elementenergy

Reflect

Lot 1 - Dataset report

for

Electricity North West

09/06/2020

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Executive Summary

Datasets and projections have been produced to inform the modelling of electric vehicle (EV) charging on the Electricity North West Ltd (ENWL) distribution network. The datasets produced and their purpose in the modelling of EV charging demand are summarised in Table 1 below. Information on projections produced is provided in Table 2 below.

Table 1. Summary of datasets produced, source material, and any processing done

Dataset produced	Purpose of dataset
Car and van ownership / current EV uptake	Used to inform modelling of EV uptake
Off-street parking access	Will be used to determine the scale and location of domestic EV charging demand
Rural/urban classification	Will be used to inform travel patterns of drivers, as rural drivers tend to drive higher daily distances than urban drivers
Vehicles commuting to work	Will be used to identify where commuters live, as they have very different travel and charging behaviour to the rest of the population
POI data (hotels, supermarkets, petrol stations, and service stations)	Will be used to predict where future EV charging infrastructure will be installed
Existing EV charging infrastructure	Will be used to map existing charging demand to network assets and understand where future infrastructure may be installed
Travel patterns (share of personal car work and shopping trip ends)	Will be used to determine the scale and location of work and public EV charging demand

Table 2. Information on projections produced from EV uptake modelling

Projection	Information on projection
EV uptake projections	Several projections produced, from the lowest end of the government Road to Zero ambition, to the fastest uptake as recommended by the Committee on Climate Change to reach net zero by 2050 **Lowest case:** 25% of cars are EVs by 2030, 88% in 2050 (13% and 70% for vans) **Highest case**: 45% of cars are EVs by 2030, 98% by 2050 (29% and 88% for vans) **Maximum BEV Uptake**: Same EV uptake as highest case but Plug-in Hybrid EV shares have been reduced (and Battery EV & Fuel Cell EV shares increased)
Car and van stock and vehicle kilometres travelled (VKT) projections	Two sets of projections: - one that follows the Department for Transport's forecasts to 2040 (2040-2050 values assumed constant). High growth in both stock size and VKT - one set with significantly lower stock and VKT, reflecting the region trying to reach net zero ahead of 2050
Regional level EV uptake projections	Several sets of projections: • The region follows national trends for uptake and stock / VKT growth • The region puts measures in place to reach net zero before 2050: very rapid EV uptake and stock / VKT projections that correspond to high modal shift and reduction in passenger km have been assumed

Key findings from projections

Future EV uptake projections cover a wide range of possible uptake scenarios. Figure 1 shows the predicted car and van stock sizes and shares of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) for the five scenarios that have been produced. These scenarios show similar variability across the region to current EV uptake, as shown in Figure 2.

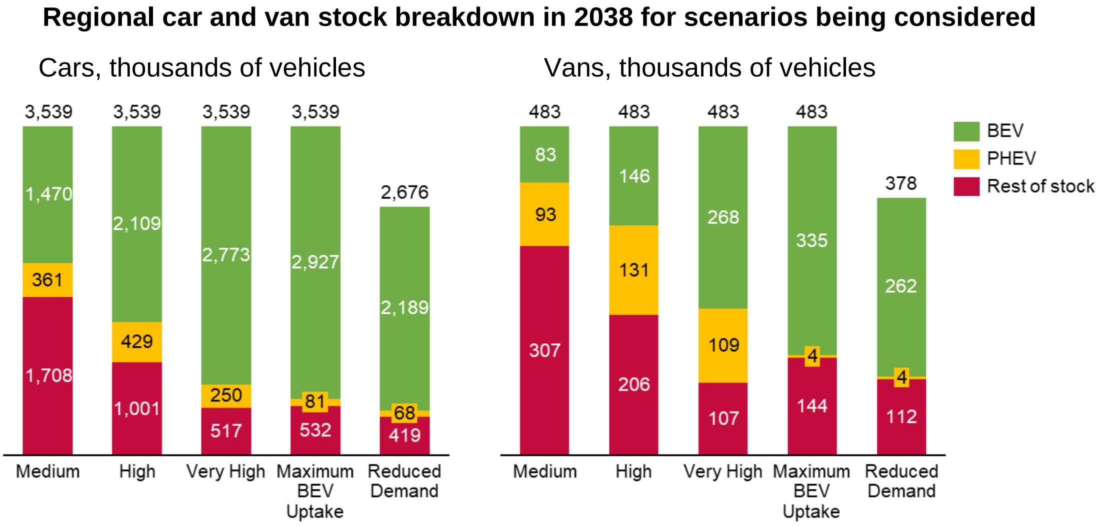

Figure 1. Breakdown of regional car and van stock by powertrain type in 2038 across the five scenarios being considered

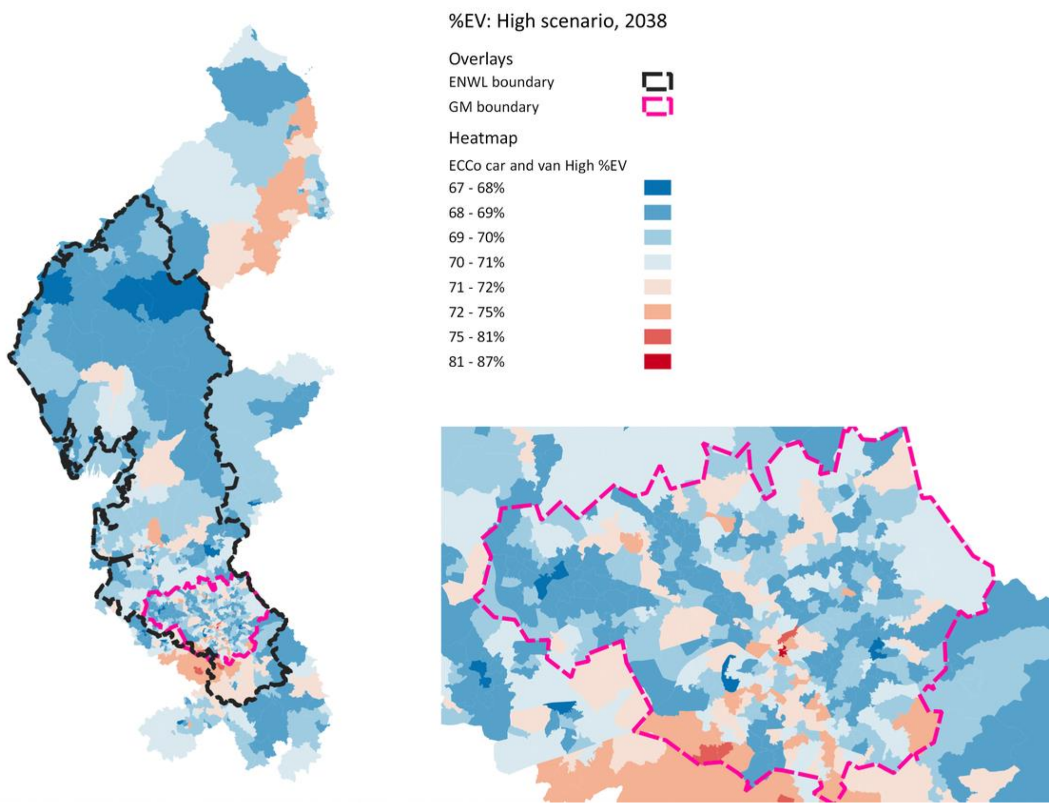

Figure 2. Share of the car and van stock in each middle layer super output area (MSOA) that are EVs for the 'High' scenario in 2038

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Acknowledgments

We would like to thank the Local Authorities who provided us with data on car parks and electric vehicle charging infrastructure. We are also very grateful to Transport for Greater Manchester for their input on the project, for sharing data from the GMEV charging network, and electric vehicle infrastructure development plans for Greater Manchester.

Acronyms

API:	Application programming interface
AQAP:	Air quality action plan
AQMA:	Air quality management area
BEV:	Battery electric vehicle
CCC:	Committee on Climate Change
CCS:	Combined Charging System, an EV charging connector capable of delivering up to 350 kW DC. Most CCS chargers installed to date are 50kW.
CHAdeMO:	An EV charging connector capable of delivering up to 62.5 kW DC. Most Chademo chargers installed to date are 50kW.
DEFRA:	Department for Energy, Food, and Rural Affairs
DfT:	Department for Transport
ECCo:	Electric car consumer model
EE:	Element Energy
ENWL:	Electricity North West Ltd – the Distribution Network Operator for the North West of England
EV:	Electric vehicle
EVCP:	Electric vehicle charging point
FCEV:	Fuel cell electric vehicle
GIS:	Geographic information system
GM:	Greater Manchester
GMCA:	Greater Manchester Combined Authority
GMEV:	Greater Manchester Electric Vehicle
HEV:	Hybrid electric vehicle
ICE:	Internal combustion engine
LA:	Local Authority
LGV: van	Light goods vehicle; a vehicle of up to 3.5t Gross Vehicle Weight. Also known as a
LSOA:	Lower layer super output area, a Census statistical reporting area with a population between 1,000 people / 400 households and 3,000 people / 1,200 households
MSOA:	Middle layer super output area, a Census statistical reporting area with a population between 5,000 people / 2,000 households and 15,000 people / 6,000 households
Nomis:	Government repository for labour market statistics
OA:	Output area, a Census statistical reporting area with a population between 100 people / 40 households and 625 people / 250 households
ONS:	Office for National Statistics
PHEV:	Plug-in hybrid electric vehicle
POI:	Point of interest
TEMPro:	Trip End Model Presentation Program
TfGM:	Transport for Greater Manchester
ULEV:	Ultra-low emission vehicle
VKT:	Vehicle kilometres travelled

1 Introduction

1.1 About the Reflect project

Reflect is a Network Innovation Allowance project funded by Ofgem and led by Electricity North West Ltd (ENWL). ENWL is the electricity Distribution Network Operator in the North West of England. The licence area includes a wide range of settlements, from densely populated urban areas, most notably Greater Manchester (GM), to sparser rural areas in Cumbria. To ensure the distribution network is able to provide sufficient network capacity to meet demand across the year, particularly during the winter peak, long-term demand forecasts are required to enable ENWL to plan investment in their network, allowing them to identify network assets which may require reinforcement or other interventions. The electrification of heating and transport are expected to lead to a rapid increase in demand, so accurate long-term forecasts that take account of these low carbon technologies are necessary for ENWL to quantify the potential impacts and plan accordingly. Due to the large range of settlements throughout the licence area, these projections must be able to inform how demand will change on a regional level. Figure 3 below shows the boundary of the ENWL licence area as well as the names of all Local Authorities (LAs) within the licence area.

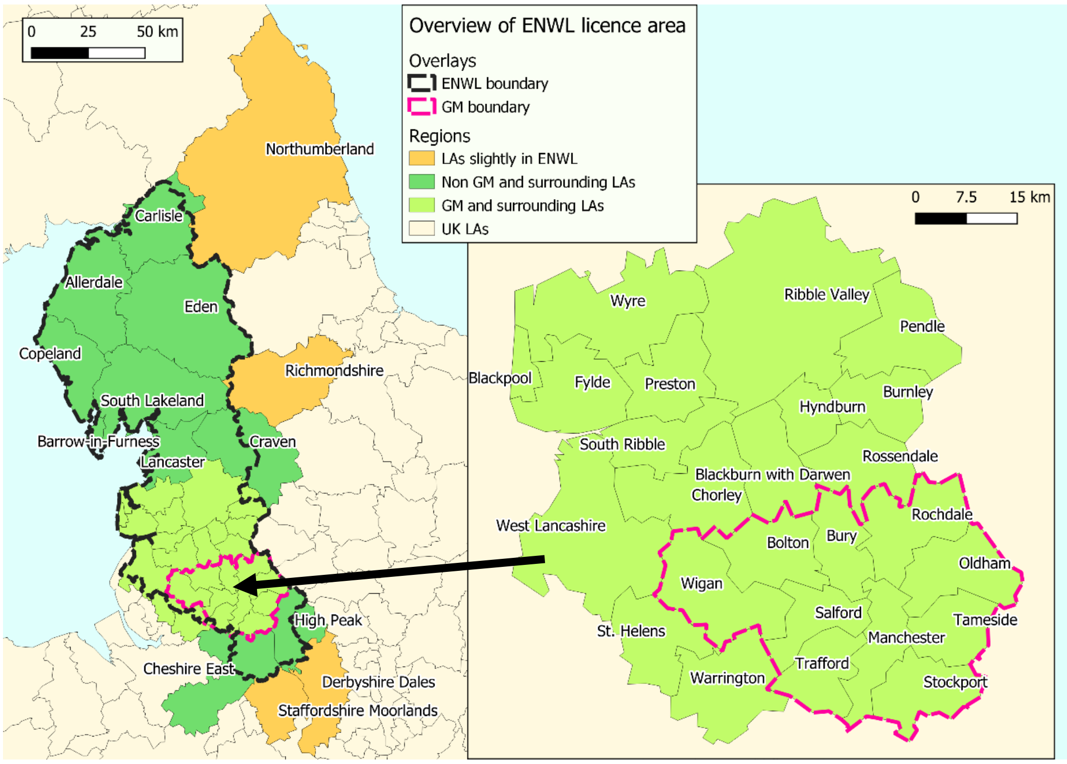


Figure 3. LAs in ENWL licence area

The Reflect project aims to produce a tool which will predict how the adoption of electric vehicles (EVs) will affect electricity demand in the ENWL area in the long-term and especially within the UK government commitment to meet net zero carbon emissions of greenhouse gases by 2050. This requires projections of EV uptake, as well as an understanding of power supplied by EV charging points, where these points are located, and user charging behaviour, as these factors will influence where and when increases in demand are expected. The project aims to cover demand from cars and vans, when charging in a variety of locations: at home, at destination, and en-route. As most vans are kept at home rather than in depots, they will make a significant contribution to domestic charging demand. The division of work and broad timeline for the project are shown in Figure 4 below.

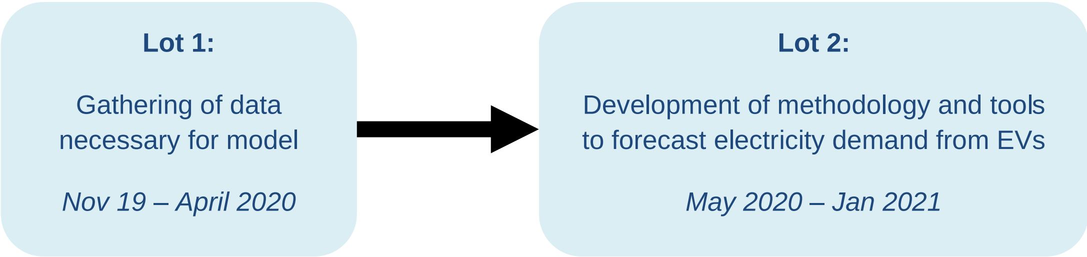


Figure 4. High-level summary of project work

1.2 About this report

This report summarises the projections and datasets produced for Lot 1 of the Reflect project, for use in developing the Reflect Python tool. The datasets produced are presented in sections 2,4 and 5. Section 3 presents the produced EV projections and section 6 outlines the key conclusions of the report and next steps of the project.

Datasets produced

The datasets produced are described in the following report sections:

- Section 2 discusses datasets for car and van ownership.
- Section 4 gives an overview of datasets used to characterise vehicle owners.
- Section 5 focuses on datasets used to characterise public and work charging.

The following points are covered for each of the datasets produced:

- Sources used to produce the dataset
- Cleaning / processing performed on the source material to produce the dataset
- The next release of source material and recommended update frequency of the dataset
- How to update the dataset when new source material is released
- Discussion of the produced dataset (including heatmaps and graphs where applicable)

Projections produced

Further to the aggregation of datasets, the study has also produced projections for several parameters:

- Percentage of uptake of EVs (Battery EVs and Plug in Hybrid EVs)
- Car and van stock and distance travelled projections
- Regional number of EVs and electric kilometres travelled

These projections are discussed in Section 3, including how national EV uptake projections have been translated to regional level.

Report appendices

Three appendices have been included which give further detail on the following areas:

- Appendix I describes the research undertaken into LA policies.
- Appendix II gives a brief introduction to the Element Energy Electric Car Consumer Model (ECCo), which has been used to produce projections of national EV uptake.
- Appendix III reports the findings of the analysis of the usage level of the charging network currently in place in Greater Manchester area.

2 Current car and van stock

The total number of cars and vans, referred to as the stock, must be known so that projections of the increase in stock size can be made, and this data is presented in Section 2.1. Current EV uptake across the ENWL licence area is discussed in Section 2.2 and is used to inform the future geographic distribution of EVs.

2.1 Current car and van ownership patterns

Sources used

Data were obtained from the Department for Transport (DfT) on total number of cars and vans at middle layer super output area (MSOA) and LA level up to 2019 Q3. A data request was made to DfT (email: vehicles.stats@dft.gov.uk), and an end user license was signed. As the data is provided at a high granularity, information on the age of vehicles is not provided, as this would risk identifying individuals.[1]

Cleaning / processing done

To avoid disclosure of identity of individuals, DfT data suppress values where there are fewer than 5 vehicles in a certain category, by denoting the value as ‘c’. To compensate for these suppressed values, MSOA level data were aggregated up to LA level and compared to the LA level data obtained from DfT, which does not suppress values as there is less risk of identifying individuals due to the larger number of vehicles in each LA. These ‘c’ values were replaced by the number of excess vehicles in the LA level data compared to the MSOA level data divided by the number of reported ‘c’ values for the MSOA level data. An example of this processing is shown for Warrington in Table 3 below. Note that values are typically not suppressed for petrol cars and diesel cars and vans as there are a large number of these vehicles in each MSOA, so there is no risk of identification of individuals. The MSOA totals also tend to exceed LA totals due to double counting of vehicles in MSOAs, however this effect is not compensated for as MSOA totals do not tend to exceed LA totals by more than 0.5%, so the effect is too small to make a significant difference.

Table 3. A table showing the process used to estimate supressed MSOA level values, using data for Warrington as an example

Vehicle body type	Cars				Vans			
Powertrain type	Petrol	Diesel	EV	Other	Petrol	Diesel	EV	Other
Warrington LA total	66,773	41,732	471	1,400	238	11,178	18	14
Warrington MSOA totals	66,962	41,899	437	1,377	203	11,189	7	0
Number of missing vehicles from MSOA totals	0	0	34	23	35	0	11	14
Number of Warrington MSOAs with ‘c’ values reported	0	0	16	13	17	0	8	9
Replace ‘c’ with…	0	0	2	2	2	0	1	2

[1] The age of vehicles and scrappage rules are accounted for at a national level by the ECCo model – see Appendix II for more information on ECCo

This data was subsequently cleaned as some MSOAs had an anomalous number of cars and vans registered. This is primarily due to a large number of vehicles being licensed to a fleet company based in a particular location, while the vehicles are in reality used by drivers around the country. MSOAs where more than 20% of the car stock or more than 80% of the van stock were owned by companies were deemed to be anomalous, and excess vehicles above these thresholds were redistributed to other MSOAs based on how far below the average company share of the car/van stock of the ENWL region these MSOAs were. This had the effect of increasing the number of company vehicles in MSOAs where the share of company vehicles was significantly below the regional average. Table 4 below demonstrates this redistribution process for selected MSOAs. For cars and vans, the three possible cases have been listed:

- In the first case, the share of company cars or vans is above the assumed threshold (20% for cars, 80% for vans) and cars or vans have been removed such that the adjusted share of company cars or vans is equal to the threshold value.
- The cars or vans that have been removed from MSOAs that fall into the first case are added to MSOAs that fall into the second case, where the share of company cars or vans is below the regional average (6% for cars, 40% for vans).[2] This process is done according to the equation below:

$$N_i = V_i \times \frac{\sum E_i}{\sum V_i}$$

  Where N_i denotes the number of cars or vans added to the i^{th} MSOA, V_i represents the number of company car or van vacancies in the MSOA (the number of company cars or vans that would need to be added to make the company share within the MSOA equal to the regional average), and the third term represents the share of vacancies that are filled, by dividing $\sum E_i$, the total number of cars or vans that have been removed from MSOAs above the threshold, by $\sum V_i$, the total number of vacancies across all MSOAs.

- In the third case, the share of company cars or vans is between the assumed threshold and the regional average and the number of company cars or vans has not been changed.

[2] National average shares of company cars and vans are 11% and 49% respectively. Shares have not been adjusted to match national averages as this would result in adding a large number of cars and vans to the parc

Table 4. A table demonstrating how company cars and vans were redistributed for selected MSOAs

MSOA name	Number of private cars	Number of company cars	Share of company cars	Number of cars added / removed	Adjusted number of company cars	Adjusted share of company cars
Bury 009	2,938	10,117	77%	- 9,383	735	20%
Chorley 007	3,659	110	3%	+ 59	169	4%
Bolton 023	2,442	283	10%	0	283	10%
MSOA name	**Number of private vans**	**Number of company vans**	**Share of company vans**	**Number of vans added / removed**	**Adjusted number of company vans**	**Adjusted share of company vans**
Manchester 055	47	450	91%	- 262	188	80%
St. Helens 009	147	50	25%	+ 8	58	28%
Trafford 003	141	244	63%	0	244	63%

Next release of source material

MSOA level data were obtained from a special request to DfT and so cannot be updated unless another request is made, however statistics on car and van stock at LA level are publicly available from the DfT website and are updated annually. Large changes are not expected to occur year on year in the total vehicle stock size, so the LA level data could be updated every two years. However, as source data are released annually and are relatively easy to obtain, this dataset could be updated with annual LA level statistics when they are released.

How to update

Data tables can be downloaded from the DfT website.[3] The relevant table for this dataset is VEH0105 (Licensed vehicles by body type and local authority).

Discussion

Figure 5a shows the number of cars and vans in each MSOA in the ENWL licence area. There are 7,201 MSOAs in the UK – if cars and vans were evenly distributed between them, each would have 0.014% of the national stock, or 5,100 cars and vans.[4]

Figure 5b gives the car and van density in vehicles per hectare in each MSOA. If cars and vans were evenly distributed across the area of the UK there would be 1.51 cars and vans per hectare. While the majority of the licence area has a car and van density below the national average, the GM area has a significantly higher car and van density.

[3] https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01
[4] There are 648 MSOAs in the ENWL licence area

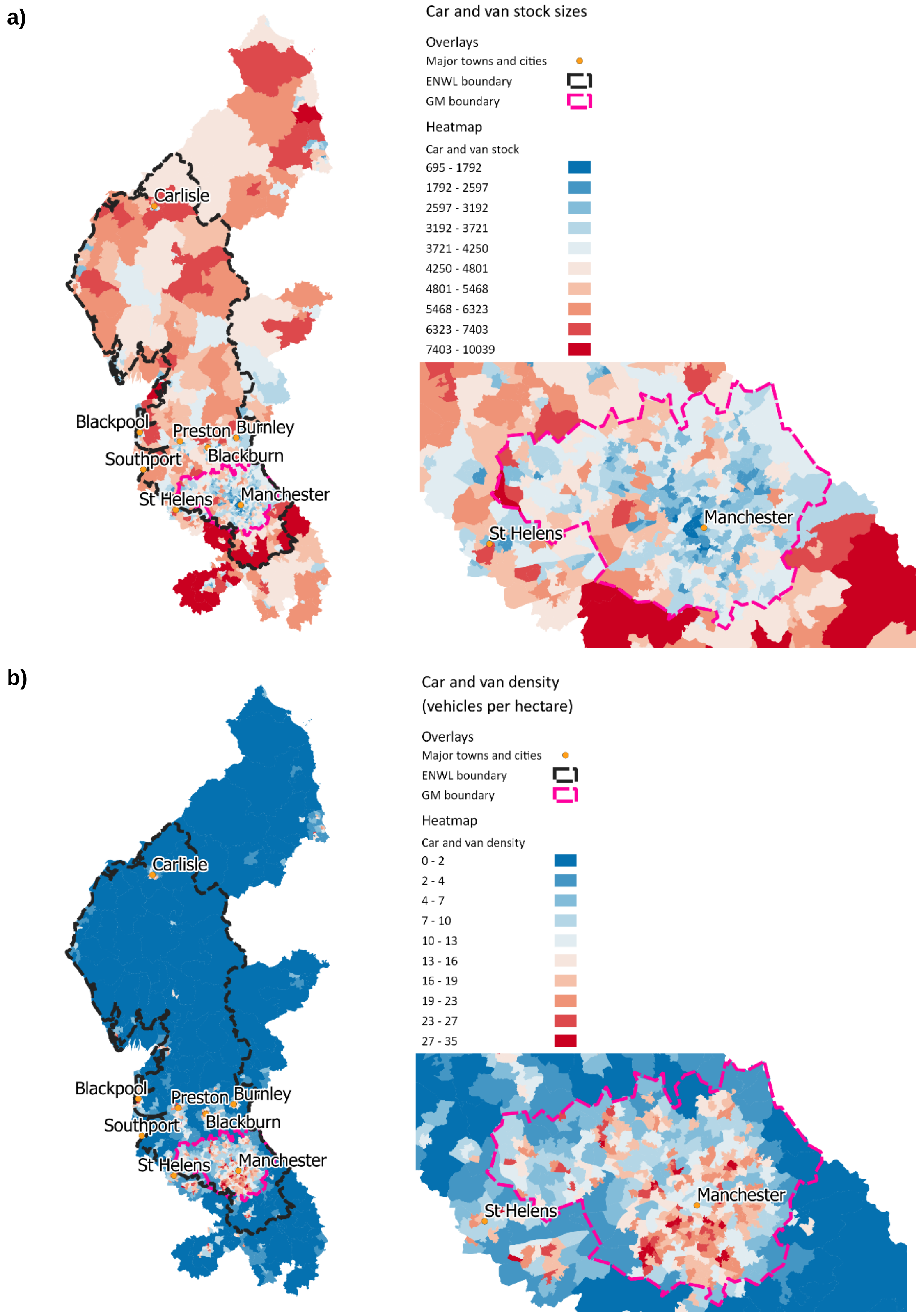


Figure 5. Heatmaps showing a) car and van stock sizes, and b) car and van density (vehicles per hectare) for MSOAs in the ENWL licence area

2.2 Current plug-in car and van uptake

Sources used

Data were obtained from DfT on the number of EVs at MSOA level, and the numbers of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) at LA level, up to 2019 Q3. A data request was made to DfT (email: vehicles.stats@dft.gov.uk), and an end user licence was signed.

Cleaning / processing done

As with the total vehicle stock data, vehicle numbers were estimated for MSOAs where the value had been suppressed to avoid disclosure of individuals – see the cleaning / processing section of Section 2.1 for a detailed explanation of this process.

This data was subsequently cleaned as the company stock in some MSOAs had an anomalously high share of EVs. Similarly to MSOAs with a high share of company vehicles, these EVs are assumed to be registered to a single fleet address, when in reality the vehicles are distributed across the country. Any MSOAs where more than 10% of the company car or van stock were EVs, and the absolute number of EVs was above 25, were considered to be anomalous (note no MSOAs had a private car or van stock with more than 10% EVs). EVs above this threshold were redistributed to the company stock in other MSOAs according to how far they were below the average share of EVs in the ENWL licence area. This had the effect of increasing EV numbers in MSOAs where the company share of EVs was significantly below the regional average.

Table 5 below demonstrates the company EV redistribution process for selected MSOAs. The three possible cases have been shown for cars below:

- In the first case, the share of company electric cars or vans is above the assumed threshold of 10% of company cars or vans being EVs, and EVs have been removed such that the adjusted share of company electric cars or vans is equal to the threshold value.
- The EVs that have been removed by this process are added to MSOAs that fall into the second case, where the share of company EVs is below the regional average (2% for cars, 0.3% for vans). This process is done according to the equation below:

$$N_i = V_i \times \frac{\sum E_i}{\sum V_i}$$

  Where N_i denotes the number of EVs added to the i[th] MSOA, V_i represents the number of company EV vacancies in the MSOA (the number of company electric cars or vans that would need to be added to make the company EV share within the MSOA equal to the regional average), and the third term represents the share of company EV vacancies that are filled, by dividing $\sum E_i$, the total number of electric cars or vans that have been removed from MSOAs above the threshold, by $\sum V_i$, the total number of company EV vacancies across all MSOAs.

- In the third case, the share of company EVs is between the assumed threshold and the regional average, or the 10% threshold has been exceeded while the number of electric cars or vans is below 25. In this case the number of EVs has not been changed.

Table 5. A table demonstrating how EVs were redistributed for selected MSOAs

MSOA name	Number of company EV cars	Number of company cars	Share of company EV cars	Number of EV cars added / removed	Adjusted number of company EV cars	Adjusted share of company EV cars
Blackpool 013	48	166	29%	- 31	17	10%
Rossendale 010	2	281	1%	+ 1	3	1%
Salford 020	10	276	4%	0	10	4%

Next release of source material

MSOA level data were obtained from a special request to DfT so cannot be updated unless another request is made. However, statistics for plug-in cars and vans at LA level are updated on a quarterly basis and it would be sensible to update this dataset at least annually as large changes are expected in the EV stock and projections may not match actual data (varying by scenario).

How to update

Data tables can be downloaded from the DfT website.[5] The relevant table is VEH0131 (Licensed plug-in cars, LGVs and quadricycles by local authority). This does not currently differentiate between BEVs and PHEVs so assumptions will have to be made on the BEV/PHEV split – it could be assumed that the split is the same as for the initial source data, which does differentiate between BEVs and PHEVs, or that the BEV/PHEV split will match the projected distribution for that year from ECCo (a model that is described later on in this report). VEH0131 only gives the total number of plug-in vehicles for each LA, however the plug-in car / light goods vehicle (LGV) split can be assumed to be the same as for the North West in VEH0130 (Licensed ultra-low emission vehicles at the end of quarter by body type and plug-in grant eligibility, including regional breakdown for the latest quarter, United Kingdom from 2010 Q1).

Discussion

The numbers of EV cars and vans in each MSOA are shown in a heatmap in Figure 6a below. Some MSOAs have fewer than 5 registered EVs, whereas others have over 100, so there is a wide variation in EV uptake across the region.

The share of the car and van stock that are EVs is shown for each MSOA in Figure 6b below. Average EV car and van uptake across the licence area is 0.34%, which is just over half the national average of 0.62% (share of car and van stock). While the vast majority of MSOAs show EV uptake below the national average, some are significantly above, with over 3% of their car and van stock being EVs. While absolute EV numbers appear to be higher in the south of the region than the north, this trend is not seen in the share of the stock that is EV.

[5] https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01

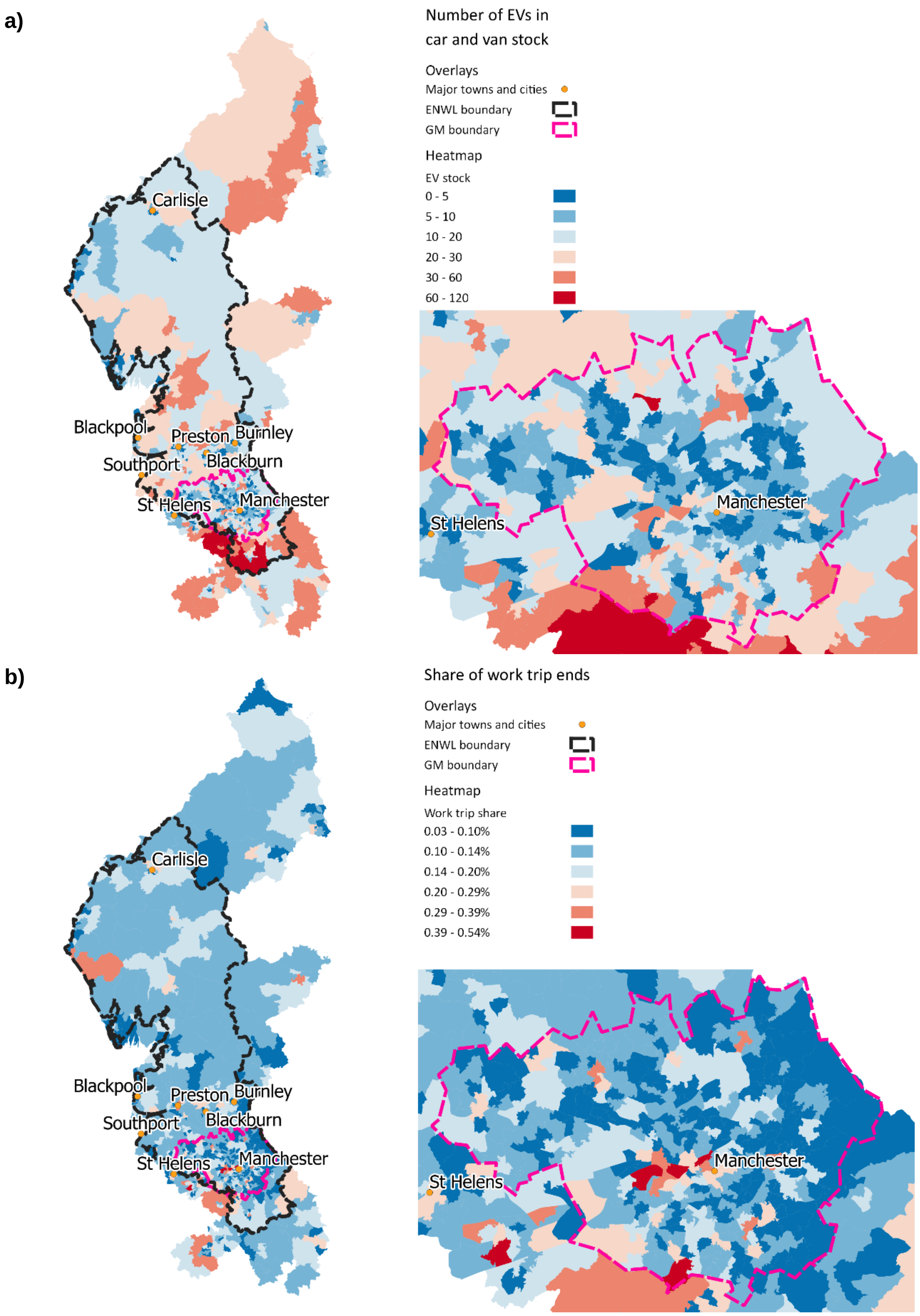


Figure 6. Heatmaps showing a) number of EV cars and vans, and b) proportion of current car and van stock that are EVs for MSOAs in the ENWL licence area

3 Future vehicle stock projections

Future vehicle stock projections are used as one of the steps to determine how the level of EV charging demand will increase. Figure 7 shows schematically the approach taken to forecast EV uptake.

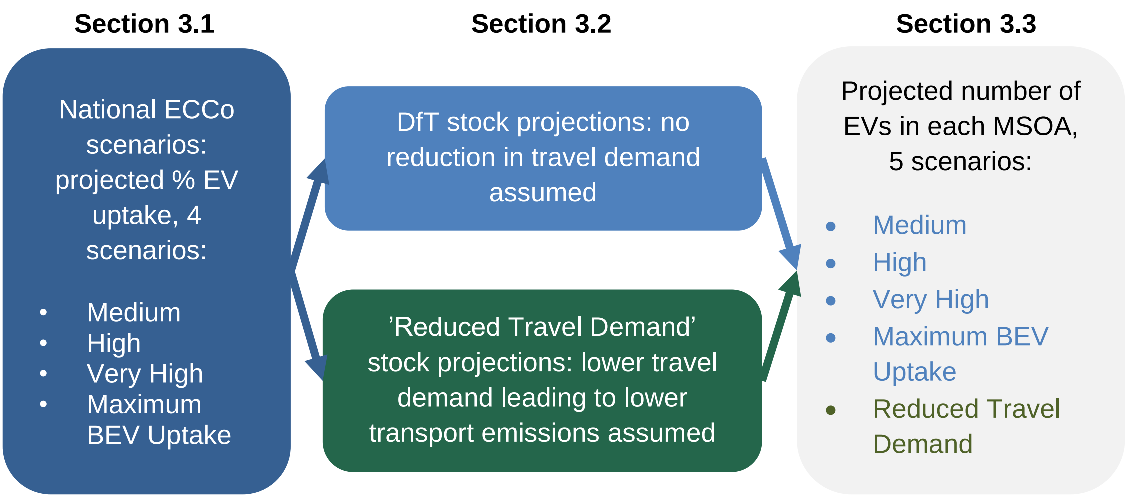


Figure 7. A schematic showing the approach taken to forecast EV uptake in the ENWL licence area

Section 3.1 outlines the national and regional EV uptake scenarios developed. Due to policy ambition from LAs across the region outlined in Appendix I, the possibility of regional emissions reduction scenarios that are more ambitious than those assumed nationally has been considered. Section 3.2 presents projections of future car and van stock and distance travelled, which inform the level of regional emissions reductions assumed to occur by 2038. 70% of LAs in the ENWL licence area have proposed to achieve net zero emissions by this date and if these target dates are to be met then road transport emissions must essentially fall to zero by this point. Due to limits in stock turnover and EV supply, this cannot be achieved by solely increasing EV uptake while following historic vehicle stock projections – rapid uptake of EVs and reduction in travel demand relative to historic projections are both required. EV stock projections for the ENWL region are developed by combining the regional uptake projections from Section 3.1 with vehicle parc growth projections from Section 3.2. The regional EV stock projections and distribution of these among MSOAs are outlined in Section 3.3.

3.1 EV uptake projections

EV uptake projections with no reduction in travel demand

The number of EV cars and vans in the national uptake projections and the share of the national stock that are EV are shown in plots for four scenarios in Figure 8a and Figure 8b respectively. Figure 8c shows the breakdown of BEVs and PHEVs in the national car and van stock for 2030. The scenarios cover a wide range of EV uptake; by 2030, EV car and van uptake ranges from 14% in the 'Low' scenario to 39% in the 'Very High' scenario. The 'Very High' scenario has been designed to be compatible with net zero emissions across the UK by 2050 at latest.[6] In order to achieve this, it is recommended that there are no emissions due to cars and vans, meaning there should not be any ICE vehicles, HEVs, or PHEVs in the car or van parc.[7]

These projections were produced using Element Energy's Electric Car Consumer Model (ECCo), which captures consumer behaviour and calculates the market share of various powertrains for given policy, vehicle technology, and infrastructure landscapes.[8] Table 6 below summarises the policy targets behind each of the ECCo scenarios.

Since these scenarios have been produced, the government has opened a consultation on the phase-out of new internal combustion engine (ICE) vehicles, hybrid electric vehicle (HEV), and PHEV sales from 2035. If agreed, this policy would be in between the assumed policy ambition for the ECCo 'High' and 'Very High' scenarios. In light of this recent announcement, the 'Low' scenario no longer seems to represent a realistic lower bound of EV uptake so this scenario will not be used in the modelling phase of the Reflect project.

Table 6. Summary of policy ambition assumed for each of the four ECCo scenarios

Scenario name	Description
Very High	Driven by new ICE/HEV sales ban in 2030, with PHEVs removed from sale in 2035. This reflects the Committee on Climate Change's (CCC) more ambitious recommendations
High	Policies to achieve 70% ultra-low emissions vehicle (ULEV) sales in 2030 (upper bound of Road to Zero[9] ambition) and 2035 ban on new ICE/HEV sales (consistent with CCC's "at the latest" recommendation)
Medium	Policies to achieve 50% ULEV sales in 2030 (lower bound of Road to Zero ambition) and 2040 ban on new ICE/HEV sales
Low	No additional policies to encourage ULEV uptake (will not be incorporated into Reflect)

[6] This produces a parc of entirely ZEVs by 2050 – the parc is not 100% BEVs as there are a small number of hydrogen fuel cell EVs which make up the rest of the stock
[7] CCC Net Zero Technical Report https://www.theccc.org.uk/publication/net-zero-technical-report/
[8] More information on the structure and function of ECCo is available in Appendix II
[9] https://www.gov.uk/government/publications/reducing-emissions-from-road-transport-road-to-zero-strategy

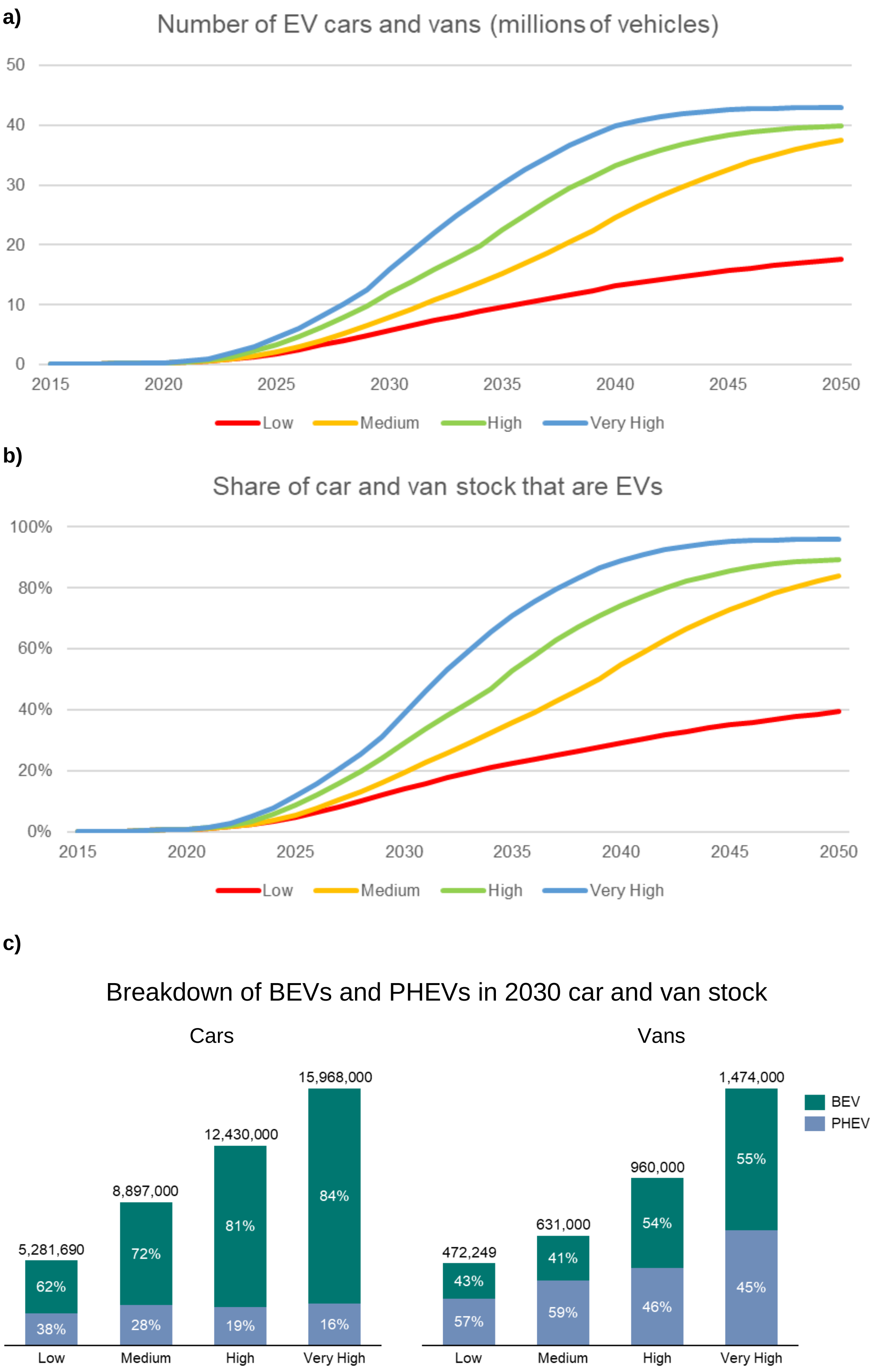


Figure 8. Plots of a) Projected number of EV cars and vans in the national stock, b) share of EV cars and vans in national stock, and c) breakdown of BEVs and PHEVs in the projected national car and van stock for 2030

EV uptake projections with reduced travel demand (lower regional transport emissions)

The first step taken in producing the 'Reduced Travel Demand' scenario was to gauge the level of regional ambition in terms of emission reduction. To this effect, research into LA policy was undertaken – this research is presented in detail in Appendix I. 82% of LAs in the ENWL licence area have declared a climate emergency and of those, 72% have set a target date of being net zero by 2030 or sooner. Climate emergency targets are used as a proxy for:

- The likelihood of a local EV uptake that is more rapid than at national level
- The likelihood of modal shift and/or reduction in travel demand, as achieving net zero emissions before 2040 is not possible by just increasing EV uptake – the number of vehicles and total distance travelled by vehicles must also decrease.

However, these targets are not yet backed by plans from LAs on how net zero would be achieved so their feasibility is questionable. As 70% of LAs in the region intend to reach net zero emissions by 2038 or sooner, and transport emissions across the whole region will impact each LA, it was decided that 2038 would be a more realistic date for road transport emissions to get as close to zero as possible.

While the 'Very high' scenario described above delivers a parc of zero emission cars and vans by 2050 (made up of rechargeable EVs and hydrogen fuel cell EVs), 25% of vehicles in the 2038 parc are still non-ZEVs (ICE vehicles, HEVs, and PHEVs). Therefore the 'Maximum BEV Uptake' scenario, a variant to the 'Very high' scenario has been created, under which the share of non-ZEVs is further decreased. Under this scenario, PHEVs are phased out from sales from 2030 (along with ICE vehicles and HEVs), leading to 84% of the vehicle parc being ZEVs by 2038.

A comparison of the 2038 vehicle stock breakdown in the 'Very High' and 'Maximum BEV Uptake' scenarios is shown in Figure 9 below. The share of PHEV cars is 5 percentage points lower in the 'Maximum BEV Uptake' scenario, leading to a 4 percentage point increase in the share of BEV cars. The share of PHEV vans is 22 percentage points lower in the 'Maximum BEV Uptake' scenario, leading to 14 and 5 percentage point increases in shares of BEV and fuel cell electric vehicle (FCEV) vans respectively. There is also a 2 percentage point increase in the ICE/HEV share.

Car and van stock breakdown in 2038 for 'Very High' and 'Maximum BEV uptake' scenarios

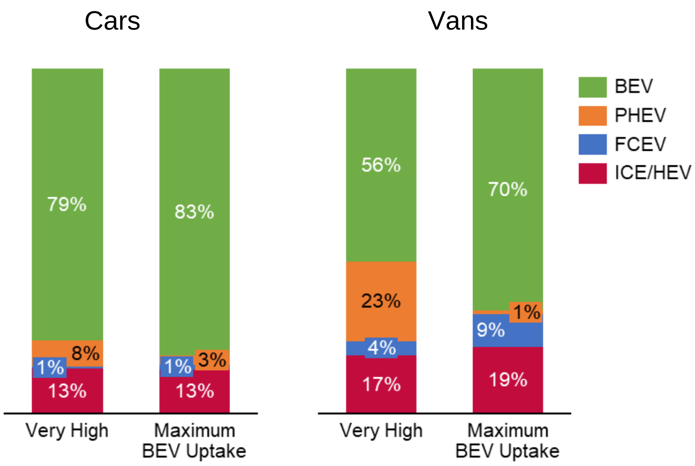


Figure 9. Breakdown of car and van stock shares by different powertrain types in 2038 for 'Very High' and 'Maximum BEV uptake' scenarios. These percentages present the breakdown of the car and van stock separately. Stock projections have not yet been applied, however the current ratio of cars to vans is ~8:1

ENWL region percentage EV uptake projections

The above EV uptake scenarios have been translated to projections of the percentage of the total car and van stock that are EVs for the ENWL region. The national 'Low' scenario has not been considered in light of the recent government policy announcement, however the 'Maximum BEV Uptake' scenario has been included in its place.

The share of projected EV cars and vans in the ENWL region for these four scenarios are shown in Figure 11a below. The shapes of the uptake curves are very similar to the uptake curves for the national scenarios – this is to be expected as EV adoption is currently very low, and the rapid increase in uptake projected from 2025 onwards outweighs the current small differences in EV uptake between the ENWL region and GB as a whole. The total EV uptake for the 'Very High' and 'Maximum BEV Uptake' scenarios is very similar, however due to the earlier phase out of PHEVs in the latter scenario, it shows higher BEV uptake from 2030 onwards. This can be seen in Figure 11b, which shows the share of projected BEV cars and vans in the ENWL region for the four scenarios.

Stock projections for the ENWL region were produced from the national EV uptake scenarios. The allocation of EVs to the regional stock initially followed the historic shares of BEVs / PHEVs (as determined from analysis of DfT vehicle stock data, see Figure 10, right), however this was gradually blended to match the BEV / PHEV proportions of the national stock. This blending was performed until 16% of the national stock was EV, as in diffusion modelling of the uptake of innovations, this is assumed to be the point at which mass production conditions are met.[10]

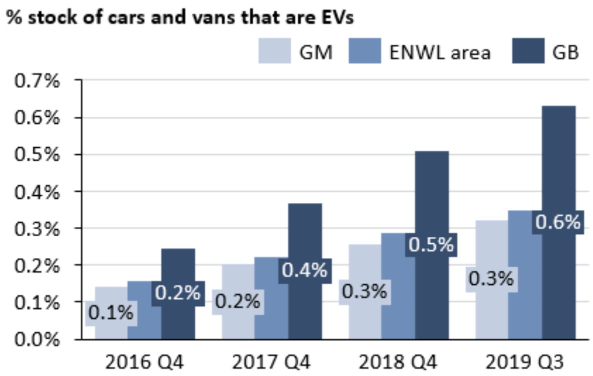
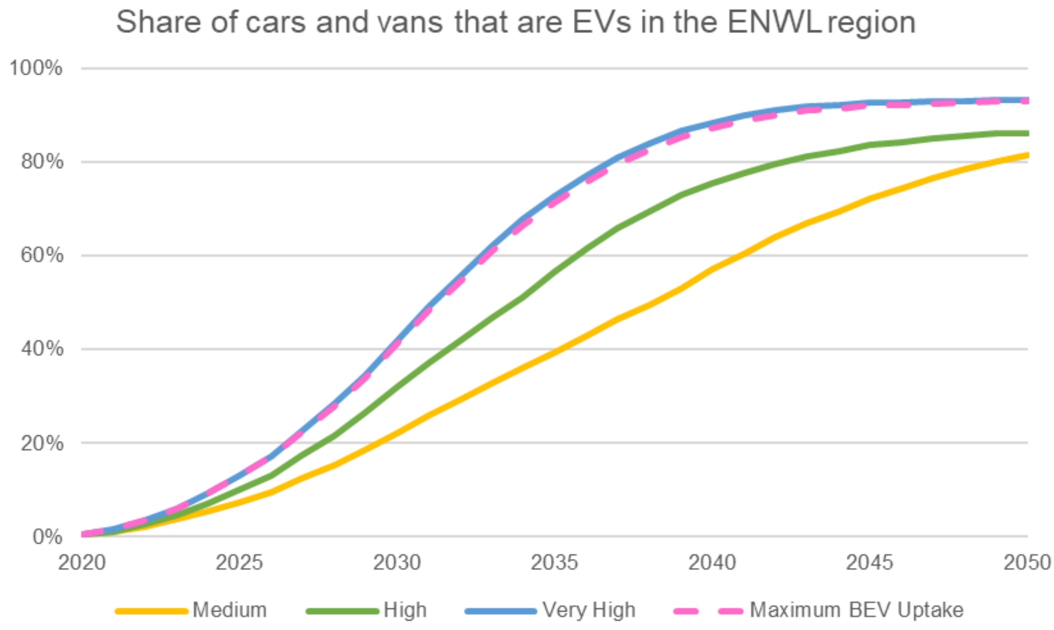


Figure 10 Historic shares of EV uptake for Greater Manchester, the ENWL region, and Great Britain

Stock projections were then converted to percentage EV uptake projections so that regional car and van parc growth assumptions that are different to the national assumptions could be applied. The national and regional parc growth and distance travelled projections assumed are described in Section 3.2 below.

[10] *Rogers, Everett M. (1962). [Diffusion of innovations](#) (1st ed.). New York: Free Press of Glencoe. OCLC [254636](#)*

a)



b)

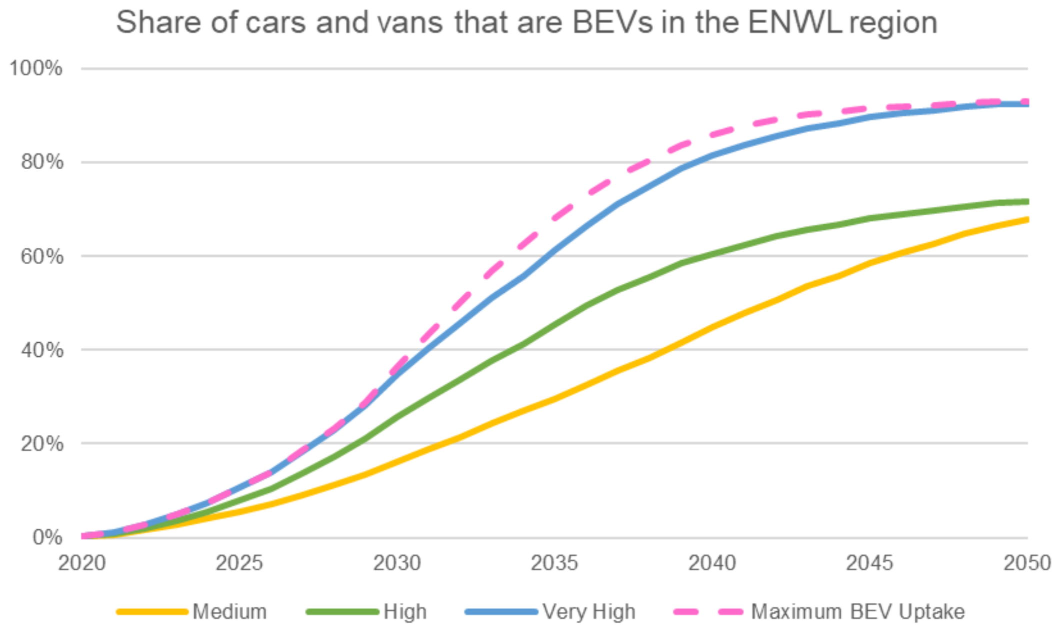


Figure 11. Plots showing a) projected share of EV cars and vans in the ENWL region; b) projected share of BEV cars and vans in the ENWL region

3.2 Car and van parc and distance travelled projections

The scenarios for car and van parc growth, and vehicle kilometres travelled (VKT), are shown in the plots in Figure 12a and Figure 12b respectively. The parc size influences the absolute number of EVs modelled, while VKT determines the overall electricity demand from the car and van stock.[11]

Scenarios with no reduction in travel demand

The series labelled 'NRD' (no reduced demand) and plotted in blue are the ones used for the scenarios with no assumed reduction in travel demand (vehicle kilometres travelled). These are from DfT published projections for values up to 2040. These DfT projections contain multiple scenarios; of these the 'base' scenario, which assumes historic average trip rates, positive and declining income growth, and central macroeconomics, was selected.[12] After 2040, the vehicle stock size and kilometres travelled have been assumed to stay constant. This has been assumed to account for modal shift to public transport and walking or cycling, as well as reduction of travel demand, which the government has incentivised through policy and funding commitments and are a highly effective method of reducing transport emissions.[13,14]

'Reduced Travel Demand' scenario

The series labelled 'RD' (reduced demand) and plotted in green in Figure 12 are the ones used for the 'Reduced Travel Demand' scenario which considers reduced travel demand leading to lower transport emissions. For the regional trends, we are setting ambitious projections, based on insights from previous projects on the modelling of carbon emissions in other regions:[15]

- 10% decrease and 10% increase for car and van stock respectively by 2038. In contrast, DfT projections assume a 20% increase in car stock and 42% increase in van stock. Stock stays constant from 2040 onwards in all scenarios other than the 'Reduced Travel Demand' scenario for cars, where stock falls by 35% of its current value by 2050
- 25% decrease and 20% increase for cars and vans VKT respectively by 2038. This compares to 22% increase for cars and 42% increase for vans in the DfT's projections.

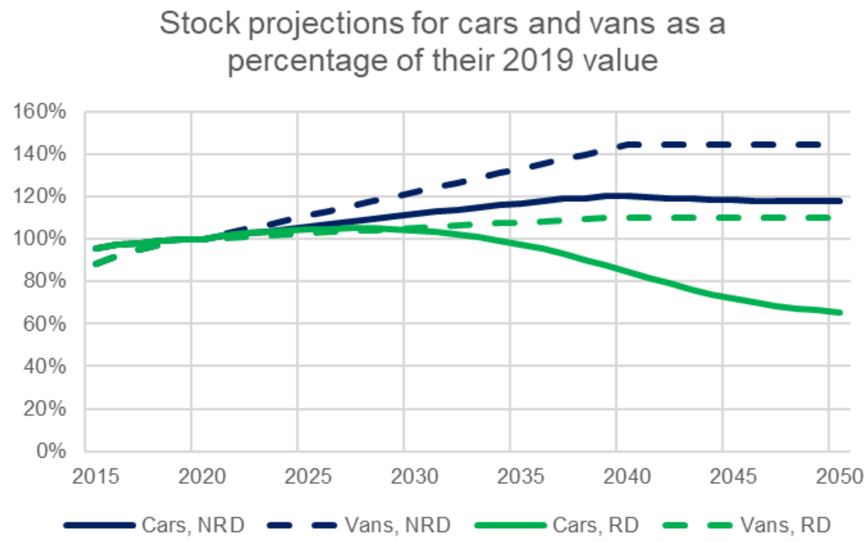
These significant reductions in car use correspond to both:

- Modal shift and increased car occupancy, i.e. current trips taken are still assumed to happen, but in a less carbon-intensive mode than by car (e.g. walking, cycling, bus, train) or through car/ride sharing.

[11] Note that stock and VKT have not been assumed to change from 2019 to 2020. This assumption was made due to the Covid-19 pandemic. At the time of writing it is very unclear what the long term impacts (both on sales and travel behaviour) will be, but the this non-increase in stock and travel demand seems an adequate assumption for 2020.
[12] DfT road traffic forecasts 2018
[13] A better deal for bus users, https://www.gov.uk/government/publications/a-better-deal-for-bus-users/a-better-deal-for-bus-users
[14] DfT Cycling and Walking Investment Strategy, https://www.gov.uk/government/publications/ cycling-and-walking-investment-strategy
[15] Studies include the *Development of the Greenwich Carbon Neutral Plan*, for the Royal Borough of Greenwich (2019-20), the *Decarbonising the Transport Sector* study for Transport Scotland (2019-20) and the *North & West Yorkshire Emissions Reduction Pathways* work for West Yorkshire Combined Authority (2020) – these studies by Element Energy have been recently conducted or are on-going, the last two reports are therefore not published yet. During these research projects, we had the opportunity to study the breakdown of trips taken by purpose, length and other characteristics (e.g. age, having a disability), giving us a solid basis to estimate the technically feasible modal shift and reduction in car use.

- Some trips are assumed to no longer happen, for instance some business trips are replaced by video conferences, urban layout is designed to bring people closer to jobs and amenities.

a)



b)

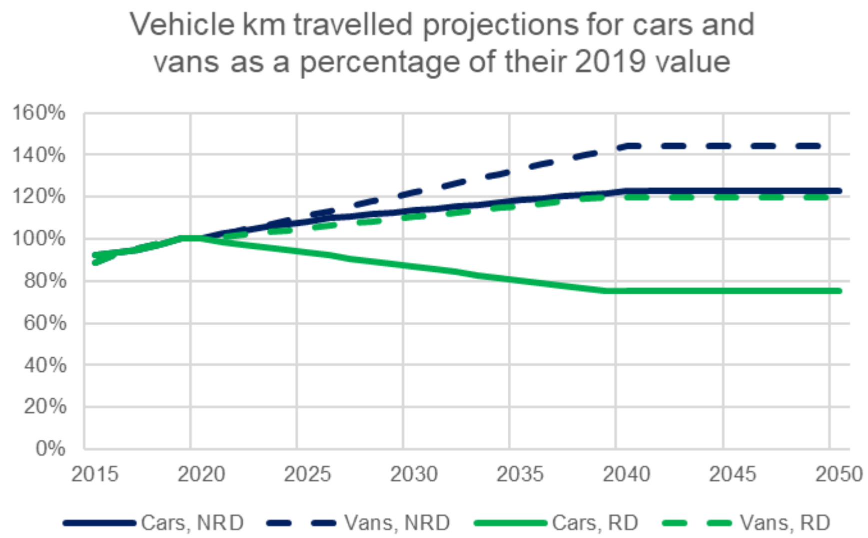


Figure 12. Scenarios for a) car and van parc growth, and b) distance travelled by cars and vans

3.3 Regional EV stock and distribution

Regional EV stock projections

Regional percentage EV uptake projections from Section 3.1 were multiplied by regional parc growth projections produced as outlined in Section 3.2 in order to produce regional EV car and van stock projections; Figure 13a shows projected EV car and van numbers, and Figure 13b shows BEV stock projections.

For the 'Medium', 'High' and 'Very High' scenarios, the DfT parc growth projections have been assumed. For the 'Maximum BEV Uptake' scenario, the DfT projections have been applied to make one scenario. The 'Reduced Travel Demand' scenario has been produced by assuming our bespoke parc growth scenario which assumes reduced travel demand with the same percentage uptake scenario as 'Maximum BEV Uptake'. Despite the 'Reduced Travel Demand' scenario having the joint highest share of EV uptake, the absolute number of EVs is lower than for the other scenarios due to the lower assumed parc growth. Therefore, if the region is able to meet the 2038 net-zero target by reducing car and van travel demand, the EV charging energy required will also be significantly lower than in the 'Very High' or 'Maximum BEV Uptake' scenarios that align with the national net zero by 2050 target.

Figure 13b shows BEV uptake for the five scenarios produced. The 'Maximum BEV Uptake' scenario shows higher BEV uptake than the 'Very High' scenario due to the earlier phase out of PHEVs. Despite the lower assumed vehicle parc growth in the 'Reduced Travel Demand' scenario, EV charging demand is still expected to increase rapidly in the next 15 years under this scenario. The BEV uptake in the 'Reduced Travel Demand' scenario is higher than in the 'High' scenario until 2040. This means that, even under a case of signifcant car travel demand reduction, the demand for EV charging (and thus potential network investment) is still expected to grow rapidly and significantly.

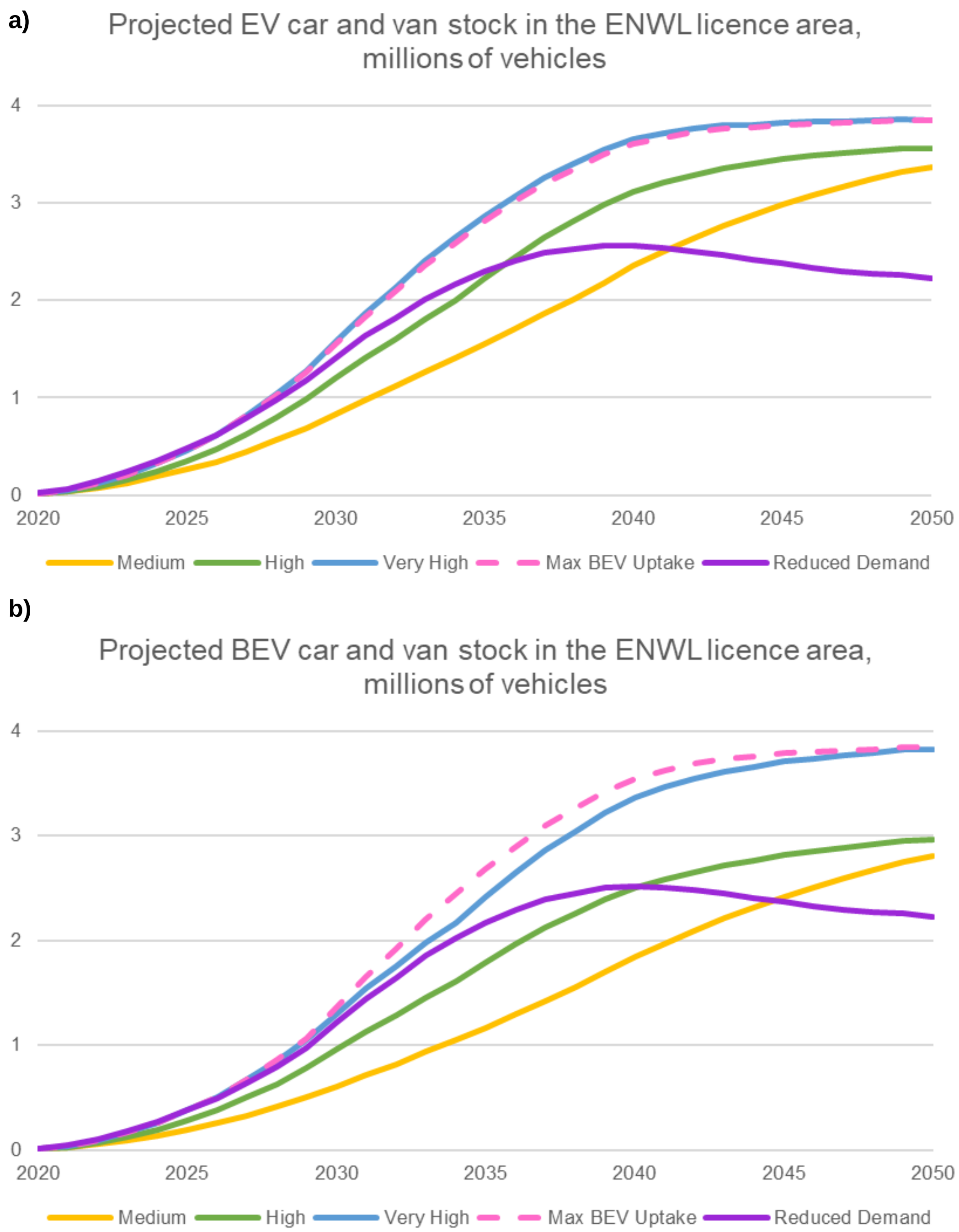


Figure 13. Scenarios for a) projected EV car and van stock, and b) projected BEV car and van stock in the ENWL licence area

Distribution of stock among MSOAs

Once regional EV stock projections had been produced, the regional stock was then distributed to MSOAs in the ENWL licence area. Figure 14 shows a heatmap of the share of EVs in each MSOA for the 'High' scenario in 2038. The heatmap shows that for all but two of the MSOAs in the region, projected EV uptake by 2038 is between 65 and 79%.

For each year in the forecast, new EVs in the regional stock are distributed amongst the MSOAs. As with the national to regional conversion described in Section 3.1, allocation of EVs to MSOAs initially followed the historic BEV / PHEV shares, however was gradually blended so that allocation of new EVs matched the BEV / PHEV proportions of the national stock once EV uptake had reached 16% and mass market conditions were assumed to have been met.[16]

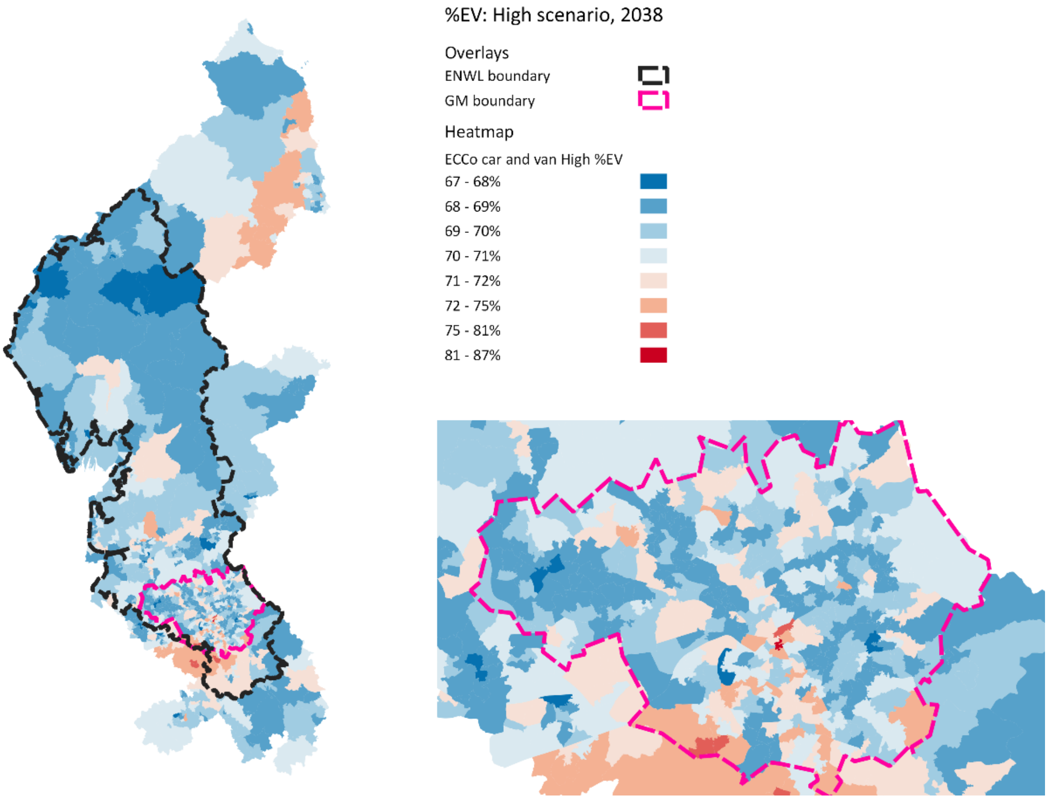


Figure 14. A heatmap of projected share of EV cars and vans at MSOA level for the 'High' scenario in 2038

[16] Rogers, Everett M. (1962). *Diffusion of innovations* (1st ed.). New York: Free Press of Glencoe. OCLC 254636

4 Data to characterise vehicle owners

The following datasets will be used to determine the travel and charging patterns of EV drivers as part of the modelling in Lot 2 of the Reflect project:

- Section 4.1 considers off-street parking access, as this informs where domestic charging can occur.
- Section 4.2 presents the rural/urban classification of the region – this is relevant as rural and urban drivers show different behavioural patterns, with rural drivers typically taking more frequent and longer car trips than urban drivers.
- Section 4.3 focuses on the share of drivers that commute to work, as commuters are likely to charge their vehicle at work if charging infrastructure is available.

4.1 Off-street parking access

Sources used

Data were obtained from the Office for National Statistics (ONS) and Nomis, a government repository for labour market statistics and Census data, on accommodation type broken down by number of cars and vans registered at each dwelling, and car and van ownership, at output area (OA) level.[17, 18]

Cleaning / processing done

The source data was used, along with Table 7 below, to estimate the number of households with access to off-street parking.[19] The calculated estimates were then calibrated against existing data for London LAs.[20] As the number of cars and vans in each household is known (for households with two or more cars or vans this is calculated using the total number of cars and vans in the OA), the number cars and vans with access to off-street parking in each OA can be estimated, Numbers were aggregated up to lower layer super output area (LSOA), MSOA, and LA level to give the share of cars and vans in each region with access to off-street parking.

Next release of source material

The underlying datasets are derived from 2011 Census data and will not be updated until 2021 at the earliest. However as off-street parking shares are not expected to change significantly and the building stock changes very slowly, this lead time is not an issue.

How to update

The production of these estimates requires applying assumptions to the Nomis data as described above. Since the building stock changes very slowly and off-street parking shares are not expected to change significantly, if this data were not updated in future this would not be expected to have a significant impact on the accuracy of the model. However, if ENWL wishes to update this dataset after the 2021 Census, a request can be made to Element Energy to update this dataset.

---

[17] ONS. *CT0876: Accommodation type (excluding caravans or other mobile or temporary structures) by car or van availability.* (2011) https://www.ons.gov.uk/peoplepopulationandcommunity/housing/adhocs/009575ct08762011census
[18] Nomis. *KS404UK: Car or van availability*. (2014) https://www.nomisweb.co.uk/census/2011/ks404uk
[19] Bates & Leibling. *Spaced Out – Perspectives on parking policy*. (2012) https://www.racfoundation.org/research/mobility/spaced-out-perspectives-on-parking
[20] Data accessible by special request to TfL

Table 7. Parking availability by type of dwelling and number of cars in the household[21]

Type of dwelling	% of households in this dwelling category	Cars in household	Percentage with			
			Garage	Other off-street parking	Adequate street parking	Inadequate street or no parking
Flats	19	2+	22	35	24	20
		1	13	33	28	27
		None	3	17	39	41
		All	**9**	**25**	**33**	**33**
Terraced house	29	2+	33	32	15	19
		1	22	27	27	23
		None	10	21	42	27
		All	**22**	**27**	**28**	**23**
Semi-detached house	26	2+	56	35	5	4
		1	50	35	10	6
		None	29	30	26	16
		All	**49**	**34**	**10**	**7**
Detached house	17	2+	87	12	0	0
		1	85	13	1	1
		None	77	20	2	1
		All	**86**	**13**	**1**	**0**
Bungalow	9	2+	75	21	3	1
		1	63	24	9	4
		None	35	22	32	11
		All	**60**	**23**	**12**	**5**
Total	**100**	**2+**	**61**	**26**	**6**	**7**
		1	**40**	**28**	**17**	**14**
		None	**15**	**21**	**36**	**28**
		All	**41**	**26**	**18**	**15**

[21] Bates & Leibling. *Spaced Out – Perspectives on parking policy*. (2012) https://www.racfoundation.org/research/mobility/spaced-out-perspectives-on-parking

Discussion

A heatmap of the resulting dataset at MSOA level is shown in Figure 15 below.

Around GM and other urban areas, the share of cars and vans with access to off-street parking is significantly lower than the rest of the region. This is likely due to the higher population density, leading to a higher prevalence of terraced houses and flats than in more rural areas. These accommodation types are less likely to have access to off-street parking than more spacious detached or semi-detached houses, which are more prevalent in rural areas where space constraints are lower. According to these estimates, 86% of all cars and vans in the ENWL licence area have access to off-street parking.

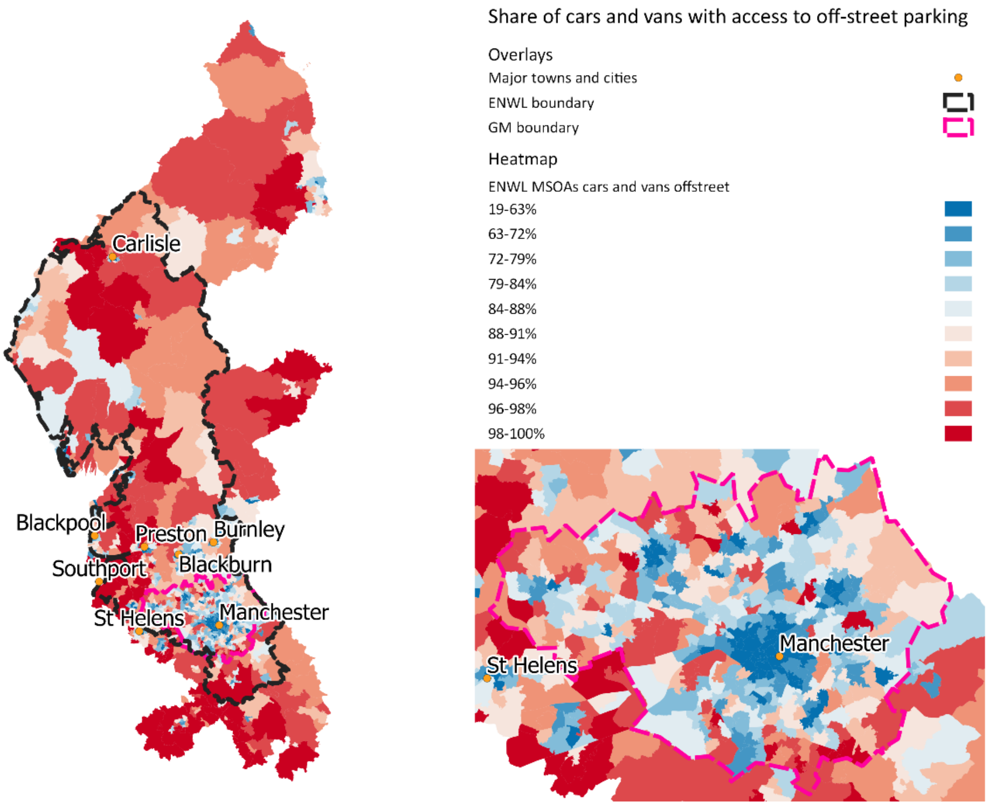


Figure 15. A heatmap showing the share of cars and vans with access to off-street parking at MSOA level for the ENWL licence area

4.2 Rural/urban classification

Sources used

The rural/urban classification of MSOAs is freely available from ONS.[22]

Cleaning / processing done

The lowest level of classification is at OA level – an OA is defined as urban if it is allocated to a settlement with a population of more than 10,000 residents, and rural if it is not. ONS classifies MSOAs based on the classification of the majority of their constituent OAs. The classification further distinguishes dispersed settlements and the proximity of rural areas to large settlements to form an 8-point scale. However, this study is only concerned with whether an area is urban or rural, so the 8-point scale has been converted to a 2-point scale (rural or urban).

Next release of source material

The next release of source data will occur after the 2021 Census has been completed, however this may be several years after 2021 due to the time required to collate and verify statistics. Depending on how large the change in rural/urban classification is, an update to the dataset may not be necessary when new source data are released.

How to update

When the next rural urban classification is released it should be available on the ONS Open Geography Portal.[23]

Discussion

The resulting classification for MSOAs in the ENWL licence area is shown in Figure 16. There is a large cluster of urban MSOAs corresponding to GM, however the northern part of the ENWL licence area is almost entirely rural. While over 80% of MSOAs are urban, by area most of the licence area is classified as rural.

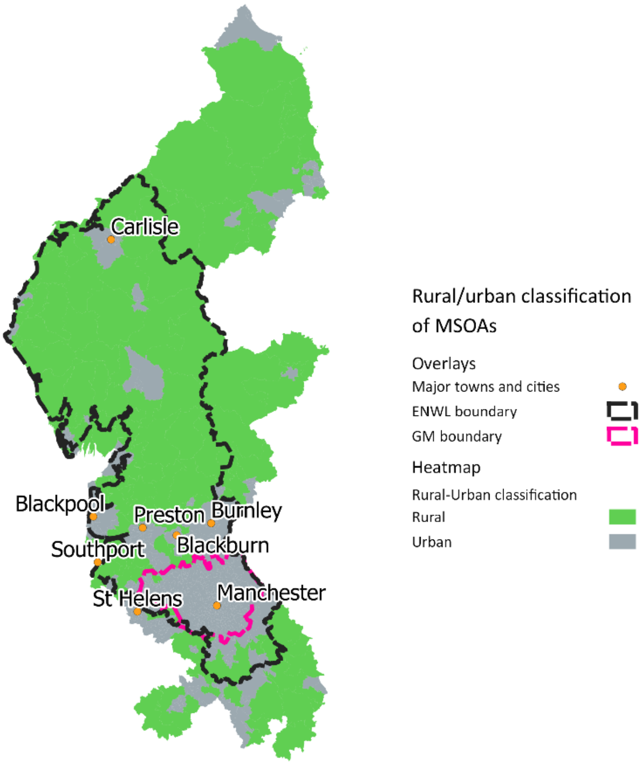


Figure 16. A map showing the 2-point rural/urban classification of MSOAs within the ENWL licence area

[22] ONS. *Rural Urban Classification (2011) of Middle Layer Super Output Areas in England and Wales*. (2018).
[23] http://geoportal.statistics.gov.uk/

4.3 Vehicles commuting to work

Sources used

The number of vehicles commuting to work and cars and vans registered in each MSOA are freely available from Nomis.[24,25]

Cleaning / processing done: None.

Next release of source material

The next release of source data will occur after the 2021 Census has been completed, however this may be several years after 2021 due to the time required to collate and verify statistics. Depending on how large the change in commuter share is, an update to the dataset may not be necessary when new source data is released.

How to update: Once released the source data will be available on Nomis.[26] The website allows for the dataset to be downloaded at different geographical resolutions – for this work, MSOA level data was used.

Discussion

A heatmap of the share of cars and vans used for commuting in each MSOA in shown in Figure 17 below. The share of commuters is highest in and around GM, where 45-65% of cars and vans are used for commuting. In other regions the share of cars and vans used for commuting mostly falls between 25 and 45%. Across the licence area 53% of cars and vans are used for commuting. Note that this dataset only considers vehicles registered within the ENWL region that are used for commuting, not those registered outside that commute into the region for work.

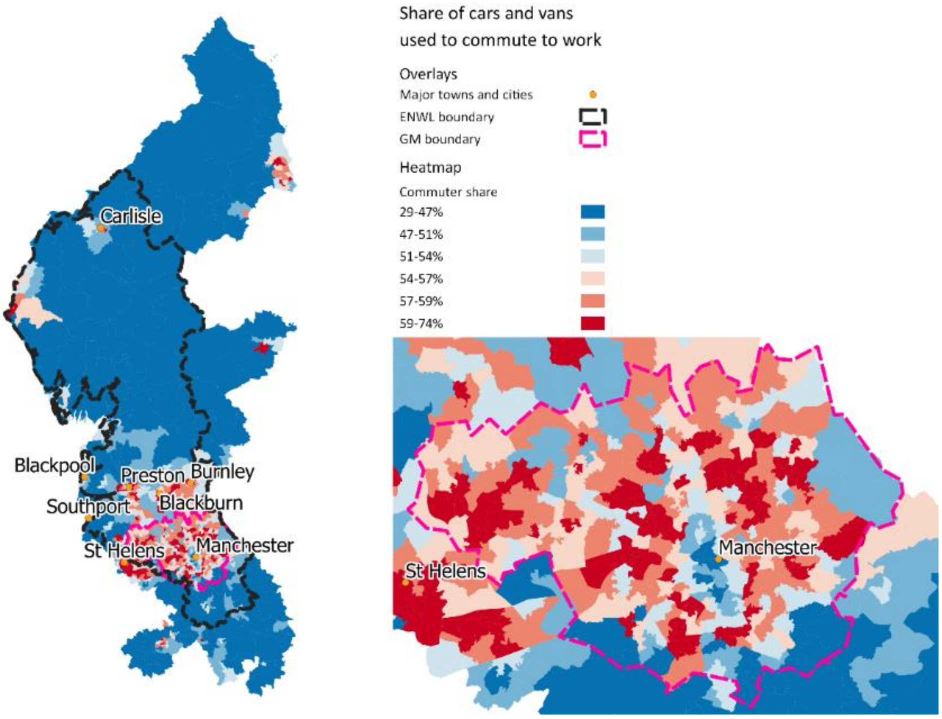


Figure 17. A heatmap of share of cars and vans used to commute to work at MSOA level for the ENWL licence area

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[24] Nomis. *WU03EW: Location of usual residence and place of work by method of travel to work (MSOA level)*. (2014).
[25] Nomis. *KS404UK: Car or van availability (MSOA level)*. (2014).
[26] https://www.nomisweb.co.uk/

5 Data to characterise public and work charging

These datasets are used to determine where and when non-domestic EV charging will occur:

- Section 5.1 details the locations of several types of points of interest (POIs) where charging infrastructure is likely to be installed.
- Section 5.2 describes the state of the current EVCP network in the ENWL licence area.
- Section 5.3 presents travel patterns of drivers as common destinations are likely to attract a high level of EV charging demand.

5.1 POI data

Sources used

Data were obtained by querying the OpenStreetMap Overpass Turbo application programming interface (API).[27] Data on car parks were also requested from LAs in the ENWL licence area to validate data gathered from OpenStreetMap.

Cleaning / processing done

The coordinates, names and postcodes (where available) were obtained for hotels, supermarkets, petrol stations, and service stations in the UK. The resulting lists were cleaned to remove sites with the same coordinates.

Next release of source material

The underlying dataset is updated on an ongoing basis, however updating annually should be sufficient for this dataset to remain relevant.

How to update

POI data can be updated by using the Overpass Turbo API.[28] This process is demonstrated in Figure 18. The following query will output all POIs of the requested type in the UK:

```
[out:csv(name, ::"lat", ::"lon", "addr:postcode")];
{{geocodeArea:United Kingdom}}->.searchArea;(
  node["tourism"="hotel"](area.searchArea);
  way["tourism"="hotel"](area.searchArea);
  relation["tourism"="hotel"](area.searchArea);
);
out center;
```

After copying the above into the code editor on the Overpass Turbo website, press the 'Run' button. After about a minute, the query will finish running and the output from the 'Data' tab can be copied into an Excel file. These data can be loaded into a geographic information system (GIS) and trimmed to leave only POIs within the ENWL licence area.

To obtain data on other POIs, the **["tourism"="hotel"]** portion of the query must be edited. Table 8 below gives the text that replaces **["tourism"="hotel"]** for other POIs.

[27] OpenStreetMap overpass turbo API. (2019).
[28] https://overpass-turbo.eu/

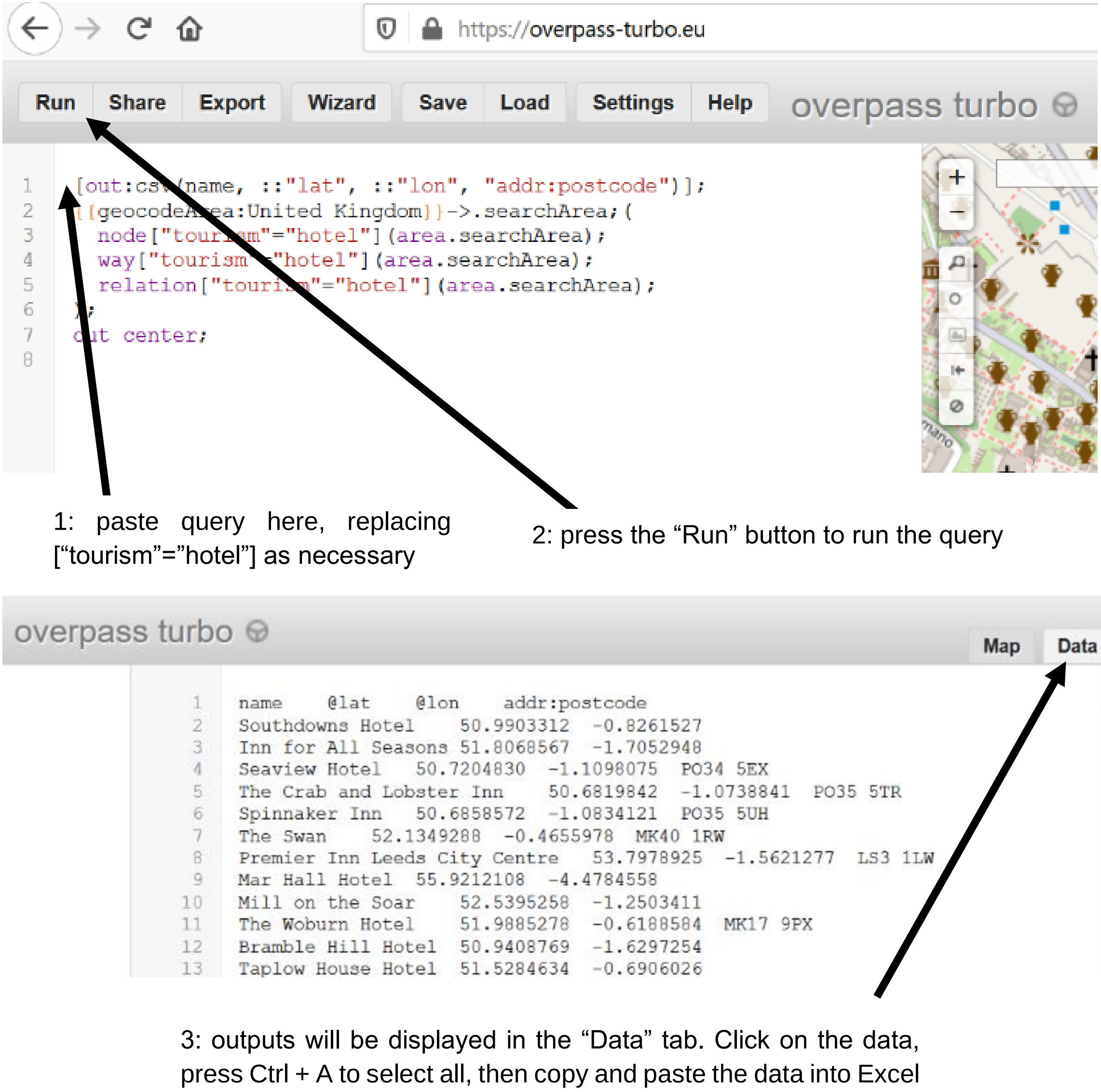

Figure 18. A diagram demonstrating how to query the Overpass Turbo API.

Table 8. Text which replaces ["tourism"="hotel"] in the Overpass Turbo query to gather data on other POIs

POI to gather data for	Replace ["tourism"="hotel"] with…
Fuel stations	["amenity"="fuel"]
Hotels	["tourism"="hotel"]
Car parks	["amenity"="parking"]
Service stations	["highway"="services"]
Supermarkets	["shop"="supermarket"]

Discussion

A map denoting the locations of POIs (excluding car parks) is shown in Figure 19 below. These sites represent future opportunities for EV infrastructure development. Supermarkets and hotels may offer short-term day or overnight EV charging respectively, while fuel and service stations may offer en-route charging. The motorway network in the licence area has also been plotted as sites close to motorways would be particularly suited to en-route charging.

Car parks have been considered separately as Transport for Greater Manchester (TfGM) have expressed an interest in installing electric vehicle charging points (EVCPs) at car parks, so they are sites where EVCP installation is particularly likely to occur. Data has been obtained directly from all LAs in GM, as well as six LAs outside of GM (Chorley, Copeland, Fylde, Lancaster, Pendle, Wyre). Table 9 compares the number of car parks listed on OpenStreetMap and LA data sources for LAs where data was provided. For LAs in GM, OpenStreetMap significantly underreports the number of car parks, while there is a better match with data for LAs outside of GM. The data obtained from GM LAs is also of a consistently high quality, giving the address and number of spaces of car parks, while data for other LAs is of a more variable quality. Therefore, data for car parks in GM have been sourced from LA data, while data for the rest of the region has been sourced from OpenStreetMap. Figure 20 shows the car parking sites identified.

Table 9. Comparison of number of car parks listed on OpenStreetMap and council data for selected LAs in ENWL licence area

LA name	Number of car parks - OpenStreetMap	Number of car parks - LA data
Bolton	26	91
Bury	5	76
Chorley	120	15
Copeland	55	29
Fylde	10	16
Lancaster	32	40
Manchester	47	127
Oldham	15	106
Pendle	7	49
Rochdale	15	52
Salford	17	80
Stockport	40	142
Tameside	14	40
Trafford	20	68
Wigan	33	124
Wyre	8	9+

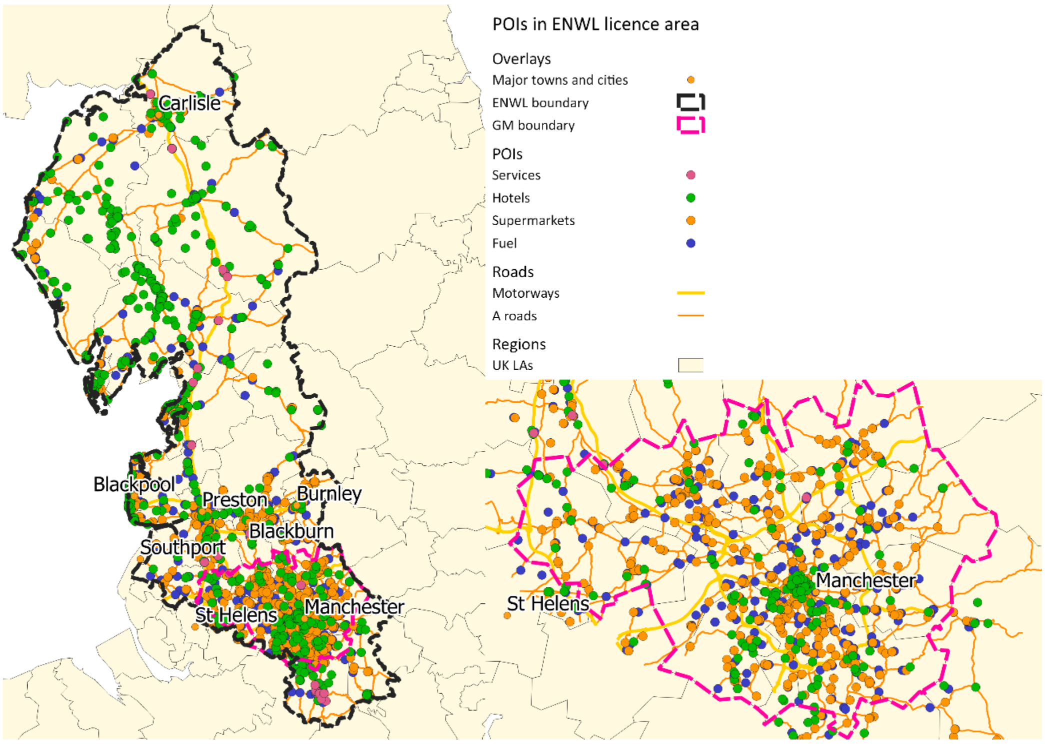

Figure 19. A map showing Points of Interest in the ENWL licence area

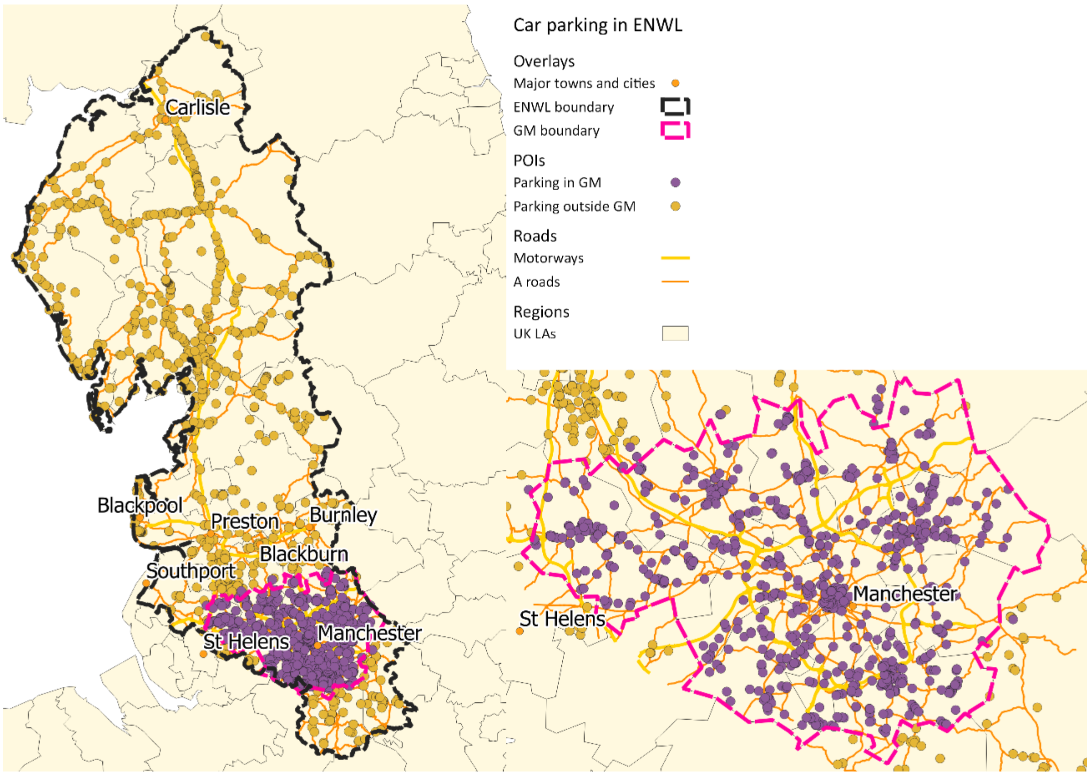

Figure 20. A map showing car parks in the ENWL licence area

5.2 Existing EVCP infrastructure

Sources used

A list of all charge points within 100 miles of Lancaster and corresponding data for each was obtained by querying the OpenChargeMap API.[29] The query was centred on Lancaster as this is roughly in the middle of the ENWL licence area so ensured that all charge points in the licence area would fall within the 100-mile range.

While other sources, most notably Zap Map, collect EVCP data, these are not open data sources and require a licence agreement to be used, whereas OpenChargeMap data is open source and free to use. While Zap Map is a more complete data source, OpenChargeMap should give sufficient detail to be of use in the project. Data requests to LAs have been made to validate data collected from OpenChargeMap, and complete data on EVCPs and charging data on the Greater Manchester Electric Vehicle (GMEV) network was also obtained from TfGM. Where available, these data are in agreement with the data gathered from OpenChargeMap.

Cleaning / processing done

The initial list produced was trimmed so that points outside the ENWL licence area were excluded. The connector type at each point was used to assume the power of the charging point, as OpenChargeMap does not have data for the power of all charging points. Power outputs were assumed based on the following connector types:

- Non-rapid AC (3-22 kW): Type 2
- Rapid DC (50+ kW): Tesla, CCS, CHAdeMO

Charge points with other connector type have been assumed to have an unknown power output. Random checks against GMEV and Zap Map data show that assumed power outputs are broadly in line with these data sources.

Next release of source material

OpenChargeMap is updated continuously, and it is recommended that this dataset is updated at least annually, as large changes in EVCP infrastructure are expected as EVs become more prominent.

How to update

Copying the following link into a web browser will download a csv file containing all charge points listed on OpenChargeMap within 100 miles of a point at the centre of the ENWL licence area:

https://api.openchargemap.io/v3/poi/?output=csv&latitude=53.983187&longitude=-2.780526&distance=100&maxresults=10000

This data can be loaded into GIS and trimmed to leave only charge points within the ENWL licence area.

Discussion

A map showing the location and assumed power of each EVCP is shown in Figure 21 below. Figure 22 shows the number of charge points within the ENWL licence area for each LA.

Approximately two thirds of points have been assumed to be non-rapid AC points (3-22 kW), and approximately one third have been assumed to be rapid (50+ kW). The power output assumptions have been based on connector type as outlined above. The density of charge points is significantly higher in GM than the rest of the region, and many lie close to motorways so are likely to be used for en-route charging.

[29] OpenChargeMap API. https://openchargemap.org/site/develop/api (2019).

Almost two thirds of LAs have less than 10 public charge points within the ENWL licence area. Manchester and Salford have the most charging points in the licence area, with 46 and 41 respectively. There is an average of 11 charge points in each LA. Only charge points in the ENWL licence area have been considered, as charging demand from points outside the licence area is not relevant to this study, so for LAs that lie mostly outside the licence area, only a small proportion of their charge points have been counted.

Data obtained from LAs on EVCPs were of a lower quality than data obtained on car parks. The data gathered for GM only covered the GMEV network, which represents a small proportion of EVCPs in GM. The EVCP data from OpenChargeMap listed more points as it also included those not on the GMEV network, however the power of these points had to be assumed from the connector type.

It should be noted that the usage rate of the EVCPs is low and quite inhomogeneous (< 5 charging events per week on average). See Appendix III for the analysis conducted on the GMEV network.

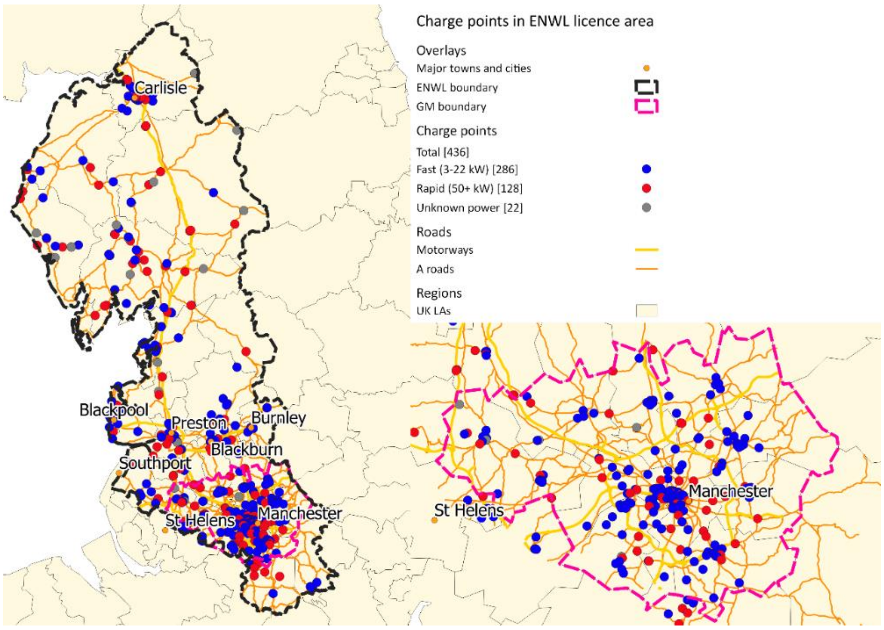

Figure 21. Location and assumed power of charge points within the ENWL licence area

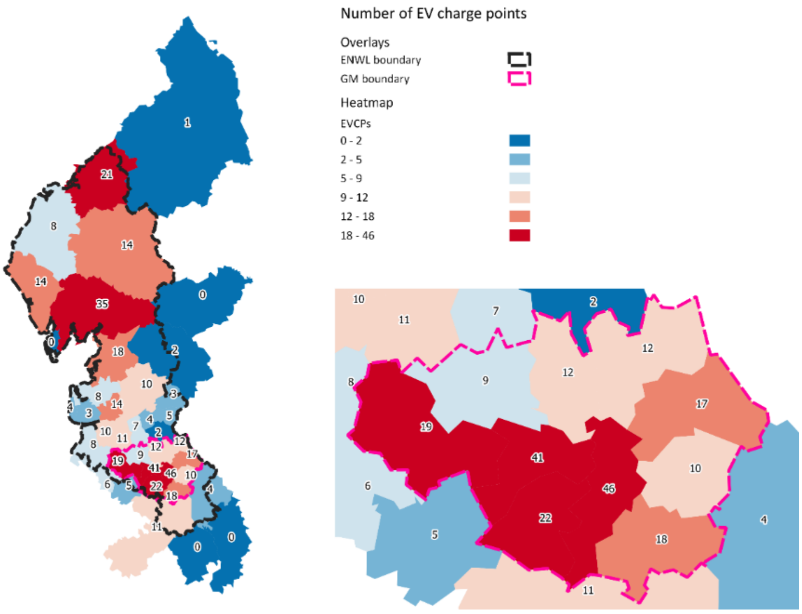

Figure 22. Number of public EV charging points within the ENWL licence area for each LA

5.3 Travel patterns

Sources used

DfT's Trip End Model Presentation Program (TEMPro) was used to determine the share of trips to work and shops ending at MSOAs within the ENWL licence area.[30]

Cleaning / processing done: None

Next release of source material

TEMPro is updated on an ongoing basis, however the program uses Census data as an input for calculations. It is therefore unlikely that any significant changes in trip share predictions will occur until the 2021 Census data is available. As EV infrastructure and usage data will be more widely available by this point, trip end data may no longer be needed as a proxy for EV charging demand, so it is not recommended that this dataset is updated.

How to update: Updates to TEMPro and underlying datasets are hosted by DfT.[30] The documentation included with TEMPro explains how to run the program and produce trip datasets.

Discussion

The share of personal car trips to work and shops ending in each MSOA in the ENWL licence area are shown respectively in Figure 23 and Figure 24 below. It can be seen that many areas with a high number of work and shop trip ends are in and around GM; the MSOAs responsible for the greatest share of work trip ends contain amenities such as the Trafford Centre, Manchester Fort Shopping Park, and Manchester Airport. The MSOA containing the Trafford Centre is also responsible for the greatest share of shopping trip ends of any MSOA in the licence area.

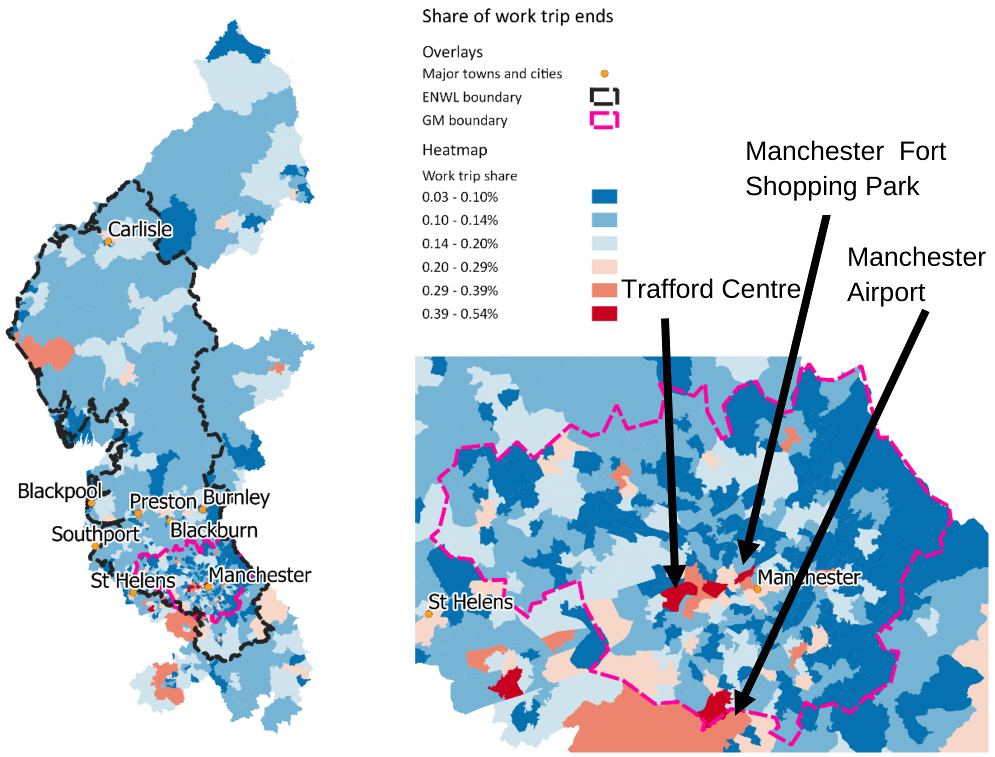

Figure 23. Share of all personal car trips to work in the ENWL licence area ending in each MSOA (the % shares for all MSOAs on the map add up to 100%)

[30] https://www.gov.uk/government/publications/tempro-downloads

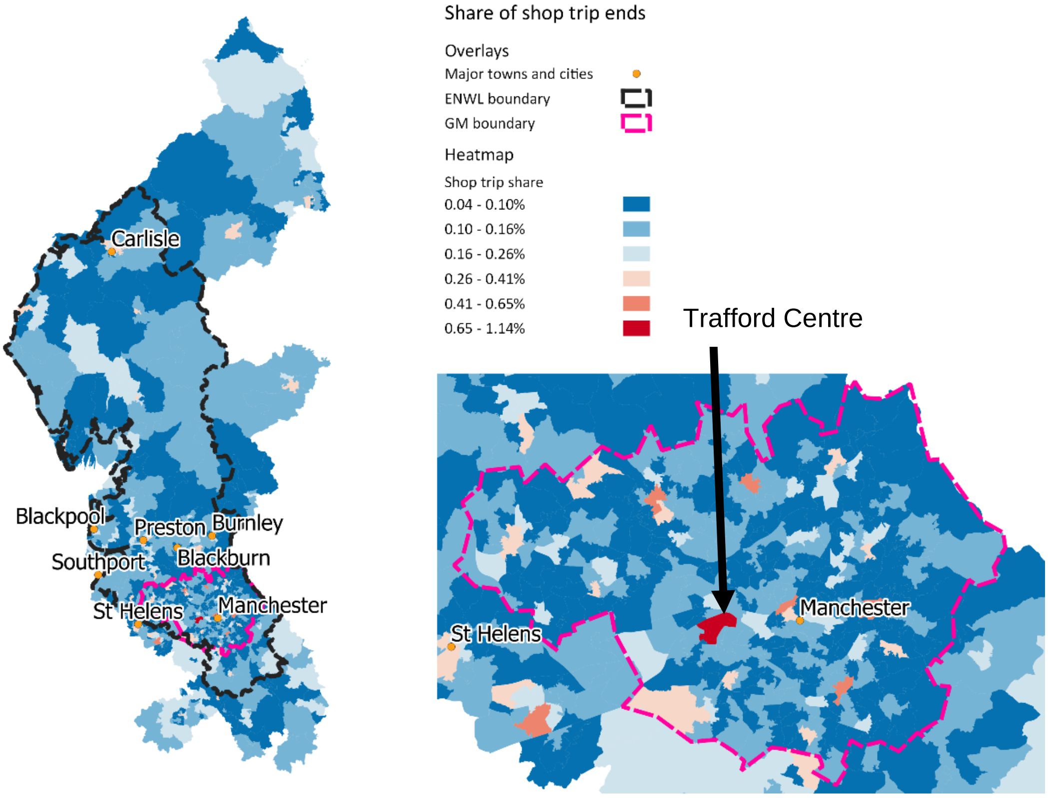

Figure 24. Share of all personal car trips to shops in the ENWL licence area ending in each MSOA (the % shares for all MSOAs on the map add up to 100%)

6 Conclusions and next steps

Datasets have been produced on the current car, van, and EV stock, and the characteristics of vehicle owners and charging locations. For each of these datasets, details on the source material used, processing steps, and next release of source data, and how to update, have been described – these details are summarised in Table 10 below. Table 11 describes how to update these datasets, where to obtain source data from, and when the next update is recommended.

Table 10. Summary of the datasets produced for use in Reflect

Dataset produced	Sources used	Cleaning / processing done	Next release of source material
Car and van ownership / current EV uptake	MSOA level data: DfT special data request LA level data: DfT vehicle licensing statistics	MSOA data estimated where values have been suppressed to avoid identifying individuals Company vehicle / EV stock cleaned where values were anomalously high	MSOA level data: by DfT request only LA level data: updated annually
Off-street parking access	Nomis and ONS data	EE off-street parking model used to calculate access at OA level, aggregated up to LSOA, MSOA, and LA levels	Based on 2011 Census data – next Census is in 2021, however may take several years for relevant stats to be published
Rural/urban classification	ONS data	8 – point scale has been translated into 2 – point scale (rural or urban)	When 2021 Census data are released
Vehicles commuting to work	Nomis data	None	When 2021 Census data are released
POI data (hotels, supermarkets, petrol stations, and service stations)	OpenStreetMap, complemented by data received from LAs	Duplicate entries removed	Map is maintained on an ongoing basis
Existing EVCP infrastructure	OpenChargeMap, complemented by data received from LAs and TfGM	Assumptions made about charging point power based on connector type	Data source is maintained on an ongoing basis
Travel patterns (share of personal car work and shop trip ends)	TEMPro	TEMPro software used	When 2021 Census data are released

Only freely available data have been used, in two broad categories:

- **Open source data**. In the case of car parks and the current EVCP network, we are aware this comes at a loss of accuracy. However, we also reached out to the LAs in the region and obtained further data to validate those collected from open data sources.
- **Official government statistics** (DfT license data, census/ONS data, including Nomis) or **DfT's model** (TEMPro). A special request was made to DfT to obtain the geographically disaggregated car and van data (total number as well as EV numbers, at MSOA level). All other DfT data and census/ONS data obtained are publicly available online.

Table 11. Information on how to update datasets

Dataset	When to next update	Source data	How to update
Car and van ownership / current EV uptake	March 2021	LA data: VEH0105, VEH0130, VEH0131 tables can all be found here MSOA data: request must be sent to vehicles.stats@dft.gov.uk	Copy data into cleaning spreadsheet
Off-street parking access	When 2021 Census data becomes available	CT0876 – accommodation type (excluding caravans or other mobile or temporary structures) by car or van availability KS404UK – car or van availability Note that web addresses may be different for 2021 Census data	Apply assumptions provided in Section 4.3 or make a request for update to Element Energy
Rural / urban classification	When 2021 Census data becomes available	Available from ONS website http://geoportal.statistics.gov.uk/	Download data and convert from 8- to 2-point scale
Vehicles commuting to work	When 2021 Census data becomes available	Available from Nomis https://www.nomisweb.co.uk/	Download data at MSOA level
POI data	March 2021	Query Overpass Turbo API as described in 5.1	Trim data to ENWL region in GIS
EVCP infrastructure	March 2021	Run this query on OpenChargeMap API	Trim data to ENWL region in GIS
Travel patterns	When 2021 Census data becomes available / TEMPro is updated with this data	TEMPro is available here	Check TEMPro documentation as this may change in the next version

Projections on future car and van stock, distance travelled, and EV uptake, have also been produced. Table 12 below summarises the sources used and approach taken for each of these projections, and Table 13 outlines the assumptions behind the EV uptake scenarios produced.

The key outputs of the modelling work are:

- EV uptake forecasts at MSOA level for various scenarios – shown in a heatmap for the 'High' scenario in 2038 in Figure 25.
- Total number of EVs in the region – shown for 2038 in Figure 26 for the range of scenarios that will be taken forward in the next steps of Reflect.

Table 12. Summary of sources and approach taken for projections produced

Projection produced	Sources used / approach taken
EV uptake projections	ECCo model, adjusting input parameters to match different levels of policy ambition
Car and van stock and VKT projections	DfT road traffic forecasts; EE's own assumptions
Regional level EV uptake projections	When following national trends, the current regional lag in EV uptake is preserved in the short term but assumed to disappear once 16% national EV uptake is achieved, which occurs between 2025 and 2030. The distribution of EVs among MSOAs is based on the current distribution of EVs across MSOAs in the short term, with EV distribution tending towards distribution of total stock across MSOAs over time

Table 13. Assumptions behind the EV uptake projections produced

<table>
<tr><th>Scenario name</th><th>ECCo policy assumptions used</th><th>Stock projections used</th></tr>
<tr><td>Maximum BEV Uptake</td><td>ICE, HEV, and PHEV sales are banned in 2030. This exceeds the Committee on Climate Change's (CCC's) most ambitious recommendations and provides a very rapid uptake of BEVs</td><td rowspan="4">Modified DfT 'Base' scenario:
• 22% increase in car stock from 2019 value by 2040, held constant after 2040
• 46% increase in van stock from 2019 value by 2040, held constant after 2040
• 2020 stock assumed same as 2019</td></tr>
<tr><td>Very High</td><td>Driven by new ICE/HEV sales ban in 2030, with PHEVs removed from sale in 2035. This reflects the CCC's more ambitious recommendations</td></tr>
<tr><td>High</td><td>Policies to achieve 70% ultra-low emissions vehicle (ULEV) sales in 2030 (upper bound of Road to Zero[31] ambition) and 2035 ban on new ICE/HEV sales (consistent with CCC's "at the latest" recommendation)</td></tr>
<tr><td>Medium</td><td>Policies to achieve 50% ULEV sales in 2030 (lower bound of Road to Zero ambition) and 2040 ban on new ICE/HEV sales</td></tr>
<tr><td>Reduced Travel Demand</td><td>Same EV policy assumptions as for 'Maximum BEV Uptake', however reduced stock uptake and VKT are assumed as this scenario considers reduced travel demand corresponding to very low emissions.</td><td>Regional emissions reduction scenario:
• 10% decrease in car stock from 2019 value by 2038, 35% decrease from 2019 value by 2050
• 10% increase in van stock from 2019 value by 2038, held constant after 2038</td></tr>
</table>

[31] https://www.gov.uk/government/publications/reducing-emissions-from-road-transport-road-to-zero-strategy

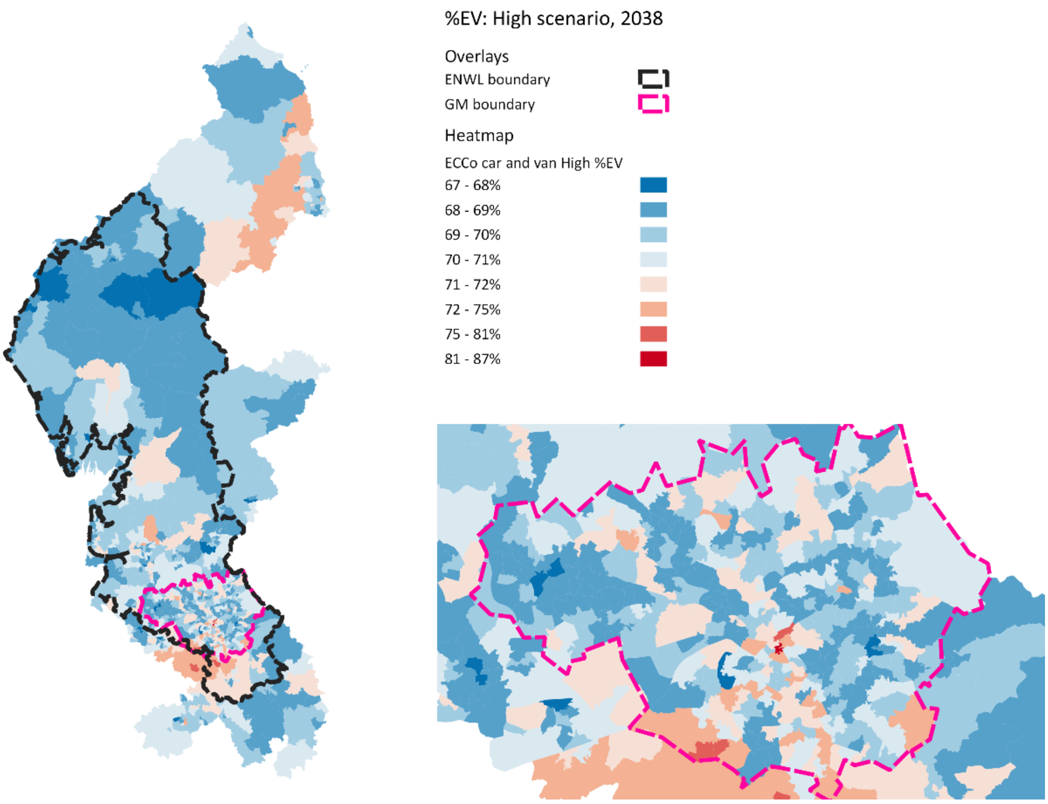

Figure 25. Share of the car and van stock in each MSOA that are EVs for the 'High' scenario in 2038

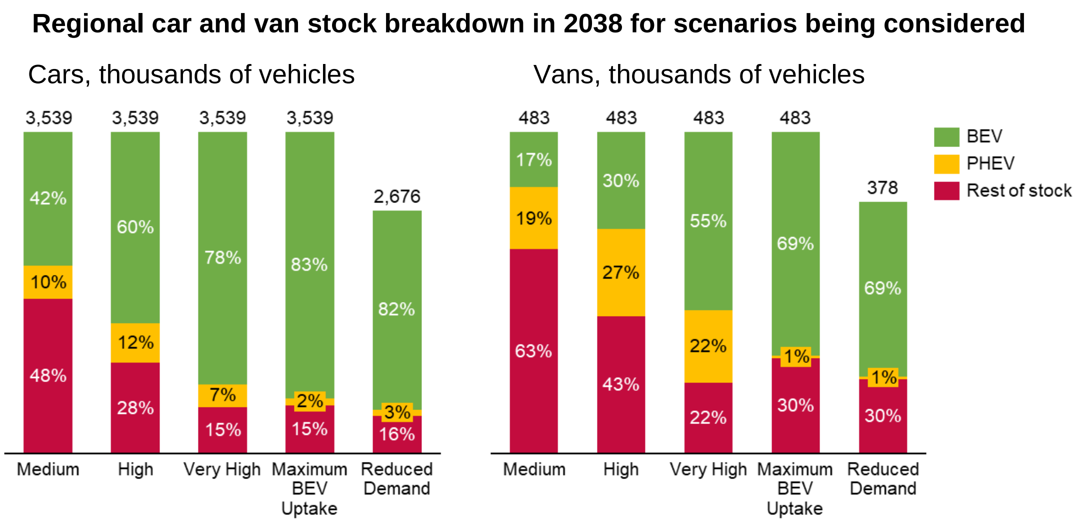

Figure 26. Breakdown of regional car and van stock in 2038 across the five scenarios being considered

These datasets and projections will be used in the next phase of the project, to forecast how the level of EV charging demand is expected to increase in the ENWL licence area, as well as the expected location and duration of charging events. Modelled charging demand will be then distributed to network assets to support ENWL's understanding of where and when constraints are likely to occur on the network, and where reinforcement or other interventions could be needed.

Appendix I Local Authority policy research

Research into LA policies has been undertaken to provide an insight into how the regional car and van stock and distance travelled are expected to change across the ENWL region. Many LAs have set ambitious net zero target dates, however these cannot be achieved by encouraging EV adoption alone – modal shift and demand reduction are required to reduce the number of trips performed by ICEs before they are phased out of the vehicle stock, and this must occur across the whole region as transport emissions in each LA will be in part due to trips from vehicles originating in other LAs.

In order to accurately cover the relevant policy context and allow comparison between LAs, 3 factors have been considered: climate emergency declarations and associated net zero target dates; air quality management areas; and any other policies or funding relevant to EV uptake. The sources used and insights gathered for each of these factors are discussed in Appendix I.i - Appendix I.iii respectively.

As these data have only been collected to inform regional car and van stock and distance travelled projections, they will not feed directly into the Reflect Python tool. Therefore, it is not necessary to update these data.

Appendix I.i Climate emergency declarations and net zero targets

This data was considered relevant as declaring a climate emergency suggests councillors are aware of the changes required to prevent climate change and will encourage EV adoption, as well as modal shift and demand reduction, as part of this shift.

Sources used

Data was obtained in December 2019 from climateemergency.uk and local council websites to determine whether a climate emergency had been declared, and if so, the agreed target date for net zero.[32]

Discussion

The resulting data is displayed in a heatmap in Figure 27. The majority of LAs have set a target date of 2030 for net zero. 32 out of 39 have declared a climate emergency, and 10 have not set a date for net zero or not declared a climate emergency.

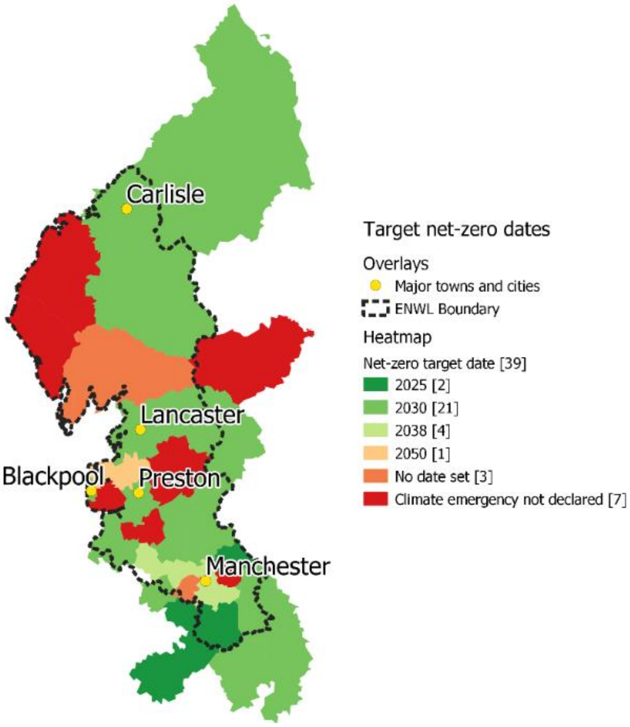

Figure 27. Climate emergency declarations and net zero target dates for LAs in the ENWL licence area

[32] https://www.climateemergency.uk/blog/list-of-councils/

Appendix I.ii Air quality management areas

LAs are required to monitor the level of several pollutants in the air. Pollutants that are linked to road traffic include particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen oxides (NO_x). These are detrimental to human health and in areas where set limits are exceeded, an air quality management area (AQMA) must be declared, along with an air quality action plan (AQAP) setting out how air quality will be improved.[33]

Sources used

Data has been obtained from the Department for Energy, Food, and Rural Affairs (DEFRA) on the number of active AQMAs in each LA.[34]

Discussion

A heatmap showing number of active AQMAs in each LA as of 2020 Q1 is displayed in Figure 28. Just over a third of LAs do not currently have any active AQMAs. The Greater Manchester Combined Authority (GMCA) has a single AQMA which is spread among the constituent LAs, which have all been denoted as having one AQMA.

AQMAs are declared where pollutant levels are exceeded, or retired where targets have been met. With the vehicle stock turnover increasing the share of Euro 6/VI vehicles, the number of active AQMAs is expected to decrease regardless of EV adoption. Therefore, the number of active AQMAs is not expected to directly correlate with policy ambition for EV adoption or modal shift / demand reduction.

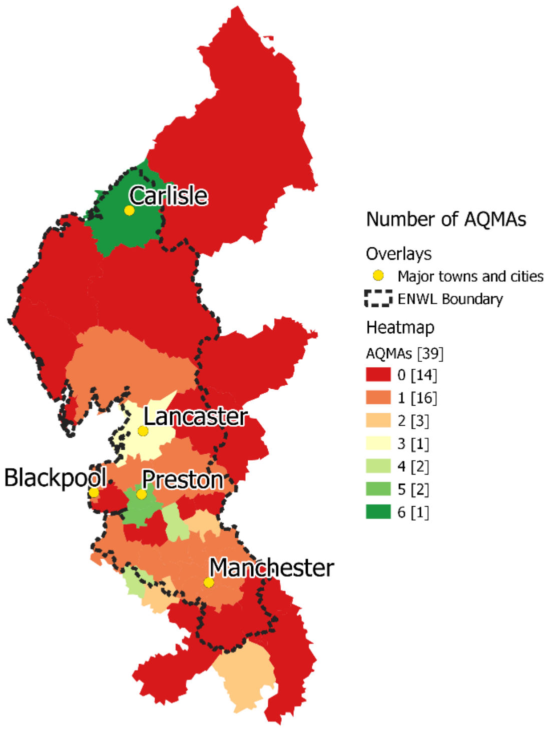

Figure 28. A heatmap of number of active AQMAs in each LA in the ENWL licence area

[33] DEFRA. Air Quality Management Areas. https://uk-air.defra.gov.uk/aqma/ (2019).
[34] https://uk-air.defra.gov.uk/aqma/maps/

Appendix I.iii Other relevant policies and funding

Sources used

Policies that incentivise EV adoption, modal shift, or demand reduction, have been researched on local council websites. This was done in as consistent a manner as possible by using a list of search terms (electric vehicles, air quality, sustainability) across all websites. This was complemented by discussions with stakeholders such as Transport for the North (TfN) and Transport for Greater Manchester (TfGM).

Discussion

In order to allow comparison, LAs have been given a policy score between 0 and 2:

- 0: no directly relevant policies;
- 1: limited relevant policy implementation;
- 2: some relevant and potentially effective policies are in place.

For this study, emissions and energy targets have been classed as low impact policies, while more direct actions such as grants or funding commitments towards EVs and supporting infrastructure for EVs, public transport, or walking and cycling are seen as more likely to result in an increase in EV uptake, or lead to modal shift or demand reduction.

A heatmap of policy scores in the ENWL licence area is shown in Figure 29 below.

Almost a third of LAs were not found to have any policies in place that would have a direct impact on EV uptake or lead to modal shift or demand reduction. Only LAs in GM have been identified as introducing policies most likely to boost EV adoption or reduce private vehicle demand, due to funding commitments towards sustainable development from GMCA.

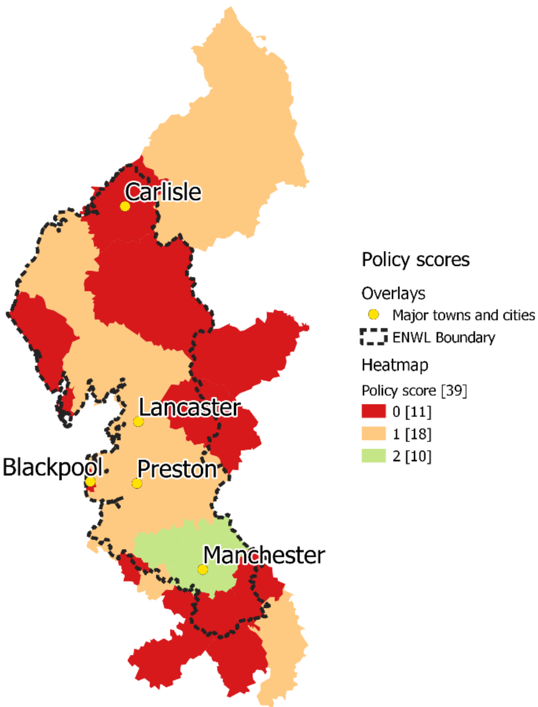

Figure 29. A heatmap of policy scores for LAs across the ENWL licence area

Appendix II Introduction to ECCo

Element Energy's light duty vehicle uptake projections are generated using our bespoke Electric Car Consumer Model (ECCo). This model captures consumer behaviour and calculates the market share of various powertrains to 2050 for given policy and infrastructure landscapes. This covers both conventional petrol and diesel vehicles, as well as full and plug-in hybrids, and range-extended, battery and fuel cell electric vehicles, across all car and van size classes. Figure 30 demonstrates the inputs required for ECCo and outputs that the model calculates from these inputs.

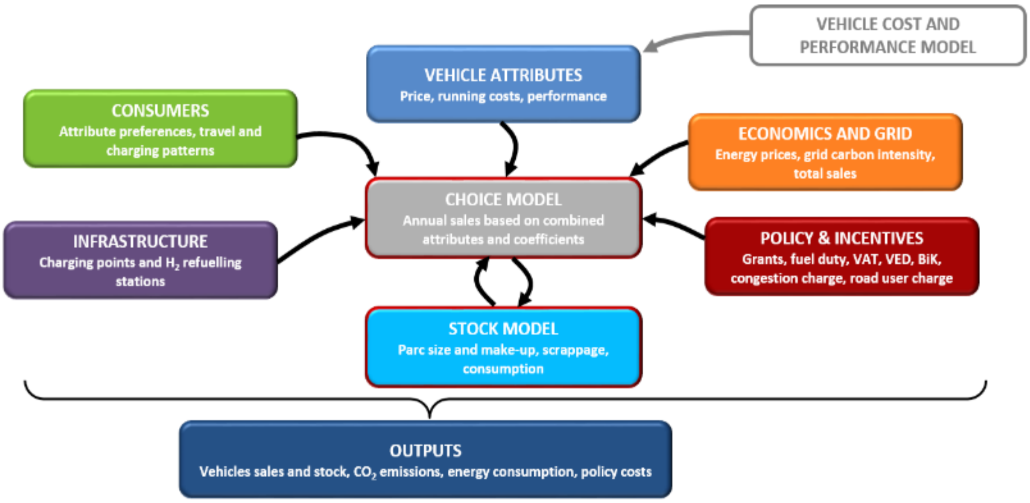

Figure 30. Schematic diagram showing inputs and outputs for ECCo

Primary research on 2,000 new car buyers was conducted to identify how UK car buyers are influenced by capital and running costs. This research has been used to define model parameters relating to consumer behaviour. Future vehicle attributes are calculated by Element Energy's Car and Van Cost and Performance Model and this allows for a range of technology deployment scenarios to be considered.

ECCo is continuously updated to ensure it reflects the rapid changes occurring in the ultra-low emissions vehicle market, including new vehicle models, policy amendments, and technology trends. It supports the work of multiple clients, for example:

- The UK Department for Transport, to aid in light-duty vehicle policy design.
- Energy Technology Institute's Consumers, Vehicles and Energy Integration project, which simulates pathways to decarbonising the light duty vehicle sector from the perspective the UK's whole energy system.
- UK Power Networks, to forecast the number of plug-in vehicles charging across their licence areas.

The current policy inputs for the four ECCo scenarios used for Reflect are shown in Table 14 below. More information on ECCo can be found on Element Energy's website.[35]

[35] http://www.element-energy.co.uk/sectors/low-carbon-transport/project-case-studies/#project_1

Table 14. Summary of policy inputs for the five ECCo scenarios used for Reflect

Scenario name	Description
Maximum BEV Uptake	ICE, HEV, and PHEV sales are banned in 2030. This exceeds the Committee on Climate Change's (CCC's) most ambitious recommendations and provides a very rapid uptake of BEVs
Very High	Driven by new ICE/HEV sales ban in 2030, with PHEVs removed from sale in 2035. This reflects the CCC's more ambitious recommendations
High	Policies to achieve 70% ultra-low emissions vehicle (ULEV) sales in 2030 (upper bound of Road to Zero[36] ambition) and 2035 ban on new ICE/HEV sales (consistent with CCC's "at the latest" recommendation)
Medium	Policies to achieve 50% ULEV sales in 2030 (lower bound of Road to Zero ambition) and 2040 ban on new ICE/HEV sales
Reduced Travel Demand	Same EV policy assumptions as for 'Maximum BEV Uptake', however reduced stock uptake and VKT are assumed based on reduced travel demand (lower transport emissions scenario)

[36] https://www.gov.uk/government/publications/reducing-emissions-from-road-transport-road-to-zero-strategy

Appendix III Analysis on the usage of the GMEV charging network

The data presented in Figure 31 approximates the utilisation of charge posts in Greater Manchester by analysing the number of separate charging events recorded each day by charge posts over a nine-month period in 2019 (January – September). Over this period 266 charge posts registered a charging event.

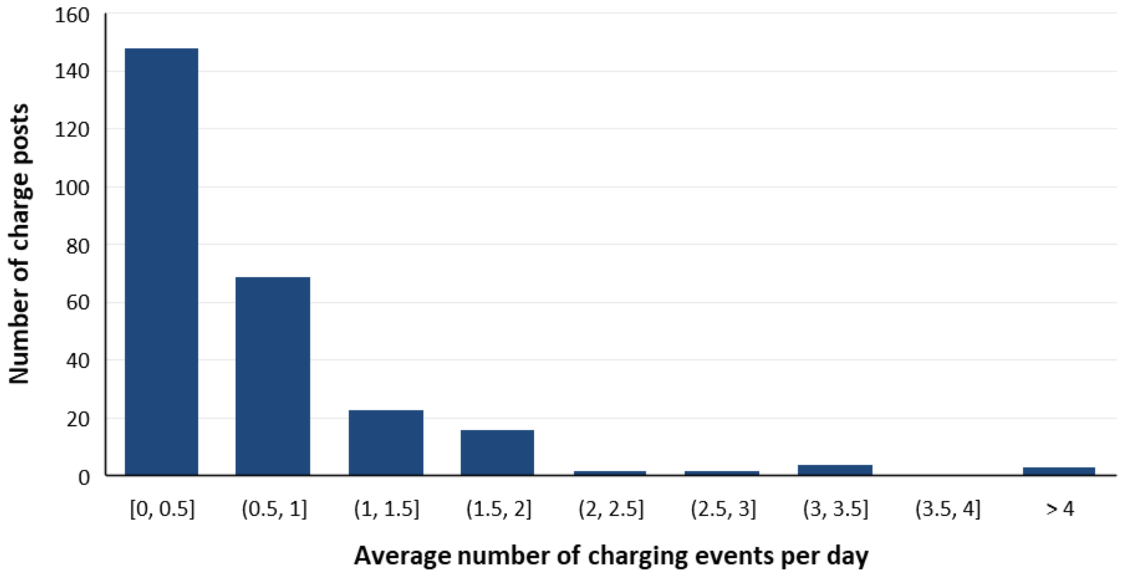

Figure 31. Number of charge posts in Greater Manchester by daily usage (number of charging events per day), Jan – Sept 2019.

Our analysis indicates that there is significant variation in the utilisation of public charge posts in Greater Manchester. 21% (57) of charging posts registering on average less than one charging event per week, with a similar number (50, 19%) registered more than one charging event each day on average. One charge post registered on average 11.8 separate charging events per day, representing a notable outlier. Across all charge posts, an average of 0.68 daily (ca. 5 per week) charging events were recorded by each charge post.

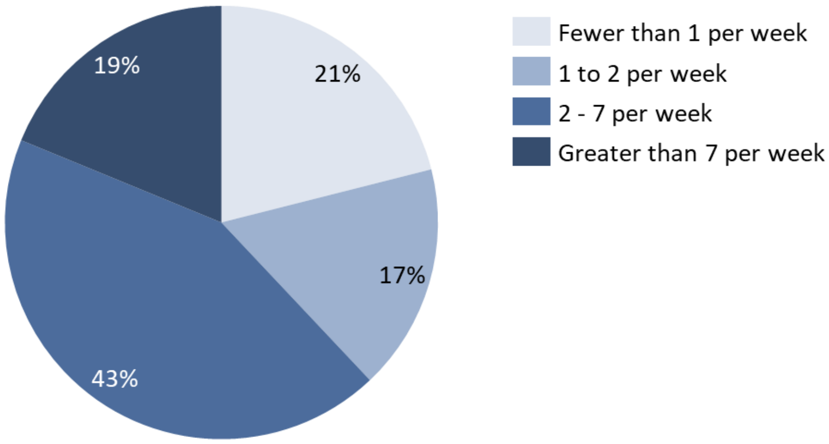

Figure 32. Split of public charge posts in Greater Manchester by average number of weekly charging events, Jan – Sept 2019