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NET ZERO BY 2030

A MODAL SHARE FOR A SUSTAINABLE TRANSPORT SYSTEM

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1. ABBREVIATIONS

BCC	Bristol City Council
CAZ	Clean Air Zone
CO_2	Carbon Dioxide
CSE	The Centre for Sustainable Energy
DfT	Department for Transport
EV's	Electric Vehicles
STN	Sustainable Transport Network
ULEVs	Ultra Low Emission Vehicles
WECA	The West of England Combined Authority
WPL	Workplace Parking Levy

2. EXECUTIVE SUMMARY

Executive Summary

Bristol has committed to being carbon neutral by **2030**. This requires an **88% reduction in emissions in the transport sector** in the next decade. While other sectors, such as energy and waste, have decarbonised significantly in recent years, there has been little change in overall transport emissions for the city.

To achieve net zero transport emissions by 2030, the **Sustainable Transport Network (STN)** has previously recommended a significant change in modal share—i.e. the share of journeys by each major mode of transport in the city. By 2030, STN recommended:

- A **maximum of 30%** of all journeys by car
- At **least 20%** of all journeys by public transport
- At **least 40%** of all journeys by active travel

Our team was asked to conduct further modelling to determine whether these modal share targets would deliver the emissions reductions needed. Our modelling indicates that the targets are not ambitious enough. Instead, the following targets for 2030 are proposed:

- A **maximum of 20%** of journeys by car
- A **suggested 25%** of journeys by public transport
- A **suggested 55%** of journeys by active travel

Car journeys are estimated to currently represent **51%** of all journeys. A reduction in car journeys is the most inflexible part of this proposal, as they represent the greatest proportion of emissions. No more than **20% of journeys** can be made by car if emissions are to be reduced to desired levels. The necessary reductions are deemed possible if the correct balance of incentives and disincentives are introduced.

Public transport journeys are estimated to currently represent **19% of all journeys** in Bristol, with **15%** of journeys occurring by **bus** and **4%** by **train.** Increasing this modal share to **25%** in the next decade will be aided by the Bus Deal and the MetroWest extension, both of which are expected to increase public transport ridership in Bristol and its surrounding region. Creating a modal shift from private cars to bus ridership will be an important part of achieving emissions reductions in transport, as the bus fleet is transitioning to bio-methane fuel and is expected to be carbon neutral by 2030. Investment in bus prioritisation measures is key to achieving this target.

Active transport is estimated to currently represent **30%** of total journeys in Bristol, with **20% walking** and **10% cycling**. Modelling suggests that this needs to **increase to 55%** by 2030 to meet the city's emissions reduction targets. This will require significant investment in safe and accessible cycling and walking infrastructure. Progress will be aided by creating an inclusive cycling environment, particularly one which encourages more women and children to adopt cycling as a mode of transport. The introduction and expansion of city centre pedestrianisation, low-traffic neighbourhoods and the Clean Air Zone will facilitate an increase in the number of people walking and cycling in Bristol. While local and regional governments have stated their support for ambitious transport measures, they must now supplement these with policy action.

If the targets suggested in this report are achieved, Bristol will look very different in 2030. While the primary aim of these targets are to reduce carbon emissions, a number of co-benefits are likely to be seen if they are achieved. Air pollution, and congestion are likely to fall, improving productivity and respiratory health in the city. Meeting these goals in the next ten years will require a rapid and significant policy shift, but these targets provide a positive, healthy vision for Bristol's future.

There are barriers to achieving the proposed targets, including funding constraints faced by authorities with responsibility for transport, poor coordination between these authorities, and the quality of data that they can access to make informed decisions. **A systematic collection of modal share data, incentives, and investments to reduce car journeys and increase active travel, and improved collaboration among key stakeholders** are all recommended to meet these ambitious modal share targets.

3. INTRODUCTION

The transport emissions problem

In November 2018, Bristol City Council (BCC) became the first local authority in the UK to declare a climate emergency (BCC, 2019d). As part of this declaration, BCC set a target of net zero carbon dioxide (CO_2) emissions by 2030. Transport is the largest single source of carbon emissions in the South West region, at **32%**, and emissions from transport have been slow to change compared to other sectors (Travelwest, 2020a). This can be seen in *Figure 1.* The amount of congestion in Bristol is three times the national average, resulting in some of the lowest peak hour traffic speeds among the UK's Core Cities. This produces significant economic costs arising from delays and a lack of journey time reliability (BGC, 2015).

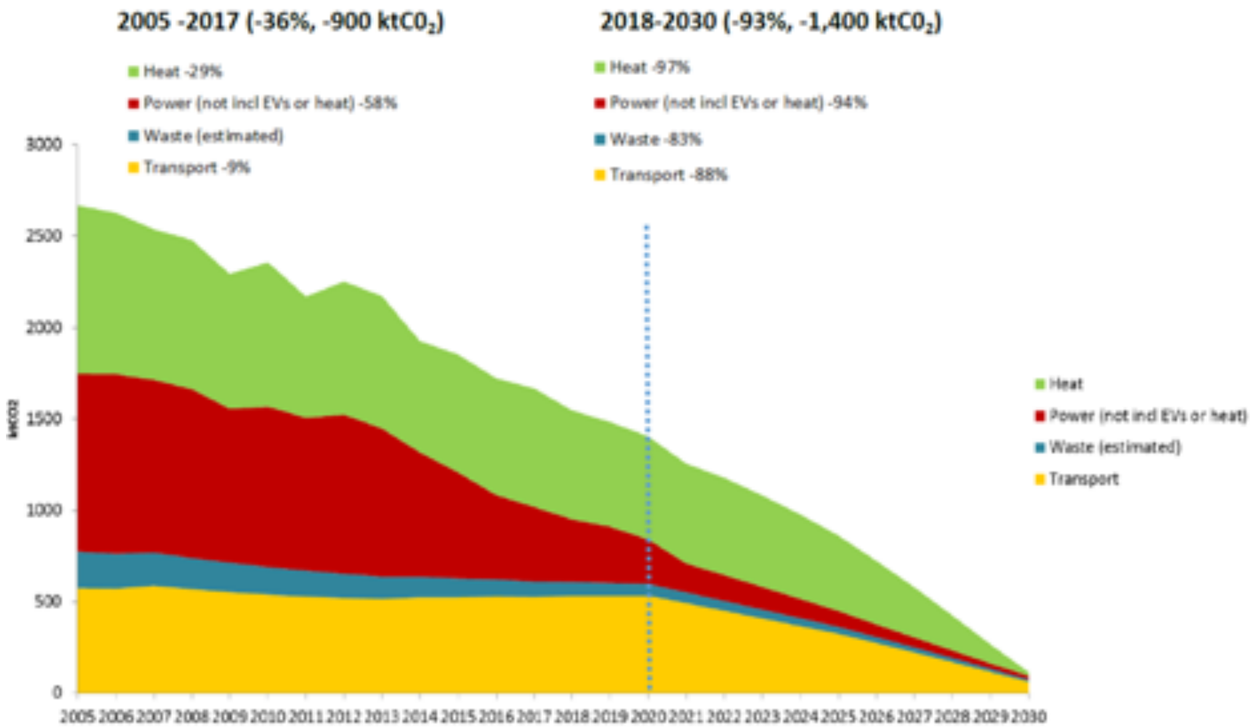


Figure 1: Changes in carbon dioxide emissions (ktCo2) in Bristol from 2005-2017 and proposed necessary changes for 2018-2030 (Roberts et al, 2019). The dotted line indicates the year 2020.

The current transport situation in Bristol

Transport management and provision in Bristol is complex and fragmented, which can present challenges and lead to piecemeal infrastructure change (Dudd, 2020b). The management of public transport was reallocated to the joint control of the West of England Combined Authority (WECA) from 1 April 2020. WECA is made up of three councils: Bristol, Bath and North East Somerset, and South Gloucestershire.

WECA receives funding and sets the transport strategy for the region, as well as consulting the public on transport planning (Travelwest 2020b). BCC retains control of roads, carriageways and pavements. The impact of reallocating transport responsibility to WECA is difficult to estimate. Decision-making may be constrained by the competing priorities of different authorities in WECA, particularly as political affiliations vary between its constituent councils.

The transport sector also faces funding challenges; WECA have highlighted the existence of a **£6 billion** shortfall which limits their investment capacity. The impact of this shortfall may be exacerbated by expected population growth, which could increase pressure on transport services (Travelwest, 2020a). Bristol's transport providers and policymakers also lack access to high-quality transport data, which would facilitate more informed decisions.

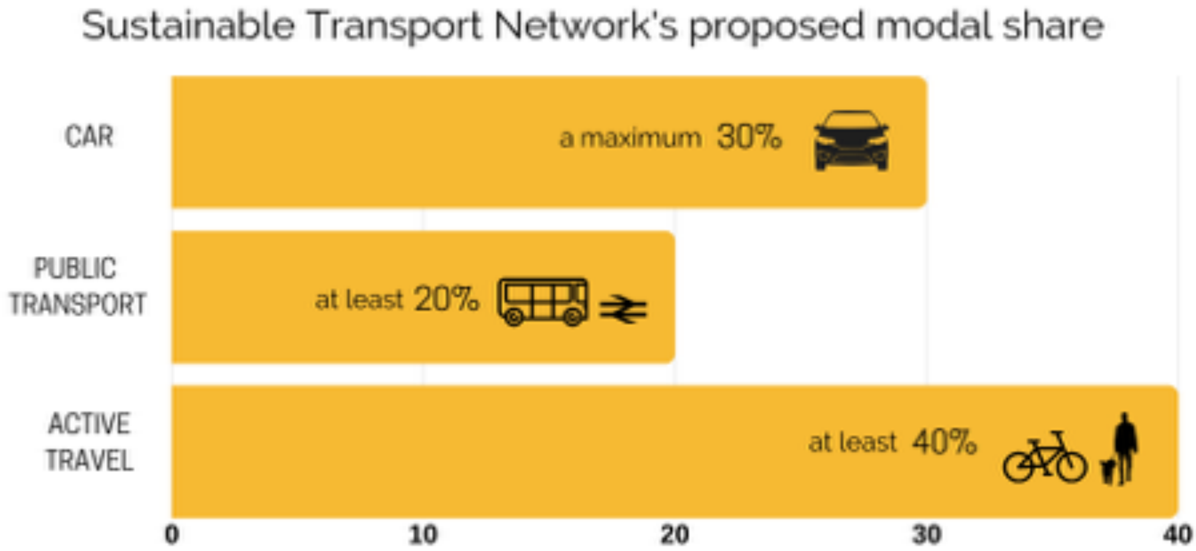
Bristol residents strongly support improving public transport and reducing congestion. In the Bristol Transport Strategy Consultation (BCC, 2019b), over 80% of respondents agreed with both of the following policy suggestions:

- 'Encourage the use of sustainable modes and embed a sustainable transport ethos'
- 'Make space and improve safety for movement by sustainable modes'.

In the Bristol Quality of Life report (BCC, 2019a), the top ranked issues in 2017 and 2018 were as follows:

- 'Improve Buses and/or Public transport'
- 'Reduce Congestion'.

In order to progress to a more sustainable transport system there needs to be a shift in the way that people in Bristol travel. The Sustainable Transport Network (STN) is a group of transport organisations with a 'vision for an integrated and sustainable transport network that can be shared by all' (STN, 2019). In order to instigate more urgent action for transport, the STN proposed a modal share to achieve net zero carbon emissions for transportation in Bristol by 2030:



The present report was commissioned to support with evidence the Sustainable Transport Network's current targets. In December 2019, the Centre for Sustainable Energy (CSE), with Ricardo and Eunomia, produced a report titled **"Bristol Net Zero by 2030: the Evidence Base"** (Roberts et al., 2019). The report establishes the road transport emissions reduction that is required for Bristol to reach net zero by 2030. In doing so, CSE shows that it is necessary to reduce car mileage, but does not discuss how this impacts modal share. This report builds upon CSE's evidence base in order to assess STN's objectives and establish the modal shift that is required.

Project aims and research questions

The following research questions are addressed in this report:

- Are the STN modal share predictions accurate?
- What modal shift is needed to reach net zero emissions in the transport sector?
- Can Bristol get to the modal share required? And if so, how?
- What might Bristol look like in 2030?

The aim of this project is to provide an evidence base for the modal share required by 2030, in the context of population growth. The provision of a stronger evidence base for modal share is necessary to inform decisions about transport in Bristol and to build an understanding of the scale of change that is required. Case studies of strategies employed by cities that have achieved the desired modal shift are discussed to supplement this evidence base. These form the basis of the final recommendations made in this report.

4. METHODOLOGY

Data analysis and modelling

Primary data sources were utilised to assess whether the STN modal share objectives are realistic. The following steps were taken:

1. Calculate estimated **emissions for all transport** to 2030 to illustrate the required change
2. Calculate a **baseline for current transport modal share**
3. Estimate **required modal share for 2030**

Emissions for all transport

The predicted emissions with no intervention were calculated by extrapolating trends of 2005-2017 emissions data from the Department for Business, Energy and Industrial Strategy (2019). This assumes a linear trend up to 2030.

This was employed as a counterfactual to CSE results, which show that an **88%** reduction in road transport emissions is required to achieve "virtually net zero transport emissions by 2030" (Roberts et al., 2019). An 88% reduction is considered possible with a **'Balanced Scenario'**; this entails both a 48% net reduction in car mileage through modal shift and the conversion of the remaining vehicle fleet to Ultra Low Emission Vehicles (ULEVs).

Railway emissions are not included in the CSE analysis, but modal shift entails increasing the number of rail journeys. There are expansion plans on the network and electrification of railways in Bristol is not expected by 2030[2]. Therefore, it is assumed that railway emissions will increase according to current trends.

Baseline for current transport modal share

To understand the modal shift that will be required, a baseline for transport modal share was derived, using data from the Department for Transport (DfT) (DfT, 2019a, 2019b, 2020a), the Office of Rail and Road (2020) and Sustrans (2020). This was necessary as there is no current data for modal share across *all journeys* in Bristol.

Travelwest produces an annual Travel to Work Survey that provides modal share data for commuting journeys and the DfT publishes regional commuting data. However, commuting journeys represent only **27%** of all journeys made in the UK (DfT, 2018).

Therefore, commuting data represents a minority of travel, and more importantly, over-represents certain groups in the sample while others are underrepresented. It is likely to disproportionately represent travel patterns of men aged **25-64,** who are most present in the labour force, thus excluding many journeys by women, children and older people (ONS, 2020).

The baseline was constructed using the most recent and relevant data available for each mode: buses and trains (public transport) and cycling and walking (active transport). The data was used to provide an estimation of the following for the current period, for each considered mode:

- **Total miles** travelled per year in Bristol
- **Average journey** length per 'journey'
- **Total journeys** travelled per year in Bristol

These were then collated to estimate modal share by percentage of all journeys travelled per mode.

Required modal share for a net zero 2030

The modal shift required is established by taking the required car mileage reduction as a proxy for the transference of journeys to other modes. By calculating the mileage that needs to be shifted from cars, the associated increase in journeys for other modes was calculated based on their relative average journey lengths. The results are not intended to be definitive, but rather to illustrate the relative levels of modal shift required.

The CSE results show car mileage needs to *total* 568 million miles to reach net zero. To calculate the *reduction* that this represents, a counterfactual of car mileage in 2030 without a modal shift is required. Regen (2019) predicts a 3.8% increase in car mileage resulting from a 13% increase in the city's population by 2030[3] . This is added to 2020 mileage data in order to provide the desired counterfactual.

In order to assess the STN modal share objectives, the threshold values for 2030 were inputted into calculations to assess whether there is sufficient uptake in mileage for non-car modes. If there are miles unaccounted for, the modal share objectives are insufficient to attain the 'balanced scenario' car mileage requirement.

Assumptions

A number of assumptions had to be made due to data scarcity and the number of different data types being used. Motorcycles and other alternative forms of transport are not included in the modal share analysis. For the emissions estimates, it was assumed:

[2] Only 2% of the railways were electrified between 2017-18 and 2018-19 (Office of Rail and Road, 2019a). Also see Shirres (2019).

- Active Transport has net-zero carbon emissions.
- Buses are 100% ULEV by 2030**;** considered carbon neutral.
- Rail passenger emissions will not decrease, assuming railways in Bristol won't be electrified by 2030.
- Decarbonisation of the national grid by 2030.

It is assumed that the average journey length for each mode does not change. This is predominantly due to the fact that there is insufficient data to incorporate a more sophisticated assumption. This would require:

- Sufficient origin-destination data for journeys travelled in Bristol. This data would open up the potential for modelling journey transfers, more detail for which journeys could be shifted to which modes and target development for most used routes.
- An incorporation of variation in journey types, lengths of journeys per mode, or variation in modes**.**

If journey lengths change, the percentage modal shift recommended may also change. Some average journey lengths are likely to change more than others if the suggested modal shift is achieved. While the number of car journeys will fall, for example, shorter car journeys are more likely to be replaced with public or active transport than longer ones.

It is also assumed that before modal shift, mileage for non-car modes remain static and are the same in 2030 as they are in 2020. Due to population growth, all mode mileage would most likely increase and thus is taken to not impact the feasibility of meeting targets.

Limitations

This research has enabled conclusions to be made and the STN modal share targets to be assessed. However, it is not without limitations. Finding data for all journeys has been challenging. This analysis has exposed the lack of relevant data available and a large number of different variables required to assess modal shift.

The most recent available data for each mode was collected between **2017-2020**. The results therefore provide a best estimate at modal share distribution in Bristol for the current period. The average journey length for cars, buses, trains and walking are all for an urban conurbation in the UK, as this data is unavailable for Bristol specifically. It was not possible to distinguish between driver and passenger and so there is minor risk of double counting car journeys. It was also not possible to account for journeys by multiple modes. Average journey length data is from the DfT and Sustrans. These datasets may have different data collection methods and sample sizes.

3 This was calculated using 2016 projections

This research built on much of CSE’s analysis. Therefore the net zero proposed has to reflect the net zero in their report, which is as close to zero as is deemed feasible.

There is little data available on train journeys within Bristol and therefore it is difficult to assess an accurate average journey length. The average journey length for trains in the available data is 20 miles (DfT, 2019b). However, this is likely to be an overestimation as the greatest distance between stations *in* Bristol is ~10 miles. In addition, the data which was used to estimate the baseline number of passenger journeys relied on estimations of entrances and exits from Bristol’s train stations. Attempts were made to contact the Transport Officer for trains at WECA but this was unsuccessful. This also represents a limitation from the Terms of Reference since a greater understanding of rail improvement plans in Bristol was expected from this interview.

An additional intention was to illustrate the counterfactual for the three modal shares. However, due to data scarcity the modelling was limited to only being able to provide **future estimates of miles for cars and was not possible for the other modes.**

5. RESULTS

Emissions for all transport

Transport emissions need to fall rapidly to reduce emissions by 88% required by 2030. This results in a ‘virtually net zero’ scenario of 68.4 ktCO_2e for all transport.

The scale of this required change is illustrated in *Figure 2* and *Figure 3*. The emissions shown include freight from rail and road, whereas this research is concerned with transport journeys only. Passenger travel currently accounts for almost 84% of rail emissions (ORR, 2019b) and an estimated 69% of road emissions (Roberts et al., 2019).

The current pathway for transport emissions until 2030 is illustrated in *Figure 2*. *Figure 3* Depicts the required change in transport emissions from 2020 to 2030 using data from the CSE analysis.

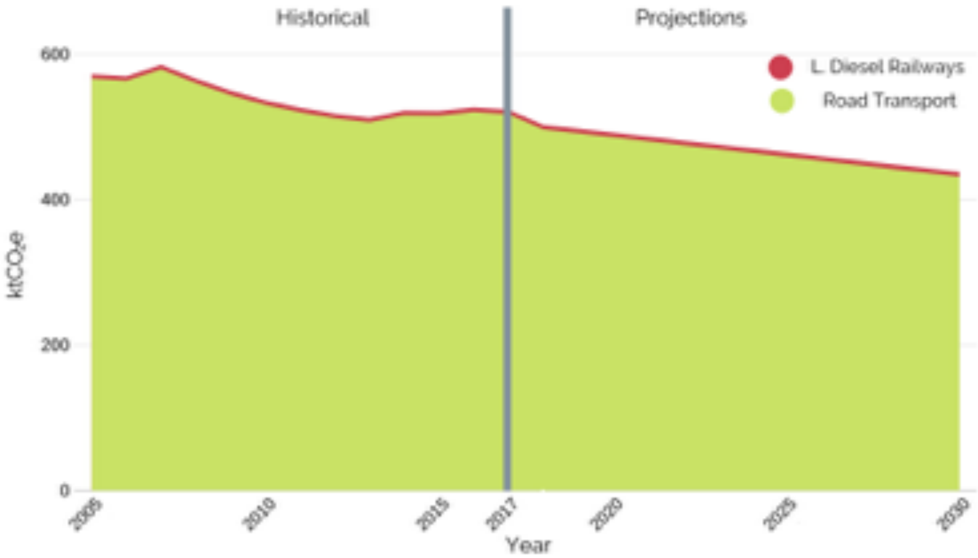


Figure 2 Transport emissions projections (2018-2030) based on historical emissions trends (2005-2017). Grey line indicates the year 2017 to distinguish historical data (DfBEIS, 2019).

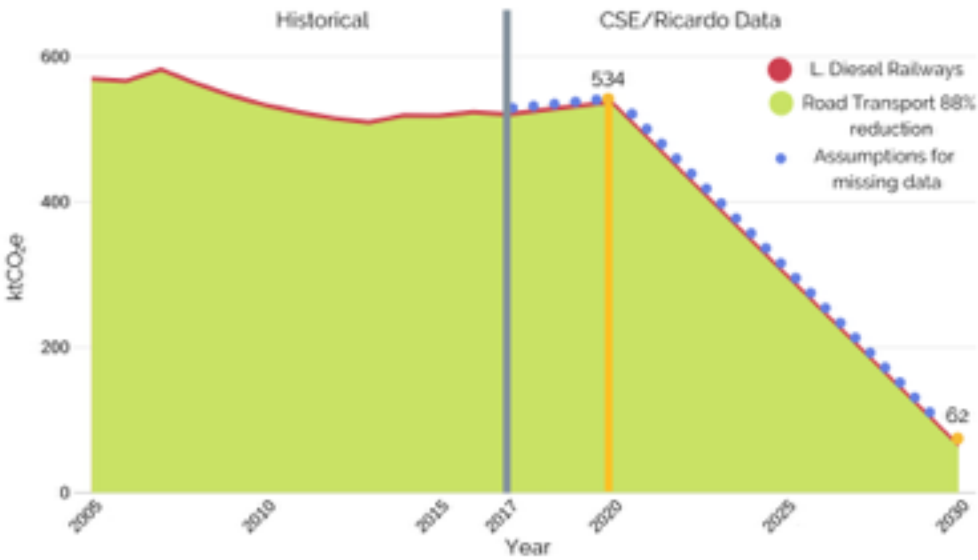
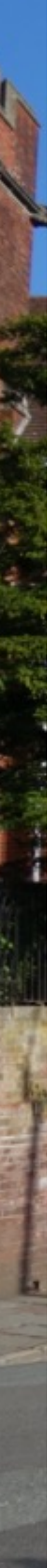
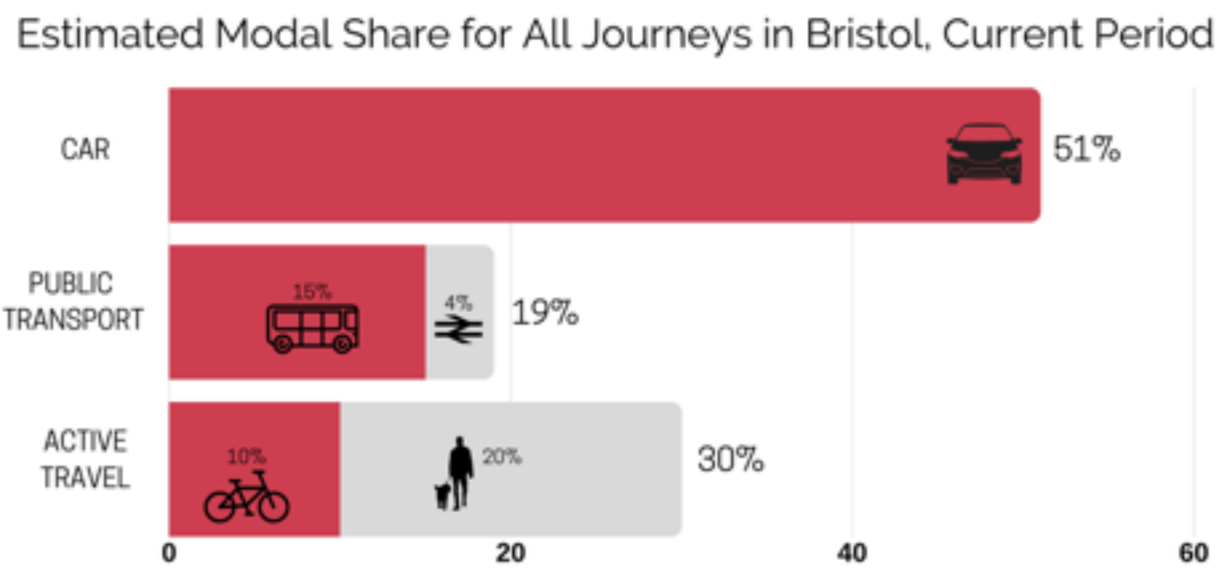


Figure 3 Historical transport emissions (2005-2016), projections for rail emissions (2018-2030) and data from CSE for road transport emissions in 2020 and 2030. Grey line distinguishes historical data (DfBEIS, 2019; Roberts et al., 2019).



Baseline for current modal share in 2020

The estimate of current transport modal share is presented below. Private vehicles dominate travel with 51% of journeys being made by car, followed by 30% by active travel and 19% by public transport. Existing data for commuting journeys depicts car travel as just 35% of the overall share, confirming the necessity of a modal share baseline for *all* journeys (Travelwest, 2019).



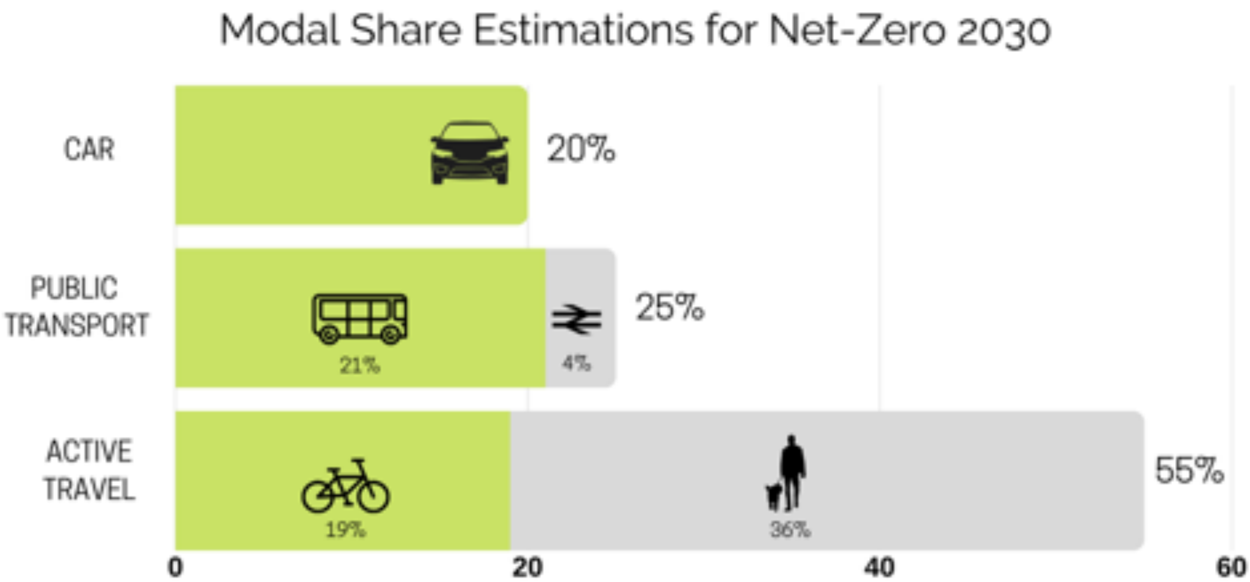
Required modal share for a net zero 2030

In order to achieve the 'virtually net zero' scenario, 551 million miles need to be shifted from cars to other modes; bus and train use, cycling, and walking must all increase to accommodate this. *Table 1* shows the assessment of the STN modal share targets and a suggested modal shift for achieving net zero.

The threshold results in Table 1 leave almost 200 million car miles unaccounted for. This means that reducing car travel to 30% of all journeys is not a sufficient modal shift. Therefore, the STN targets are insufficient.

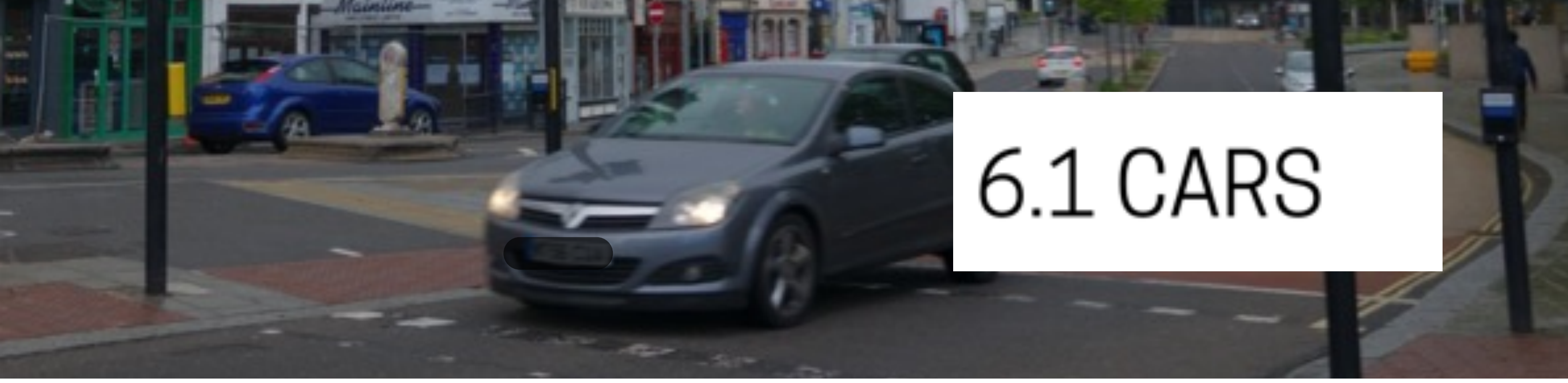
Mode	Cars	Buses	Trains	Cycling	Walking	*Total*
Counterfactual: No Modal Shift						
Total Miles per year (million)	1119	188	260	97	111	*1775*
% Share of Journeys	52 %	14 %	4 %	10 %	20 %	*100 %*
STN modal shift thresholds						
Total Miles per year (million)	568	228	519	169	99	*1583*
% Share of Journeys	30 %	20 %	10 %	20 %	20 %	*100 %*
Suggested Modal Shift for Net-Zero						
Total Miles (million)	568	377	312	242	277	*1775*
% Share of Journeys	20 %	21 %	4 %	19 %	36 %	*100 %*

The modal share distribution, accounting for all required shifts of car mileage, is proposed below. This is achieved by doubling bus mileage, increasing active transport mileage by 2.5 times, and increasing rail journey mileage by 1.2 times.



The results indicate that an upper threshold of **30%** for car journeys is **too high,** and that this should be lowered to **20%.** In this model, **suggested** targets for both active and public transport are higher than those proposed by the STN, at 55% and 25% respectively.

6. HOW TO GET THERE?



6.1 CARS

Reaching the required targets

Emissions from cars must be reduced to reach net zero emissions within the transport sector. Firstly, car travel must reduce by 551 million miles, to **20%** of journeys by **2030.** Secondly, Bristol must move away from fossil fuels and initiate a step change in the road vehicle fleet towards **ULEVs** (Roberts et al., 2019). The greater the reduction in emissions that can be reached through modal shift, the smaller the responsibility on electrification.

Improvements in fuel efficiency have caused a 5% decrease in car emissions since 1990, despite a **22%** rise in car traffic (UKERC, 2019). However, average emissions per mile for new cars have increased steadily, largely due to an increase in SUV sales (Ibid.). This illustrates the need for more specific policies to target the changing private vehicle market. It is important that the UK's **'Road to Zero'** strategy continues to pursue an approach that is focused on setting binding emission reduction targets, including fines for non-compliant manufacturers (EU, 2019; DfT, 2019c).

BCC's proposals to reduce car use in Bristol include the implementation of a Clean Air Zone (**CAZ**) in 2021, the pedestrianisation of the Old City, and piloting low traffic neighbourhoods. These schemes are intended to reduce air pollution, encourage active transport, and make more street space available (Dudd, 2020b). The forecasted success of these strategies is supported by data showing that **40%** of commuting car journeys are less than 2km, and could be undertaken by active transport (Travelwest, 2020a).

Case studies in reducing car use

Congestion charging: Stockholm

Congestion charges were introduced in Stockholm in 2006 as a way to reduce traffic, and therefore congestion and travel time variability (Börjesson et al., 2012). Traffic across the toll cordon was reduced by **22%**, leading to considerable congestion reductions (Eliasson, 2014). An original exemption for alternative-fuel cars stimulated the market introduction; the share of alternative-fuel cars increased from 3% in 2006 to **15%** in 2009 (ibid.). Cost-benefit analysis results are detailed in ***Figure 4.*** Similar results were witnessed within the London Congestion Charge, with private car use falling by **34%** (Leape, 2006). The Stockholm case study demonstrates the feasibility of congestion charging in a similarly sized city to Bristol, and its implementation in London proves that there are no legal barriers to implementing such a scheme in the UK.

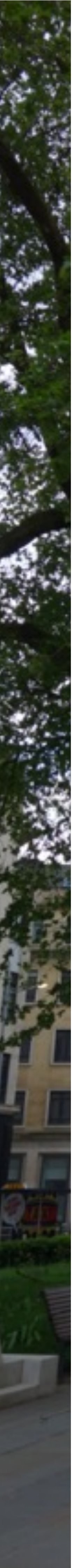


Figure 4 : Cost benefit analysis of Stockholm's congestion charge

Case Study
Workplace Parking Levy (WPL) in Nottingham

In 2012, Nottingham City Council introduced a WPL, which levied charges on occupied private non-domestic off street parking places (Dale et al., 2017). The WPL acts as both a demand management strategy and raises funds for transport developments. The WPL faced opposition from employers and the Chamber of Commerce initially. However, working with businesses proved successful and in 2015/16 the levy raised £8.8 million in revenue (Dale et al., 2017). The WPL effectively reduced congestion and reduced carbon emissions from transport to the lowest of all core cities. 8.6% of surveyed commuters changed their behaviour in part due to the WPL (Dale et al., 2019).

The schemes within the case studies were introduced in response to severe congestion, similar to that experienced in Bristol, and have all resulted in notable improvements. Although introducing policies similar to those mentioned above offers no guarantee of achieving the same results, key successes should be considered as part of a car reduction strategy in Bristol.

Electrification of the transport sector

The UK Government is investing close to £2.5 billion to aid motorists' transition towards ULEV, aiming for the electrification of 90% of the car fleet by 2030 (Roberts et al., 2019). Bristol has adopted programmes to generate a shift towards ULEVs. Go Ultra Low, for example, is supporting capacity building for Electric Vehicles (EVs) and activities aimed at improving their popularity (Michalec et al., 2019). The Committee on Climate Change has called for policies to accelerate the transition to ULEVs, including grants towards their higher purchase costs, adjustments to company car tax, and additional charging infrastructure (Hopkinson and Sloman, 2019). While these measures are necessary, there are risks associated with focusing primarily on incentives, as Norway's experience suggests.

Case Study
Incentives to increase ULEV ownership in Norway

Norway has facilitated rapid EV uptake. ULEVs accounted for over 45% of new vehicle sales in Norway in 2018, and at the present growth rate, ULEV market share will reach 100% by 2025 (Chen et al., 2020). This was predominantly driven by attractive incentives and policies. However among purchasers of ULEVs, public transport for commuting decreased from 23% to 6%, whilst car-mode share increased from 65% to 83% (Højklint and Hansen, 2017). This experience suggests that a greater balance between ‘pull’ and ‘push’ measures is required to ensure that EV uptake is not prioritised to the detriment of more sustainable transport modes (Halvorsen and Frøyen, 2009).

This case study suggests that incentives must be thoughtfully constructed so as not to encourage undesirable growth in car ownership. One way to achieve this would be for grants to be replaced by trade-in rebates (Bauer, 2018). Alongside ULEV incentives, the government could propose economic support for public transport tickets and EV club membership or e-bikes in exchange for scrappage of high-emission vehicles. Even if all new car sales are ULEVs in 2030, around 40% of the fleet will still be conventional petrol and diesel vehicles (Hopkinson and Sloman, 2019). Therefore the need to reduce emissions from conventional vehicles remains.

Assessments by National Grid indicate that the EV transition is unlikely to present a risk to the security of national electricity supply (BEISC, 2018). Adverse impacts are more likely to be experienced on distribution networks. The cost of managing these impacts can be reduced through smart charging, with vehicle-to-grid technologies potentially offering further future savings (Falahati et al., 2016).

Likelihood of meeting the required targets

It should be possible for Bristol to achieve a 20% modal share in car travel if some of the strategies mentioned above are considered and if lessons are learned from other cities that made a similar transition. It is critical to target shorter journeys that can be easily undertaken by other modes, particularly short journeys that could be undertaken by active transport. There has been a noticeable increase in licensed ULEV ownership within Bristol, which suggests that BCC’s policies and strategies are effective. The licensed number of ULEVs increased from 188 in 2012, to 3,875 in 2019 – a 1961% increase in uptake (DfT, 2020b). Bristol must continue to implement ambitious policies to improve ULEV uptake to be able to meet the target of an almost entirely ULEV fleet. However, such policies must be matched by efforts to facilitate modal shift.

6.2 PUBLIC TRANSPORT

Buses

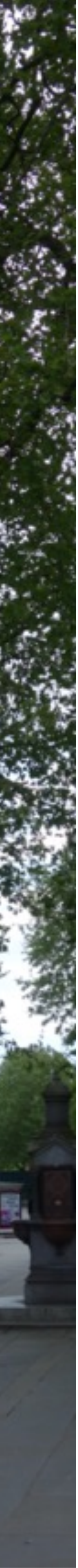
Reaching the required targets

The modelling has projected that the modal share of bus journeys in Bristol needs to increase from **15% to 21%** between 2020 and 2030. While this is ambitious, it is broadly supported by current trends and the growth potential of policy already agreed between BCC and local bus operator, First Bus.

The Greater Bristol Bus Network experienced a **54%** increase in passenger numbers between 2012/13 and 2018/2019, against the backdrop of a national trend of declining bus use (BCC and First Bus, 2019). This growth has been attributed to a number of measures implemented by both BCC and First Bus, including the introduction of residential parking zones and the reduction and simplification of bus fares (BGCP, 2019). Bus satisfaction among passengers in Bristol has remained high, reaching 89% in 2017 (Travelwest 2020a). However, in both 2017 and 2018, when Bristol residents were asked what action or change would most improve quality of life in Bristol, the most commonly raised issue was the improvement of buses and public transport (BCC, 2019a). This demonstrates that investment in improved bus infrastructure is both effective and popular.

Building on this success, BCC and First Bus have recently agreed a landmark partnership agreement called the Bus Deal, the aim of which is to achieve **20%** peak-time modal share for buses by **2031.** The central tenet of this partnership is agreement by First Bus to double the peak frequency of buses on key radial corridors into the city. This is proceeding in response to commitment from the council to **invest in bus priority** schemes which should improve bus punctuality and speed, and reduce variability in journey times (BCC and First Bus, 2019).

Evidence for the effectiveness of bus priority measures can be seen in the increase in bus ridership following the introduction of the T1 Thornbury-to-Bristol route. This replaced a non-prioritised route and created a year-on-year mean increase in weekly passenger numbers of more than **60%** in the months following its introduction, with multiple weeks showing more than **100%** increases compared to the previous year (Freeman, 2020). First Bus are initially testing the doubling of peak service on a route which has the highest passenger numbers, but the worst performing in terms of reliability (ibid.).



BCC is developing further park and ride facilities which should encourage those travelling from outside the city to take alternative transport into the centre (BCC and First Bus, 2019).

First Bus has taken significant steps towards reducing vehicle emissions, by investing in a biogas fleet. The buses are considered “carbon neutral,” because they are powered by **bio-methane** which has been produced through the anaerobic digestion of food waste that would otherwise have gone to landfill (Freeman, 2020). The introduction of carbon neutral biogas buses will make a significant contribution to reducing Bristol’s transport emissions. Biogas buses also contribute **less to harmful air pollution** than their electric equivalents. Their PM10 emissions are lower, as they are between **1.5 and 3 tonnes lighter,** and therefore wear tires less quickly. First Bus intends to have an entirely biogas fleet by 2030 (Ibid.).

Trains

Reaching the required targets

This model has predicted that there needs to be a 20% increase in train journeys in the next ten years for trains to comprise the same modal share as today, of 4%. This could be deemed a conservative estimate, given WECA’s MetroWest plans to extend the region’s rail network. However, as the extension is predominantly taking place outside BCC’s borders and there has been little information outlining a timeline for completion, it is assumed that modal share of train journeys will not increase markedly by the end of the decade. Most rail users are commuters (DfT, 2018a) and commuting journeys only make up a limited number of total journeys.

Case study

Increasing public transport use in Freiburg

The city of Freiburg in Germany offers an example of how a significant increase in modal share for public transport can be achieved in a short time period, similar to what is required in Bristol. Between 1983 and 1995, public transport ridership in Freiburg more than doubled, causing an increase in modal share from 11% to 18% (FitzRoy and Smith, 1998).

As well as consistent investment in a high quality transport infrastructure comprising trams and buses, the integration of the regional ticketing system is credited with much of the success of the public transport sector. A low-cost travel card can be used on all public transport in the region and is transferable between people. A pass holder can take another adult and up to 4 children for free on public transport on Sundays and public holidays, and tickets for major events also serve as tickets for public transport. These features encourage leisure as well as commuting journeys to be done without a car (VAG, 2020). This ticket integration was achieved without the municipal transport company suffering any long-term damage to their operating deficit (FitzRoy and Smith, 1998).

Investment in public transport in Freiburg was supported by disincentives for car use, such as 30kph speed limits, extensive city centre pedestrianisation, and high costs for parking (FitzRoy and Smith, 1998). Both trams and buses are fast and reliable, as they are given priority at intersections and run at very regular intervals during rush hour (ICLEI, 2018). It is important to note that public transport use in the city would likely be even higher if bike journeys had not also nearly doubled between 1982 and 1999, from 15% to 27% of total journeys (City of Freiburg, 2016).

There are a number of parallels between Bristol and Freiburg, including that Freiburg is a university city and has sought to be a national leader in sustainability. However, there are some key differences which may limit Bristol's ability to replicate Freiburg's transport development:

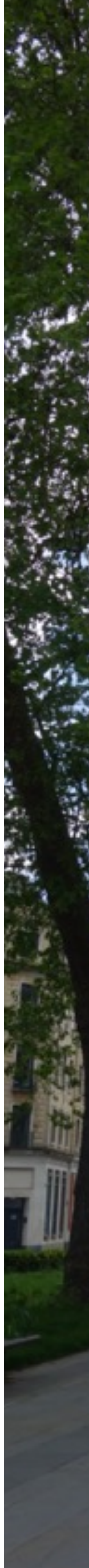
- In Bristol, the transport system is managed across multiple **fragmented forms of authority**, including private transport operators. This may lead to challenges in long-term planning or promoting integrated, low-cost transport across operators and throughout the region.

- **Limiting car use** in the city centre, including by pedestrianisation, was key to making public transport more attractive to those travelling to and from Freiburg. Consistent delays to the CAZ in Bristol indicate a lack of prioritisation of these measures.

- Freiburg has a very different **topography** to Bristol. Freiburg is very flat, which makes investment in trams and bicycles more attractive.

Likelihood of reaching the required targets

A **25%** modal share for public transport by 2030 is considered feasible and necessary. Modal shift from cars to carbon neutral buses, particularly for longer journeys, is key to reducing Bristol's emissions. The successful implementation of the Bus Deal is essential to reach a **21%** modal share for buses. BCC must follow through on commitments to introduce extensive bus prioritisation measures and park and ride facilities to ensure this is achieved. While it is hoped that trains will extend their modal share, **maintaining a 4%** share is considered a realistic estimate in the absence of more detailed information about the impact of MetroWest within the city's boundaries.



6.3 ACTIVE TRAVEL

Reaching the required targets

The modelling in this report suggests that **55%** of journeys should be made by active transport to ensure Bristol reaches its carbon-neutral goal. Currently, walking accounts for 20% of journeys in the city, and cycling accounts for 10%. It is estimated to achieve the target, these proportions need to increase to **36% and 19%,** respectively. These proportions have been chosen based on popularity of walking over cycling and the current accessibility of each mode. However, if cycling infrastructure is prioritised in the coming decade, cycling is likely to comprise more than 19% of journeys by 2030. Modelling for this report only considered walking and cycling, but micro-mobility may play an increasingly important role in active transport moving forwards. In particular, WECA's upcoming e-scooter trial could have lasting impacts on Bristol's transport landscape (Hern, 2020).

Bristol is taking significant steps towards making the city more accessible. Key streets in the city centre are being pedestrianised, and a CAZ is expected to be implemented in **2021,** which will limit some vehicle traffic entering the city (BCC, 2020). These measures are likely to discourage driving in the city centre, and provide more pleasant and safe public space for pedestrians. In Copenhagen, the pedestrianisation of the main shopping street, Strøget, led to a **35% increase in pedestrian** volumes within a year, demonstrating how effective making space for people can be in encouraging active transport (Gehl, 2013).

In the WECA region, **40%** of commuting car journeys are **less than 2km,** a distance that could be walked in less than half an hour (Travelwest, 2020a). WECA's Local Walking and Cycling Infrastructure Plan proposes funding more than **£400 million** worth of projects to improve infrastructure across the region, aiming to make active transport the preferred choice for short journeys (Travelwest, 2020b).

This can be facilitated through improved walkability, which involves developing connectivity between places, fostering a diversity of businesses within neighbourhoods, and increasing housing density (Boer et al., 2007; Lo, 2009). Improvements in safety, particularly promoting accessible paths and traffic calming measures, are effective in increasing pedestrian activity (Southworth, 2005). BCC is trialling the introduction of low-traffic neighbourhoods, modelled on a successful programme in Waltham Forest, London (Dudd, 2020b). An average weekly increase of **32 minutes of walking and 9 minutes of cycling** per person has been recorded in these neighbourhoods (Aldred et al., 2019).

Introducing low-traffic neighbourhoods may play a particularly important role in encouraging active travel among children, as **47%** of parents in the UK cite traffic danger as a reason for not allowing children to walk to school alone (DfT, 2014). Additionally, only **15%** of Bristol's residents consider cycling safety for children to be good, limiting the number of everyday journeys that will be taken by bike (Sustrans, 2020).

Cycling has gained increasing popularity in Bristol in recent years. It is estimated that the number of cycling journeys in the city doubles approximately every **8 years** (Sustrans, 2018). In 2019, 28% of Bristol residents cycled at least once per week; a **7.6%** increase from 2018 (BCC, 2019a). There is also a significant appetite for cycling in the city among non-cyclists, with **23%** of residents saying that they do not currently cycle but would like to (Sustrans, 2020).

There are a number of barriers to cycling in Bristol which need to be addressed to increase the number of journeys in the next decade. Research by Sustrans suggests that 69% of Bristolians think cycling is unsafe**,** and there is a lack of inclusivity in cycling infrastructure. Only **7%** of residents over the age of 65 cycle once a week, in contrast to **39%** of people aged 26-35 (Sustrans, 2020). In the Netherlands, **24%** of journeys by those over the age of 75 occur by bike, demonstrating that older people will use active transport if the appropriate infrastructure and policies are in place (Pucher and Dijkstra, 2000). This age group may particularly benefit from programmes to expand electric bike ownership and use (Johnson and Rose, 2015). Women in Bristol are half as likely to cycle as men, but **30%** of women who do not currently ride a bike would like to, and a majority cite safety as the major barrier to starting (Sustrans 2018). This demonstrates that there is significant latent potential for increasing cycling in Bristol, which could be activated if appropriate infrastructure is provided for all who wish to cycle.

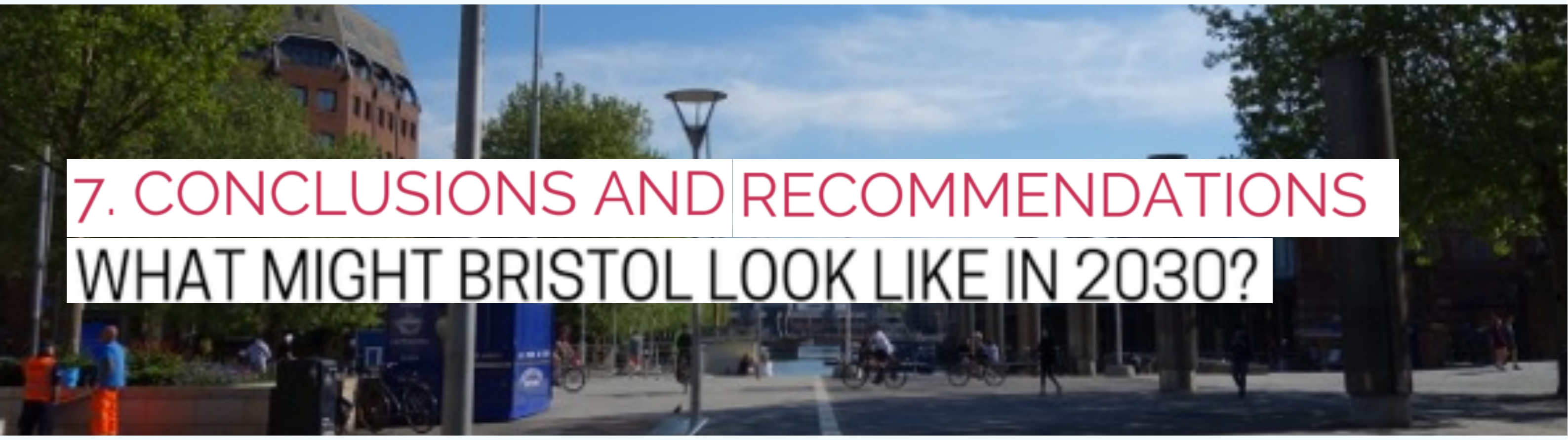
Improving active transport could provide numerous co-benefits for Bristol's economy and society, positively contributing to air quality, public health, and the local economy (Sustrans, 2020). Across England, inactivity costs approximately **£450 million** to the NHS (Travelwest, 2020b). Cycling and walking benefit both mental and physical health, with cycling alone saving the NHS an estimated **£1.5 million per year** in Bristol (Sustrans, 2020). Active travel also contributes positively to the local economy as connections between people and sources of employment and local business increase (Travelwest, 2020b).

Case Study
Increasing active transport in Amsterdam

In the 1970s, Amsterdam faced a similar conflict to that which faces Bristol today: a high modal share for cars set against increasing environmental awareness. Through the implementation of effective transport policies, Amsterdam experienced a modal shift to **36% cycling and 23% walking** by 2015 (Nikitas, 2019). Two types of policies facilitated this change: i) 'carrot' policies advocate cycling by developing cycling lanes and expanding bicycle parking facilities; ii) 'stick' policies indirectly encourage cyclists by decreasing car parking, continuing taxes on petrol and car purchases, and governing low density sprawl (Pucher & Buehler, 2008). De Boer and Caprotti (2017), suggest that to replicate Amsterdam's successful cycling uptake, policy must address the **reputation of the bicycle**, solely as it exists in opposition to car culture. Its image must be transformed to reflect its accessibility, flexibility, and most importantly inclusivity - while also providing adequate cycling infrastructure.

Likelihood of meeting the required targets

The transport strategies produced by BCC and WECA demonstrate an understanding that **inclusive and safe active travel infrastructure** is required to increase its uptake (Travelwest, 2020b). The introduction of low-traffic neighbourhoods, extensive pedestrianisation, and improved bicycle infrastructure are all steps in the right direction for increasing active travel. However, greater coordination is needed to ensure that more ambitious strategies are effectively and quickly implemented. Advocacy groups have suggested that the proposed strategies need to be supported by more specific planning to set and meet active transport goals (Travelwest, 2020b). This is challenging as transport plans struggle to get funding, particularly for long-term projects. Policymakers must therefore **prioritise funding active transport.** BCC and WECA are promoting the right strategies, but **lack of coordinated planning and funding** may limit their ability to execute them.



7. CONCLUSIONS AND RECOMMENDATIONS

WHAT MIGHT BRISTOL LOOK LIKE IN 2030?

The initial STN modal share estimates are not ambitious enough for Bristol to reach its **net zero goal by 2030**. From the results of this research, the modal share required to reach the transport emissions targets should be:

- A **maximum of 20%** of journeys by cars
- A **suggested 25%** by public transport (21% bus, 4% train)
- A **suggested 55%** by active transport (36% walking, 19% cycling)

A significant shift to active and public transport and a transition to ULEVs is required to reduce car travel emissions and overall mileage. Achieving a **21%** modal share for **buses** by 2030 is considered realistic, provided that the Bus Deal receives the necessary support. Additionally, the MetroWest extension will likely increase the number of train journeys, maintaining the current modal share. Active transport should be prioritised during planning, as it is where the greatest modal shift is required and investment provides numerous co-benefits. **Pedestrianisation and traffic reduction** plans in the City Centre, with safer and better-connected infrastructure and low traffic neighbourhoods, may encourage Bristolians to cycle and walk more. **Micromobility** may also contribute to an increasing modal share for active transport, but the impact of these technologies is unknown.

There are barriers to making the changes required in Bristol. Significant **funding gaps and inconsistency in transport responsibility** in recent years have meant progress has often been slow. Now that funding and transport planning for the region are under the combined responsibility of WECA, more strategic changes may be implemented. There are also social barriers to walking and cycling which must be addressed, particularly those which limit the inclusiveness of active transport.

Bristol has the potential to achieve its 2030 transport emissions targets and reap co-benefits for improving quality of life. There are multiple plans, strategies, and task forces that exist with the passion and motivation to transform the city. However, **improved coordination and collaboration are needed**. Meeting the proposed goals will require those in charge to build the collective **political will and resources** to put these plans into action and source adequate funding.

What will Bristol look like in 2030?

Bristol's transport landscape will be radically transformed by 2030 if it meets these ambitious targets. There will be a proliferation of effective and joined up **cycling and walking infrastructure** which is safe enough to **encourage** use by people of all ages and abilities, with micromobility solutions offering greater access to active transport. This is likely to lead to greater levels of health and **well-being** among the city's population. Congestion and air pollution will fall as a result of a shift to non-car modes and initiatives such as the CAZ. Car share schemes and EVs will mean further emission reductions and fewer cars on the road. Bus prioritisation will result in an increase in ridership and improved confidence in the effectiveness of the bus system. In 2030, Bristol could be working towards a light rail mass transit system. It is appreciated that this would require an investment up to **£4 billion** (BCC 2019c), but it would help solidify any progress made on modal share changes and contribute further to a higher percentage of journeys being made by public transport, instead of cars.

Recommendations

1. Effective modal share data

More data for journey lengths and improved origin-destination data is required to provide accurate estimates for the expected shift of modal use. A key recommendation is to **employ data collection and analysis** specifically related to modal share as this will enable more informed and effective planning. In Manchester, there is a rolling household survey examining travel behaviour. This informs transport policy and provides a measure of how travel behaviour changes in response to population and transport investment (TfGM, 2020). It is recommended that a similar scheme is adopted in Bristol. The Bristol Transport Strategy calls for the implementation of '**modal shift monitoring'** (BCC, 2019c) as a data source for measuring many of the objectives; what is being proposed here would provide the data required.

2. Implementation of disincentives for driving

Car reduction schemes need to be implemented without further delay. Case studies of Nottingham, Stockholm and London have shown these to be successful in reducing congestion and emissions. These schemes can also provide funding earmarked for public and active transport infrastructure. The CAZ has now been delayed three times (Rees, 2020). The biggest priority with modal shift is switching use away from cars to other modes and thus **there need to be increased disincentives for driving and more incentives for walking, cycling and taking public transport**. There is widespread support in Bristol for safer streets; the majority of residents express a desire to reduce the levels and speed of traffic in neighbourhoods and to increase space for active travel (Sustrans, 2020). This illustrates that there is great potential for incentives, such as better quality infrastructure for active travel and introducing low-traffic neighbourhoods.

3. Creating a more inclusive active transport infrastructure

If Bristol is going to achieve a 55% modal share for active transport by 2030, walking and cycling must be made more accessible. Safety concerns appear to be the most significant barrier to increased uptake of walking and cycling. **Building more connected, segregated cycling infrastructure and introducing more low-traffic neighbourhoods are likely to improve safety and facilitate a shift to more active modes, particularly among women and children**. Cycle training programs and organised social rides may also encourage cycling uptake. It is important to note that many cities that have been successful in encouraging active transport, such as Amsterdam and Copenhagen, are quite flat. Bristol's hilly topography presents an additional challenge. We may need to consider complementary micromobility solutions. E-bikes, for example, may comprise a greater proportion of the city's bicycle fleet than they do in the cities discussed. However, these technologies come at a higher cost than traditional bicycles, and may be prohibitively expensive for many residents. Introducing a local financing scheme, particularly one which incentivises people to replace a car with an e-bike or cargo bike, could play an important role in making active transport more inclusive.

4. Collaborative, long-term planning

Our research revealed the 'patchwork' approach to the funding of cycling and walking infrastructure in Bristol. To respond to the piecemeal availability of funding, the local government needs to have long-term plans, ordered by priority and phased to reduce disjointed pathways and cycleways. This will require **coordination between all transport stakeholders in the region, particularly WECA, BCC, and members of the Sustainable Transport Network**. Input from the active transport sector will be particularly important, given the modal shift to walking and cycling which is required by 2030. The interdependency of transport modes also needs to be considered, with all modes taken into account when implementing change. The opportunities that arise from bus prioritisation and the Bus Deal could be considered alongside improvements for cycle lanes, for example. The plans put in place for active transportation need to be as robust as for buses.

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9. APPENDICES

Transport Emissions							
		Road Transport Total			L. Diesel Railways		
Year	Point	Actual Value	LoBF value	Residual	Actual Value	LoBF value	Residual
Historical: ktCO2							
2005	1	566.252	567.045	-0.793	5.966	6.026	-0.06060994
2006	2	563.243	561.619	1.624	5.909	6.043	-0.13356158
2007	3	578.934	556.194	22.740	6.135	6.060	0.0752688
2008	4	559.926	550.768	9.158	6.121	6.076	0.04445232
2009	5	543.350	545.343	-1.993	6.136	6.093	0.0432148
2010	6	529.933	539.917	-9.984	6.184	6.109	0.07508792
2011	7	519.941	534.492	-14.550	6.093	6.126	-0.03330772
2012	8	511.800	529.066	-17.266	6.192	6.143	0.04943507
2013	9	506.269	523.641	-17.371	6.142	6.159	-0.01713894
2014	10	515.698	518.215	-2.517	6.240	6.176	0.06457193
2015	11	515.276	512.790	2.486	6.224	6.192	0.03139095
2016	12	520.347	507.364	12.983	6.163	6.209	-0.0463303
2017	13	517.359	501.939	15.420	6.137	6.226	-0.08821909
Trendline:		y= -5.4255x +572.47			y=0.0166x + 6.0097		
R^2:		R^2 = 0.7343			R^2 = 0.4758		
Projections: kt CO2 + error							
2018	14		496.513			6.2421	
2019	15		491.0875			6.2587	
2020	16		485.662			6.2753	
2021	17		480.2365			6.2919	
2022	18		474.811			6.3085	
2023	19		469.3855			6.3251	
2024	20		463.96			6.3417	
2025	21		458.5345			6.3583	
2026	22		453.109			6.3749	
2027	23		447.6835			6.3915	
2028	24		442.258			6.4081	
2029	25		436.8325			6.4247	
2030	26		431.407			6.4413	

Data: (DfBEIS, 2019)

Bristol Net Zero by 2030: The Evidence Base - CSE, Ricardo and Eunomia (Roberts et al., 2019).		
	Baseline 2020	Balanced Scenario
Total CO2 emssions (ktCO2e)	534	62

Data Sources by mode and use						
Mode	Data	Purpose	Source	Year	Location	Additional Information
Cars	Total Mileage	Modal share estimation	Ricardo	2020	Bristol	
	Average Journey Length (Miles)	Modal share estimation	DfT, NTS9910	2017/18	Urban Conurbation, UK	*
Bus	Number of passenger journeys on local buses	Total journey mileage estimation	DfT, BUS0109a	2018/19	Bristol, City of	Derived from DfT PSV survey
	Average Journey Length (Miles)	Modal share estimation	DfT, NTS9910	2017/18	Urban Conurbation, UK	*
Trains	Entries & Exits in Bristol Stations	Total journeys estimation	ORR, Estimates of Station Usage	2018/19	Bristol Stations	Estimated by Steer
	Average Journey Length (Miles)	Modal share estimation	DfT, NTS9910	2017/18	Urban Conurbation, UK	*
Cycling	Total Journeys	Modal share estimation	Bike Life, Sustrans	2019	Bristol	From: local cycling data, modelling and an independent survey (conducted April-July 2019) of 1,440 residents aged 16 or above in Bristol
	Total Mileage	Modal share estimation	Bike Life, Sustrans	2019	Bristol	
Walking	Proportions of Adults that Walk, by frequency	Total journeys estimation	DfT, CW0303	2017/18	Bristol, City of	Walking' refers to any continuous walk over 10 minutes
	Population	Total journeys estimation	ONS, mid-year population estimates	2018	Bristol, City of	
	Average Journey Length (Miles)	Modal share estimation	DfT, NTS9910	2017/18	Urban Conurbation, UK	Walk includes all travel on foot. It is also used when respondents ride in non-motorised wheelchairs, prams or pushchairs, as well as when they ride on toy bicycles, roller-skates, skateboards, non-motorised scooters, or when they jog. For example, children who accompany their parents on a visit to the shops on toy bicycles/tricycles (where the parents are walking) are coded as having walked there*

***NTS9910, DfT**: Two survey years combined, e.g. 2017 and 2018. The results presented are weighted. The survey results are subject to sampling error.

Summary of Data and Calculations				
Mode	Journeys per Year	Miles per Year	Average Journey Length (miles)	Calculations
Car		n/a	7.3	Miles per year dependent on scenario. Journeys per Year calculated by: x = (Miles per year)/(Average journey length)
Bus	42,800,000		4.4	Miles per year calculated by: x = (Journeys per year)*(Average journey length)
Train	12,954,348		20	Entries and exits used as journeys per year. Miles per year calculated by: x = (Journeys per year)*(Average journey length)
Cycling	29,600,000	96,700,000		Average journey length calculated by: x = (Miles per year)/(Journeys per year)
Walking			1.9	Journeys per year calculated using walking frequencies and 2018 population data - see below**

Empty cells indicate where no raw data was used, but calculations instead using other raw data instead.

**Calculations for Walking Data in Bristol						
	Once per Month	Once per Week	Three times per week	Five times per Week	Never	Total
CW303, DfT Data						
Cumulative % of people	83.3	75.3	48.4	34.3		

Additional Calculations						
% of People	8	26.9	14.1	34.3	16.7	100
Frequency in days per year	12	52	156	260	0	
Percentage of Bristol Population***	37072.4	124655.9	65340.1	158947.9	77388.6	463405.0
Number of Trips	444868.8	6482109.1	10193056.4	41326457.9	0	**58446492.2**

***Population ONS 2018 mid year population estimate for Bristol, City of = 463405

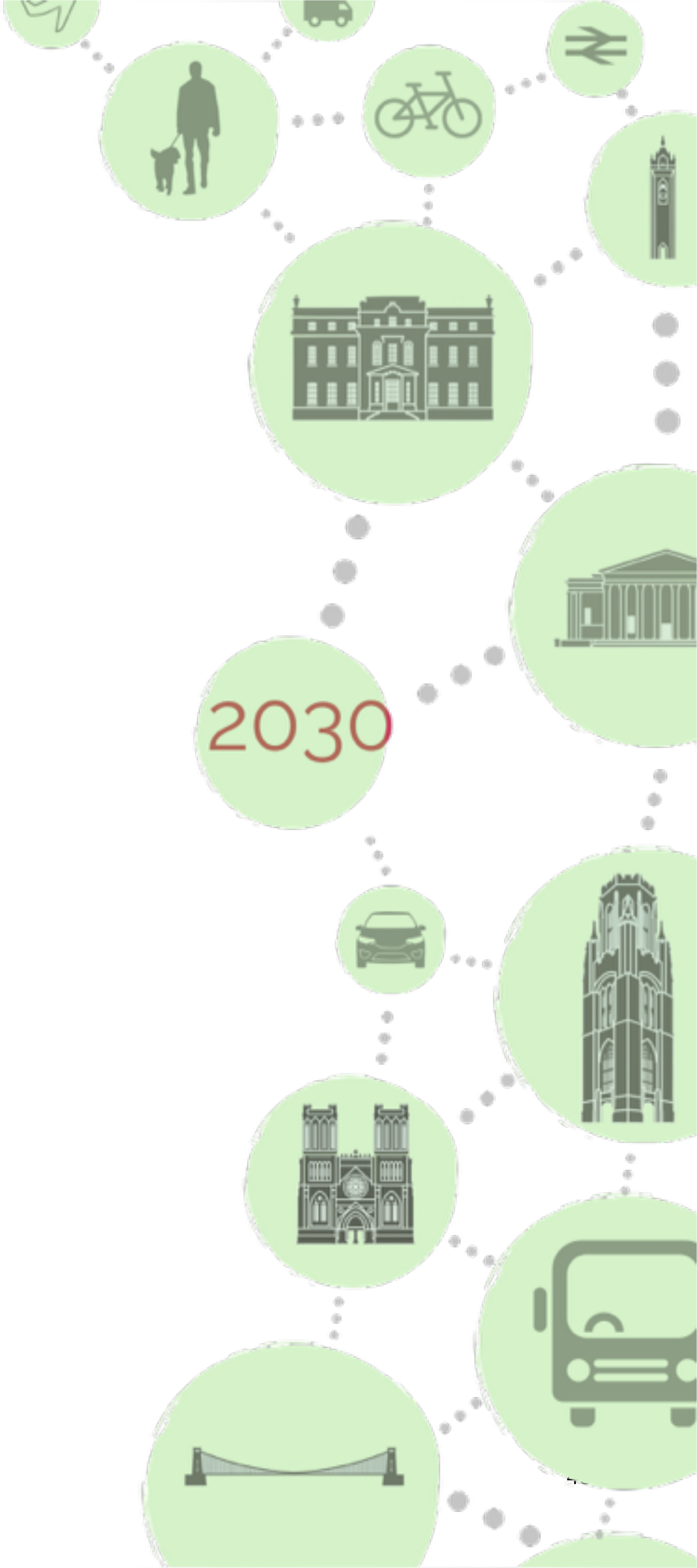
Models for % share of journeys — All figures rounded to 3dp

"Current Period"						
Mode	Cars	Buses	Trains	Cycling	Walking	TOTAL
Total miles per year (million)	1078.000	188.320	260.000	96.700	110.960	1733.980
Average miles per journey	7.300	4.400	20.000	3.267	1.900	
Journeys per year (million)	147.671	42.800	13.000	29.600	58.400	291.471
% share	51%	15%	4%	10%	20%	100%

2030 Baseline: population increase no mode shift						
Mode	Cars	Buses	Trains	Cycling	Walking	TOTAL
Total miles per year (million)	1119.000	188.320	260.000	96.700	110.960	1774.980
Average miles per journey	7.300	4.400	20.000	3.267	1.900	
Journeys per year (million)	153.288	42.800	13.000	29.600	58.400	297.088
% share	52%	14%	4%	10%	20%	100%

2030 Balanced Scenario: Sustainable Transport Network's Objectives (threshold values)						
Mode	Cars	Buses	Trains	Cycling	Walking	TOTAL
Total miles per year (million)	568.000	228.237	518.721	169.461	98.557	1582.977
Difference	-551.000	39.917	258.721	72.761	-12.403	-192.003
Average miles per journey	7.300	4.400	20.000	3.267	1.900	
Trips (million)	77.808	51.872	25.936	51.872	51.872	259.361
% share	30%	20%	10%	20%	20%	100%
Comment	STN is insuffcient as does not give enough modal shift. Difference needs to total ~0 to account for reduction in car miles					

2030 Balanced Scenario: Most feasible and sufficient share						
Mode	Cars	Buses	Trains	Cycling	Walking	TOTAL
Total miles per year (million)	568.000	376.640	312.000	241.750	277.400	1775.790
Difference	-551.000	188.320	52.000	145.050	166.440	0.810
Average miles per journey	7.300	4.400	20.000	3.267	1.900	
Trips (million)	77.808	85.600	15.600	74.000	146.000	399.008
% share	20%	21%	4%	19%	37%	100%
Comment	Sufficient for car mileage reduction: Miles are in excess but close to 0.					


2030