Electric Vehicle Charging Infrastructure Framework

A 'whole network; whole system' approach to electric vehicle charging across the North of England

October 2022

TRANSPORT FOR THE NORTH

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Chief Executive Foreword

The Transport for the North Board has identified that an acceleration towards a zero-carbon transport network must be at the heart of public policy making and investment decisions. The achievement of our vision of a thriving North of England, where world class transport supports sustainable economic growth, excellent quality of life and improved opportunities for all, requires a shift in the way we plan for, develop, and then implement transport solutions. Our Regional Decarbonisation Strategy sets out the urgency of the task and the need to reduce our greenhouse gas emissions across everything that we do.

We are committed to working with our partners – locally and nationally - to support the shift towards low carbon transport so as to reduce the impact of harmful emissions on our environment.

Emissions from road transport remain by far the largest transport emitter of carbon. And so whilst our road network will remain a key part of our transport system (providing access to homes, education, employment opportunities and services) there is a need for us to redefine how we use the available road space.

TfN's work shows that we will require a mix of technology, behavioural and place-based solutions. Low and zero emission transport technologies such as electric vehicles, as well as other alternatives including hydrogen fuel cell power, are a critical part of our mix of solutions to replace fossil fuel-powered vehicles and reduce greenhouse gas emissions and air pollution. Our business community across the North is already responding to this need ensuring that the North is at the forefront of harnessing the need for change to act as a catalyst for green growth.

Electric vehicle uptake is rapidly increasing stimulated by the leadership provided by national policy. The phasing out of new petrol and diesel cars and vans by 2030 has been confirmed and manufacturers have responded accordingly. EV demand accounted for more than one in four new car registrations in August 2022, and we are seeing global action to build new electric vehicles markets, and investment in battery technology and manufacturing processes, which have led to reductions in the costs of Zero Emission Vehicles. The next decade will need to see a rapid and consistent transition to EVs and ZEVs, and this uptake must be supported by investment in the enabling charging infrastructure.

Our whole network approach recognises that realising the potential of electric vehicles and delivering the charging infrastructure are issues that require an approach at a scale beyond individual local authority boundaries. Regional travel patterns require integrated considerations, and our partners have recognised the value of common interest, regional collaboration and alignment when seeking the right solutions for charging infrastructure. By working with our transport and energy partners, through our regional EV Steering Group, TfN has developed a framework of evidence that can not only speed up delivery across the region at this key time, but which will influence and shape processes and programmes at the national level.

While speed and acceleration in implementation is important, so too is the need to achieve the right result, recognising the needs of the users across the whole regional network. It is key that this delivery of charging infrastructure is user-centred, placed-based and outcome-focused to ensure EVs are equitable, accessible and inclusive to all who need to drive. Our approach also provides a means to make better assessments regarding the many social and spatial considerations associated with EV charging infrastructure, particularly those impacting the non-EV users.

We must also recognise the significant requirements placed on the electricity grid and energy networks arising from the electrification of road vehicles. There is a need for investment in new energy infrastructure, in terms of electricity generation, distribution, and storage (particularly for high load vehicles such as freight). That is why we have taken a systems approach to work collaboratively with the public sector, chargepoint operators (CPO), and the energy sector to plan effectively to unlock delivery and investment right across the region.

Our Electric Vehicle Charging Infrastructure Framework breaks new ground by applying our transport demand, land-use and socio-economic intelligence for the North, to understand EV charging needs. This takes advantage of our state of the art analytics to a develop rich data-driven understanding of need, at a previously unmapped geographic scale. Our evidence can help ensure the North's strategic needs are reflected in the planning, development and delivery of charging infrastructure.

That is why we are sharing this evidence openly, to boost the region's capacity and capability to plan and collaborate confidently towards accelerated implementation and delivery on the ground. And we will use it to shape our input into the National Infrastructure Commission's work to produce the next National Infrastructure Assessment.

The evidence is clear that we must act now, if we're to roll out the EV charging points needed to support our decarbonisation, economic, and inclusivity ambitions. The public sector must play an active role in shaping this, and TfN will continue to act as a strategic thought leader, to champion the opportunities and requirements for our region, and support our partners in implementing the right infrastructure needs in the right place, at the right time.

Martin Tugwell
Chief Executive

The North's major road network plays a vital role in underpinning economic activity, opening up access to jobs, goods and services and in enabling growth in new employment and housing, but the largest contributor to transport carbon emissions.

97%

of all personal journeys and 88% of freight movements in the North made using our highways

75%

of car emissions in the North are from journeys 10km - 50km+ long

70%

of road distance travelled in the North occurs on our major roads.

23%

of vehicle kms in the UK (cars, vans and HGVs)

6%

of total UK emissions; 23% of UK roads emissions

50%

of emissions generated by cars; 28% by HGV's; 11% from LGVs.

65% of car trips in the North are 10km or less (short journeys for everyday activities).

Significant potential to switch a proportion of these to less polluting travel modes such as walking, cycling or shared transport.

2022

2.7% of vehicle fleet are EV's in 2022.

2025

20% of vehicle fleet estimated to be EV's in 2025

2030

40% of vehicle fleet estimated to be EVs in 2030

33 Average chargepoints per 100,000 population in July 2022

1:20 Ratio of chargepoint to EV in the North

6,400
Total EV chargepoints

(3.8% of 2030 requirement)

>1,450
En-route public rapid charge points

(2.2% of 2030 requirement)

>4,950
Public non-rapid chargepoints

(4.7% of 2030 requirement)

Significant total charging requirement across the North of England during 2020s, increasing as time goes on if early 2020 deployment rate is not met

2025
39,000 - 54,000
Cost estimate 2020-2025: £335 - £675m

2030
123,500 - 161,200
Cost estimate 2025-2030: £930m - £1.3bn

41.4 tonnes CO2e saved per year per charging point in 2030

Each charging point in the ground is the equivalent of a hectare of woodland (13,000 trees).

En-route public rapid charging development by 2030

80 - 166 installations per week between 2022 - 2025

2025
12,000 - 26,000 chargepoints

128 - 235 installations per week between 2025 - 2030

2030
33,000 - 61,200 chargepoints

Non-rapid public charging requirement by 2030

176 - 307 installations per week between 2022 - 2025

2025
27,500 - 48,000 chargepoints

365 - 384 installations per week between 2025 - 2030

2030
985,000 - 1,000,000 chargepoints

7,312 GWh total additional electricity demand across the region's electricity grid by 2030

Equivalent of the yearly electricity consumption of 2,087,500 households

1. Introduction

Transport for the North (TfN) is a Sub-national Transport Body (STB) of elected leaders and a partnership of business leaders who collectively represent the region's fifteen million people. As a partnership, TfN brings 20 Local Transport Authorities and 11 Local Enterprise Partnerships together with Network Rail, National Highways, HS2 Ltd, and UK Government.

Through its statutory powers, TfN provides a single voice for the North of England to support the development and implementation of transport strategies across the region and help determine investment decisions, working with Government to enable Northern priorities to be included within national priorities. Operating within this strategic position, TfN and partners work collaboratively to identify the transport infrastructure and policy measures that are required to achieve the North's ambitions.

2. Aims and objectives

A key challenge for national Government, local authorities and the private sector is planning and delivering EV charging infrastructure with confidence. This needs to be based on the latest qualitative and quantitative evidence which considers the full range of influencing factors for EV charging, and encourages the right investment which delivers comprehensive EV charging solutions across the region.

With its regional perspective, partnerships, and modelling capabilities, TfN is ideally positioned to develop an enhanced evidence base that considers the users' needs and movements across the region's road network.

Our framework has been developed to support local authority and national government partners in the planning and deployment of local EV charging infrastructure, to underpin any public sector funding, as well as to inform and enhance any delivery through partnership with the private sector.

Acting as a centre of excellence to deliver an Effective; Integrated and Inclusive charging network.

- User centred
- Data driven
- State of the art evidence
- Systems approach to infrastructure delivery
- Collective spatial and temporal routemap
- Managing uncertainty
- Public/Private partnerships
- Place based outcomes

TfN's regional EV Steering Group

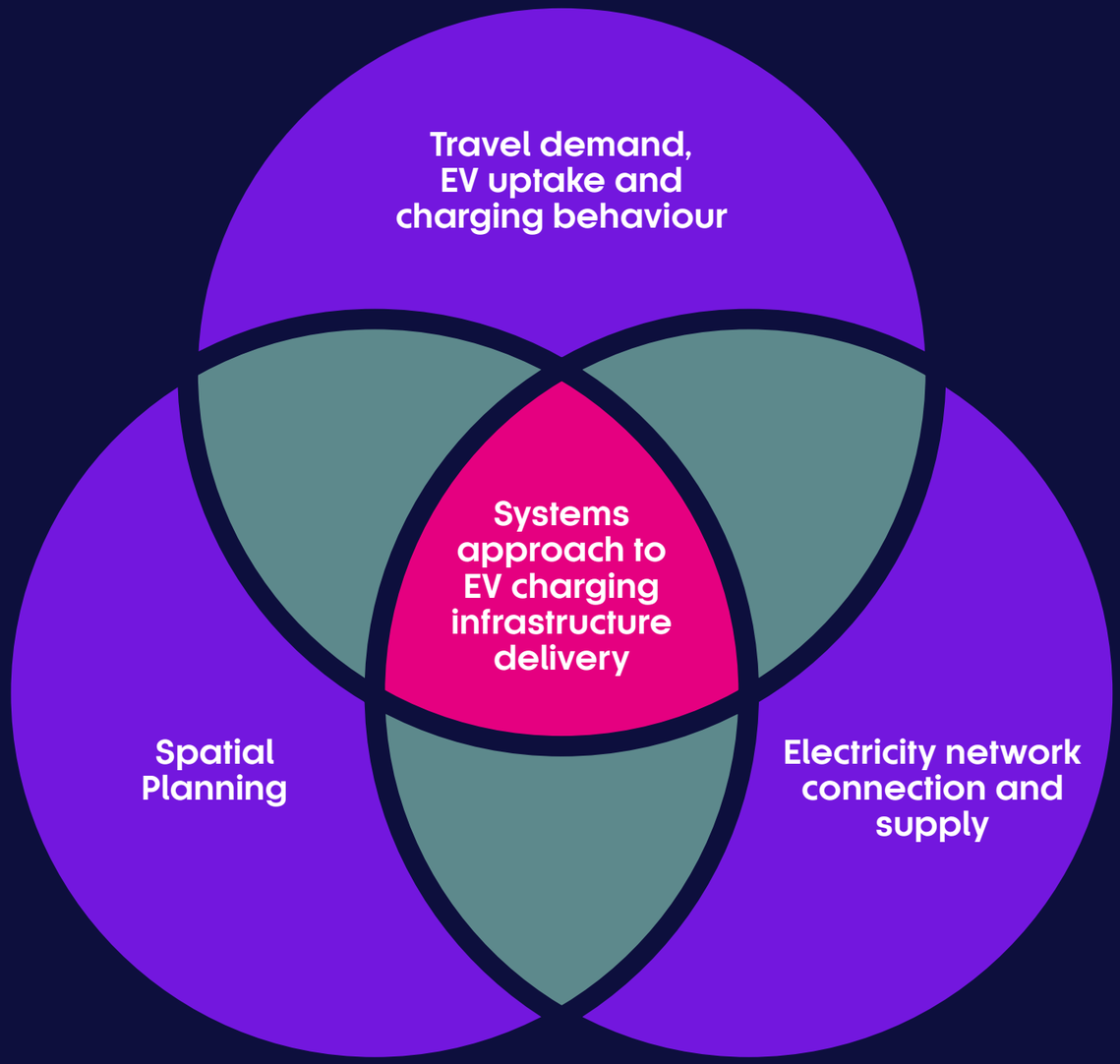
TfN established our EV Steering Group in Summer 2021 to help accelerate the planning, delivery and investment in EV infrastructure. The group plays a key role in shaping evidence development; sharing knowledge and skills across the region; and supporting clarity and consistency through the collective focus of its members. The group has built upon existing relationships, and developed new collaborations, with local partners in identifying requirements, solutions and opportunities across EV workstreams. This improves the coordination of EV charging infrastructure initiatives across the North to ensure the greatest benefit to partners. Its guiding principles are to:

- Support the effective development of TfN's EV Charging Infrastructure Framework to enhance local, regional and national decision-making capabilities.
- Develop a tangible evidence base for EV charging infrastructure in the North, which supports the maximisation of opportunities for EV uptake and progress towards decarbonisation targets, but remains cognisant of broader social, environmental and economic objectives.
- Facilitate a constructive sharing of knowledge and collaboration of EVCI partner expertise across the North, bringing multiple agencies together to support delivery of a whole system approach through integration of transport, spatial and energy systems.
- Support clarity, consistency and a 'joined up' approach to EVCI where appropriate. TfN, via the Steering Group, will seek avenues to promote awareness and communicate key messages and evidence supporting the shared vision for the North.

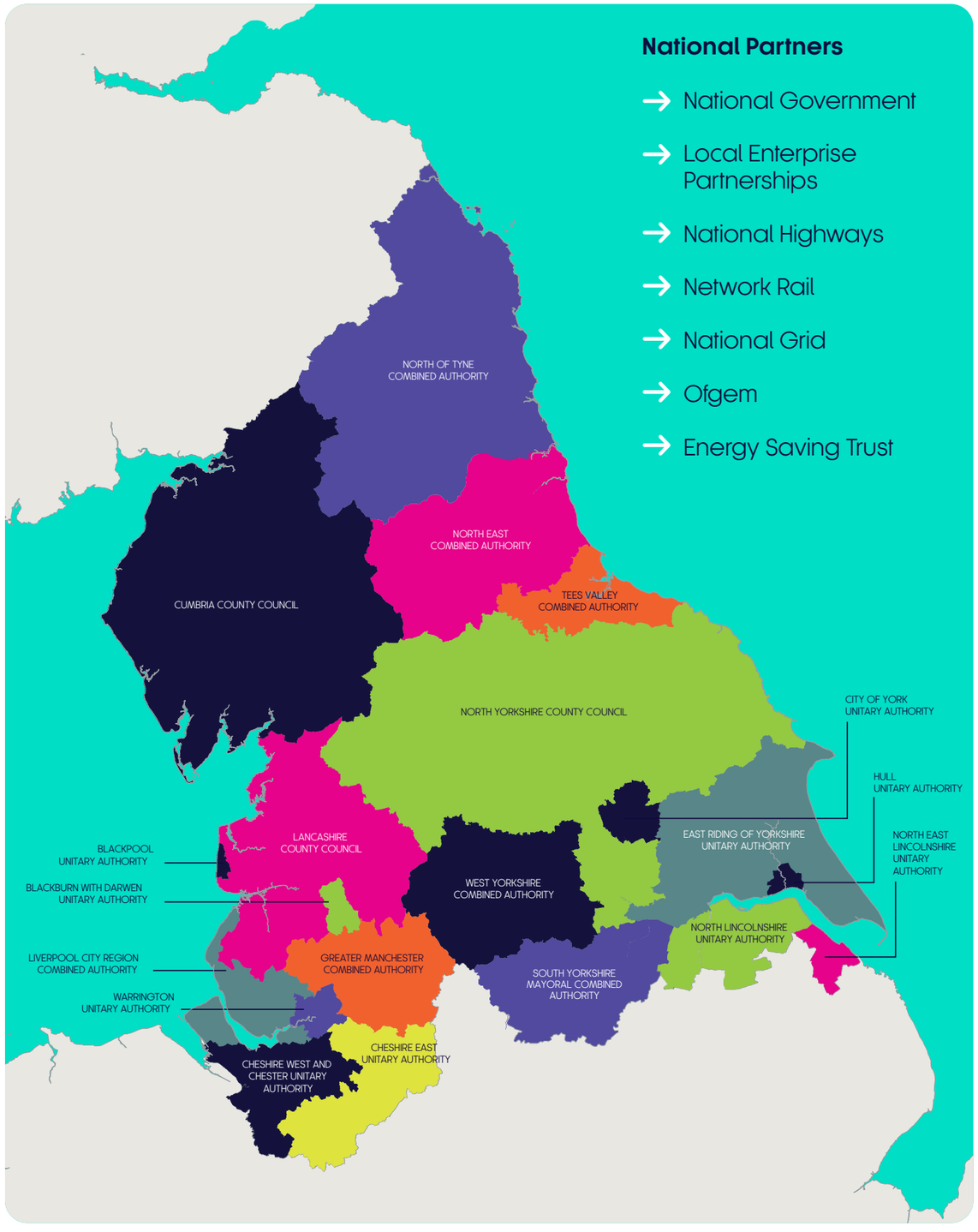
Now we have reached the stage where the EVCI model has been developed, the focus of the Steering Group will shift to applying the evidence through collaboration and partnership. As referenced in the National EV Strategy, we will continue to use our established EV Steering Group to identify different levels of engagement and progress within local authorities in the region and locations where additional support is needed to enable planning of local chargepoints.

This includes informing national government decisions and working with National Highways and Network Rail to seek integrated evidence-based outcomes on the MRN and SRN, and the national rail network. Thereby supporting policy agendas including decarbonisation, levelling up, as well as turning focus towards associated spatial planning and social inclusivity considerations.

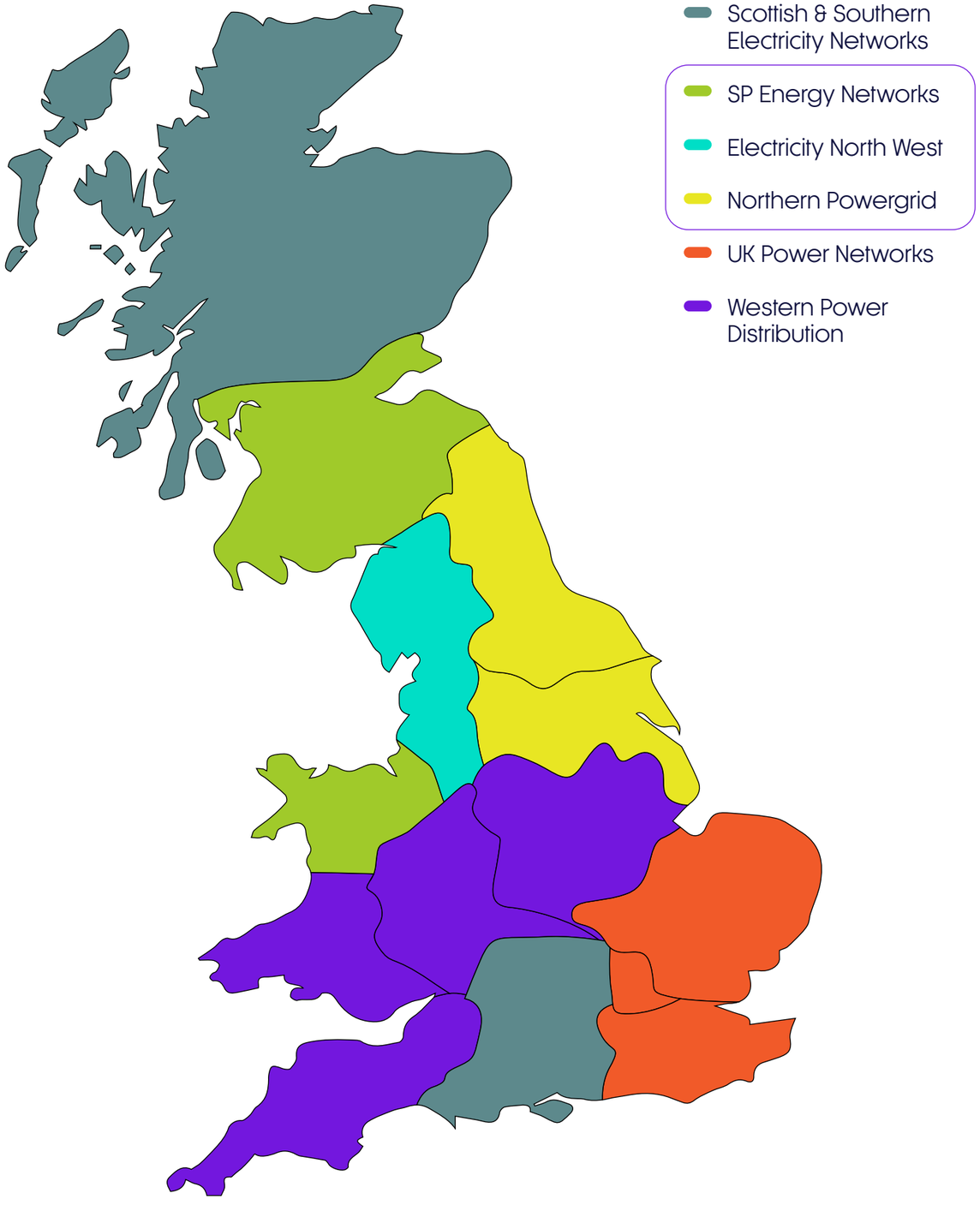
Our engagement with existing EV Steering Group partners continues, but TfN and its local authority partners welcome the opportunity to collaborate with new partners to enhance delivery opportunities across the region. We are also happy to receive feedback via engagement@transportforthenorth.com.



Transport for the North partnership and EV Steering Group members



Electricity Distribution Network Operators (DNOs) in the United Kingdom



Our regional EVCI framework aims and objectives have been developed in conjunction with our regional EV Steering Group. The objectives are therefore aligned with our local authorities' visions and ambitions, as well as a full understanding of barriers and challenges faced across our partnerships in the North.

TfN's EVCI framework objectives

1

Support delivery of an integrated EV network based on a robust and data-driven evidence base of demand and requirements.

It is important that we account for the regional and trans-boundary nature of private car and freight movements when considering EV charging needs. Through an understanding of cross-boundary travel across the North, we can support the North in delivering the density and coverage of chargepoints to meet our decarbonisation ambitions.

This means putting the right infrastructure in the right place, at the right time - taking value-for-money decisions based on user needs and specific place types. Our evidence can support local partners in planning and delivery in their area.

2

Provide a collective routemap towards an effective, attractive and inclusive network.

By understanding whole network distribution and identifying charging requirements across all places in the North, we can ensure no one is left behind. Our framework seeks to actively avoid any reactive, piecemeal deployment of EV infrastructure across the region.

A common understanding of relative costs and impacts for our different places will be critical in exploring the optimum timing and distribution of EV infrastructure delivery to meet our decarbonisation targets.

3

Support delivery of a 'whole network and whole system' approach through public and private partnerships.

Diverging EV strategies risk perpetuating uncertainty in the market and make it hard to create the environment for private investment (i.e. scale investment opportunities to be of sufficient size for investors). Our evidence is aimed at creating an attractive environment for operators and investors, to develop and embed sustainable and inclusive long-term commercial models that deliver an efficient and effective network for the EV user.

This regional long-term framework also enables us to work collaboratively with the public sector, chargepoint operators (CPO) and the energy sector to plan effectively to unlock delivery and investment right across the region.

4

Recognise and negotiate uncertainty for EV infrastructure decision-making.

One of the biggest concerns for the public sector is committing decisions and finance on infrastructure which may result in being obsolete or abortive quite quickly. Our EVCI Framework provides a mechanism to better understand and navigate the uncertainties currently faced, and what they might mean for charging needs across the region, to enhance confidence in making decisions towards EV charging infrastructure.

The model behind our framework is a live tool within TfN's Analytical Framework[1], allowing us to react quickly and flexibly to understand the impact of any new evidence and trends around user charging behaviours, as well as charging and vehicle technology advances. By applying TfN's Future Travel Scenarios[2] within our framework, we can continue to assess the broader drivers of user travel movements and what that might mean for network demand (both highway and electric charging).

[1] https://ournorth.transportforthenorth.com/analytical-framework

[2] https://transportforthenorth.com/future-travel-scenarios/

3. How our bespoke regional EVCI Framework breaks new ground

- **A state-of-the-art regional evidence base** - Built to apply and integrate with TfN's Analytical Framework, our work takes advantage of one of the richest transport and land-use data sets available to build a regional EVCI evidence base. This data-driven approach enables us to forecast the full range of infrastructure requirements, based on our understanding of a wide range of road user factors, in a manner that provides additional capacity and capability for TfN and local authorities.

- **A systems approach** - Built up from Middle Super Output Area (MSOA[3]) level, the tool translates TfN and partners regional travel demand (for car, van and HGV fleet demand) and land-use estimates (travel patterns, car population, socio-demographics, household types etc) to quantify the requirement for chargepoints covering the full range of journeys being made to, from, and within our region. From this we can also identify the impact of EV charging on the electricity distribution network, and work with the energy sector to seek a collective whole systems approach to EV infrastructure.

- **Informing strategic and place-based outcomes** - It provides TfN and partners with robust temporal and spatial routemaps at a granular level for all places across the North. This can inform value-for-money, resilient and integrated decisions. It does this with a view to supporting outcomes across the North which provide coverage of chargepoints to meet our decarbonisation ambitions. Our framework seeks to identify the right infrastructure needs in the right place, at the right time; whilst recognising the need of the user across the whole regional network. It also provide a means to assess social and spatial considerations associated with EV charging infrastructure.

[3] Middle Layer Super Output Areas (MSOA) are a geographic hierarchy designed to improve the reporting of small area statistics in England and Wales. The minimum population is 5,000 and the mean is 7,200.

- **An enabler of accelerated delivery** - It provides a framework with which to create an attractive investment environment for all area types across the region. Providing both public and private sectors with evidence which can help de-risk investment decisions helps ensure we target EV infrastructure that provides for a rapid and consistent transition to EV which is accessible right across the North. Our tool provides the capability to monitor and evaluate progress to ensure EV uptake across the region is one of the active solutions to reach our decarbonisation targets.

- **Navigating uncertainty to support delivery** - Our evidence supports a rapid roll out of EV charging infrastructure, but also allows decision makers to plan and act responsively in the face of uncertainty. Human behaviours (both travel and charging) and technology advances will have a major impact on the demand for EV charging infrastructure (both amount and type). By applying TfN's Future Travel Scenarios, we can understand different EVCI requirements suited to potential future user travel patterns and choices. Our evidence also supports an understanding of impacts resulting from different charging behaviour preferences (i.e. at home/on-street, at destination or en-route).

- **A trusted centre of excellence** - The EVCI model is designed to provide outputs as open data. The Intellectual Property (IP) sits with TfN and will therefore be integrated into TfN's Analytical Framework, allowing TfN to maintain and update it based on new evidence, and to share freely with our local authority partners and other stakeholders.

4. Viewing our interactive EVCI Framework findings

EVCI visualiser tool

Our interactive tool is available online at:

https://transportforthenorth.com/major-roads-network/EV-charging-infrastructure

We have done this to openly communicate EV charging requirements for the region. With a view to supporting rapid deployment of the right solution across all areas of the North of England. The development processes behind these tools and its wider supporting information is also available here.

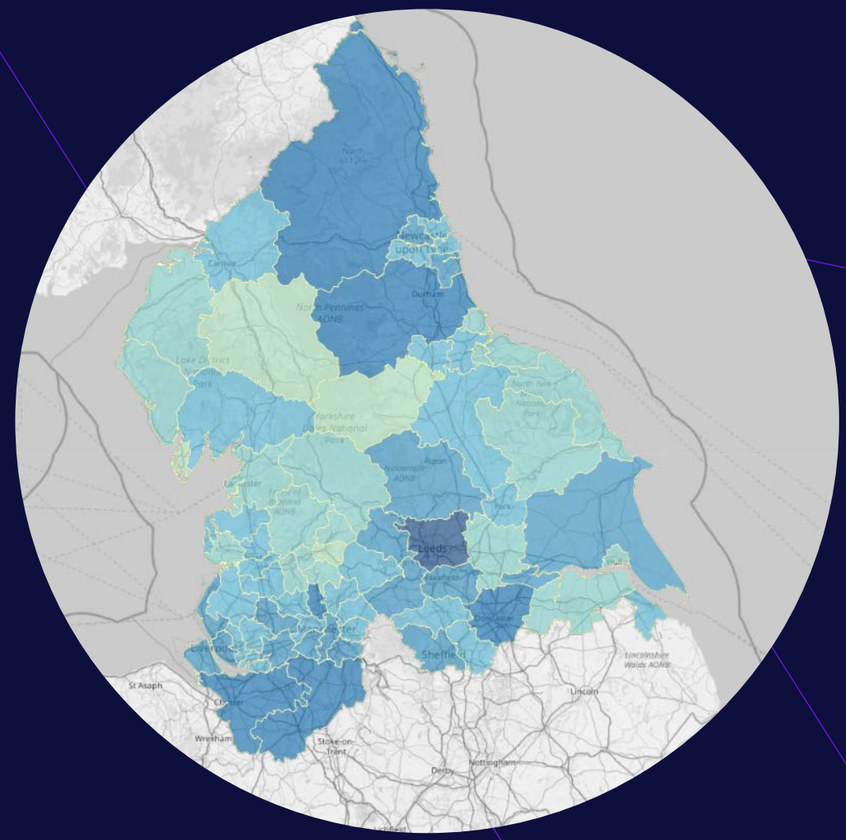
Our innovative work on EV charging infrastructure takes strategy and planning in this area further, based on one of the richest data sets available. It enables an evidence-based approach to move forward with implementation at pace. We have launched an interactive visualisation platform to communicate the key EVCI findings developed. Requirements can be viewed regionally; by combined authority; by local authority; or by Middle layer Super Output Area (MSOA). TfN is supporting local authority partners to interpret and extract local evidence with a view to informing or supplementing their own activities.

Rapid Charging Site Location Tool

This in-house tool presents the strategic identification and assessment of potentially suitable sites for en-route rapid charging hubs along the Strategic and Major Roads Networks (SRN and MRN). This includes major roads operated by National Highways and local Highway Authorities.'

This tool will be used as we apply our EVCI Framework evidence to support planning and delivery of electric charging infrastructure. The key potential locations for rapid charging can be viewed in the EVCI visualiser.

Later sections of this report outline examples of the strategic assessments towards rapid charger sites on our road network. This includes assessment of traffic flows, land-use, and environmental considerations when considering locations for charging.



5. Glossary

Abbreviations

BEV Battery Electric Vehicle
CPO Charge Point Operator
DNO Distribution Network Operator
ENWL Electricity North West Ltd. – DNO for north west England
EV Electric Vehicle
EVCI Electric Vehicle Charging Infrastructure
EVCP Electric Vehicle Charging Point
HGV Heavy Goods Vehicles (trucks or lorries)
LA Local Authority
LDV Light Duty Vehicle (cars and vans)
MRN Major Road Network
MSOA Middle layer Super Output Area
NCR National Chargepoint Register
NPg Northern Powergrid – DNO for north east England
PHEV Plug-in Hybrid Electric Vehicle
SPEN SP Energy Networks – DNO for southern Scotland and west of England
SRN Strategic Road Network
STB Sub-National Transport Body

Primary substation: a transformer which converts high voltage (33 kV) electricity to low voltage (11 kV). These typically have a capacity of 10 – 30 MVA, and serve 50 -100 secondary substations.

Secondary substation: a transformer which converts low voltage (11 kV) electricity to 240 V electricity for domestic use. These typically have a capacity of 50 – 300 kVA and serve 50 – 100 households and businesses.

6. TfN's regional Transport Decarbonisation Strategy

TfN has a clear remit to identify the transport infrastructure required to support transformational economic growth in the North, and to prioritise that investment. This places TfN and partners in a strategic position to identify the transport infrastructure and policy measures that are required to achieve the North's decarbonisation ambitions. When prioritising transport infrastructure delivery in the region, TfN must make decisions based on a knowledge of how those projects and programmes are likely to support or challenge the region's decarbonisation objectives outlined by TfN's Transport Decarbonisation Strategy[4].

Our Transport Decarbonisation Strategy sets out the decarbonisation trajectory for the North with the aim of reaching a regional near-zero carbon surface transport network by 2045. The strategy and our enabling Future Travel Scenarios[5] provide the vision and understanding towards the mix of technology, behavioural and place-based solutions that is required to reach our decarbonisation targets. While most of the responsibility for policy implementation lies with national and local government, TfN operates at a geographical and institutional level that allows us to facilitate a regional approach to decarbonisation measures and research.

[4] https://transportforthenorth.com/wp-content/uploads/TfN-Transport-Decarbonisation-Strategy-TfNDEC2021.pdf

[5] https://transportforthenorth.com/future-travel-scenarios/

7. Decarbonising our roads

TfN published the Major Roads Report[6] (December 2021) which sets out the strategic importance of our national, regional and local roads network, in the context of our decarbonisation and economic ambitions. With 97% of personal journeys and 88% of freight movements in the North made using our highways, our roads have a vital role in underpinning economic activity, opening up access to jobs, goods and services and in enabling growth in new employment and housing.

However, motorised road travel is the largest contributor to transport carbon emissions, with more than 95% of the 26 million tonnes of transport-related carbon emissions per year from road transport. As shown in Figure 1, road vehicles are by far the largest transport emitter of carbon, with the North's highway network responsible for 23% of UK road emissions and 6% of total UK emissions[7]).

[6] https://transportforthenorth.com/major-roads/

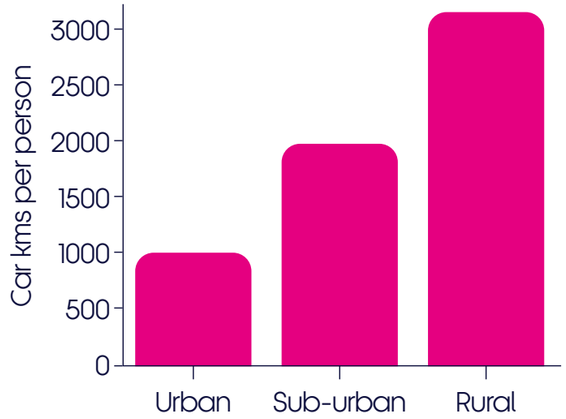
[7] TfN Decarbonisation Strategy, December 2021

Figure 1: Headline figures relating to surface transport emissions in the North of England in 2018

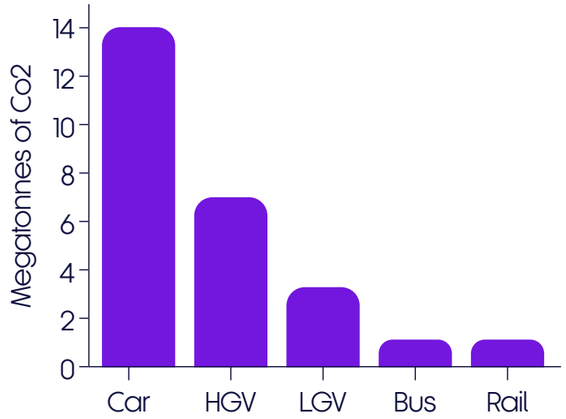
→ **126 billion vehicle kms**
→ **23% of vehicles kms in the UK** (Cars, LGVs, HGVs)

→ **26 million tonnes of CO_2**
→ **23% of UK road emissions**
→ **6% of total UK emissions**

Car kms per person by area type

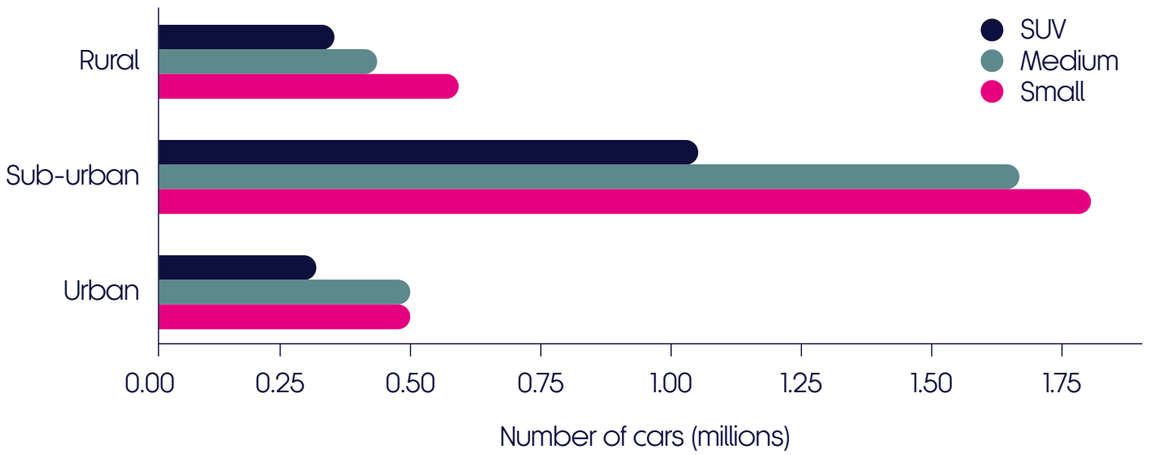


Total megatonnes of CO2 by mode



→ **8 million registered cars**
→ **23% of registered cars in the UK**

Car ownership by area type and segment



Through collaboration with our transport and highway authority partners, TfN has defined the MRN as the roads that are crucial to supporting economic activity and growth in the North. Including the Strategic Road Network (SRN), the MRN accounts for about 7% of the roads in the North - 2,444miles of Strategic Road Network (SRN) managed by National Highways plus 5,454miles of major roads managed by local highway authorities. The MRN connects important economic centres and planned centres of economic growth, as well as the major transport hubs supporting multimodal journeys. Together they provide the functionality needed to support end-to-end journeys, connecting people, connecting businesses and moving goods within and to/from the North of England.[8]

[8] It is important to note that the MRN defined by TfN differs from the MRN defined by the DfT. The key differences are that the TfN MRN encompasses the SRN, and a number of additional MRN links.

Figure 2: Major Road Network in the North

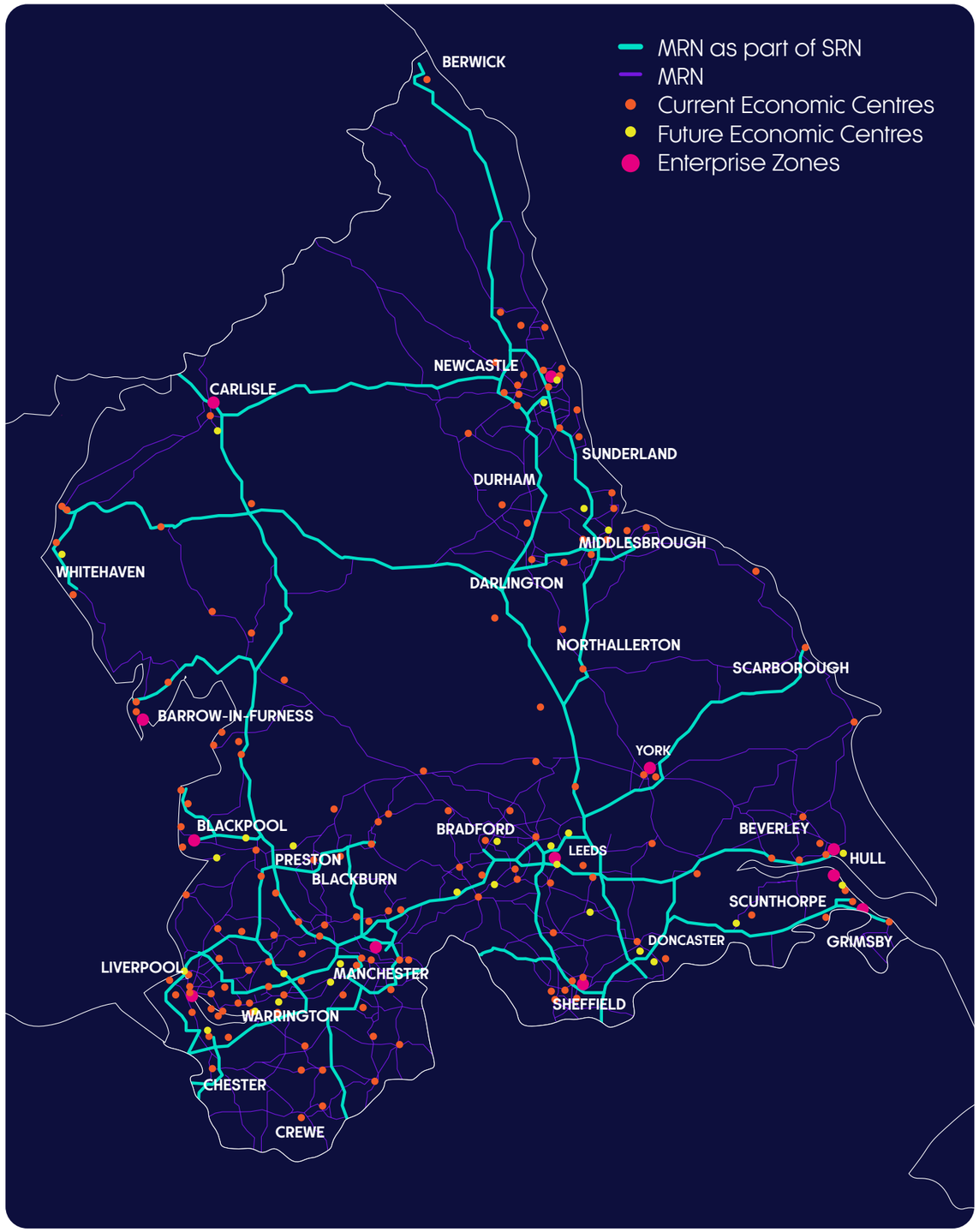


Figure 3 shows how a significant proportion of trips which are medium and long-distance (over 10 kms) generate 75% of car emissions in the North. TfN is working with national and local partners to support the shift towards low carbon transport to reduce the impact of harmful emissions on the environment.

Figure 3: Percentage of car emissions by distance travelled across the North of England

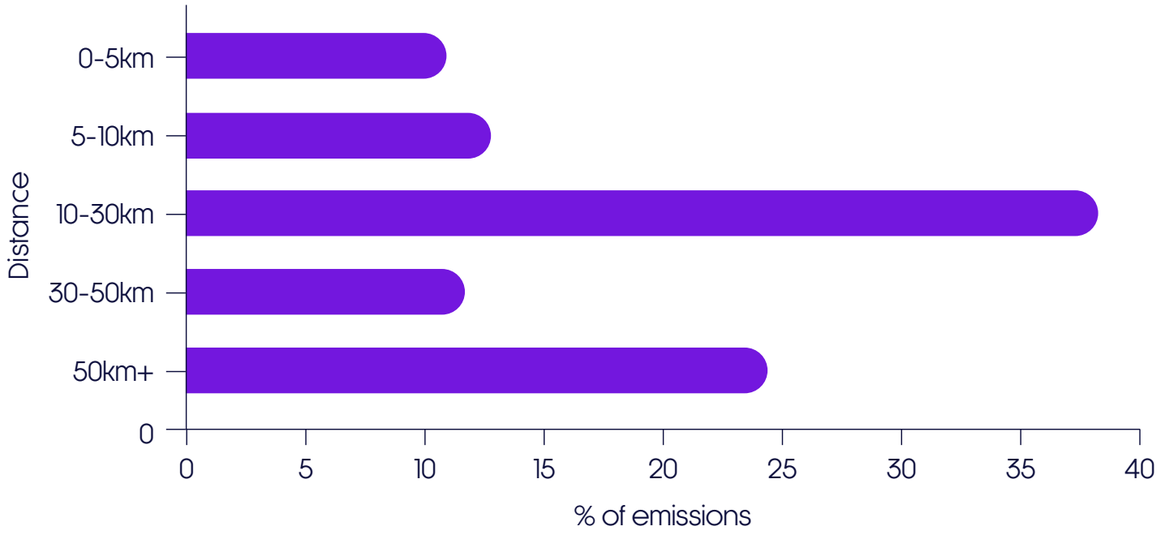
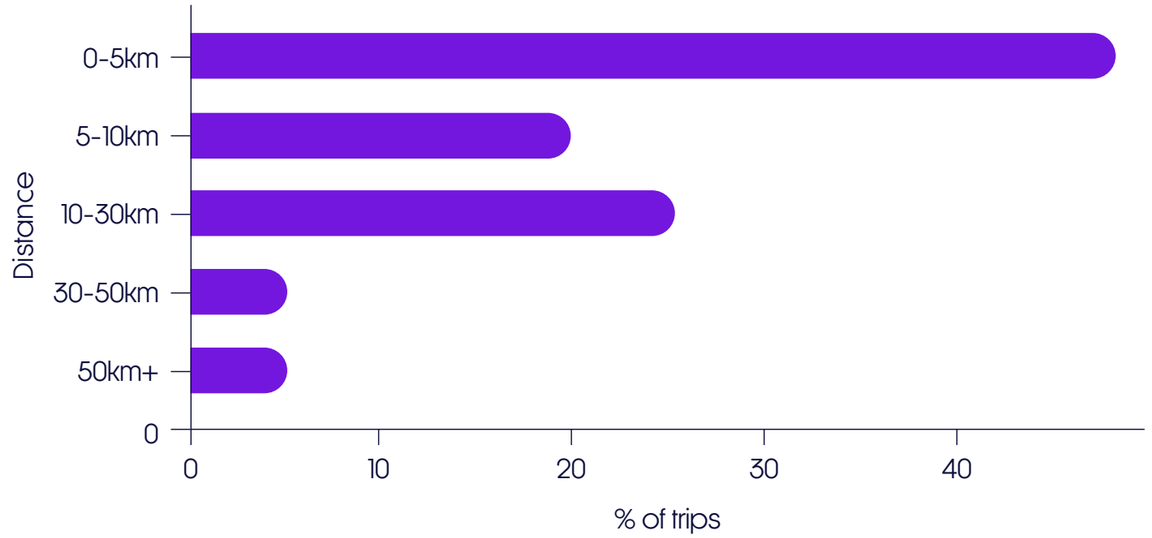


Figure 4: Percentage of trips by distance across the North of England



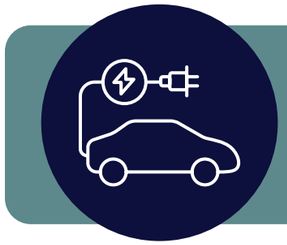
Our evidence of road travel patterns[9] across the region shows that around 65% of car trips in the North are 10km or less. We need more of these short trips to be undertaken by active travel or public transport, and to support this with appropriate infrastructure and place making frameworks.

Where a vehicle is required, shorter trips are likely to see different electric charging behaviours or preferences to those undertaking longer journeys. For example, shorter journeys may see a top up, or grazing, charging behaviour on more local roads, rather than requiring extended journeys to rapid en-route charging on the Major Road Network (MRN). To support this, the charging network needs to be integrated and able to manage and reduce unintended journeys that do not suit the user's needs, or consequences such as increased congestion or environmental impacts.

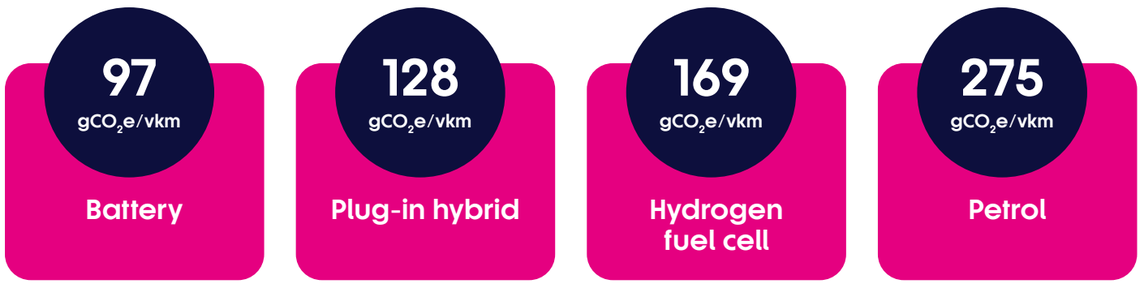
[9] TfN Major Roads Report, December 2021

Road transport has a critical role in meeting UK targets for decarbonisation, and one of the central solutions to this will be the need for a rapid rollout of electric vehicle (EV) charging infrastructure. Even with substantial investment in rail and policies to reduce traffic growth, road transport will remain the dominant mode of travel for longer distance travel across the region. This is why fast and efficient action is required to decarbonise how we use our roads, and this will require integrated planning across energy, spatial and other sectors.

Analysis by Ricardo[10] shows that electric powertrains used in UK road vehicles already have significantly lower greenhouse gas impacts across all vehicle types. Due to the UK's clean electricity mix in 2020, and efficient end-to-end use of renewable energy in their operation, a typical battery electric car is estimated to save ~65% GHG emissions, compared to an equivalent conventional petrol car. Improvements to further decarbonised UK electricity grid, battery technology and manufacturing, as well as end-of-life treatment could reduce the emissions of BEVs in the future, with Ricardo estimating ~76% GHG reduction compared to an equivalent conventional petrol car. However, this is subject to uncertainty due to BEV production emissions, and also the real world performance of batteries and owners charging behaviour.



A battery electric car now produces only a third of the lifecycle emissions of an equivalent petrol car.



[10] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1062603/lifecycle-analysis-of-UK-road-vehicles.pdf

Further vehicle decarbonisation is required

Whilst use of EV's produces zero tailpipe emissions and can reduce lifecycle emissions significantly, they are not entirely emission-free. There are further advances across the whole production and usage system to be made and this remains an emerging market.

The European Environment Agency[11] (EEA) report outlines how manufacturing and production of EV's carries a significant environmental impact, and is much higher than fuel-based vehicles. This is due to the materials used to produce an EV and the requirement of more energy to mine raw materials such as lithium and cobalt. These processes will need to be considered as the demand for these materials increases. A circular economy approach can help offset this, through approaches which encourage reuse and recycling of vehicles and batteries.

Electric cars need regular charging, which has a direct impact on the power production industry. Although the energy sector has rapidly decarbonised, as outline above, this use of energy is still likely to be partially supplied from fossil fuels. This requires the electricity sector to continue decarbonising its generation from more renewable energy sources.

Air quality issues remain

Whilst EVs reduce the amounts of Nitrogen Oxide and Suplur Dioxide released by road vehicles, tyre wear remains an issue for air quality.

Microplastics, produced as waste, are small and can be carried into water courses, inhaled or ingested by animals and passed up the human food chain.

Tyre wear remains an issue for air quality, with microplastics produced as waste and entering the surrounding environment. These are small, and can be carried into water courses, inhaled or ingested by animals and passed up the human food chain.

The release of these microplastics can be, at this time, exasperated by new EVs' on the road. The average size and weight of all cars has been increasing and the weight of batteries adds to this. As electric vehicles manufacturers and owners seek higher ranges and faster recharge times, their weight may well increase, adding to the amount of pollution that brakes and tyres will produce. This non-tailpipe pollution now releases larger emissions than that released by the tailpipe, and is currently unregulated.

[11] EEA report confirms electric cars are better for climate and air quality — European Environment Agency (europa.eu)

8. Electric vehicles in the North

Electric vehicles in the North

A movement away from fossil fuelled vehicles is critical to achieve near-zero emissions in the North's surface transport network. The typical life of a car is around 15 years, with some lasting longer in the fleet, meaning it will take roughly this long for zero emission vehicles (ZEVs) to tip the balance and deliver the deep emissions reductions required to meet decarbonisation targets.

The UK Government's Transport Decarbonisation Strategy confirmed the phasing out of new petrol and diesel cars and vans by 2030, and all new cars and vans to be 100% zero emission tailpipe in 2035. Analysis from our Decarbonisation Strategy[12] suggests we need an ambitious uptake of ZEV cars (55% of sales) and vans (40% of sales) by 2025. It is therefore critical to introduce policies and supporting infrastructure that will rapidly increase ZEV uptake as soon as possible.

EV uptake is rapidly increasing due to national policy and decarbonisation stimulus. The Society for Motor Manufacturers and Traders (SMMT) found that Electric and hybrid electric vehicle demand accounted for more than one in four new cars in December 2021)[13]. Global action to build new electric vehicles markets, and investment in battery technology and manufacturing processes, have led to significant reductions in the costs of ZEV cars and vans.

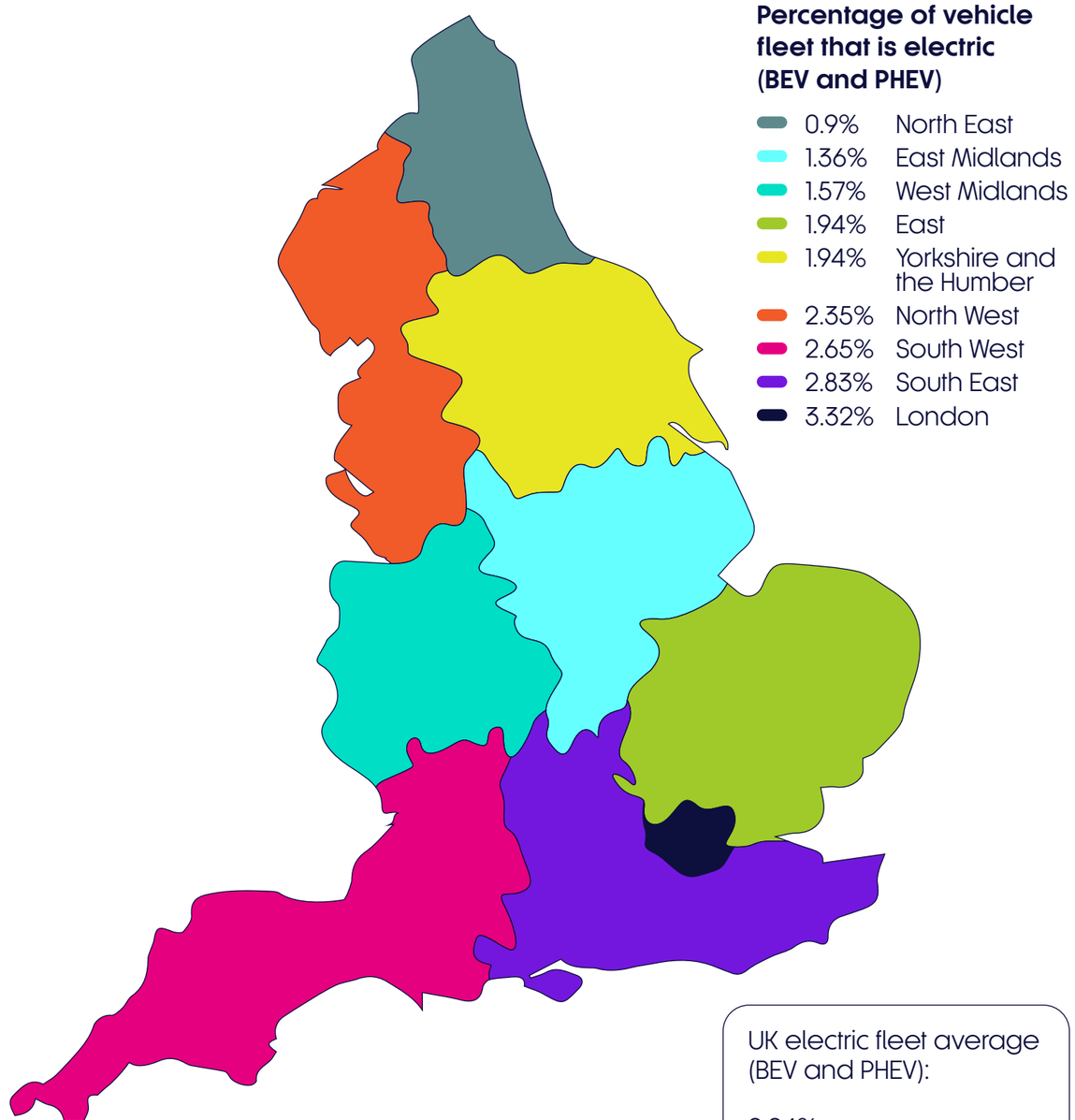
Although uptake has increased in recent years, electric vehicles still only represent 2.2% of total cars on UK roads in early 2022[14]. Evidence also indicates that the North of England is seeing a slower uptake rate of EVs, compared to the national average. Figure 5 shows the percentage of EV sales across the North of England.

12. https://transportforthenorth.com/decarbonisation/

13. https://www.smmt.co.uk/vehicle-data/car-registrations/

14. Vehicle licensing statistics: January to March 2022 - GOV.UK (www.gov.uk)

Figure 5: Proportion of registered vehicles sales which are Electric Vehicles in England (August 2022) [15]

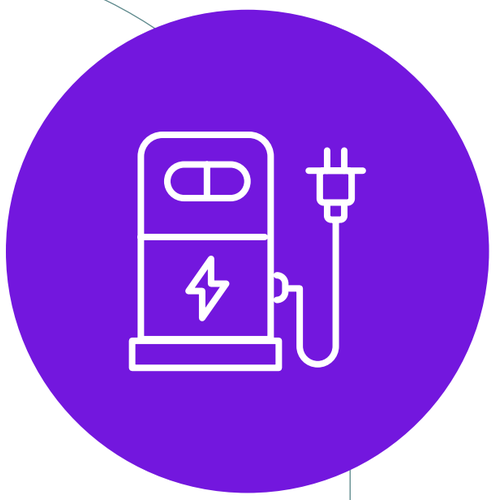


15. Both Stockport and Leeds see a higher number of licensed EVs, which evidence suggests is due to large fleet registrations in those areas. TfN are working to understand how we continue to account for these aspects in our framework, as well as engaging with fleet associations to test approaches.

There are number of uncertainties and challenges with regards to uptake of EVs, with upfront cost of purchasing a new EV and having effective supporting charging infrastructure remaining key blockers to further EV uptake across the region and the wider UK. Figure 6 indicates the projected EV uptake across TfN's Future Travel Scenarios, as outlined in our Decarbonisation Strategy.

EVs are cheaper to operate than internal combustion engine (ICE) vehicles (particularly if charging on at-home tariffs), and the driving range of newer EV models is beginning to offset 'range anxiety' and user concerns about running out of charge. The cost of acquiring an EV is likely to fall during the 2020s, as battery costs fall and a second-hand market develops the cost of EV's will fall, with price parity anticipated between 2025-2028 for many vehicle segments. In the short run, the market is still heavily skewed towards higher cost vehicles, however 2021 saw the sales of used EVs rise by 119%[16].

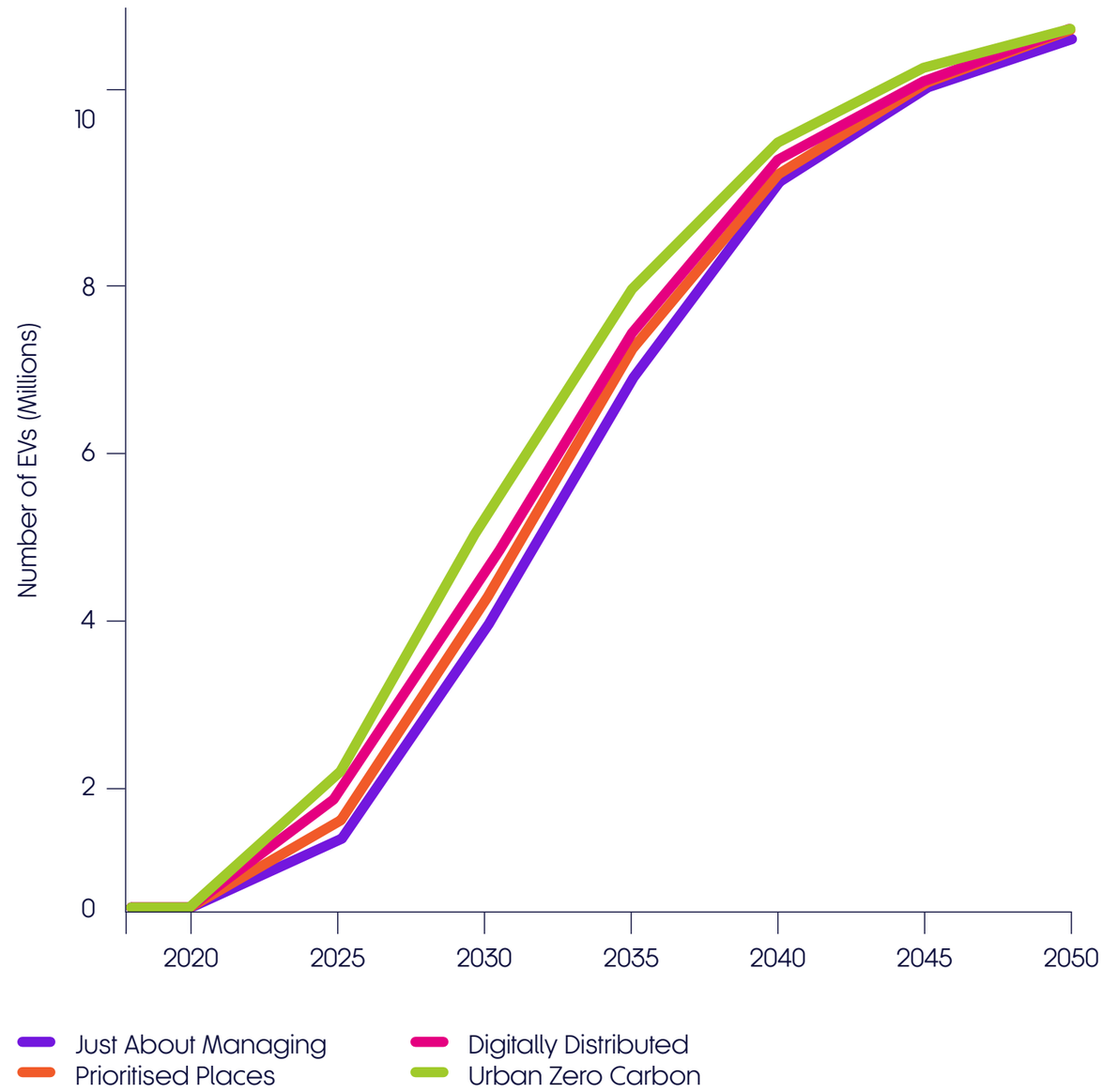
A combination of policies that help to differentiate the upfront costs of new ZEV and ICE vehicles will be required, as seen in other parts of Europe. France, Germany and the Netherlands have all adopted incentives or grants to support a second-hand vehicle transition[17]). This increase can be further encouraged by the transfer of corporate fleets to EVs, which also feed the second-hand market. By scaling their fleets sooner, companies will provide a larger supply of lower-cost vehicles to the public in the years ahead. However, second-hand users will need to be aware that older vehicles may not be capable of their maximum range of the battery due to any degradation, and will therefore require replacing earlier than a newly made model.



[16] https://www.rac.co.uk/drive/news/electric-vehicles-news/record-year-for-second-hand-ev-sales-as-used-car-market-grows/

[17] https://thedriven.io/2021/05/11/the-role-of-the-used-car-market-in-accelerating-equal-access-to-electric-vehicles/

Figure 6: EV (BEV and PHEV) uptake across the North of England as projected by the TfN analytical Framework (across our Future Travel Scenarios)[18]



[18] https://transportforthenorth.com/future-travel-scenarios/

9. EV charging infrastructure in the North

9.1 The need for delivery at scale and pace

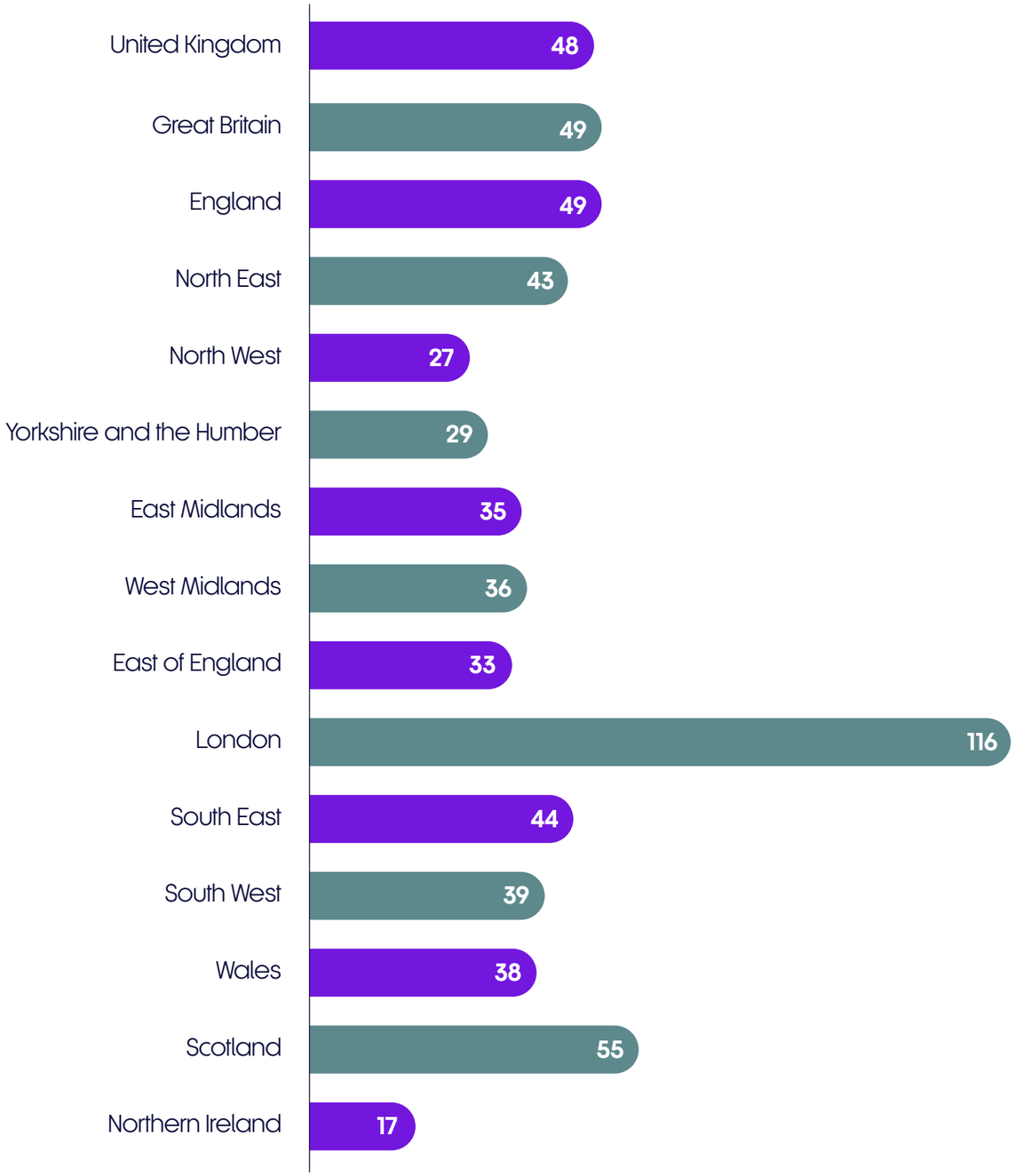
Feedback from public consultation on TfN's Transport Decarbonisation Strategy[19] included support for the development of a regional EV charging infrastructure framework as an urgent priority in the 2020s, to support planning for a comprehensive roll out of the charging points needed to achieve the rapid transition to electric vehicles. Respondents also expressed concerns relating to ensuring equitable access to EV charging for all, and potential impacts on those without access to an electric vehicle.

Public charging infrastructure has struggled to keep pace with EV uptake to date. With the North seeing lower levels of overall EV infrastructure development than many other areas of the UK. Data in July 2022 indicated the North West (27 per 100,000 population), Yorkshire and Humber (29 per 100,000) and the North East (36 per 100,000) are all below the UK average for charging devices (49 per 100,000)[20]. This low rate of charging deployment correlates closely with the lower rate of EV uptake across the region outlined in Figure 5. Figure 7 shows how charging deployment fares in comparison to the rest of the UK.

[19] https://transportforthenorth.com/wp-content/uploads/Consultation-Analysis-Report-Decarbonisation-.pdf

[20] Electric vehicle charging device statistics: July 2021 - GOV.UK (www.gov.uk)

Figure 7: Public charging devices per 100,000 of population by region [21]



[21] Electric vehicle charging device statistics: July 2021 - GOV.UK (www.gov.uk)

9.2 A coherent and comprehensive approach

Delivery of an effective electric charging network will require a mixture of public and private investment. This is likely to see different delivery models with the UK National Electric Vehicle Infrastructure Strategy referring to a vision for the private sector to lead on chargepoint roll out, working with local authorities, transport and energy bodies to install new chargepoints as efficiently as possible. However, local leadership is vital to ensure any market led approach delivers the best solutions for all areas of the region. Whether that is through public funding for the least commercially viable sections of the market, working with the private sector through commercial models, or delivery strategies which knit these various elements together looking at the whole network view.

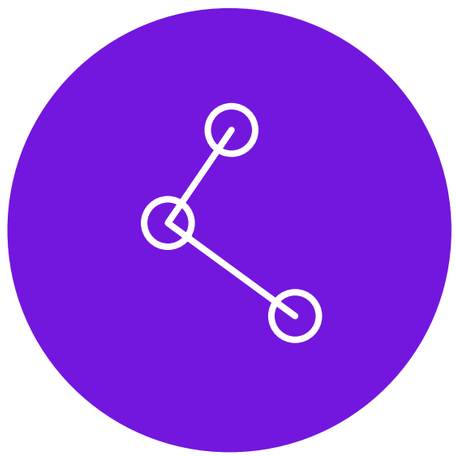
9.3 Regional EVCI requirements identified – what, where and when

Our EV Charging Infrastructure Framework provides additional clarity to tackle some of the challenges set out above. Our evidence identifies the scale and pace of change required across our region to support a rapid transition to electric vehicles. By developing robust evidence we can support decision-making and manage the many uncertainties around EVCI deployment to accelerate infrastructure role out across the region with confidence, while maximising value for money.

With close to 70% of all vehicle kilometres on the Major Road Network, including the Strategic Road Network[22], our aim is to provide an integrated assessment, understanding the requirement to cater for the full range of journeys being made to, from and within our region. We also aim to account for the large proportion of trips which are 'trans-boundary' (origins and destinations that go beyond a single local or combined authority boundary) and which are responsible for a substantial proportion of the North's road-based carbon emissions.

70% of road distance travelled in the North occurs on the Major Road Network

A large number of drivers will do most of their charging at home, overnight. Public charging is required to enable long distance journeys, and support those EV users without off-street parking. We need public chargepoints to provide a charging network that provides both consumer confidence and convenience of charging availability.



[22] TfN Major Roads Report

Our evidence identifies that between 27,600 and 48,000 publicly available non-rapid[23] EV chargepoints, and between 12,000 and 26,000 rapid[24] chargepoints, will be required across the North by 2025[25] to support our regional decarbonisation ambitions. This demand forecast rises throughout 5-year increments to 2050, but it is the 2020s that sees the most significant demand growth to support rapid decarbonisation of the fleet, with a further increase to a regional requirement of 95,000 to 100,00 publicly available non-rapid chargepoints and 33,500 to 61,200 rapid chargepoints by 2030[26].

[23] On-street, work, destination, HGV depot (slow to fast charging between 7kw and 22kw; averaging 1 – 8 hours charging currently)

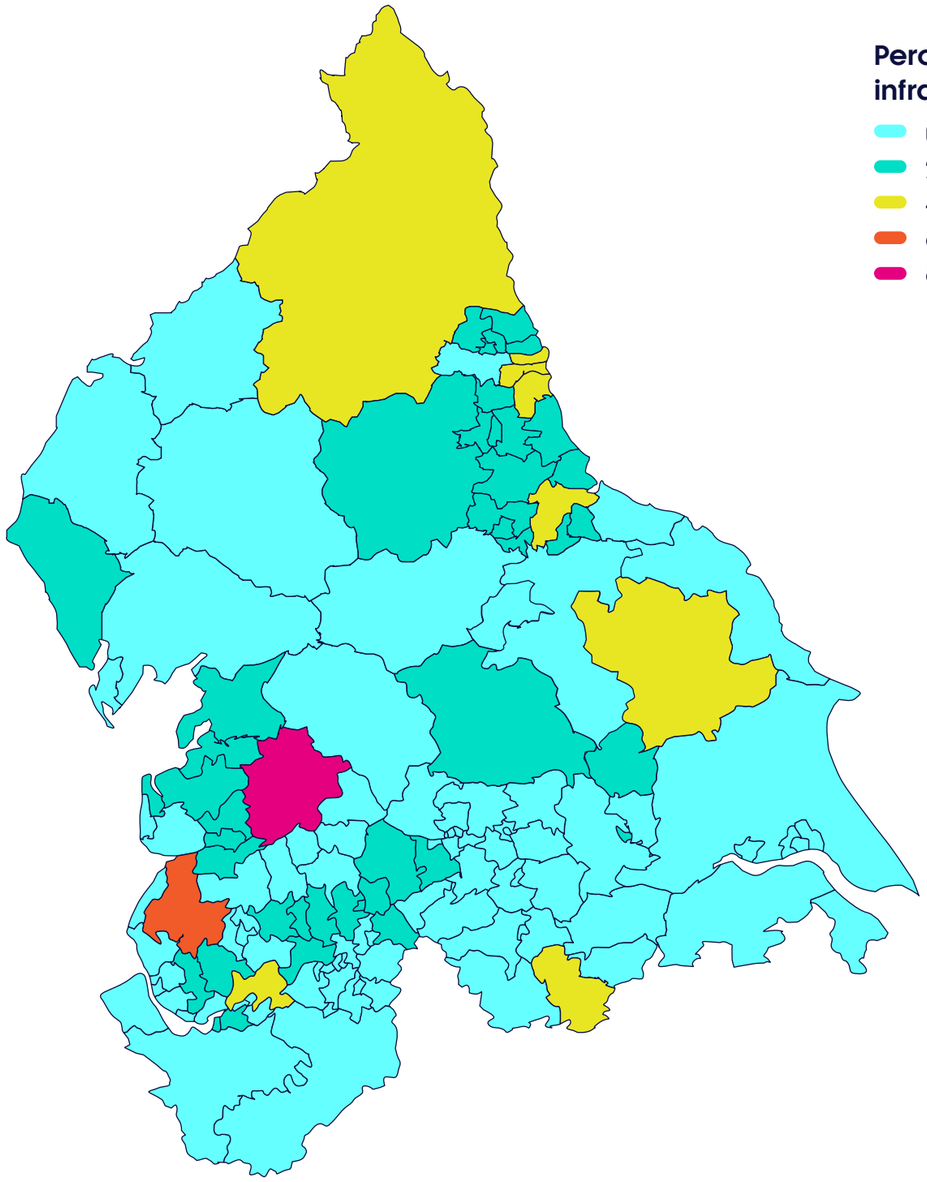
[24] Rapid on the move charging (50kw and above, averaging 1 hour or less charging currently)

[25] Outputs have been developed across different future travel scenarios and charging behaviours to understand the range of possible requirements.

[26] Calculations based on 3.3 – 4.6 million electric vehicles on the road by 2030. Range developed across TfN's Future Travel Scenarios.

Figure 8 shows the gap between public non-rapid charging available now and the requirement for these chargers by 2025 across the North of England.

Figure 8: Percentage of public non-rapid charging required by 2025 (to support TfN's regional decarbonisation trajectory) that is available in 2022[27]



[27] Comparison of TfN EVCI forecasts under TfN Digitally Distributed scenario with National Chargepoint Registry. On-street, work, destination, HGV depot chargers.

Table 1: A summary of the different charging categories, the current number seen across the North of England (August 2022), and the requirements outlined by our EVCI Framework for 2025 and 2030 (with modelling capability available in 5-year increments to 2050).

Charging category	Description	Average charging power and speed of charge (as of August 2022)	Number across the North (August 2022 National ChargePoint Register, NCR Data)	TfN evidenced requirement across the North of England[28]	
				2025	2030
Total public charging requirement	All chargepoints across the region	All	>6,400	39,000 - 54,000	123,500 - 161,200
En-route rapid publicly accessible charging	Typically a rapid hub describes a cluster of 4 or more DC rapid chargers functioning in a similar way to a petrol station. These sites are typically located along the SRN/MRN.	50 – 350 kW charge 30 mins	>1,450	Between 12,000 and 26,000 (80 - 166 installations per week between 2022-2025)	Between 33,500 and 61,200 (128 - 235 installations per week between 2025-2030)
Non-rapid publicly accessible chargers.	**Destination chargers** - refer to sites where drivers are visiting for a purpose other than charging, and so are located in urban centres and businesses, at workplaces, retail parks, supermarkets, restaurants/cafes and roadside convenience stores. **Community charging hubs** - are a grouped hub of charge points set in more suburban areas, typically providing a mixture of slow to fast AC chargers, and a number of rapid chargers.	<50kW	>4,950	Between 27,500 and 48,000 (176 - 307 installations per week between 2022-2025)	Between 95,000 and 100,000 (365 - 384 installations per week between 2025-2030)
Non-rapid publicly accessible chargers.	**On-street residential chargers** - These charge points are typically slow to standard AC chargers positioned at the kerbside, providing EV owners who do not have off-street parking the opportunity to charge.			Between 27,500 and 48,000 (176 - 307 installations per week between 2022-2025)	Between 95,000 and 100,000 (365 - 384 installations per week between 2025-2030)
At home	Private at home and off-street charging on driveways and in garages	~7kW	NA	Between 550,000 and 1,000,000 (3,500 – 6,400 installations per week between 2022-2025)	Between 2,150,000 and 2,950,000 (8,270 - 11,350 installations per week between 2025-2030)

9.4 The national context

The UK Government published its UK electric vehicle infrastructure strategy in March 2022. TfN have worked in collaboration with the Office of Zero Emission Vehicles (OZEV) and the Department for Transport (DfT) to help inform the national vision and action plan. With a particular focus on the role that regional bodies such as TfN are playing in providing a centre of excellence to support national and local EV charging planning and delivery activities. Transport for the North has actively engaged with, and informed, various consultation exercises by the UK Government and the catapult network (as part of UK Research and Innovation). We have also provided written and oral evidence to the Transport Select Committee inquiry into Zero emission vehicles and road pricing[29].

[28] TfN's framework can provide is in 5 year increments to 2050. We have provided 2025 and 2030 as the 2020s will see the most rapid growth in demand to meet decarbonisation stimulus.

[29] https://committees.parliament.uk/work/900/zero-emission-vehicles-and-road-pricing/publications/written-evidence/

We will continue to develop our research and evidence, and support regional and national collaboration to support rapid deployment of EV charging infrastructure and position the North as a test bed for new approaches, techniques and commercial opportunities.

Our EVCI Framework outlines charging requirements in a range of 39,000 – 54,000 by 2025; 120,000 – 160,000 public chargers needed in the North of England by 2030, depending on which future travel scenario may come to pass. To put this in context with other forecasts, our overall framework requirements for the 2020-2030 period fall within the central bounds of other studies, when apportioned evenly to the TfN area based on population.

- The UK Government's National EV Strategy makes an estimate of 300,000 public chargers needed nationally by 2030. However its supporting modelling material also estimates that this could be between 280,000 and 720,000 public chargepoints nationally by 2030.
- The Committee on Climate Change Sixth Carbon Budget estimated the total number of public chargepoints across the UK may be 280,000 by 2030.
- The Competition & Markets Authority (CMA) plotted a range of forecasts for the number of public Electric Vehicle Charging Point (EVCPs), ranging from between 200,000 and 525,000 by 2030.

As outlined by this report, our innovative data driven approach to our EVCI framework tackles a number of constraints recognised by similar forecasting work to date. This framework puts Transport for the North at the forefront of charging infrastructure assessments, and we have worked closely with the UK Government to inform and shape the Sub-National Transport Body role as outlined in the National EV Strategy.

This is recognised by the Sub-national Transport Body role referred to within the National EV strategy and the assessments requested to produce regional assessments to support energy system stakeholders and local authorities in planning charging infrastructure provision. These aspects fill intelligence gaps seen nationally to date, many of which we are completing through launch of this EVCI framework.

"This framework puts Transport for the North at the forefront of charging infrastructure assessments, and we have worked closely with the UK Government to inform and shape the Sub-National Transport Body role as outlined in the National EV Strategy."

Table 2: How TfN's framework has shaped and delivered the role of a Sub-national Transport Body towards EV charging so far

National EV Strategy requests of STBs (National EV Strategy, March 2022)	How TfN's EVCI framework delivers
Produce scenarios for potential demand for EV infrastructure in the region. These may either build on demand assessments from individual local authorities or provide the basis for more tailored demand scenarios for specific local authorities, depending on the status of existing plans across the region.	Our EVCI Framework provides demand based assessments of need, across various future travel scenarios. The evidence is developed for all areas of the North, with capability to access needs at regional, combined authority, local district, or Middle Super Output Area (MSOA)[30] levels. Through developing a regional evidence base for EV chargepoint demand, TfN can support our Local Authorities in their EV rollout activities, noting that Local Authorities are best placed for the delivery and implementation of chargepoint infrastructure through applying their local knowledge and expertise to deliver the best outcomes for their locality. Our evidence can also be applied to inform national policy and strategic decision making.
Identify clusters of demand in the region, including bringing together data on current demand and potential future demand from fleets operating in the region (where possible, this should include demand from buses and other heavy vehicles, as well as cars and vans). This should identify charging demand in areas without off-street parking, and at sites such as depots where many vehicles may be charging overnight. This will help electricity network operators to plan their networks to meet this expected demand.	Covered by our EVCI Framework and our collaborations with the electricity network operators and wider energy sector. Future extensions are possible now that we have a strong and tested evidence base. This can include exploring the possibility for further assessment and understanding of considerations for fleet operations, buses and depot sites. These are outlined in our future steps section of this report.
Identify different levels of engagement and progress within local authorities in the region and locations where additional support is needed to enable planning of local chargepoints.	TfN's regional EV Steering Group encourages collaboration across our region, maintaining a clear understanding of challenges and opportunities faced by local authorities and sharing of best practice and evidence. TfN will continue to monitor and identify areas that STBs can offer additional support to local authority planning and delivery. Our EVCI framework tools also allow us to monitor and evaluate the progress of charging against forecasted requirements.
Highlight examples of best practices between local authorities and foster partnerships between authorities to ensure charging infrastructure is delivered in an efficient and cohesive manner. Successful charging infrastructure deployment will need committed engagement from across sectors.	Our EVCI framework is an example of how partnership and collaborative working can deliver results for multiple parties, across sectors, who are aligned to the same goal. Our regional Steering Group will continue seeking to foster partnerships with our whole systems view towards both planning and delivery of EV charging infrastructure deployment and associated transport, decarbonisation and socio-economic considerations. This may be in the form of supporting publicly funded solutions (either individual or exploring collaborative models which support an economy of scale delivery) or supporting public and private sector engagements.

30. Middle Layer Super Output Areas (MSOA) are a geographic hierarchy designed to improve the reporting of small area statistics in England and Wales. The minimum population is 5,000 and the mean is 7,200.

9.5 Defining an 'adequate' charging network

A key difficulty in forecasting electric vehicle chargepoint (EVCP) requirements lies in defining what is deemed to be 'adequate' EVCP provision. Supporting the North in delivering the density and coverage of chargepoints can support the meeting of our decarbonisation ambitions. However, determining an optimum network must also cover the many social and spatial considerations associated with EV charging deployment.

As far as possible our EVCI evidence has sought to account for all these criteria and seeks to deliver enough infrastructure for the peak demand hour of the year without queueing, and deploys infrastructure within the MSOA of need. With this evidence and EVCI Framework now available, we have the ability to explore and expand on these factors in future activities.

→ Provision

Whether we support the absolute minimum level of provision required, assuming all the EVCPs are optimally positioned and intensively utilised. Alternatively, what level of provision would actually be needed in terms of providing the utmost reassurance to users that there is adequate EVCP coverage/availability.

→ Utilisation and reliability

At present, EVCP utilisation is typically very low - in many cases EVCPs have been installed and available ahead of demand. Or they are sometimes poorly situated or un-reliable. In such instances, there is not an immediate return on commercial investment. As the number of EVs increases this utilisation would be expected to increase.

Decisions will need to extend to whether the focus is on minimising waiting times and maximising user convenience, or maximising EVCP utilisation to improve the investment case. Another example is whether destinations (such as supermarkets, shopping centres, cinemas) provide charging at scale to support top-up charging or 'grazing' by the user, as each location could see a different level of utilisation. In future advancements of our EVCI framework, we will explore what our evidence means for policy choice and business model approaches

This can help to refine our understanding of how to react to demand, which may not be to support or encourage peak load 100% of the time and to support local authorities in identifying sustainable, efficient and commercially viable delivery models in the context of local strategies and plans.

→ Environmental perspective

An 'adequate' level of EVCP can be considered to mean that there is at least enough infrastructure that it does not slow down the uptake of Battery Electric Vehicles (BEVs). Chargepoint delivery should also be appropriate to place and support the mobility hierarchy, as well as place based spatial strategies. Our Major Roads Report[31] sets out how planning for future transport investment, including on new improved roads, should take a holistic and hierarchical account of all options for improving access for people and goods. This will ensure any provision of EVCI does not scupper local modal shift and traffic reduction measures.

→ Social perspective

Adequate' provision could mean the infrastructure is local, accessible and affordable. The wrong balance of charging could negatively impact on the affordability and inclusivity of EVs. Social equity needs to be high on the agenda to achieve targets and wider ambitions. The transition to EV will be more challenging for citizens who cannot access off-street charging, particularly lower income groups. This analysis, and future iterations, can allow consideration towards how we support EV uptake for all who wish to access, or might be impacted by Electric Vehicles.

[31] https://transportforthenorth.com/wp-content/uploads/TFN_MajorRoads_Report_Dec21_V2.pdf

10. A framework which navigates uncertainty to inform delivery

While rapid developments in EV technology and deployment are positive, the low proportions of EVs in our road fleet leads to uncertainty around user charging behaviour and preferences. Assessing public EVCI requirements is complex, and depends on a wide range of factors, including charging behaviours, off-street parking availability, technological developments, and mobility trends. This presents a number of challenges for EV infrastructure planning and decisions, and may also have major spatial impacts with regards to place-making and electricity grid requirements.

Applying TfN's Future Travel Scenarios to navigate uncertainty impacting user travel needs

Even before the Covid-19 pandemic, the effects of the digital age colliding and merging with the motor age over the last two decades were becoming apparent in our daily lives. Long-run trends of relevance to travel and transport have been changing (in the UK and other countries). Technology-based innovations are a source of ongoing potential disruption and change. Now underscored by Covid-19 and its effects, there is deep uncertainty regarding what the future has in store.

Recognising the need to ensure that our policymaking and statutory advice should account for a sophisticated range of future uncertainties, in 2020 TfN completed work on identifying four plausible Future Travel Scenarios[32] looking ahead to 2050. Our scenarios take a whole system view to capture environmental, social, spatial, economic, technology drivers of change to understand how the user might wish to engage with the transport system.

[32] https://transportforthenorth.com/future-travel-scenarios/

Just About Managing

This scenario sees a state of inertia, although this should not be taken as neutral. It sees a future where people do not alter their behaviours much from today, or give up certain luxuries, although there is a gradual continued trend towards virtual interaction. Economic growth continues at a moderate rate, but it is largely consumption-led and unequal, lacking agility and vulnerable to shocks. This scenario is led by markets, without much increase in political direction, with its biggest driver being economic

Digitally Distributed

This scenario sees a future where digital and technological advances accelerate, transforming how we work, travel and live. In general, we embrace these technological changes and the move towards a distributed, service-based transport system. Long-term climate change targets are met, but there is slow progress in the short-term due to a general preference for individualised mobility over traditional public transport. This scenario is led by technology, with the biggest drivers being technical advances and a willingness to embrace mobility-as-a-service and shared mobility in the long-term.

Prioritised Places

This scenario sees a significant shift in political and economic direction to ensure that no place is left behind. Every area, including cities, towns and rural and coastal areas, has a bespoke local economic strategy, supported by investment in local assets, specialisms and economic and social infrastructure. Community, localism and place-making across the North is applied to build a sense of local identity to improve local economies. There is a focus on work-life balance and social equity within and between places. This scenario is led by a change in priorities, with its biggest driver being the push for a fairer redistribution of economic prosperity.

Urban Zero Carbon

This scenario sees a significant shift in public attitudes towards action on climate change, and strong national Government response to meet it. There is a boost to economic productivity to levels consistent with the NPIER, primarily through a combination of urban agglomeration and place-making. Transport users demand and embrace publicly available transit and active travel options, as there is a blurring of the line between 'public' and 'private' with increasing shared mobility systems online. This scenario is led by attitudes to climate action and urban place-making, with the biggest drivers being strong Government policy and trends of urban densification.

Using our scenarios is a key tool to help manage the uncertainty around the share of vehicle fleet which is EV (BEV or Plug in Hybrid Electric Vehicle (PHEV)), vehicle mileage, and ownership trends which impact EV charging needs. They ensure we are adaptable, and can make decisions based on new evidence over time as the market matures and more evidence around consumer behaviour, preferences and technology emerge. By taking this agile approach, we can reduce any unintended consequences of a charging category approach which is not suited to a particular location or user group. This can mitigate risks of obsolete infrastructure, forcing new and unintended journeys and consequences, or behaviours to the detriment of uptake in active and public travel across the region and locally.

EV user charging behaviours

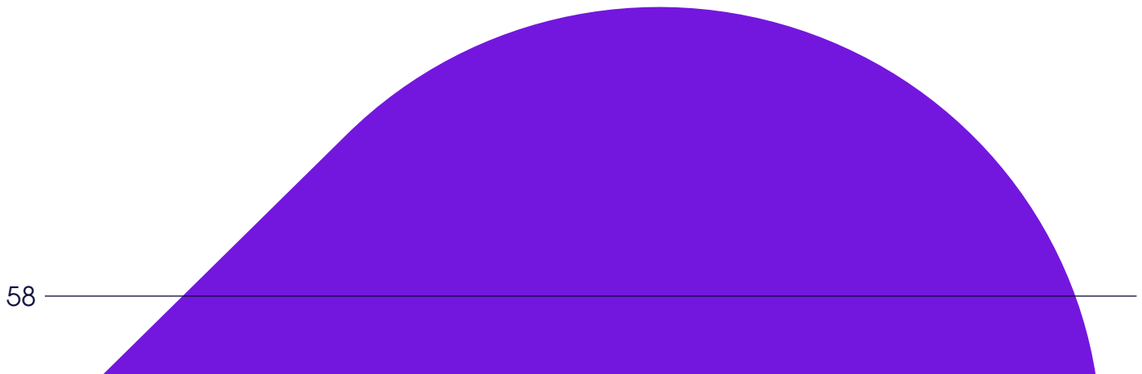
Charging behaviour is one of the greatest unknowns for EVs. User charging preferences are currently not well understood, even by the consumers themselves, as we have not lived with a BEV long enough to form a robust preference.

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 (~80% of kWh delivered), but this ratio may change over time. Similarly, there are some contrasting views, as to whether in the future EV charging habits and infrastructure will pivot more decisively towards a larger proportion of charging at ultra-rapid charging hubs. Others anticipate continued high levels of home and workplace charging, or greater destination charging supporting 'grazing' behaviour.

To account for uncertainty regarding user charging behaviour we have explored a number of charging behaviour sensitivities, and TfN's EVCI model enables the impact of changes in these assumptions to be considered through adjustments to key input factors, to see how they may affect infrastructure requirements.

Advances in vehicle and charger technologies

Future chargepoint requirements will depend on EV battery size, range, efficiency and charge acceptance rates on the vehicle side, average chargepoint charging rates and the number of vehicles which can be supported by each unit. As these increase, this potentially enables each EVCP to support a larger number of EVs. There has been a steady upward trend in all of these aspects, and that trend is expected to continue.



- **EV battery size, range, efficiency and charge acceptance rates on the vehicle side** - Improving vehicle efficiencies (miles per kWh) have implications for charging requirements, as larger ranges and battery capacities will lessen the need to stop at an intermediate charger en-route.

- **Average chargepoint charging rates** - EV charger technology is evolving, with increasing charge rates being delivered at up to 400kW/900V+, as well as improved functionality and ease of payment, scalable lower cost deployments and smart load management. Faster charge rates (kW) and an increasing number of vehicles supporting ultra-rapid charging potentially means a greater share of charging could be delivered by fewer chargers. A further consideration is the legacy charge points, whether these are upgraded, and what these mean for the average charge rate.

- **Number of vehicles which can be supported by each unit** - Charger utilisation is expected to increase over time, meaning the ratio of electric vehicles supported by each public charger evolves over time. This is illustrated by analysis by the International Council on Clean Transportation (ICCT)[33] which forecasts the ratio of electric vehicles per normal speed charger to rise. Estimating that standard chargers (AC, up to 22kW) will go from being able to support up to 10 EVs in 2020, to 16 EVs by 2030. For rapid (43kW plus) charging, they anticipate the number of EVs per charger increasing from 66 in 2020 to more than 300 in 2030. Faster charge rates (kW) and an increasing number of vehicles supporting ultra-rapid charging potentially means a greater share of charging could be delivered by fewer chargers.

However, whilst we have seen a rapid shift in vehicle and charging technology, these remain key uncertainties. Charging as we know it today is very different to the refuelling behaviours experienced with combustion engine vehicle. The turn up, top up, and go model that the user is used to, is not replicated by the current electric charging capability. Even with a rapid charger, the user experiences a longer wait when using an EV, which may put new users off from purchasing an EV at present. Congestion is potentially more likely without adequate provision, which may cause network problems, especially on major roads. Rapid and super-rapid charging in particular carry a significant demand on the power supply and distribution networks, often with high costs and challenging geographic deployment issues.

Our EVCI model captures many of these trends with intelligence towards EV vehicle power capabilities, charger speeds and utilisation over time. Inputs and assessments will be regularly reviewed in future to ensure they represent any new evidence or behavioural insight in response to technology advancement.

[33] https://theicct.org/wp-content/uploads/2021/06/UK-charging-gap-082020.pdf

11. Building regional EVCI evidence capabilities

11.1 Applying TfN's regional transport modelling capabilities

Our work on EV charging infrastructure takes advantage of our powerful and innovative Analytical Framework engine[34]. The Analytical Framework aims to provide a consistent approach to data, modelling and appraisal across all pan-Northern travel modes and regions of the North. It provides the basis to generate comprehensive evidence to support TfN programme activities. Our Analytical Framework:

- Balances local detail with regional scale and builds a consistent approach to modelling (MSOA level upwards).
- Models the whole regional surface transport demand and network, including road and rail, passenger and freight (current and future demand).
- Captures transformational wider economic and social impacts.
- Represents the impact of non-transport policies (e.g. land-use).
- Aims to realise economies of scale by making our data and tools shareable with local partners and stakeholders

Using the TfN Analytical Framework as the engine for our evidence development, we have built an EVCI model to provide an evidence base for forecasting EV infrastructure requirements across the North of England. This model applies a wide range of datasets (see Table 3) to measure levels of demand for different types of EV charging points.

[34] https://transportforthenorth.com/tame/

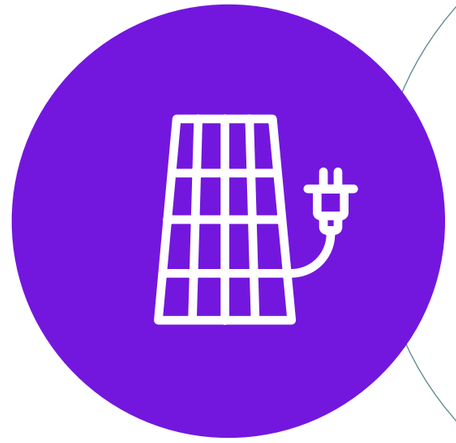
Table 3: TfN's data capabilities which enable our enhanced EVCI requirement evidence

Data inputs	Segmentation (every year to 2050, and geo-spatial disaggregation at MSOA geography across the region)
Population and households	Socio-economic group; Occupation and traveller type; Car availability; Household size
Housing	Flat, Terraced, Semi-Detached, Detached
Employment and jobs	Skill level; Employment status and EV uptake across the fleet according to ONS socioeconomic income segmentation
Travel demand	• Origin and destination of user movements; • Mode (car, rail, bus, walk, cycle); • User class (i.e. commute, business, non-work); • Purpose (user class + detail in other e.g. education, shopping, leisure etc); • Seasonal variation; • Time period (AM, inter-peak, PM).
Vehicle flows on roads and electric vehicle uptake	• Regional highways model providing a whole network view. • For car, van, HGV movements • EV uptake across the fleet for different decarbonisation pathways
TfN Future Travel Scenarios	The travel matrices for the four TfN Future Travel Scenarios cover the agreed set of forecast years, time periods, fleet make-up and emissions

11.2 Developing a pan-Northern EV charging infrastructure model

Our TfN data inputs are combined with the latest research intelligence of EV charging behaviours, utilisation and power usage, in our EVCI modelling to develop the latest understanding of charging need across the region.

Our Statement of Method[35] outlines the full technical approach, data sources, inputs and outputs for our EVCI framework evidence base. This has been published alongside this report. For any additional information or queries regarding data usage, please contact data.requests@transportforthenorth.com.



[35] https://transportforthenorth.com/EV-charging-infrastructure

Our modelling has been based on current known and widely used chargepoint technologies, future technology solutions are likely to enter the chargepoint / EV market that may transform current assessments of consumer chargepoint demand. This is based on current industry knowledge, and benchmarked by an understanding of similar research from the Committee on Climate Change (CCC) and the ICCT, as recorded in our Statement of Method. The inputs, processes and outputs of our work has also been peer reviewed by academic partners at DecarboN8[36] and ITS Leeds[37].

Our EVCI model sits within our in-house Analytical Framework, providing TfN and our partners with the capability to update considerations and understanding of needs as more information arises.

Figure 9 summarises the key steps taken during our evidence development in the EVCI model:

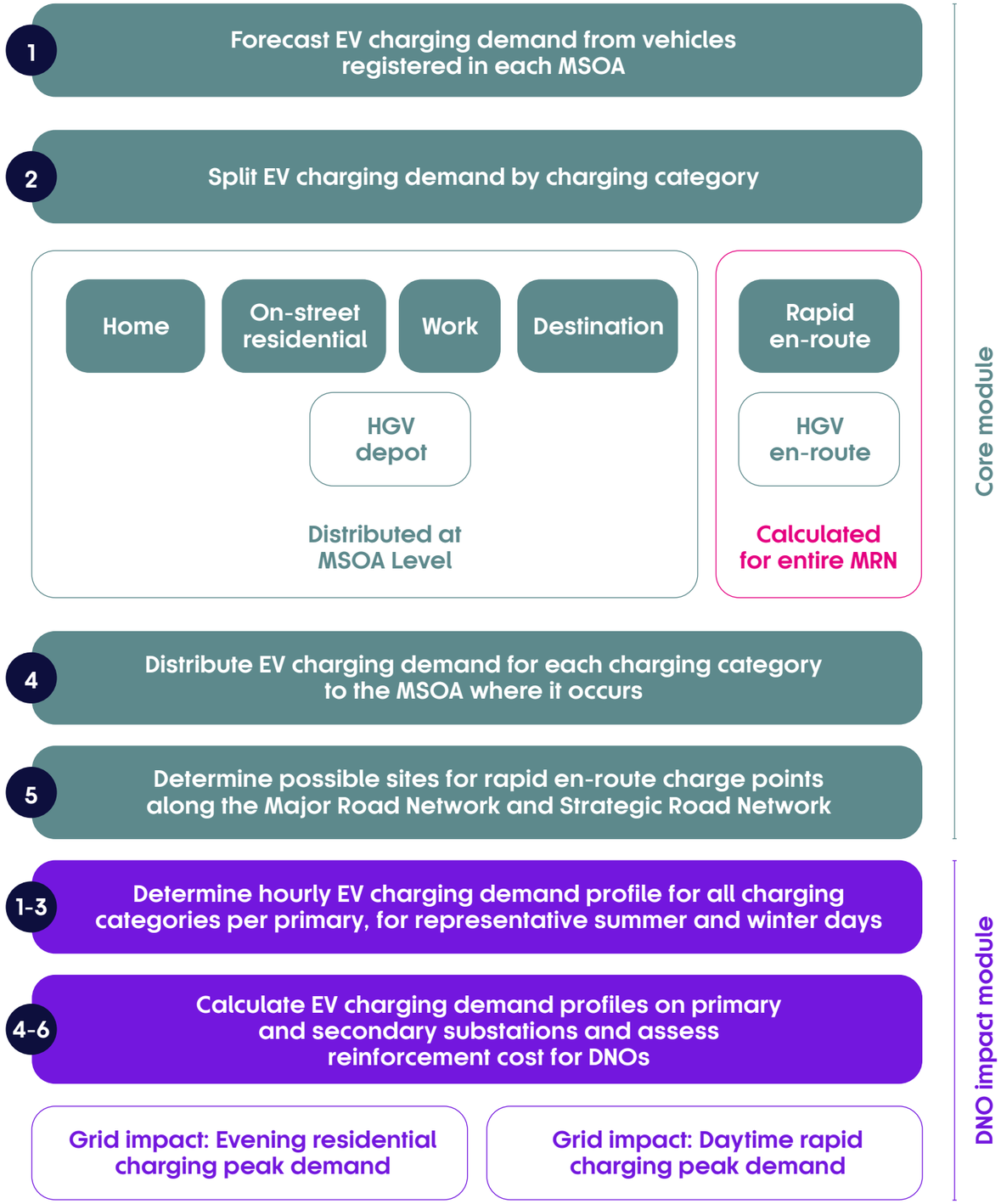
- **Core Module, Steps 1 to 4** identify what, where and when different chargepoint types are required to support car, vans and HGVs. This is produced across different geospatial areas, for different travel scenarios and charging behaviour states.
- **Core Module, Step 5** develops indicative locations for rapid en-route charging on the Major Roads Network (MRN) and Strategic Roads Network (SRN).
- **DNO module, Steps to 1 to 6** provides an indication of the impact of EV charging on the electricity distribution network and how these might vary dependent upon rate of EV uptake[38].

[36] https://decarbon8.org.uk/

[37] https://environment.leeds.ac.uk/transport

[38] It is outside of project scope to model non-EV customer demand and to consider overall demand on individual substations. However, our analysis provides the DNOs with data on EV requirements they can use to support planning for a resilient distribution network and is sufficient to give an indication of likely network costs.

Figure 9: High level steps taken to build TfN's EVCI framework evidence



11.3 How regional assessments of EV charging infrastructure can support the National EV Strategy

The National EV strategy outlines the inherent uncertainty regarding the EV modelling results as the electric vehicle and chargepoint market is still at an early stage of development. It rightly points to the large amount of uncertainty about future consumer preferences and behaviour, and how the market will respond to these. Our EVCI Statement of Method also points to similar uncertainties and trends or evidence which TfN will monitor and review in order to remain agile to future developments.

TfN's regional EVCI modelling tools can provide more detailed regional insights than provided by the National EV strategy, an approach that supports national EV policy and our regional and local partners in developing their delivery plans.

Table 4: How TfN's regional EVCI framework supports and informs evidence in the National EV Strategy

Data inputs	OZEV / DfT modelling	Transport for the North EVCI model
Time Periods	Demand mapped to 2030.	Demand mapped in 5 year increments 2020 – 2050
Geo-spatial disaggregation	Averaged Nationally. Recognised that further analysis utilising area-specific inputs would be required to forecast requirements at a more granular (i.e. local) level.	Yes – to MSOA (local specific) level, applying transport, land-use and socio-economic inputs at this level. EV purchasing behaviour and fleet uptake assessments based on localised socioeconomic income and occupation classifications. Providing a fuller understanding of potential high and low EV uptake zones.
Assessment of demand variation impacts	DfT's modelling does not provide outputs to indicate variation beyond the national average day.	Our EVCI tool applies origin and destination of trips, trip purpose, time of day considerations, visitor economy data – providing more intelligence on peak, average day and seasonal peak comparison ability
Assessment of need by chargepoint category and locations of needs	Need by different chargepoint category averaged nationally. Highest and lowest bounds of the estimated range across vehicle mileage and behavioural scenario assessments.	Specific place based charging needs identified at MSOA level. Our MRN location tool identifies potential suitable locations for en-route charging across the region, based on highway network movements and MSOA level evidence.
Scenario based assessment	Modelling covers some consideration of different vehicle mileage; where drivers prefer to charge; how frequently drivers charge; how long drivers occupy a chargepoint.	Application of the Future Travel Scenarios provide a detailed picture of plausible future developments and their impacts on travel demand volumes and patterns; trip purposes; socio-economic and spatial impacts across the region. The built in EVCI charging behavioural sensitivities cover a wider range of the uncertainties that will influence EV charging requirements. Allowing us to assess requirements based on a richer picture of user needs and demand, but also adapt our evidence to remain fleet of foot.
Energy demand	Averaged equally across all days of the year. As such, the projections reflect the number of chargepoints required to meet peak demand on an average day; they do not reflect the number of chargepoints to meet peak demand on the busiest day of the year.	Determines hourly EV charging demand profile for all charging categories per primary substation, for representative summer and winter days. Provides overall peak for EV charging demand on primaries and secondaries and allows for assessment of reinforcement costs for DNOs
Vehicle licensing data - some vehicles are licensed to the business address rather than place of use.	Challenge noted by both models. TfN's Framework can be viewed either: - on real world historic registrations and future year projections of these. Which will amplify the spikes in areas known to contain registered fleets; or - with EV purchasing behaviour and fleet distribution based on socio-economic income, which has the effect of 'smoothing' these rare spikes based on a fuller assessment of the likely general EV purchasing behaviour. TfN will look to collaborate with fleet associations to obtain more data and intelligence where possible.	
Modelling has been based on current known and widely used chargepoint technologies.	Challenge noted in both models. Future technology solutions are likely to enter the chargepoint / EV market that may transform current assessments of consumer chargepoint demand. TfN's in-house EVCI framework provides the capability to monitor and update our modelling settings as new trends and evidence arises, so we remain agile to future developments and change.	
Chargepoint utilisation	Modelled chargepoint numbers are required to meet the direct charging demand of EV drivers, rather than to incentivise uptake or minimise installation or energy system costs. TfN's model provides capability to undertake further work informing utilisation and delivery models for specific local areas, as outlined in the next steps section of this framework report.	

12. What our EVCI framework evidence tells us

12.1 A mixture of charging infrastructure is needed to support our region's travel movements and decarbonisation aims

By applying our transport understanding and modelling capabilities we can identify the amount and type of charging needed to support anticipated travel movements. Charging infrastructure should, where possible, meet a user's requirement and behaviours rather than influencing new and unintended consequences or journeys.

Our evidence identifies that between 27,600 and 48,000 publicly available non-rapid[39] EV chargepoints, and between 12,000 and 26,000 rapid[40] chargepoints, will be required across the North by 2025[41] to support our regional decarbonisation ambitions. This demand forecast rises throughout the 5-year increments to 2050, but it is the 2020s that sees the most significant demand growth to support rapid decarbonisation of the fleet, with further rises to a regional requirement of 90,000 and 100,00 publicly available non-rapid chargepoints 33,500 and 61,200 rapid chargepoints by 2030[42]. Figure 10 indicates how our framework provides evidence for a mix of charging solutions across the North.

These results are for the region as a whole, but can be viewed by particular areas of the North in our EVCI visualiser interactive tool.

Our evidence suggests a large proportion of publicly available electric vehicle chargepoints will be required in public residential areas (e.g. on-street, in public car parks, local charging hubs) to supplement at-home charging, compared to lower needs of destination (e.g. supermarkets, gyms, etc.) and en-route rapid charging.

[39] On-street, work, destination, HGV depot (slow to fast charging between 7kw and 22kw; averaging 1 – 8 hours charging currently)

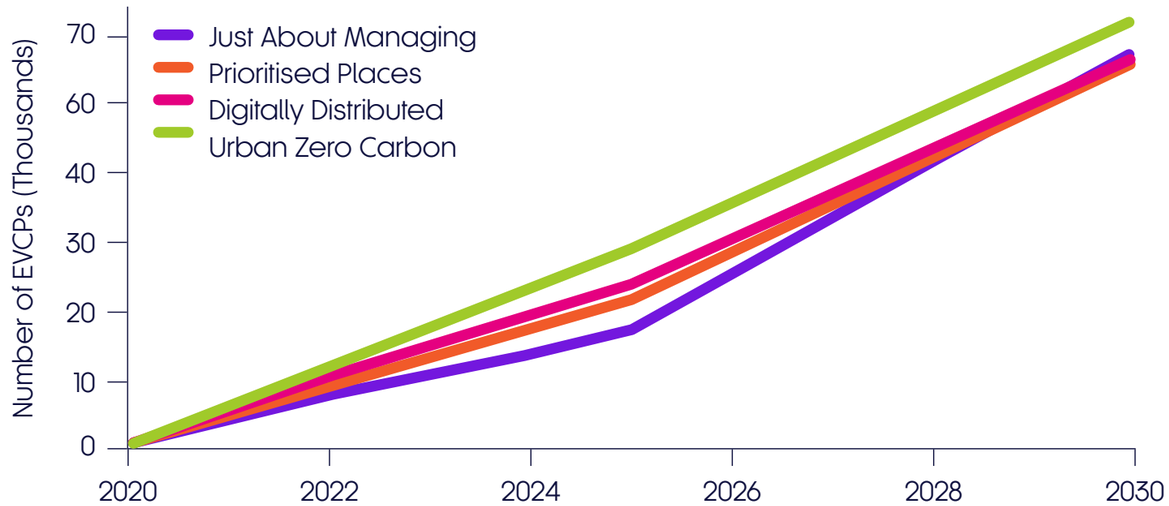
[40] Rapid on the move charging (50kw and above, averaging 1 hour or less charging currently)

[41] Outputs have been developed across different future travel scenarios and charging behaviours to understand the range of possible requirements.

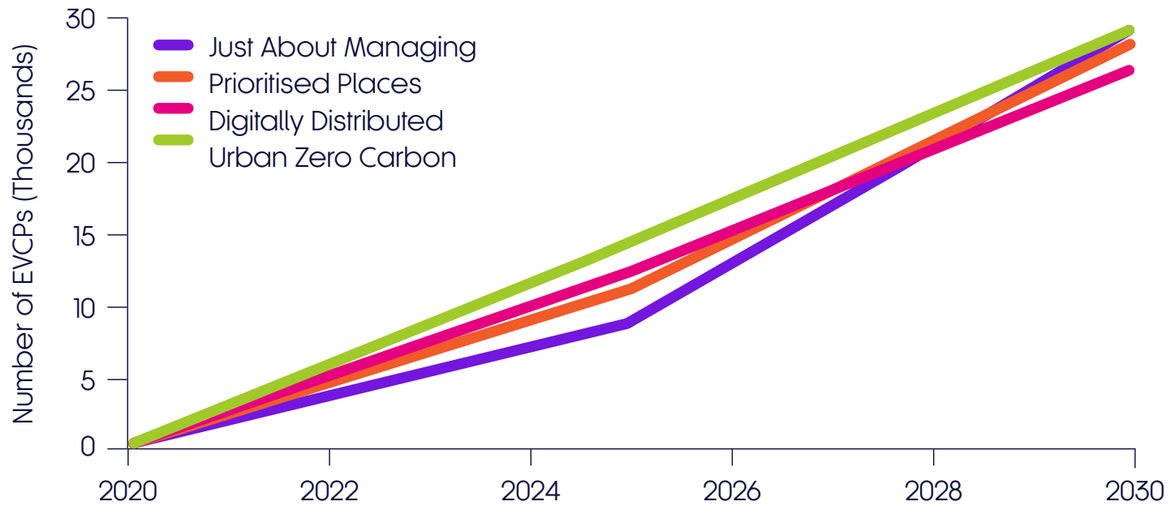
[42] Calculations based on 3.3 – 4.6 million electric vehicles on the road by 2030. Range developed across TfN's Future Travel Scenarios.

Figure 10[43]: Total charge point requirements for the North of England, by charging category, during the 2020s.

Public residential EVCP numbers (baseline charging behaviour scenario in the North)

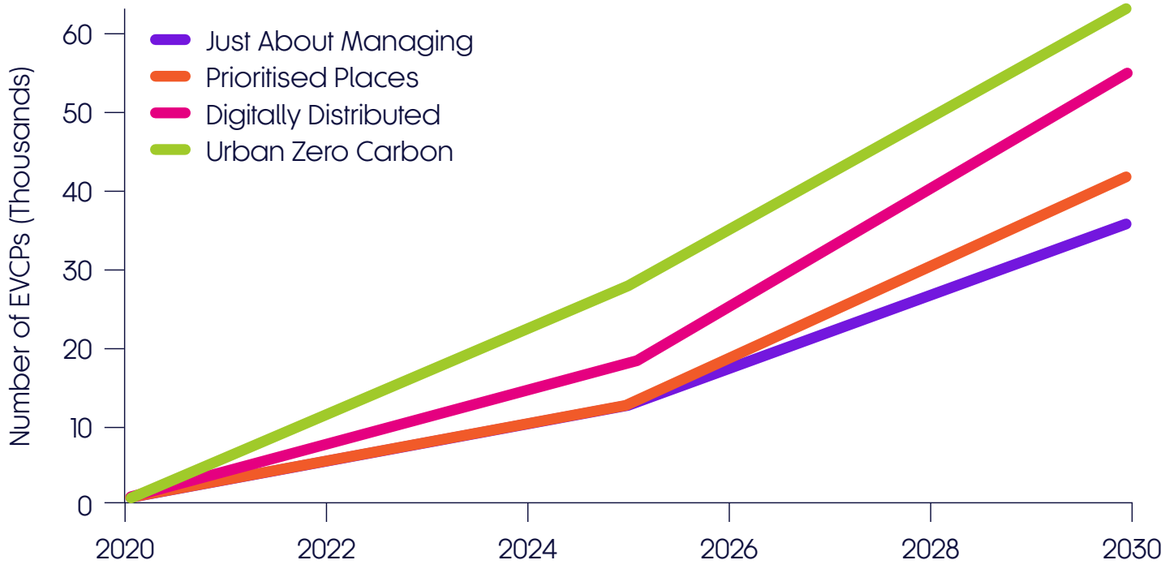


Destination EVCP numbers baseline charging behaviour scenario in the North)



[43] While most TfN models use a 2018 baseline, some data required by the model is output from 2020 onwards. Consequently, the first year with full data available is 2020, as shown above.

Rapid EVCP numbers
(baseline charging behaviour scenario in the North)



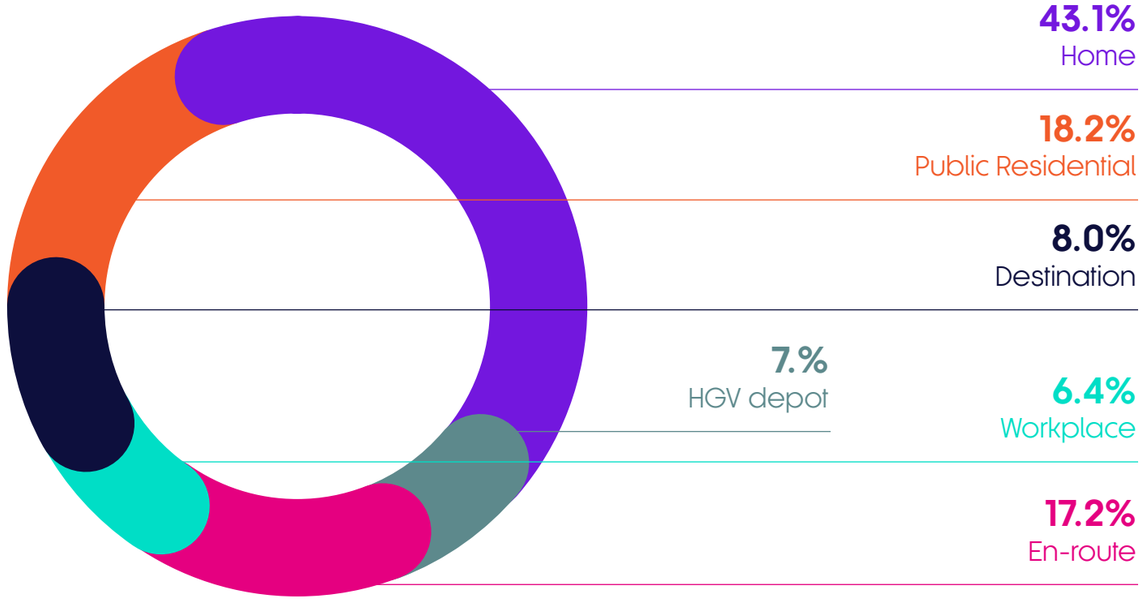
The breakdown of chargepoint categories seen in Figure 11 and reflects our evidence of travel patterns outlined in the Major Roads Report, with around 65% of car trips in the North being 10km or less. With current evidence suggesting more people may undertake short journeys for everyday activities, TfN also has an aspiration to support non-car or shared travel for such journeys where possible. These trips are likely to see top-up, or grazing, charging behaviours on more local roads than seeking diversions to the MRN for rapid en-route charging.

En-route rapid EV charging is likely to be regularly used by high mileage drivers, and only occasionally by the majority of other drivers. However, all drivers will want confidence that rapid chargers will be accessible when needed. Rapid and super-rapid charging presents challenges for the electricity grid (both in terms of upgrade and re-enforcement) and will require particular whole systems planning to achieve best results. It some instances, this may mean we do not see rapid charging locations in the same way we see petrol station locations we are used to. Applying the evidence developed, we have been able to identify potential locations for en-route rapid EV charging across the MRN and SRN.

As a further example, Figure 12 indicates what these breakdowns of chargepoint requirements look like for a section of the Liverpool City Region area. Our interactive visualiser tool allows the user to zoom in on any part of the North of England, to view similar place specific results.

Figure 11: 2025 charger demand by charging type, in TfN's Just About Managing and Urban Zero Carbon Future Travel Scenarios

JAM 2025



UZC 2025

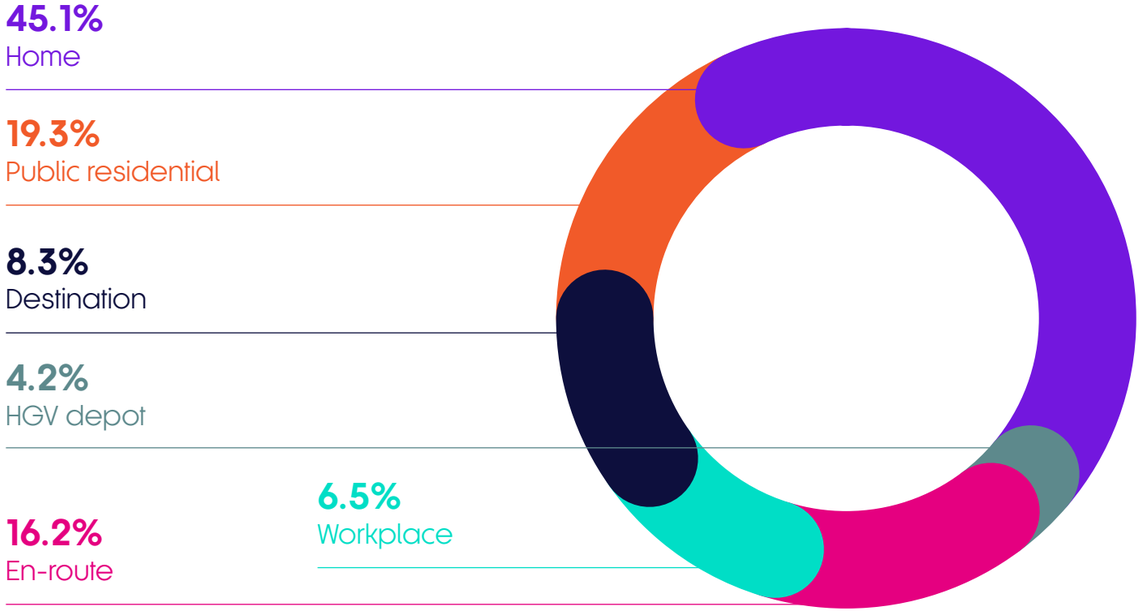
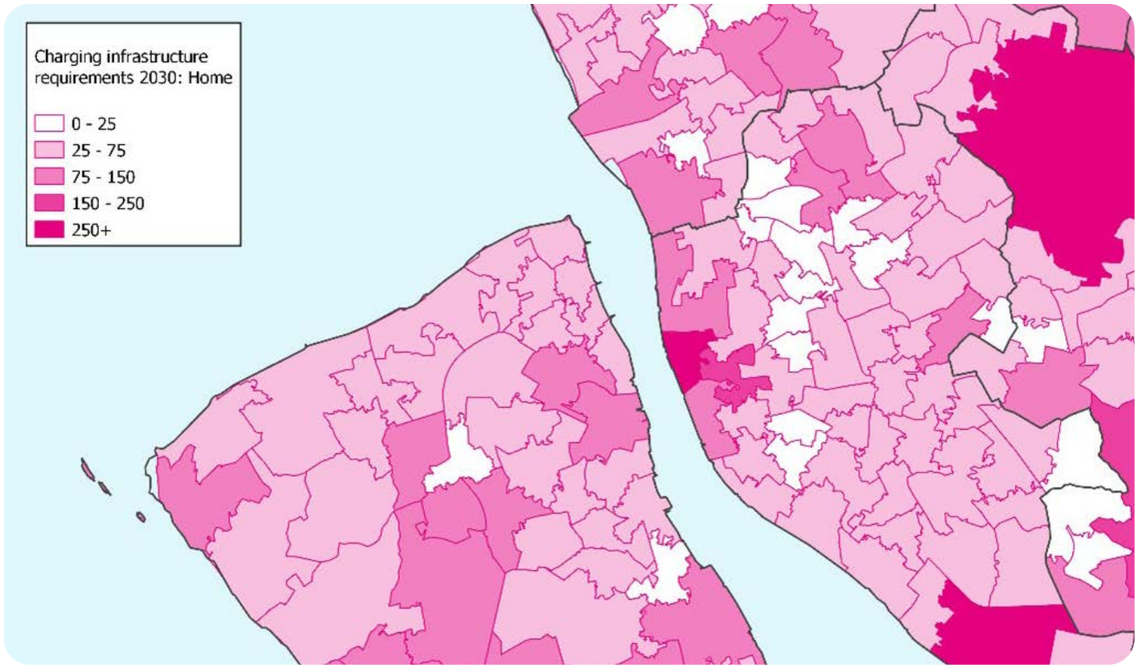
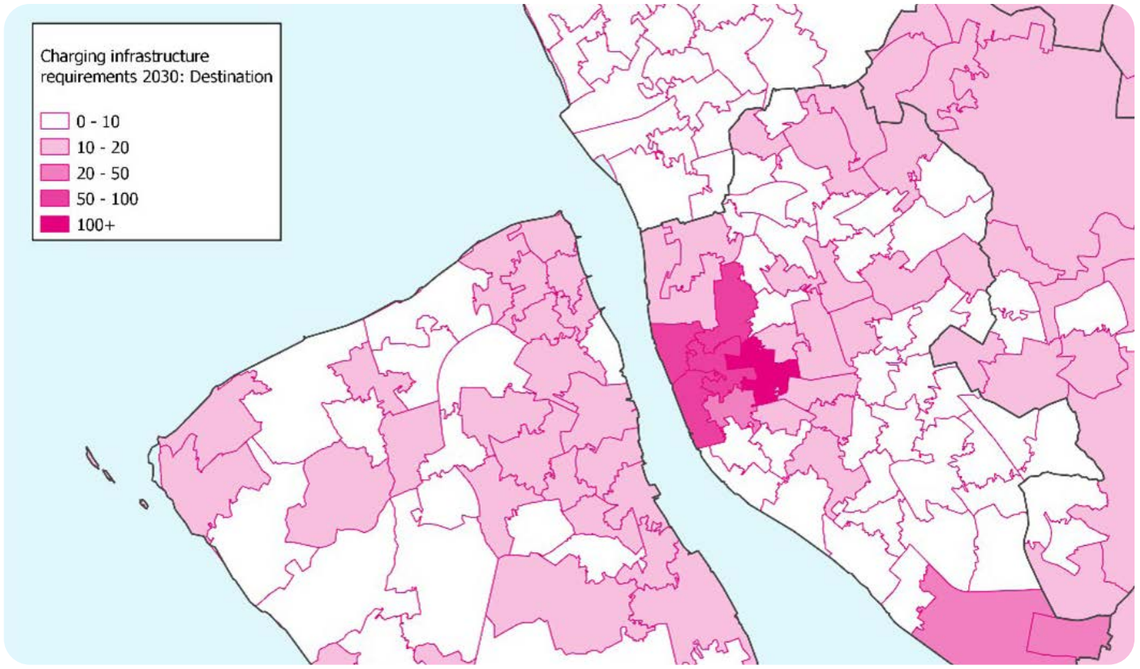
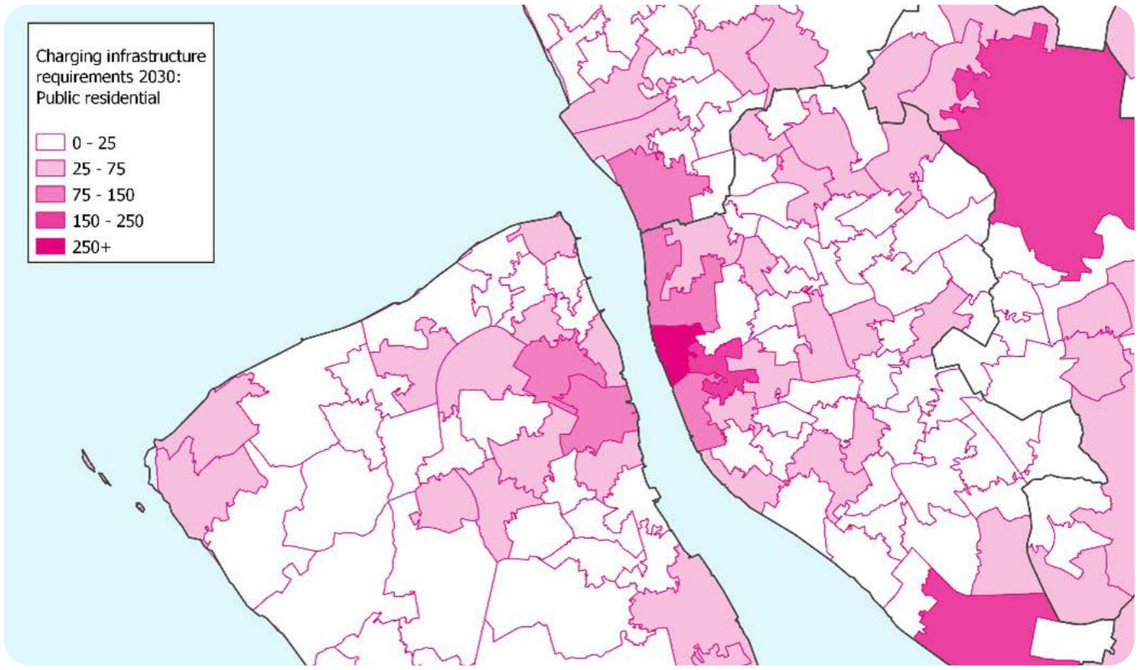
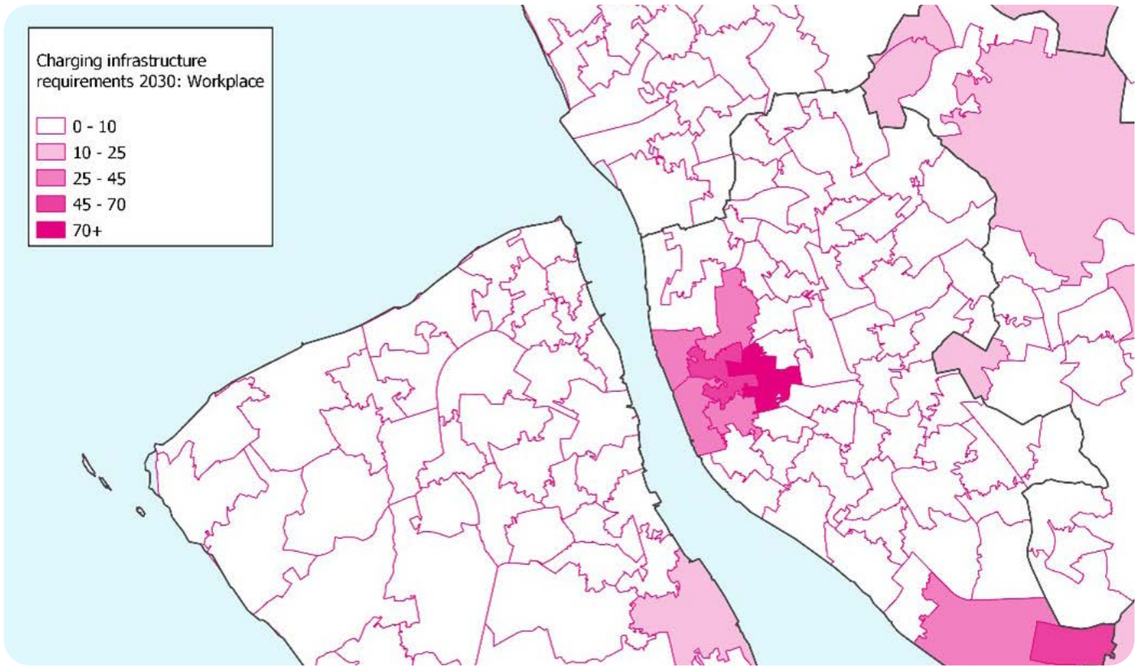


Figure 12: Forecasted mix of charging requirements identified for a section of the Liverpool City Region (by 2030, under TfN's Digitally Distributed scenario)









12.2 The right charging infrastructure, at the right time, in the right place across our region

Our framework evidence identifies charge point requirements to meet the needs of all place types across the North. Private sector interest is often focused around the most commercially attractive sites, meaning some areas are likely to be left behind if left solely to market forces. TfN's EVCI evidence identifies the needs right across the region to maintain a whole network view that reaches all users in the region. This framework evidence can support further work to identify the best delivery solution within different local areas, as well as de-risk private sector investment.

It also recognises that the distribution of EV chargers is complex and there are large differences in EVCI needs between areas of our region. Charging need can also be presented in different ways. Figure 13 provides an indication of charging needs by density, whilst Figure 14 shows total public residential charging need. In both, the results outline the charging needs to meet local demand as modelled by our EVCI framework.

When viewed by density, we see higher numbers in urban areas due to high populations and housing, higher number of second-hand vehicles (with the spread of second-hand cars likely to be quicker in these areas too), higher levels of destination charging (shopping, entertainment etc). However, as shown by Figure 14, a large rural or coastal LA with a low EVCP density can still require a large number of chargepoints to meet demand. Communicating this demand and that opportunities for charging solutions to be successfully deployed across the region is key if we are to achieve a whole network coverage which supports users in making a effective and efficient transition to EV. This can be viewed in our EVCI framework visual platform, and explored for all areas and place types in the North of England.

Figure 13: Requirement for public non-rapid EV charging, by density, for the Northeast of England in 2030 UZC scenario (at MSOA level)

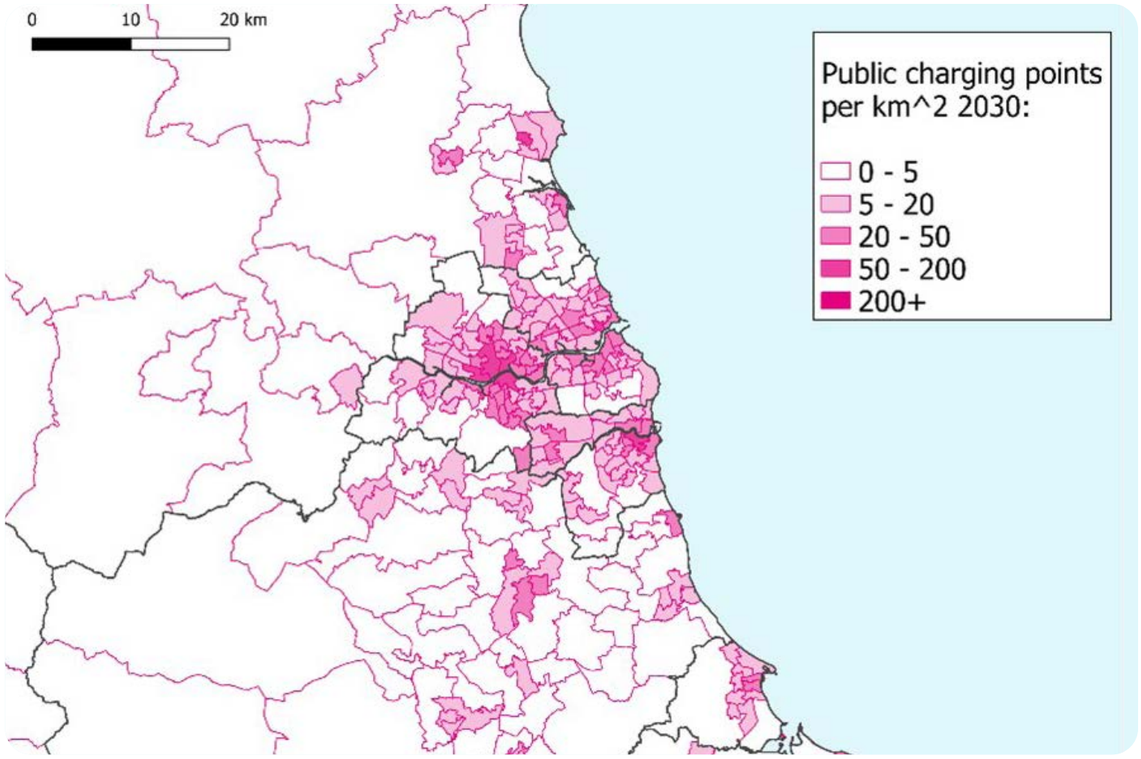
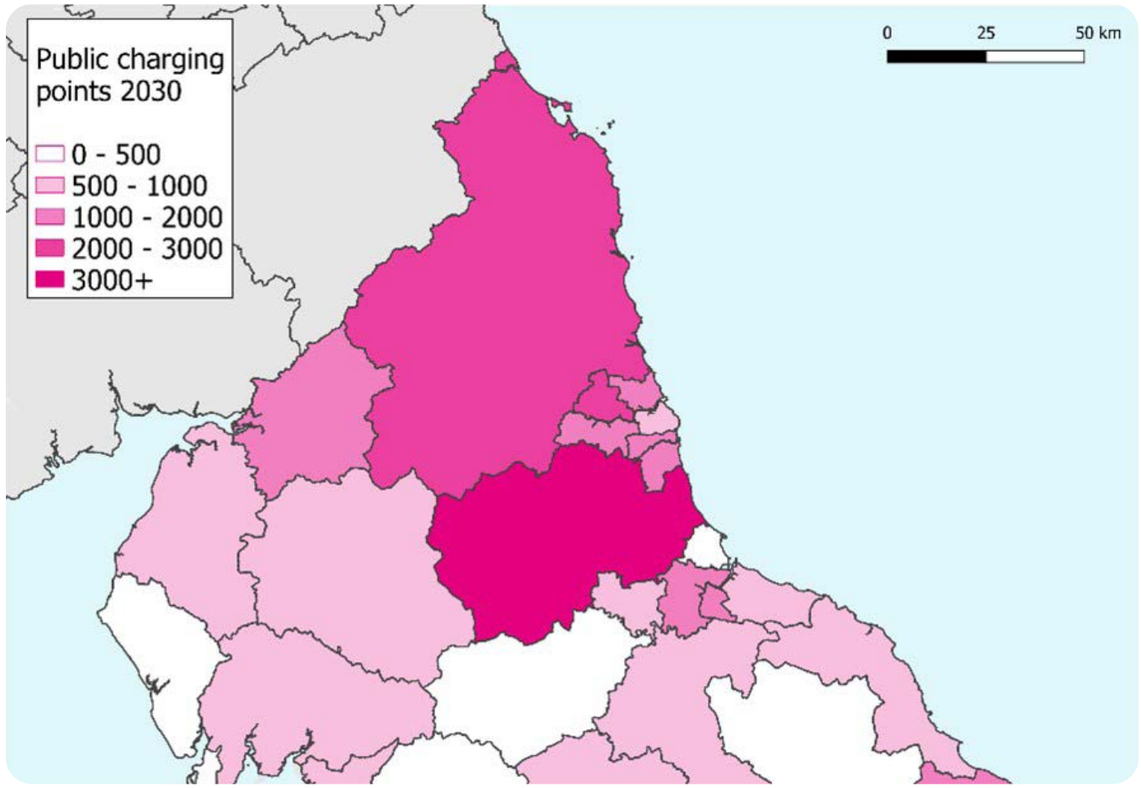


Figure 14: Total requirement for public non-rapid EV charging for the Northeast of England in 2030 DD scenario (by Local Authority area)



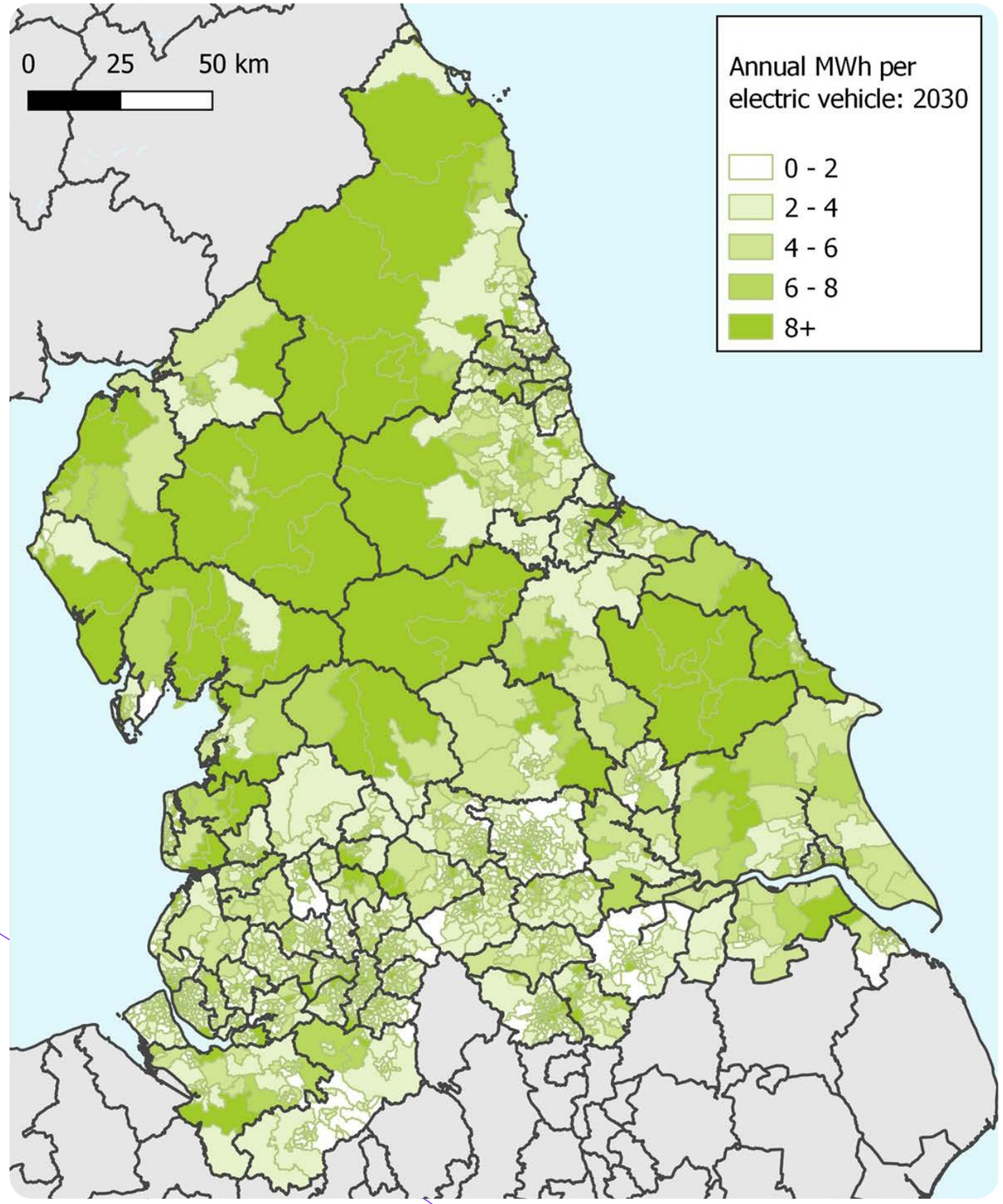
Our framework analysis has demonstrated the importance of providing adequate levels of public charging infrastructure, with the greatest focus being in supporting areas more reliant on this infrastructure, i.e. areas with more limited access to off-street parking. EVCPs should therefore be delivered slightly ahead of anticipated demand, to ensure sufficient ratios of EVCPs to EVs are provided, ensuring appropriate baseline coverage is provided, but tailored to the requirements of the local area.

12.3 Understanding visitor economy and impacts of long-distance transboundary movements

For the first time, we can apply our understanding of visitor economy demands to the regions considerations towards EV charging infrastructure. By drawing on TfN's visitor economy data, we can compare average day (no seasonal variation factors applied), and a peak day (highest seasonal variation factors applied) demands for the various charging categories. Figure 15 shows how we can apply our intelligence of regional travel movements, public charging demand, and fleets – to identify areas which draw visitors and charging need to them. All non-rapid charging categories other than HGV depot charging are affected by seasonal variation factors. The darker green areas on the map are areas that attract more public charging demand than is created by vehicles registered in the same area. This gives us the ability to understand any impacts on areas sensitive to weekend and holiday trips and undertake further assessments, such as annual variation analysis to support deployment and utilisation planning.

This can be used to highlight city centres where people may visit for commercial and leisure activities. But we can also see the impact of longer transboundary journeys in rural and coastal areas which have lower populations, but public charging demand remains high due to through movements and significant visitor economy and high tourist activity.

Figure 15: Ratio of charging demand to electric vehicles registered in each MSOA



12.4 Informing business models to suite place based requirements

Our EVCI framework can inform an understanding of suitable business cases for different locations, to help our local authorities navigate different needs, but also ensure we deliver a comprehensive whole network solution.

Densely populated urban areas will attract high levels of public charging demand relative to vehicles registered in these areas. Chargers in these areas are likely to attract consistent demand throughout the year, so can be installed with confidence that they will be well utilised all year. Whereas some rural areas will also attract high levels of public charging demand relative to vehicles registered outside of their immediate area.

However, as this additional demand is from tourism and tends to be highly seasonal, utilisation of charge points will vary more throughout the year – meaning infrastructure could either be deployed to meet peak demand and have low utilisation off-peak, or be sufficient for an average day but lead to queuing on busy days.

Utilisation is an important consideration when considering delivery models for EV charging, and this will mean different choices in different areas. Our regional evidence base provides valuable insights to support those considerations which will need further local intelligence and decision making.

12.5 Strategic assessment of suitable sites for rapid charger hubs on our major roads network

TfN's Rapid Charging Site location tool

This tool draws from our EVCI model, and its key results can also be viewed in our main EVCI visualisation platform. This enables the strategic identification and assessment of potentially suitable sites for rapid charger hubs for en-route charging along the SRN and MRN. This tool and its wider supporting information is maintained by TfN. There are key outputs from the model which will inform future planning of EV infrastructure, such as highest levels of on-street parking, longest journey lengths for en-route charging, and areas with greatest environmental constraints.

The Rapid Charging Site location tool considers 14 data points, drawing from our travel and land-use regional evidence base, as well as the evidence developed in our EVCI framework. Descriptions of these data inputs can be found in our EVCI model statement of method. The ranking of these factors alongside geographic (i.e. distance to junctions; existing chargepoints) and constraints (i.e. green belt) results in the identification of highlight hot spots for prospective en-route charging sites.

Our EVCI model and regional evidence base can assist in providing supporting analysis when identifying suitable areas for deploying chargers, or in helping LAs identify where public sector led deployments are most required. We are also working with National Highways, and with OZEV to ensure our regional charging evidence informs the Government's plans for charging on the Strategic Road Network and Major Roads Network.

This section summarises how our Rapid Charging Site location tool identifies these potential sites for rapid charging, and its capability to draw out associated considerations.

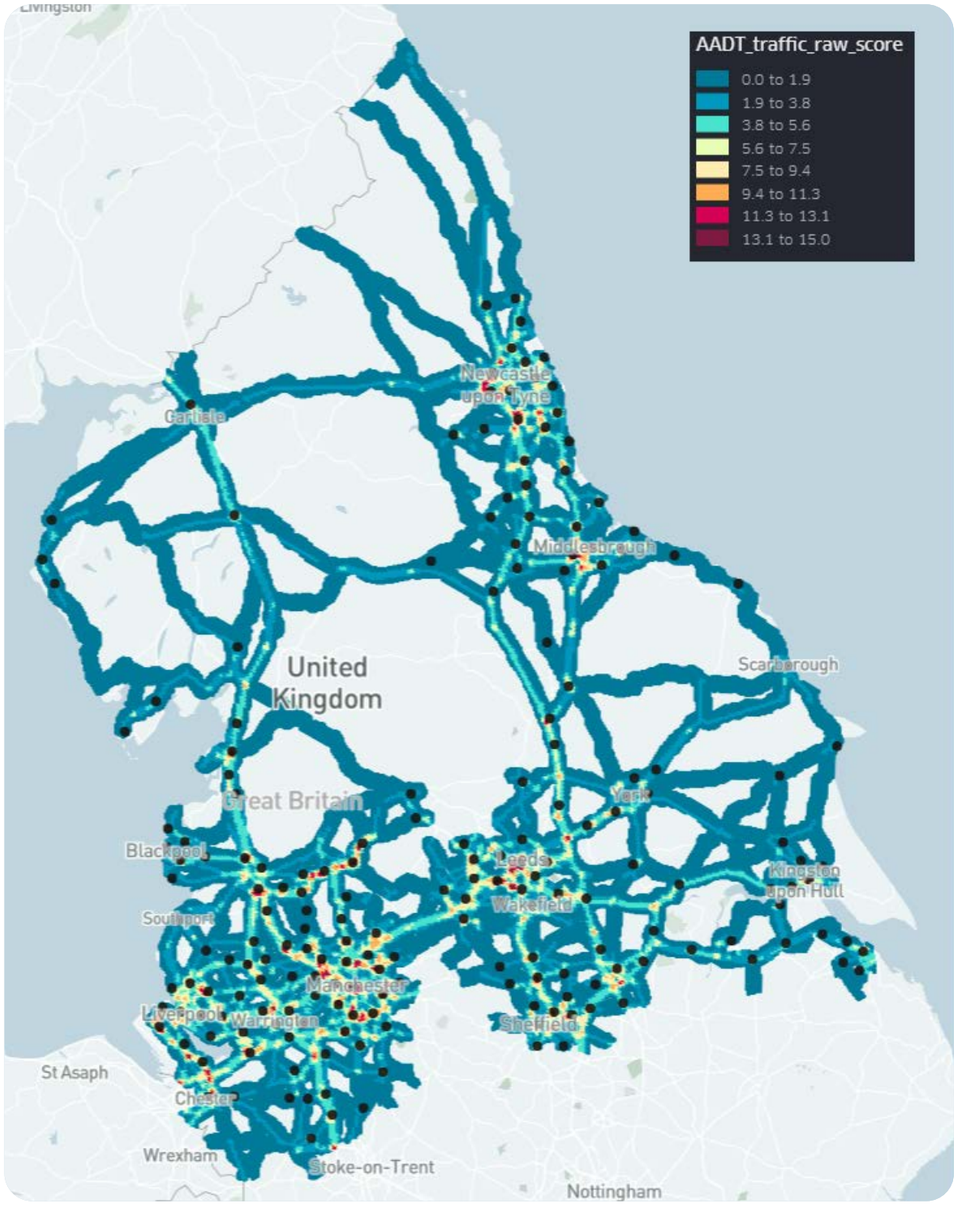
Core traffic flows across the TfN area and potential top locations for rapid charging

Figure 16 shows how travel and charging demand impacts rapid charging needs across the TfN area, with the greatest activity focused around the major urban centres, and along the sections of the strategic road network, including the core north-south routes (M6, M1, A1(M), and M62). HGV charging and depot sites were observed to be tightly aligned with the core networks, reflecting HGV routing, and the proximity of major industrial areas to the SRN. The top sites for HGVs show a strong alignment to major roads and specifically areas such as business parks, industrial estates and truck stops as areas where HGVs would naturally coalesce, and so may present suitable prospective sites for charging infrastructure for freight purposes.

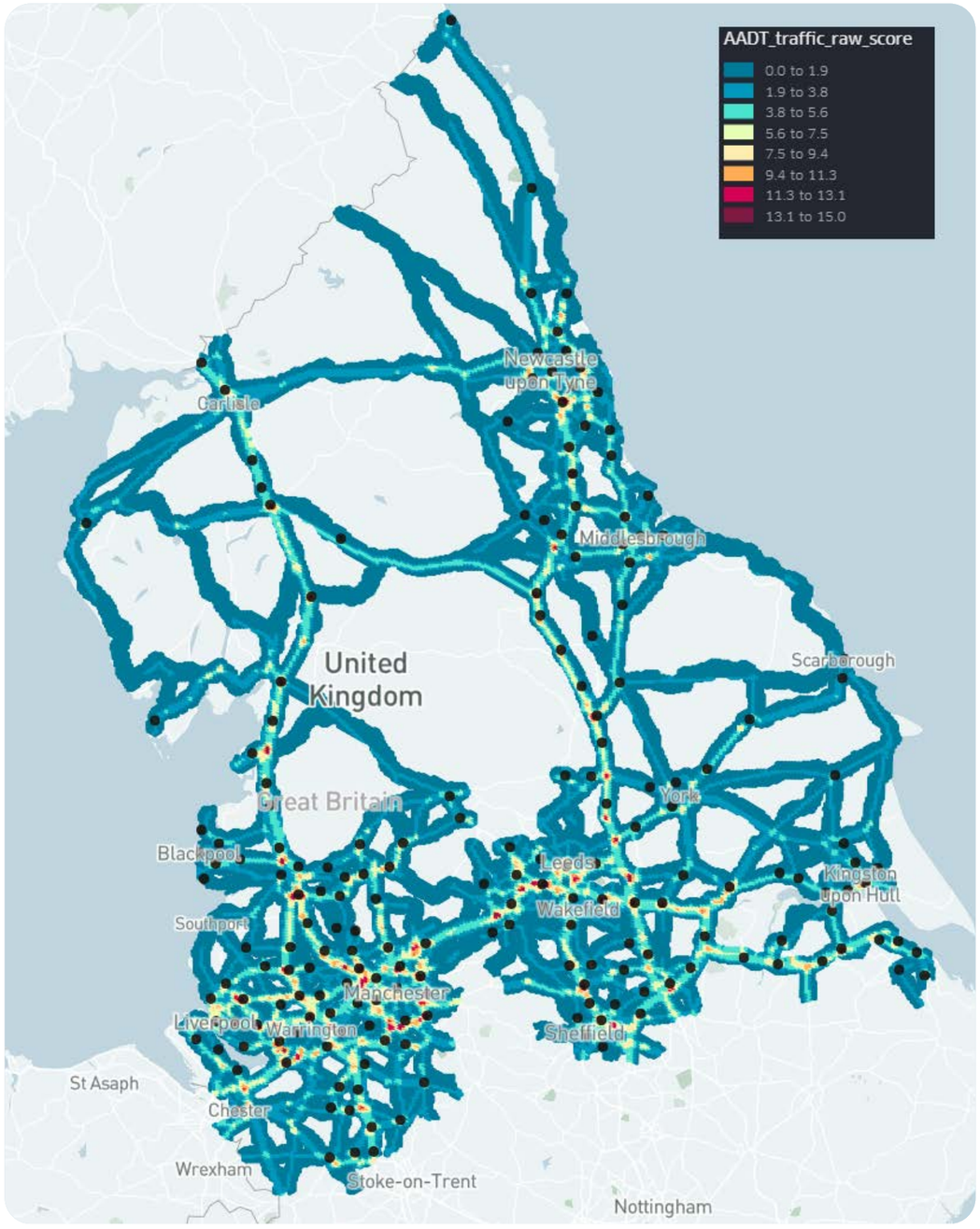
Car and van charging sites were slightly more dispersed, with additional demand created by BEV owners without access to off-street parking being more concentrated in urban centres, though as with HGVs, many sites are drawn towards strategic locations along the SRN. Most of the top sites identified were located away from city centres, and often in places between large cities.

Figure 16: Areas with high potential for en-route rapid charging demand (2025) by core regional traffic flows (AADT - Annual average daily traffic flow) and charging needs. (0 - low daily average score to 15 - high daily average score) [44]

Cars and Vans, 2030, Digitally Distributed scenario



HGV's, 2030, Digitally Distributed scenario

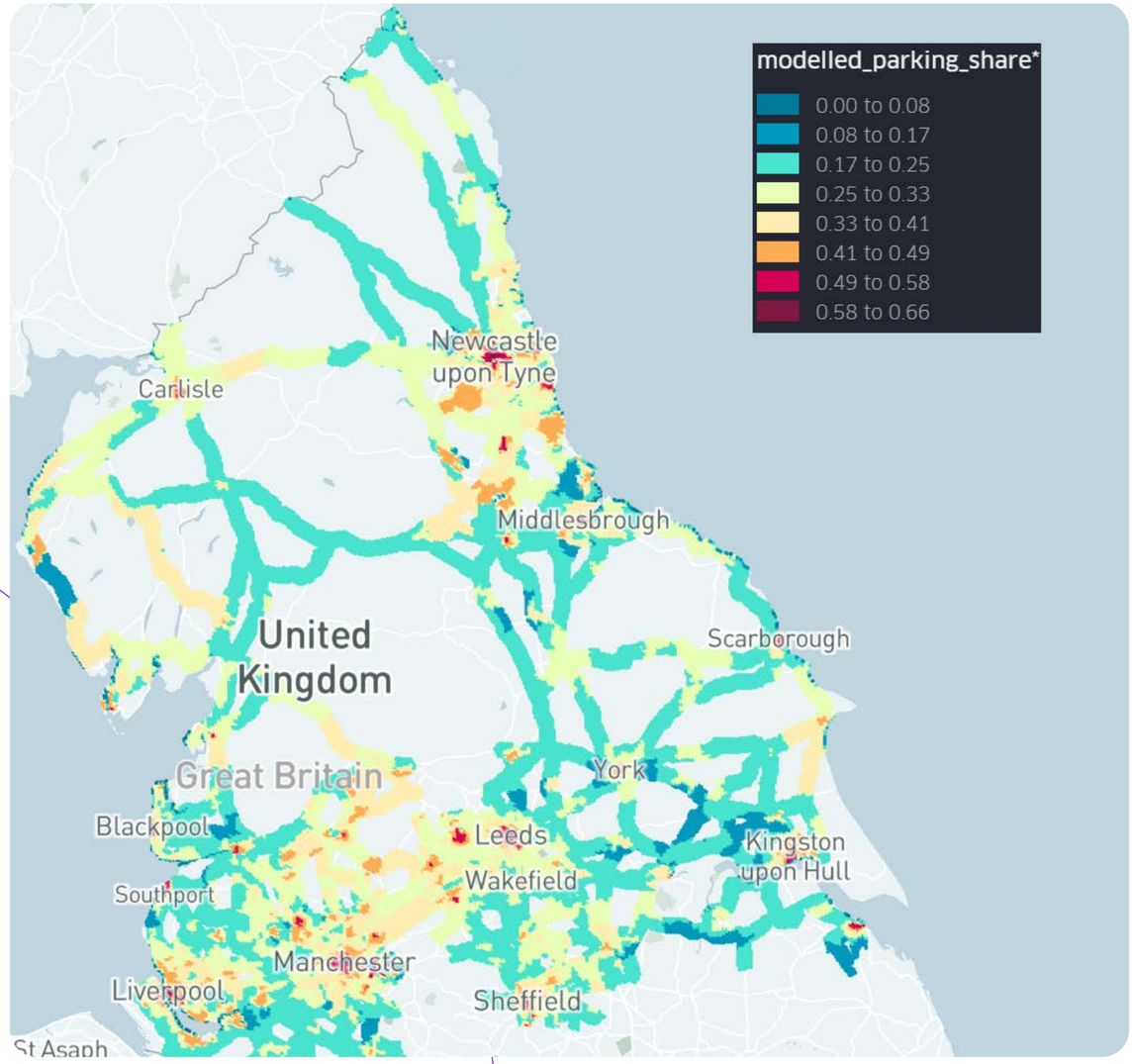


[44] Is this site an area of high EV uptake with a high proportion of on-street charging (not in driveways, carparks etc.)? Does it have a high modelled demand for en route charging (and, to a smaller extent, destination charging)?

Areas reliant on on-street parking will require a greater level of public charging infrastructure or rapid charging

Figure 17 shows areas reliant on on-street parking, which as may be expected, picks out the denser urban areas. Newcastle, Bradford, Bolton and parts of Leeds, Manchester and Liverpool stand out as having the most concentrated areas of on-street parking reliance. Conversely, as might be expected, the more rural authorities have lower reliance on on-street parking, particularly large areas of North Yorkshire and parts of Cumbria and Northumberland.

Figure 17: A regional view of areas reliant on on-street charging (0 - low proportion on-street parking to 0.66 - high proportion on-street parking)

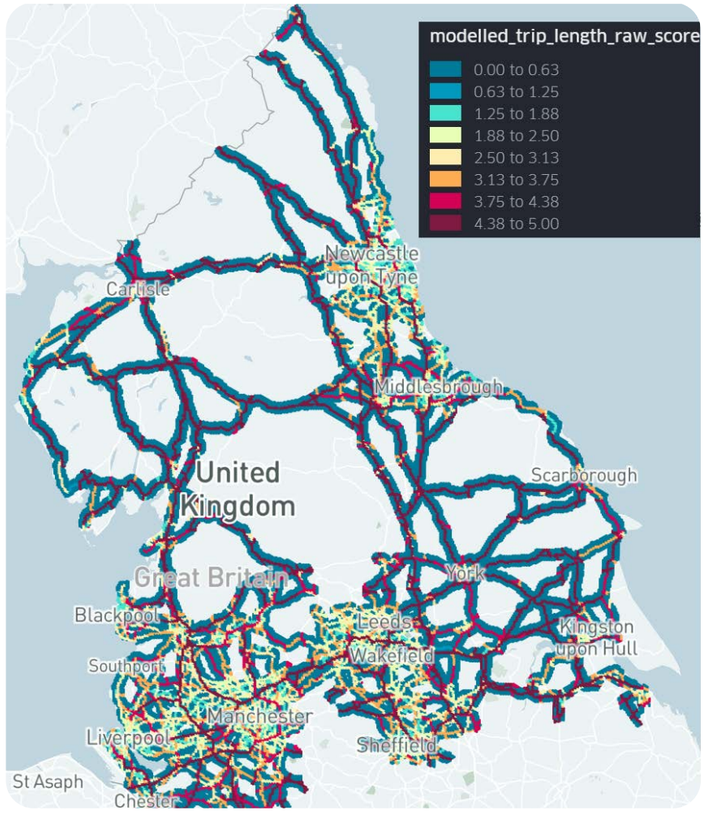


Distance travelled from origin analysis

The tool also enables site shortlisting for more detailed origin-destination and select link analysis, interacting with TfN's Northern Highway Assignment model (NoHAM). Figure 18 shows a measure of average trip length, generated using NoHAM. This dataset picks out the strategic road network more clearly, with the highest average trip lengths evident on the core east-west and north-south routes. This is unsurprising as these roads allow for long trips between different parts of the TfN region and the country more generally.

While some roads within large cities such as Leeds and Manchester are darker, indicating longer distance trips, the majority of the network in the metropolitan areas show a fairly low average trip length. This corresponds with how urban road networks cater more for local trips within the city region rather than for long-distance ones.

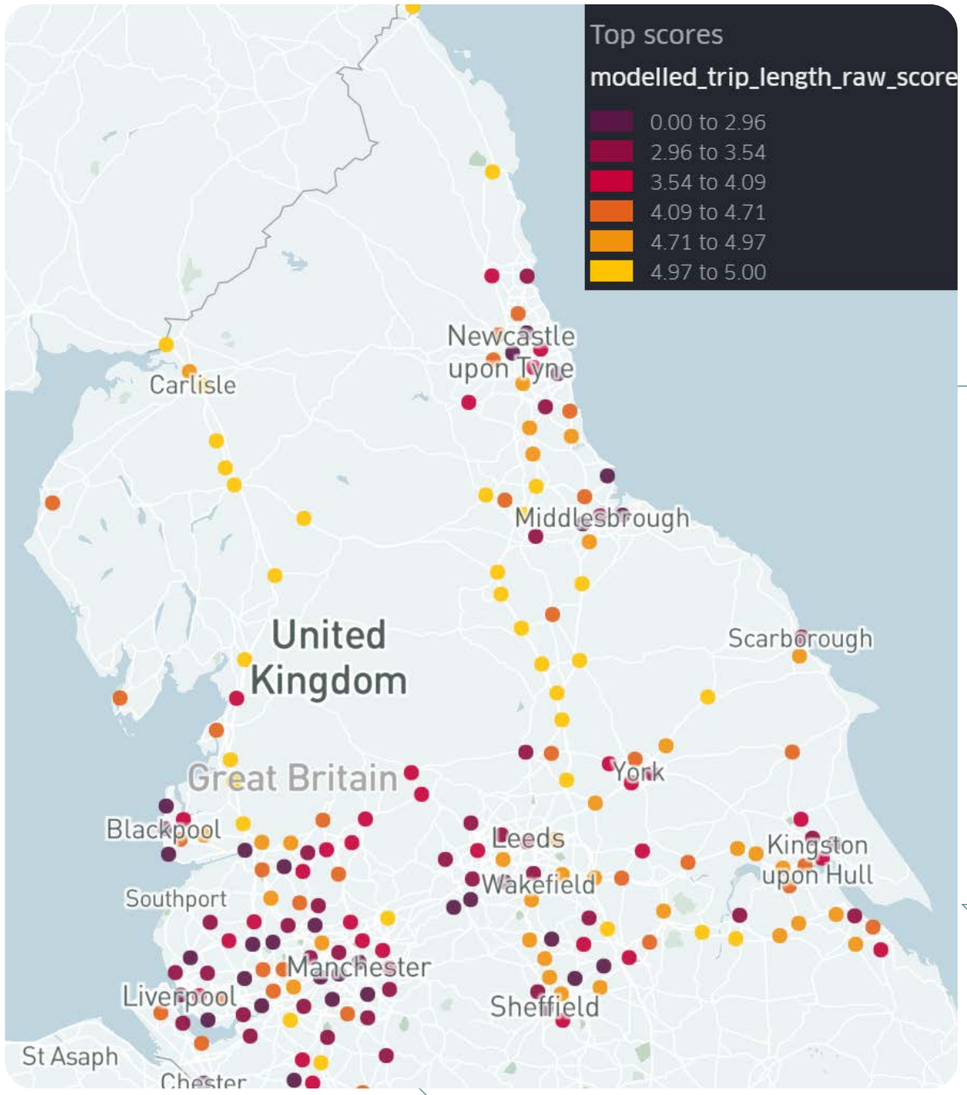
Figure 18: Spatial Distribution of average trip length highlights sections of the network carrying greater numbers of long distance trips [45]



45. Helps to identify whether a site sees high traffic volumes, and trips which are long and therefore likely to need en route top-up charging.

The average trip length measure is useful as it allows EV charger placement to consider locations where a greater number of trips are longer distance trips, and so more likely to require charging mid-journey. This is particularly useful to provide confidence for chargepoint operators when assessing commercial viability of charging locations. Figure 19 outlines how this trip length analysis impacts the scoring of top potential locations of rapid charging across the region. Analysis of trip lengths of vehicles passing shortlisted site highlights the varying distance travelled, with vehicles having travelled considerably further past more remote rural sites than more urban sites.

Figure 19: Spatial Distribution of average trip length highlights which charging locations may carry greater numbers of long distance trips (0 - low trip length to 5 - high trip length)



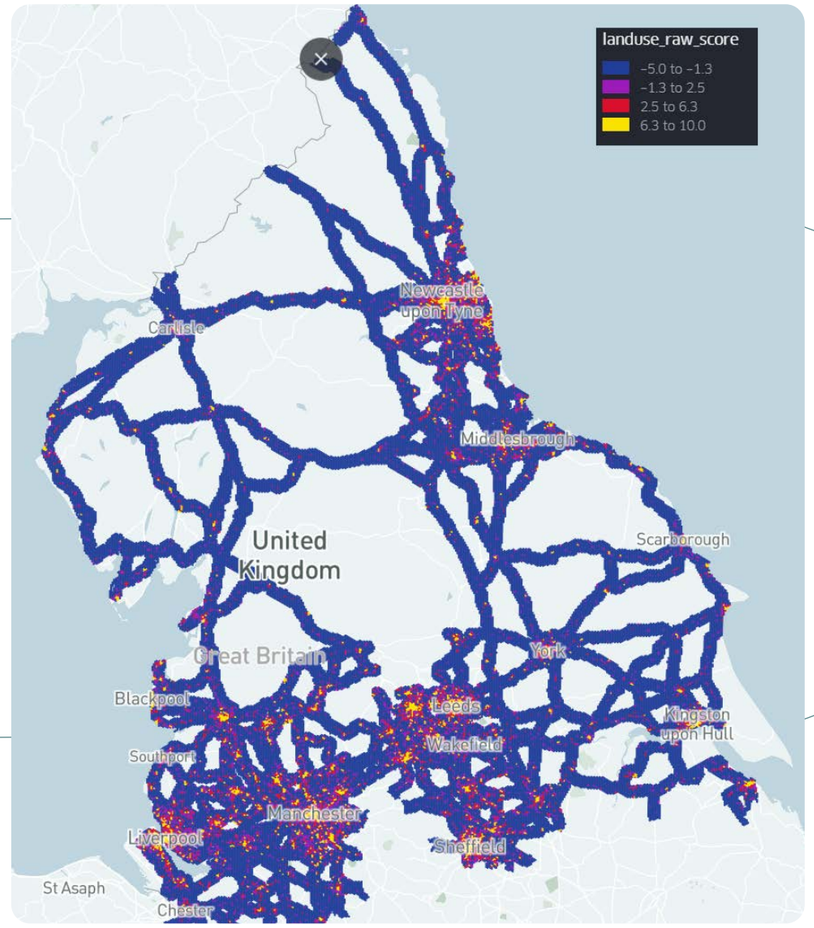
Land use data indicative of potential EVCI host sites

Figure 20 shows the widespread distribution of land uses which may make suitable hosts for en-route charging infrastructure, including retail parks, petrol stations, fast food outlets and hotels.

Not surprisingly they are most concentrated in and around the major urban centres. Along the core road network they are become more sparsely populated in more rural areas.

The presence of these sites increases the likelihood the area being able to attract and sustain private investment to deliver EVCI, as they are potential hosts for the chargers, with the necessary supporting amenities and parking to make the sites attractive to passing BEVs

Figure 20: Potential areas suitable and attractive for land-use towards rapid EV charging (-5 - low suitability to 10 - high suitability)



Potential gaps in coverage are likely emerge in some areas without public sector intervention

Based on the preceding analysis and outputs, the types of sites and specific areas across the region where it would be anticipated that private sector is more or less likely to deliver the requisite charging infrastructure include:

- Areas of high reliance on on-street parking, such as Newcastle, Bradford, Bolton and parts of Leeds, Manchester and Liverpool stand out as having the most concentrated areas of on-street parking reliance. Particularly where there are fewer prospective host sites with off-street car parks for privately funded chargers.

- Rural areas where there are limited areas of sufficiently concentrated demand for charging to make a compelling investment case, including relatively lightly trafficked in places, including the A69, the A66, and large parts of the core road network in Cumbria and North Yorkshire, or where there is a scarcity of prospective host sites, including areas of North Yorkshire, Cumbria and Northumberland.

- Areas hampered by grid constraints or high connection costs. This will require more detailed localised and place specific feasibility assessments, but according to some CPOs experiences, this can make as many as 1 in 3 sites commercially unviable.

- In terms of en-route charging demand, the areas identified as having fewer high scoring sites are the more rural areas, including large areas of North Yorkshire and parts of Cumbria and Northumberland

- Though it is important to note that whilst the areas of higher demand offer more potential sites, they will also require a greater number of sites, which presents its own challenges, particularly if this amounts to more concentrated requirements for high powered connections, which potentially impacts on the deliverability.

12.6 Estimating costs of total regional requirements

The cost of a chargepoint depends upon a number of factors, including its output power rating, location, and costs of connecting to the electricity network. Charger technology is evolving rapidly and higher powered chargers (150kW +), which take less time to fully charge an electric vehicle are now becoming more common with a number of private sector charge point networks. Higher powered chargers are more likely to incur significant grid connection (and use) costs.

Estimate costs (2022 prices) for the total regional public chargepoints identified (public residential, destination, workplace, en-route) from the development of our framework evidence are provided in Table 5. This estimate covers hardware, installation, and connection for new installations, as well as repeat and replacement chargepoints). These costs are presented as a range as they are developed from the different charging demand levels across our scenario outputs. They are also provided in 5-year increments to match the timescales of our requirement outputs.

Table 5: Estimated cumulative costs for total EV charging requirements as forecasted by our EVCI Framework evidence.

Cumulative cost	2020-2025	2020-2030	2020-2035
Cost range across scenarios	£335m – £675m	£930m – £1.3bn	£1.5bn – 1.7bn

12.7 Informing regional and local strategic decisions towards energy requirements

Encouraging collaboration with our energy sector partners

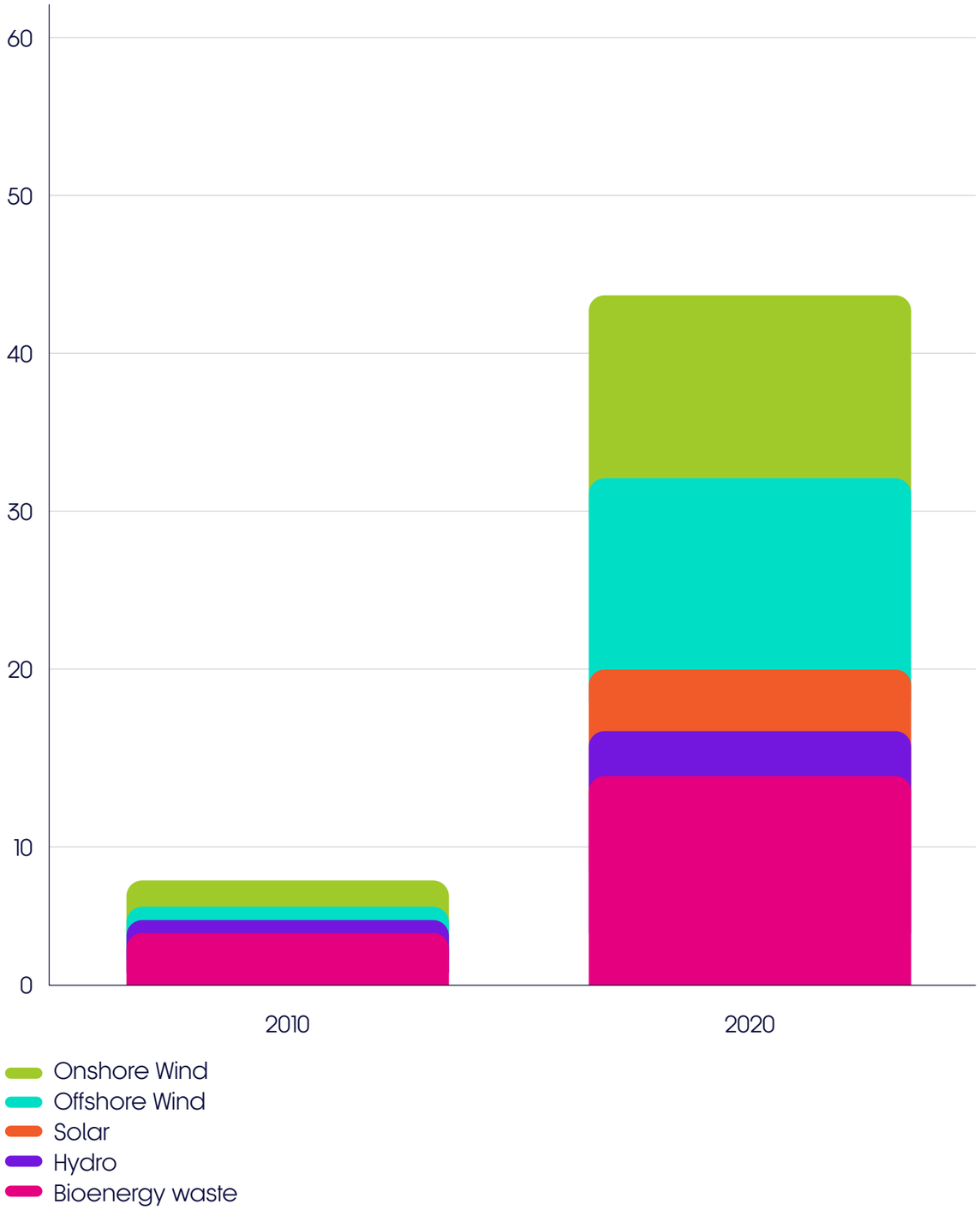
A key aim of our EVCI framework is to provide evidence, thought leadership and champion strategic collaboration across the region to reach mutual goals. An example of this is how we have extended our framework, both the evidence available but also the development processes behind it, to Northern Distribution Network Operators (DNOs), National Grid and Ofgem. Grid capacity and connections are considered a key requirement by our national and local our partners to support EV rollout. Future proofing delivery decisions, but also early and effective planning for future grid requirements and what they mean for transport and spatial planning, are essential to delivering a user focused, effective and value for money charging network. Only by working with the electricity Distribution Network Operators (DNOs), Ofgem, National Grid and other energy partners such as Energy Systems Catapult can we achieve this.

Thinking whole system

To deliver the whole system ambition set out in this EVCI framework, we need to think beyond travel demand and EV chargepoint requirements. We need to be cognisant of how our electricity (or other alternate fuel such as hydrogen) supply is generated and what this means for emissions related to EV usage. The Government's Energy Security Strategy[46] confirms ambitions to meet the UK target of net zero, by accelerating the transition away from oil and gas, which depends on how quickly we can roll out new renewables. The growing proportion of our electricity coming from renewables reduces our exposure to volatile fossil fuel markets, whilst a mixture of UK energy generation sources provides the UK with more resilience, agility and a security of supply.

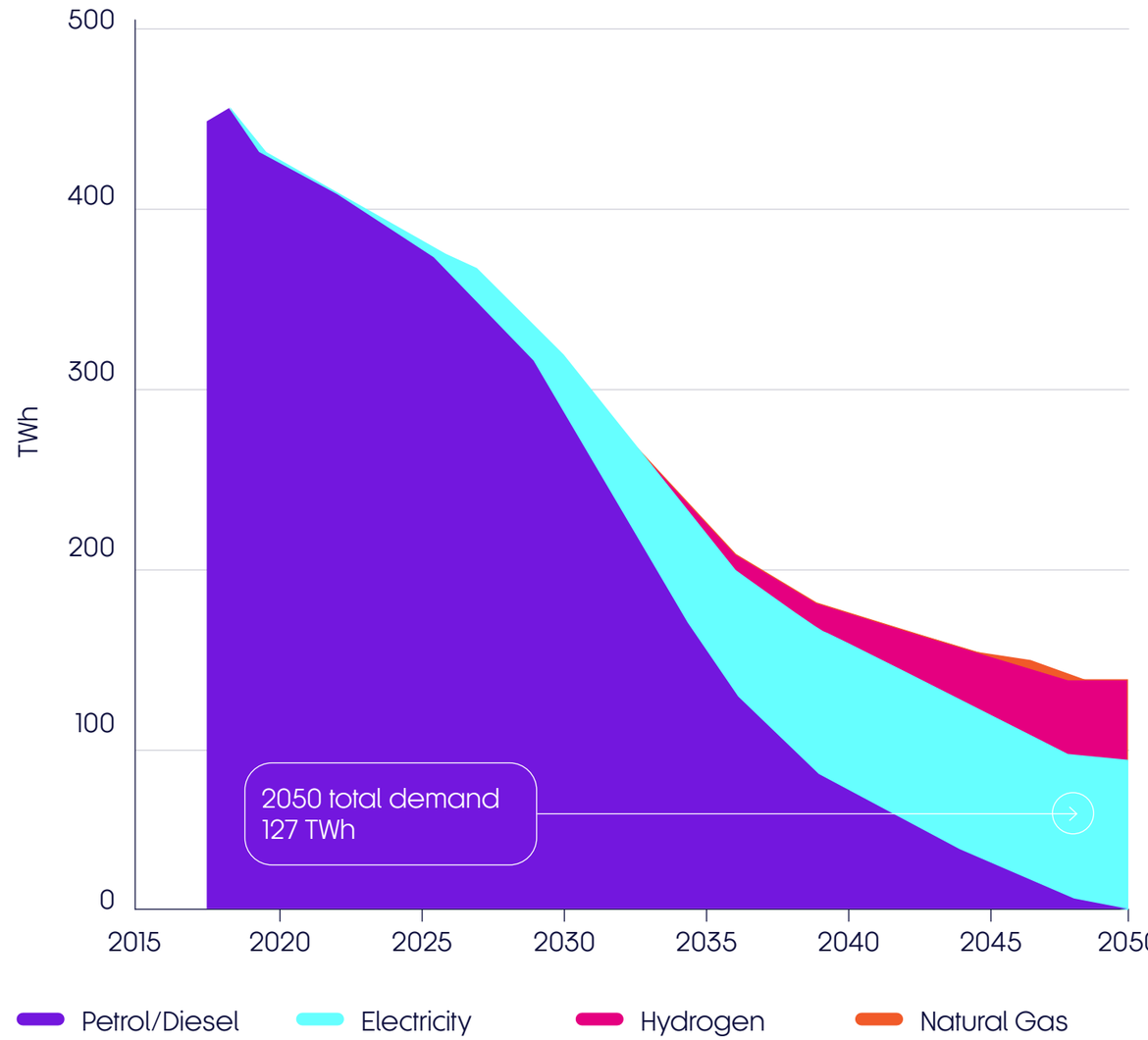
[46] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

Figure 21: How the UKs overall proportion of renewable generation mix has changed since 2010



Electric Vehicles will have a significant impact on the demand for electricity from our energy networks. According to National Grid's 'Leading the Way' Future Energy Scenario[47], overall road transport energy demand would decrease significantly by 2050 due to the higher efficiency of electric vehicles. However, National Grid projects rapid electrification during this period so that by 2040 it would constitute over half of road transport energy demand.

Figure 22 – Projected annual energy demand for road transport by source up to 2050, according to National Grid's 'Leading the Way' future energy scenario.



[47] https://www.nationalgrideso.com/future-energy/future-energy-scenarios

Building a framework to support whole system thinking

Our EVCI framework is built in a manner which applies TfN modelling suite and the EVCI modelling system to inform regional and local strategic decisions towards EV energy requirements. Our framework translates spatially localised charging infrastructure forecasts into data on distribution network demand requirements. It also draws from our Future Travel Scenarios and Distribution Network Operators/National Grid Future Energy Scenarios to develop a better understanding of likely grid requirements, constraints and implications when supporting transport decision making.

This has helped to facilitate technical integration with northern electricity DNOs, exploring additional intelligence and sharing capabilities of the DNO in supporting delivery of our EVCI framework. We have engaged with Northern DNOs throughout development of our framework and regional evidence base, to confirm technical applications but also to identify avenues of future development across transport and energy bodies.

The total impact of electrification on the grid over the coming decades will be driven by a combination of electrification of transport and heating. To accurately assess the impact, projections for both transport and heat are needed. As this study focuses on transport alone, the relative differences (i.e. increase of electricity demand) rather than the absolute values are the main output.

Our Statement of Method outlines the capabilities and constraints that apply to our EVCI modelling and current integration with the energy sector planning and delivery.

Translating EV charging demand to electricity grid demands

Our evidence identifies the charging demand of non-rapid and rapid charging solutions to primary and secondary substations in the region. This allows our framework to assess the potential increase in peak electricity load from electrification of transport for each of the DNOs in the TfN region. Seasonal variation effects have been included to assess demand on a peak day, and the effect of residential smart charging has also been included.

As with the chargepoint requirements identified by our EVCI framework, we can also present the electricity demand increase as a total, per square km (to understand density), or by density. This provides the capability to assess requirements by specific geographic compositions, but also to understand impacts of travel movements across the region by comparing charging need against actual EV registrations in an area.

Figure 23 shows what the regional need for electricity by density looks like. As with chargepoint requirements, this indicates a clear need in urban areas of our region. However, by taking travel demand and regional movements into account, Figure 24 provides a view of the full electricity demand increase we can expect. Rural area demand may might not be intuitive and has been difficult to demonstrate to date. This is intelligence is therefore vital to help support and achieve a whole network solution for all areas of our region.

Figure 23: Electricity demand increase for all charging, by density, in 2030, for current charging behavioural trends, in TfN's Just About Managing future travel scenario.

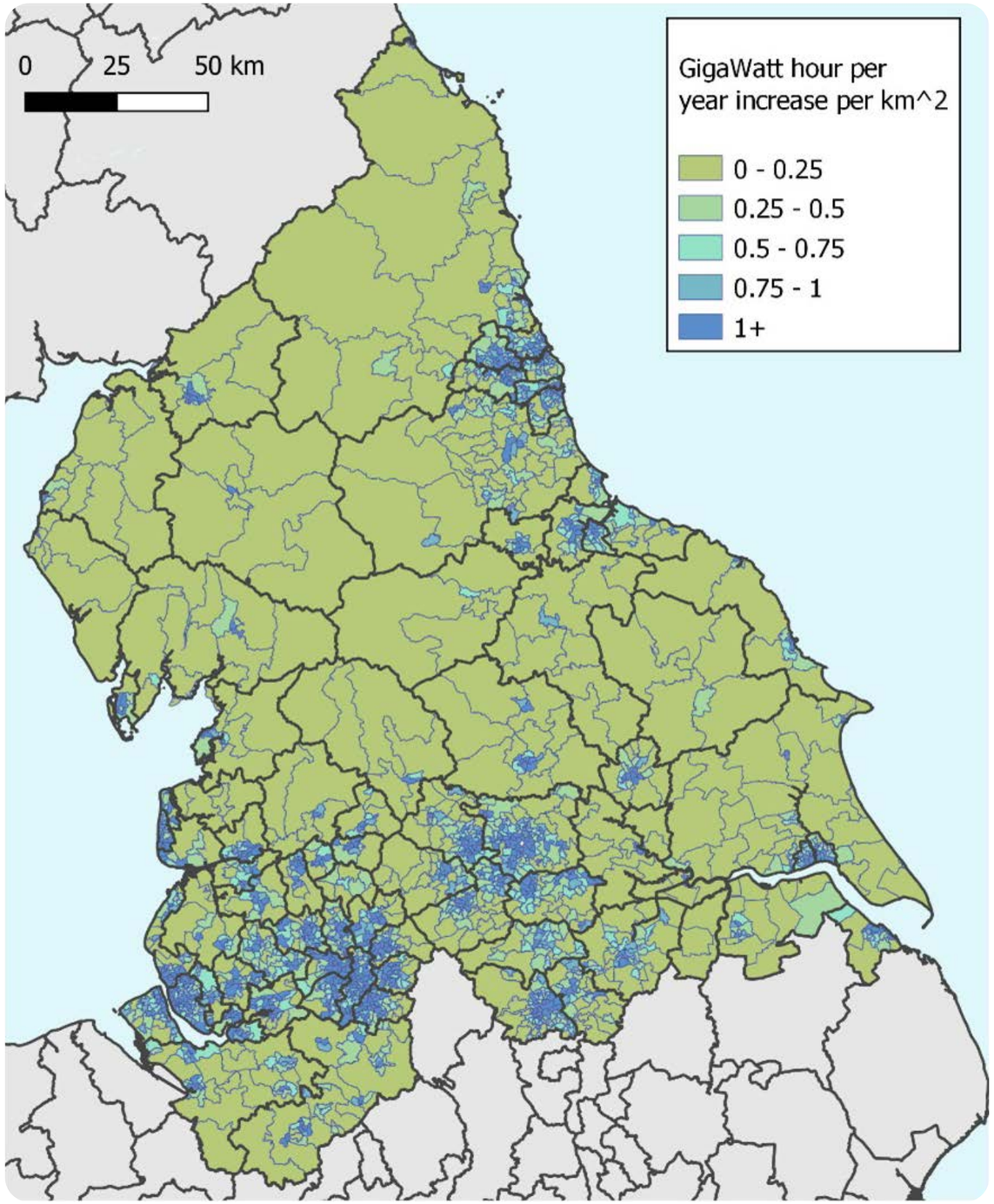
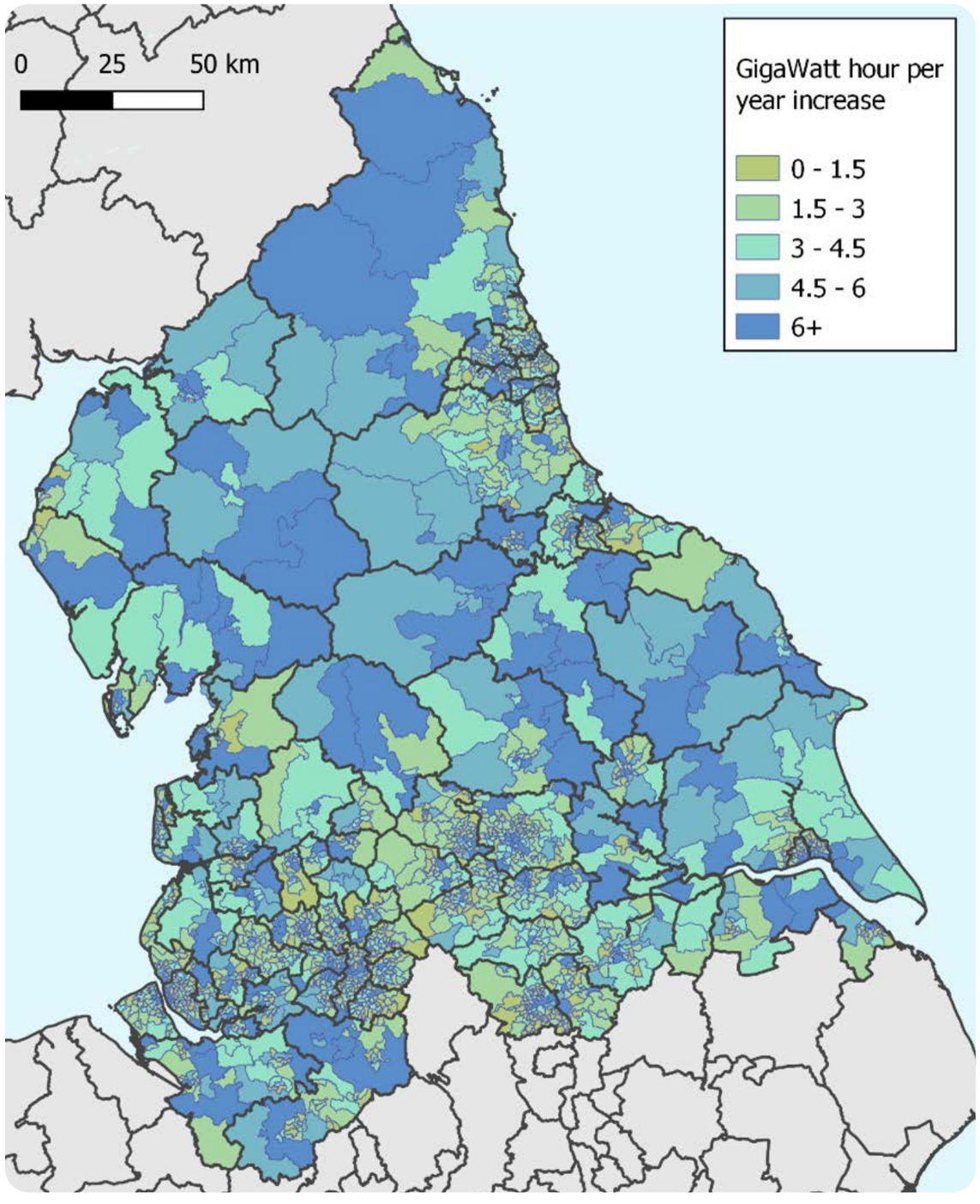
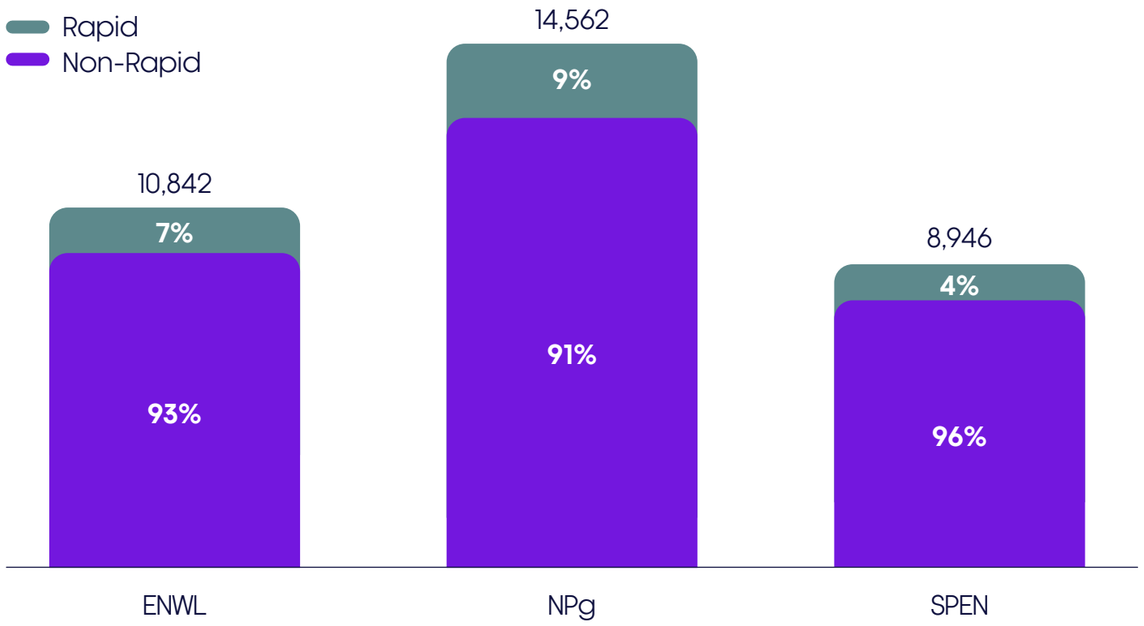


Figure 24: Electricity demand increase for all charging in 2030, for current charging behavioural trends, in TfN's Just About Managing future travel scenario.



Daily charging demand is dominated by non-rapid charging at primary substation level. This is due to rapid charging being assumed to only be used for a small fraction of vehicles' daily charging demand (5 – 10% for BEV cars and vans, 20% for BEV HGVs), and rapid charging not being accessible to PHEVs. These assumptions are recorded in the EVCI Statement of Methodology, and tested with our local authority partners, academic advisors Decarbon8, as well as the Department for Transport.

Figure 25: Total charging demand for primary substations within TfN area on the peak day, 2030 (MWh)



While rapid charging only accounts for a small share of daily charging demand, it could contribute significantly to peak load due to the higher power and lower charging duration of charging events at rapid chargers.

Though it is important to note that while the areas of higher demand offer more potential sites, this also presents its own challenges, particularly if this amounts to more concentrated requirements for high powered connections, which potentially impacts on deliverability.

TfN will continue to work with the energy sector in developing our EV work, identifying opportunities to support our partners with long-term planning for grid capacity and connections. This includes collaboration towards how our system can make the most of smart charging solutions and policies available, to use EVs in conjunction with the national grid for efficiency gains as well as smoothing peak demand on our road networks. Some of these areas are outlined in the final section of this report.

13. Monitoring and evaluation

TfN will monitor how charging behaviours and travel movements evolve through our analytical and evidence tools to maintain an accurate view of future need and tailor our actions and advice. We will undertake periodic reviews of the drivers for our EVCI evidence base on a regular basis, including testing these with academia and industry, while also seeking to engage with the public via mechanisms such as TfN's Citizen's Panel and as we update our Strategic Transport Plan.

We will also explore how our EVCI model and visualiser tool can be combined with planning and deployment data (such as NCR and ZapMap) to provide a fuller picture of what is on the ground now, what is being planned, and what is required.

The National Chargepoint Registry (NCR) enables a comparison between the EVCI model's short-term projections of public charging infrastructure growth and the expansion of the NCR, which records submitted publicly accessible chargepoints. As the NCR model does not include private charging, any comparison is restricted to destination, en-route and public residential charging, though this is enriched by the NCR's inclusion of the chargepoints' speed classification within the database. The discrepancy between the number of chargepoints registered in the NCR and other databases, like Zap Map, means that the NCR must be treated as inexhaustive, however it remains useful as an evaluative tool against our EVCI framework projections.

TfN's Monitoring and Evaluation Framework also contains six pan-Northern metrics to monitor the roll out of electric vehicles and electric vehicle charging in the North, using a combination of DfT data and the TfN EVCI evidence base. These will be published alongside other metrics in the form of a TfN monitoring dashboard in 2023. These metrics are linked to the STP objective, 'Promoting and enhancing the built historical and natural environment' and the related impact 'Rapid decarbonisation of surface transport.

TfN has also used its programme benefits mapping process to identify tangible short to medium-term outcomes that TfN aims to deliver through the EVCI Framework and how these contribute to TfN's long-term strategic objectives. These can be used to define what success would look like for TfN in this area. The full EVCI benefits map will be published alongside TfN's Monitoring and Evaluation Strategy, and the associated outcomes include the following:

- Increase uptake of public EV charging points at scale and pace across the North to support TfN's regional decarbonisation trajectory
- Proportion of licensed cars and vans that are battery electric in the North
- Proportion of licensed cars and vans that are plug-in in the North
- Proportion of vehicle kilometres travelled by fully electric cars
- Number of public EV charging points in the North
- Number of public EV charging points in the North (rural)

TfN has also used its programme benefits mapping process to identify tangible short to medium-term outcomes that TfN aims to deliver through the EVCI Framework and how these contribute to TfN's long-term strategic objectives. These can be used to define what success would look like for TfN in this area. The full EVCI benefits map will be published alongside TfN's Monitoring and Evaluation Strategy, and the associated outcomes include the following:

- Improved ability to deliver the objectives established in the TfN Transport Decarbonisation Strategy.
- Development of a consistent pan-Northern Evidence Base that all partners can freely utilise.
- Local authorities are supported to deliver EV infrastructure through a 'whole system' approach that supports EV as part of the solution to transport decarbonisation.
- Greater appreciation of the role improved connectivity can play in reducing social exclusion.
- Improved understanding of the optimal spatial allocation of EV infrastructure. Infrastructure investment can reflect geographic differentials, support place-making and encourage the uptake of active travel.
- Strengthened dialogue with central government as a result of establishing a single voice for the North on pan-Northern benefits and scheme prioritisation.
- Increased likelihood of central government sponsorship for innovative solutions and infrastructure trials in the North.

14. EV charging infrastructure delivery models

To date the majority of public charge points installed in the UK have been funded by public sector grants from the Office for Zero Emission Vehicles (OZEV) and elsewhere. However, private sector partnerships and revenue share arrangements are becoming increasingly common as the business case improves and market confidence grows, with the National EV Strategy stating that Government will encourage new business models to deliver new charging infrastructure. The launch of the LEVI fund will test how Government can best support Local Authorities' in procuring chargepoint deployment by trialling different delivery mechanisms, business models and technologies.

There is also 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.

Table 6: Common delivery models for the rollout of EV chargepoint infrastructure

	Delivery model	Description	Advantages	Disadvantages
Highest potential public sector control / Highest potential public sector risk ↓ **Lowest potential public sector control / Lowest potential public sector risk**	**Public Ownership Model**	The local authority holds ownership of the EVCP as well as the electrical connection. Typically a local authority will contract a Chargepoint Point Operator (CPO) to both operate and maintain the EVCP for a fixed fee, with all the revenue going back to the local authority.	• Highest income potential • Quickest and simplest to deliver • Most control over location of EVCPs regardless of commercial viability	• Highest capital cost of any model requiring grants and likely authority match-funding • Highest risk in terms of asset cost and ongoing maintenance costs for life of asset • Lack of income share may disincentivise CPOs to repair faults following install • Locations that lack commercial viability may mean authority loses out commercially
	Concessionary Model	Public/private funded concession models involve the local authority contributing towards the enabling works and/or charger capital costs, typically using grant funding, with the CPO also contributing to the capital costs, helping to reduce the burden on the local authority.	• Middle ground potentially in terms of income share • Reduced risk to public sector • Retains reasonable scope to select sites if the package overall is attractive, useful in offsetting sites with high connection costs • Leverages private funding, enabling public funding to go further and deliver more EVCPs on a typical contract	• Reduced income share • Complexity and time taken to agreed contract terms and potential for failure • Requires a strong understanding of what the market can offer and tender process • Risk that CPOs will not accept the agreement terms, leading to negotiation or a failed tender • Needs to be a relatively large number of sites so that CPO can balance risk across sites.
	Fully Funded Model	The private sector model involves a private sector body paying for all upfront capital and operational costs associated with providing EVCPs. The local authority will lease parking bays to the CPO who will then install EVCPs at their own risk and cost.	• Low risk to council as no infrastructure/ maintenance obligations • Can deliver large numbers of charge points • If rental agreements agreed can provide guaranteed income over a long period of time i.e. 10+ years	• Lowest potential income • Least control • Likely to involve long agreement periods or exclusion areas • Many areas currently unlikely to be commercially viable without public investment or strong evidence of need / demand to encourage investment. • Reliant on commercial viability of sites as judged by CPOs • Could see exclusion areas where the authority is unable to install chargepoints through other delivery models, unless CPOs are encouraged of required demand to allow commercially viable delivery.

Private sector considerations

A private sector organisation choosing to deploy an EVCP in any given location is subject to a wide range of locally specific factors, which determine the overall commercial viability of the site, including:

Higher demand sites - near heavily trafficked routes or destinations, likely to achieve greater utilisation:

- Destinations and intermediate sites where passing vehicle numbers or parking turnover is high (i.e. service stations, roadside cafes, shopping centres), 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, as they can sell more kWh per day to pay down their initial capital outlay and so deliver more attractive returns on investment (RoI).
- Conversely, on-street residential chargers are more challenging to deliver on a commercial basis, as they are often more costly and complex to deliver, and so are generally grant funding led.

Power availability and grid connection costs – are a key consideration. Grid constraints can pose a significant barrier to the roll-out of EV infrastructure, adding to the delivery cost, introducing delays and preventing sites from being commercially viable. Smart charging and dynamic load management are fundamental in this regard at the local site level, in managing within the available capacity as far as possible. If supply capacity is lower than demand then options need to be considered to increase the energy supply available to the chargers. The cost benefit of installing at these sites of needs to be carefully considered.

In some circumstances there is a requirement to upgrade secondary or primary substations, or even build a new one. The costs of doing this can be significant and impact the economic viability of charge points, as it may take years for revenue generated by the charge point to pay down this initial investment.

There is also likely to be a significant impact on programme as well as cost when liaising with DNO's as often an application will have to be agreed and approved, then detailed construction plans, wayleaves and Section 50 agreements completed with sub-contractors.

Prospective hosts, partners and supporting amenities - CPOs are often focused on partnering with chains with nationwide estates, such as large supermarket; coffee shop; fast food chains, as this enables them to quickly scale up their network whilst engaging with fewer individual stakeholders.

15. User groups and socio-economic considerations

The table opposite outlines a range of particular user groups, each faced with differing potential barriers in switching to EV, and potential solutions for overcoming these issues and promoting socially inclusive access to EVs. TfN will monitor the requirements, barriers, and solutions as the EV landscape evolves and more evidence becomes available. TfN will also consider societal factors when reviewing and updating our EV framework.

Table 6: Considerations towards user group requirements, barriers to access and solutions for Electric Vehicles and charging infrastructure

EV user challenge	User requirements	Barriers faced	Potential solutions and likelihood of private sector delivering these?	Potential public (UK Government/TfN/Local Authority) and private sector solutions
Reliant on on-street parking/ communal parking	User requires on-street charging for typical overnight charge, perhaps once every two or three days	• Anxiety surrounding charging overnight if commuting • Permission to install charge points from property managers • On-street charging solutions remain difficult to deliver commercially	Range of innovative lower cost on-street charging solution, but these remain difficult to deliver commercially.	• Targeted deployment and subsidies for public chargers in areas reliant on on-street parking, including on-street residential chargepoints such as lamp column charging, rapid hubs, community charging hubs • Promote chargepoint sharing such as Co Charger • Promote workplace chargepoints and available funding • Provide guidance and clear requirements as part of planning permissions around future proofing communal parking
Financial accessibility	Low-cost energy and access electric vehicles at an equivalent price to ICE vehicles.	• Prohibitively high upfront cost of some EVs • Lack of second-hand market at present. • Concerns about charging costs in long term	As battery costs fall and a second-hand market develops the cost of EVs will fall, with price parity anticipated between 2025-2028 for many vehicle segments. In the short run, the market is still heavily skewed towards higher cost vehicles.	• Sustained grant funding from UK Government to increase EV uptake, particularly focusing on supporting the second hand EV car market. • E-car clubs can provide a new entry level for adopters who may otherwise be priced out to experience EVs, as well as ZE buses (ZEBs) • Scrappage schemes to support low income groups, including local businesses, taxis etc, particularly where affected by the introduction of Clean Air Zones (CAZs) etc • Try before you buy schemes and awareness raising campaign

Continued on next page

EV user challenge	User requirements	Barriers faced	Potential solutions and likelihood of private sector delivering these?	Potential public (UK Government/TfN/Local Authority) and private sector solutions
Late adopter – techno-phobic	Extended range of EVs beyond existing technology A more mature charging network across the UK with a mix of destination/ intermediate/ home/ workplace charging	• Range anxiety • Concerns about EV cost • Inability to access charge points / lack of confidence in chargepoint availability and reliability	Growing public awareness and familiarity with EVs. Private sector is naturally seeking to achieve this, though they will inevitably target parts of the market most likely to switch, potentially neglecting some market segments.	• Tailored awareness raising campaign at consumer groups not likely to be addressed within commercially driven marketing campaigns, explaining EVs and chargepoints to alleviate range anxiety • Free telematic tests, and dealership led 'try before you buy' schemes. • Support proactive engagement in delivering local experience centres, pop-up events etc • E-car clubs, ZEBs and e-taxis help raise awareness and improve familiarity with EVs
High mileage drivers with special requirements	High mileage drivers or those who require specific vehicles to conduct their work i.e. vans/4x4s	• Range anxiety • Concerns about EV cost • Inability to access charge points / lack of confidence in chargepoint availability and reliability • Market for specialist EVs not as mature as standard EVs and likely higher in cost compared to ICE equivalents	Ongoing private sector investment into vehicle size/ battery range/ charging infrastructure will increase the availability of solutions.	• Grant funding from UK Government/authorities to increase EV uptake, particularly focusing on workplace solutions and fleet vehicles. • Scrappage schemes • Try before you buy schemes • Awareness raising campaign • Clean air zones to incentivise ultra-low emission vehicle (ULEV) uptake
Fleet user (SME or large business)	Large-scale fleet conversions to EVs, able to fulfil the same operational requirements to meet business needs, depot charging and a comprehensive charging network across the SRN/MRN, with no significant increase in costs or time delays	• Inability to access charge points / lack of confidence in chargepoint availability and reliability • Range anxiety • Limited availability of suitable vehicles, and supply side issues • Providing charging infrastructure at depots or homes of employees can be prohibitively expensive • Concerns of cost to convert EV fleet	Fast evolving market, with significant ramping up of production and models underway across most light duty segments. Private organisations investing into EV fleets will drive manufacturers to produce better EV fleet options such as vans.	• Proactive support in ensuring an adequate EVCI is in place across the region • Support and advice to organisations (i.e. telematics trials) • Grants to support fleet conversion from ICE to EV uptake and EVCP installs • Clean air zones to incentivise ULEV uptake • Co-ordinating role in identifying opportunities for fleet charging at public sites, for example bus/ council depots not in use during the daytime

EV user challenge	User requirements	Barriers faced	Potential solutions and likelihood of private sector delivering these?	Potential public (UK Government/TfN/Local Authority) and private sector solutions
Disabled users	Disabled users require specific types of vehicles and accessible charge points.	• Poor accessibility of existing infrastructure rendering it either un-usable, or inconvenient • Issues include a lack of dropped kerbs, display/ controls being out of reach, a lack of adequate space to manoeuvre between bollards and charge point, heavy or impractical charging cables	Solutions are available to many of these problems, but there are few examples of best practice where all these issues are designed out.	• TfN to advise and recommend the Government promote EV accessibility standards expected in 2022 • TfN commission a study into EVCP accessibility standards and rate all regional chargers on this system • TfN to work with installers to ensure accessible chargepoints are possible as part of any procurement
Long haul freight	Requires zero emission options which enable them to fulfil the same operational requirements to meet business needs, depot charging and a comprehensive charging network across the SRN/MRN	• Lack of suitable vehicles in mass production - current electric trucks have been developed for pilot schemes or prototypes with limited production runs. • Charging network in the UK does not have sufficient infrastructure to charge such large vehicles	Heavy duty vehicles are currently poorly catered for in terms of market-ready solutions, though a number of new vehicles are coming to market over the coming years.	• Be proactive in seeking to participate in pilot schemes and trials and funding • Encourage partners to be trail blazers and promote adopting ZEM HGVs as part of their own operations • Actively engage with local industry operators and seek to work with them to identify where they can move soonest, and support them in accessing funding • Monitor market developments
Tourists/ visitors	Users require a network of chargepoints at intermediate and destination locations, this includes charge points at key tourist hotspots and on the MRN/SRN	• Anxiety about availability of chargepoints in unfamiliar locations • Anxiety about accessing chargepoints	Private sector has readily available solutions in the form of the existing market of 7-50kW chargepoint networks that are currently operated nationwide. Variable commercial viability depending on highly localised factors.	• Development of comprehensive EVCP charging network targeted at key tourist/SRN/MRN locations • Support for local accommodation businesses to install slow chargers (up to 7kw) – i.e. B&Bs, campsites or hotels. To support slow overnight full charging which relieves pressure on rapid charging on major roads. • Support, guidance and access to grants funding for key tourist sites to install at car parks

16. Next steps and applying TfN's EVCI Framework to support delivery

TfN's EV Steering Group

TfN's regional EV Steering Group is now well established following its formation in Summer 2021. This draws together our local authority partners, Northern electricity Distribution Network Operators, the Office of Zero Emission Vehicles, National Highways, Network Rail, the Energy Saving Trust and National Grid. This provides an ideal forum that can be used to drive forward the need to accelerate the investment in EV infrastructure. The Steering Group has a key role to play in ensuring our evidence base is kept up to date; in sharing knowledge, skills and resource across the region in a timely and cost-efficient way; and in ensuring that our experience is available more widely across the UK. The EV Steering Group has identified a number of challenges and opportunities that require consideration by local authorities, and other partners, when developing plans for EV infrastructure and EV uptake. We will look to address and support these through our EVCI Framework were possible, as well as collaborating on any new activities arising which support local, regional and national ambitions.

Maintaining and evolving our evidence-based 'whole system; whole network' approach

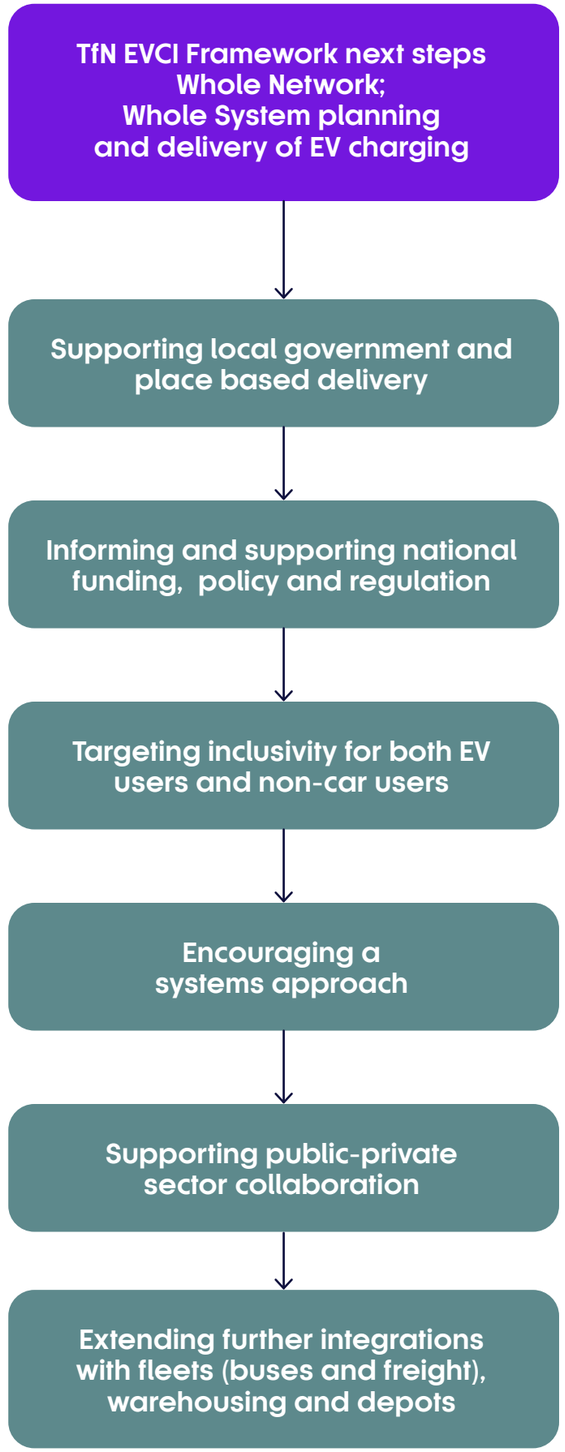
Taking an integrated approach is the only way to deliver the transition to EVs that we need. This means asking difficult questions and challenging the norm across sectors and with new partners. We will continue to collaborate with existing and new partners, as well as using our regional forum to share knowledge and a joined-up approach where appropriate, with a view to maintaining our 'whole network, whole system' approach, encouraging constructive resolutions, and informing national, regional and local EVCI planning and decision-making.

In additional, we are developing plans for additional activities which target key areas of priority and challenge identified by partners and feedback from academic reviews. This section outlines some of the EVCI framework evidence enhancements now available that can take our assessments further. Any immediate advancements to our EVCI Framework will particularly focus on broadening our capability to consider sustainability, spatial and social factors associated with the transition to electric vehicles. These elements are key when considering wider place policies and strategies, particularly at local authority level were challenges faced can cross over a number of plans and strategies.

Taken as a package, the following activities can communicate, apply and advance our EVCI framework evidence published in 2022. These activities can enhance our capabilities to make more rounded, confident and comprehensive decisions towards EVs, EV charging and its associated considerations.

Supported by further assessments towards key factors enabling user centric and place based evidence.

- → Sustainability of deployment and charging delivery models
- → Social equity and inclusion (EV user and non-EV user)
- → Spatial planning, energy and systems integration



i. Supporting local government and place based delivery

Our evidence is available for local authorities across the North to support their local transport plans and strategies and business case development for EV charging delivery. It provides intelligence which can enable local authorities to seek sustainable delivery models which deliver value for money, balance risk and incentivise the best outcome.

We will seek to apply the capacity and capability we have built in ways that assist, supplement or validate local authority planning and delivery partner strategies and business case development for delivery. Our framework can help to deliver consistent deployment across a region that will require very different solutions depending on the place in question.

This evidence puts the North in a strong position to respond to, and access, public funding and delivery mechanisms. But also supports our region in developing successful commercial delivery models with the private sector. This could see involve combined local activities to leveraging scale, combine funding and procurement activities were appropriate, supported by TfN's regional evidence base.

EVCI framework application actions:

- Make TfN EVCI Framework evidence available to all Northern Local Authority partners, to support consistency, integration and application within local specific activities were appropriate.
- Support public investment for planning and delivery, by individual or combined Local Authorities, through the Local Electric Vehicle Infrastructure (LEVI) fund, On-street Residential Chargepoint Scheme (ORCS), and Rapid Charging Fund for motorways and major A roads.
- Support Local Authorities in engagements with the Private Sector.
- Support our Local Authorities when informing the National EV Strategy with regards to their role, and that of Sub-national Transport Body's, in planning and delivery of EV charging infrastructure. Including advice towards consultations on whether Local Authorities should have a statutory role to plan and deliver EV charging.

EVCI framework evidence enhancements available:

- Exploring how our EVCI visualiser can be combined with planning and deployment data (such as NCR and ZapMap) to provide a fuller picture of what is on the ground now, what is being planned, and what is required.
- Taking our scenarios approach further to identify 'no regrets' requirements which are necessary in all Future Travel Scenarios, and all charging behaviour and preference scenarios, across the region. To build further confidence in decision-making to deliver sustainable solutions.
- Apply our EVCI model to actively monitor change to navigate uncertainty, by identifying a scorecard of key variables (i.e. EV range and understanding of behaviour as it evolves), and schedule for when they should be re-visited (with a view to closing off uncertainties when possible) for MSOA requirements and MRN locations.
- Explore what our evidence means for policy choice and business model approach decisions across the current evidence we have. Building a better picture of different utilisation strategies to support local authorities in identifying effective, efficient and commercially viable delivery models.
- Application, enhancement and communication of TfN's seasonal data to interrogate related EV charging needs further.

ii. Informing and supporting national policy, regulation and delivery

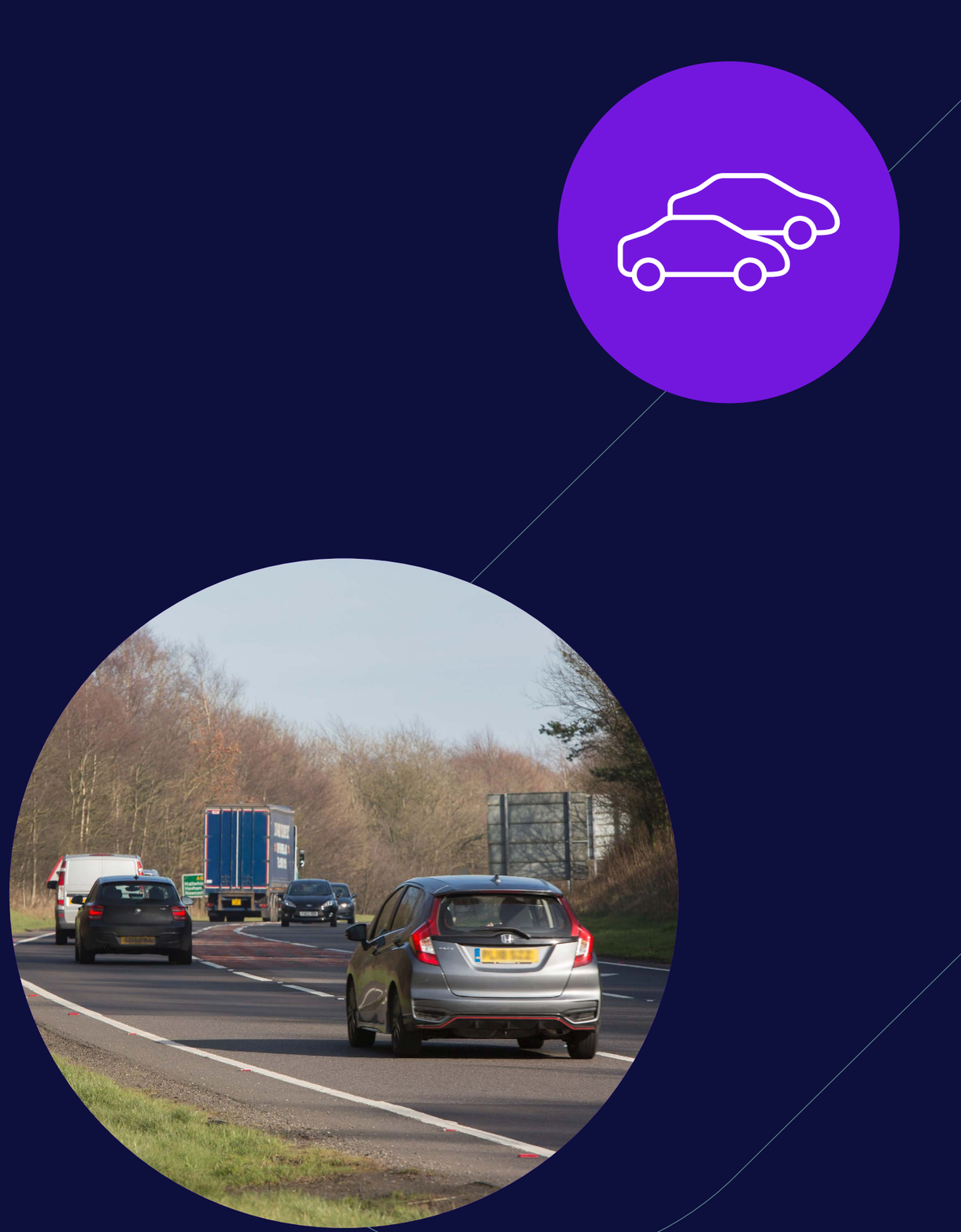
Sub-national bodies can offer significant benefits from consolidating and facilitating multi-agency activities, evidence and analysis on an integrated regional scale, and the decision-making to deliver an evidenced solution.

The partnership that underpins our EV Steering Group offers the opportunity to work collaboratively in resolving issues of policy, legislation, and guidance more generally that will be important to achieving our nationally shared ambitions. This includes informing national government decisions and working with National Highways and Network Rail to seek integrated evidence-based outcomes on the MRN and SRN, and the national rail network.

Thereby supporting policy agendas including decarbonisation, levelling up, as well as turning focus towards associated spatial planning and social inclusivity considerations.

EVCI framework application actions:

- → Respond to the National EV Strategy (via this EVCI framework publication) and continue active collaboration with Government towards infrastructure decisions, informed by our regional EVI Framework.
- → Share our approach and findings with other Sub-National Transport bodies, to extend benefits of our framework and seek consistency across England were possible.
- → Work with our local authority partners and OZEV/DfT to identify further opportunities in the North to accelerate EV roll out/trials and monitor outputs.
- → Work with National Highways and Network Rail to seek integrated, evidence-based outcomes on the MRN and SRN, and the national rail network.
- → Applying our regional EV Steering Group and our role as a strategic thought leader - seek to inform national policy and regulations, as well as policies, plans and delivery at a local level to ensure EVCI decisions consider the importance of social, spatial and sustainability aspects.
- → Continue to build an understanding of user needs as vehicle and charging technologies change and improve. Using our framework and collaborative strengths to best understand user behaviour impacts, but also to issues impacting the user now, such as consistency and 'interoperable' booking and payment of charge points for long distance trips to incentivise a transition to EV.



iii. Targeting inclusivity for both EV users and non-EV users

A significant part of decarbonising our transport system is doing so in an inclusive and equitable way, which is resilient across our Future Travel Scenarios. For this to happen, all solutions need to be accessible and affordable to all sections of society. This is particularly relevant across the North where we see a range of urban, semi-urban, rural and remote place types. There are different spatial, social, energy and transport challenges across these very different place types. National Government funding mechanisms and local authority delivery plans will need to recognise the need for flexibility to ensure solutions fit for a particular place, which can drive the uptake of EVs.

Affordability and inclusiveness of EV user uptake

The wrong balance of charging infrastructure could negatively impact on the affordability and inclusiveness of EV uptake. The transition will be more challenging for citizens who cannot access off-street charging, and particularly lower income groups. The upgrading of infrastructure to enable smart energy solutions and the roll-out of electric vehicles must be done fairly to support equitable opportunities for all households and safeguard against exacerbating existing socioeconomic disparities.

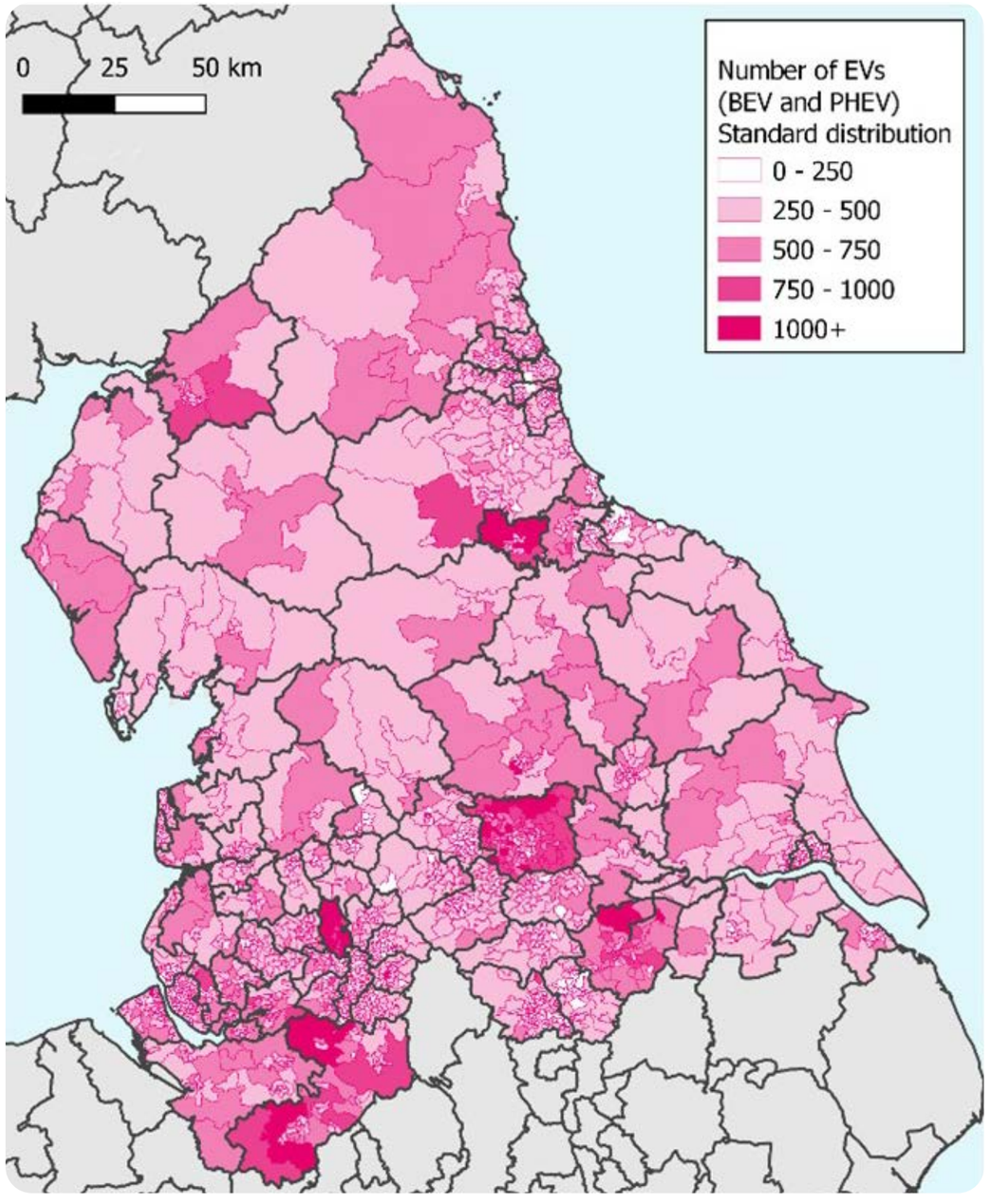
Recent enhancements in TfN's analytics now allow for a better understanding of potential EV purchasing and growth distribution across areas of differing levels of income and wealth. Whilst total EV numbers remain the same (compared to broadly applying sales across all areas), looking through an income-based lens demonstrates in a consolidation of earlier and faster EV uptake in more wealthier areas. These new updates also highlight the more difficult task of decarbonising for some areas of our region, as some EV charging demand shifts across the region but also varies within specific local areas. An example of this impact of this can be seen in the comparisons between Figures 26 and 27.

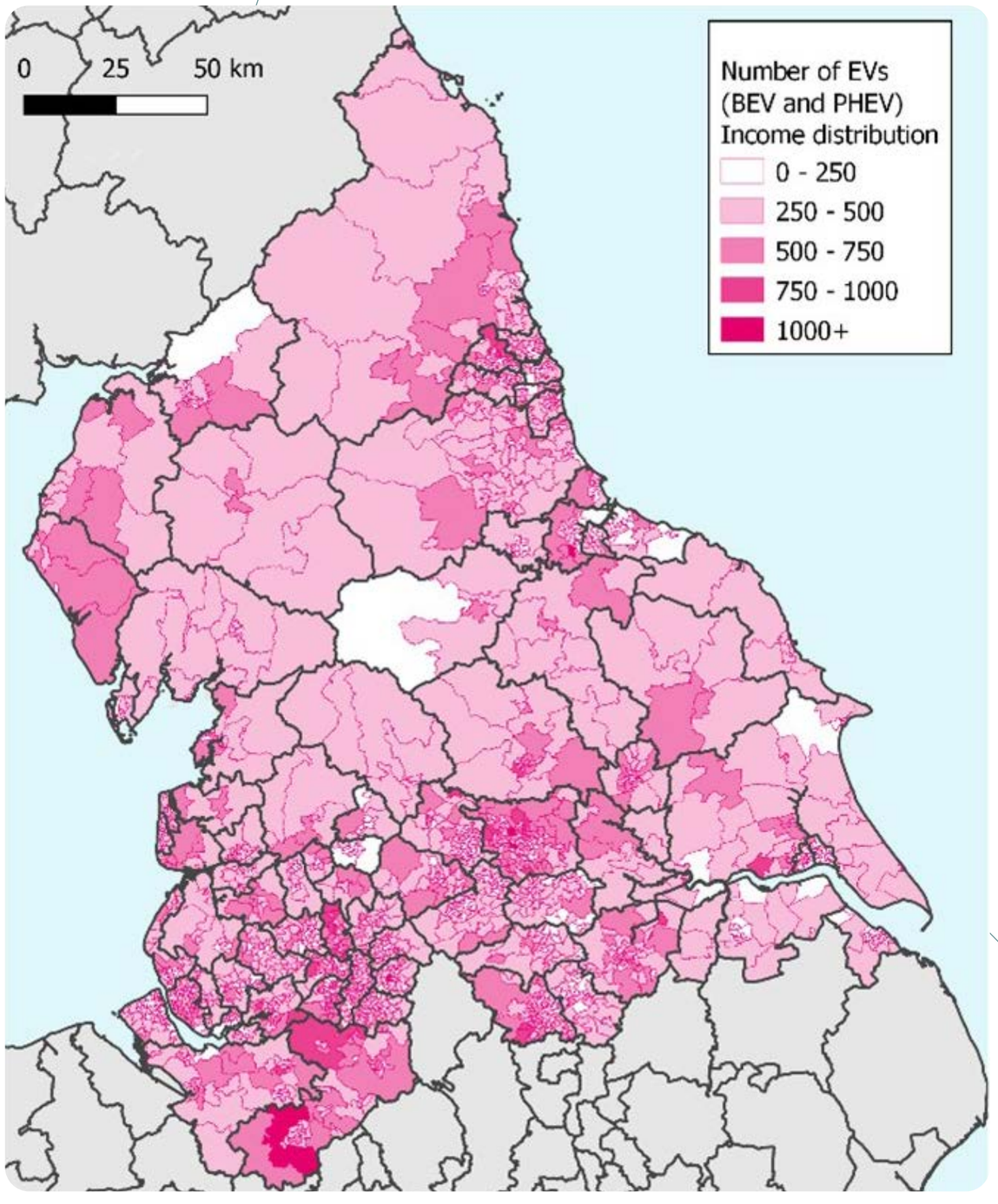
Future iterations of our EVCI framework evidence will be able to assess the likely distribution of EV uptake amongst different socioeconomic groups.

- → Support a stronger correlation between demand and charging infrastructure investment. Identify and target priority areas which might need faster deployment to support early EV uptake, high annual mileages (higher emitting trips) and charging demand or to be more commercially attractive.
- → Link with household compositions to target areas with high earlier EV uptake with no off-street charging.
- → Support stimulus for more policy or infrastructure action to improve social access to EV solutions where uptake may be slower in the short term (including were charging access is a blocker).
- → Understand areas of low uptake and possible need for other decarbonised travel options in the short to medium term (i.e. public transport and active travel connectivity).
- → Link to distance travelled to target areas of high potential uptake and the high emitting journeys.
- → Understand potential first and second-hand market impacts to better inform planning.

We will work with our regional EV Steering Group to understand and assess findings from this new evidence.

Figures 26 and 27: Example comparison of how charging demand differs when applying standard EV distribution and income-based distribution (based on EV fleet and charging demand in 2025)[48]





48. Total EVs remains the same across the figures. Scale ranges are held consistent to indicate how patterns change across the region. Further application of this evidence will identify specific impacts both locally and regionally.

Public residential and on-street charging challenge

Parking and charging availability is a key barrier to an equitable sharing of benefits. For those living in accommodation without off-street parking, such as flats or terraced houses, charging can be both less convenient and costlier than for those who have access to off-street parking. 93% of EV owners to date are estimated to have access to off-street parking. However, the Resolution Foundation found that 'one third of households (9.8 million) across England and Wales do not have access to off street parking, with 76 per cent of the wealthiest families living in homes with a garage or driveway, compared to 56 per cent of the poorest fifth of households' (See Figure 28). This would indicate EV ownership is significantly lower among those without access to off-street parking.

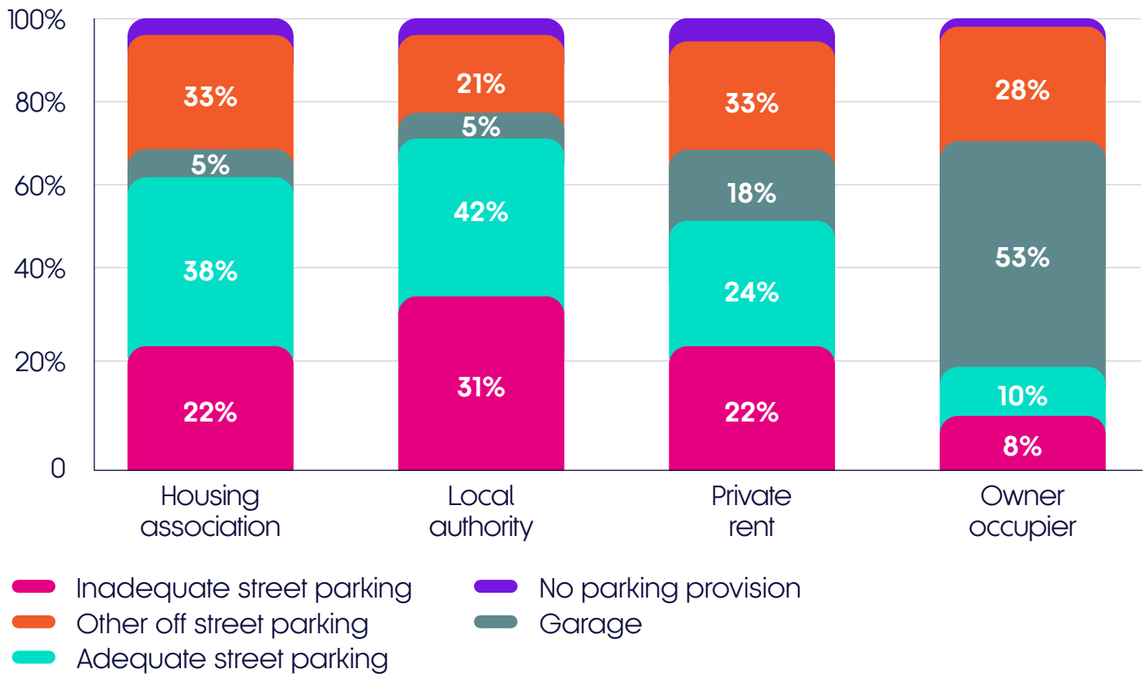
Tackling on-street charging is particularly key for the levelling up of access to EVs and the need to charge vehicles. Those without driveways will not benefit from discounted or free parking, but may also continue to pay taxes through Vehicle Excise Duty and Fuel Duty. Old Internal Combustion Engines (ICE) may well be passed down the income chain and kept within the fleet for longer; with those same owners incurring the environmental impacts and costs of those vehicles remaining in use. Whilst incentives for uptake of EVs has and will encourage new EV uses, we must be careful to support all potential EV users in doing so.

Nonetheless, as the second hand EV market grows and more people and families without off-road parking acquire EVs, this will naturally result in an increase in the proportion of EVs with no access to home charging, and so more reliance on public charging infrastructure.

Tariffs for charging electric vehicles

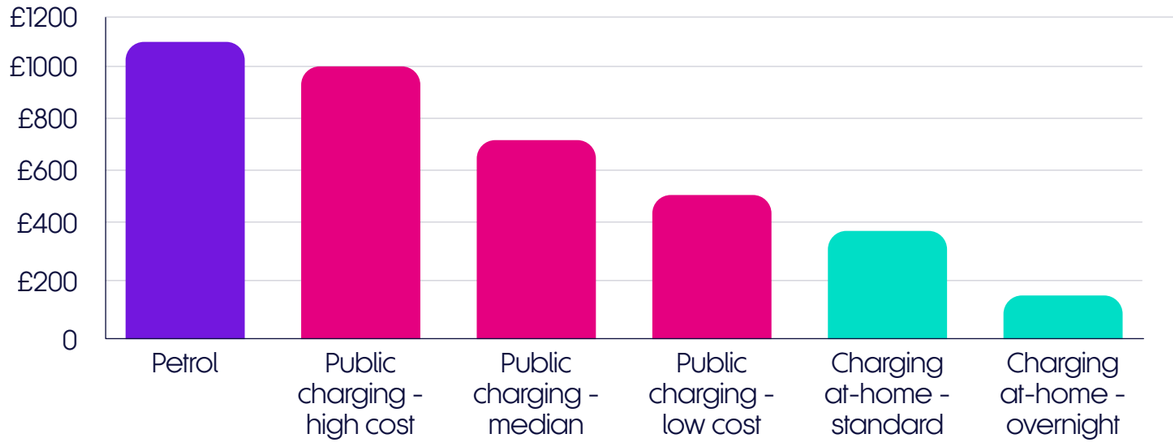
The impact of not having off-street charging capability is further compounded by the tariffs faced by those without driveways to park and charge. The cheapest and easiest way to refuel an electric car is at home. This cheaper charging using home supply is only available to those who can afford houses with driveways. People in areas without this access to home charging will need to seek publicly available or commercial chargers which carry a higher charging tariff currently, reducing the lifetime cost savings of owning an EV compared to a petrol engine vehicle.

Figure 28: Parking provision by housing tenure, England, 2019[49]



Source: Analysis of English Housing Survey

Figure 29: Estimated annual private vehicle fuel costs based on different charging regimes[50]



[49] https://economy2030.resolutionfoundation.org/wp-content/uploads/2022/03/Shrinking-footprints.pdf

[50] https://economy2030.resolutionfoundation.org/wp-content/uploads/2022/03/Shrinking-footprints.pdf

EV charging planning and delivery to account for the non-EV user

There is also a risk that mass adoption of EV and other low emission vehicles, with lower running costs will lead to an unsustainable increase in private vehicle mileage, impacting on levels of traffic congestion and pollution from particulates. Our Decarbonisation Strategy is clear that a use of low and zero-emission vehicles alone will not be enough to ensure we meet shorter term carbon reduction targets. The challenge is that alternative vehicle solutions are seen as providing the whole answer, without a complementary focus on reducing the need for motorised travel and support for a higher proportion of travel by public transport. Achieving net zero will require a broad based strategy implementing measures to reduce travel demand, particularly that from private vehicles can significantly reduce our emissions, but also reduce congestion, increase operational efficiency, and improve air quality and health.

As public charging deployment increases, we must fully consider the impacts on non-vehicle users in the North. Central to this is the extent to which the transition to EVs further entrenches car-dominated environments unsuitable for people with disabilities and reduced mobility, poor conditions for active travel, and exacerbates the significant gap between what is accessible by public and private transport. TfN will seek to integrate our EVCI framework findings with other capabilities within TfN during the course of 2022/23, including:

- **Transport Related Social Exclusion (TRSE):** Over the last year, TfN has gathered a significant body primary evidence from communities affected by TRSE, and has developed a data tool to measure the risk of TRSE across local areas in the North. TfN will publish a report on TRSE in May 2022, and will be launching a public-facing data tool on TRSE in September 2022.
- **Clean Mobility Visions:** The Clean Mobility Visions project will identify evidence-based policies to reduce levels of private car, and assess the suitability of these policies in specific place and population contexts. This is to support Local Transport Authorities in reducing transport carbon emissions, in improving population health, and in improving social inclusion and quality of place. TfN will launch an online tool to enable LTAs and others to access these policies and the evidence underlying them in Q4 of 2022/23.
- **TfN's Active Travel and multi-model policy positions:** TfN's Active Travel and multi-model policy positions[51] highlight the importance of enabling travel by foot and bicycle, and the need to join-up transport options across different modes.

[51] https://transportforthenorth.com/press-release/two-new-policy-positions-highlight-importance-of-active-travel-and-multimodal-hubs/

EVCI framework application actions:

- Support and inform local and national delivery activities to shape EV charging infrastructure planning and delivery that delivers for EV users were car usage is required, but is also cognisant of specific spatial environments and needs.

EVCI framework evidence enhancements available:

- Extend our framework evidence to assess the extent to which different income groups may experience EV uptake and how access to charging might vary. This will develop a more rounded view of how to support a more equal and fairer transition to electric vehicles. Share this understanding with our Local Authority partners to identify possible solutions to manage both high and low uptake areas (i.e. targeted infrastructure, policy actions and informing market incentivisation).
- Integrate our EVCI framework findings with other capabilities within TfN to explore and define an optimum EVCP network which also considers the many social and spatial considerations associated with EV charging deployment.
- Carry out modelling to explore the impacts of an increased focus on local parking hubs as an alternative to on-street charging. Apply the TfN EVCI model intelligence to develop a greater understanding of delivery options suited to place and demand, and to maximise user access and inclusivity.
- Explore improvements to the EVCI model to provide more evidence towards impacts of scenarios where a significant fraction of cars are not privately owned (i.e. more Car Clubs) to inform business models.
- Seek avenues to understand which users may need to charge on domestic tariffs and on public tariffs – each of which will face a very different per mile fee.

iv. Supporting public-private sector engagement

Table 6 outlines the delivery models available for EVCI deployment, with growing interest and investment from the private sector. Private Sector led delivery has often focused around the most commercially attractive sites, where demand is guaranteed and electricity supply can be delivered such as rapid en-route sites near key destinations or on major road arteries. To date, public residential or rural areas with lower perceived demand or high delivery costs have naturally carried a weaker commercial case and therefore have resulted in public or concessionary delivery models. Although our engagements with the private sector has indicated interest and application, in some parts, to shift the balance of focus to public residential areas.

The pattern seen so far, does mean some areas are likely to be left behind without public sector intervention, or new delivery models and evidence which help to de-risk private sector investment. TfN's EVCI evidence can support further work to identify opportunities, needs, and also the best delivery solution within different local areas. In particular, our evidence can be applied to work with the private sector on areas which would usually be viewed as having limited concentrated demand for charging, to make a more compelling investment case.

Local Authorities across the North have seen success with different delivery models. However TfN and our partnership are clear that public-private collaboration is vital to ensure a successful whole network of the right charging infrastructure. Our strategic planning and coordinated approach is essential to allow open sharing of evidence at sufficient scale for investors to develop and embed sustainable commercial models. We are already seeing this in action across the region. We will seek to encourage this further, using our EVCI framework intelligence to reduce uncertainty to unlock delivery and support sustainable and inclusive long-term commercial models.

EVCI framework application actions:

- → Apply our regional partnerships to explore collaborative approaches to delivery, including the sharing of data and options for trials of new delivery mechanisms to support regional deployment of EV charging infrastructure. Including how this could be supported by National policy and legislation.
- → Use our regional EV Steering Group as a mechanism to enhance public-private sector engagement to communicate requirements across the region identified by our evidence and capabilities.

EVCI framework evidence enhancements available:

- → Look to illustrate the challenges in delivering EVCPs on a commercial basis in differing area types, integrating considerations about financial viability with EVCI identified provision. To provide a better understanding of which EVCI requirements may be covered by private sector funding, or require public investment through local transport plans and strategies.
- → Explore whether new pan-Northern procurement framework processes and contracts can support regional delivery and the actions of our local authorities in engaging the private sector to drive economies of scale. To attract the right level of investment, support collaborative sharing of risk and benefits within commercial models, and drive optimum results.

[52] https://transportforthenorth.com/future-travel-scenarios/

[53] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1046250/consultation-response-electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf

v. Encouraging a systems approach

We are mindful that EV charging interventions are part of the wider strategic infrastructure system. To deliver a comprehensive EV infrastructure rapidly and effectively, a whole system approach is needed to create a platform for co-ordinated EV uptake. Regional and local bodies can play a critical role in delivering integrated results (across transport, energy and spatial systems) which enable the rapid delivery of a widespread EV network which ensures no place is left behind, supporting improvements to air quality and the UK in meeting committed carbon budgets.

We will look to share and apply our EVCI framework evidence to inform local delivery and support confidence in solutions being planned and delivered.

Energy considerations

Electrification of the transport system increases the importance of aligning investment in transport with that in the country's energy systems. This is a significant undertaking and requirement of our energy and transport networks which requires robust, integrated and evidence-based planning across 'sectors'. This will also be key to tackle areas of need which are hampered by grid constraints or high grid connection costs (making them commercially unviable). Although it is important to note that while the areas of higher demand offer more potential sites, they will also require a greater number of sites, which presents its own challenges, particularly if this amounts to more concentrated requirements for high powered connections, which potentially impacts on deliverability.

Collaboration between transport and energy sectors is key to deliver supply, distribution and demand management of networks which support future travel and energy demand. How we will move around (or not travel) in the future still remains uncertain (as mapped by our Future Travel Scenarios[52]), therefore developing a view of likely future travel demand, and the associated charging energy demands, will inform the delivery of EV and other solutions are 'future proofed' and resilient. We will seek to further consolidate and align our systems thinking with energy network and regulatory partners across the energy sector, to encourage a holistic and collective approach to EVCI planning and delivery.

We also need to future proof our networks to support grid capacity; enhance interoperability and interchangeability; harness 'disrupter' technologies such as Smart Charging and Vehicle to Grid (V2G), potential for energy generation and storage technologies; and flexible prices or time of use tariffs. There is a challenge that if not done correctly, we will uphold conventional vehicle use norms (refuelling at petrol stations) rather than encouraging new behaviours which take advantage of opportunities to spread energy demand and efficiencies across a wider network and time period.

Maximising the use of renewable energy in fuelling ZEV's will be a critical part of the equation, and TfN supports the Government's aim to maximise the use of smart charging, and mandate that all new private charge points must be smart, as an important factor in reducing peak electricity demand and through building flexibility into the network, supporting greater use of renewables within the mix of overall power supply.

Spatial considerations

Clear and effective spatial planning and regulations will be critical in creating certainty of the suitable locations to meet a range of charging needs without unintended consequences.

As noted in the inclusivity section above, there is a need to consider the future make up of housing developments, principles and technological solutions holistically in order to deliver place-based solutions and understand the impact of housing developments on the number of available chargepoints, and vice versa. Particularly with the Government regulation for all new homes with associated parking to have an electric vehicle chargepoint[53]. This could see exploration of the wider behaviours associated with housing developments, for example, supporting the ownership of EVs or promoting more car sharing and public transport access.

[52] https://transportforthenorth.com/future-travel-scenarios/

[53] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1046250/consultation-response-electric-vehicle-charging-in-residential-and-non-residential-buildings.pdf

EVCI framework application actions:

- → Our enhanced regional evidence provides a basis on which to engage with the Department for Transport, Department for Business, Energy and Industrial strategy (BEIS), Energy Systems Catapult and other parties to inform both hard infrastructure, as well as policy and strategic choices which can contribute to successful role out of EVs.
- → We are aware that Ofgem is finalising their network planning decisions for 2023-28 during 2022. Given the likely rapid increase of EVs during this time horizon, this is an important time to share our understanding of EV charging requirements and support this decision-making.
- → Continue our collaborations with National Grid (as the national transmission as the owners of high voltage transmission networks in England and Wales) and the Northern Distribution Network Operators (as members of our regional EV Steering Group). With a view to further consolidating and aligning our collective understanding of actions required to support a rapid transition to EVs and support the decarbonisation agenda. This could include:
  - Engagement with Northern DNOs to understand how outputs need to be adapted for integration into their models.
  - Working together, in conjunction with local authorities and the private sector, to facilitate and shape large regional level charging infrastructure planning and delivery.
  - Seeking addition data sharing to definitively map the additional electricity demand for EVs identified by our framework to distribution network assets.
- → Look to further consolidate and align our systems thinking with energy network and regulatory partners, including linking up with the Northern Hydrogen workstream which TfN is partnered with, to consider how we make the most of alternative fuelling and charging opportunities.

EVCI framework evidence enhancements available:

- → Seeking addition data sharing to definitively map the additional electricity demand for EVs identified by our framework to distribution network assets, to enhance collaborative planning and delivery of EV charging infrastructure.
- → Identification of headroom on primary and secondary substations to improve forecasting of reinforcement needs and costs per MW.
- → Seek to integrate our EVCI framework with TfN's regional spatial development log to provide intelligence towards EVCI planning and decision making, link to new housing regulations and impacts, support local authority EVCI plans and energy network requirements.

vi. Extending further integrations with fleets (buses and freight), warehousing and depots

Our EVCI framework identifies the charging needs for HGVs and vans across the region. This charging in the model is currently split between depot charging and charging at rapid hubs on the SRN.

It is likely charging will also occur at warehouses and retail locations as well as at Light Duty Vehicle urban charging hubs (for the smaller trucks). Both of which have an impact of charging decisions and electricity demands. There is opportunity to integrate EVCI framework findings with TfN's Freight Strategy[54] and our Local Freight tool. This could see TfN develop a richer strategic view with regards to freight, warehousing and charging clustering. Recognising recent developments pointing to LGVs being more likely powered by electric drivetrains.

54. https://transportforthenorth.com/freight-logistics/

EVCI framework application actions:

- Inform and enhance delivery of TfN's wider Decarbonisation and Freight Strategies.
- Ensure strategic planning for electric freight drivetrains is fully considered and consistent across a regional geography (particularly key for the movements of goods)

EVCI framework evidence enhancements available:

- Integration with TfN's Local Freight tool and regional spatial development log may provide additional intelligence towards EVCI required at specific depot sites.
- Future advancement to the TfN Analytical Framework with regards to buses and freight may allow for more intelligence to feed into our EVCI model. Providing the potential for assessment of bus and fleet depots, as well as HGVs and LGVs broken into segments such as delivery purpose; commodities; and warehouse throughputs. To understand the correspondent effect on electric charging patterns and to target points of interest for infrastructure needs.
- Apply the above advances to better understand potential impact on electricity grid needs (either transmission or distribution networks) and actively inform planning and delivery decisions across the region.

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