Decarbonisation Strategy

February 2021

TRANSPORT FOR THE NORTH

Contents

Introduction

The science is conclusive - the world is facing a climate emergency.

In the UK, transport is the largest contributing sector to greenhouse gas emissions, accounting for 22% of all emissions in 2019[1], of which more than 95% are from road transport. Furthermore, transport emissions have continued to grow since 2013.

Whilst it is possible that 2020 figures will show a drop in emissions due to reduced levels of travel during the COVID-19 lockdown, this is likely to be temporary, with demand for car travel rebounding more quickly than public transport, approaching pre-pandemic levels.

In our Strategic Transport Plan, published in 2019, Transport for the North (TfN) committed to scoping, developing and implementing a 'Pathway to 2050' in line with the then UK law of achieving an 80% reduction in national emissions by 2050 (now superseded by the current UK Government commitment to achieve net zero emissions by 2050). For the surface transport sector, this meant that road transport emissions would need to be near-zero and rail would need to be decarbonised by 2050.

TfN and our partners believe that an acceleration towards a zero-carbon transport network must be at the heart of public policy-making and investment decisions. Our ambition for the North is to travel faster and further than national policy and maximise the clean growth opportunities that decarbonisation can provide for the North. Through this Decarbonisation Strategy, TfN and our partners are committing to a regional near-zero carbon surface transport network by 2045.

The achievement of TfN's vision of a thriving North of England, where world class transport supports sustainable economic growth, excellent quality of life and improved opportunities for all, is contingent on how we can reduce our greenhouse gas emissions across everything that we do, and then, making the right decisions at the right time.

22%

Transport sector's contribution to greenhouse gases in 2019

95%

of greenhouse gases come from road transport

[1] This relates to surface transport and does not include emissions from aviation and international shipping.

The Role of TfN

Through its statutory powers, TfN acts as 'one voice' for the North, communicating pan-Northern priorities to the Secretary of State for Transport. We have 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. This Decarbonisation Strategy provides a tool to robustly consider how our Investment Programme is performing in this respect. It will also provide guidance to support an appropriate sequencing of those investments and the mitigation actions that may be needed to deliver transformational economic growth in line with decarbonisation ambitions.

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, for example, developing a series of pan-regional low-emission vehicle charging network principles. Indeed, a high proportion of the emissions from private road vehicles is generated by longer distance regional-level trips, with our analysis indicating that around 60% of road transport emissions in the North originate from trips on the Major Road Network. This means TfN has both an opportunity and a responsibility to help reduce this significant share of road transport emissions.

TfN is also uniquely placed to assist our partners in the development of place-based solutions by analysing emissions at a more disaggregate level and providing enhanced evidence, data platforms and intelligence to inform bespoke local and regional strategies. This can, in turn, support national policies to take account of spatial and social variation.

At a project level, TfN has a responsibility to ensure that the design and construction of our projects and programmes reduce lifecycle carbon and to encourage partners to adopt similarly ambitious policies.

The North is also extremely well placed to support the testing and trialling of many emerging technologies that will be crucial to transport decarbonisation in the UK, including through existing initiatives such as the UK's first Hydrogen Transport Hub in the Tees Valley, Zero Carbon Humber, and HyNet North West. Through partnerships and co-working with Local Authorities, Local Enterprise Partnerships, transport providers and regional academic and industry players, TfN is committed to promoting the North as hub for innovation, research and the testing of emerging technologies.

Finally, TfN needs to lead by example. Whilst the focus of this strategy is upon understanding, measuring and reducing the emissions from surface transport in the North, and the construction and operation of the proposed schemes within our Investment Programme; it is important that we look to reduce the emissions resulting from TfN directly as a result of our everyday business. These are called our 'organisational emissions'.

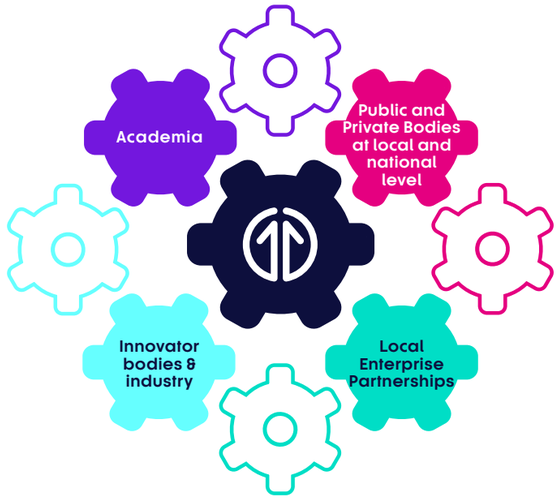
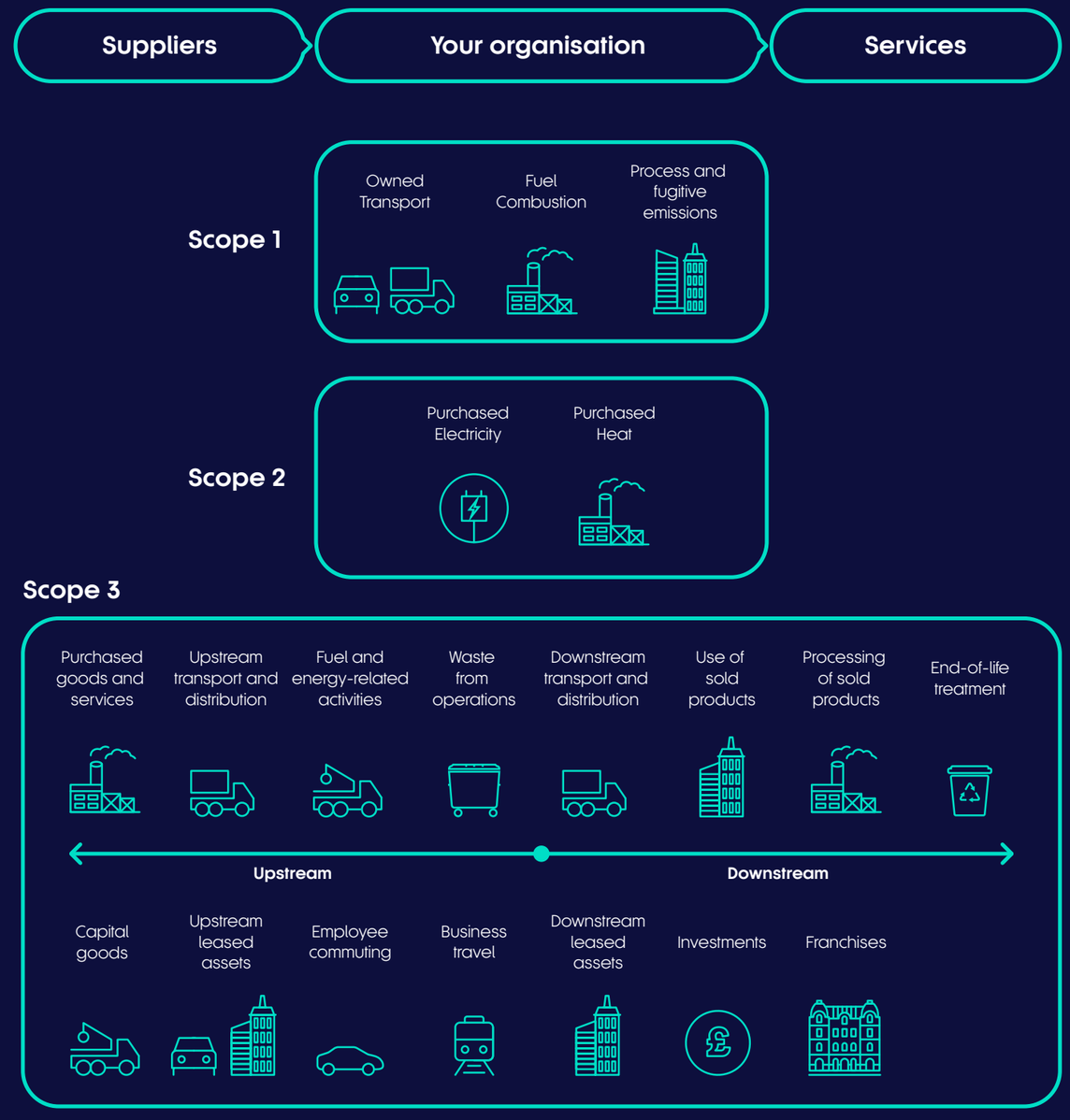


Figure XXX, Carbon Footprinting – Organisational Barriers[2]



[2] Image sourced from Carbon Trust and The Greenhouse Gas Protocol, 'A Corporate Accounting and Reporting Standard, Revised Edition' (2004).

The Role of TfN

The full range of activities and goods, through which an organisation might generate greenhouse gas emissions, is illustrated in Figure XXX. These emissions sources are split into three types – known as Scope 1, 2 and 3. Different emissions sources will be of relevance to different types of organisations, particularly in relation to Scope 3. For TfN, these organisational emissions are likely to include:

- ⇒ Scope 1 emissions, which are direct emissions resulting from activities that TfN can control, such as the gas used to heat our offices.
- ⇒ Scope 2 emissions, which are indirect emissions resulting from the generation of any power that we use within our offices.
- ⇒ Scope 3 emissions, which cover indirect emissions as a result of our operations that are outside of TfN's direct control. This includes things like the emissions from the manufacture and transport of goods we use, like stationery and IT equipment, and also services we purchase, like cleaning and catering. It also includes emissions generated by our employees' commuting and business travel, along with those generated by the disposal of our waste and our water consumption.

TfN is committed, by 2022, to understanding the carbon footprint of its organisational Scope 1 and 2 emissions and agreeing a target date for reducing these emissions to net-zero.

In the same timeframe, TfN will also develop a suitable carbon footprint scope for measuring its organisational Scope 3 emissions. This will reflect data availability, our environmental goals and the sources we can influence.

Emissions generated from the design, construction and operation of schemes within our Investment Programme, along with changes to the emissions generated by surface transport in the North as a result of TfN activity, are the main focus of this strategy document. Our approach to measuring these emissions and our Decarbonisation Trajectory are covered within Chapters 2 to 6.

Why a Decarbonisation Strategy?

To achieve a near-zero emissions surface transport network in the North by 2045, there must be a clear understanding of the policies and measures required to bridge the gap between future emissions projections and future emissions targets. TfN's Decarbonisation Strategy reflects work undertaken to define four plausible baseline emissions trajectories, based on our Future Travel Scenarios, and to identify and assess the gap between each trajectory and TfN's Decarbonisation Trajectory.

We have also undertaken a policy analysis to understand the policy ambition and suite of policy measures that could fill the policy gap for each scenario. This provides insights into the key, low-regret policy measures required under all scenarios, as well as the areas where TfN and partners are likely to require additional national support to achieve decarbonisation ambitions.

It is hoped that this guidance is of use to our partners and other organisations across our region.

Building upon these findings, this strategy lays out the North's minimum expectations in relation to both local and national decarbonisation policy ambitions. It is intended to provide an overarching framework for our partners and other organisations across the region to meet their decarbonisation responsibilities and ambitions.

The Strategy also recognises the importance of considering embodied carbon and climate change adaptation and resilience, drawing on the experience of our delivery partners, Highways England and Network Rail, in these areas.

Finally, this strategy outlines TfN's key commitments to enabling the decarbonisation of surface transport in the North. Developed through research and engagement with partners, regional research bodies and industry, these relate to activities that would benefit from coordination at the regional level and can be most effectively undertaken by TfN. As part of this analysis, a key consideration for TfN has been how the decarbonisation of transport can support our partners' economic growth ambitions, championing clean growth opportunities across our region. Cross-sectoral co-operation and planning will be essential if the North is to deliver both a decarbonised transport system and capitalise on the possibilities from green industrial revolution, especially with the energy generation and distribution sector.

The timeline for undertaking these activities is outlined within Chapter 9, Priority Actions to 2025.

This strategy builds upon the four objectives in TfN's Strategic Transport Plan:

- ⇒ **Transforming economic performance:** We want to understand the full range of clean growth opportunities within the North as a result of transport decarbonisation.
- ⇒ **Increasing efficiency, reliability, integration and resilience in the transport system:** We want to integrate decarbonisation measures into existing and future programmes and projects in order to maximise efficiency and reliability gains (such as the electrification of our railway network). We also need to ensure that climate change adaptation and resilience is a key consideration in policy and project development.
- ⇒ **Improving inclusivity, health and access to opportunities for all:** The decarbonisation of transport in the North provides an important opportunity for reducing transport-related social exclusion. We want to ensure that decarbonisation measures optimise co-benefits relating to physical health, improved air quality and increasing levels of mobility for all communities and areas in the North.
- ⇒ **Promoting and enhancing the built, historic and natural environment:** While environmental conservation is the ultimate driver for decarbonisation, we need to consider the localised impacts of decarbonisation policies and measures. For example, local air quality, reduced noise levels, and the environmental impact of new infrastructure and operations required as part of the decarbonisation agenda (e.g. electrification infrastructure).

TfN's Decarbonisation Trajectory

What is TfN's Decarbonisation Trajectory?

Our route to a decarbonised transport system is illustrated by a measurable, evidence based and time-bound carbon emissions reduction curve, which starts with 'where we are now' and travels towards alignment with the objectives of the Paris Agreement, i.e. deep emissions reductions over the coming decades towards a zero-emissions transport system before 2050.

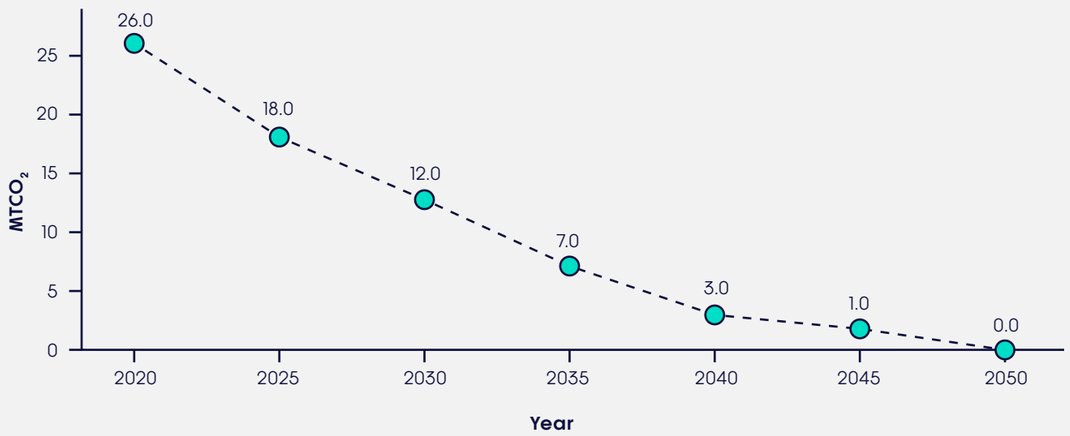
That journey is called our Decarbonisation Trajectory, with the shape of the curve being dictated by a series of interim emissions reduction milestones that ensure a rate of progress aligned to the Climate Change Committee's Carbon Budgets as a minimum.

Our agreed Decarbonisation Trajectory is shown in Fig X, with the headlines being:

- ⇒ A 55% reduction in emissions from 2018 to 2030, achieved mostly through mode-shift and demand reduction.
- ⇒ An 90% reduction in emissions from 2018 to 2040, reflecting longer-term decarbonisation measures, such as a high proportion of zero-emissions vehicles in the vehicle fleet.
- ⇒ A close to zero date of 2045 for carbon emissions from surface transport in the North. This is a challenging benchmark reflecting the ambition of our partners and their desire to push further and faster than current national policy.

The scope of the emissions included within the trajectory is described below.

Figure X: TfN's Decarbonisation Trajectory



Why 2045?

A decarbonisation trajectory set at a regional scale is, by its nature, a compromise between areas that have set different decarbonisation timescales and have different geographies, demographics and patterns of passenger and freight demand.

A number of our partners have set ambitious, economy-wide decarbonisation targets with net-zero dates pre-2040 for their authority areas. The contribution of transport emissions reductions to these economy-wide targets will depend on progress in other sectors and the assumed availability of negative emissions measures, but it is clear that these authorities are aiming for transport emissions close to zero by 2040.

In preparing a Decarbonisation Trajectory, TfN seeks to achieve a compromise by moving faster than current national policy and the Climate Change Committee's advised trajectory, while being mindful of the varying levels of progress that our partners have made in terms of their own climate change responses. In this way, TfN's Decarbonisation Trajectory considers the ambitions of the whole region, but does not override or specify local place-based targets.

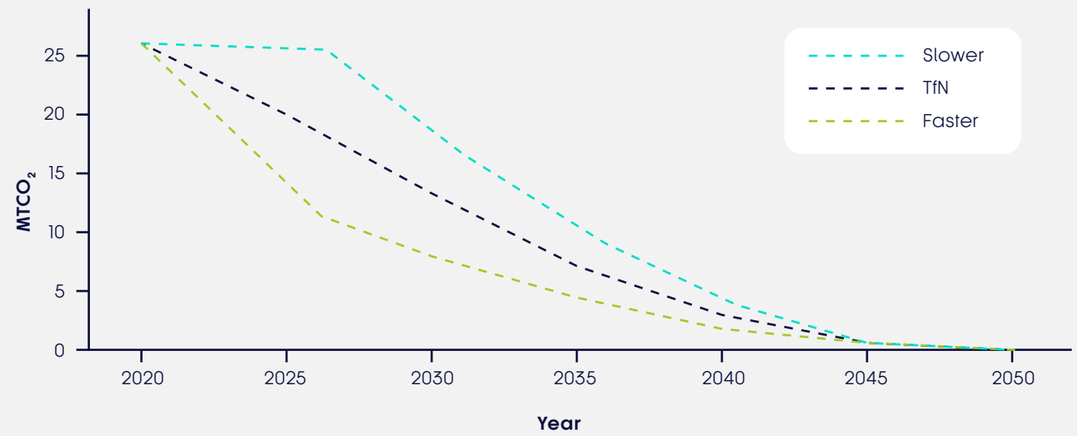
Indeed, the deep emissions reductions achieved by our most ambitious partners over shorter timescales will be needed if the region is to align itself, as a whole, with the level of reductions suggested by TfN's Decarbonisation Trajectory.

The interim points along our trajectory effectively represent an average for the region, with some areas' local transport systems decarbonising more quickly, while some may decarbonise slightly slower. The end point of our Decarbonisation Trajectory means that by 2045, emissions from surface transport in the North will need to be close to zero.

Figure X illustrates how different places within the North may move ahead with different trajectories, helping to achieve an average regional trajectory, but with all places reaching close to zero by the agreed end date.

Aligned to this, the programmes and projects that together make up TfN's Investment Programme should collectively emit close to zero carbon dioxide emissions by 2045. It is also true that many of these projects and programmes may actively help reduce emissions in the short term, for example, rail schemes may lead to a reduction in car vehicle and road freight mileage. This consideration will be important as we look to benchmark ourselves against our trajectory over the coming decades.

Figure X: TfN's Decarbonisation Trajectory reflects an average across local authorities that can decarbonise slightly slower or slightly faster



What is included in our trajectory and why

TfN's Decarbonisation Trajectory comprises emissions from surface transport sources. This includes cars, vans and Heavy Goods Vehicles (HGVs), as well as bus and rail.

In recognition of TfN's remit, the Decarbonisation Trajectory relates to emissions from vehicle mileage that takes place on the transport network within the North, including through trips (e.g. Scotland to the South of England), as illustrated by the orange roads in Figure X.

Other forms of transport with significant emissions profiles include aviation and shipping (both domestic and international), which together accounted for 10% of the UK's total emissions in 2018 (compared to 23% from surface transport sources). Seven percent of this was generated from aviation, of which 93% was from international aviation.

As these modes lie outside of TfN's jurisdiction, emissions from aviation and shipping are not accounted for within TfN's Decarbonisation Trajectory. Nevertheless, we recognise the need for aviation and shipping to be included in national targets and for strong national strategy in this area which aligns the UK aviation strategy with the Paris Agreement.

TfN believes that the emissions from all flights from airports in the North need to be fully aligned with the requirements of the Paris Agreement. This means operating within a defined carbon budget for UK aviation as part of a wider international budget.

Some residual emissions from aviation and shipping are assumed within the current Government target of net-zero emissions, for the whole economy, by 2050. It is important to note that by excluding aviation and shipping from our trajectory, surface transport emissions will need to be zero by 2050.

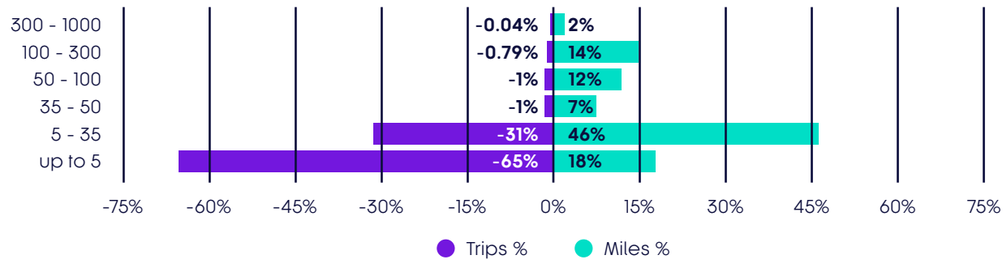
TfN's Decarbonisation Trajectory, set at a regional level, also recognises the importance of scale when attributing longer distance journeys against decarbonisation budgets of smaller areas of spatial governance. For example, some authorities with relatively small populations may be assigned relatively large emissions because they happen to have a segment of motorway that passes through their boundary, or a large source of traffic, such as a seaport. If through traffic dominates local traffic, the ability of that authority to influence the carbon outcomes are low.

Similarly, a smaller authority may choose to discount emissions from through traffic from their decarbonisation plans, resulting in the responsibility for considering those emissions slipping between the gaps of different areas and levels of spatial governance.

Figure X, compiled from National Travel Survey data, demonstrates that although approximately 95% of passenger trips (all modes) occur at a spatial scale that would suit consideration by a district, county or combined authority, these trips only account for about 65% of all miles travelled.

The remaining 35% of total miles travelled occur on journeys over 35 miles in distance, and whilst some of the longest trips would extend even outside of a pan-Northern focus, the majority of trips over 35 miles will be best considered at a pan-Northern level.

Figure X: Percentage of trips (all modes) and percentage of all miles, by trip length[1]



[1] Source: Addel, M. Wadud, Z. and Anable, J. 'An exploratory analysis of long distance travel in England', 99th Annual Meeting of the Transportation Research Board (TRB), Jan 2020, Washington DC.

Figure X: Map of the Northern boundary in which TfN operates. The white section represents the areas that TfN covers and the orange roads represent the key roads within this boundary.

How we use our trajectory

Providing guidance

To understand the impact of our Investment Plan in terms of carbon emissions, we need to understand a number of things:

⇒ Where are we likely to be living and working in the future, and what will our travel habits and patterns look like?

⇒ What national and local transport policy is likely to be in place that may affect the carbon emissions of transport?

Once we understand the answers to these two questions, we can work out the approximate carbon emissions from surface transport at a number of set points in the future. These are our future baseline emissions, and when you join these points together, it forms our baseline trajectory.

Of course, the future is not certain, and for that reason TfN has created and modelled a number of Future Travel Scenarios. These scenarios have given us the ability to calculate transport emissions change by scenario and area type - providing four plausible baseline emission trajectories. We will add to these any increase or reduction of emissions stimulated by our projects and programmes within our Investment Programme at any given point. Chapter 3 explains more about the characteristics of each Future Travel Scenario and how they have been used.

If our baseline trajectories, plus any emissions changes as a result of our Investment Programme, exceed our Decarbonisation Trajectory at any point in the future, the gap between the two is known as the Policy Gap. As part of the preparation of this strategy, TfN has modelled the Policy Gap for a number of interim points along the Decarbonisation Trajectory.

This Decarbonisation Strategy sets out how these Policy Gaps may be addressed through two main areas:

⇒ Identification of additional local policy commitment required to achieve the Decarbonisation Trajectory.

⇒ Identification of additional national policy commitment required to achieve the Decarbonisation Trajectory.

The identification of required additional policy commitment is important as it helps TfN and its partners evidence and illustrate the additional support required from national government to achieve our decarbonisation ambitions as a region.

This support could be in the form of additional national policy or Government provision of more devolved funding or powers. Chapter 4 sets out the change in policy commitment that we believe is required to bridge the policy gap found in each Future Travel Scenario, and Chapter 5 identifies and provides qualitative guidance on the measures that are likely to be required to achieve those policy commitments.

Making the right decisions

At a strategic level, we need to understand how TfN's Investment Programme affects the future projected emissions from surface transport in the North.

The Investment Programme is due to be appraised against a number of environmental, social and economic objectives to arrive at a preferred mix of schemes. Changes to surface transport emissions generated in the North, as a result of these schemes will be modelled so that we understand what local and national decarbonisation policy commitment will be required at different points in the future to allow the schemes to be delivered within the parameters of TfN's Decarbonisation Trajectory. Ultimately, we will be asking the question: 'what needs to be true, if the North is to effectively decarbonise it's surface transport as well as enjoy the significant connectivity, economic and environmental benefits that our IP will deliver?'

Recognising that the development of local and national policy is ultimately the responsibility of our partners and national government respectively, and that our actual future travel habits may occur differently from the four plausible Future Travel Scenarios we have modelled, TfN will embed consideration of our Decarbonisation Trajectory within the business case development process for individual projects within our Investment Programme.

This means that when the time comes to start to develop each individual project, over the next 30 years, we shall assess whether the carbon impact of the project is consistent with the Decarbonisation Trajectory, given the prevailing external policy context, travel habits and patterns. Recognising the detailed, and sometimes extended, consenting and design processes that precede the construction of major infrastructure projects, we shall assess the carbon impact of the project at both the concept / early design stage and then again once the detailed design is known, pre-construction.

In relation to the early design stage assessment, where a project may not deliver operational emissions in line with our Decarbonisation Trajectory, TfN will require mitigation measures to be developed as part of the project. Mitigation could take the form of fundamental design changes, influencing national government for further policy support or implementation of further local transport decarbonisation policy measures.

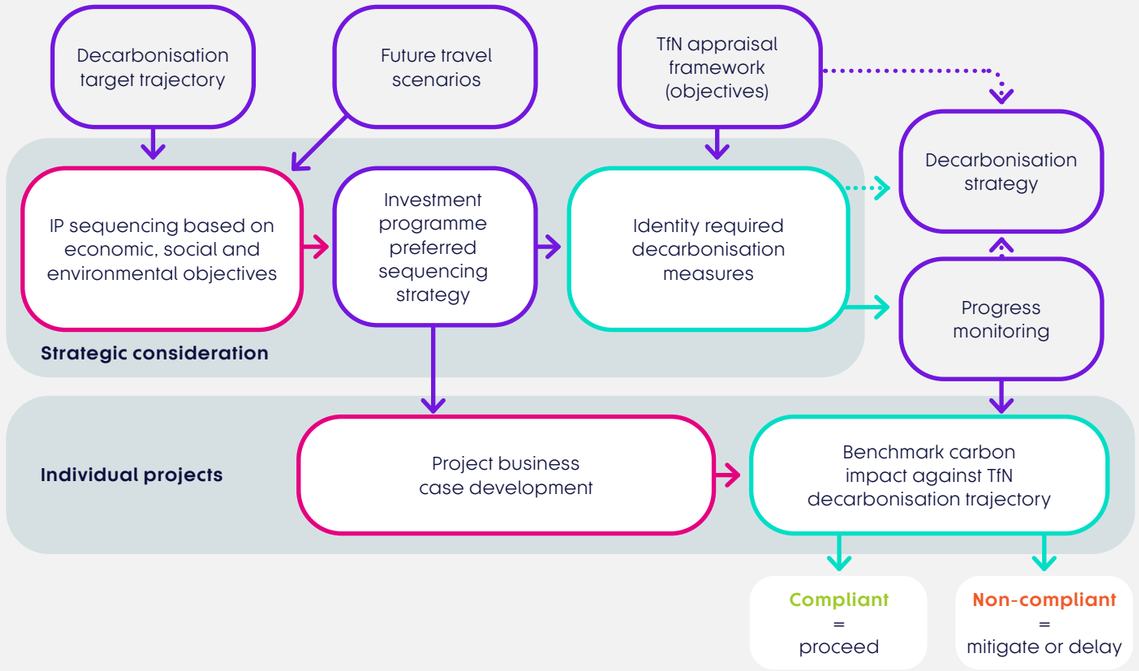
Following detailed design and before the start of construction, we will model the expected changes to surface transport emissions in the North during the expected year of opening to understand the potential success of any mitigation measures employed.

If those changes to emissions are not consistent with our decarbonisation trajectory, we shall consider additional mitigation measures such as investigating further options to provide the same transport outcomes, through to employing carbon sequestration measures such as integrating tree planting into schemes or investigating the feasibility of using innovative carbon 'absorbing' construction materials.

If it is not possible to mitigate the project's impact upon emissions, the delivery of the project may be re-sequenced within the Investment Programme to a date when the future travel context enables the project to operate within the Decarbonisation Trajectory. For example, a particular road project may be re-scheduled to a point when the majority of additional traffic generated is by zero emission vehicles.

Our approach to incorporating the consideration of our Decarbonisation Trajectory within our decision making at both a strategic and project level is illustrated in Figure X.

Figure X: Framework for assessing a project against TfN's Decarbonisation Trajectory



Estimating current and future emissions

Estimating current and future emissions is key to identifying the policy gap between baseline and decarbonisation trajectories. TfN's Northern Carbon Modelling Tool, NoCarb, was developed for this purpose, taking in historic demand, fleet and emissions data as well as those associated with TfN's Future Travel Scenarios.

This chapter outlines the context and rationale behind TfN's Future Travel Scenarios, and how they have been used through our Decarbonisation Pathway work as a tool for exploring plausible futures for which emissions can be estimated. As the starting point for all four Future Travel Scenarios, the chapter goes on to outline baseline emissions estimates for 2018, before presenting the unique emissions trajectory of each Future Travel Scenario.

Future Travel Scenarios

TfN's Future Travel Scenarios explore how trends in society, the economy and national policy could influence the level and distribution of travel demand in the future. By using a series of different Future Travel Scenarios, we aim to future-proof our decision-making as much as possible, making it resilient to wide-ranging and cross-sector uncertainties.

The Future Travel Scenarios represent factors[1] that are external to TfN's direct control, acting as 'reference cases' to test the performance of TfN strategies and policies against objectives. They form the starting point for TfN's Decarbonisation Pathways.

In each scenario, the level of national government ambition and support for decarbonisation in the North is different, as is the level and distribution of travel demand[2].

Assessing the decarbonisation 'policy gap' - that is, the gap between each Future Travel Scenario's emissions trajectory and the decarbonisation trajectory - will allow TfN to develop a resilient Decarbonisation Strategy that can adapt to different future circumstances. The policies and measures that are likely to bridge this policy gap are captured in TfN's Decarbonisation Pathway, which address the different levels of additional action required under each of TfN's four Future Travel Scenarios, recognising that the same action applied in different scenarios will result in different levels of efficacy in terms of the emissions reductions required.

The Future Travel Scenarios were developed in partnership with Local Authority partners, national delivery partners and academic experts and informed by local strategies and priorities. The scenarios represent uncertainty across the following five external factors:

1. Growth in the population and economy;
2. Spatial planning policy and economic distribution;
3. National policy on environment and sustainability;
4. Technological change and advancement; and
5. Social and behavioural change.

The key elements of the scenarios can be summarised using the following set of 'what if' questions:

⇒ **Scenario 1: Just About Managing** - What if society keeps developing broadly following existing trends? What if there is a gradual shift in lifestyles and travel, public and political behaviours do not alter, and we don't give up certain 'luxuries', leaving major developments and change to be shaped by market forces.

⇒ **Scenario 2: Prioritised Places** – What if society becomes focused on quality of life, place-making and community, rather than primarily economic growth? This scenario is led by a change in priorities, with its biggest driver being the push for a fairer redistribution of economic prosperity.

⇒ **Scenario 3: Digitally Distributed** – What if Northern Powerhouse ambitions[3] are realised by using technology solutions to create connections and agglomeration across towns and cities? This scenario is led by technology and some policy influence, as we fully embrace technological change, work remotely, and use an accessible service-based transport system with connected and autonomous shared mobility options.

⇒ **Scenario 4: Urban Zero Carbon** – What if society achieves Northern Powerhouse ambitions by using policy interventions to maximise energy efficient city growth and urban densification? This scenario is led by public and political attitudes to climate action and urban place-making, with the biggest drivers being strong government policy, resulting in fast action on zero-emission transport systems and places, with integrated planning across energy, spatial and other sectors.

TfN's Future Travel Scenarios Report provides a comprehensive overview of the process undertaken to develop the new Future Travel Scenarios. It also delves into the contextual factors underlying each scenario and the expected implications on transport.

[1] A list of travel-related development, policies and measures under each Future Travel Scenario can be found in the Future Transport Measures and Solutions Annex.
[2] Key national policy changes up to December 2020 are reflected within the scenarios.
[3] As set out in the Northern Powerhouse Independent Economic Review.

Modelling carbon emissions in the North

Over the past two years, TfN's Technical Assurance, Modelling and Economics (TAME) team has been developing and refining the Analytical Framework; a consistent set of data, modelling tools and appraisal approaches designed for TfN's programmes of transport strategy and business case development. TfN's NoCarb model forms part of the Analytical Framework and draws on other framework elements and data sources to estimate future vehicle emissions. These inputs relate to:

1. The composition of the vehicle fleet by size and fuel type;
2. The distribution of travel demand;
3. Emissions per kilometre travelled for each distinct type of vehicle.

Using these inputs, NoCarb carries out two core functions:

1. Projecting the make-up of future fleets using sales scenarios; and
2. Calculating emissions using fleet, emissions and demand inputs.

The first step involves projecting the make-up of the vehicle fleet under each of TfN's Future Travel Scenarios, while the second step estimates emissions based on the composition of the fleet and distance travelled in a given year. Estimates of kilometres travelled by each vehicle type under each of the Future Travel Scenarios were produced using TfN's travel demand modelling tools. Further information on NoCarb and these travel demand modelling tools is provided in Annex X.

Baseline emissions in the North

Figure X provides headline figures related to baseline surface transport emissions in the North. At 26 mega-tonnes of CO_2, surface transport emissions in the North represent nearly one quarter of UK road emissions and 6% of total UK emissions. Over half of those emissions were generated by cars, with HGVs and vans producing 28% and 11% of surface transport emissions respectively. Bus and rail, on the other hand, represent just 5% of emissions.

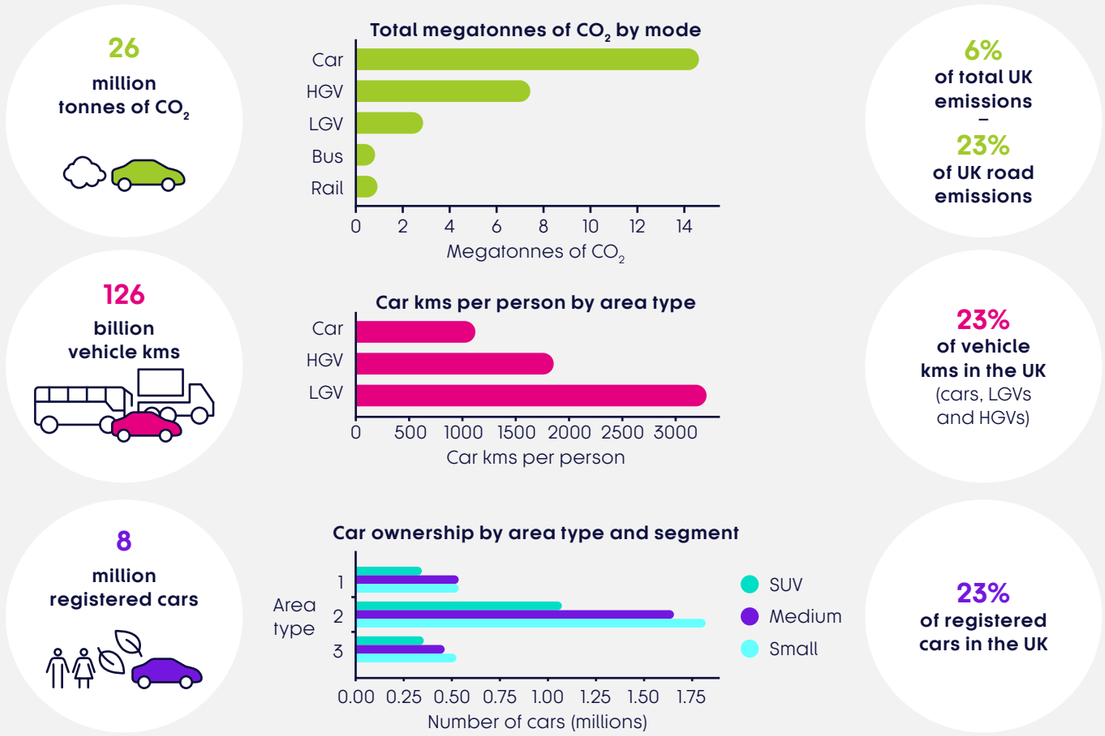
A total of 126 billion kilometres were travelled in the North in 2018, representing 23% of vehicle kilometres travelled in the UK. The majority of the North's travel was through sub-urban areas, though distance per head was much higher for those in rural areas.

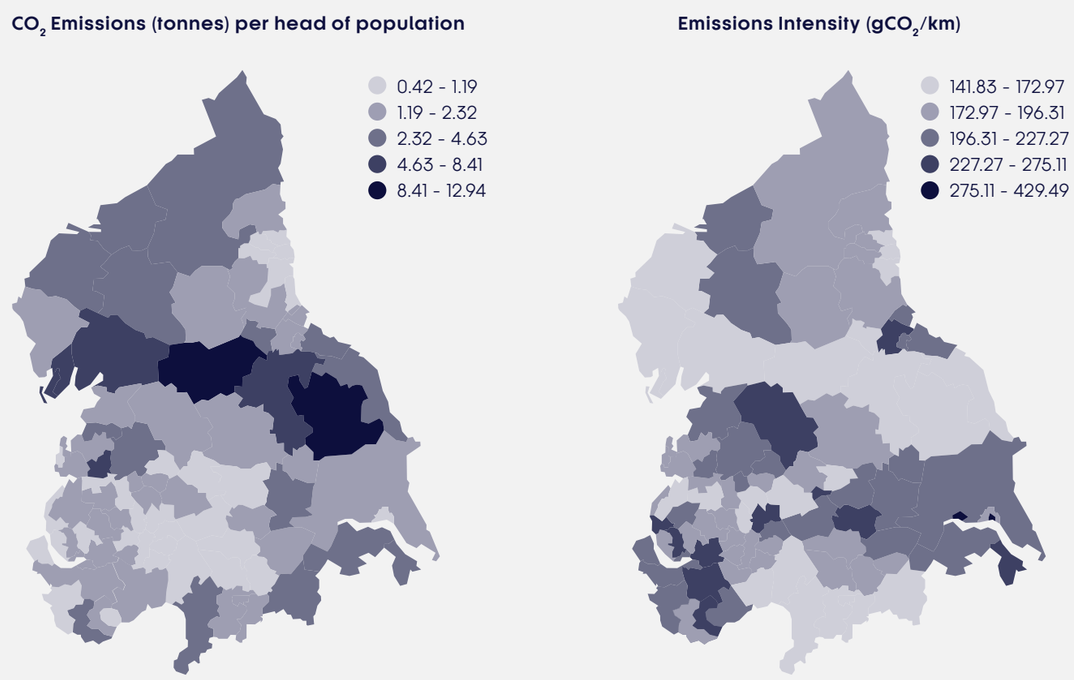
The North had 8 million registered cars in 2018. Large and SUV cars, which typically have higher emissions intensity, made up nearly one quarter of those cars. This reflects a national trend over the last two decades, which has seen a gradual increase in the purchase of larger cars.

Urban areas typically showed lower CO_2 intensity and emissions per head of population than rural areas. However, there was some variation within area types, with coastal areas having slightly more fuel-efficient cars.

The next two sections show how emissions vary by travel type and traveller type in the North of England at a regional level. We have used disaggregate trip data from the National Travel Survey to carry out this illustrative analysis, as some of the parameters are not currently included within NoCarb.

Figure X: Headline figures related to surface transport emissions in the North in 2018.





Emissions by trip purpose and distance

The majority of car emissions in the North related to discretionary travel, with 67% generated by 'other' travel, 24% by commuting and the remaining 9% by business travel.

Through an increase in remote working and social distancing measures, the pandemic has demonstrated the potential for car emissions to be reduced across trip purposes. In the short-term, as we wait for a greater proportion of the vehicle fleet to be replaced by zero-emissions vehicles, reducing car travel will play a vital role in meeting decarbonisation targets.

Three-quarters of car trips in the North were under 5 kilometres, and just under 90% under 10 kilometres. Given their short distance, a notable proportion of these trips could be switched to walking, cycling, e-bikes, or public transport. Medium and long-distance trips, on the other hand, made up the majority of car emissions, with trips over 10 kilometres generating 54% of car emissions. Trips over 50 kilometres, while only representing 1% of car trips, were responsible for 14% of emissions. The difficulty of shifting these trips to cleaner modes demonstrates the importance of decarbonising the vehicle fleet in order to meet decarbonisation targets in the medium and long-term.

Figure X: Percentage of car emissions in the North in 2017 by trip purpose

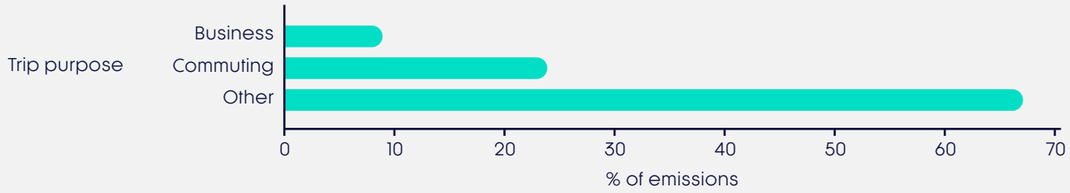


Figure X: Percentage of car trips by distance

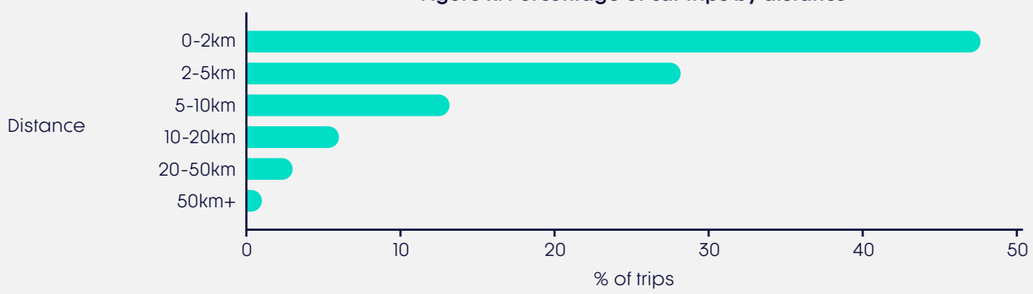
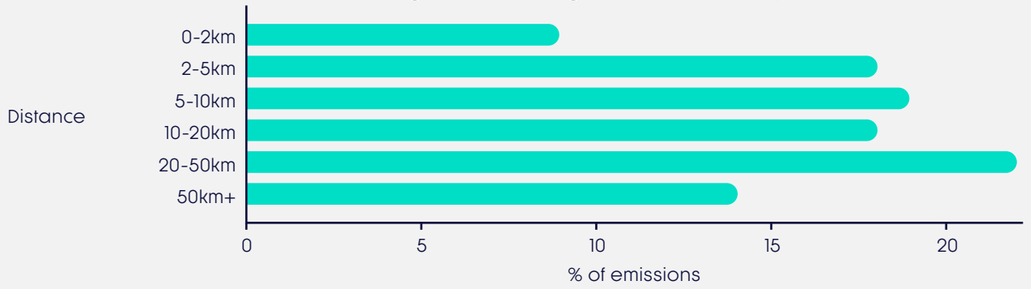


Figure X: Percentage of car emissions by distance



Distributional impacts

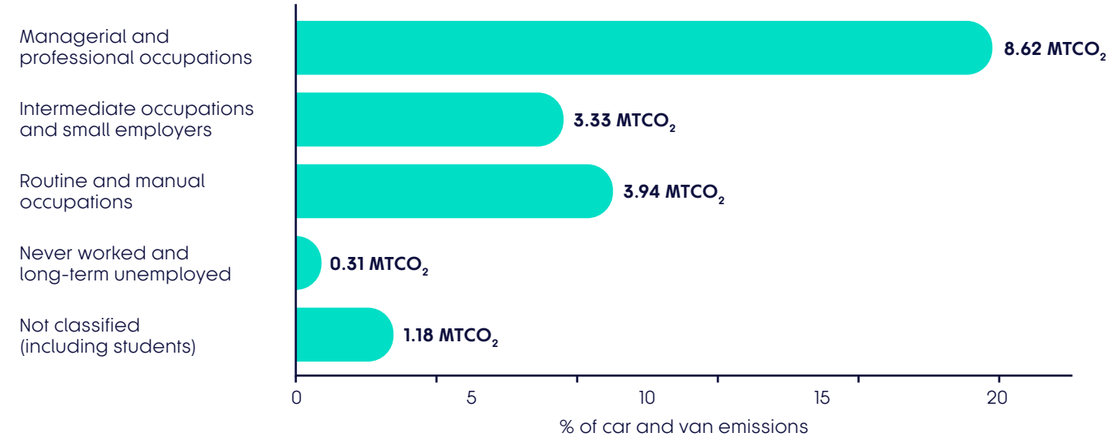
Distribution of emissions by employment group[4]

Different sections of the community produce varying rates of emissions. Our analysis[5] suggests that around half of car and van emissions in the North are generated by individuals in managerial and professional occupations, as opposed to less than 2%by non-working individuals (Figure X). Individuals in managerial and professional occupations are also responsible for the majority of rail emissions, making up over 60% of the total distance travelled by rail.

With the lowest total emissions of all modes, bus travel sees a more balanced distribution across income groups. Just under 40% of bus emissions are produced by individuals working in routine and manual occupations, while those who are long-term unemployed and unclassified take up a notably larger share compared to cars, vans and rail.

These figures align with evidence that lower income groups are more likely to use buses than those on higher incomes, as the cost of bus travel is lower than trains and cars.[6] This highlights that, to effectively reduce surface transport emissions, proportionately greater focus will be needed on transport decarbonisation measures that are likely to affect higher-income groups.

Figure X: Percentage of car and van emissions by employment group



[4] These employment groups relate to the Office for National Statistics' Socio-economic classifications (NS-SEC).
[5] This analysis was derived from the National Travel Survey 2017, filtered to only include trips that took place in the North. The share of emissions was assumed to be equivalent to the share of car, van and taxi kilometres travelled by each group. For the purpose of this analysis, it was not possible to isolate unique trips, so there may be some instances where trips were counted more than once (i.e. where people from the same household travelled together). Looking exclusively at trips undertaken by car/van drivers (or taxi passengers over 16 years old), the trends explained in this section are even more extreme. For example, the share of emissions increases from 50% to 54% for individuals in managerial and professional occupations and increases from 52% to 60% for men. The share of car and van emissions does not reflect the type and age of vehicles, meaning that newer, lower-emitting cars may slightly offset some of the emissions by higher-income groups.
[6] Gates, Shivonne et al. Transport and inequality: An evidence review for the Department for Transport. NatCen Social Research. 2019.

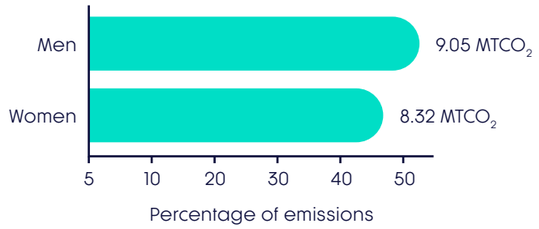
Distributional impacts

Distribution of emissions by gender

Responsible for 52% of car travel in the North, men produce slightly higher emissions than women (Figure X). This is equivalent to the gender split of drivers, with 48% of trips recorded as having a woman as the main driver. Trips taken by men also have slightly lower car occupancies, with an average of 1.93 people in a car or van compared to 2 for women.

Men represent just over half of rail emissions, making up 55% of rail travel in the North. The opposite is true for bus travel, with 55% of emissions produced by women.

Figure X: Percentage of emissions by gender



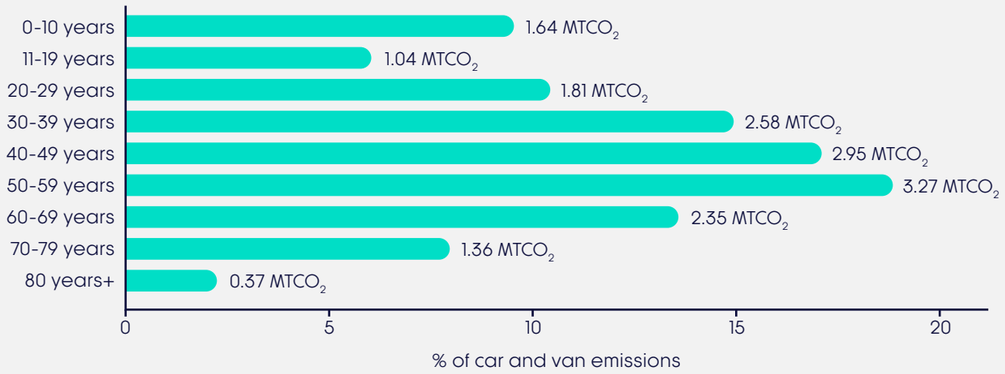
Distribution of emissions by age

Over 50% of car and van emissions, and 60% of rail emissions, were produced by people aged 30-60 years old. Covering most of the working age population, this likely reflects more commuting, business and escort[7] trips.

50-60 year-olds have the highest share of car and van emissions out of all age groups (19%), while 40-49 year-olds produce the highest share of rail emissions (23%).

Bus travel is weighted more towards groups outside of the typical working age. 11-19 year-olds represent the highest share of bus emissions at 22%, and 60-69 and 70-79 year-olds together represent 29% of bus emissions.

Figure X: Percentage of car and van emissions by age group



[7] Such as driving children to school or other activities.

What this means for decarbonisation

While this section provides a high-level overview of how emissions can vary across groups, it is not an exhaustive list; nor does it capture the complex relationships between income, gender, age, disability, location (to name a few) and carbon consumption. For example, research suggests that low-income individuals in rural areas experience the worst effects of transport poverty, with high transport costs and low public transport access.[8]

Nevertheless, emissions intensity and emissions per head is often higher in rural areas compared to urban and sub-urban areas. This means that these individuals could be disproportionately disadvantaged by targeted decarbonisation measures, such as road-user charging.

Considering the impact of decarbonisation methods on different groups is critical to ensuring that the gap between disadvantaged and privileged groups is narrowed rather than widened. This is discussed further in Chapter 5.

[8] Gates, Shivonne et al.

Future emissions estimates

Scenario 1: Just About Managing

Under Just About Managing, economic growth continues at a moderate rate and is largely market-driven, consumption-led and unequal (both geographically and socially). While there is global climate change awareness, as people become more conscious of regular disasters, the policies introduced under this scenario are not radical enough to meet the UK carbon budgets and the net zero target of 2050.

The main consequence of this scenario is that highway networks become increasingly congested, and public transport levels remain similar to today. This is also reflected at the global scale, meaning that extreme weather events become more common in the UK, leading to frequent disruption to transport networks.

Mode	Demand growth 2018-2050	CO_2 emissions in 2030 (mega-tonnes)	CO_2 emissions in 2050 (mega-tonnes)
Rail	83%	0.6	0.4
Bus and shared mobility	-3%	0.3	0.0
Car	28%	10.8	0.0
Van	47%	1.7	0.0
HGV	6%	8.0	7.0
Active travel	4%	0.0	0.0

What if society continues to develop in line with existing trends?

⇒ Existing trend of urbanisation and growth distribution continues. Little change in demographics and from travel behaviour seen today.

⇒ No transformation in level of economic growth. Reactive political direction results in a rigid economy, lacking agility and vulnerable to economic shocks.

⇒ Net Zero 2050 target not met – climate change and travel disruption becomes more extreme.

⇒ Technology uptake driven by existing policy; Electric Vehicle (EV) uptake at slowest rate of all four scenarios and some autonomy. Continuation of shared transit and public transport use as seen pre-2020.

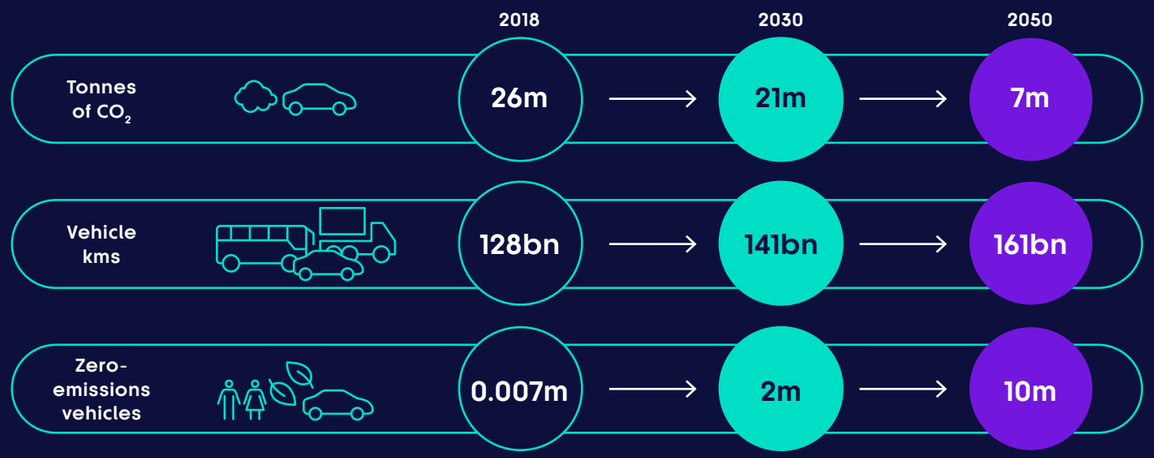
⇒ Continued trends of active travel, with increases experienced during 2020, although any further step-change increase would require a continued and committed impetus.

⇒ Moderate growth in remote working. Continuation of freight transportation as seen today.

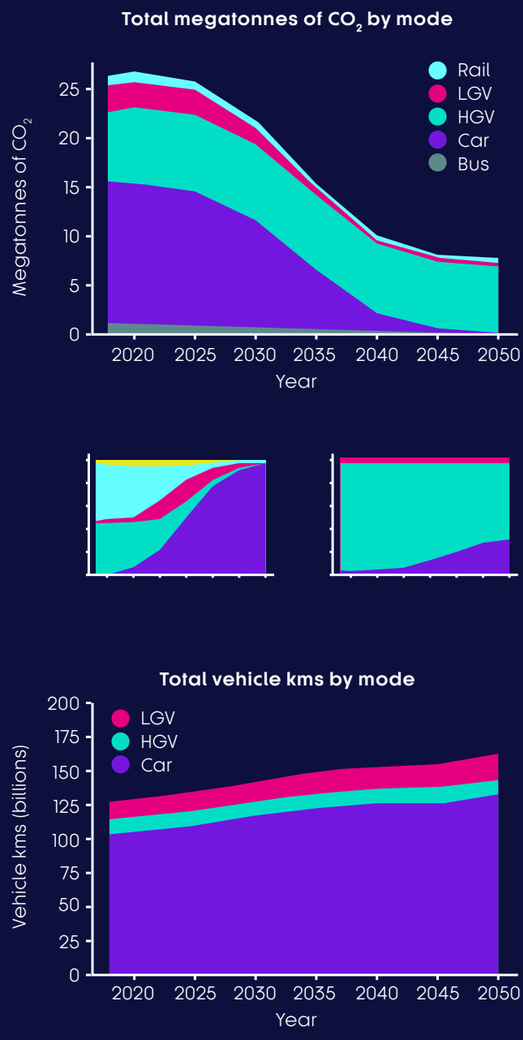
Area type	Population in 2050 (millions)	Vehicle kilometres in 2050 (billions)	CO_2 emissions in 2050 (mega-tonnes)
Urban	3.9	21.9	0.8
Sub-urban	9.8	90.0	4.8
Rural	2.3	49.0	1.5

Increases in car and van demand are largely offset by a growing share of zero-emissions vehicles. However, due to the higher costs associated with zero-emissions HGVs, most continue to be run on diesel. This makes up almost all residual emissions in 2050, which stand at just under 25% of 2018 levels.

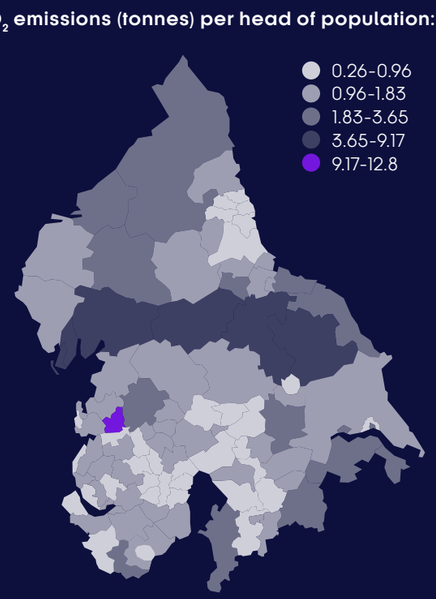
Vehicle type	Fuel type	Share
Car	BEV	99%
Car	PHEV	1%
Van	BEV	98%
Van	PHEV	2%
HGV	BEV	27%
HGV	Diesel	73%

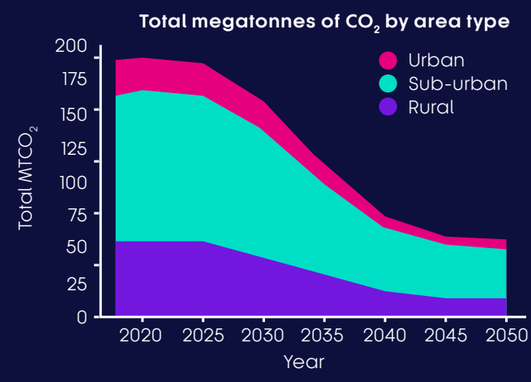


Mode and fuel breakdown



Area breakdown





Future emissions estimates

Scenario 2: Prioritised Places

Prioritised Places sees a focus on work-life balance and social equity within and between places. This involves a shift in the UK's 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 and economic and social infrastructure.

This scenario is led by a change in priorities, with the biggest driver being the push for a fairer redistribution of economic prosperity. Although an emphasis on localising activity and use of public transport helps to reduce emissions at a more rapid rate, a failure to sufficiently embrace technology sees continued private mobility ownership and a struggle to realise a fully zero-emission transport network before 2050.

Mode	Demand growth 2018-2050	CO_2 emissions in 2030 (mega-tonnes)	CO_2 emissions in 2050 (mega-tonnes)
Rail	122%	0.6	0.4
Bus and shared mobility	19%	0.3	0.0
Car	28%	10.0	0.0
Van	47%	1.6	0.0
HGV	1%	7.6	6.7
Active travel	13%	0.0	0.0

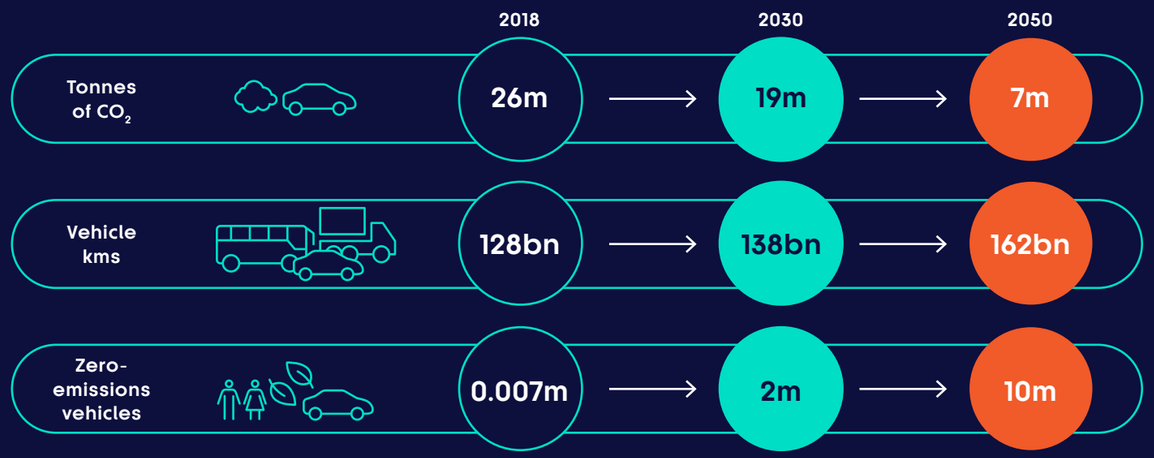
What if society becomes more focused on place, place-making and community than growth or connectivity?

- ⇒ Bespoke local strategies, focusing on quality of life, place-making and community, rather than primarily economic growth. Slower growth in cities, more in towns and rural/coastal areas.
- ⇒ No transformation in level of economic growth, but society is more equitable and there is a fairer distribution of prosperity across the region.
- ⇒ Moderate growth in electric vehicles and some autonomy, especially in cities. Realisation of benefits for vulnerable groups, people with disabilities and extending Autonomous Vehicle (AV) networks to more isolated areas.
- ⇒ Continued private mobility ownership sees a struggle to realise a zero-emission transport network.
- ⇒ More active and public transport within communities. People value face-to-face interaction.
- ⇒ Focus on work-life balance and social equity within and between places.

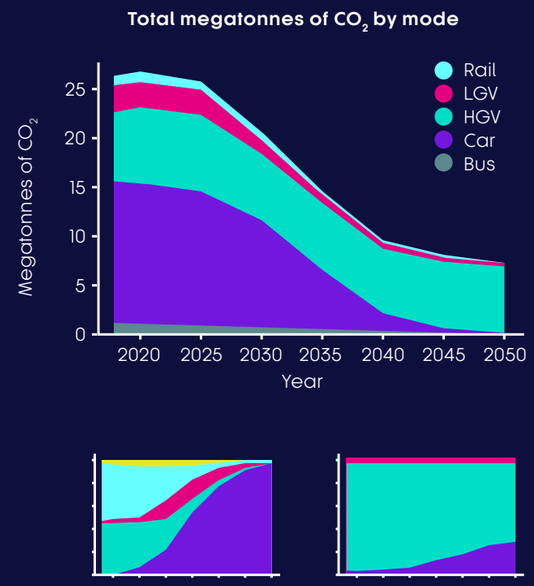
Area type	Population in 2050 (millions)	Vehicle kilometres in 2050 (billions)	CO_2 emissions in 2050 (mega-tonnes)
Urban	3.8	20.7	0.7
Sub-urban	9.6	87.8	4.5
Rural	2.7	53.4	1.4

Similar to Just About Managing, increases in car and van demand are largely offset by a growing share of zero-emissions vehicles. Most HGVs also continue to run on diesel, though only a marginal increase in demand means that the emissions are slightly lower.

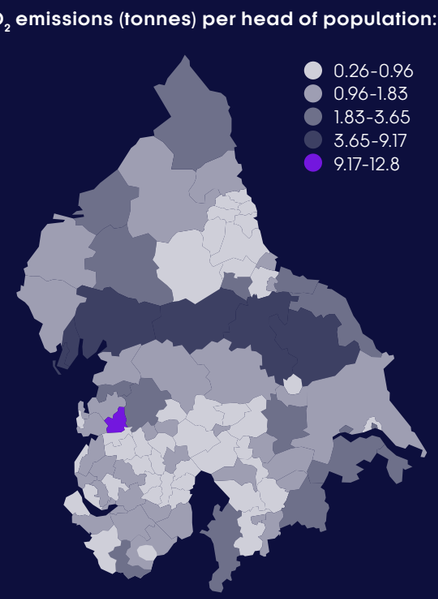
Vehicle type	Fuel type	Share
Car	BEV	99%
Car	PHEV	1%
Van	BEV	99%
Van	PHEV	1%
HGV	BEV	27%
HGV	Diesel	73%

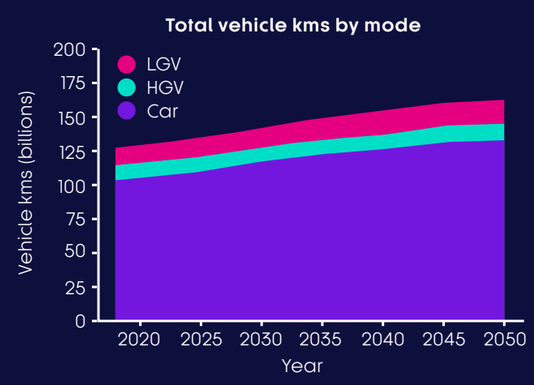


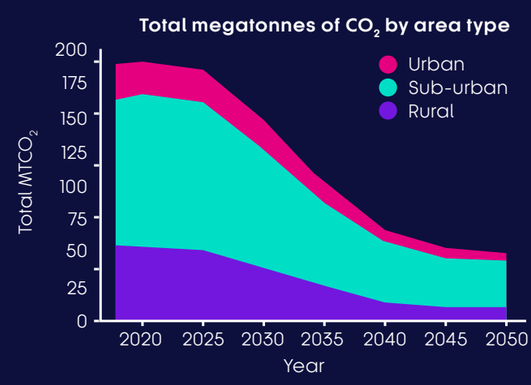
Mode and fuel breakdown



Area breakdown







Future emissions estimates

Scenario 3: 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, with the biggest drivers being technical advances and a willingness to embrace mobility-as-a-service and shared mobility. 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.

Mode	Demand growth 2018-2050	CO_2 emissions in 2030 (mega-tonnes)	CO_2 emissions in 2050 (mega-tonnes)
Rail	78%	0.6	0.0
Bus and shared mobility	11%	0.3	0.0
Car	44%	9.6	0.0
Van	74%	1.6	0.0
HGV	4%	7.9	1.2
Active travel	6%	0.0	0.0

What if society achieves Northern Powerhouse Independent Economic Review (NPIER) outcomes by using technological solutions to create connection and agglomeration across towns and cities?

⇒ Growth dispersed between cities and towns and less city-centric.

⇒ High uptake of EV, Ultra Low Emissions Vehicles (ULEVs), Zero Emissions Vehicles (ZEVs) and driverless vehicles means zero emissions before 2050 (but slow progress in short-term). Some fiscal and regulatory action to influence technology use, but congestion persists in places due to availability of transport options. Increased digital remote working and dispersed employment means trip lengths are longer but less often.

⇒ General willingness to embrace Mobility-as-a-Service (MaaS) and shared mobility - through technology acceptance which supports increased efficiency and use of road capacity.

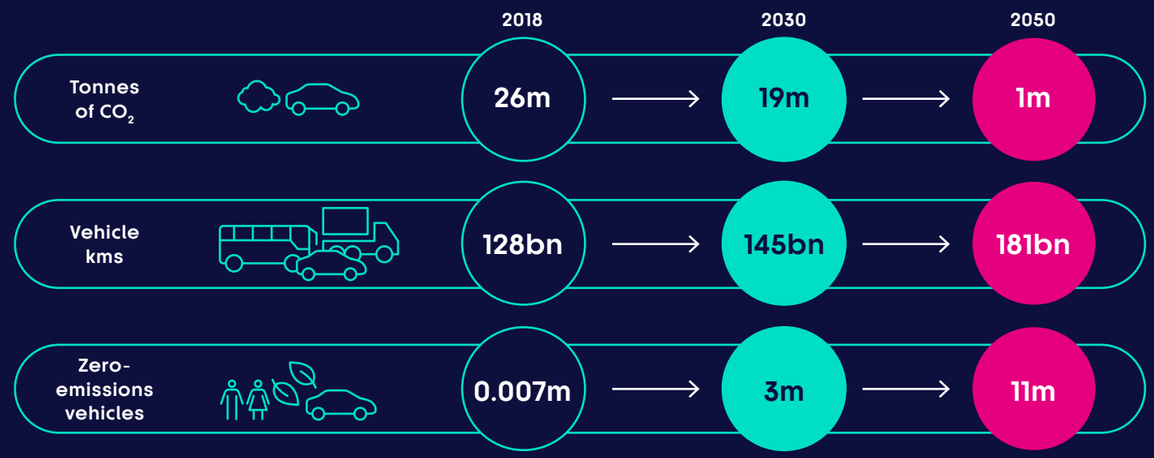
⇒ Freight warehousing, distribution and logistics centres are distributed.

⇒ Transformational economic growth as towns and cities see polycentric agglomeration and become more interdependent, due to better skills-matching within geographical areas.

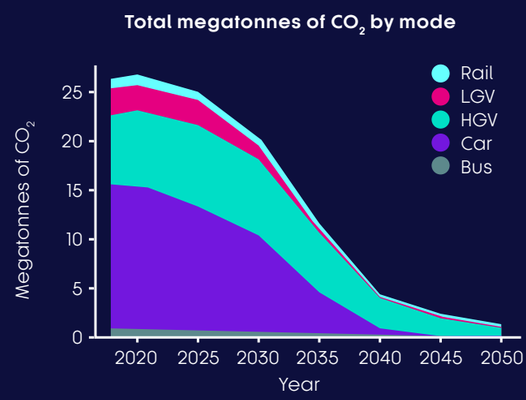
Area type	Population in 2050 (millions)	Vehicle kilometres in 2050 (billions)	CO_2 emissions in 2050 (mega-tonnes)
Urban	4.0	24.4	0.1
Sub-urban	10.6	101.4	0.8
Rural	2.6	54.9	0.3

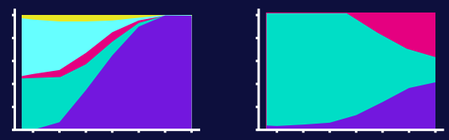
With just under 1 $MTCO_2$ of residual emissions in 2050, this scenario sees the benefits of decarbonising HGVs earlier, with over 85% running on hydrogen or battery electric fuel cells.

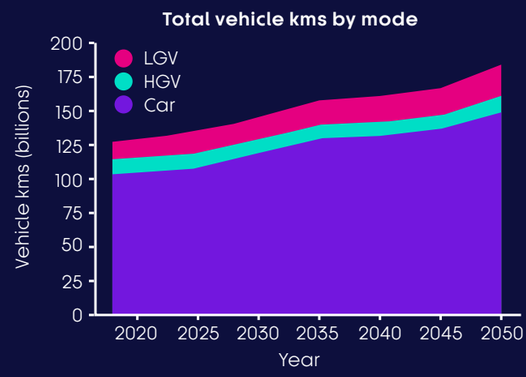
Vehicle type	Fuel type	Share
Car	BEV	99%
Car	PHEV	1%
Van	BEV	99%
Van	PHEV	1%
HGV	BEV	27%
HGV	Diesel	73%
HGV	Hydrogen	47%



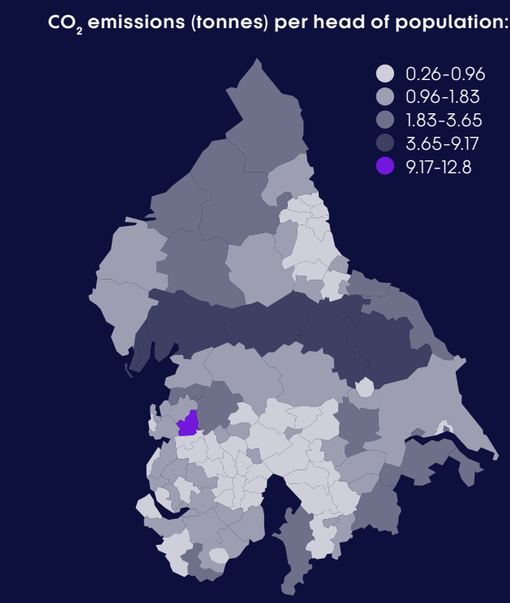
Mode and fuel breakdown

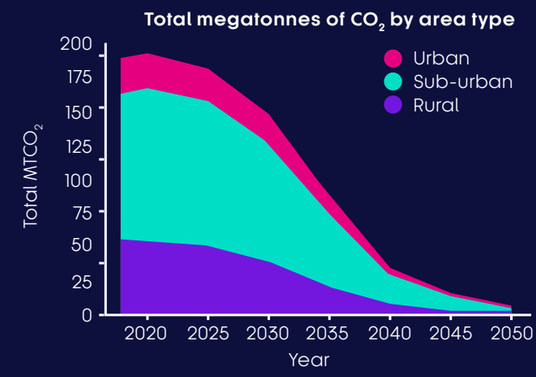






Area breakdown





Future emissions estimates

Scenario 4: Urban Zero Carbon

This scenario sees a significant shift in public attitudes towards action on climate change, and a strong government response to meet it. Transport and energy planning and systems are adapted and integrated to deliver effective clean networks. All road transport is powered by electric drivetrains ahead of 2050, with an increasing supply of low-carbon hydrogen available for some vehicles. This scenario is led by attitudes to climate action and urban placemaking, with the biggest drivers being strong government policy and urban densification.

Mode	Demand growth 2018-2050	CO_2 emissions in 2030 (mega-tonnes)	CO_2 emissions in 2050 (mega-tonnes)
Rail	193%	0.6	0.0
Bus and shared mobility	21%	0.3	0.0
Car	9%	7.1	0.0
Van	50%	1.2	0.0
HGV	-3%	7.6	1.1
Active travel	30%	0.0	0.0

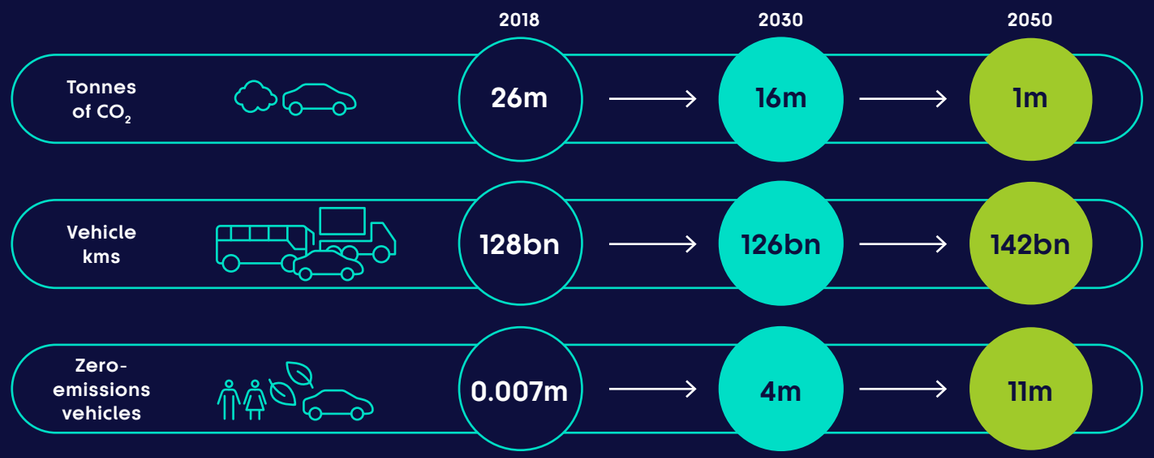
What if society achieves NPIER outcomes by using policy intervention to maximise energy-efficient city growth?

- ⇒ Cities and large towns become more dense but attractive places to live. Large rural settlements may benefit, others will see reduction in population and employment without support of national policy.
- ⇒ Transformational economic growth primarily through urban agglomeration and place-making.
- ⇒ Strong fiscal and regulatory action set us on a pathway to zero carbon before 2050. Increased devolution leads to integrated transport and energy systems which deliver clean networks.
- ⇒ Urban living reduces remote working and increases urban freight consolidation centres.
- ⇒ Increased public and active transport, including shared mobility, as public and private travel becomes blurred.
- ⇒ All new vehicles have a high level of autonomy, but are not fully autonomous by 2050. Shared AVs are well integrated into urban transport systems to complement public transport, but this doesn't extend to rural areas or small towns. Opportunities are not available to all, both geographically and due to attitudes and abilities with technology, sharing and data use.

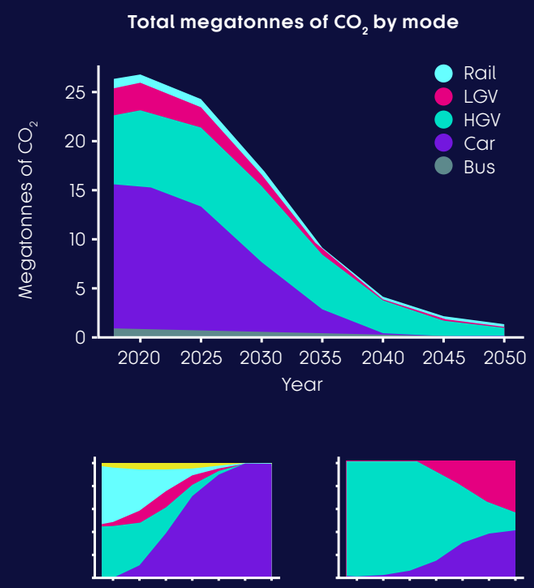
Area type	Population in 2050 (millions)	Vehicle kilometres in 2050 (billions)	CO_2 emissions in 2050 (mega-tonnes)
Urban	4.9	20.6	0.1
Sub-urban	10.0	78.8	0.8
Rural	2.3	42.4	0.2

This scenario sees increased demand across public transport and active modes, with a decrease in HGV demand. Consequently, it sees the lowest residual emissions (attributed to a small number of diesel HGVs) in 2050 at just over 1 $MTCO_2$.

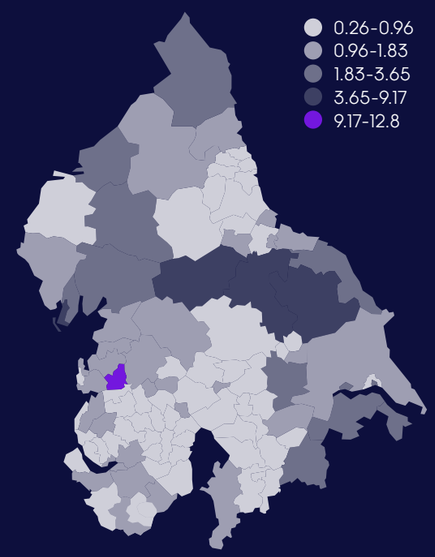
Vehicle type	Fuel type	Share
Car	BEV	100%
Car	PHEV	0%
Van	BEV	100%
Van	PHEV	0%
HGV	BEV	38%
HGV	Diesel	14%
HGV	Hydrogen	47%

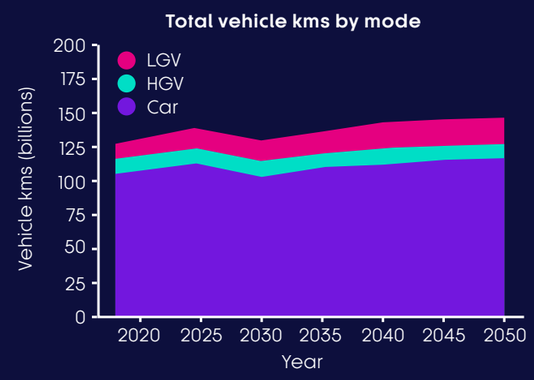


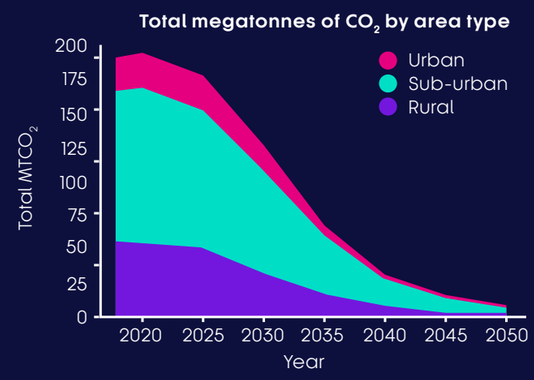
Mode and fuel breakdown



Area breakdown



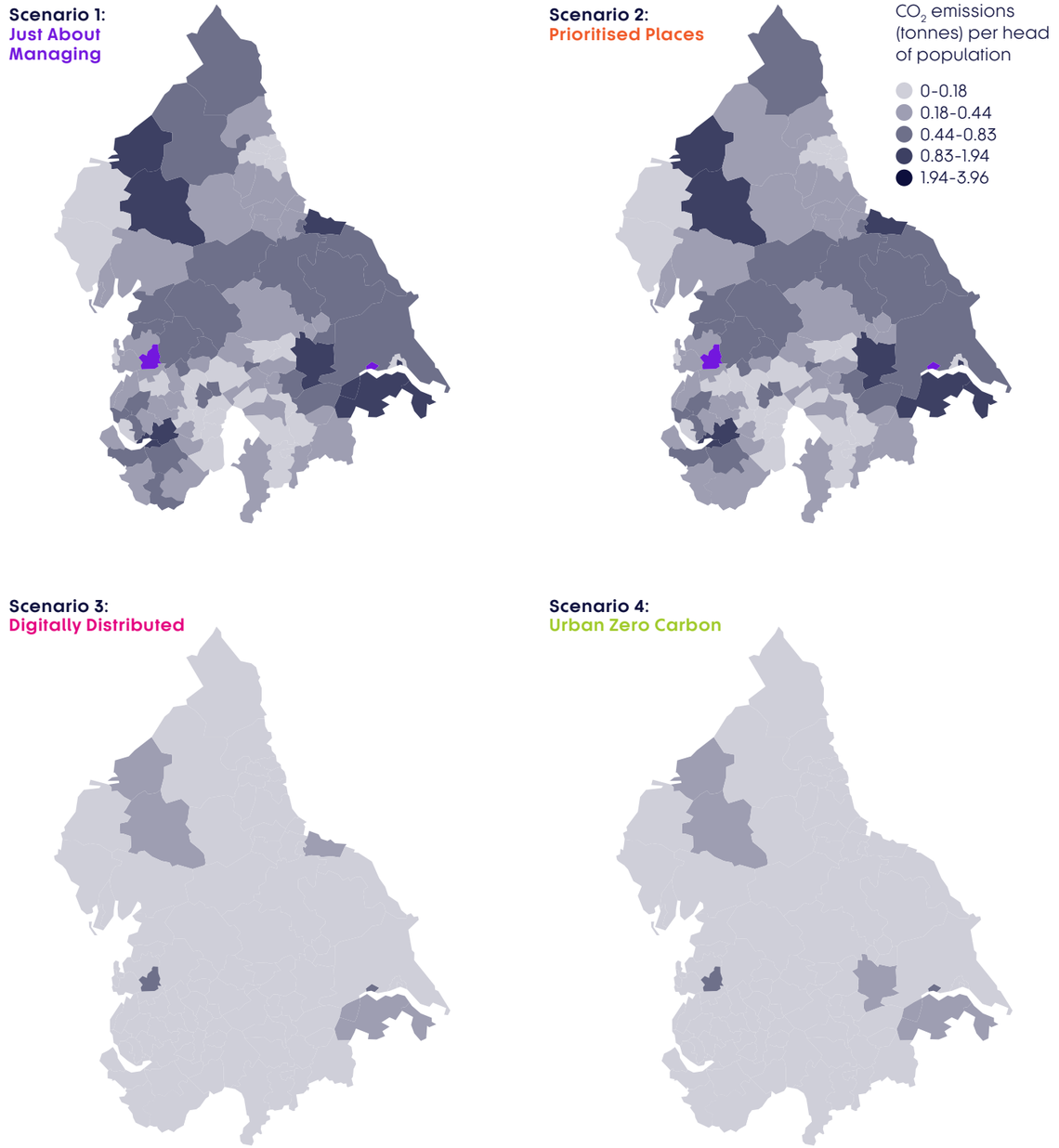




Future Travel Scenarios compared

Placeholder: Explain how the distribution of emissions is different between scenarios – related to densification, economic growth etc. Include some of the scenario comparison from the Future Travel Scenarios report. Ximo iure ipsuntincias es minumqu iassequi utem vendisi commodit opta voloratumqui tem alique quam volesse quis et laut unt apedit, ut ullamet hillabo. Olendic iissuntota volorer itius, audi qui a platiunt dolecab oreium doluptur? Toria doluptas vendis il ipsam conecerume volorro omnihic tempora estiis aut hil ent ea volessunt omnim re nobis aut lis apis et ut lit aut am, temquat aut la cum rectus aut int landucidunt, nonsedic tem conseque conet quasimi lignatium ipsum facit inusae invel et eturi volore pla sundus quide volesci mincturero iur? Olorenis excepel enditincturi accus eos di dolorrum quassequati aspid maximporum, cum debita vel incimintist que del idellup tatibus dit id quatur rerum faccatur alicide dolecae in corum doluptatiis cus rent. Eprat. Aceatem aut inum in eictaectur aut ari comniendant.

Figure 7: CO_2 emissions per person (tonnes) in 2050 under each Future Travel Scenario, broken down by TfN's geographic zones.



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