WPI ECONOMICS

The decarbonisation dividend

The economic, environmental and social benefits of more bus and coach journeys

July 2022

Contents

About WPI Economics

WPI Economics is a consultancy that provides economics that people understand, policy consulting and data insight. We work with a range of organisations – from FTSE 100 companies, to SMEs and charities and Central and Local Government – to help them influence and deliver better outcomes through improved public policy design and delivery. Our focus is on important social and economic policy debates, such as net zero, levelling up and poverty, productivity and mental health. We are driven by a desire to make a difference, both through the work we undertake and by taking our responsibilities as a business seriously. We are an accredited Living Wage employer.

wpieconomics.com matthew@wpieconomics.com @wpi_economics

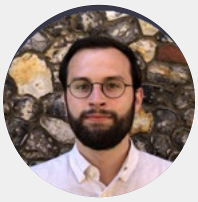
About the authors

Matthew Oakley – Director

Matthew founded WPI Economics in 2015. He is a respected economist and policy analyst, having spent well over a decade working in and around policy making in Westminster. He has previously been Chief Economist at Which?, and Head of Economics and Social Policy at Policy Exchange. He began his career as an Economic Advisor at the Treasury, predominantly working on microeconomic, analysis and modelling issues around tax and welfare reform. He holds an MSc in Economics from UCL.

James Edgar – Chief Economist

James has fifteen years of experience working as an economist at the forefront of policy making. Prior to joining WPI, James was Head of Policy for Digital and Regulation at the consumer champion Which?. Before this he worked for a decade at the Department for Transport, including as the Head of Road Economics after establishing the successful multi-disciplinary team and has experience of local transport, freight, rail and environmental issues. James holds an MSc in Economics from UCL.



André Novas – Consultant

André is an economist from the Spanish Open University, holding as well a BA (Hons) in Politics and Portuguese from University of Bristol. Before joining WPI, André worked as an International Consultant in an innovation consultancy firm, specialising in the fields of regional development and international cooperation, particularly in Latin America, Spain and Portugal. André speaks Galician and Spanish (his mother languages), and is fluent in English and Portuguese, having lived in Portugal and Brazil during his year abroad.

About the Confederation of Passenger Transport

We help a dynamic bus and coach industry to provide better journeys for all, creating greener communities and delivering economic growth.

We do this by representing around 900 members from across the industry be they large or small, bus or coach, operator or supplier. We use our influence to campaign for a supportive policy environment, give our members practical advice and support to run their businesses safely, compliantly, and efficiently and bring the industry together to share ideas and best practice. We are ambitious to make things better for passengers, inclusive in seeking out different perspectives and we are always there when our members need us.

About this report

The Confederation of Passenger Transport, the trade body for the bus and coach industry, commissioned WPI Economics to analyse the role that switching car journeys to bus and coach journeys ("modal shift") may have in achieving the country's net zero emissions goal. This report summarises the result of the first stage of the project, demonstrating why modal shift is necessary to ensure a just transition to net zero and desirable for its multidimensional benefits, while the next report will assess different policy interventions to demonstrate that modal shift is possible.

Foreword

Convincing people to change some of their car journeys to more sustainable transport modes, such as walking, wheeling, cycling, and as this report outlines - buses and coaches – isn't just helpful for the UK in meeting its net zero targets, it is essential. Deep down, it's what we all want to do, and will bring huge benefits to the environment, to society, and to the nation's health and wellbeing.

Critically, it's still within the grasp of the UK to achieve this. It's not too late to make meaningful change if we do this properly.

Public transport must be at the heart of the net zero transition, and we must ensure that it is fast, fair and affordable. Transport in the UK has increased its emissions since 1990, in spite of technological advances. Bus and coach is one of the few exceptions. It is critical that the UK acts quickly to rectify this, so we must encourage, and more importantly, enable more people to travel by bus and coach between now and 2050.

We cannot meet our net zero targets through technology alone – travel habits must change. Bus operators are committed to decarbonising their fleets and have made great progress so far. But it needs to be part of a wider solution. Decision makers in Westminster and beyond need to put impactful policies in place that reward people for making more journeys using public transport instead of private vehicles.

More than this, it will give individuals an affordable choice, and a fair transition to net zero. As households are coming to terms with tightly constrained budgets, the cost of a zero-emission vehicle will simply delay them from playing their part in reaching net zero. Fast, reliable and convenient public transport must be on hand to help them.

Increased use of public transport will bring a reduction in vehicle congestion, and we will see a manifold decrease in emissions beyond those not being used in favour of public transport. Bus use therefore, is a virtuous circle in relation to congestion. Faster and more reliable buses mean more people will use them, leading to fewer cars on the road, less congestion and ever fewer emissions. We need to take a course that propels us in this direction, rather than the one which leads us the other way.

If each car user switches just one journey per month from car to bus by 2030 and two journeys per month by 2050, there are almost £15bn in health benefits and £30bn in economic benefits to be unlocked. It is a straightforward and compelling equation. Alongside improving air quality and protecting the lungs of our children, these are opportunities that we can't afford to turn down – for our planet, and for our economy.

This journey is not optional, it is essential.

Ralph Roberts, CPT President

Executive Summary

The Confederation of Passenger Transport, the trade body for the bus and coach industry, has commissioned WPI Economics to analyse the role that switching car journeys to bus and coach journeys ("modal shift") may have in achieving the country's net zero emissions goal. This report summarises the result of the first stage of the project, demonstrating why **modal shift is necessary** to ensure a just transition to net zero and **desirable for its multidimensional benefits**, while the next report will assess different policy interventions to demonstrate that **modal shift is possible**.

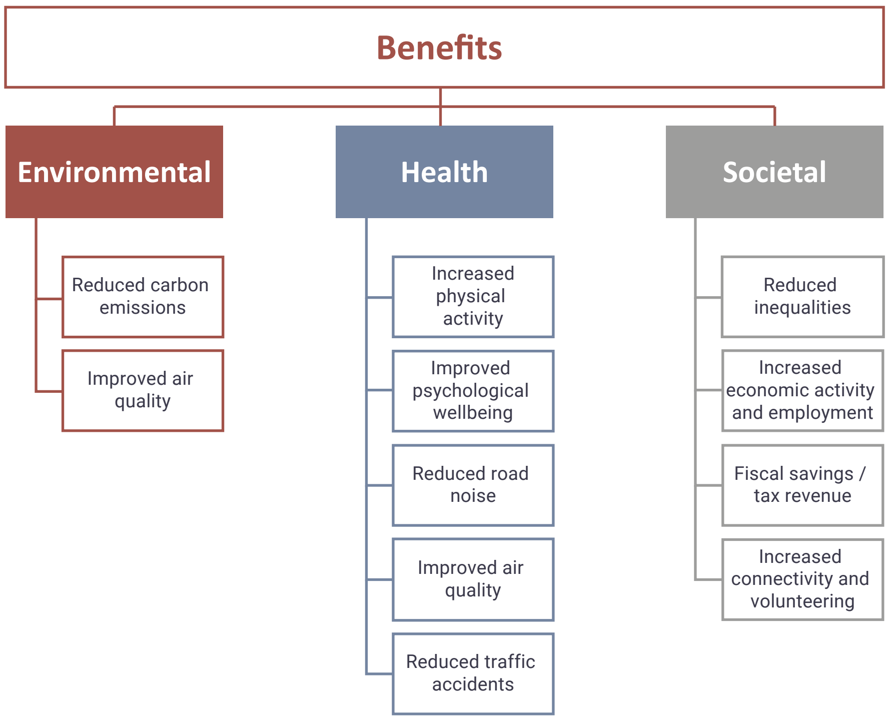
Modal shift is necessary to ensure a just transition to net zero

The UK's net zero commitments require a decarbonisation of the transport sector, the highest emitting sector and the only one whose emissions have increased since 1990. This requires ambitious action to tackle car greenhouse gas (GHG) emissions, which account for the majority of surface transport emissions. While the electrification of the car fleet has a role to play in this, the Climate Change Committee (CCC) and others have established that technological change alone is not enough. Decarbonisation also requires limiting demand for car travel in favour of lower-carbon modes of transport. **In short, the UK will not meet its net zero ambitions without shifting some of the demand for cars into buses and coaches.**

Without shifting demand from cars to buses and coaches, the UK will fall short of its net zero ambitions

Modal shift is desirable for its environmental, health and societal benefits

The benefits of modal shift are not just environmental. In fact, higher public transport use has additional benefits: it would be cheaper, fairer and more equitable than a car-led transition.



Estimating the benefits of modal shift

We have modelled three scenarios based on three different scales of modal shift across Great Britain, all consistent with the CCC's Balanced Pathway to net zero. For Great Britain as a whole, the modal shift modelled in our central scenario sees **bus patronage increase by more than 80% in 2050 relative to 2018/19 levels**.

	Local bus pkm (billion)				
Region	**2019**	**2030 - baseline**	**2030 - with modal shift**	**2050 - baseline**	**2050 - with modal shift**
East Midlands	1.5	1.3	2.3	1.3	3.2
East of England	1.4	1.4	2.6	1.4	3.9
London	9.5	10.1	10.8	10.1	11.5
North East	1.0	1.1	1.5	1.1	1.9
North West	2.5	2.4	3.7	2.4	5.0
Scotland	2.8	2.8	4.1	2.8	5.2
South East	2.4	2.2	3.8	2.2	5.6
South West	1.7	1.6	2.6	1.6	3.7
Wales	0.9	0.8	1.5	0.8	2.1
West Midlands	2.0	2.2	3.3	2.2	4.4
Yorkshire and The Humber	1.9	1.9	2.9	1.9	3.8
Great Britain	**27.6**	**27.8**	**39.0**	**27.8**	**50.4**

All regions except London see substantially higher increases than the Great Britain average. This reflects the more modest increase (in proportional terms) in the capital, where bus passenger kilometres (pkm) go from representing 16.8% of car pkm in 2018/19 to 17.6% in 2050.

This means that some more rural regions, like the East of England, see large increases in bus pkm *in proportion to current usage*. This represents the scale of the challenge posed by the decarbonisation of transport in areas that have relied more on car transport. Buses and coaches (as well as other lower/carbon modes of transport) will need to achieve a higher degree of penetration in these areas than has traditionally been the case.

We use these projections for increases in bus patronage, alongside evidence of the environmental, health and societal benefits of reduced car use and increased use of bus and coach, to estimate the potential benefits of modal shift.

The decarbonisation-dividend from modal shift

The main environmental benefits of modal shift derive from its contributions to decarbonisation and to better air quality .

x4

Travelling by car from Cardiff to Manchester produces on average 4 times more CO_2 emissions than travelling by coach

Modal shift brings about these environmental benefits directly, by switching higher-emitting car miles for cleaner bus miles. It also has indirect benefits; by increasing demand for buses, modal shift will improve the economic and environmental case for investing in zero emission buses and coaches. Modelling for this report suggests a total of 19.5 million ton reduction in CO2 up to 2050, resulting from modal shift from car to bus and coach.

Cumulative GB savings in GHC emissions by 2050

from modal shift to local buses:

15.8 million tons of CO_2

more than the total CO_2 emissions of the North East in 2019

from modal shift to coaches:

3.7 million tons of CO_2

equivalent to the total CO_2 emissions of Leeds in 2019

Improvements in air quality from modal shift

Improvements in air quality are driven by reductions in emissions resulting from a shift from car to bus and coach. In addition to the direct difference in cars' and bus emissions, modal shift to buses and coaches can also improve air quality by reducing congestion, a key driver of air pollution.

x10

euro 6 diesal cars produce **10 times more NO_x emissions** per passenger/km than a Euro VI diesel bus

Modelling for this report suggests a total of 5,600 ton reduction in nitrogen oxides (NOx) and 121 ton reduction in PM10 up to 2050, resulting from modal shift from car to bus.

Cumulative reduction in air pollution by 2050 from modal shift to local buses

5,600 tons of NO_x

more than the total NO_x emissions of diesel cars in London in 2019

121 tons of PM10

more than the total PM10 emissions from motorway car driving in Scotland in 2019

These reductions in air pollution are valued in **£28 million – enough to pay 800 nurses for year**.[1]

Cumulative benefits from reduced air pollution by 2050 valued at:

£28m

Enough to pay 800 nurses

Health benefits from modal shift

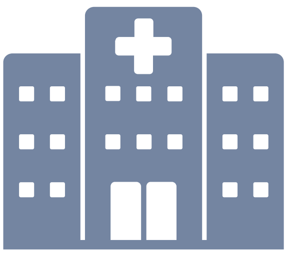
Increasing people's use of buses and coaches can have a positive impact on their and others' health outcomes by:

- Contributing to more active mobility and to **increased levels of physical activity**.
- Reducing traffic and therefore leading to **fewer road accidents and lower levels of road noise**.

Modelling for this report suggests that the cumulative value of these positive impacts by 2050 amounts to close to £15bn. These health benefits are comprised of:

- Reductions in road accidents valued at £9.3bn.
- Reductions in noise pollution valued at £160m.
- Improvements in lifestyle valued at £5.4bn.

Cumulative health benefits by 2050 valued at:

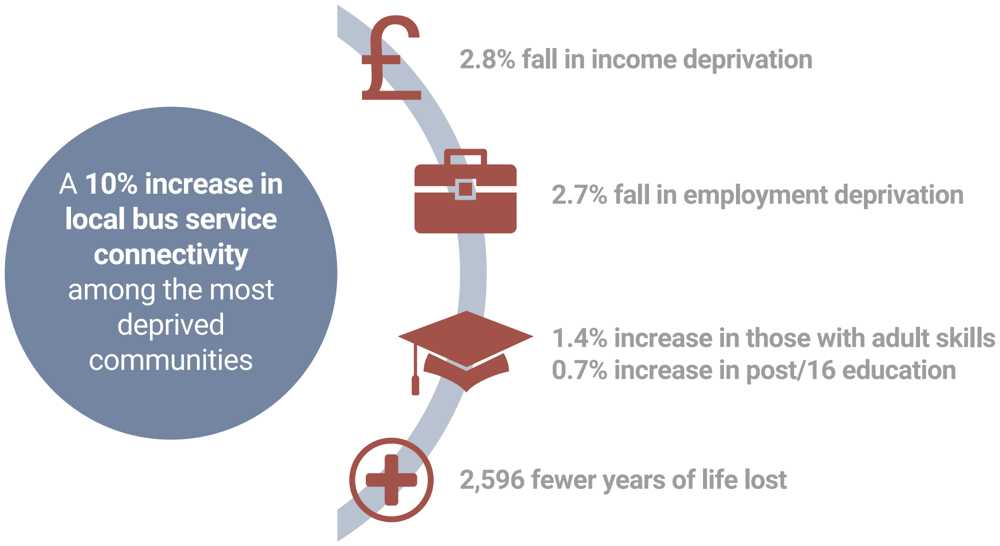


£14.9bn

This would be enough to build 33 new NHS hosptails

Societal benefits of modal shift

A well-designed transport system, with good and affordable provision of public transport, can play a role in mitigating socio-economic inequalities:



Source: Greener Journeys – The Value of the Bus to Society

Bus connectivity supports both:

- **Employment**: for instance, if bus journey times for commuters were reduced by 10%, there would be more than 50,000 additional people in employment; and
- **Economic activity**, by helping reduce congestion.

Modelling for this report focuses on a relatively narrow measure of societal benefits – the economic value of reduced congestion. Even this narrow measure suggests cumulative benefits from modal shift to bus and coach of close to £30bn by 2050.

Cumulative reductions in congestion by 2050 valued at:

£29.4bn

That's more than the GDP of the city of Manchester in 2019

Conclusion

The main body of this report shows that modal shift from car to bus and coach is both necessary and desirable.

Necessary — To ensure a just transition to net zero

- Technological change alone is not enough; decarbonisation requires reducing demand for car travel in favour of lower-carbon modes of transport, including buses and coaches.
- A transition to net zero supported by increased public transport usage will be fairer and more equitable than a car-led one.

Desirable — For its multidimensional benefits

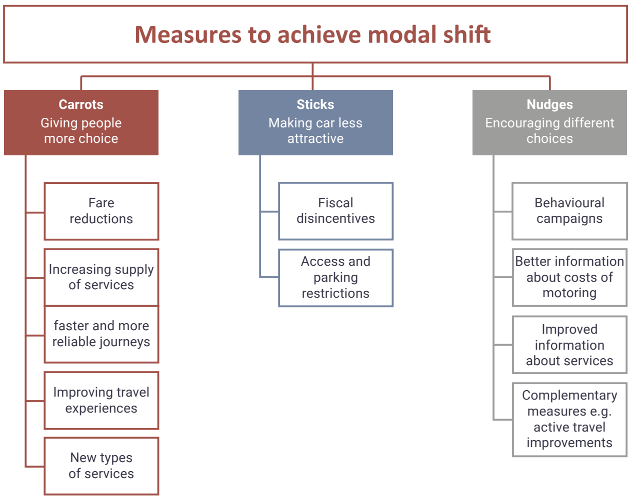
- There are environmental, health and social benefits from switching from car to bus & coach journeys.
- These are benefits that accure not only to new and existing bus users, but to society at large.

The final section of the report builds on this to show that it is also possible.

Possible — Based on evidence and public opinion

- Even in a general context of declining bus patronage some local authorities and bus operators have recently managed to increase demand for buses.
- Public opinion is receptive to the idea of reducing car traffic and using buses more.
- There is evidence that different interventions aiming to give people more choice and encouraging them to choose the bus can increase demand for bus.

The progressive modal shift we have modelled would require **every person in Great Britain to switch just over 1 car trip per month** (13 trips per year) **for the bus by 2030,** rising to just above **2 car trips per month** (26 trips per year) **by 2050**. Despite reductions in bus and coach use over several decades, there is evidence that indicates that such change is possible. The next stage of this project will be to develop and model a set of approaches through which this modal shift could be realised. This will consider the full range of possible options, including those in the figure here.



CHAPTER 1

Introduction

About the project

The Confederation of Passenger Transport, the trade body for the bus and coach industry, has commissioned WPI Economics to analyse the role that switching car journeys to bus and coach journeys ("modal shift") may have in achieving the country's net zero emissions goal. The project has two main stages:

1. Researching the **benefits associated with modal shift**, with a particular focus on decarbonisation and the transition to net zero, but accounting as well for a wider set of positive impacts; and
2. **Assessing the different policy options available** to produce the scale of modal shift that is necessary to achieve the benefits outlined in the previous stage.

About the report

This report presents the main results of the first stage of the project. It summarises evidence about the scale of modal shift and increase in bus and coach patronage that is necessary to achieve the UK's decarbonisation targets. It then provides estimates of the potential benefits – environmental, health and societal – that would be associated with this shift. This report focuses on Great Britain, presenting regional and country comparisons when appropriate. It is accompanied by place-specific shorter reports for each region and nation of Great Britain.

The results presented here are the product of an extensive literature review and our own modelling. Our work has benefited greatly from the contributions of the industry experts, researchers and campaigners that we have interviewed.

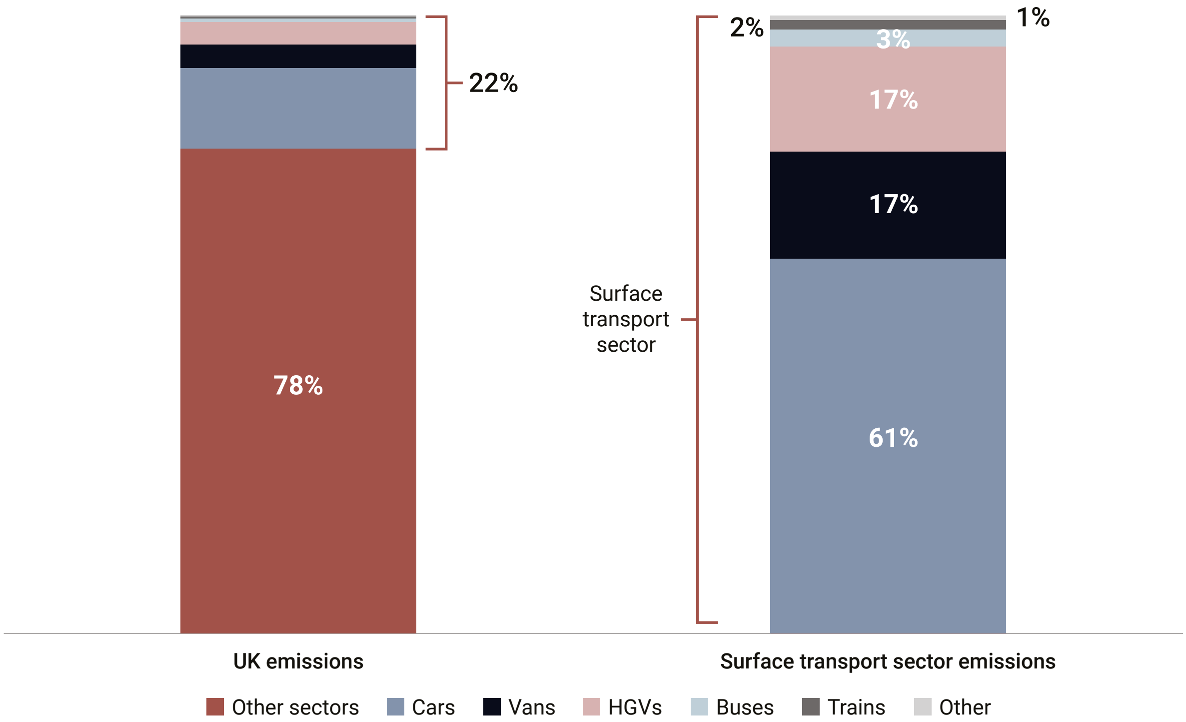
The key message from all of this work is that modal shift from cars to buses and coaches is necessary, desirable and possible.

CHAPTER 2 Why is modal shift necessary?

The UK's net zero commitments require a decarbonisation of the transport sector

Reducing the UK's net greenhouse (GHG) emissions to zero by 2050 became a legal requirement in 2019,[2] with the Scottish Government committing to net zero by 2045.[3] The Climate Change Committee's (CCC) Sixth Carbon Budget outlines their "preferred path" to net zero. This includes a 78% reduction of emissions compared to 1990 levels by 2035. Figure 1 demonstrates the challenge that this presents for the transport sector (including both surface transport and aviation). In 2018, surface transport was the highest emitting sector in the country, accounting for 22% of total GHG emissions.[4]

Figure 1: UK emissions from the surface transport sector

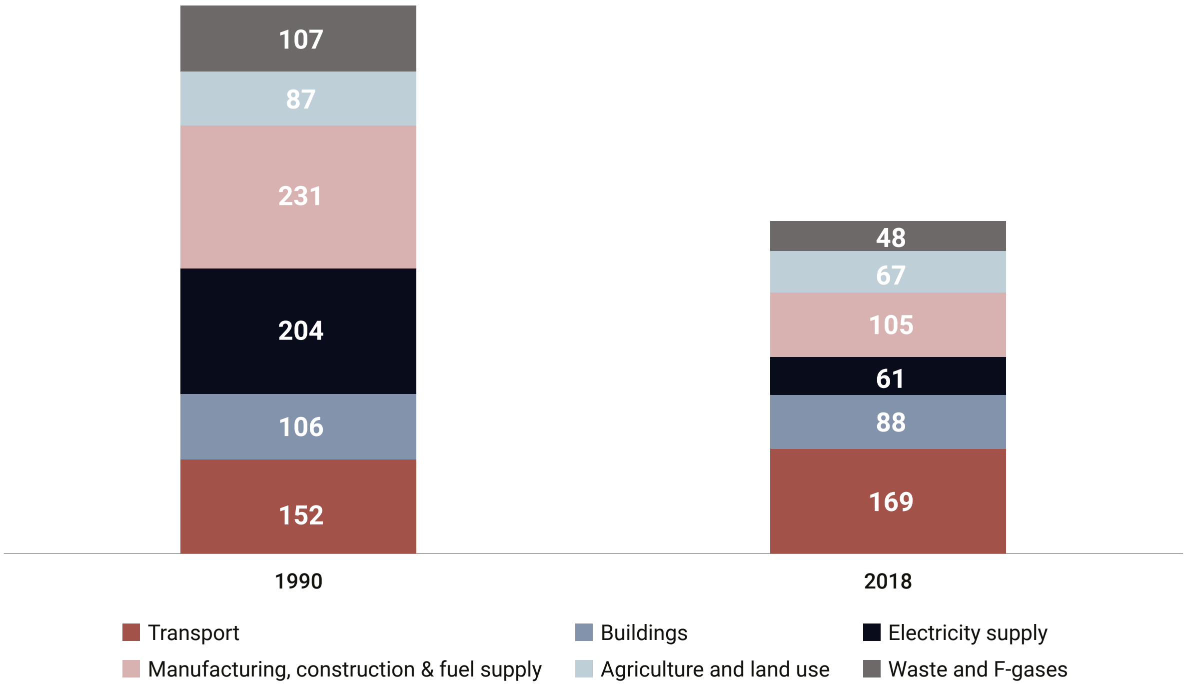


Source: Climate Change Committee (2019).

This challenge is compounded by the fact that Figure 2 shows that transport is the **only sector where emissions have increased** since 1990.[5]

This means that, to achieve the 2035 and 2050 commitments, the transport sector must turn this trend around. With more than 60% of emissions from the surface transport sector originating from cars (while buses and coaches are responsible for only 3%), it should be no surprise that the CCC has recognised that this will require a reduction in demand for car travel.[6]

Figure 2: Evolution of sectoral carbon emissions in the UK



Source: Climate Change Committee (2019)

Technological change alone is not enough: decarbonisation requires limiting demand for car travel in favour of lower-carbon modes of transport, including buses and coaches.

Given this context, it is not surprising that the CCC has recognised that the decarbonisation of the UK's transport system requires reducing "…demand for car travel, through both societal and technological changes (…) and by enabling journeys to be shifted onto lower-carbon modes of transport".[7]

For the CCC this means reducing future demand in relation to the level of car usage we could expect considering future population and economic growth. The Committee's Balanced Pathway to net zero envisages a reduction of total car kilometres of between 12% and 34% by 2050 in comparison to forecast car traffic in the absence of net zero policies.[8] However, this pathway still allows for increases in car traffic and ownership relative to current levels (+11% and +28%, respectively).[9] This means that, even with very ambitious car electrifications targets, **the UK will fall short of its net zero ambitions without shifting some of the demand for car travel to public transport usage**, including buses and coaches.

In comparison to the CCC's Balanced Pathway, research by Green Alliance has found that reducing average car mileage would enable a slower and less intense uptake of Electric Vehicles and other estimations have found that absolute reductions in car usage may be necessary to decarbonise our transport systems.[10] Research commissioned by the Scottish Government estimated that car kilometres need to be reduced by 20% with respect to 2019 levels, in order to decarbonise the Scottish transport sector[11], to which the Scottish Government has committed as part of its Climate Change Plan.[12]

The question is then how this reduction in car use can be delivered. The evidence points to the fact that the reduction in car demand needs to come mostly from increases in active travel (walking and cycling) and modal shift to public transport (including buses and coaches but also trains). As the CCC argues in its latest progress report to Parliament, **"…the decarbonisation pathway should not be all about replacing fossil-fuelled vehicles with electric ones, it also offers**

an important opportunity to change the way people view mobility".[13] The final section of this report sets out some of the ways that modal shift can be achieved, through increased funding and different transport policy interventions, which will be the focus of the second report of this project. Yet it is important to bear in mind the role that other policy areas have to play in this: new housing developments, for instance, need to be planned in a way that contributes to active travel and public transport usage, rather than reinforcing car-dependent mobility.

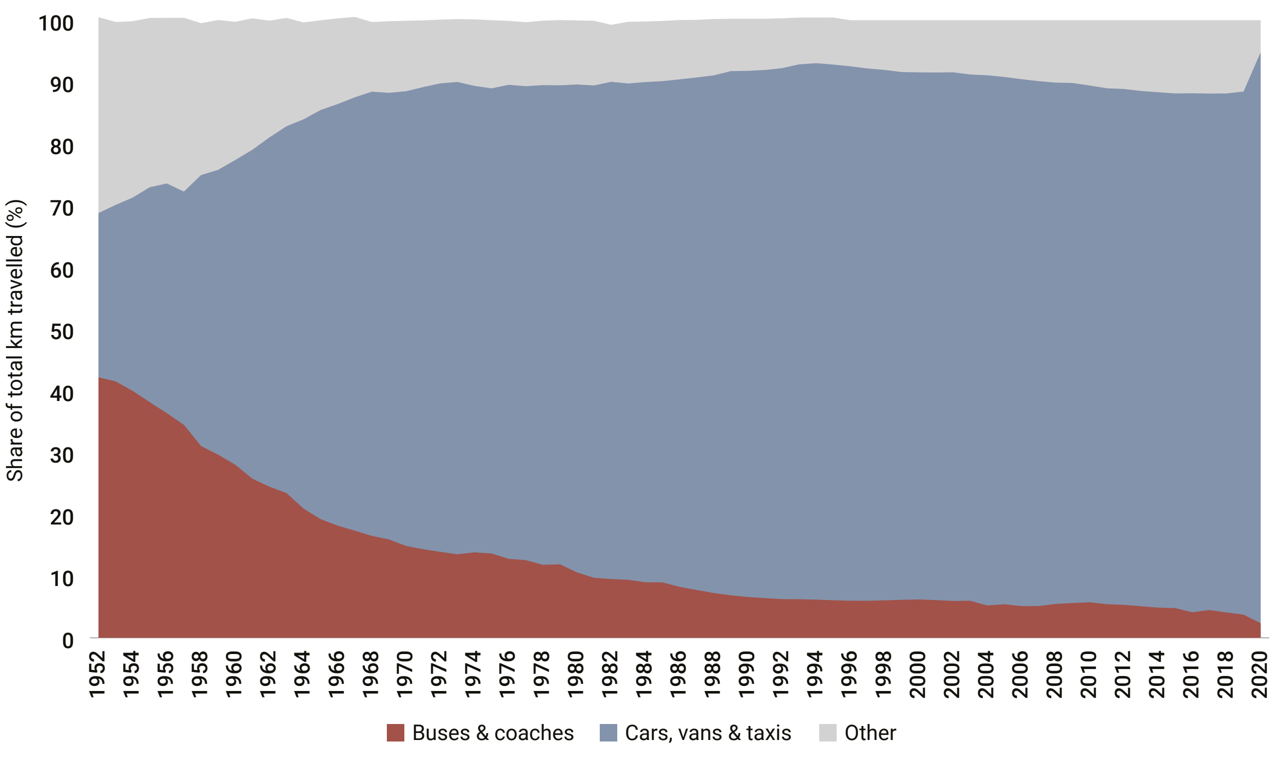
Modal shift to buses and coaches should therefore be framed in the context of "...enabling delivery of well-integrated, affordable, and appealing transport systems [that] can free communities from car dependence", helping deliver on the mobility transformations the CCC regards as necessary to decarbonise our transport systems.[14] Buses and coaches will thus contribute to decarbonisation in a twofold way:

- Directly, by virtue of their lower intensity of greenhouse gas emissions.
- Indirectly, as a key element of a less car-dependent mobility, in conjunction with other modes of transport.

Reversing recent trends and increasing bus and coach usage is necessary to ensure a just transition to net zero

Achieving this shift from car to bus and coach requires decisive action, given that one of the key features of the UK's surface transport sector since the 1950s, is the shift from buses and coaches, towards private vehicles such as cars, vans and taxis (Figure 3).

Figure 3: Proportion of total km travelled by mode.



Source: WPI Economics, based on Department for Transport (2021) Modal comparisons (TSGB01)

Most recently, there has been a fall in the absolute demand for buses. Between 2010/11 and 2018/19 the number of bus journeys fell in each type of area in Great Britain (Figure 4).

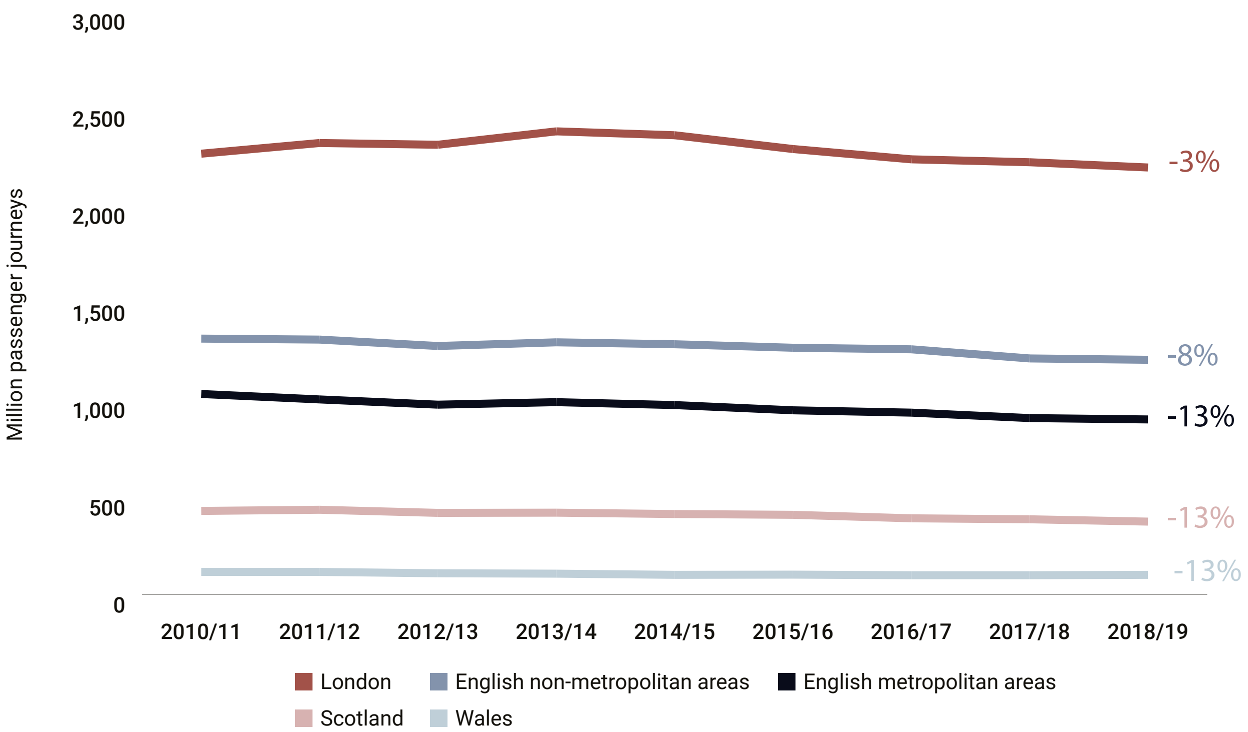
Research commissioned by the Independent Travel Commission found that this recent decline in bus usage "…is largely due to a fall in the proportion of the population who are bus users, rather than existing bus users travelling less often".[15] This has been attributed to both:

- Socio-demographic and economic changes, such as increasing car ownership rates.
- Changes in price, quality and availability of bus services.[16]

The latter are affected by a wide range of variables, with congestion being a prominent factor. Congestion increases bus journey times and operating costs which in turn can affect fares and service frequency, leading to a direct corelation between bus operating speeds and bus patronage.[17]

More generally, this deterioration has also taken place in the context of austerity and reduced funding for bus services: between 2009/10 and 2018/19, local authorities' funding for bus services suffered a reduction of 43% in real terms, causing the total or partial withdrawal of more than 3,000 local authority-supported bus services.[18]

Figure 4: Change in the number of bus journeys in Great Britain since 2010/11



Source: Department for Transport (2021) "Passenger journeys on local bus services by metropolitan area status and country: Great Britain (BUS0103)".

Reversing this trend and increasing bus and coach usage is important not only for their contribution to lowering GHG emissions, but also **because a decarbonisation of the transport sector that relies on increased public transport usage has additional benefits** vis-à-vis a car-led decarbonisation.

This is at the heart of recent calls by the CCC for the government to take more ambitious actions to reduce car demand in favour of public transport and active travel, arguing that "reducing traffic (…) can offer immediate emissions reductions while the fleet is transitioning to ZEVs [zero emission vehicles], reduce the emissions associated with ZEV production, and deliver a range of ongoing co-benefits including lower congestion, better air quality, and cost savings" – co-benefits we stand to gain from even once all cars are electric.[19]

Examples of these co-benefits are clear. Firstly, according to the CCC, a **public-transport led transition to net zero would be cheaper**, noting that "…if car ownership growth can be avoided, then fewer electric vehicles will be needed and the transition will be achieved at lower cost". The savings of meeting car demand reduction through reduction in car ownership rates, rather than reduction in average mileage per car, **have been estimated to amount to £17bn by 2050**. As the CCC has recently put it, the benefits of reducing car demand in favour of buses and coaches are even larger "in the present context of high fuel prices and cost of living pressure", where "…actions to provide affordable, appealing alternatives to car travel offer an opportunity to lower costs and reduce the UK's reliance on oil imports".[20]

Secondly, **a car-led transition to net zero would be a less fair and equitable pathway**, which would "…fail to address the inequalities within our transport systems", compared to one supported by a substantial increase in public transport usage and provision:

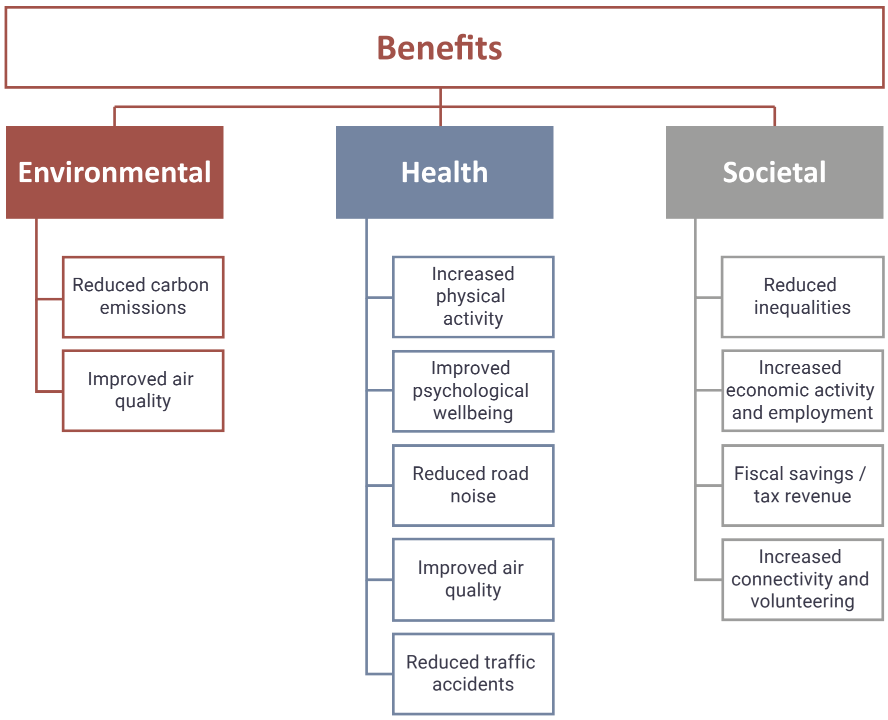
- Those on higher incomes would benefit far more than those on lower incomes from government financial support for EVs purchases - in 2019, the proportion of households that did not own a car was three times higher in the lowest income quintile (45%) than in the highest (14%).[21]
- Those on lower incomes would also be more affected by any further erosion of the bus and coach network - the proportion of total bus and coach mileage accounted for by the lowest income quintile (8.8%) is four times higher than for households in the highest (1.9%).[22]
- Those on lowest incomes are also more likely to be negatively affected by the congestion and road traffic accidents that a further increase in car usage could bring.[23]

Overall, this shows that a significant modal shift from car to bus and coach will be required for the country to achieve its net zero commitments and do this in a way that is fair.

CHAPTER 3 Why is modal shift desirable?

The previous section demonstrated why modal shift from car to bus and coach is essential in the UK delivering a just transition to net zero. However, its contribution to decarbonisation is not the only benefit associated with modal shift. Our literature review has identified a wide range of benefits that switching car for bus journeys would bring about, which we have grouped in three broad categories: environmental, health and societal benefits (Figure 5). Each of these main areas are discussed in more detail below.

Figure 5: Benefits of modal shift



Source: WPI Economics

Environmental benefits of modal shift

The main environmental benefits of modal shift derive from its **contributions to** reductions of greenhouse gas (GHG) emissions and to **better air quality** (through a reduction of emissions in a variety of air pollutants). The scale of these benefits can be sizeable:

- **Well-designed and effective bus priority measures could cut GHG emissions by three-quarters compared to those same passengers travelling by car.**[24]
- **Travelling from Cardiff to Manchester by coach produces around one quarter of GHG emissions per passenger** (10.12 kgC02e) than in the average diesel (39.8 kgCO2e) or petrol car (42.4 kgC02e).[25]
- **Nitrogen oxides (NOx) pkm emissions of Euro 6 diesel cars are ten times higher than those of a Euro VI diesel bus.**[26]

In addition to the direct difference in car and bus emissions, **modal shift to buses and coaches can also improve air quality by reducing congestion**, a key driver of air pollution. It has been estimated that "…in nose-to-tail traffic, tailpipe emissions are four times greater than they are in free flow traffic".[27] At the height of lockdown, NOx emissions in Manchester City centre fell by 70%, partly as a result of reduced traffic and congestion.[28] It has been estimated that the **reduction in car usage** witnessed in April 2020 alone, led to **improvements in air quality resulting in 1,700 fewer deaths**.[29] Combined with **improvements in the bus fleet**, reductions in car traffic can deliver even greater air quality benefits. Assessments by the Greater London Authority has concluded that "…central London ULEZ [Ultra Low Emission Zone], including the upgrading of the bus fleet, has **contributed to the sharp decrease in NO_2** at roadside sites", which has been estimated at 35% by the end of 2019 compared to before the introduction of the ULEZ.[30]

Indeed, improvements in the technological efficiency of different combustion engines and the adoption of zero emissions vehicles will bring environmental benefits of their own. In the case of buses, recent technological improvements in diesel engines meant that in 2017 **the cost of saving 1kg of NO_x by retrofitting a diesel bus** to a more advanced model (EuroDiesel V to EuroDiesel VI) was estimated to be **almost 10 times lower than by providing grants for electric cars**.[31] The **decarbonisation of the bus and coach fleet will bring about substantial GHG savings** when compared to the present situation, estimated at between **35 and 37 million tons (Mt) of CO_2** between 2020 and 2050, as well as **significant improvements in air quality**, which have been valued at £160m.[32]

The scale of these benefits now and in the future depend on two key factors. First, bus occupancy (i.e. the number of people transported by each bus) is important as a bus or a coach typically emits more carbon and air pollutants than a car per vehicle km (vkm). However, per-passenger km rates are lower, as they carry more people. This means that, if capacity is underutilised, the environmental benefits derived from using the bus instead of the car are diminished. Second, is the speed at which technological improvements are made to the bus fleet. This means that, **to maximise the environmental benefits of modal shift from cars to bus and coach, interventions should aim to increase the number of passengers per bus and coach and, in turn, this will improve the economic case for investing in zero emission buses and fleets**, thereby contributing to making the benefits associated with decarbonising the fleet a reality.

Health benefits

The Review of the impacts of carbon budget measures on human health and the environment, commissioned by CCC, identifies the following health benefits associated with modal shift:[33]

- Lifestyle: Using public transport involves a greater degree of active travel than using the car (in its estimations the review assumes 1 km walking per day). KPMG has estimated that **every £1 invested on concessionary travel for older and disabled people has a return of £0.66 just in terms of the increased physical activity it fosters**.[34]
- Road accidents: **modal shift to public transport reduces traffic** and therefore road accidents.
- Noise: as modal shift reduces traffic, it will also **reduce road noise**.
- Psycho-social environment: the review argues that reduced traffic can have wider positive social impacts (by increasing time children spend playing outside, for instance) and be beneficial for people's mental wellbeing (by reducing stress, for instance).

The importance of the health challenges modal shift would help address should not be underestimated:

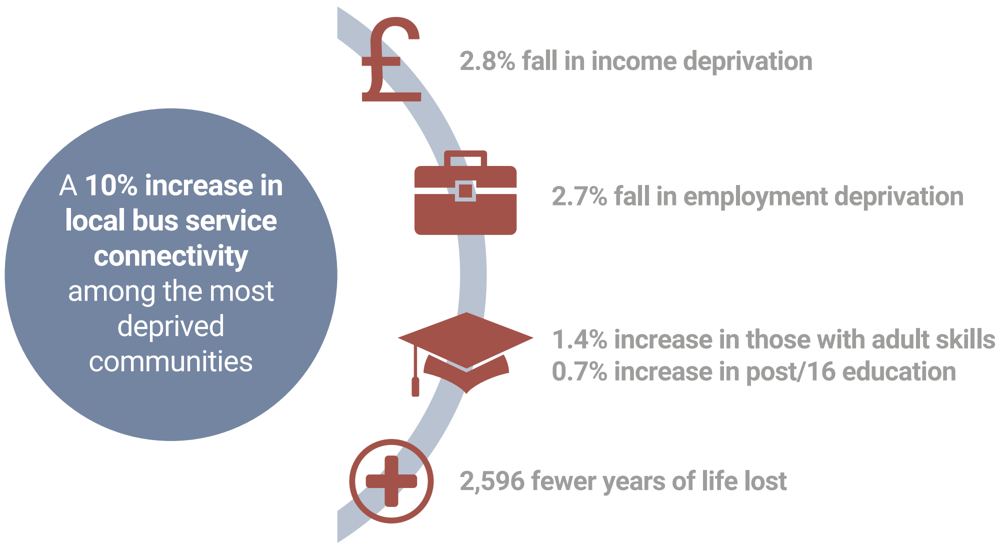
- The **costs of urban road noise in England** alone has been estimated to amount to **£7-10 billion** per year.[35]
- This represents a similar scale to **road accidents**, whose costs have been estimated at **£9 billion** per year in England.[36]
- **Physical inactivity has been estimated to cost the NHS around £1billion per year across the UK**. This rises to more than £7bn if wider societal costs are included.[37]

Socio-economic benefits

The links between transport and social exclusion are well-documented in the literature and understood by an increasing number of practitioners and policy-makers.[38] For instance, the 2020 update of the Marmot Review of health inequalities in England concluded that "…the Government's prioritisation of road and train travel over buses since 2010 has also affected inequalities".[39] On the other hand, a well-designed transport system, with good and affordable provision of public transport (and buses in particular) can also play a role in mitigating these wider inequalities:

- A 10% improvement in local bus service connectivity across all communities in England is associated with a 3.6% reduction in deprivation.[40]
- Within the most deprived communities in England, a 10% increase in local bus service connectivity would result in:[41]
    - **2.8% fall in income deprivation**, which would equate to more than 22,500 people with increased income;
    - **2.7% fall in employment deprivation**, which would equate to about 10,000 more people in work;
    - **1.4% increase in those with adult skills**, which would equate to more than 7,000 people gaining adult skills;
    - **0.7% increase in post-16 education**; and
    - **2,596 fewer years of life lost**.

Figure 6: Socio-economic benefits of increasing bus connectivity in deprived areas



Source: Greener Journeys – The Value of the Bus to Society

More generally, bus connectivity also supports economic activity and employment:[42]

- Bus users for shopping and entertainment purposes have been estimated to spend £27bn per year, of which £22bn would take place in town and city centres. Bus trips account for **29% of total expenditure on retail and entertainment** in city centres; and
- If bus journey time for commuters were reduced by 10%, there would be **more than 50,000 additional people in employment**.

Additionally, a report by KPMG has also pointed out there are important fiscal benefits associated to increased bus usage, in terms of reduced costs or additional revenue, which derive from:

- The additional income tax resulting from the employment created as a result of the new/improved bus service;
- The health fiscal savings associated with these new jobs; and
- The fiscal savings from increased education.

These societal benefits come from a range of different factors related to bus supply (e.g. reduced journey times and increased connectivity). They are a key part of the overall business case surrounding the modal shift from car to bus and coach and will play an important part in our assessment of different policy options to drive modal shift forward in the second stage of the project. However, given the range of considerations involved, it is not possible to include them in our modelling in this report. For this purpose, the socio-economic benefits of modal shift that are included in the model are mainly the **economic benefits of the reduction in congestion that would be associated with modal shift**. The scale of these benefits can be significant considering:

- The potential for buses to reduce congestion – **a double decker bus can take up to 75 cars off the road, eliminating over two miles of traffic**.
- The **high economics costs of congestion**, which in English urban areas alone have been **estimated to amount to £11bn**.[43]

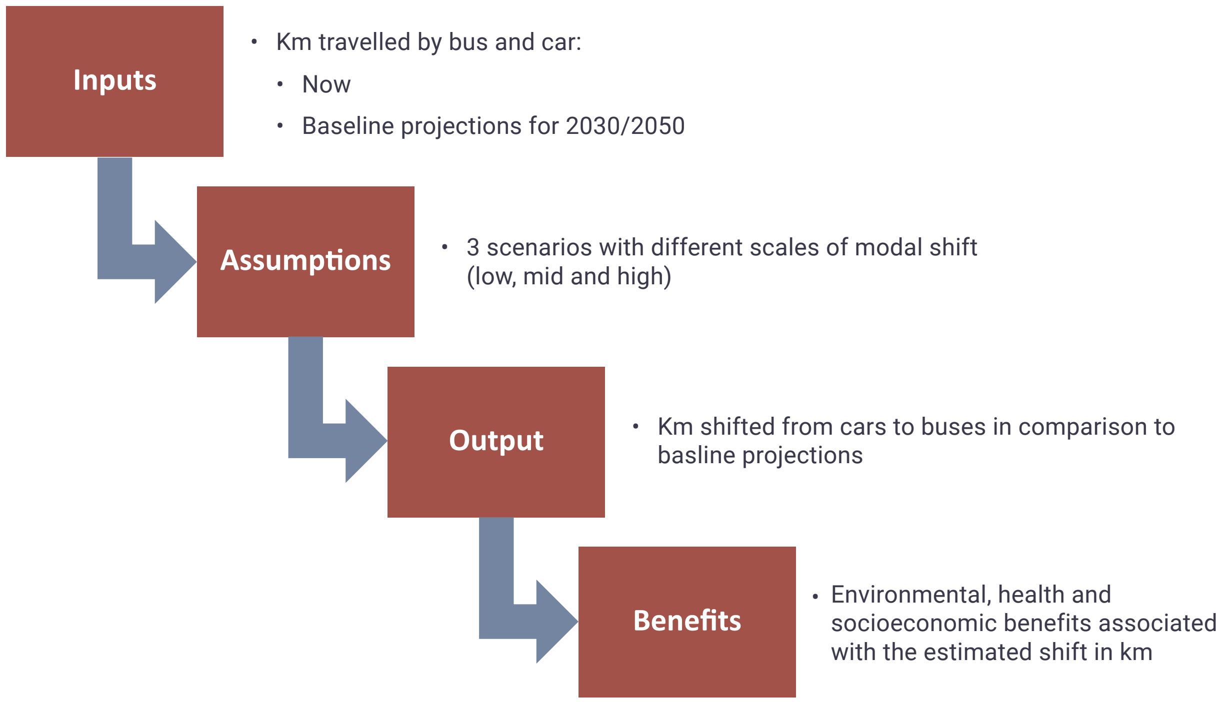
CHAPTER 4

How can the benefits of modal shift be estimated?

Methodology

The key contribution of this report is to estimate the scale of benefits that might be associated with a given shift of passenger kilometres from car to bus and coach. This section provides a brief overview of our approach to modelling this. More detail on the approach and assumptions can be found in the annex.

Figure 7: Structure of the model to estimate the benefits of modal shift



Source: WPI Economics

Scenarios

Whilst there is debate over the overall ambition of the CCC's reductions of car usage, we believe that they provide an agreed and realistic base for our modelling, particularly considering the recent trends in bus patronage reviewed above.

Scale of modal shift: CCC's estimations provide an ambitious and realistic base to model the scale of modal shift from cars to buses and coaches

The CCC's preferred pathway to net zero includes **a shift of car km to public transport that ranges between 2% and 4% by 2030, and between 5% and 8% by 2050**, relative to the baseline scenario without net zero policies.[44] We use these estimations to model three scenarios about the scale of modal shift that Great Britain should strive for as part of the transition to net zero. We assume that these additional public transport kilometres are split between buses and railways on the basis of their current shares- i.e. **assuming 30% of those additional passenger kilometres in public transport take place in bus and coach**.[45]

Different localities will have different potential for increasing bus usage based on factors such as their demographics, economic geography and the focus of past transport policy in the area. We have considered this varying potential for different areas, informed by previous modelling undertaken for Greener Journeys, which has enabled us to identify local authorities that may have a higher potential for modal shift than the base level.[46] In addition to this, because the Scottish government has set out more ambitious targets in terms of reducing car mobility than the rest of the country, our model assumes that the shift from cars to buses in Scotland would be on the upper end of CCC's estimation in our more conservative scenarios, going beyond that in the more ambitious ones (Table 1).

Table 1: Percentage of car km shifted to local buses in the different scenarios

	Proportion of car km shifted to bus by 2030			Proportion of car km shifted to bus by 2050		
Local Authority classification	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
Highest potential	1.20%	1.20%	1.20%	2.40%	2.40%	2.40%
Higher potential	0.90%	1.20%	1.20%	1.95%	2.40%	2.40%
Base potential	0.60%	0.90%	1.20%	1.50%	1.95%	2.40%
Scotland	1.20%	1.50%	1.50%	2.40%	2.85%	2.85%

Source: WPI Economics

The rest of this document provides the estimations resulting from our "central scenario", scenario 2. Detail on the other scenarios can be found in the Annex.

Outputs

Our model estimates the number of car pkm that would be shifted to buses in each local authority by applying the different scenarios to the baseline projections for car pkm in 2030 and 2050 from Department from Transport 2018 Road Traffic Forecasts. This sees total bus pkm in Great Britain increase by more than one third (40%) by 2030, and more than three quarters (81%) by 2050, relative to 2018/19 levels. We also use these average GB-wide increases in local bus pkm to model increases in coach pkm by 2030 and 2050.

Table 2: Current and projected levels of bus patronage across Great Britain

	Local bus pkm (billion)				
Region	**2019**	**2030 - baseline**	**2030 - with modal shift**	**2050 - baseline**	**2050 - with modal shift**
East Midlands	1.5	1.3	2.3	1.3	3.2
East of England	1.4	1.4	2.6	1.4	3.9
London	9.5	10.1	10.8	10.1	11.5
North East	1.0	1.1	1.5	1.1	1.9
North West	2.5	2.4	3.7	2.4	5.0
Scotland	2.8	2.8	4.1	2.8	5.2
South East	2.4	2.2	3.8	2.2	5.6
South West	1.7	1.6	2.6	1.6	3.7
Wales	0.9	0.8	1.5	0.8	2.1
West Midlands	2.0	2.2	3.3	2.2	4.4
Yorkshire and The Humber	1.9	1.9	2.9	1.9	3.8
Great Britain	**27.6**	**27.8**	**39.0**	**27.8**	**50.4**

Source: WPI Economics modelling. Note: central case, see annex for other scenarios.

To get a sense of what this means for different regions we compare bus pkm as a proportion of car pkm in different regions. Bus pkm are currently 3.1% of car pkm across Great Britain as a whole. However, the countries and regions of Great Britain vary significantly.

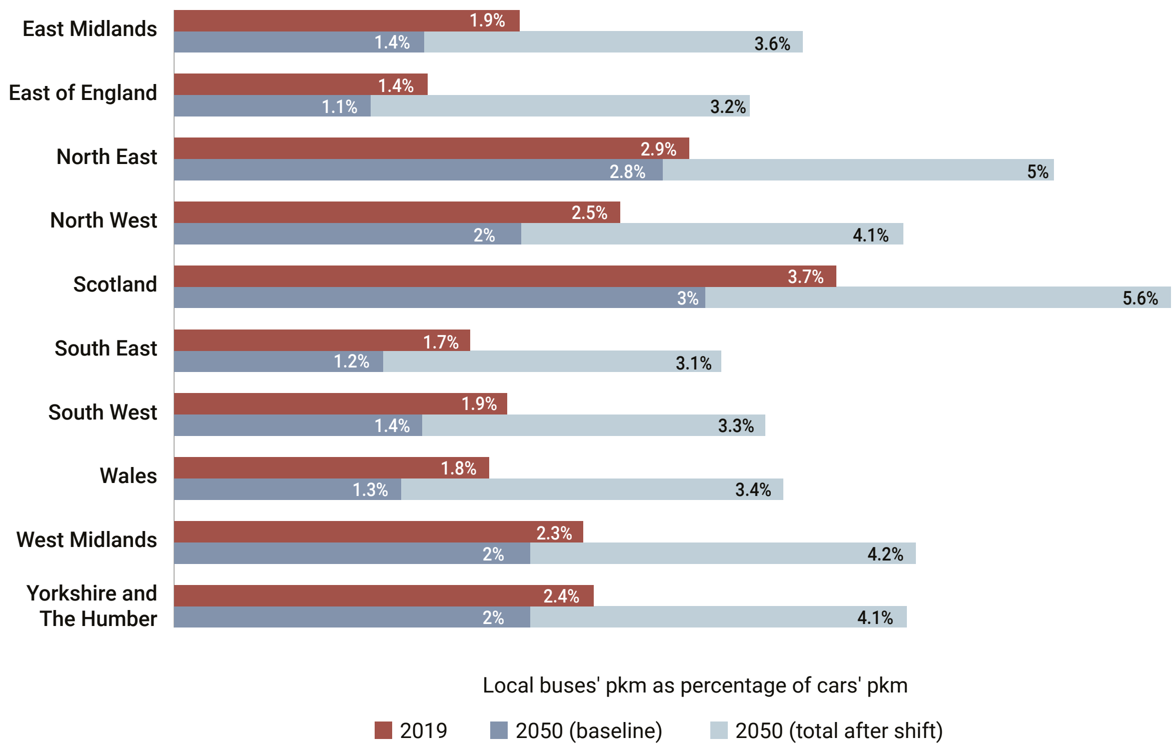
- London is substantially higher than anywhere else - bus pkm are 16.8% of car pkm.
- The East of England is the region of England where this metric is lowest (1.4%), and the North East the region where it is highest (2.9%).
- Bus pkm as a proportion of car pkm in Scotland are higher than Wales and all English regions except London, at 3.7%.

The projections result in all regions except London experiencing substantially higher increases than the Great Britain average. This reflects the more modest increase (in proportional terms) in the capital, where bus pkm go from representing 16.8% of car pkm in 2018/19 to 17.6% in 2050.

This means that some relatively more rural regions, like the East of England see some large increases in bus pkm in *proportion to current usage*. This represents the scale of the challenge posed by the decarbonisation of transport in areas that have relied more on car transport. Buses and coaches (as well as other lower/carbon modes of transport) will need to achieve a higher degree of penetration in these areas than has traditionally been the case.

The comparison shown in Figure 8, demonstrates that this is a sizeable task with substantial increase in bus travel as a proportion of car travel across every country and region. However, it also suggests that it should be achievable. For example, even after the large increase in bus usage modelled by 2050 buses would represent a similar percentage of car pkm in the South East and East of England as they did across Great Britain in 2019.

Figure 8: Projected increases in the relative importance of local buses compared to cars (central case)



Source: WPI Economics modelling. Note: central case, see annex for other scenarios.

Note: London has been excluded from the graph due to the large difference in both current and projected importance of buses compares to cars, which means its inclusion would not enable the graph to show the significant changes modelled for the other regions. Figures for London are discussed in the text.

CHAPTER 5 Benefits - headline results

This section provides estimates of the potential environmental, health and social benefits of modal shift from car to bus and coach, based on our central scenario. Results from other scenarios can be found in the annex.

Decarbonisation

Modelling the decarbonisation benefits associated to modal shift by 2030 and 2050 relies on two further assumptions:

1. **Changes in bus occupancy**: reaching international comparators, whilst ensuring services are not reduced.

As established in the previous section, buses' higher carrying capacity means that while their emissions are higher than cars on a vehicle kilometre basis, their passenger kilometres emissions can be much lower provided their occupancy rates are high enough. As Table 3 shows, average bus occupancy rates in Great Britain are currently lower than those of our international peers.

Table 3: International comparison of bus occupancy levels

Country	Average number of passenger per local bus (2018)
Great Britain	12
Switzerland	13
France	15
Italy	18
Germany	19

Source: Eurostat.

Based on these international comparisons we use three occupancy levels within our scenarios – 14, 16 and 18 passengers per bus. We model occupancy levels increasing to these levels across all areas in Great Britain provided the projected increase in bus pkm is sufficient for this to occur (otherwise we use the maximum occupancy rates this projected increase allows for).

The one exception is London, which we assume remains at its current high level (implying all increased bus usage is matched with increased bus services).

Table 4: Projected occupancy rates in Local Buses across Great Britain

Geographic area	2019	2050		
		Scenario 1	Scenario 2	Scenario 3
London	20	20	20	20
England metropolitan	10.6	14.0	16.0	16.9
England non-metropolitan	9.8	14.0	16.0	16.9
Scotland	7.9	14.0	14.4	14.4
Wales	8.5	14.0	16.0	16.9
International benchmark	-	**14.0**	**16.0**	**18.0**

Source: WPI Economics modelling.

2. **Decarbonising the bus and coach (and car) fleets**: conservative and achievable levels.

In the medium- and long-term context of the transport sector's transition to net zero, the adoption of zero emission vehicles in both car and bus and coach fleets is set to impact on the decarbonisation benefits associated to modal shift. Although CCC's analysis and policy recommendations put more emphasis on the electrification of the car fleet (envisioning the ban of non-electric battery cars by 2032 in its "Balanced pathway" to net zero), the government's plan to decarbonise transport recognises the ambitions of the bus and coach industry, noting several operators "…have committed to purchase only ultra-low or zero emission buses from 2025".[47]

We follow a similar approach to the CCC, whereby the decarbonisation benefits of modal shift are assessed against baseline car fuel emissions without net zero policies. This follows the logic that decarbonising transport requires as much reduction in car demand as realistically possible, and the remaining car usage needs to become zero carbon. For buses, our model assumes vkm emissions will be zero by 2050, as part of the transition to a decarbonised transport system, reducing progressively at the pace of car emissions in the "electrification scenario" of the Department for Transport's Road Traffic Forecasts (2018). We use car emissions as reference because, having been published in 2018, the forecasts do not reflect the ambitions of the Decarbonising Transport Plan, or the commitments the bus industry has put forward since: four major operators, representing around two thirds of the total bus and coach fleet, have committed to run net zero fleets by 2035 or earlier. In this context, we believe reduction in bus emissions we have modelled is a conservative estimation of realistic and achievable levels of electrification of the bus fleet. Bringing together our projections for vkm emissions and occupancy levels, we can estimate car, bus and coaches pkm carbon emissions by 2030 and 2050, as shown in Table 5.

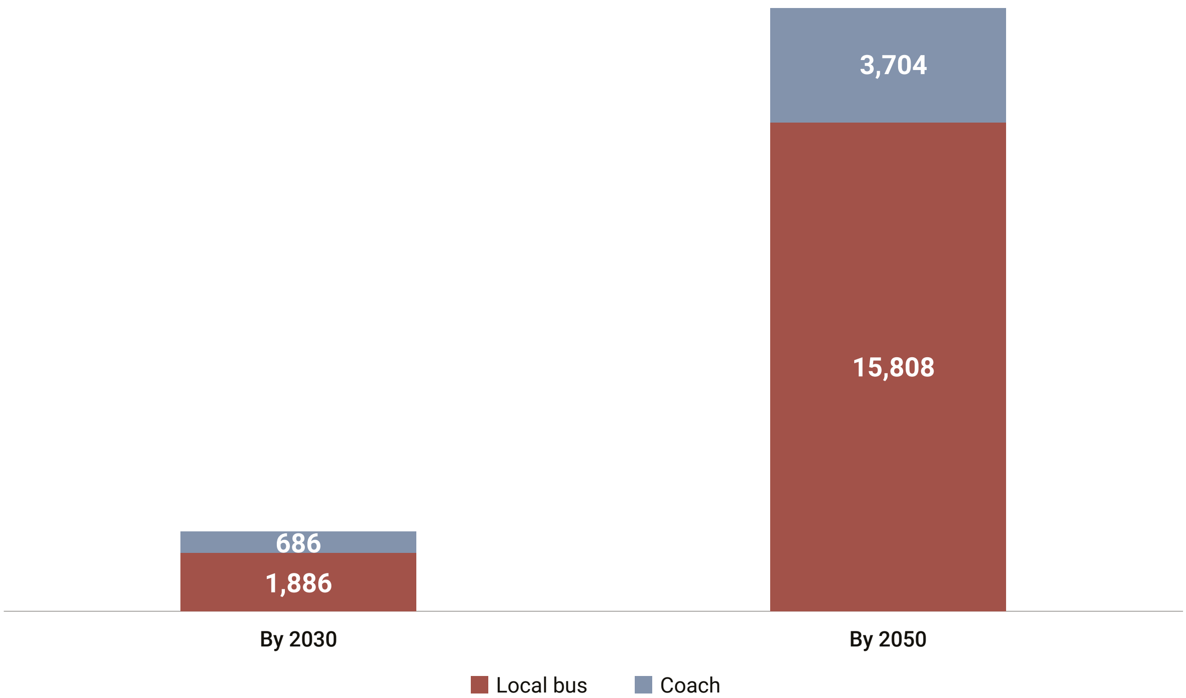
Table 5: Emissions per passenger kilometre (gC02e), for cars and local buses in our central scenario

	2019			2030			2050		
Mode	Car	Local Bus	Coach	Car (Baseline)	Local Bus	Coach	Car (Baseline)	Local Bus	Coach
London	92	38	26	64	23	11	47	0	0
England metropolitan	92	72	26	64	33	11	47	0	0
England non-metropolitan	92	78	26	64	37	11	47	0	0
Wales	92	90	26	64	33	11	47	0	0
Scotland	92	96	26	64	37	11	47	0	0

Source: WPI Economics modelling. Note: see Annex for further details on assumptions, sources and methodology.

Based on these assumptions, across Great Britain as a whole, by 2050 accumulated decarbonisation benefits associated with modal shift to local buses is estimated to save 15.8 MTC02e (more than total carbon emissions of the North East in 2019), and modal shift to coach would bring accumulated savings of 3,7 MTC02e (equivalent to the total carbon emissions of Leeds in 2019). [48]

Figure 9: Decarbonisation benefits associated with modal shift to local buses and coaches



Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Cumulative GB savings in GHC emissions by 2050

from modal shift to local buses:

15.8 million tons of CO_2

more than the total CO_2 emissions of the North East in 2019

from modal shift to coaches:

3.7 million tons of CO_2

equivalent to the total CO_2 emissions of Leeds in 2019

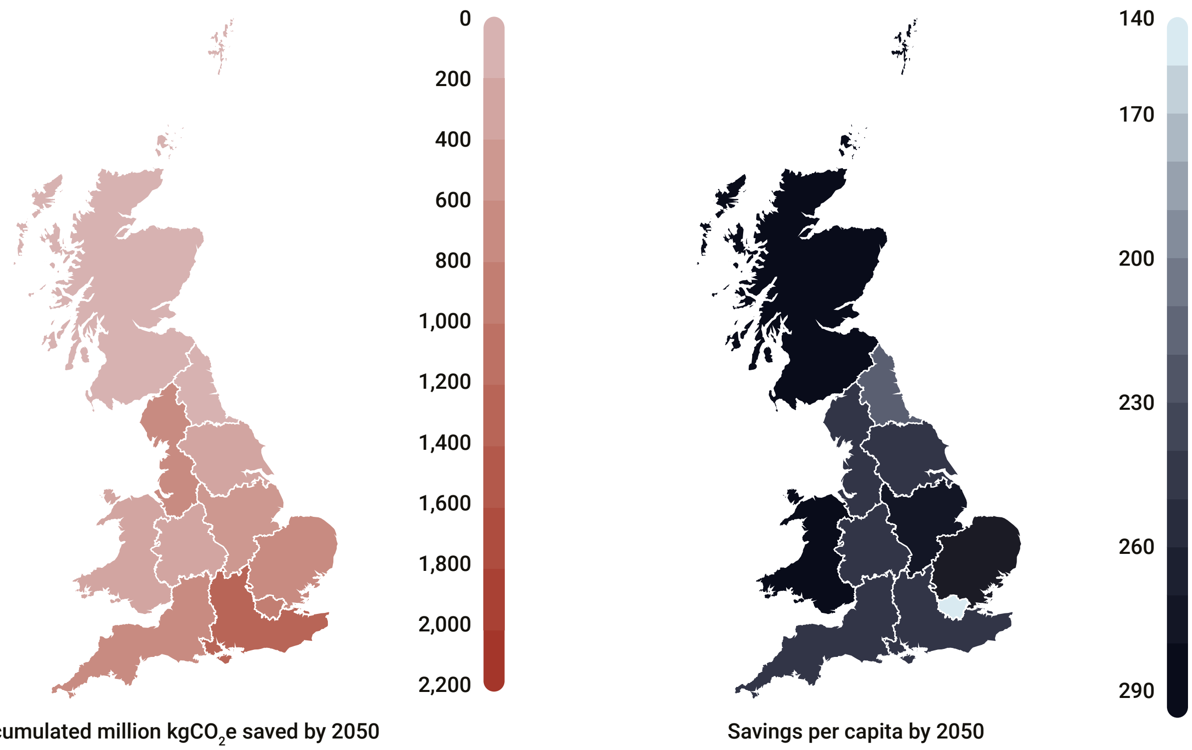
As Table 6 shows, all countries and regions across Great Britain would benefit from these reductions in GHG emissions associated with modal shift to local buses. In absolute terms, those regions that are modelled to experience a larger shift of car pkm to local buses (such as the South East or the North West) would see the larger decarbonisation benefits by 2050. In per capita terms, regions like Wales, East and West Midlands or East of England are modelled to benefit the most.

Table 6: Estimations of decarbonisation benefits associated with modal shift to local buses and coaches across Great Britain

	Accumulated million kgCO2e saved by:		Savings per capita	
Region (local buses)	**By 2030**	**By 2050**	**By 2030**	**By 2050**
North East	71	588	27	220
North West	219	1,803	30	246
Yorkshire and The Humber	164	1,349	30	245
East Midlands	158	1,335	33	276
West Midlands	190	1,574	32	265
South West	168	1,448	30	257
East of England	203	1,725	33	277
South East	273	2,366	30	258
London	198	1,178	22	131
Scotland	145	1,542	27	282
Wales	96	900	31	286
Great Britain (local buses)	**1,886**	**15,808**	**29**	**244**
Coaches	**686**	**3,704**	**-**	**-**

Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Figure 10: Decarbonisation benefits associated with modal shift to local buses



Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Air quality

Our modelling of the air quality benefits of modal shift relies on the same assumptions about occupancy rates and decarbonisation of the fleet as described above regarding decarbonisation. For NOx emissions, we adjust the estimations from the Road Traffic Forecasts by reducing bus emissions to zero by 2050, since these result from the deployment of combustion engines which will be phased-out from the fleet by then. Emissions of particulate matter (PM10) are less dependent on the type of engine use, since they also derive from the wearing down of brakes, tyres and road surfaces, so our model uses the estimations of the Road Traffic Forecasts directly (from the baseline scenario for cars and their electrification scenario for buses).

Table 7 below shows in the average savings of NOx and PM10 that would derive from every pkm shifted from car to buses in 2050:

Table 7: Air quality benefits of modal shift in 2050 (savings per car passenger km shifted to bus)

Region	NO_x (mg)	PM10 (mg)
London	72	0.48
East Midlands	57	0.5
East of England	57	0.49
North East	59	0.46
North West	62	0.5
South East	59	0.52
South West	57	0.51
West Midlands	60	0.5
Yorkshire and the Humber	56	0.5
Scotland	62	0.5
Wales	57	0.48

Source: WPI Economics modelling. Note: see Annex for further details on assumptions, sources and methodology.

Based on the assumptions above, the modal shift to local buses we have modelled in our central scenario would lead to meaningful improvements in air quality. By 2050 in Great Britain as a whole, modal shift would lead to cumulative savings of:

- 121 tons of PM10 emissions – this is above total motorway driving car emissions in Scotland in 2019.[49]
- Almost 6,000 tons of NOx emissions – this is above the total NOx emissions of diesel cars in London in 2019.[50]

These savings in PM10 and NOx emissions are **valued in £28 million** [51]– this would be **enough to pay for 800 nurses**.[52]

Figure 11: Accumulated savings in the emission of air pollutants associated with modal shift to local buses in Great Britain (tons)

Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Cumulative reduction in air pollution by 2050 from modal shift to local buses

5,600 tons of NO_x

more than the total NO_x emissions of diesel cars in London in 2019

121 tons of PM10

more than the total PM10 emissions from motorway car driving in Scotland in 2019

Cumulative benefits from reduced air pollution by 2050 valued at:

£28m

Enough to pay 800 nurses

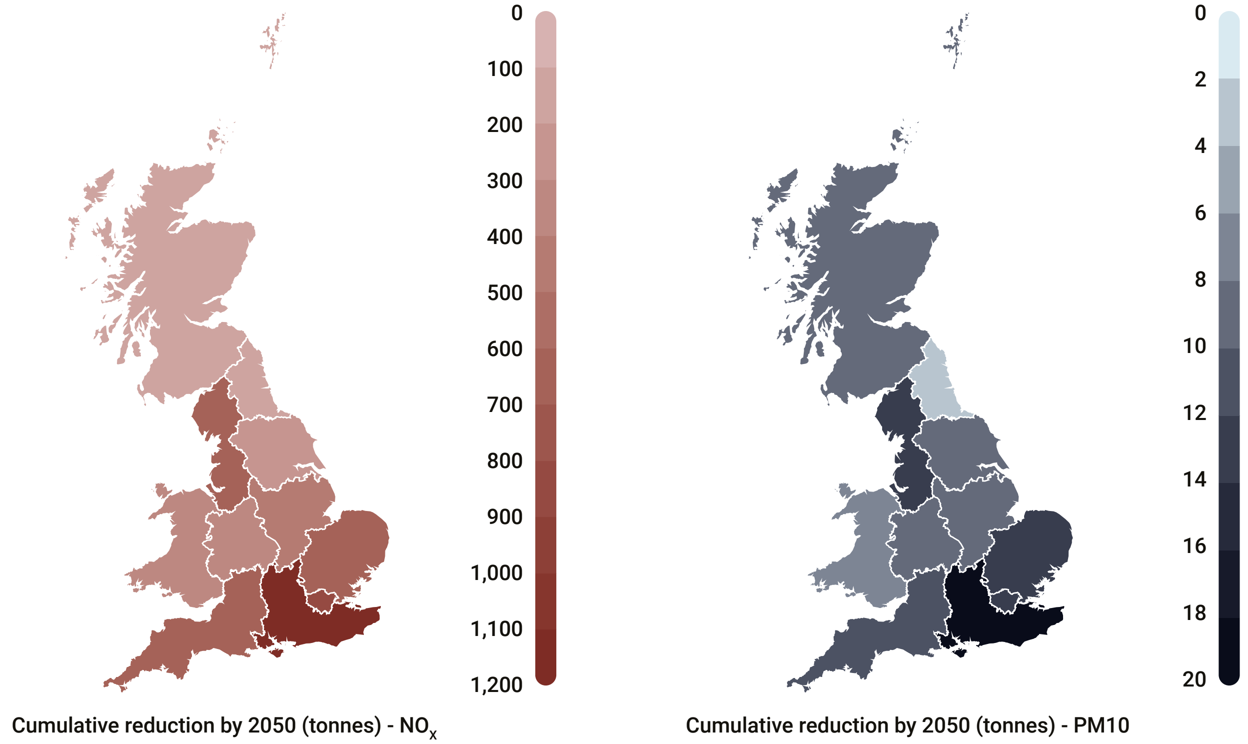
All regions and countries across Great Britain would experience air quality benefits as a result of modal shift. In our model, larger regions with currently higher levels of car traffic, such as the South East or the North West, would see the larger benefits.

Table 8: Estimations of air quality benefits associated with modal shift to local buses across Great Britain

	Accumulated savings by 2050 (tons)	
Region	**NO_x**	**PM10**
North East	111	3
North West	618	13
Yorkshire and The Humber	212	9
East Midlands	498	10
West Midlands	337	10
South West	651	12
East of England	627	13
South East	1,256	21
London	812	14
Scotland	169	9
Wales	365	7
Great Britain	**5,656**	**121**

Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Figure 12: Accumulated savings in the emission of air pollutants associated with modal shift to local buses by 2050



Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Health benefits

The review commissioned by the CCC quantified three types of health benefits, which we include in our modelling. The total annual health costs of these are significant.

Estimated total annual costs of...

Physical inactivity	Road noise	Road accidents

£7bn	£7-10bn	£9bn

Source: Department for Environment, Food and Rural Affairs (2014) Noise pollution: economic analysis; and National Institute for Health and Care (2018) Physical activity and the environment.

The CCC's estimates of the benefits of reduced vkm on each of these areas are shown below.

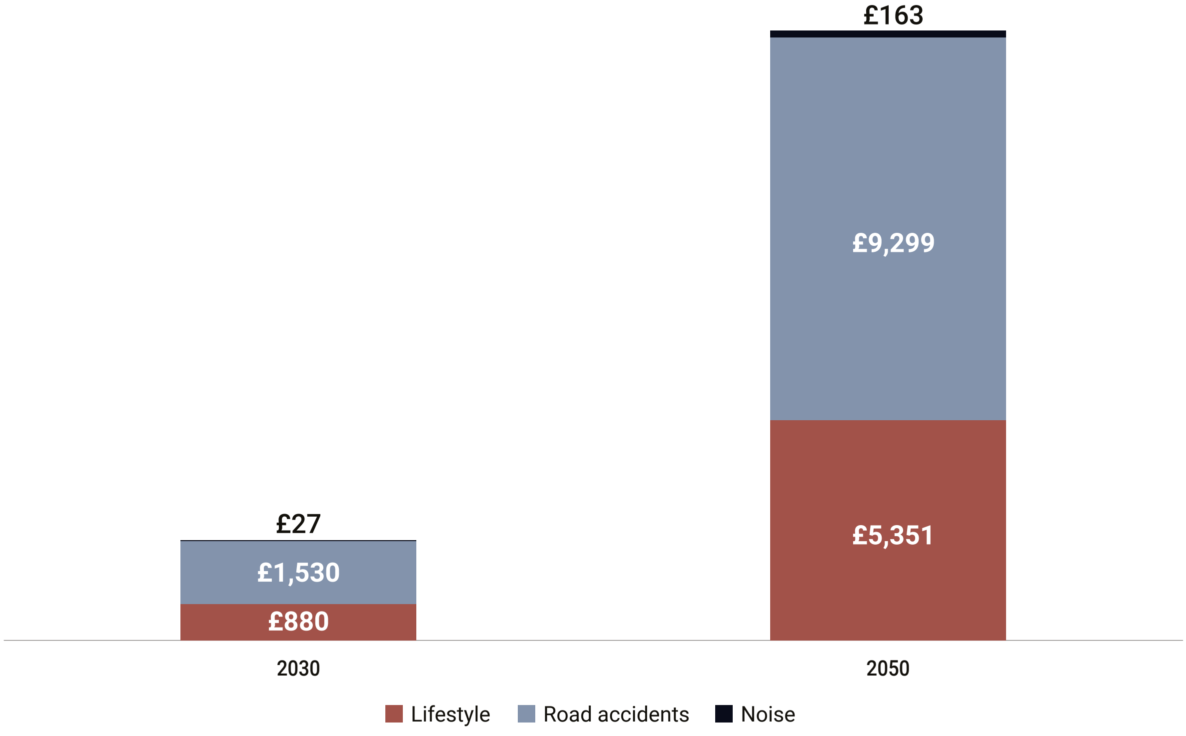
Table 9: Estimations of health benefits associated with modal shift

Dimension	Estimated benefits (2012 prices)
Lifestyle	£21.36 per car vkm shifted
Road accidents	£37.12 per car vkm shifted
Noise	£0.65 per car vkm shifted

Source: Ricardo AEA (2013) "Review of the impacts of carbon budget measures on human health and the environment", report for Committee on Climate Change.

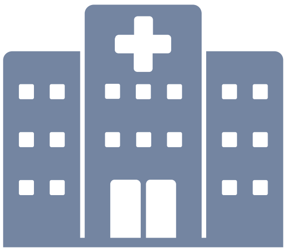
Based on these assumptions, the accumulated value of health benefits associated with modal shift to local buses is expected be valued at £14.9bn by 2050. Two thirds of these health benefits correspond to the reduction in road accidents that would ensue from the fall in overall traffic levels, followed by the lifestyle benefits (derived from an increase in physical activity) and by the reduction in noise levels.

Figure 13: Accumulated value of health benefits from modal shift to local buses, all of Great Britain (£million, 2019 values)



Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Cumulative health benefits by 2050 valued at:



£14.9bn

This would be enough to build 33 new NHS hosptails

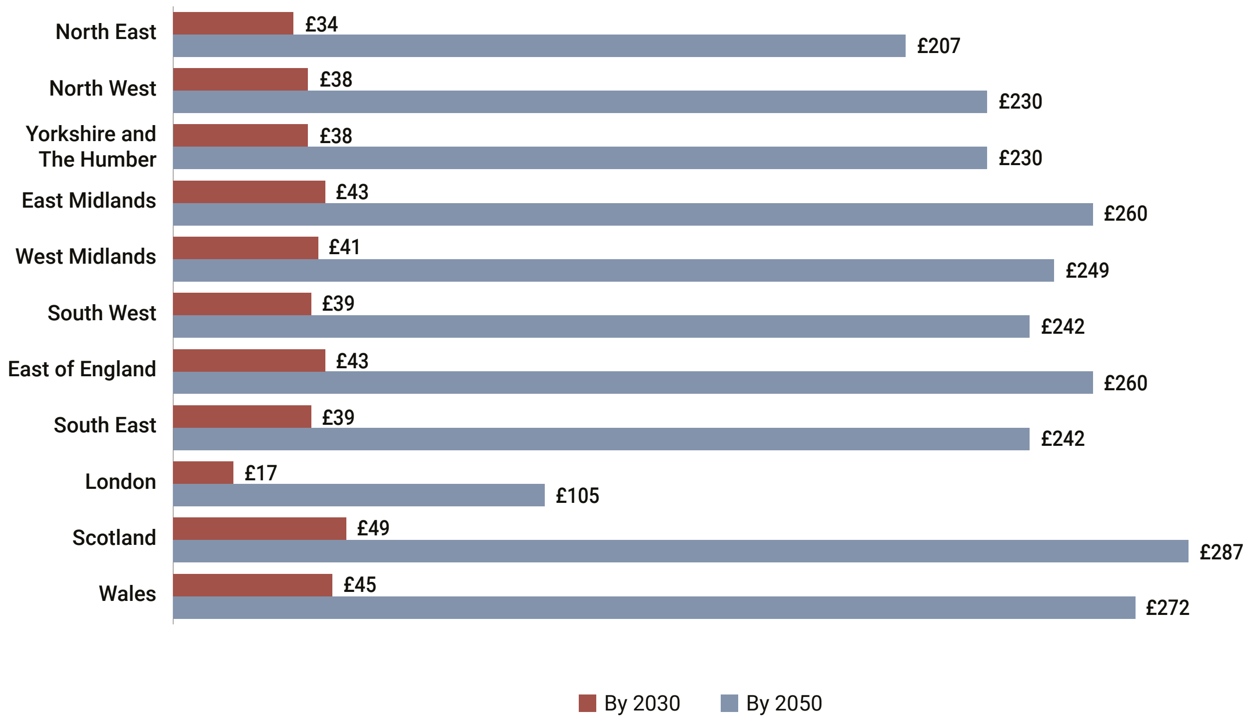
Source: WPI Economics, based on £450m cost per hospital[53]

These health benefits are comprised of:

- Reductions in road accidents valued at £9.3bn
- Reductions in noise pollution valued at £160m
- Improvements in lifestyle valued at £5.4bn

Across Great Britain, all countries and nations would benefit from the positive effects on health associated with modal shift to local buses. While in absolute terms large, populous regions such as the South East or the North West see the largest benefits, looking at the benefits on a per capita basis, our model finds Scotland, Wales, East Midlands and East of England benefitting the most.

Figure 14: Per capita value of health benefits from modal shift (£, 2019 values)



Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

Societal benefits

Increased bus usage would deliver a range of economic benefits, as discussed above. Many economic benefits stem from the decrease in congestion that would result from increased bus usage. The reasons are clear. Travel by bus can significantly reduce traffic and congestion, and the current economic costs of congestion are very large.

A double-decker bus can eliminate up to 2 miles of traffic

£11bn

The current economic costs of congestion in english urban areas

We focus on the benefits arising directly from this reduced congestion, which have been estimated to amount to **£108 per 1,000 car vehicle km avoided**.[54] So, even focusing on congestion alone, accumulated societal benefits associated with modal shift are modelled to be almost double the size the health benefits, reaching almost £30bn pounds by 2050. This is **larger than Manchester's GDP in 2019**.[55]

Figure 15: Accumulated value of reduced congestion benefits from modal shift to local buses, all of Great Britain, (£million, 2019 values)

Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

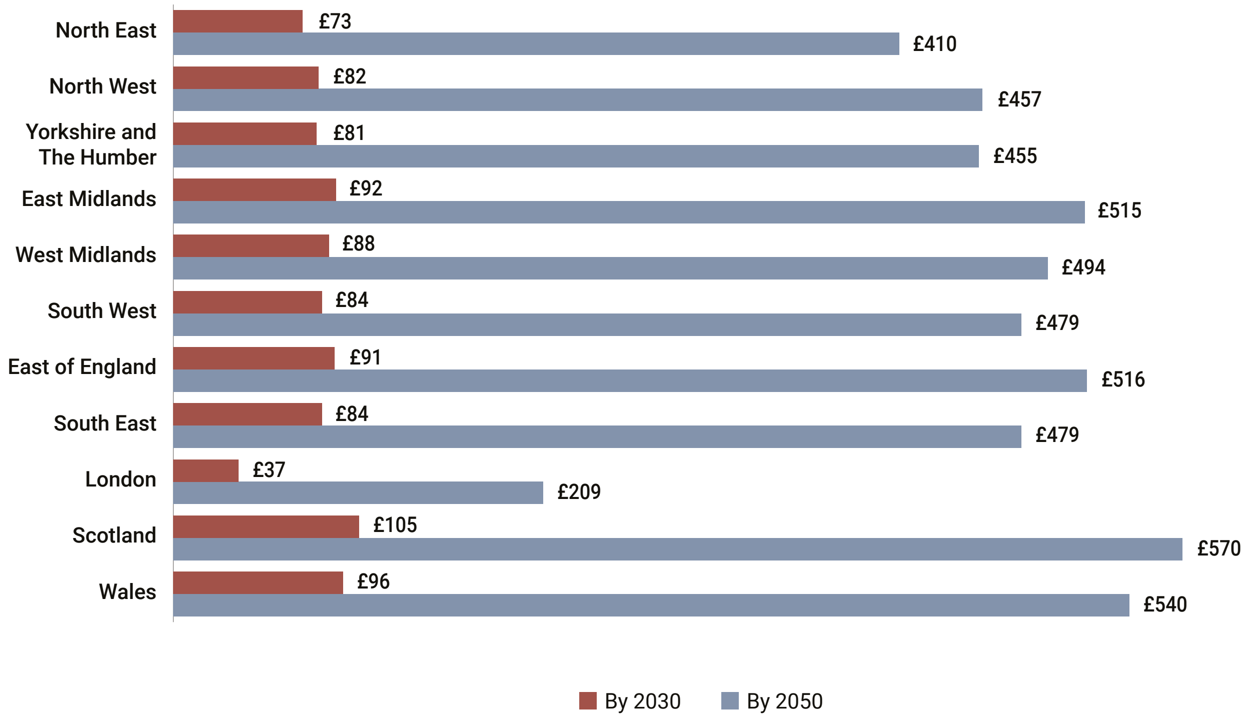
Cumulative reductions in congestion by 2050 valued at:

£29.4bn

That's more than the GDP of the city of Manchester in 2019

Across Great Britain, our model shows substantial socioeconomic benefits associated to modal shift across all regions and countries, which are expected to be 5 times larger by 2050 in comparison to 2030.

Figure 16: Value per capita of reduced congestion benefits from modal shift to local buses(£million, 2019 values), by nation and English region



Source: WPI Economics modelling. Notes: central case – see annex for further scenarios.

CHAPTER 6 How can this be made possible?

The previous sections have demonstrated the scale of benefits that could be achieved from modal shift from car to bus and coach. They also highlighted existing evidence that shows that, aside from these benefits, modal shift is necessary in order to deliver on the country's net zero commitments. The scale of modal shift we have modelled is significant, but possible with modest changes to our habits and behaviour. The progressive modal shift we have modelled would require **every person in Great Britain to switch just over 1 car trip per month** (13 trips per year) **for the bus by 2030**, rising to just above **2 car trips per month** (26 trips per year) **by 2050**. Despite reductions in bus and coach use over several decades, there is evidence that indicates that such change is possible.

Research shows that **the general public identifies the negative consequences of too much car use**. Congestion is regarded as a serious problem by increasing proportions of people since 2012,[56] and the majority of people are concerned about air quality and noise pollution in their immediate locality. The overwhelming majority of those concerned consider cars as the main cause of this problem (82% and 74%, respectively).[57]

Crucially, the public also appears willing to **switch to buses provided services are better and cheaper**:

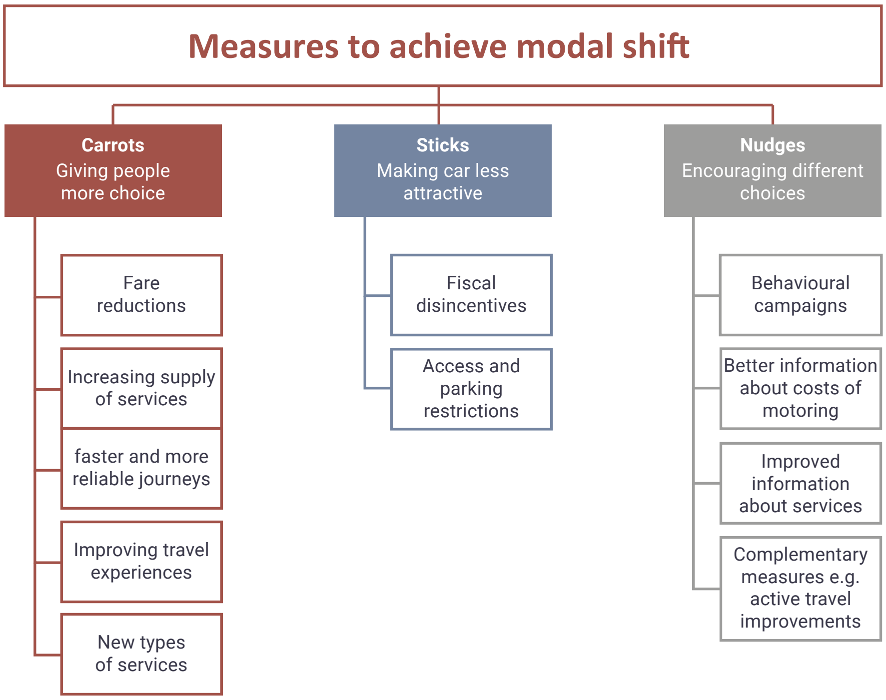
- In 2019, **31% of English people** surveyed claimed to be willing to **switch from car to buses for trips under 2 miles**.[58]
- In the same year, another survey found that more than **55% of drivers would use their cars less if public transport was better**.[59]
- Most recently, **58% of English people** surveyed in 2020 would **be encouraged to use the bus more in the future if fares were standardised to between £1 and £2**. [60]

The potential to increase bus usage is further illustrated by those local areas which have managed to increase bus patronage locally even whilst national bus usage has been falling. This includes both urban areas like Bristol, Brighton and Hull, and rural areas such as Cornwall and West Berkshire. These **local success stories demonstrate that adequate investment can encourage people to use buses**:

- According to the Independent Travel Commission , what these successful cases have in common is that bus patronage rose after **increases in bus service supply**.[61]
- In their analysis of some of these successful cases, KPMG also bring attention to the **investments focused on improving the price, speeds and reliability of bus services** (from the unification and upgrade of services under a common Transport for Cornwall brand, to the rationalisation of the network and fares, coupled with investment in infrastructure, in Hull; or the reduction of journey times through bus priority measures in Bristol).[62]

The experience of places that have achieved increases in modal shift and the evidence from public opinion shows that modal shift is possible. It also indicates that this will require a variety of measures that give people more choice (by making good quality and affordable bus services available) and encourage them to choose these services. The different policy interventions this includes, summarised in Figure 17 below, will be assessed in the next stage of the project.

Figure 17: Summary of types of policy options to achieve modal shift from cars into buses



Annex 1: Methodology

This Annex provides further details about our the sources and methods used in the construction of our model.

Inputs

Our model relied on two sets of inputs: car and bus passenger kilometres (pkm) per local authority in 2018/19, and baseline projections for 2030/2050 (what is forecasted to happen without any net zero and/or modal shift policies).

2018/19 data

Car pkm were estimated using data on car vehicle kilometres (vkm) at local authority level in 2018/19, and applying the average car occupancy rate in that same year (1.55 passengers per car).[63] This same method was applied across Great Britain.

For local buses, different estimation methods were applied for England, Wales and Scotland:

- In England, we used 2018/19 data for passenger journeys on local buses by local authority,[64] to which we applied 3-year averages of regional data about the average length of local bus journeys.[65] This first estimation was adjusted to ensure that our total bus pkm in England did not exceed the figure reported directly by Department for Transport.
- In Scotland and Wales, our starting point was the total bus pkm for both countries,[66] which was distributed among their local authorities on the basis of their share of total road traffic.

For coaches, pkm for 2018/19 were estimated as the difference of total local bus pkm reported for Great Britain[67] and pkm reported for bus and coach.[68]

Baseline projections for 2030 and 2050

Our baseline projections for buses and car pkm derive from Scenario 1 of Department for Transport's Road Traffic Forecasts from 2018.[69] These statistics provided estimations for annual vkm in each English region and Wales for different vehicles types (for buses the "Public Service Vehicle category was used), for every 5 years between 2015 and 2050, as well as the growth rate from 2015. For each local authority, we estimated 2015 car and bus pkm (following the methodology described above), to which we applied the regional growth rate for car and Public Service Vehicle vkm by 2030 and 2050 (for Scottish local authorities, the average growth rate in England and Wales was used).

Scenarios

As explained in the main body of the report, we have taken the modal shift to public transport envisioned in CCC's balanced pathway to net zero as reference to model our three scenarios: between 2 and 4% of car pkm shifted to public transport by 2030, and between 5% and 8% by 2050. We first make the assumption that bus and coaches will account for 30% of the total modal shift to public transport, based on their current share of public transport passenger kilometres. The bands provided by CCC were divided in three sections (lower end, central value and upper end). Then local authorities in England and Wales were classified on the basis of their potential to achieve modal shift beyond base level, informed by previous modelling undertaken for Greener Journeys.

In England and Wales scenarios with different scales of modal shift (in terms of car pkm shifted to buses) were constructed as follows:

- In Scenario 1, local authorities classified as "Base potential" saw a shift in the lower end of the CCC bands for 2030 and 2050, those classified as "Higher potential", a shift corresponding to the central value of CCC bands, and those classified as "Highest potential" a shift corresponding to upper end of those bands.

- In Scenario 2, local authorities classified as “Base potential” saw a shift a shift corresponding to the central value of CCC bands, and those classified as either “Higher potential” or “Highest potential” a shift corresponding to upper end of those bands.
- In Scenario 3, all local authorities are modelled to experience a shift corresponding to the upper end of CCC bands for 2030 and 2050.

In addition to this, because the Scottish government has set out more ambitious targets in terms of reducing car mobility than the rest of the country, our model assumes that the shift from cars to buses in Scotland would be on the upper end of CCC’s estimation in our more conservative scenarios (Scenario1) going beyond that in the more ambitious ones (by growing at the same rate as local authorities with Base Potential in Scenarios 2 and 3).

	Proportion of car km shifted to bus by 2030:			Proportion of car km shifted to bus by 2050:		
Local Authority classification	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Highest potential	1.20%	1.20%	1.20%	2.40%	2.40%	2.40%
Higher potential	0.90%	1.20%	1.20%	1.95%	2.40%	2.40%
Base potential	0.60%	0.90%	1.20%	1.50%	1.95%	2.40%
Scotland	1.20%	1.50%	1.50%	2.40%	2.85%	2.85%

Outputs

The outputs of the model are car pkm shifted to local buses and coaches every year between 2018/19 and 2050. To obtain these, first the car pkm shifted in 2030 and 2050 were calculated (see below), and, assuming modal shift would occur progressively, values for the rest of the years were inputted using a linear interpolation.

To estimate the car pkm shifted in 2030 and 2050:

- For local buses, we apply the percentages of car pkm shifted in each scenario to our baseline projections for these years for each local authority.
- For coaches, we apply the same rate of growth relative to 2018/19 levels as the average growth of local buses by 2030 and 2050 relative to that same year across Great Britain.

Benefits

Our general approach to estimate the benefits of modal shift has been to measure accumulated benefits by 2030 and 2050 (taking 2023 as a starting point), on the basis of estimated annual benefits. The latter were obtained multiplying our “unit of benefit per car pkm shifted”, to the estimated total car pkm shifted every year per local authority.

How this “unit of benefit per car pkm shifted” was calculated varies across the different types of benefits estimated.

Decarbonisation benefits

In general terms, to calculate the savings of CO2 emissions associated to modal shift to local buses (see below for coaches) we have calculated the difference between the average car and bus pkm. To calculate the latter, we have first calculated vkm emissions and then applied occupancy rates to obtain pkm emissions.

vkm emissions

As described in the main body of the report, key factors when modelling bus and car emissions until 2050 are changes in the technological efficiency of combustion engines and the rate of decarbonisation of both fleets. Inspired by the CCC approach, we have assumed that the car pkm that are being shifted to buses would follow the baseline trajectory of emissions reductions, as net zero policies decarbonise the remaining car demand that was not reduced or shifted to active travel and public transport.

- For cars, hence, we have calculated vkm CO2 emissions in 2030 and 2050 as the ratio between total car CO2 emissions and total car vkm emissions in those same years, as provided in the scenario 1 of the Road Traffic Forecasts.
- For local buses, we have included that the fleet will be zero emissions by 2050. To estimate what this means in 2030, we have used the rate of vkm emissions reductions for cars derived from scenario 7 (which has more ambitious targets for car fleet electrification) of the Road Traffic Forecasts.[70]

The saving in CO2 emissions in those years was calculated as the difference between the hypothetical emissions of the car pkm emissions that are being shifted and the emissions of the local bus pkm for which they are being replaced.

pkm emissions

To estimate pkm emissions in 2030 and 2050, as described in the main body of the report, different assumptions about the rise in occupancy rates in local buses as part of modal shift were used in each of our scenarios, based on different international comparators. On the basis of these international comparisons we identify three reasonable increased occupancy levels to model within our scenarios – 14 passengers per bus, 16 and 18. We model occupancy levels increasing to these levels across all areas in Great Britain provided the projected increase in bus pkm is sufficient for this to occur (otherwise we use the maximum occupancy rates this projected increase allows for).

The one exception is London, which we assume remains at its current high level (implying all increased bus usage is matched with increased bus services).

	2019		2030			2050	
Geographic area	**Scenario 1**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 1**	**Scenario 2**	**Scenario 3**
London	20	20	20	20	20	20	20
England metropolitan	10.6	13.00	13.66	13.66	14.0	16.0	16.9
England non-metropolitan	9.8	13.00	13.66	13.66	14.0	16.0	16.9
Scotland	7.9	11.42	12.16	12.16	14.0	14.4	14.4
Wales	8.5	13.00	13.66	13.66	14.0	16.0	16.9
International benchmark	-	13.00	14.00	16.00	14.0	16.0	18.0

For cars, we have used CCC's assumptions of rising car occupancy rates as part of behaviour change in the transition to net zero, rising to 1.7 by 2030 and 1.9 by 2050.

Again, values for the rest of the years were imputed through linear interpolation. These were then multiplied by the total number of car pkm shifted to calculate the annual decarbonisation savings resulting from modal shift to local buses in each local authority.

To calculate the decarbonisation benefits associated with modal shift to coaches, our starting point were current pkm emissions, which are much lower than for local buses (mainly due to higher occupancy rates and the less urban and congested nature of coach routes).[71] With this we calculated the unitary benefit of shifting one car pkm to coaches in 2018/19, to which we then applied the average rate of reduction of the unitary benefits of modal shift to local bus to project it until 2050.

Air quality benefits

The approach to calculate the savings in the emissions of air pollutants (namely NOx and PM10, which are the ones for which Road Traffic Forecasts provide estimations) was the same as described above:

1. estimate bus and car vkm emissions separately for 2030 and 2050, using baseline and electrification assumptions (respectively),
2. apply the same assumptions about occupancy rates as described above to calculate pkm emissions in 2030 and 2050,
3. calculate the unitary savings in those years;
4. input values to the rest of years through linear interpolation.

For NO_x, which is an air pollutant resulting from the burning of fuel in combustion engine, the same assumption about the bus fleet being zero emissions by 2050 was used. For PM10, which is less dependent on the usage of combustion engine, buses vkm emissions for 2050 were estimated using the same rate of reduction as estimated for cars in the scenario 7 of the Road Traffic Forecasts.

Health benefits

For health benefits our starting point were the monetary benefits (in 2012 £ values) provided by Ricardo AEA in terms improvements in lifestyle, reduced road noise and car accidents per car vkm shifted to public transport.[72] On this basis we have estimated unitary benefits per car pkm shifted for each of this categories (in £2019 values), by:

- updating the £ values per vkm shifted to 2019 values (instead of 2012), using changes to the Consumer Price Index since then,
- using average car occupancy rates to estimate pkm unitary benefits in 2019, 2030 and 2050,
- inputting values for the rest of the years through linear interpolation.

Socio-economic benefits

The same approach as described above for health benefits was followed, using Ricardo AEA's monetary benefits (in 2012 £ values) for the reduction in congestion derived from shifting car vkm to public transport.[73]

Annex 2: Sensitivity analysis

This Annex provides the outputs and benefits we have estimated in the three scenarios of our modelling

Outputs

Increases in bus and coach patronage (pkm)						
	2030			2050		
Region (local buses)	S1	S2	S3	S1	S2	S3
East Midlands	55%	66%	66%	116%	132%	133%
East of England	69%	86%	91%	149%	174%	182%
London	6%	8%	8%	12%	15%	15%
North East	33%	42%	42%	71%	84%	84%
North West	47%	51%	51%	96%	101%	102%
Scotland	35%	44%	44%	70%	84%	84%
South East	49%	69%	81%	114%	143%	162%
South West	46%	60%	69%	104%	124%	138%
Wales	55%	74%	74%	120%	148%	148%
West Midlands	54%	57%	57%	110%	114%	114%
Yorkshire and The Humber	49%	51%	53%	100%	103%	106%
Great Britain (local buses)	**34%**	**41%**	**43%**	**72%**	**82%**	**85%**
Coaches	**34%**	**41%**	**43%**	**72%**	**82%**	**85%**

Environmental benefits

Cumulative savings in CO2 emissions from modal shift (million kg)						
	2030			2050		
Region (local buses)	S1	S2	S3	S1	S2	S3
East Midlands	126	158	160	1,128	1,335	1,346
East of England	156	203	216	1,414	1,725	1,816
London	148	198	198	926	1,178	1,178
North East	54	71	71	474	588	588
North West	196	219	220	1,668	1,803	1,810
Scotland	106	145	145	1,235	1,542	1,542
South East	188	273	322	1,787	2,366	2,712
South West	124	168	193	1,152	1,448	1,628
Wales	68	96	96	697	900	900
West Midlands	173	190	190	1,482	1,574	1,574
Yorkshire and The Humber	151	164	170	1,275	1,349	1,388
Great Britain (local buses)	**1,489**	**1,886**	**1,981**	**13,236**	**15,808**	**16,483**
Coaches	**563**	**686**	**721**	**2,974**	**3,704**	**3,867**

Cumulative savings in air pollutant emissions from modal shift to local buses by 2050 (tons)						
		NO_x			PM10	
Region	S1	S2	S3	S1	S2	S3
East Midlands	376	498	501	9	10	10
East of England	465	627	652	10	13	14
London	654	812	812	11	14	14
North East	69	111	111	2	3	3
North West	481	618	620	11	13	13
Scotland	33	169	169	7	9	9
South East	913	1,256	1,410	16	21	24
South West	486	651	716	10	12	14
Wales	264	365	365	5	7	7
West Midlands	224	337	337	9	10	10
Yorkshire and The Humber	122	212	212	9	9	10
Great Britain	4,089	5,656	5,905	98	121	126

Health benefits

Cumulative health benefits from increased physical activity (million 2019 £)						
		2030			2050	
Region	S1	S2	S3	S1	S2	S3
East Midlands	63	75	76	390	454	458
East of England	77	96	102	489	586	617
London	42	56	56	268	341	341
North East	26	33	33	163	199	199
North West	94	101	101	576	611	613
Scotland	77	96	96	467	566	566
South East	93	129	152	615	802	922
South West	61	79	91	397	491	553
Wales	38	51	51	244	310	310
West Midlands	84	88	88	513	534	534
Yorkshire and The Humber	72	75	78	440	456	470
Great Britain	728	880	925	4,562	5,351	5,584

Cumulative health benefits from reduced road accidents (million 2019 £)						
	2030			2050		
Region	S1	S2	S3	S1	S2	S3
East Midlands	109	130	131	678	788	795
East of England	134	167	177	849	1,018	1,073
London	73	98	98	466	593	593
North East	45	57	57	284	347	347
North West	164	175	176	1,001	1,061	1,065
Scotland	134	167	167	811	984	984
South East	162	224	265	1,069	1,394	1,602
South West	106	138	159	690	853	961
Wales	67	89	89	424	539	539
West Midlands	146	153	153	891	928	928
Yorkshire and The Humber	125	130	135	765	793	816
Great Britain	1,265	1,530	1,608	7,927	9,299	9,703

Cumulative health benefits from reduced road noise (million 2019 £)						
	2030			2050		
Region	S1	S2	S3	S1	S2	S3
East Midlands	2	2	2	12	14	14
East of England	2	3	3	15	18	19
London	1	2	2	8	10	10
North East	1	1	1	5	6	6
North West	3	3	3	18	19	19
Scotland	2	3	3	14	17	17
South East	3	4	5	19	24	28
South West	2	2	3	12	15	17
Wales	1	2	2	7	9	9
West Midlands	3	3	3	16	16	16
Yorkshire and The Humber	2	2	2	13	14	14
Great Britain	22	27	28	139	163	170

Societal benefits

Cumulative benefits from reduced congestion (million 2019 £)						
	2030			2050		
Region	S1	S2	S3	S1	S2	S3
East Midlands	372	444	449	2,140	2,491	2,512
East of England	458	569	606	2,679	3,215	3,389
London	251	335	335	1,470	1,873	1,873
North East	154	196	196	896	1,095	1,095
North West	559	599	601	3,162	3,353	3,366
Scotland	458	572	572	2,562	3,113	3,113
South East	552	767	904	3,366	4,401	5,061
South West	364	471	543	2,175	2,694	3,037
Wales	228	304	304	1,336	1,702	1,702
West Midlands	500	524	524	2,815	2,931	2,931
Yorkshire and The Humber	427	446	461	2,416	2,506	2,579
Great Britain	**4,322**	**5,227**	**5,494**	**25,017**	**29,375**	**30,660**

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WPI Economics Limited

11 Tufton Street
London
SW1P 3QB

@WPI_Economics

wpieconomics.com

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