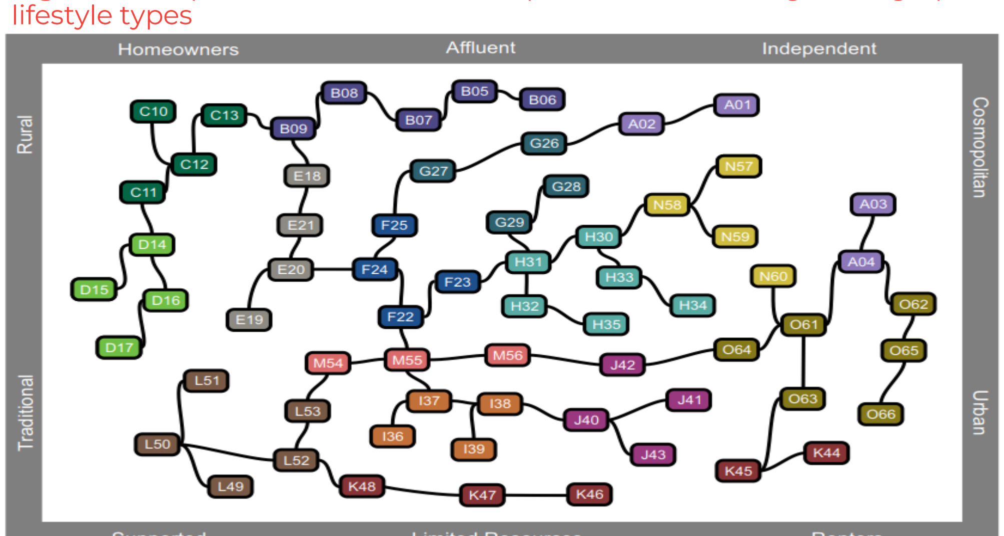


Figure B6: Experian Mosaic groups

Group	Description	% (person)	% (house)	Type	Description	% (person)	% (house)
A	City Prosperity	3.97	3.58	A01	World-Class Wealth	0.68	0.59
				A02	Uptown Elite	1.31	1.12
				A03	Penthouse Chic	0.48	0.53
				A04	Metro High-Flyers	1.51	1.34
B	Prestige Positions	9.01	7.42	B05	Premium Fortunes	1.33	1.00
				B06	Diamond Days	1.06	1.14
				B07	Alpha Families	1.47	1.43
				B08	Bank of Mum and Dad	3.12	1.74
				B09	Empty-Nest Adventure	2.03	2.11
C	Country Living	6.49	6.07	C10	Wealthy Landowners	1.58	1.34
				C11	Rural Vogue	1.76	1.49
				C12	Scattered Homesteads	1.52	1.41
				C13	Village Retirement	1.62	1.82
D	Rural Reality	5.55	5.87	D14	Satellite Settlers	1.68	1.88
				D15	Local Focus	1.93	1.83
				D16	Outlying Seniors	1.50	1.70
				D17	Far-Flung Outposts	0.44	0.46
E	Senior Security	6.58	8.46	E18	Legacy Elders	1.32	1.89
				E19	Bungalow Haven	1.53	1.88
				E20	Classic Grandparents	2.30	2.23
				E21	Solo Retirees	1.42	2.46
F	Suburban Stability	10.32	8.40	F22	Boomerang Boarders	3.29	2.02
				F23	Family Ties	3.74	2.11
				F24	Fledgling Free	1.89	1.85
				F25	Dependable Me	1.40	2.41
G	Domestic Success	7.05	6.86	G26	Cafés and Catchments	1.54	1.31
				G27	Thriving Independence	1.59	1.85
				G28	Modern Parents	1.82	1.66
				G29	Mid-Career Convention	2.10	2.05
H	Aspiring Homemakers	8.17	8.79	H30	Primary Ambitions	2.06	1.96
				H31	Affordable Fringe	2.20	2.16
				H32	First-Rung Futures	1.73	2.10
				H33	Contemporary Starts	1.09	1.25
				H34	New Foundations	0.12	0.16
				H35	Flying Solo	0.97	1.17
I	Family Basics	8.74	7.22	I36	Solid Economy	1.85	1.67
				I37	Budget Generations	2.72	1.54
				I38	Childcare Squeeze	2.02	1.99
				I39	Families with Needs	2.15	2.01
J	Transient Renters	5.95	6.45	J40	Make Do & Move On	1.45	1.95
				J41	Disconnected Youth	1.04	1.36
				J42	Midlife Stopgap	1.92	1.60
				J43	Renting a Room	1.54	1.54
K	Municipal Challenge	5.69	6.46	K44	Inner City Stalwarts	0.71	0.84
				K45	Crowded Kaleidoscope	1.22	1.18
				K46	High Rise Residents	0.32	0.43
				K47	Streetwise Singles	1.37	1.81
				K48	Low Income Workers	2.07	2.20
L	Vintage Value	4.73	6.82	L49	Dependent Greys	0.81	1.23
				L50	Pocket Pensions	0.84	1.28
				L51	Aided Elderly	0.61	0.94
				L52	Estate Veterans	1.21	1.61
				L53	Seasoned Survivors	1.25	1.76
M	Modest Traditions	5.95	5.85	M54	Down-to-Earth Owners	1.80	1.75
				M55	Offspring Overspill	2.74	1.71
				M56	Self Supporters	1.41	2.40
N	Urban Cohesion	5.37	4.79	N57	Community Elders	1.18	1.05
				N58	Cultural Comfort	1.85	1.37
				N59	Asian Heritage	1.19	0.95
				N60	Ageing Access	1.15	1.42
O	Rental Hubs	6.43	6.96	O61	Career Builders	1.45	1.59
				O62	Central Pulse	0.91	1.04
				O63	Flexible Workforce	1.26	1.26
				O64	Bus-Route Renters	1.35	1.81
				O65	Learners & Earners	0.85	0.72
				O66	Student Scene	0.61	0.54

EV Uptake Forecasting

EV UPTAKE FORECASTS COMBINING PROPENSITY, VEHICLE OWNERSHIP AND PARKING

Based on a combination of the factors previously outlined, the propensity for people to buy electric vehicles, vehicle ownership and the likelihood of a person to have a house with a driveway, a final EV sales profile is then provided for each Mosaic type.

By deriving a bespoke EV sales profile for each Mosaic type this means that for each postcode, there is an estimate for the likelihood of a person from that postcode purchasing an EV.

This forecast is then applied to the estimated number of vehicles owned by that Mosaic type across the local authority. The total number of EV vehicles for each Mosaic type is then divided by the number of households to provide the number of EVs per household, which can then be multiplied by the number of households per postcode to calculate the number of EVs per postcode in the study area. These results are calibrated to ensure the base year matched the DfT data.

Following updated data from DfT in April/May 2021, there is a greater focus on reporting where vehicles are expected to be kept and in use, based on forecast vehicle ownership, as opposed to where existing EVs are formally registered within the baseline data.

This effectively corrects for some of the distortions arising through the baseline DfT vehicle registration data, and assumes differences between the initial baseline figures level off slightly more quickly, so if an area is expected to have a higher or lower uptake than the baseline, it will tend towards this more quickly.

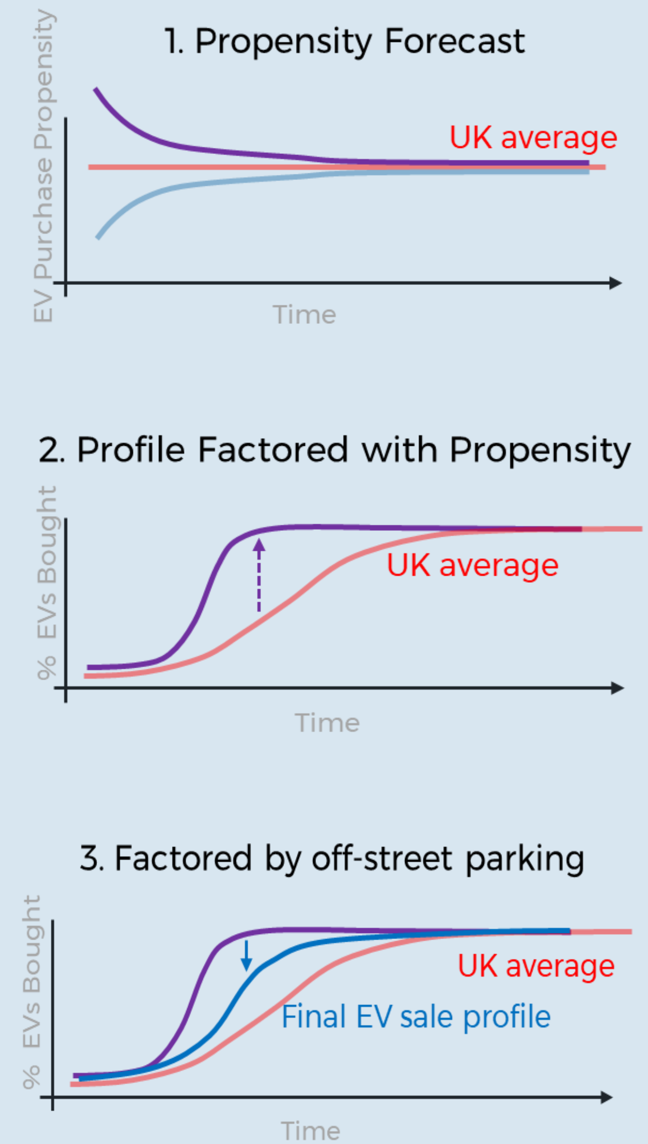
Once the most appropriate forecasts are selected, and the weightings applied, a logistic equation is fitted to the data, by optimising the three parameters of the logistic equation to reduce the weighted distance between the calibrated curve, and each forecast. Here the weighted distance is the distance squared between the logistic equation and the given forecast for each year, multiplied by the weighting of the given forecast. This process is illustrated by Figure B7.

The first figure illustrates how over time, the differing EV uptake propensities exhibited by differing consumer groups are expected to increasingly converge, as EVs become more common and price and charging barriers are removed. The purple line represents a consumer profile with a higher-than-average propensity for example, and the blue line a lower-than-average propensity.

The second figure illustrates how the EV uptake rates differ between different consumer groups relative to the national mean. For example, if the forecast is for 28% of registered to be EVs by 2030 overall, a consumer segment with a higher propensity towards EV uptake will be above that average (illustrated by the purple line in this case), whilst a group with a lower propensity will be below the average.

The third figure demonstrates how the on-street parking factor also serves to make the EV uptake curve either steeper or shallower, depending on the degree of reliance on on-street parking of a given area. The purple line represents a consumer profile with a higher-than-average access to off-street parking for example, and the blue line is lower, though still above the UK average, and so both result in higher EV uptake amongst those consumer profiles.

Figure B7: Simplified summary of EV sales profile factoring



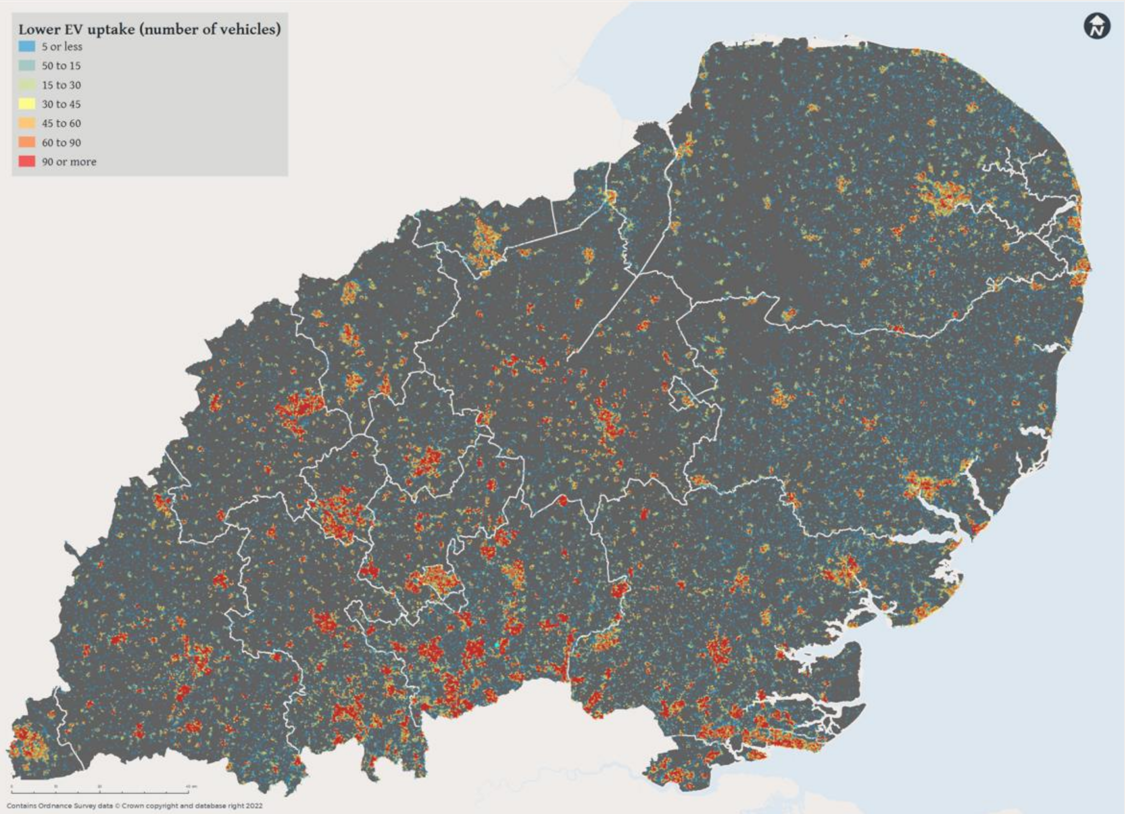
EV Uptake Forecasting

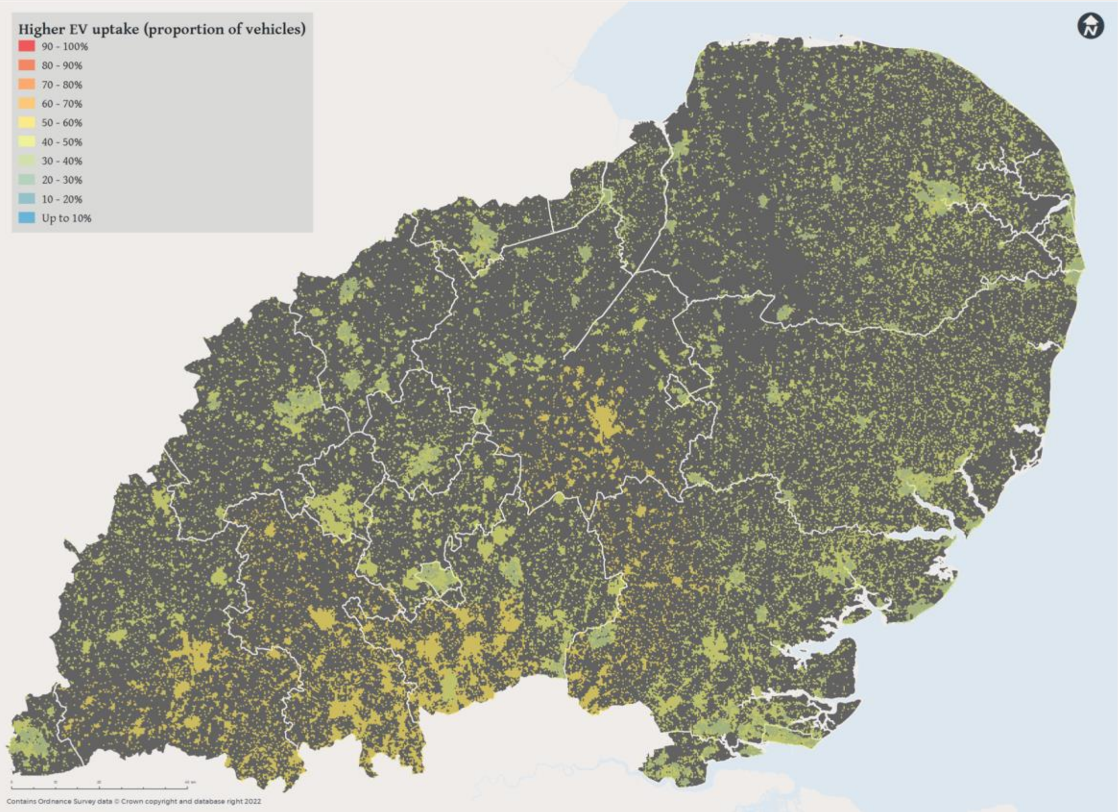
RESULTING LOCAL FORECASTS

The output of the analysis of the above factors is the local, area specific forecasts that account for local socio-demographics, the availability of off-street parking, vehicle ownership, vehicle sales and turnover rates and vehicle ownership trends.

Figure B8 presents example map outputs for the forecast EV uptake for 2030. The figure shows the uptake in both proportion and number of vehicles.

Figure B8: Example map outputs, Top: Lower EV Uptake Forecast 2030 (Number of Vehicles) Bottom: Higher EV Uptake Forecast 2030 (Proportion of Vehicles)





EV Uptake Forecasting

ASSUMPTIONS AND LIMITATIONS

In order to undertake this analysis, it is necessary to make a number of assumptions, which will naturally present limitations. In this analysis, it is assumed that a number of parameters remain constant. The key assumptions that were made are outlined below.

For the purposes of this study, an EV is defined as a battery electric vehicle (BEV) or plug-in hybrid electric vehicle (PHEV) which fulfils the OLEV requirements to qualify as a ULEV, i.e. any vehicle that uses low carbon technologies and emits less than 75g of CO2/km from the tailpipe.

Several factors within a local authority are assumed to remain constant over the study period. Below is a list of factors which are assumed to remain constant, and what limitations this assumption may introduce:

- **Population and population density.** The number of households and the population demographics (Mosaic type) are assumed to remain constant for each postcode. If there are areas with growing/declining populations, or areas where the majority of residents are altering (areas of regeneration or gentrification), this process is likely to be less accurate.
- **Proportion of vehicles in a local authority compared to the UK.** The base year proportion of vehicles in a local authority compared with the UK is assumed to remain constant over the study period. This assumption is made as the removal of vehicles needs to be calibrated each year in the study period, so total vehicle forecast is required to calibrate against. If a region has a changing demographic or age profile it is possible the number of vehicles in a local authority will change relative to the UK.

Mosaic data assigns one-person group to a postcode. This means that results for individual postcodes may not be representative of the entire population of the postcode. However, at a local authority level or greater, where the study area is of a large enough scale, the larger sample sizes typically overcome this issue.

Forecasts are informed by available published vehicle uptake and sales data related to vehicles which are newly registered with the DVLA. For this reason, when the second-hand market for EVs becomes mature this process will be less able to determine EV hotspots. However, by this stage, it is expected that uptake will begin to correlate more closely with areas of higher vehicle ownership, as EVs increasingly become the norm and differential uptake by propensity becomes less pronounced. This limitation means that we assume that when vehicles are registered, they will remain assigned to the same postcode until they are scrapped, and do not account for transfers due to the second-hand market.

PART C

EVCP Requirements Forecasting

EVCP Requirements Forecasting

OVERVIEW

The forecast uptake of EVs by 2030 enables an assessment of associated charging infrastructure requirements.

For the purposes of this assessment the charge point demand being considered is limited to publicly accessible charge points, and excludes home, workplace and other private chargers.

The EVCP requirements have not been forecast beyond 2030, owing to the increasing degree uncertainty from this point.

Forecasting public charging infrastructure requirements presents a number of challenges and is a matter of some debate within the industry, with wide ranging estimates based on a number of critical assumptions and forecasts implicit within these estimates.

A number of variables are considered throughout this process, with details of those used for each step listed below:

Step 1 – calculate amount of electricity required to service the forecast numbers of electric vehicles

- Forecast numbers of EVs (as presented in Section 1 of this report)
- Vehicle mileage and efficiency (kW per mile)
- BEV and PHEV ratios, and PHEV mileage in electric mode

Step 2 – calculate the kWh of electricity which will be delivered by the public charging network

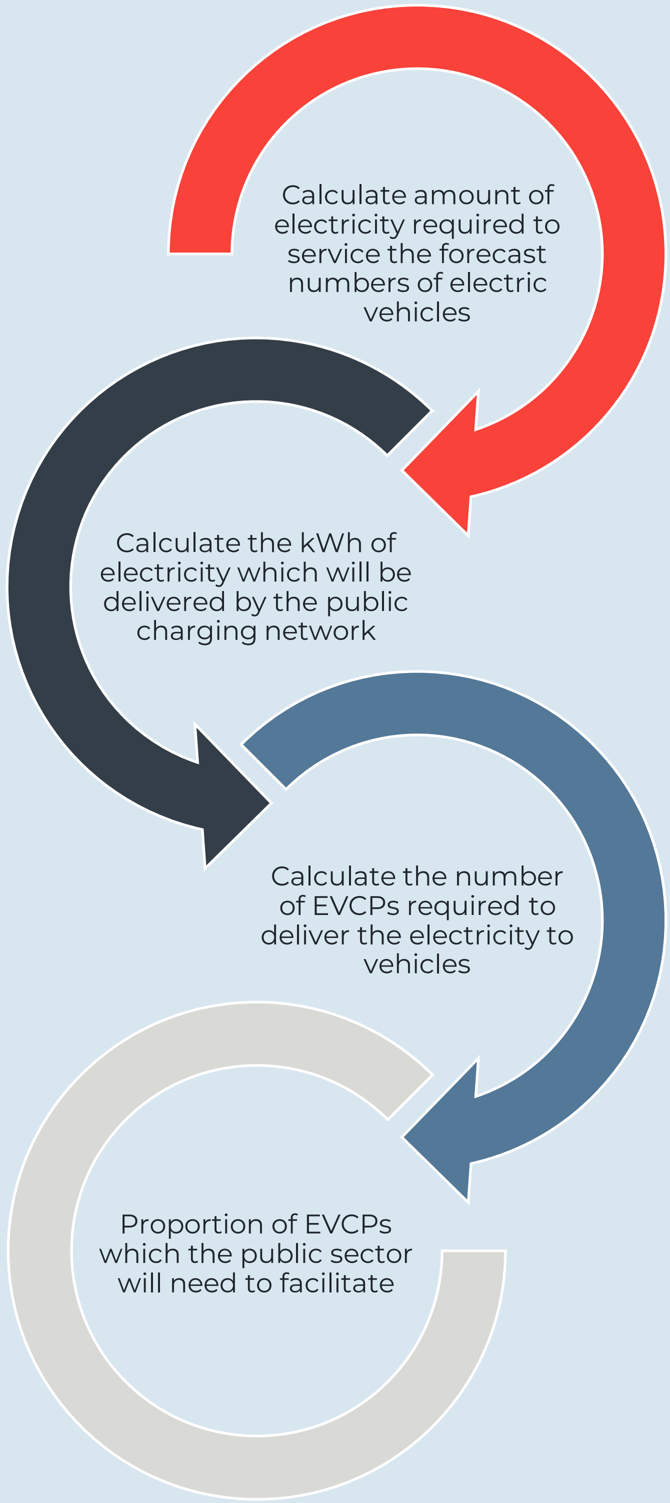
- Charging habits - public vs private charging, rapids vs slow chargers
- EVs with access to off-street parking
- Proportion of charging (kW) delivered via public chargers

Step 3 – calculate the number of EVCPs required to deliver the electricity to vehicles

- Trends in vehicle and charger technologies – charge rates
- Average charge rate (kW), and
- Average charger utilisation.

Step 4 – proportion of EVCPs which the public sector will need to facilitate

Two scenarios are presented for the number of EVCPs required based on the two EV uptake forecasts.



EVCP Requirements Forecasting

TOTAL EV POWER REQUIRED

To understand the electricity requirements of an EV, vehicle mileage and fuel efficiency needs to be estimated.

Vehicle mileage

The average annual mileage of all vehicles is assumed to be 7,400 miles. This is taken from the 2019 DfT National Travel Survey results as 2020 and 2021 data is not likely to be representative of long-term trends due to the impact of COVID-19 and the associated lockdowns. As such, 2019 data is still referred to when considering trends in vehicle mileage. Mileage of EVs is likely to differ to ICEs but there is large variations in reported figures, it was therefore not considered as a factor.

Vehicle efficiency by mode

The efficiency of electric vehicles, measured in miles per kW, affects the power requirements. Research was carried out to understand the average efficiency across modes. It should be acknowledged that there is some uncertainty as vehicle technology is evolving rapidly. Figure C1 shows the efficiency of electric vehicles by mode.

BEV and PHEV ratios, and PHEV mileage in electric mode

PHEVS only drive in electric mode for a fraction of their mileage. It must therefore be understood the percentage of EVs which are hybrids and the mileage which they travel in electric mode rather than under their ICE powertrain. PHEVs made up 45% of the UK ULEV fleet at the end of 2020. However the ratio of BEVs to PHEVs is changing over time, with the proportion of PHEVs decreasing.

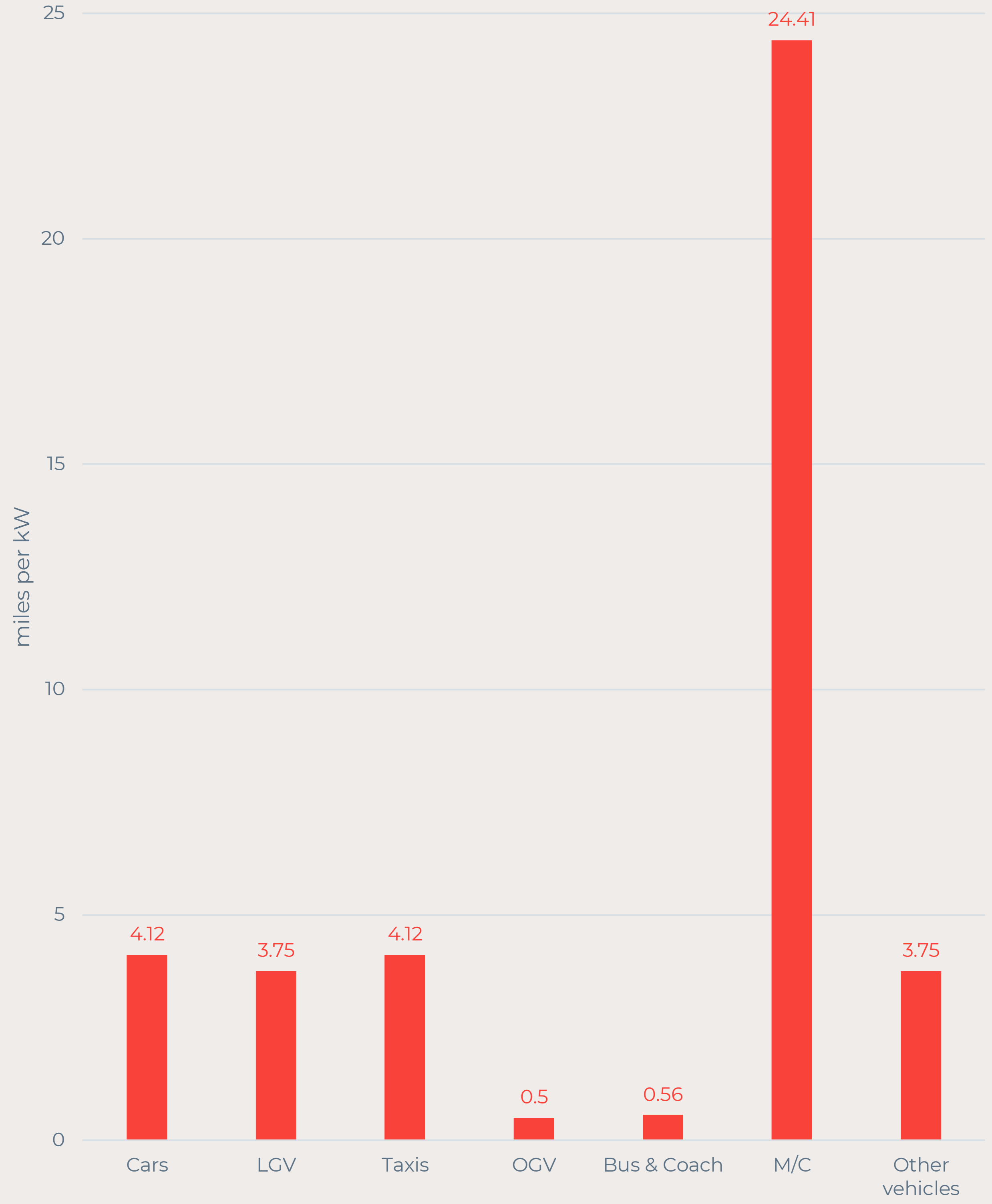


Figure C1: Efficiency of electric vehicles by mode

EVCP Requirements Forecasting

POWER DELIVERED BY THE PUBLIC CHARGING NETWORK

Charging habits – public vs private charging

Firstly, there is a need to consider the extent to which vehicles will use public chargers, as opposed to private residential or workplace charging. At present, a large majority of charging takes place at homes and workplaces (~85% of kW delivered). However, this ratio may change over time, with implications for the number of public chargers required.

There are some contrasting and often strongly held views amongst the EV industry as to whether in the future, EV charging habits and infrastructure will pivot more decisively away from the current model, towards a far larger proportion of charging at ultra-rapid charging hubs, with quick turnaround times which are more akin to the petrol station model. Others anticipate sustained high levels of home and workplace charging, or greater destination charging, with slow / fast chargers proliferating within car parking spaces and supporting a 'grazing' or top-up behaviour.

Workplace charging may sometimes double as publicly accessible charging. There are also diverging views of the extent to which workplaces will accommodate employees wishing to charge, particularly where larger numbers of chargers would be required, triggering electrical upgrades making them more costly to install. A further consideration relates to any wider trends in commuting following the COVID pandemic, and for example whether this serves to accelerate trends towards greater home working.

Off-street parking availability

A further challenge in assessing the future trends in EV charging behaviour is that the current sample size of EV ownership is still very small in percentage terms as a part of the overall vehicle fleet (2%), still dominated by early adopters, and not reflective of the wider population.

For example, around 93% of EV owners to date are estimated to have access to off-street parking, yet on average only around 72% of cars are parked in a garage or on private property. This would indicate EV ownership is significantly lower amongst those without access to off-street parking. It should be noted however, that car ownership is much lower amongst households without off-street parking. A study by PWC estimated as many as 78% of UK drivers have access to off-street parking at home.

As the profile of EV owners comes to reflect the wider population, it is expected there will be an increase in the proportion of EVs with no access to home charging, and so more reliant on public infrastructure, as summarised in Figure C2.

Proportion of charging (kW) delivered via public chargers

Figure C3 presents the assumed charging behaviours used in forecasting the proportion of charging that will take place off-street, and on-street, informed by a review of a number of industry publications*, and engaging with charge point operators.

Proportion of charging (kW) delivered via public chargers

Figure C4 reports the estimated proportion of EV charging assumed to be delivered via public chargers.

Figure C2: Proportion of EVs with access to off-street parking at home

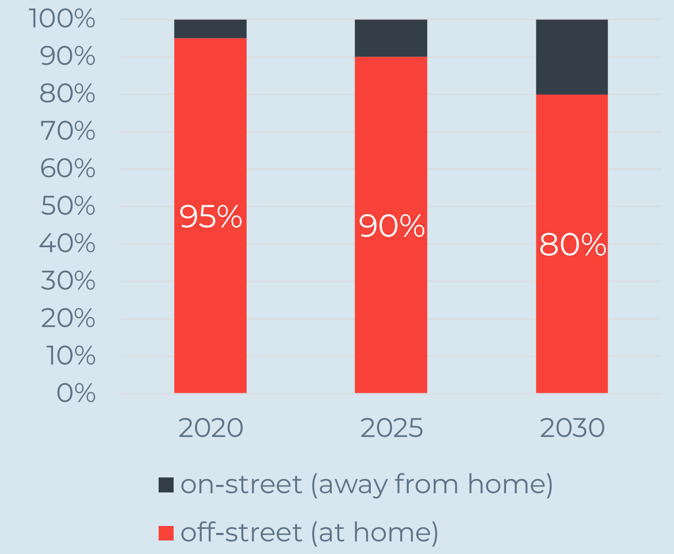


Figure C3: Proportion of EV charge (kW) delivered at public chargers (%)

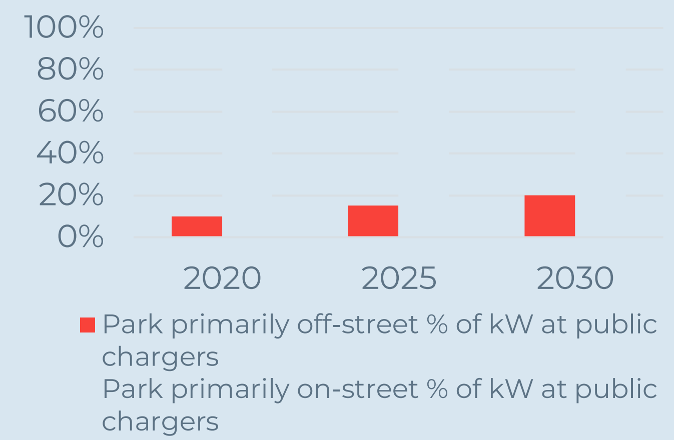
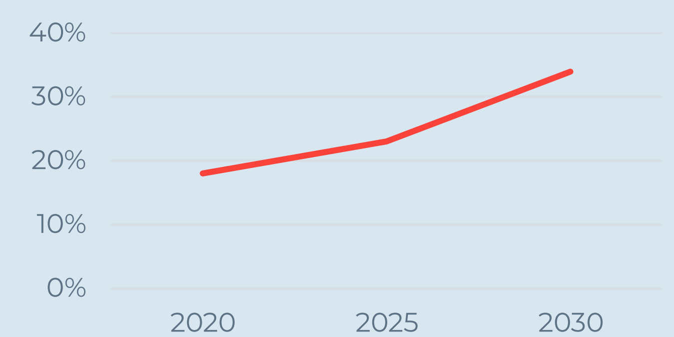


Figure C4 Proportion of EV charging (kW) delivered at public chargers (%)



EVCP Requirements Forecasting

EVCPS REQUIRED TO DELIVER POWER

Future charge point requirements will depend on the average charge rates (kWh), and the number of vehicles which can be supported by each unit.

Charge rate is dependent both on the speed of the charger and the capability of the car / battery to receive the charge. As the vehicle and charger technology evolves this rate will change.

The average charge rate for fast chargers is forecast to increase from around 6kW/h at present, to between 8-20kW/h by 2030. The average charge rate for rapid chargers is forecast to increase from around 45kW/h at present, to between 75-200kW/h by 2030.

Faster charge rates (kWh) and an increasing number of vehicles supporting ultra-rapid charging potentially means a greater share of charging (in terms of energy consumed) could be delivered by fewer ultra-rapid chargers. Equally, however, larger ranges and battery capacities will lessen the need to stop at an intermediate charger on route. Improving vehicle efficiencies (miles per kW) also have implications for charging requirements.

Similarly, the EV charger technology is evolving, with increasing charge rates being delivered at up to 400kWh / 900V+, as well as improved functionality and ease of payment, scalable lower cost deployments and smart loads management. Future charge point requirements will depend on the prevailing average charge rates, and the number of vehicles which can be supported by each unit. A further consideration is the legacy charge points, where these are upgraded, and what these mean for the average charge rate.

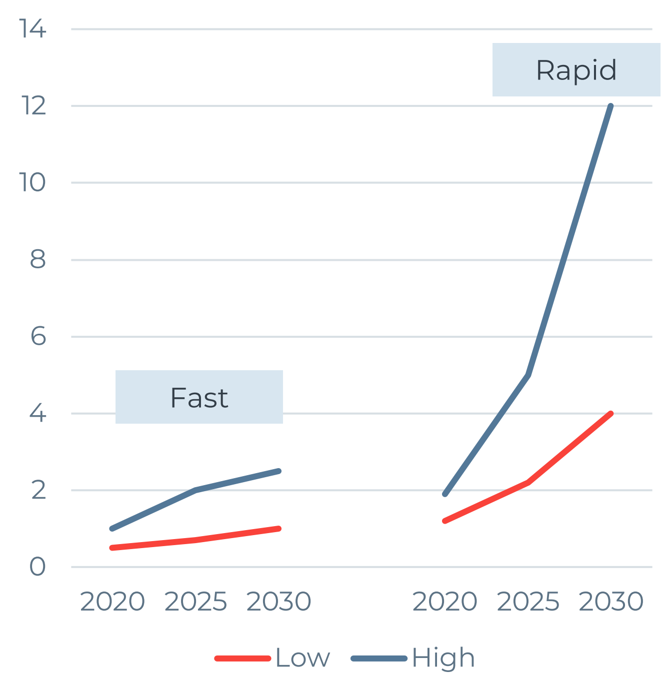
Average charger utilisation

The utilisation of chargers is a key sensitivity in the model. Values for current and future utilisation rates were established by reviewing the utilisation of existing EVCP networks and through discussions with CPOs.

Utilisation is relatively low level at present but is increasing as the number of EVs on the road grows. Figure C5 shows the range of possible utilisation scenarios, for both fast and rapid chargers.

Fast and Rapid chargers have different utilisation rates. In the case of fast chargers, which currently average around 0.5-1 charges per day, they are forecast to increase to between 1.25 and 2.5 chargers per day by 2030. Rapid chargers are currently utilised around 1-1.5 times per day on average, and this is forecast to increase to between 4 and 12 charges per day by 2030.

Figure C5 (charges per day)



PRIVATE SECTOR INVESTMENT AND THE ROLE OF THE PUBLIC SECTOR

In order to create a successful EV charging network, that meets the needs of drivers, both the public and private sectors will need to invest in EVCPs.

The ratio of change of public to private sector investment will change over time. Currently we are in the early stages of the transition to electric vehicles and the number of EVs which require public chargers is relatively low. As a result there are many locations where EVCP installations are not commercially viable for the private sector. The contribution required by the public sector is therefore relatively high. As the number of EVs increases, the commercial viability will improve and the public sector contribution will decrease.

There is a keen appetite to invest in EV charging infrastructure from the private sector, with a number of large operators having established themselves, as well as new entrants and acquisitions by major investors.

However, commercial charge point deployments are typically focused on destinations and intermediate sites (i.e. service stations, roadside cafes), where demand is high, with high traffic volumes or reasonable dwell times. Rapid chargers are more likely to be commercially deliverable by the private sector than standard / fast chargers.

Spatial Distribution of EVCP Supply and Demand

FORECASTING DEMAND FOR EVCPS

Regional transport models are utilised to determine EV demand at three stages of a journey; origin, en-route, and destination. Results from the EV uptake forecasting are provided as input to the transport models to calculate the number of vehicles at origin and destination, and the vehicle kilometres travelled along the route of a journey. Outputs are at transport zone level, which is adjusted to hex-level to be consistent with other EV:Ready outputs.

It is assumed that those travelling to their destination would require a speedy charge, similar to that of stopping at a petrol station for non EVs, and therefore demand for rapid chargers would be greatest along the route of a journey. Standard chargers are more likely to be utilised at the origin and destination of a journey, where the user generally has a longer dwell time.

The hex-level outputs from the transport model are compared against one another, with a score from 0 to 1 being assigned for each origin, en-route and destination demand.

Examples of the demand maps are shown in Figure C6.

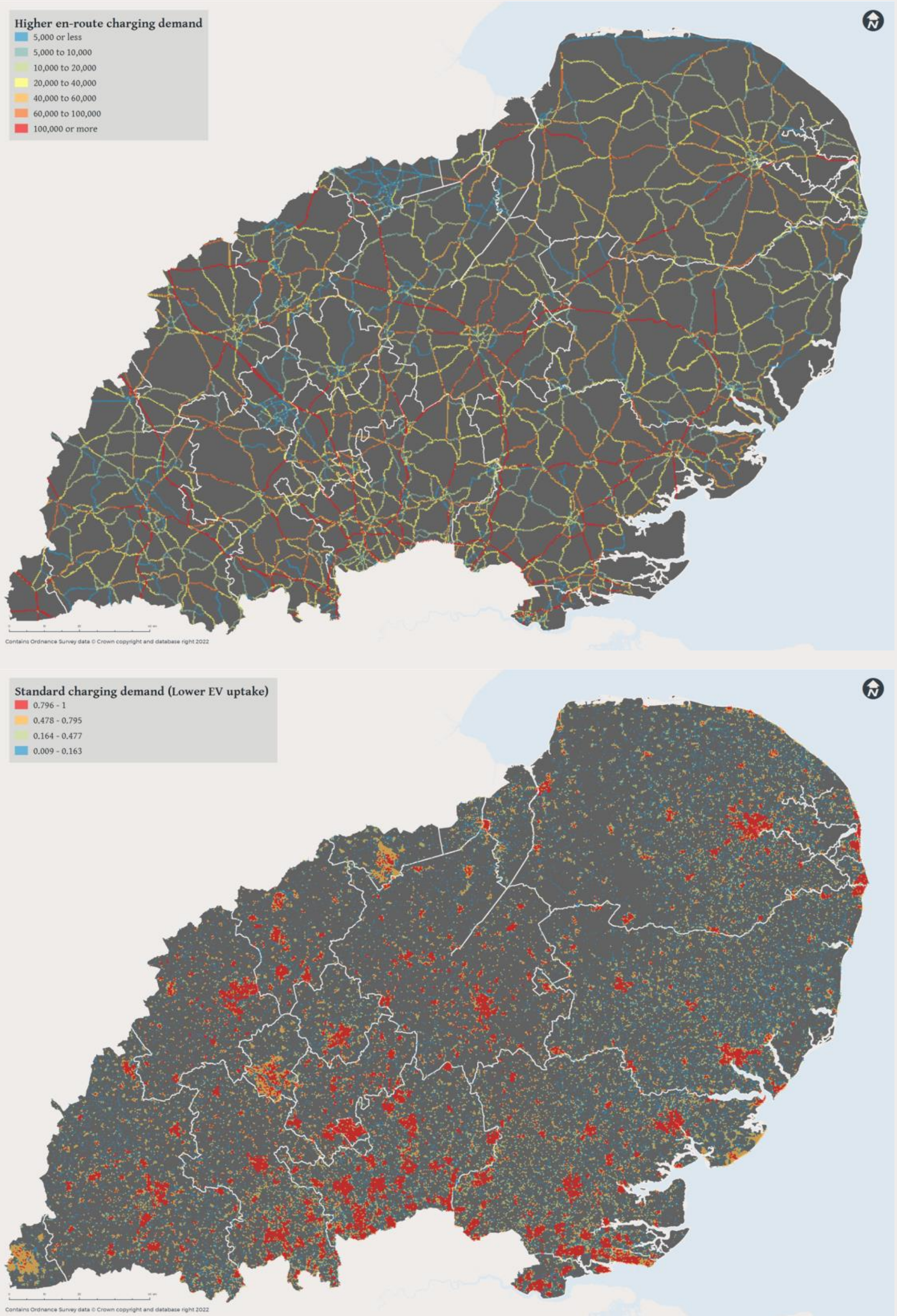


Figure C6: Examples of demand maps

Spatial Distribution of EVCP Supply and Demand

FORECASTING SUPPLY OF EVCPS

A multi criteria assessment is undertaken, bringing together the criteria listed below and normalising each criteria on a scale of zero to one. EV demand, as described in the previous section, is also included as, naturally, whether an area has demand for EV charging is a key indicator.

- **EV uptake.** As explained in Section 2
- **Reliance on on-street parking.** Areas where reliance on on-street parking is greatest are areas where residents will rely more on publicly accessible charge points rather than privately owned, and so these hex-cells would receive a higher score.
- **Grid supply.** Used to account for the relative deliverability of each site based on DNO forecasts for the available headroom of the nearest Primary (and if available from the DNO, also the Secondary) Substation. A RAG status is determined based on available headroom (which varies slightly between DNOs but generally follows this rule, Green: spare capacity >20%, Amber: spare capacity between 5% and 10%, Red: spare capacity <5%). Each hex-cell is then assigned a score based on distance from the nearest substation and which RAG rating the substation has.
- **Land use.** A greater score is assigned to hex-cells with large areas of relevant land uses such as shopping centres, retail parks, offices, healthcare facilities, and tourist attractions etc.

Supply scores are split into the same three categories as demand and are similarly further refined to determine supply of rapid and standard chargers.

Table C1 presents the weightings for each criteria for origin, en-route and destination supply scores.

Assumptions and weightings	EV uptake	Reliance on on-street parking	Modelled Flow (en-route demand)	Grid supply	Land use	Origin demand	Destination demand	EVCP Weighting
En-route / Rapid Supply Score (out of 1)			50%	50%				Rapid - 0 Standard - 0.5
Standard Supply Score (out of 2)	Sum of the origin and destination supply calculations							
Origin Supply (out of 1)	25%	25%		25%		25%		0.5
Destination Supply (out of 1)			25%	25%	25%		25%	0.5

Table C1: Criteria weightings for supply scores

Spatial Distribution of EVCP Supply and Demand

FORECASTING GAPS IN EV CHARGING PROVISION

Private sector investors and CPOs are regularly consulted to understand their key considerations when identifying prospective sites that would be commercially viable, and so deliverable by the private sector.

To identify areas where gaps are anticipated in the provision of chargers by the private sector, a gap analysis is undertaken which consists of comparing supply and demand scores. Where the resultant score is positive, supply outweighs the demand and so these areas would be commercially attractive to the private sector. Where the score is negative, demand outweighs the supply and therefore it is anticipated that there will be a gap in private sector investment in these areas, so the public sector should 'plug the gap'.

Areas of the highest demand (i.e. the top 100 ranking demand scores in each local authority) are considered alongside the gap analysis to determine the top areas for public or private sector. Using the split of rapid and standard charger supply and demand, the gaps can be refined further, highlighting patterns in private and public sector investment. For example, it is expected that the private sector would prefer to install rapid chargers along high traffic routes such as motorways and A roads, and therefore the public sector is recommended to install standard chargers in town or village centres.

Figure C7 presents examples outputs of the EVCP gap analysis.

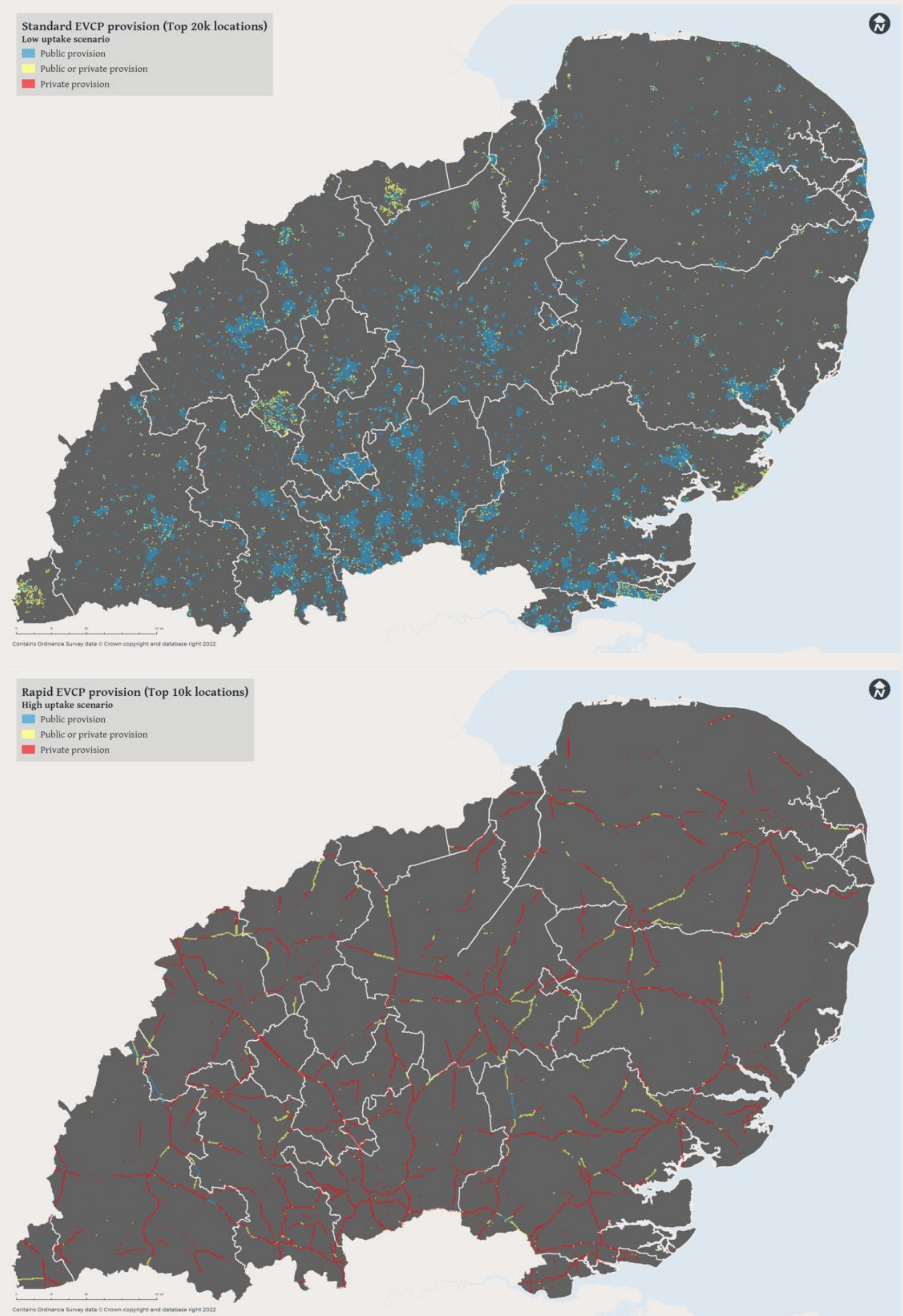


Figure C7: Examples of gap analysis maps

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