





Achieving low carbon and sustainable transport systems in Yorkshire and Humber

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1 Introduction

- 1.1 JMP Consultants Ltd and the Stockholm Environment Institute (SEI) York Centre at the University of York were commissioned by the Yorkshire and Humber Regional Assembly to provide, examine and evaluate what measures would be needed to achieve a reduction in carbon dioxide emissions from transport in the Yorkshire and Humber region to meet regional targets. This level of reduction in carbon dioxide was initially outlined in the Yorkshire and Humber Assembly report *Evaluating the contribution that key regional strategies make towards addressing climate change*¹ in what is known as the *Stabilising Carbon Trends Scenario*.
- 1.2 This work has been undertaken by examining the changes in patterns of travel behaviour that can be achieved through the implementation of best practice transport interventions, and modelling the carbon impact of such changes in behaviour using the REAP (Resource and Energy Analysis Programme) model. The commission has focused on assembling a number of scenarios of **practical, deliverable measures within the scope of regional transport policy** that will deliver a reduction in the emissions of carbon dioxide from transport across the region. Crucial to an understanding of the level of change required within transport policy in the region to achieve low carbon transport systems is the suite of transport interventions modelled. These are highlighted in Chapter 4 of this report.
- 1.3 This follows a brief contextual outline of current thinking on global climate change, to be found in Chapter 2, together with what this means for the Yorkshire and Humber region, and how regional strategies are seeking to address climate change. The chapter concludes by outlining the importance of carbon emissions from transport in the region and the need to tackle these transport emissions.
- 1.4 Chapter 3 includes a brief outline of the modelling approach used in this research, and Chapter 4, as noted above, explains the interventions used within the scenarios that have been modelled. Chapter 5 outlines how these transport interventions were packaged for the purposes of modelling.
- 1.5 Chapter 6 highlights the results of this modelling, including a brief explanation of the significance of modelled carbon emissions from aviation.
- 1.6 Finally, chapter 7 highlights the results of the research, and draws some headline conclusions.

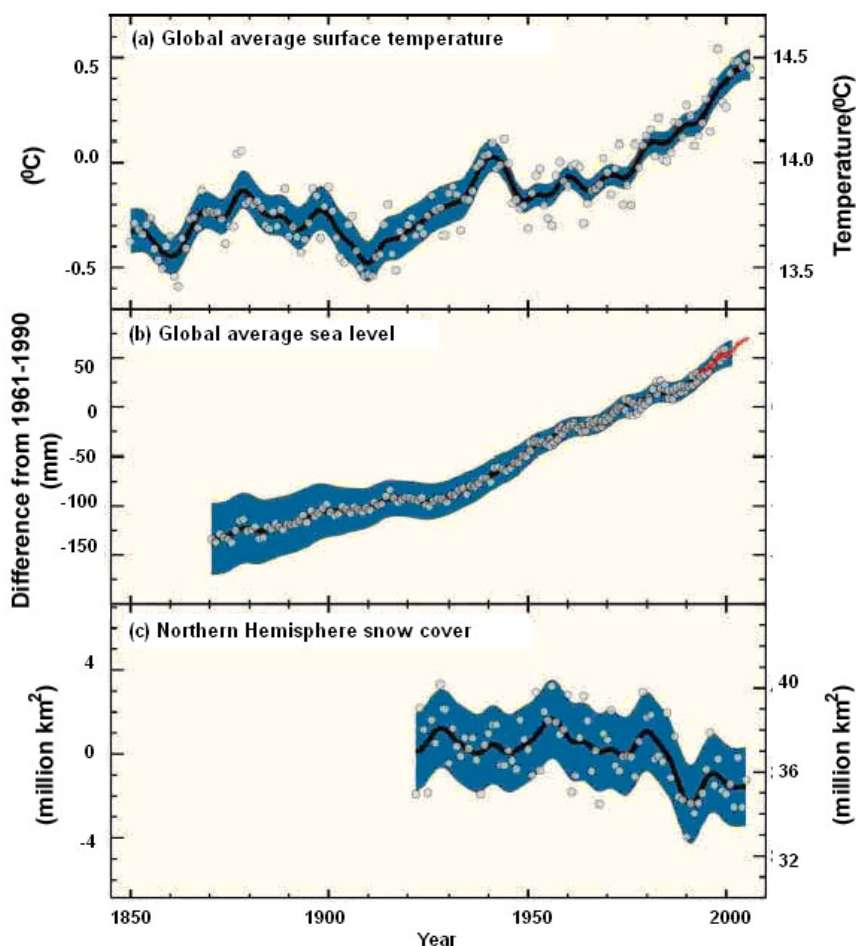
¹ Arup, SEI and Cambridge Econometrics (2007) *Evaluating the Contribution that Key Regional Strategies Make Towards Addressing Climate Change*, Yorkshire and Humber Assembly

2 Climate change

Global context

- 2.1 Climate Change is considered to be one of the greatest challenges that the world faces today. The increasing use of fossil fuels such as oil, coal and gas since the industrial revolution, over 200 years ago, is the main source of greenhouse gases (GHGs) such as carbon dioxide (CO₂). Once emitted, these gases stay in the atmosphere and add to the natural 'greenhouse effect'. They make the blanket of gases surrounding the earth thicker, which leads to heat being trapped. As a result, the planet is beginning to warm up and our climate is starting to change.
- 2.2 The global average surface temperature has increased by approximately 0.74°C (1.3°F) since 1906. Most of the warming over the last century has occurred in recent decades². The majority of the world's scientists now agree that it is at least 90 per cent certain that emissions of GHGs resulting from human activity, rather than natural variations, are warming the planet's surface³.
- 2.3 The figure below shows with clarity the changes in global climate indicators over the last 150 years.

Figure 2.1 Indicators of climate change



² Intergovernmental Panel on Climate Change (2007) Fourth Assessment Report, Climate Change 2007: Synthesis Report, IPCC

³ Ibid

2.4 The effects of global climate change are becoming ever more evident. The Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment⁴ of the evidence for climate change showed that:

- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level;
- Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases;
- Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70 per cent between 1970 and 2004;
- Global atmospheric concentrations of CO₂, methane (CH₄) and nitrous oxide (N₂O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years;
- Most of the observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. It is likely there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica);
- Anthropogenic warming over the last three decades has likely had discernible influence at the global scale on observed changes in many physical and biological systems;
- There is high agreement and much evidence that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades.

2.5 The IPCC predict an increase in global temperatures of 1.8 - 4°C (3.2 - 7.2°F) by the end of the century⁵. These temperature rises will affect the climate system and lead to an increase in the frequency and intensity of extreme weather as well sea level rise, which is expected to have adverse effects on natural and human systems.

Climate change in Yorkshire and the Humber

2.6 An assessment of how climate change will affect the Yorkshire and Humber region, based on UK Climate Impacts Programme (UKCIP) future climate scenarios, suggests that the region will be 1°C to 2.3 °C warmer by the 2050s and 1.6 °C to 3.9 °C warmer by the 2080s⁶. This warming will occur throughout the year; however the greatest rises will be in the summer months, with a rise of up to 2.9 °C in the Humber Estuary by the 2050s under a high emissions scenario. This warming will be accompanied by wetter winters and drier summers. The findings suggest that summers will be drier throughout the region and, along with drier springs and autumns, will lead to a reduction in average annual rainfall of between 10 and 20 per cent.

⁴ Ibid

⁵ Ibid

⁶ WS Atkins, SEI, The Met Office(2002) Warming up The Region: The Impacts of Climate Change in the Yorkshire and Humber Region, Environment Agency, Yorkshire Forward, Yorkshire and Humber Assembly and Government Office for Yorkshire and Humber

- 2.7 The climate will change significantly by the 2050s and dramatically by the 2080s. The major changes by the 2080s include⁷:
- Increases in sea level of between 6cm and 82cm, with the greatest rates of rise in the Humber Estuary under the high emissions scenario;
 - An increase in high rainfall intensities during the winter across the region, causing urban flooding problems in Bradford and other cities;
 - Increases in the number of very hot days throughout the region with the greatest impact in large cities such as Leeds away from the coast;
 - An increase in the length of the growing season by between 45 and 100 days along the Yorkshire and Lincolnshire coasts.
- 2.8 The main impacts of climate change are likely to be related to changing extreme events. The most notable changes for the 2080s based on medium-high emissions scenario include⁸:
- A fourfold increase in the frequency of “wet” winters with 60 per cent more rainfall than average (1961-1990);
 - A fourfold increase in the frequency of a “dry” summer with 50 per cent less rainfall than average (1961-1990);
 - Hot, “1995” type summers nearly every year rather than once in a hundred years.
- 2.9 Changes in future climate will interact with future social and economic changes and other factors to shape the Yorkshire and Humber region over the next 50 years. The potential impacts of climate are likely to be a range of positive and negative impacts on flood risk, water resources, agriculture, forestry, the service sector, industry and commerce and transport⁹.
- 2.10 The Stern Review (2006) showed that a 10–20 year window exists to reduce GHG emissions and stabilise the atmosphere, albeit at a level already associated with significant risks. The review estimated impacts associated with climate change could rise to 20 per cent of GDP or more if action is not taken. In contrast, the costs of action – reducing GHG emissions to avoid the worst impacts of climate change – can be limited to around 1 per cent of global GDP each year¹⁰.

Evaluating the contribution that key regional strategies make towards addressing climate change

- 2.11 A challenge for regional policy makers is to deliver a consistent and co-ordinated approach which not only addresses climate change now but one which yields results in the long term. A previous study commissioned by the Yorkshire and Humber Assembly in 2007, *Evaluating the contribution that key regional strategies make towards addressing climate change*, evaluated the impact of current regional strategies in tackling both production related GHG emissions (i.e. production and delivery of goods and services consumed in and outside the region) and consumption related GHG emissions associated with goods and services consumed in the region (including goods imported

⁷ Ibid

⁸ Ibid

⁹ Ibid

¹⁰ Stern, N. (2006) *The Stern Review on the Economics of Climate Change*, HM Treasury

to the region). It evaluated the approaches that current regional strategies take towards the need to adapt to a changing climate.

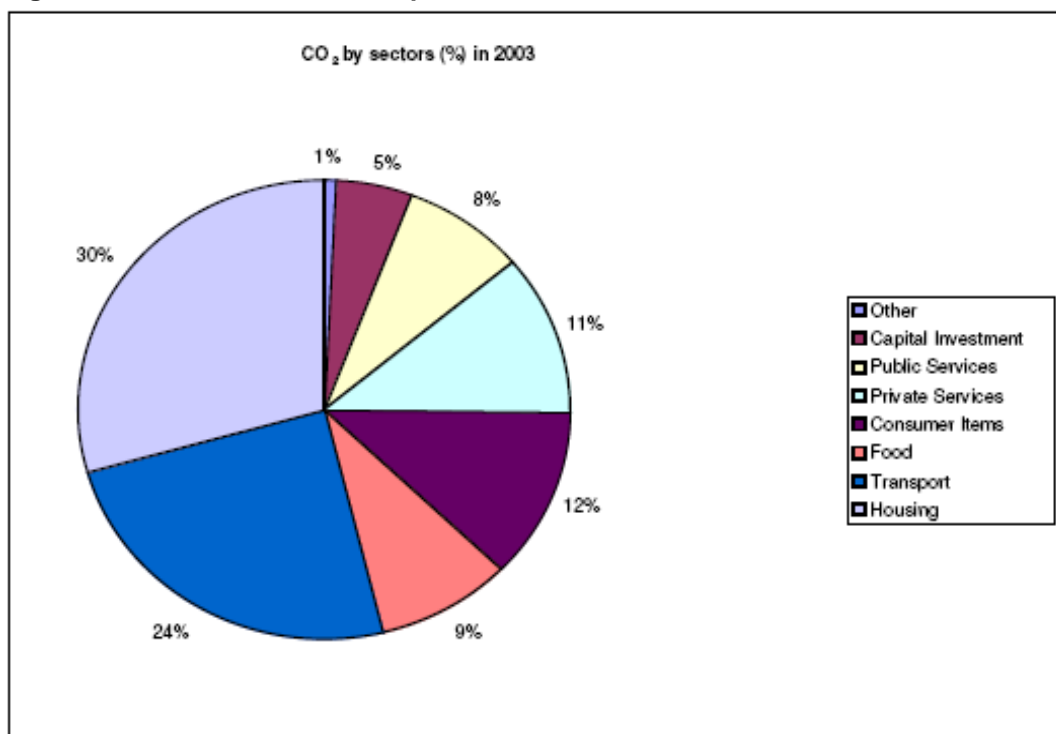
- 2.12 This study examined the impact that current regional strategies will have on reducing both production and consumption related emissions up to 2021. It considered a *Baseline Scenario* (i.e. what would happen in the absence of regional strategies) and a *Vision Scenario*, this being the impact on carbon emissions of current regional strategies in achieving outcomes in terms of economic development and housing provision within the region. It used the following regional GHG emissions targets used to show whether the desired reduction of emissions is likely to be achieved:
- 20% reduction in 1990 levels of greenhouse gases by 2010;
 - 25% reduction in 1990 levels of greenhouse gases by 2015.
- 2.13 The study found that current regional strategies will be able to achieve stability in production related GHG emissions up to 2021. However, this will not be enough to meet a 20 per cent reduction in overall GHG emissions by 2010 and a 25 per cent reduction by 2015. With regard to consumption related emissions, current regional strategies are far from both stabilising and achieving a 20 per cent reduction in consumption related emissions by 2010 and 25 per cent by 2015. In the *Vision Scenario* consumption related emissions are projected to almost double between 2003 and 2021.
- 2.14 So, within the context of current regional strategies, consumption related emissions from housing, transport and food are set to continue increase up to 2021. To achieve the 80 per cent reduction in current emissions by 2050, significant reductions are required in each of the housing, transport and food sectors. In terms of the transport sector, effective measures include increasing vehicle occupancy rates, reducing GHG emissions from vehicles through technological advances, reducing the distance travelled per person, and achieving modal shift by transferring passengers from private car to public transport.
- 2.15 Implementing such measures will require a very different policy landscape to that which exists with regard to current regional strategies. The 2007 study considered a *Stabilising Carbon Trends (SCT) Scenario*, a hypothetical scenario that assumes that there would be no additional growth in aviation or consumption of consumables. This is challenging scenario which runs counter to the national agenda rather than being within the sphere of direct regional influence.
- 2.16 *The SCT Scenario* delivers a 35 per cent reduction in transport CO₂ emissions. The principal assumptions (or potential policy measures) behind this scenario included:
- Improved car efficiency to 2021;
 - Increasing car occupancy from 1.6 to 2.5 people per car;
 - A 35 per cent reduction in the total distance travelled;
 - Increasing modal shift.
- 2.17 It is worth noting that whilst the impact of these assumptions was modelled, no practical means of achieving this reduction were identified in what was, as noted earlier, a hypothetical scenario. It is the intention of this study to identify and test what practical means of achieving these levels of reduction might be.

- 2.18 The *SCT scenario* results in a reduction of 0.85 tonnes CO₂ per capita by 2021. Efficiency improvements alone will only deliver approximately 16 per cent of the overall reduction. The remainder requires behavioural change in terms of either the mode of transport used, or the distance travelled.
- 2.19 The *SCT Scenario* assumes a zero per cent growth in aviation. However, the *SCT Scenario* shows a relative increase in the contribution from aviation from 15 per cent in 2003 to nearer 25 per cent of total transport emissions by 2021.

The importance of tackling transport in addressing climate change

- 2.20 The 2007 Yorkshire and Humber Assembly report¹¹ identified that transport was one of the key contributors of GHG. The figure below, with transport being shown in the darker blue, illustrates the contribution that transport makes to carbon emissions in the region:

Figure 2.2 Contribution of transport to Yorkshire and Humber carbon emissions¹²

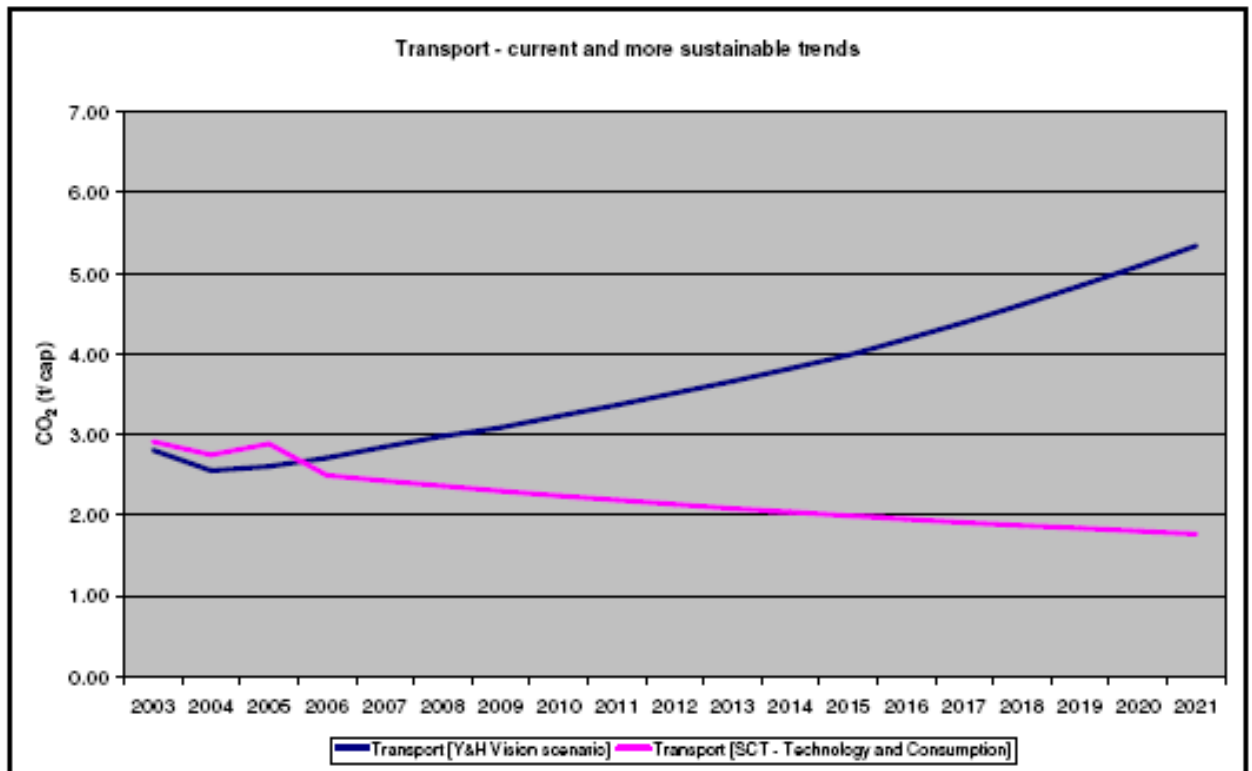


- 2.21 The importance of the transport sector identified in this earlier report, has led the Yorkshire and Humber Assembly wishing to understand the practical measures that can be taken in terms of regional transport policy that might help to reduce the level of carbon dioxide emissions resulting from the sector.
- 2.22 The 2007 report also separately identified the transport related emissions within both the *Vision Scenario* and the *Stabilising Carbon Trends (SCT) Scenario*. The figure overleaf eloquently expresses the scale of the reduction that this scenario postulated was required within the transport sector to deliver a low carbon future within the region.

¹¹ Arup, SEI and Cambridge Econometrics (2007) Evaluating the Contribution that Key Regional Strategies Make Towards Addressing Climate Change, Yorkshire and Humber Assembly

¹² Ibid

Figure 2.3 Contribution of transport to Yorkshire and Humber carbon emissions¹³



- 2.23 The research and modelling undertaken now by JMP and SEI seeks to identify practical, achievable transport policy interventions that can help deliver this *SCT Scenario* for transport, or at the very least close the diverging gap between the current “direction of travel” as expressed in the *Vision scenario*, and a future scenario that stabilises carbon emissions to a level that delivers regional and national target reductions in carbon emissions.
- 2.24 However, the scale of the challenge may in reality be even greater. The latest science¹⁴ suggests that even achieving reductions in carbon emissions in line with current national and regional targets, which approximate to the level of reduction needed to achieve the *SCT Scenario*, will be insufficient to achieve the reductions required to stave off the most serious effects of climate change. This suggests that the scale of the challenge facing all sectors, and especially transport, may be even larger than that outlined in agreed targets and the *SCT scenario*.
- 2.25 The recent United Nations Climate Change Conference in Bali in December 2007 highlighted the need for global action on climate change. This is encapsulated in the concluding remarks of the President of the Conference, His Excellency Mr. Rachmat Witoelar, in his closing address, Bali, 15th December 2007. Mr Witoelar noted that “the road from Bali to Poznan and Copenhagen must be paved not with good intentions but concrete actions and rigorous implementation”¹⁵.
- 2.26 This need for action at a global level, across all sectors, points the way for regions such as Yorkshire and the Humber, to tackle specific issues, in this case transport, now, and with purpose.

¹³ Ibid

¹⁴ IPCC (2007) Fourth Assessment Report, Climate Change 2007: Synthesis Report, IPCC

¹⁵ Closing statement by President of the Conference, Mr Rachmat Witoelar, UN Climate Change Conference 15th December 2007, Bali , Indonesia

3 Carbon emission modelling

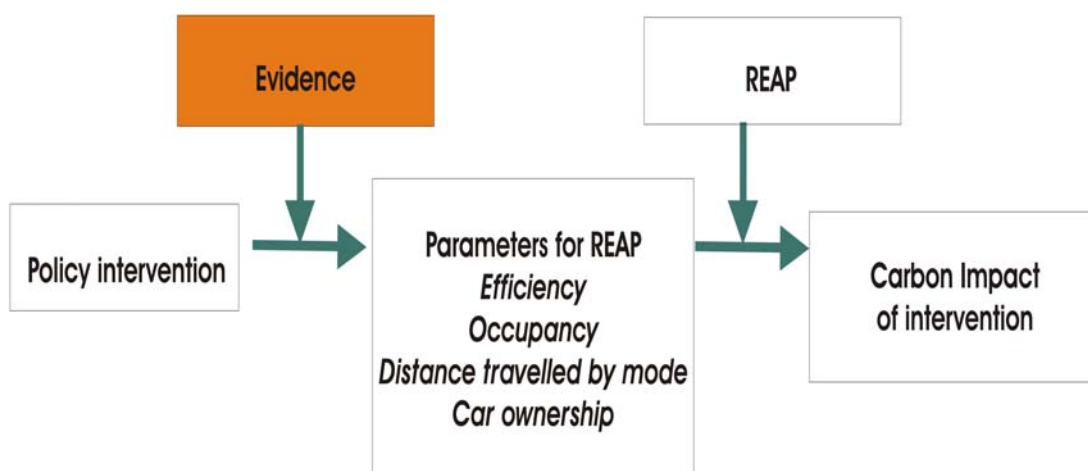
Approach to the modelling

- 3.1 Having established the scale of the challenge for the transport sector within the region, the research and modelling undertaken within this commission has focused on assembling a number of packages of ***practical, deliverable measures within the scope of regional transport policy*** that will deliver a reduction in the emissions of carbon dioxide from transport across the region. In simplistic terms, this has been undertaken through the researching of best practice examples of the scale of change that can be delivered through transport policy interventions. This change has been defined through the change of distance travelled by mode and the change in occupancy levels that can be achieved through particular measures. This data is then used to model the carbon impact of the interventions using the REAP model.
- 3.2 The Resources and Energy Analysis Programme (REAP) is a software tool developed by SEI, and can be used for the assessment, development and appraisal of the implementation of policy as well as a tool to formulate strategies for local, regional and national government. A fuller explanation of REAP and its workings is provided at **Appendix A**.

The key variables

- 3.3 The variables which are examined in REAP to influence the carbon output from transport include:
- Vehicle efficiency
 - Vehicle occupation
 - Distance travelled by mode (measured using Person KM per year by mode)
 - Car ownership

Figure 3.1 The modelling process



- 3.4 As this research is looking at the impact which can be achieved through regional and local transport and land use policies, the inputs for vehicle efficiency and car ownership (which are outside the scope of regional and local policy), have been projected using the national average

figures. For example, technological improvements in isolation, assuming the national average trend, result in a 14% reduction in carbon dioxide emissions from 2001 to 2020.

- 3.5 The remaining two variables, occupancy and distance travelled by mode, were the key inputs to REAP examined as part of this research. Distance travelled by mode is measured in annual person kilometres (PKM), namely the average number of kilometres travelled per person per year by mode. This is a function of average trip length, number of trips and population. Occupancy in REAP is a function of trips and capacity. The occupancy input into REAP is expressed as a proportion of the total capacity of the vehicle, for example if all cars were single occupancy vehicles then the input into REAP for cars would be 0.2.

Interventions modelled

- 3.6 This ability to examine the impact on carbon emissions of variations in the distance travelled by mode and vehicle occupancy allows the modelling of the effect of interventions designed to reduce travel distance, shift mode of travel away from the private car, and increase vehicle occupancy levels. In this way, the identification of practical, deliverable measures within the scope of regional transport policy to deliver a reduction in the emissions of carbon dioxide from transport across the region can be achieved.
- 3.7 These interventions, and their impact on carbon emissions from transport, are crucial to understanding the scale of the challenge in delivering low carbon transport systems in the future, and are described in the next Chapter.

4 Practical transport measures

Introduction

- 4.1 A crucial element of the modelling process, and therefore of the interpretation of the results of this study, is the identification of practical transport interventions that are available to the Yorkshire and Humber region. The evidence used within the modelling has focused on measures that have a proven record within a context broadly similar to the Yorkshire and Humber region, that is to say, can be delivered within the UK or similar contexts. For this reason many best practice examples of delivering behavioural change through reducing distances travelled and promoting mode shift from the car from outside the UK have not been used unless a suitable UK source was not readily available to derive inputs to the modelling, as the effects in the UK context may be different.
- 4.2 In this sense, the transport interventions modelled conform to the stated aim of the study, namely to identify **practical, deliverable measures within the scope of regional transport policy** that will deliver a reduction in the emissions of carbon dioxide from transport across the region. The interventions are practical and deliverable in the sense that they are based upon empirical evidence from best practice examples.
- 4.3 However, **the scale of delivery of such measures that has been assumed within the modelling far exceeds the levels of delivery of such measures in Yorkshire and the Humber to date**. No limits have been placed on the availability of the levels of resources or funding required for delivering this unified programme of transport investment across the region. The scale of investment and change modelled is therefore unprecedented. Nor have the interventions modelled been subject to adjustment to account for political or public acceptability.
- 4.4 The modelling undertaken does account for practicality in terms of where, spatially, measures are likely to be delivered. The proportion of the population likely to be affected by a particular measure in each district within Yorkshire and Humber has been identified. This forms a fundamental element of the modelling. Account has been taken of the different character of urban and rural areas. To ensure these measures were applied at an appropriate scale for each district, the districts were divided into three categories (city, town, rural) and the measures applied on a different scale for each category, which whilst necessarily broad for the modelling, give some spatial distinction to the research. Details of which districts have been included within each category can be found in **Appendix B**.
- 4.5 The practical transport measures modelled are as follows. A full explanation of data sources, the level of behavioural change including changes to distance travelled and mode shift, together with references can be found in **Appendix C**.
- 4.6 In Chapter 5, there is a full explanation of how the impacts of these measures have been combined into two future scenarios, which have been identified as the *Step Change scenario* and the “accelerated step change” or *Accelerated scenario* for short.

Bus Rapid Transit

- 4.7 The best practice case study used is from Dublin. The scheme consists of with-flow bus priority lanes, together with traffic signal priorities on nine radial corridors into the city. Additional measures include improved waiting facilities with real-time passenger information, an upgraded bus fleet with low-floor, air-conditioned vehicles, restrictions on parking on the priority routes and staff

trained in customer care. Over a six year period this reduced total person trips by car by 26%, and total person trips by bus increased by 61%.

- 4.8 Results were applied to all car and bus trips. In both future modelled scenarios, the impact of bus rapid transit was predominantly applied to city and town locations. This, for the future modelled “step change” scenario was on the basis of BRT being available to 50% of city populations and 40% of town populations in the period 2011-16, with a further 25% of city populations and 10% of town populations being able to access BRT in the period 2016-21. No BRT implementation was identified in rural districts. In the “accelerated” scenario slightly higher proportions in all areas were targeted.

Smartcard

- 4.9 The best practice case study used is from Belfast. The evidence relates to a smartcard scheme covering both concessionary and commercial tickets. The ticket machine data was made available for the same months in 2002 and 2003, which allowed a comparison before and after the smartcard scheme was introduced. Analysis of the data showed that smartcards contributed to an increase in patronage of around 2%.
- 4.10 Results were applied to all bus trips. In both future modelled scenarios, the impact of a regional smartcard system was applied to all locations for the whole population during the period 2011-16, with operation of the system continuing through the 2016-21 period.

Light Rail

- 4.11 Light rail systems currently exist outside London in Tyne and Wear, Manchester, Sheffield, Birmingham and Nottingham. Best practice using data from these systems made it possible to derive the average number of passenger journeys per kilometre of track. On average, on the light rail systems outside of London, there are 430,000 passenger journeys per year, per kilometre of track. On average, on the same networks, 17% of trips were previously made by car.
- 4.12 Results were applied only to the “accelerated” future modelled scenario in the period 2016-21, as follows:
- Leeds – 28km (length of proposed Supertram)
 - Hull – 20km (slightly less than Leeds assumed)
 - Sheffield – 3km (extension to current system)
 - Rotherham – 3km (extension to current system)

Rail Improvements

- 4.13 The best practice case study used is from West Yorkshire. The scheme consists of the Airedale electrification programme. As part of the baseline data collected to support the Yorkshire and Humber Route Utilisation Strategy, patronage growth data in West Yorkshire from 1996 – 2006 has been compared to growth on other “unimproved” lines. The data showed that patronage growth on the Airedale Line was 44% higher than on the other lines in West Yorkshire. Evidence from other studies suggests that new or improved fixed or quality public transport systems deliver a mode switch of 20% from car use.

- 4.14 Results were applied to the population of the area surrounding each railway station within each district to derive how much of the population in each district would be affected by electrification. In the future modelled “step change” scenario, the impact of rail electrification was predominantly applied to city and town locations. This was on the basis of rail electrification affecting 100% of relevant city populations and 50% of relevant town populations (those near a rail station) in the period 2011-16, with the remaining relevant town populations being able to access electrified services in the period 2016-21. In the “accelerated” scenario all relevant populations were identified as being able to access electrified rail services in the period 2011-16 onwards.

Workplace Travel Plans

- 4.15 The report *Smarter Choices - Changing the Way We Travel* refers to research detailing the reduction in car trips which may be achieved through workplace travel plans both in the UK and abroad of 6% - 25% depending on the measures contained within the plan. The *Guidance on the Assessment of Travel Plans* report suggests reductions in car trips from 3% - 30% depending on the measures implemented. The DfT *Making Travel Plans Work: Research Report* contains monitoring data from 21 best practise workplace travel plans from around the country, and this research gives an average reduction in car trips of 18%. A reduction of 20% for well implemented travel plans was therefore used as best practice. The average increase in public transport use from the *Smarter Choices* report was 148% and in car sharing was 33%.
- 4.16 Using data from the National Statistics *UK Business: Activity, Size and Location -2007*, the percentage of businesses with over 20 employees was calculated for each district. This percentage was then multiplied by the population of each district to find the number affected by the measure. The results were applied to car and bus commuting trips which then accounts for people in the population that do not work. Evidence identifies that 90% of workers can potentially be targeted, and this has been applied across the whole working population in the future modelled scenarios. For the “step change” scenario 45% of populations were assumed to be affected in the period 2011-16, with a further 45% of city populations in the period 2016-21. In the “accelerated” scenario, 90% were assumed to be affected from 2011-16 onwards.

Home Working and Teleworking

- 4.17 The best practice case studies used for this measure are from the Netherlands and Germany. In the Netherlands, teleworkers’ overall number of trips fell by 17% compared to the number of trips made before the teleworking began. In Germany, people who began teleworking reduced their trips by 19%. Hence 18% is used in the modelling. The research suggests that the potential for teleworking in the employed population could be 23 – 40%, and accounting for 7% of the working population already being at home, an average of 24% was adopted. Using Census and travel to work data this was applied to each district’s working population.
- 4.18 Results were applied to all trips by car, bus and rail (as the research applied to all trips made by teleworkers). The impact of teleworking was predominantly applied to town and rural locations as there is less potential for residents within the cities. For the “step change” scenario 50% of town and rural populations were assumed to be affected in the period 2011-16, with a further 50% in the period 2016-21. In the “accelerated” scenario, 100% of town and rural populations were assumed to be affected from 2011-16 onwards.

Travel Awareness and Education

- 4.19 Best practice case studies from York, Nottingham and Brighton suggested that sustained awareness campaigns could reduce car use by between 0.17% and 2.4% (an average of 1.3% used for modelling); and achieve bus passenger growth of 1.8% to 5% per year (4% growth was used for modelling).
- 4.20 Results were applied to all car and bus trips. In both future modelled scenarios, the impact of a travel awareness campaigns was applied to all locations for the whole population. In the “step change” scenario it was assumed half of the population would be affected in the period 2011-16, with the further half in the period 2016-21. In the “accelerated” scenario, 100% of the population was assumed to be affected from 2011-16 onwards.

Personalised Journey Planning

- 4.21 Best practice case studies from the UK suggest that on average, car driver trips reduced by 10%, car passenger trips reduced by 8% and public transport trips increased by 12% through the implementation of personalised travel planning projects.
- 4.22 Results were applied to all car and bus trips. The evidence suggests that 45% of households participate in this type of programme. In both future modelled scenarios, the impact of personalised travel planning was applied to all city and town locations for 45% the population. In the “step change” scenario it was assumed half of this, or 22.5% of the population would be affected in the period 2011-16, with the further 22.5% in the period 2016-21. In the “accelerated” scenario, 45% of the population was assumed to be affected from 2011-16 onwards, with a further 15% in the later period. Uptake in rural locations is assumed at a lower level.

School Travel Plans

- 4.23 The report *Smarter Choices - Changing the Way We Travel* details the effectiveness of school travel plans in reducing car use in several local authority areas in England. The report concludes that an 8-15% reduction in car use may be achieved in schools, so 12% was used in the modelling.
- 4.24 The School Travel Plan Co-ordinator for Yorkshire and Humber has advised that 64% of schools currently have travel plans. Hence the results were applied to the schools trips of the remaining 32%. In addition, the proportion of education trips made by bus with respect to other sustainable modes (walk, cycle, bus) was calculated, and an equivalent increase in bus use was applied. In the “step change” scenario it was assumed half of this relevant population would be affected in the period 2011-16, with the further half in the period 2016-21. In the “accelerated” scenario, the whole of the relevant population was assumed to be affected from 2011-16 onwards.

Grocery Home Shopping

- 4.25 The report *Smarter Choices - Changing the Way We Travel* details the effectiveness of grocery home shopping in reducing trips. Two studies in the report conclude that grocery home shoppers make on average, 3.5 fewer car journeys per month. Combined with National Travel Survey data, this equates to a 19% reduction in shopping trips.
- 4.26 Results were applied to car and bus shopping trips, with evidence suggesting that 15% of city and town populations could be affected. In the “step change” scenario it was assumed half (7.5%) of this relevant population would be affected in the period 2011-16, with the further half in the period

2016-21. In the “accelerated” scenario, the whole 15% of the relevant population was assumed to be affected from 2011-16 onwards. A much smaller proportion of rural areas was assumed to be affected.

Car Clubs

- 4.27 The report *Smarter Choices - Changing the Way We Travel* provides a summary of the growth in car clubs, their target market and the current scale and scope of car clubs both in the UK and abroad. Through a number of case studies, it was possible to calculate the average percentage reduction in annual car mileage per car club member. Furthermore Carplus has also carried out research into the reduction in car mileage which can be achieved through joining a car club. An average reduction per member of 30% was adopted in the model.
- 4.28 Results were applied to car mileage for all purposes, with evidence suggesting that 10% of city and town populations could be affected. In the “step change” scenario it was assumed half (5%) of this relevant population would be affected in the period 2011-16, with the further half in the period 2016-21. In the “accelerated” scenario, the whole 10% of the relevant population was assumed to be affected from 2011-16 onwards. A much smaller proportion of rural areas was assumed to be affected.

Car Share

- 4.29 The best practice case study used is from Milton Keynes and is primarily aimed towards commuters. The evidence identifies a 34% increase in car sharing amongst the 11,658 car drivers and passengers entering Milton Keynes in the peak hour before the scheme was implemented.
- 4.30 Results were applied to commuting car trips. In the “step change” scenario it was assumed half of the relevant population would be affected in the period 2011-16, with the further half in the period 2016-21. In the “accelerated” scenario, the whole of the relevant population was assumed to be affected from 2011-16 onwards.

HOV Lane

- 4.31 The best practice case study used is from Leeds. A High Occupancy Vehicle (HOV) lane was introduced on the A647 Stanningley Road and Stanningley By-Pass in 1998. The HOV lane is available to buses, coaches, other vehicles carrying 2 or more people, motorcycles and pedal cycles. Goods vehicles over 7.5T are not permitted to use the lane. The lanes operate in the morning and evening peak periods (07:00 – 10:00, 16:00 – 19:00) on Mondays to Fridays. Average car occupancy rose from 1.35 in May 1997 to 1.43 by June 1999 and 1.51 in 2002 (12% increase in total) and bus patronage increased by one per cent in the first year of operation.
- 4.32 Results were applied to car and bus commuting trips. In both future modelled scenarios, the impact of HOV lanes was predominantly applied to city and town locations. This, for the future modelled “step change” scenario was on the basis of HOV lanes being available to 50% of city populations and 40% of town populations in the period 2011-16, with a further 25% of city populations and 10% of town populations being able to access HOV lanes in the period 2016-21. No HOV lanes were identified in rural districts. In the “accelerated” scenario slightly higher proportions in all areas were targeted.

Mileage-based Road User Charging

- 4.33 The example used here is not best practice, but a theoretical study. In 2003, the Government commissioned a study to examine how charging for road use could help make better use of current road capacity. As part of the study, the impact on traffic and congestion of various pricing regimes was examined. In addition, more detailed analysis of a marginal social cost scenario with 10 prices and a maximum charge of 80p/km was also carried out. As part of this analysis, the impact on mode choice by journey purpose was presented. For commuting, educational and personal business trips, car driver trips reduced by 4%, car passenger trips increased by 8%, bus trips increased by 2% and train trips increased by 5%. For recreational trips, car driver trips reduced by 7%, car passenger trips increased by 10%, bus trips increased by 5% and train trips increased by 14%.
- 4.34 Results were applied to car, bus and train trips according to the classification used in the DfT report. Results were applied only to the “accelerated” future modelled scenario in the period 2011-16 onwards.

Congestion Charging

- 4.35 The best practice case study used is from London. The scheme consists of a fixed charge for driving in central London in a motorised vehicle (buses, taxis and motorbikes excepted) between 07.00 and 18.30 Monday to Friday. The zone is clearly indicated by signs, on-road markings and publicity. Monitoring of the scheme indicated that traffic levels in the zone had reduced by 18%. Social and behavioural surveys undertaken showed that of these, around 55% changed to public transport use.
- 4.36 Results were applied to 30% of trips to city centres based on research from Leeds on the amount of trips entering the city terminating in the city centre. Results were applied to car commuting trips and were applied only to the “step change” future modelled scenario in city areas in the period 2011-16 onwards.

Car Free Zones

- 4.37 The best practice case study used is from Oxford. The scheme consists of central area access restrictions and various supporting measures. Between 1999 and 2002, traffic into the city centre reduced by an average of 18% and bus patronage increased by 8-9%.
- 4.38 As with congestion charging, results were applied to 30% of trips to city centres based on research from Leeds on the amount of trips entering the city terminating in the city centre. Results were applied to all car and bus trips and were applied to the “step change” future modelled scenario in city areas in the period 2011-16 onwards and in town areas from 2016-21, and to the “accelerated” future scenario in both city and town areas from 2011-16 onwards.

Land Use Planning in New Household Schemes

- 4.39 The best practice case study used is from Camden in London. The council has a policy in favour of car free housing, where the developer will sign up to it via a section 106 agreement. Schemes should have no on-site car parking spaces and residents of car free housing schemes are not eligible for on street car-parking permits and are not allowed to park in a council owned car parks (with exemptions for disabled drivers). Camden estimates that the 242 agreed schemes, covering

2,330 dwellings, will save around 4,660 car trips per day (equivalent to 730 trips per household per year).

- 4.40 The predicted growth in household numbers was derived for each district from the Sub-Regional Household Projection figures (2004) and combined with the number of people per household. Case study results were then applied to car trips amongst this group. This was then applied to all city areas in both future scenarios from 2011-16 onwards. In town and rural areas it was applied to 50% of development in the “step change” scenario, and all development in the “accelerated” scenario.

5 Packages of transport interventions

Combining interventions

- 5.1 In order to test the impact that a series of these practical transport policy interventions and investments might have on carbon emissions from transport, three packages have been developed and tested using REAP. These three packages specifically address transport, and have been modelled within scenarios referred to as follows:
- Business as Usual;
 - Step Change; and
 - Accelerated Step Change (or Accelerated for short).
- 5.2 The *Business as Usual scenario* has been developed to identify the current “direction of travel” based on existing regional transport policy and investments.
- 5.3 Both the *Step Change scenario* and the *Accelerated scenario* have been developed by identifying a package of transport investments and interventions (from the case studies in Chapter 4) that would deliver a change in transport behaviour that will positively influence distance travelled by each mode and vehicle occupancy levels. That is to say, the scenarios include suites of interventions that aim to reduce the need to travel, reduce the distance travelled by private car, promote modal shift to more sustainable modes, and increase vehicle occupancy levels. Both can be regarded as a significant step change in the scale of transport investment and delivery over the period 2011 to 2021.
- 5.4 This is crucial to understanding the outputs of the modelling. Both the *Step Change scenario* and the *Accelerated scenario*, whilst identifying transport interventions that are practical, deliverable and have the potential to deliver changed behaviour, include combinations of intervention that goes way beyond the scope of current investment levels, or indeed the capability of existing regional and local structures in terms of delivery. Therefore the scenarios are practical in the sense that they are based upon empirical evidence from best practice examples, but represent a paradigm shift in the sense that the scale of parallel delivery of initiatives or levels of resources required across the region in a unified programme of transport investment would be unprecedented. Nor have the interventions modelled been subject to adjustment to account for political or public acceptability.

Business as usual scenario

- 5.5 To create a baseline estimate of the carbon impact of current *Business as Usual* transport policy in the Yorkshire and Humber region, data from the Local Transport Plans (LTPs) from across the region was examined. Using the current policy framework, taking Local Transport Plan 2 (LTP2) trajectories and projecting them forward over the modelling period to 2021, including the impact of any regionally significant major schemes, relevant data which was consistently available across the region was used, namely:
- Change in area wide traffic mileage to 2011; and
 - Change in public transport patronage to 2011.

- 5.6 The area wide traffic mileage data was used to calculate a scaling factor to extrapolate the 2001 car person kilometre figure for each district within region to 2020. It is this modal person kilometre data that acts as one of the key transport inputs to REAP. Similarly, the public transport data was used to calculate a scaling factor to extrapolate the 2001 bus person kilometre figures in each district to 2020. The West Yorkshire and South Yorkshire LTPs also contained data regarding growth in rail patronage to 2011 and hence in these areas, the 2001 train person kilometre data was also extrapolated to 2020 (in other areas the train person kilometres was assumed to remain constant under the 'business as usual' scenario).

The future scenarios

- 5.7 In order to calculate the changes in the REAP model parameters which may be achieved through various policy interventions, evidence from best practice examples from the UK and abroad was examined. The range of transport policy interventions is identified in detail in Chapter 4. In addition, the National Travel Survey was used to derive the number of trips and the average trip length of journeys by car, bus and train across all trip purposes. This information was then used to apply each intervention to the appropriate trips (e.g. workplace travel plan results were only applied to commuting trips). Further assumptions were also employed on a case by case basis for specific issues relating to individual interventions. The impact of the policy interventions were input into REAP on a district by district basis, and as outlined in Chapter 4, to ensure these measures were applied at an appropriate scale for each district, the districts were divided into three categories (city, town, rural) and the measures applied on a different scale for each category.
- 5.8 The modelling also accounted for the potential for interdependency of the impacts of inter-related interventions. Evidence from *Smarter Choices Changing the Way we Travel*¹⁶ was used to identify the likely scale of overlap and consequent adjustments to inputs were made in the modelling process.

Step Change scenario

- 5.9 The *Step Change scenario* again took the LTP2 trajectories until 2011. After 2011, the *Step Change scenario* phased the measures evenly over two time periods: 2011 – 2016, then 2016 – 2021. For example in the city and town districts, personalised journey planning was modelled by targeting 22.5% of the population in the first 5 year phase and 22.5% in the second 5 year phase. The rationale was to try and reflect a more gradual programme of change. A background growth from the business as usual scenario was applied to the inputs to reflect the continued growth and development of the region. Again the level at which each intervention was applied has been described in Chapter 4.

Accelerated scenario

- 5.10 The *Accelerated scenario* took the LTP2 trajectories until 2011. After 2011, the Accelerated scenario implemented the majority of the measures in the first five year period (2011 – 2016) with any remainder over the second five year period. For example in the city and town districts, personalised journey planning targeted 45% of the population in the first 5 years, with reinforcement of the measure on 15% of the population in the second 5 year period. The rationale behind this approach being that the earlier implementation of measures would increase the pace of change and reduce the overall scale of change required to meet the targets. Again a background growth was applied to the inputs to reflect growth and development in the region.

¹⁶ Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) *Smarter Choices – Changing the Way We Travel*, Final Report of the Research Project: The Influence of Soft Factor Interventions on Travel Demand, Department for Transport

5.11 The scale, as identified by the proportion of population in each district, to which the measures were applied (i.e. the proportion of the population the measures were applied to) under each scenario is provided in **Appendix D**.

6 Modelled outputs

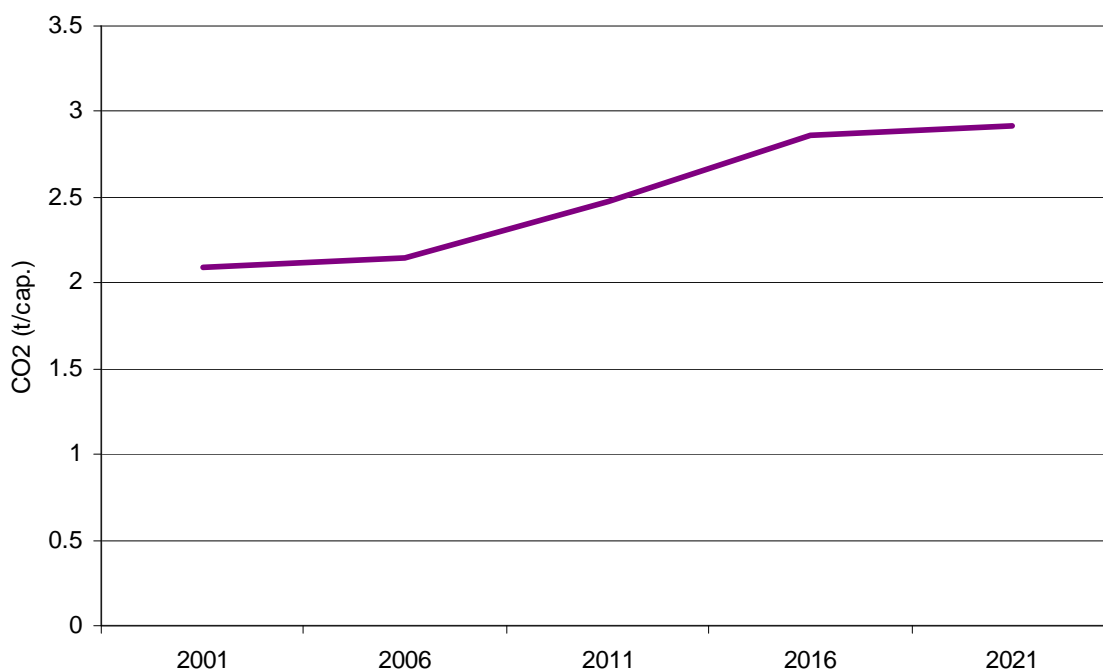
6.1 The outputs of the modelling undertaken are illustrated in the following section. The outputs from REAP are shown in graphical form, and show the carbon dioxide emissions per capita of the various scenarios modelled over the period to 2020.

Business as usual scenario

6.2 Initially, within the *Business as Usual scenario*, the impacts of the three individual transport parameters that have been varied within the modelling have been identified separately to illustrate the effect of each of these parameters on carbon emissions from transport over time across the region. The details of these results are included as **Appendix E**.

6.3 Figure 6.1 below shows the overall modelled results from the *Business as Usual scenario*. This figure accounts only for land transport impacts, but even so, demonstrates a rising trend.

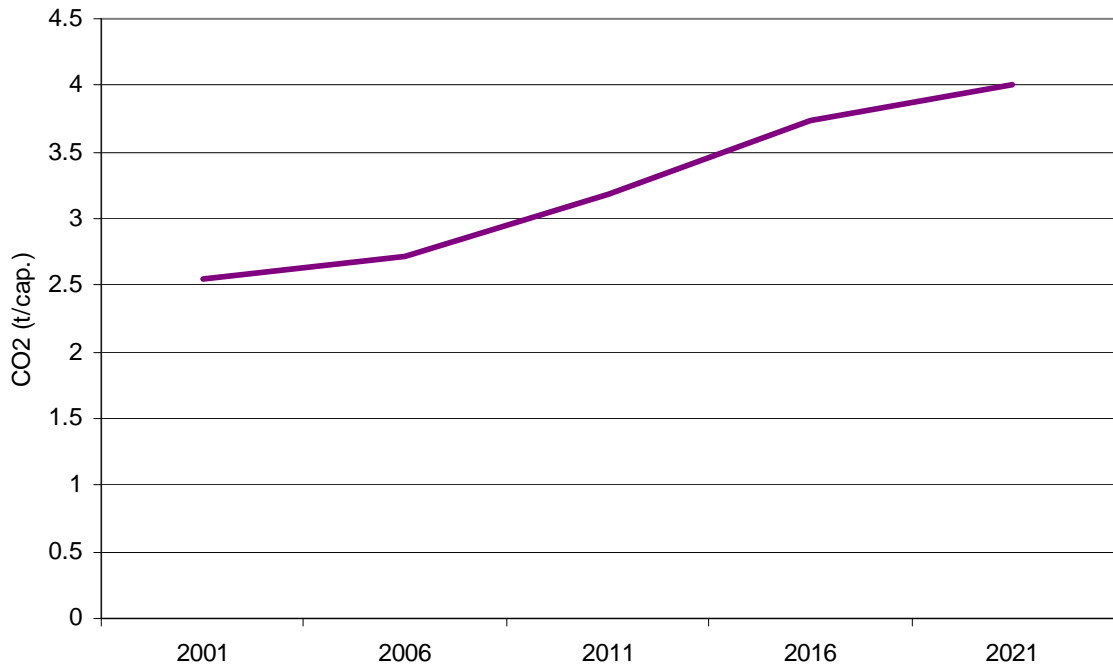
Figure 6.1 Modelled CO₂ emissions from land transport within the Business as Usual scenario



6.4 Figure 6.2 overleaf shows the overall modelled results from the *Business as Usual scenario* with the influence of aviation added. The general trend remains an upward one, and crucially, the scale of emissions is significantly higher than that without aviation.

- 6.5 By 2021, carbon dioxide emissions per capita for Yorkshire and Humber residents from transport including aviation are expected to be around a third higher than those that simply account for land transport impacts.

Figure 6.2 Modelled CO₂ emissions from all transport use including aviation within the Business as Usual scenario

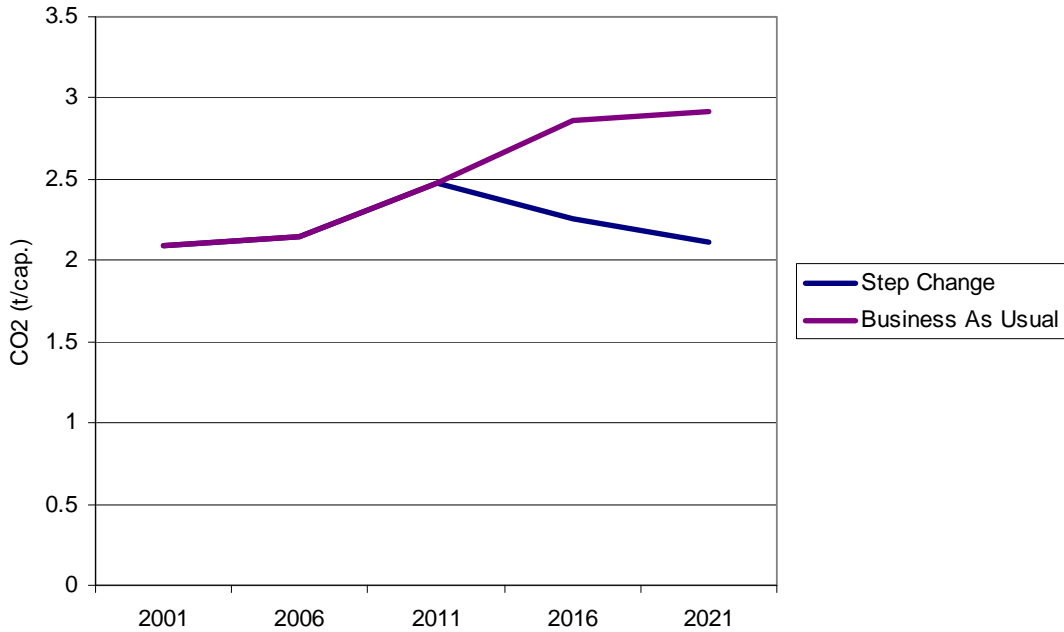


Step Change scenario

- 6.6 The first of the “do something” future scenarios to be modelled has been termed the *Step Change scenario*. The distinctive feature of this scenario, as identified in chapter 5, is that there is a degree of phasing of implementation of the measures modelled within the scenario. The *Step Change scenario* takes the LTP2 trajectories until 2011. After 2011, the *Step Change scenario* phases the measures evenly over two time periods: 2011 – 2016, then 2016 – 2021.
- 6.7 It is important to re-iterate however that the *Step Change scenario* has been developed by identifying a package of transport investments and interventions that would deliver a significant change in transport behaviour that will positively influence distance travelled by each mode and vehicle occupancy levels. That is to say, the scenario includes a suite of interventions that aims to reduce the need to travel, reduce the distance travelled by private car, promote modal shift to more sustainable modes, and increase vehicle occupancy levels. It is by no means a trivial package of such measures.

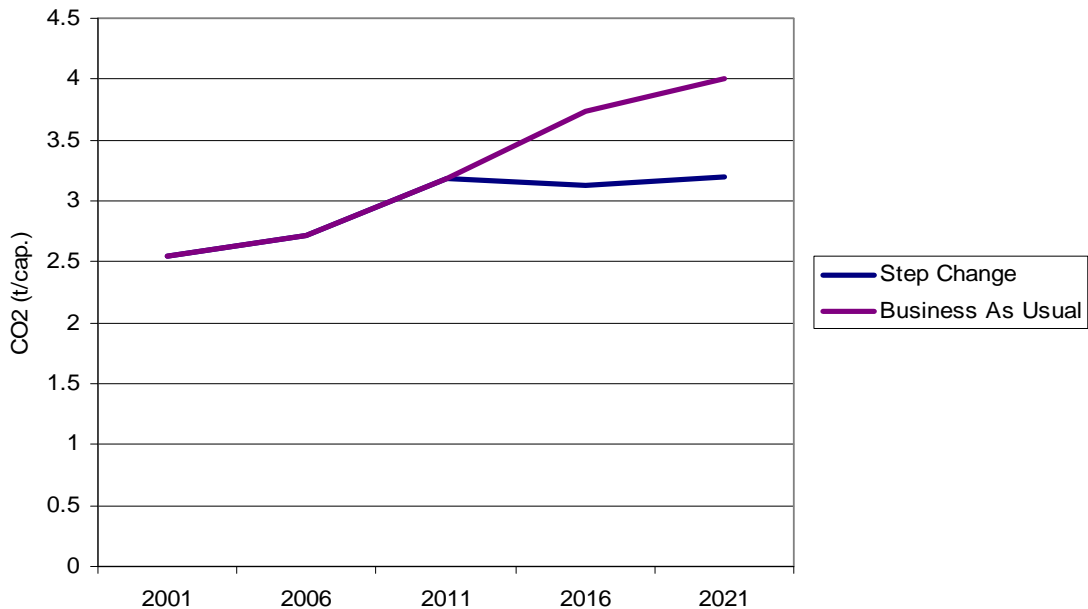
6.8 Figure 6.3 overleaf shows the overall modelled results from the *Step Change scenario* for land transport only.

Figure 6.3 Modelled CO₂ emissions from land transport within the Step Change scenario



6.9 Figure 6.4 below shows the overall modelled results from the *Step Change scenario* for all transport, including aviation.

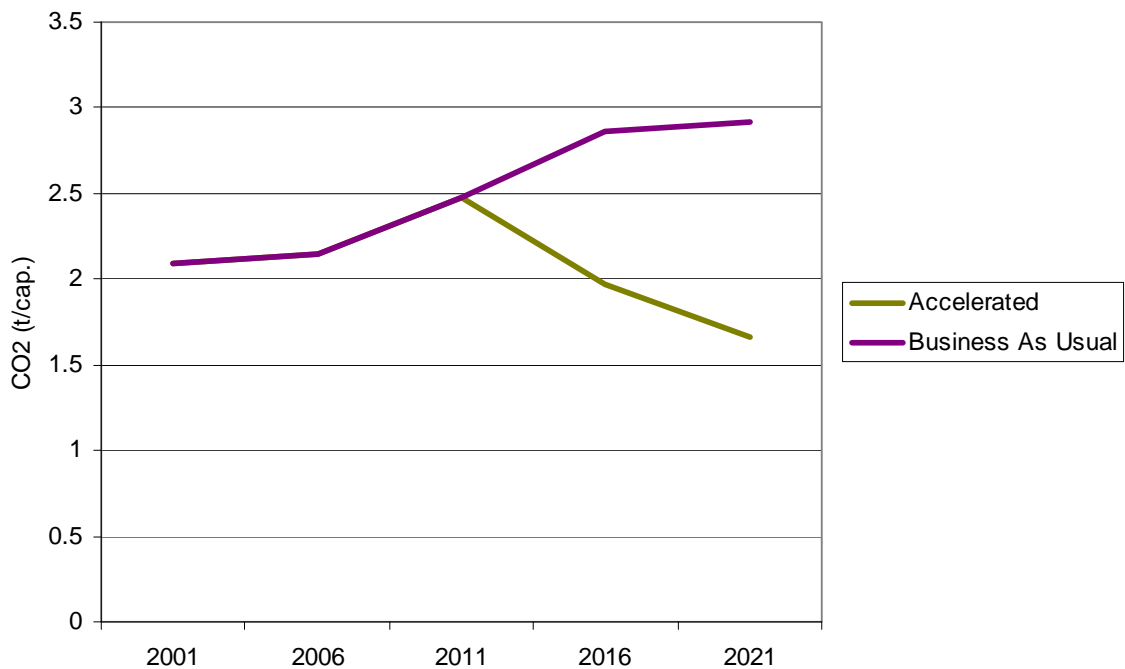
Figure 6.4 Modelled CO₂ emissions from all transport use including aviation within the Step Change scenario



Accelerated scenario

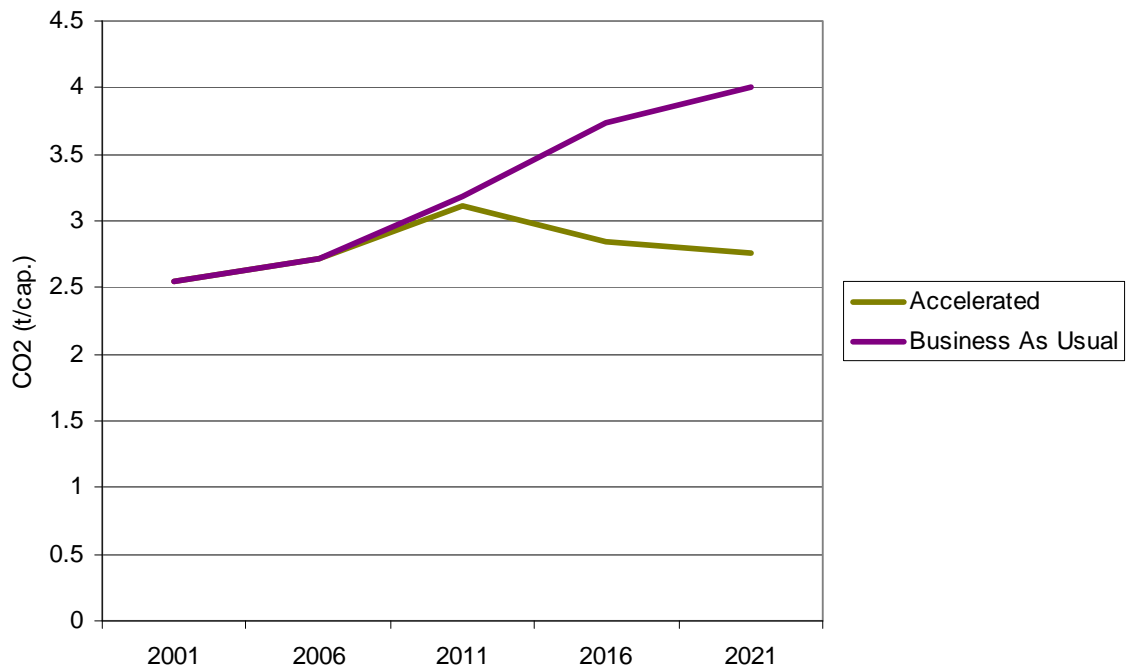
- 6.10 The second of the “do something” future scenarios to be modelled has been termed the *Accelerated scenario*. As its name suggests this scenario is more far reaching, and includes the majority of the measures in the first five year period (2011 – 2016) with any remainder being implemented over the second five year period. The *Accelerated scenario* again took the LTP2 trajectories until 2011. It is again by no means a trivial package of measures in the years beyond 2011.
- 6.11 Figure 6.5 below shows the overall modelled results from the *Accelerated scenario* for land transport.

Figure 6.5 Modelled CO₂ emissions from land transport within the Accelerated scenario



6.12 Figure 6.6 below shows the overall modelled results from the *Accelerated scenario* for all transport including aviation.

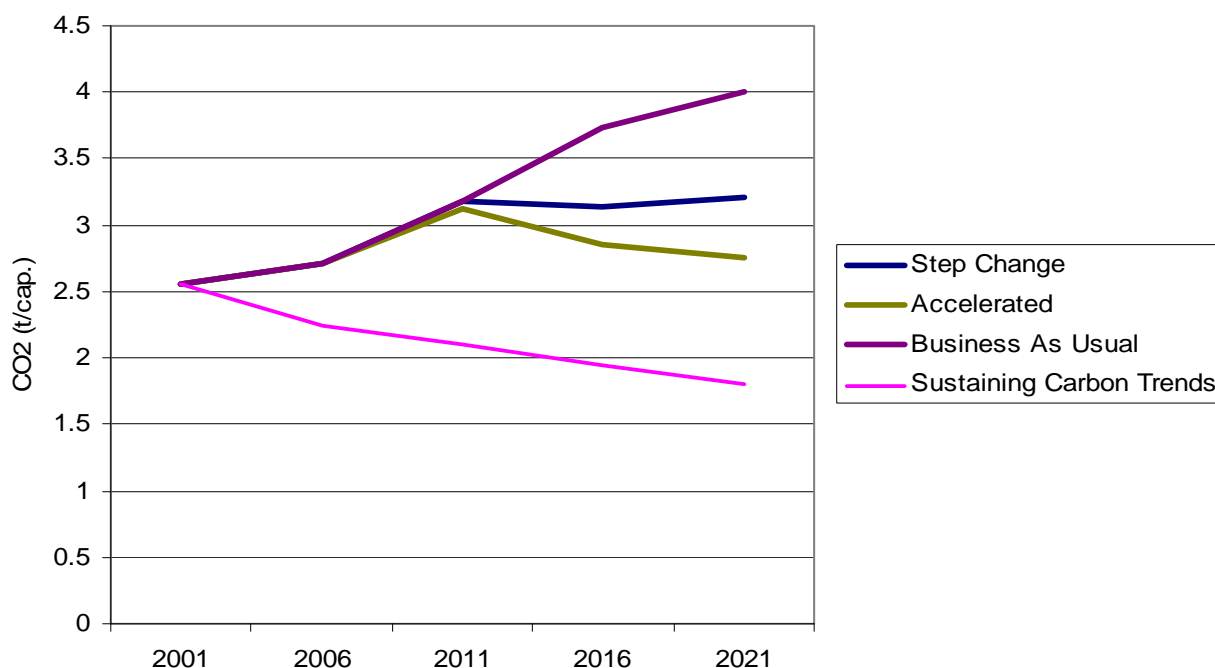
Figure 6.6 Modelled CO₂ emissions from all transport use including aviation within the Accelerated scenario



Comparison of scenarios

6.13 Figure 6.7 plots all three scenarios modelled, together with the *Stabilising Carbon Trends scenario* from the Assembly's earlier 2007 commission. This demonstrates that even under the *Accelerated scenario* CO₂ emissions are still higher than the 2001 baseline, and significantly higher than the *SCT scenario* represented by the pink line. It is important to stress here that the *SCT scenario* was developed based on the levels of carbon reduction required to achieve regional and national targets, and is thus a hypothetical projection of future carbon emissions. The carbon savings levels delivered in this scenario are not based upon any practical assessment of delivery, and therefore appear unrealistic when compared with the scenarios derived from practical transport measures in this commission.

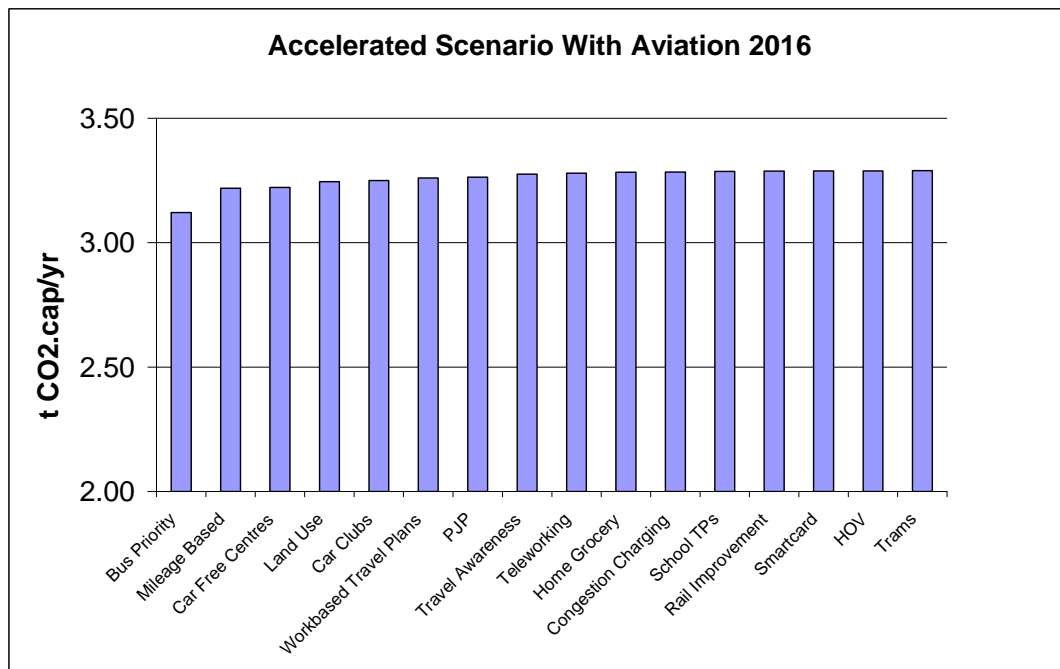
Figure 6.7 Comparison of modelled CO₂ emissions from all scenarios with respect to the Stabilising Carbon Trends (SCT) scenario



Impact of specific interventions

6.14 In an attempt to gain some understanding of the effect of each individual intervention, in addition to the overall scale of effect of the combinations modelled and presented earlier in this chapter, the following figure demonstrates the modelled carbon impact of each of the individual interventions across the region. This impact is modelled on a region wide basis. **Error! Objects cannot be created from editing field codes.**

Figure 6.8 Comparison of modelled CO₂ emissions by intervention



- 6.15 Each of the interventions does have some positive impact. There is no demonstrable difference between the scale of impact of each of the interventions, with all broadly delivering a similar level of impact based on a common starting point. The bus priority measures modelled do appear to reduce carbon emissions by slightly more, but the impact of each intervention within the modelling is strongly related to the best practice case studies examined.
- 6.16 It may be that a particular type of intervention has more impact in certain geographical locations, but this has not been identified, as there are many thousands of possible combinations of intervention and district.
- 6.17 The initial modelling of individual interventions suggests that whilst the overall impact of the combination of a suite of interventions is broadly positive, it will be necessary for action on tackling carbon emissions from transport to be in the form of a combination of measures, as no single transport measure appears to provide the “solution” on its own, nor have an impact of an order of magnitude larger than any of the other modelled measures.

Geographical differences

- 6.18 The impact of the scenarios modelled has been separately identified on a district by district basis across the region.
- 6.19 Figures 6.9 and 6.10 present results for all local authorities for the Accelerated scenario modelled in REAP for 2016. Each pair of maps shows the scenario with and without aviation. Figure 6.9 shows total carbon emissions and Figure 6.10 show per capita emissions.

Figure 6.9 Total emissions by district in the Accelerated scenario at 2016

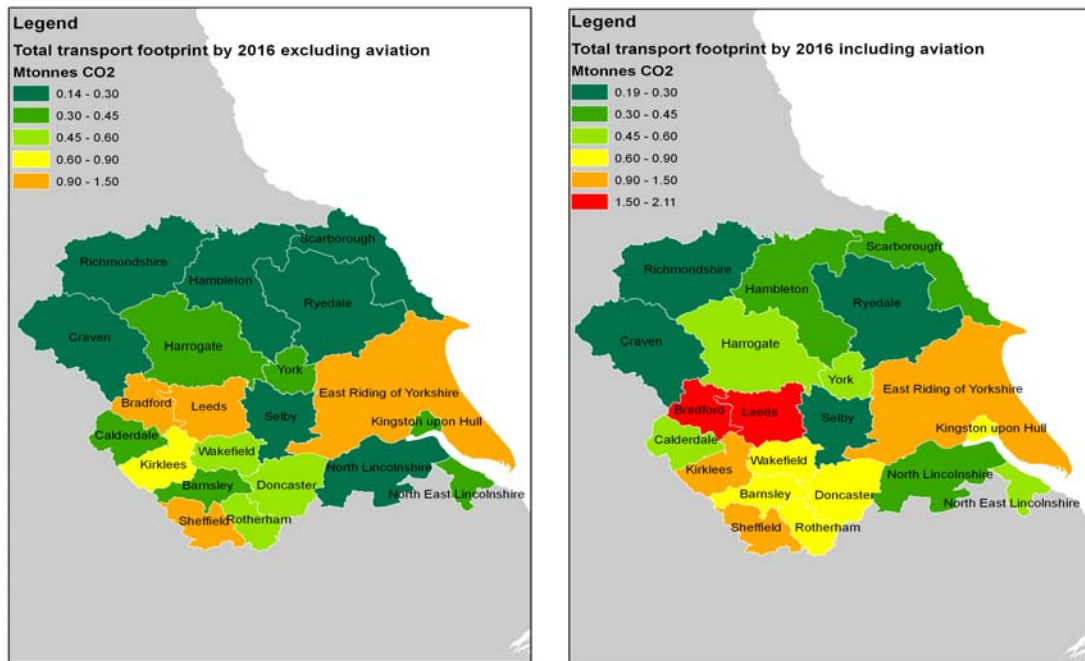
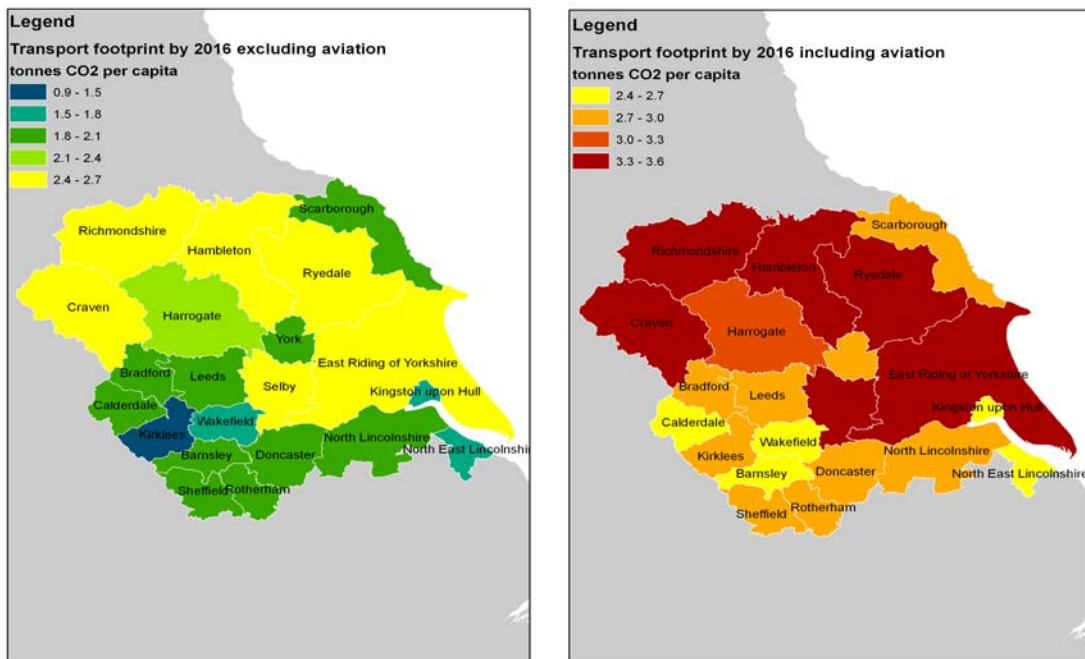


Figure 6.10 Emissions per capita by district in the Accelerated scenario at 2016

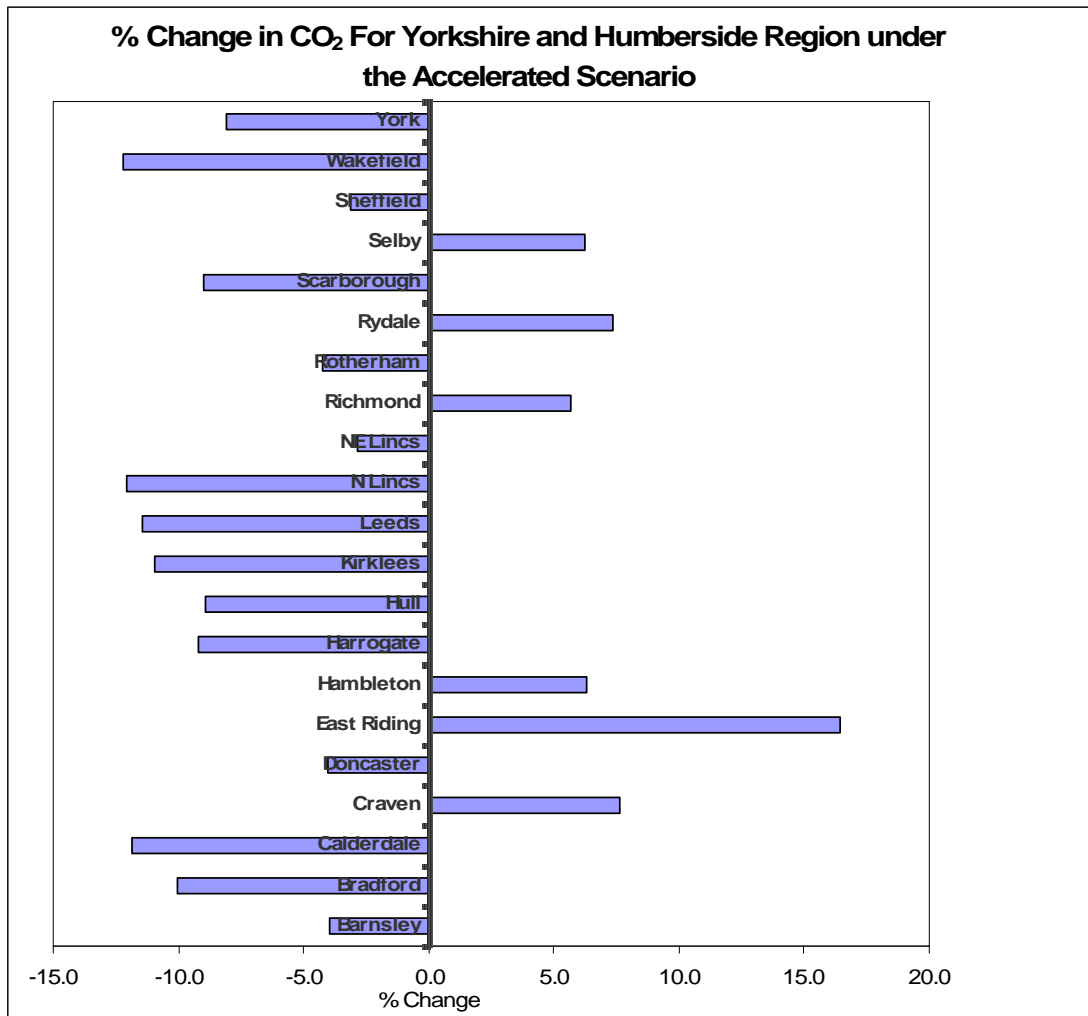


6.20 Whilst it is not surprising that Leeds and Bradford have higher total emissions due to the larger populations, when comparing the per capita emission maps in Figure 6.10 there are clear regional differences. Without a detailed examination of socio-economic profile data it could be explained by differences in disposable income, and a range of other contributory factors such as the influence of second homes abroad, and the frequency of making trips to family. Retirement may possibly also be an influence.

6.21 Finally, Figure 6.11 shows the percentage change in emissions for all local authorities in 2016. The graph shows that CO₂ emissions per capita in some rural local authorities increase as much as

16.4 per cent even if aviation emissions are not included. This could suggest to policy makers that additional transport policies need to be looked at in rural areas when examining carbon emissions, as the existing mix of policies would appear to be urban focused. Whilst the current available mix of policy tools does not achieve the levels of change required within the region, there is at least a suggestion that in urban areas, a sophisticated and hard hitting mix of transport policies is available that promotes the right “direction of travel” in carbon emission levels.

Figure 6.11 Change in emissions by district in 2016 under the Accelerated scenario



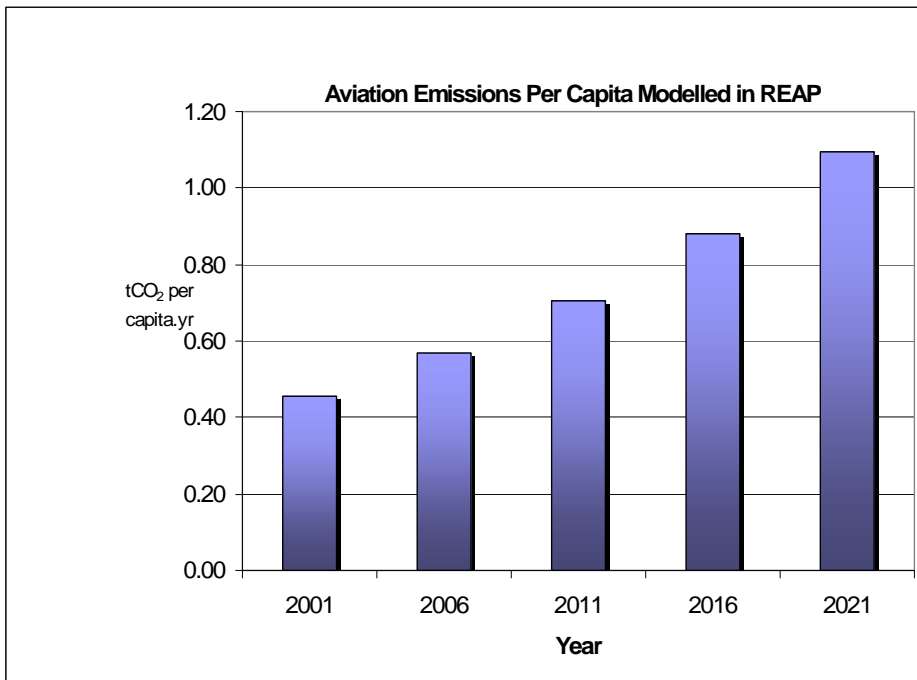
Aviation

6.22 The impact of aviation on the modelled outputs described in the previous sections is significant. It is the most challenging element of the transport sector in terms of carbon emissions, and is worthy of separate analysis. Aviation policy and planning is an area in which the influence of the region is very limited. As a consequence, none of the interventions modelled in the future scenarios directly affect carbon emissions from aviation. The practical toolkit available to the region is essentially one that tackles land based transport. A more extensive examination of some of the aviation issues relating to carbon emissions from transport in the region can be found in **Appendix F**.

Modelled aviation results

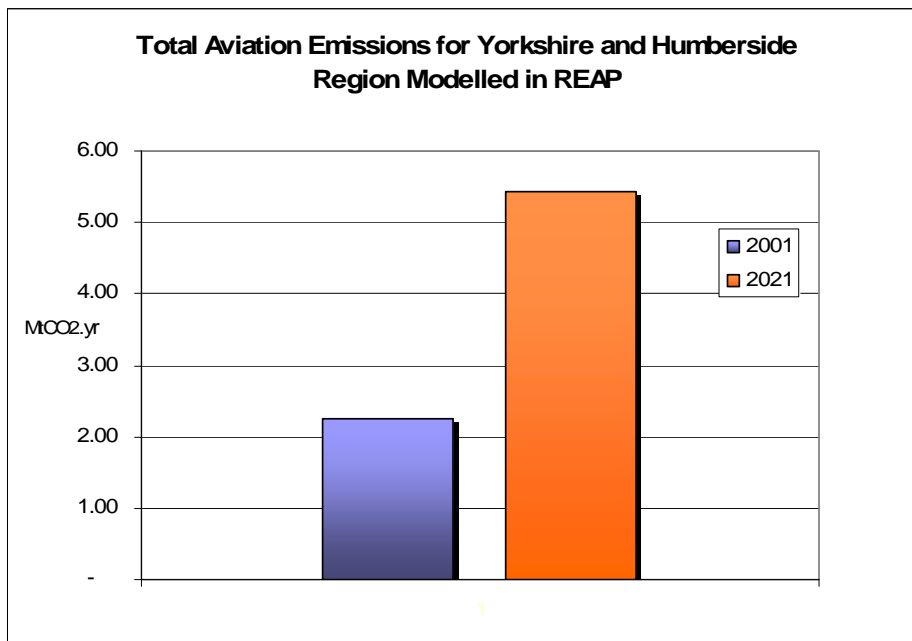
6.23 The results for aviation growth for all scenarios is shown in Figure 6.12 and shows that emissions per capita will more than double between 2001 and 2021. This is essentially the impact of aviation growth, unaffected by any potential interventions at the disposal of the region. As noted above, the region has limited influence on aviation policy.

Figure 6.12 Aviation emissions per capita (all scenarios)



6.24 Total emissions for the Yorkshire and Humber region are projected to increase from 2.26 million tonnes of CO₂ per year to 5.2 million tonnes per year as shown in Figure 6.13.

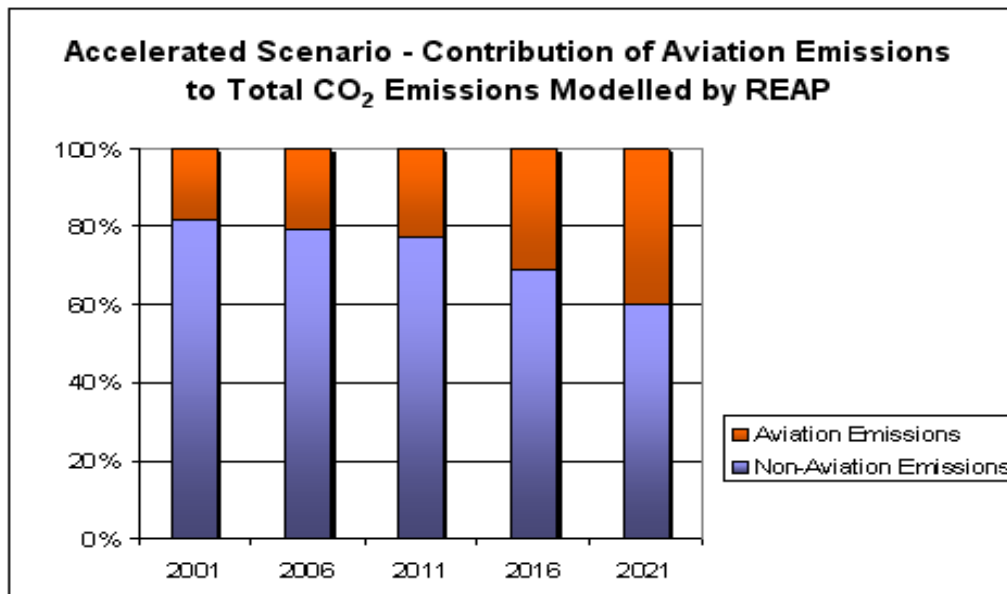
Figure 6.13 Total modelled aviation emissions in Yorkshire and Humber



6.25 This inability to influence aviation policy at the regional level has a consequence of, whilst land based emissions are being tackled within the modelling, aviation emissions are not. As a

proportion of all transport emissions, aviation emissions over the next 20 years will become an increasingly larger portion, as shown in Figure 6.14. Under the *Accelerated scenario*, by 2021 CO₂ emissions from aviation account for nearly 40 per cent of people's emissions.

Figure 6.14 Modelled contribution of aviation emissions in Yorkshire and Humber



Wider impacts

The “Rebound” effect

- 6.26 In addressing the results of the modelling of policies that reduce carbon emissions from transport, the region must be wary of the “rebound” effect. Many of the potential carbon savings as a result of transport policies may be lost due to this rebound effect. Where transport policies make travel cheaper (subsidised public transport), quicker (high-speed rail) and require less essential travel (tele-working) the result is that individuals actually have more time and money to spend on other things including other non-essential travel. The rebound effect may actually have the consequence of increasing emissions.
- 6.27 People might spend the money saved by walking or cycling to work on consumer items which may, for example, be produced overseas, such as in China and air-freighted into the country. In switching to a more fuel efficient car or commuting less people may put the money saved towards a short haul flight for a weekend break where the overall effect will be higher carbon emissions. A quicker train journey, say from York to London, might mean people will switch from driving to taking the train which will reduce emissions (a good thing) but it may also mean that people prefer to move to York and are prepared to commute longer distances than previously if the journey time is reasonable. All are examples of “rebound”.
- 6.28 Therefore, it is important to consider when developing sustainable transport policy that there is the potential to increase carbon emissions as well as reduce them. This might result in the burden of emissions shifting from the transport sector to another sector. However, the individual's carbon impact might be the same or greater. Incentives, subsidies and grants can provide a pricing

framework which minimises the rebound effect by rewarding more sustainable behaviours¹⁷. In addition, communication which raises awareness about reducing carbon emissions from the transport in the region should also involve discussion about the wider issues associated with low carbon lifestyles.

Socio-economic impacts

- 6.29 This study seeks to examine the potential for low carbon transport systems in the future, using practical transport interventions to deliver that low carbon future. This relatively narrow brief must however have cognisance of other objectives of the region, such as economic priorities, and socio-economic and environmental impacts. In order to do this, a number of the interventions modelled have been examined against the Yorkshire and Humber regional methodology for prioritising transport interventions within the Regional Funding Allocations (RFA) process¹⁸. A summary of these assessments is included at **Appendix G**.
- 6.30 This methodology looks at how interventions will deliver regional policy, whether they represent value for money, and are affordable and deliverable. Essentially, all of the interventions examined under the RFA framework fully accord with, and should contribute as a group to the delivery of, the wider policies of the region.
- 6.31 More concern exists in examining the value for money and deliverability dimensions of the RFA framework. It has already been indicated that the scale of delivery modelled far exceeds the levels of delivery of transport interventions and investment in Yorkshire and the Humber to date. The scale of investment and change modelled is therefore unprecedented, and unrealistic under current funding mechanisms. The programme is therefore unaffordable. No assessment of the economic and financial benefits of the investments and interventions has been undertaken.
- 6.32 Nor have the interventions modelled been subject to adjustment to account for political or public acceptability. The acceptability of the more radical suggestions within the interventions modelled may present more of an issue to the region. This, and the issue of affordability and value for money of the interventions, does place questions on the deliverability of such a wide ranging programme of transport measures.

Acceptability of interventions modelled

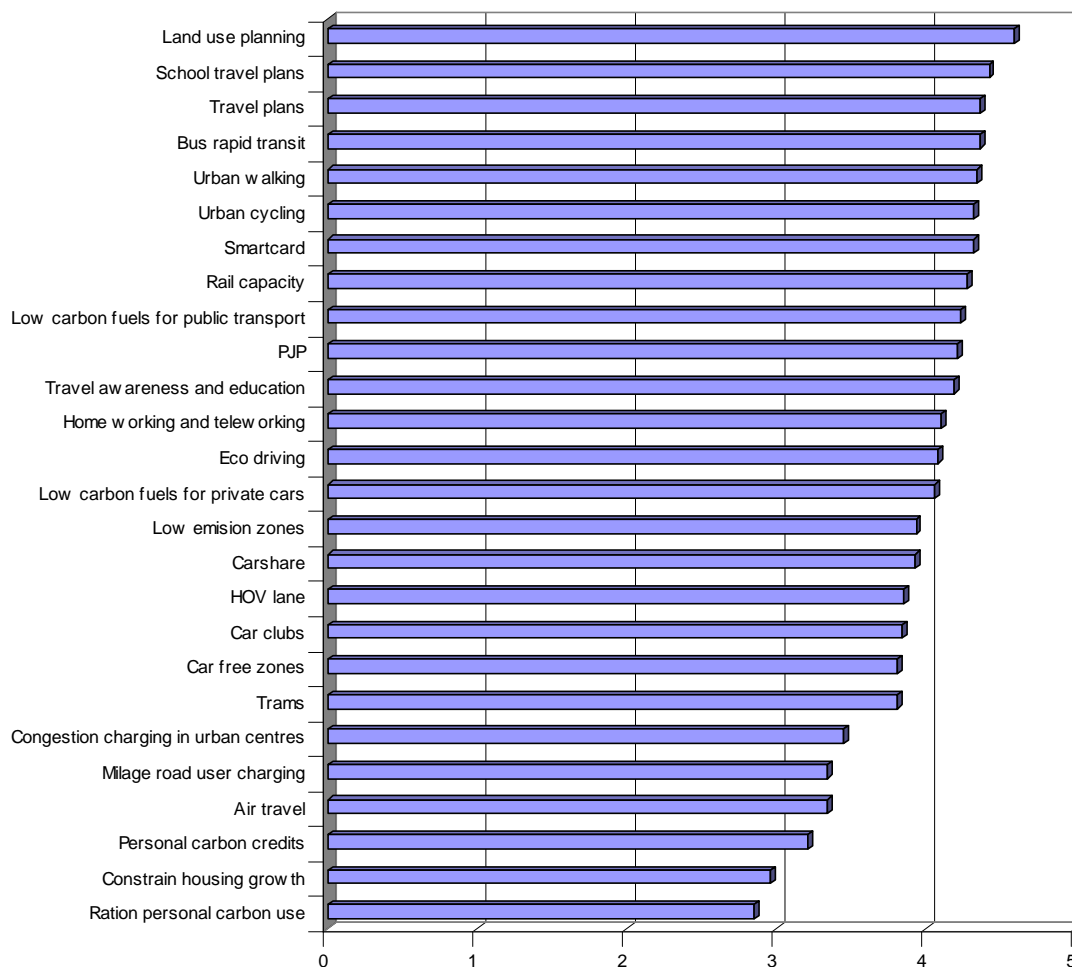
- 6.33 In order to assess how acceptable the modelled and other measures would be within the region, a consultation exercise was devised to collate the views of key stakeholders from both transport and sustainable development backgrounds within the region.
- 6.34 A simple questionnaire was developed to collect the views of key stakeholder groups on the “acceptability” of potential measures. Respondents were asked to rate each measure’s “acceptability” on a scale of 1 to 5, 1 being very unacceptable and 5 being very acceptable.
- 6.35 The questionnaire was distributed to members of the following groups:
- Regional Transport Officers Group (RTOG);
 - Regional Transport Forum;
 - Sustainable Development Board.

¹⁷ SEI (2007) Towards a low footprint Scotland. Living well within our ecological limits. A Report to Scotland's Global Footprint Project, WWF Scotland.

¹⁸ JMP (2007) Regional Funding Priorities: Advice for Scheme Sponsors, Yorkshire and Humber Assembly

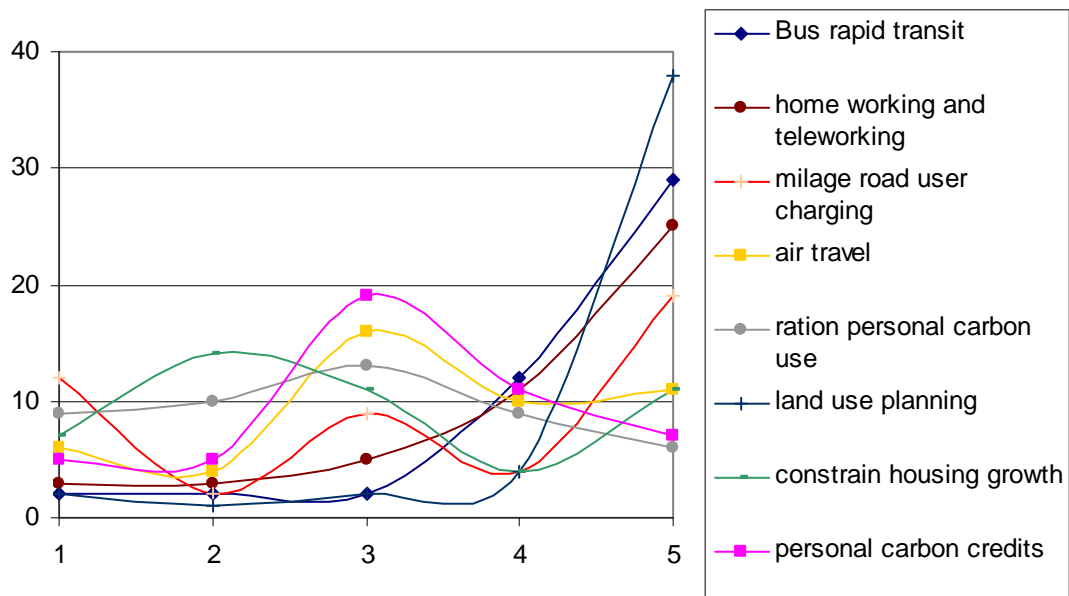
- 6.36 In total, 47 responses were received to the questionnaire, giving a response rate of approximately 20%. The measure with the highest average score was “*Better plan land use to actively reduce the need to travel*” with an average score of 4.6, followed by “*Regional programme of school travel plans*”, “*Support for businesses to develop employee travel plans*” and “*Bus Rapid Transit Superoutes into urban centres including extensive bus priority*” all with an average score of 4.4.
- 6.37 The lowest level of support was received for “*Rationing personal carbon use*” (average score 2.9) followed by “*Constrain housing growth to below RSS levels*” with an average score of 3.

Figure 6.15 Summary graph of average score for acceptability of measures



- 6.38 Figure 6.16 overleaf illustrates the variance of response with land use planning, bus rapid transit and home or teleworking all having lines which peak to the right hand side of the graph showing high levels of acceptability. In contrast mileage-based road user charging has two peaks one at either end of the spectrum illustrating the polarization of views on this topic. While measures such as constrain growth in air travel to current levels and personal carbon credits have a peak in the centre of the graph suggesting a neutrality of views surrounding these measures (three was defined on the questionnaire as neither acceptable or unacceptable), this response could also be a result of the abstract nature of these measures as constraining air travel and personal carbon credit approach have not been widely trialled in other areas and so their impacts and repercussions are unclear.

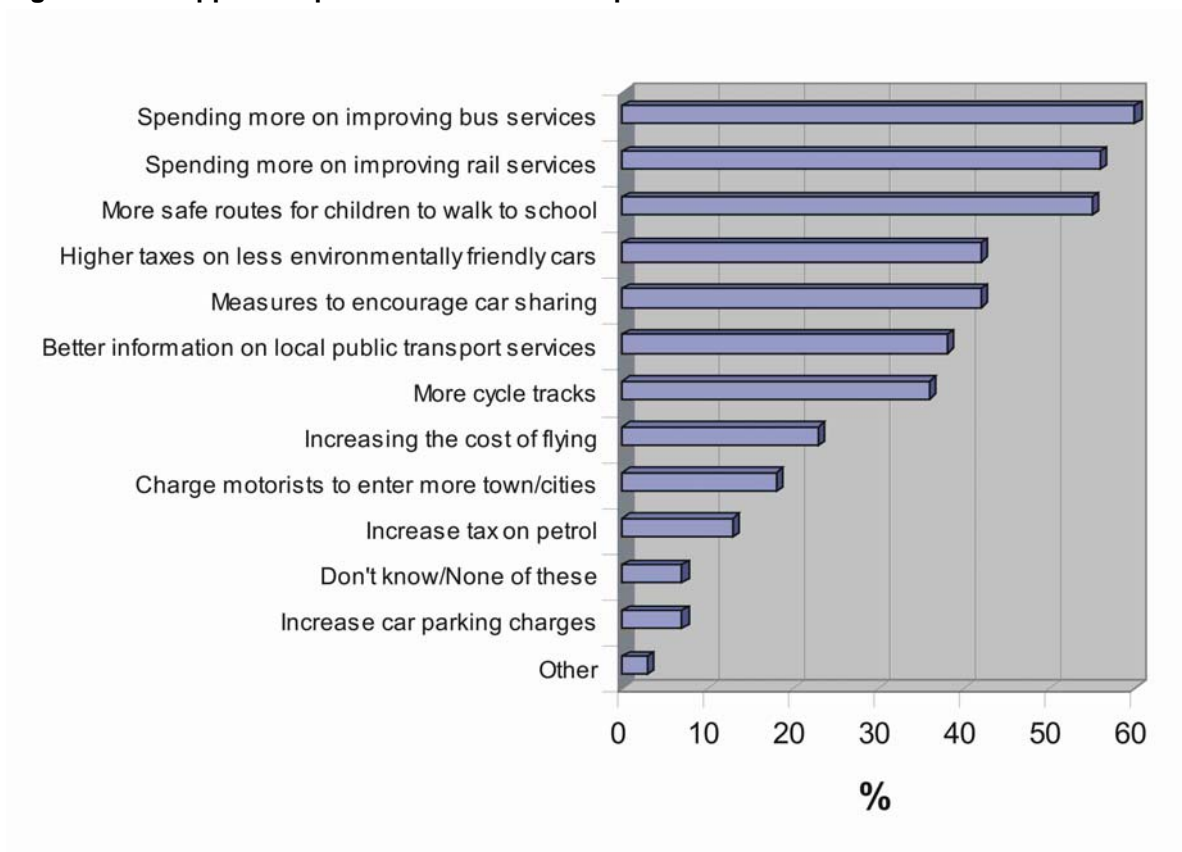
Figure 6.16 Examples of the variation in response to acceptability of different measures



- 6.39 A recent report produced by the Office for National Statistics (ONS) aimed to summarise people attitude towards climate change in relation to transport¹⁹. These results can be compared with the results from the Yorkshire and Humber stakeholder consultation to give a view of the types of measures which are acceptable both publicly and politically and those which are less so.
- 6.40 The ONS research suggested that the majority of the public believe that transport emissions contribute to climate change (70% of respondents selected this as a cause of climate change). Further to this 40% of respondents selected aeroplane as the mode of transport which contributes most to climate change, with 51% selecting some form of road transport.
- 6.41 In general support was highest for “soft” measures rather than measures which would increase the cost of car travel. Just under half of respondents selected that air travel should be limited for the sake of the environment (45%). The policies which received the most public support were; spending more on improving bus services, spending more on improving rail services and more safe routes for children to walk to school. Pricing measures aimed at reducing car and plane use were far less popular. Figure 6.17 illustrates the results from the survey.

¹⁹Office of National Statistics (2008) Attitudes to Climate Change and the Impact of Transport, Transport Statistics

Figure 6.17 Support for policies to reduce transport emissions²⁰



6.42 Improving bus and rail was positively received in both the local survey and the ONS work as were school travel plan measures. Road charging mechanisms were the least acceptable measures in both exercises. Measures to address air travel were also less well supported.

²⁰ Ibid

7 Conclusions and implications

Headlines

- 7.1 This research commenced with the intention of outlining the **practical, deliverable measures within the scope of regional transport policy** that would be required to deliver a reduction in the levels of carbon dioxide emissions from the transport sector by a sufficient amount to meet the *Stabilising Carbon Trends scenario* identified within a previous study commissioned by the Yorkshire and Humber Assembly in 2007, *Evaluating the contribution that key regional strategies make towards addressing climate change*. This has been undertaken by modelling the carbon impact, using REAP over the period to 2020, **of a far reaching programme of transport investment and interventions in the period from 2011, way beyond the scale of current practice in the region**.
- 7.2 The research suggests that **even with significant large scale implementation of an uncompromising suite of current practical transport policy approaches to delivering low carbon transport in the Yorkshire and Humber region, this aim is unlikely to be achieved**.
- 7.3 That said, the picture is not universally bleak, as the suite of practical, deliverable transport interventions modelled does make an impact on carbon emissions, and demonstrates that **with large scale, and accelerated, implementation, concerted action by the region can make a difference**.
- 7.4 Headline conclusions are that:
- The far reaching programme of modelled interventions, implemented on an unprecedented scale, representing a real step change, does not reduce carbon emissions from transport in line with the theoretical levels of reduction required to deliver transport's "share" of carbon reduction targets within the region;
 - Much greater action still is required to make a real difference, and certainly to deliver transport's share of carbon reduction across the region;
 - That said, the programmes of transport interventions modelled, with accelerated implementation, do change the direction of travel of carbon emissions from land transport sources, and flatten out the growth in emissions from the Yorkshire and Humber region, demonstrating that transport can and does have a significant role in delivering a low carbon future for the region, and that with concerted action, the region can make a difference;
 - Each individual transport intervention modelled has a broadly similar impact, and no one measure or intervention provides the answer to reducing carbon emissions from transport on its own – it is the sum of a combination of measures that makes a difference;
 - The transport measures modelled, regardless of the scale of change required, are unlikely to be deliverable within the current regional funding and resource context, emphasising the need at both national and regional level for a step change in delivery of transport measures that reduce carbon emissions;
 - Without this step change in delivery through transport, other sectors may therefore be required to deliver greater shares of the required carbon reduction, faster;
 - The policies modelled within the research accord with wider regional policies to deliver the RSS and RES and complement policies to support social and economic indicators. However, recognition needs to be made that education and reinforcement of the benefits of such

measures will be needed with regard to public acceptability of such measures, at least in the short term;

- These wider implications must include consideration of locking in the benefits of reducing transport's impact on carbon, to guard against the rebound effect;
- That whilst the influence of the region and regional transport policy makers is significant for measures that influence land transport, the effect of transport that lies broadly outside the direct influence of regional policy, such as aviation, must be considered, and approaches to influencing such policies developed;
- Finally, and most immediately, this research should be used to raise awareness amongst professionals and decision makers of the scale of the challenge facing the region in terms of carbon emissions from transport.

The modelling and its results

7.5 The three scenarios modelled are:

- The Business as Usual scenario, which has been developed to identify the current “direction of travel” based on existing regional transport policy and investments;
- The *Step Change scenario*, which adopts a phased approach to implementing transport measures;
- The *Accelerated scenario*, which includes a more rapid introduction of transport interventions.

7.6 The *Step Change scenario* and the *Accelerated scenario* have been developed by identifying a package of transport investments and interventions that would deliver a change in transport behaviour that will positively influence distance travelled by each mode and vehicle occupancy levels. That is to say, the scenarios include suites of interventions that aim to reduce the need to travel, reduce the distance travelled by private car, promote modal shift to more sustainable modes, and increase vehicle occupancy levels.

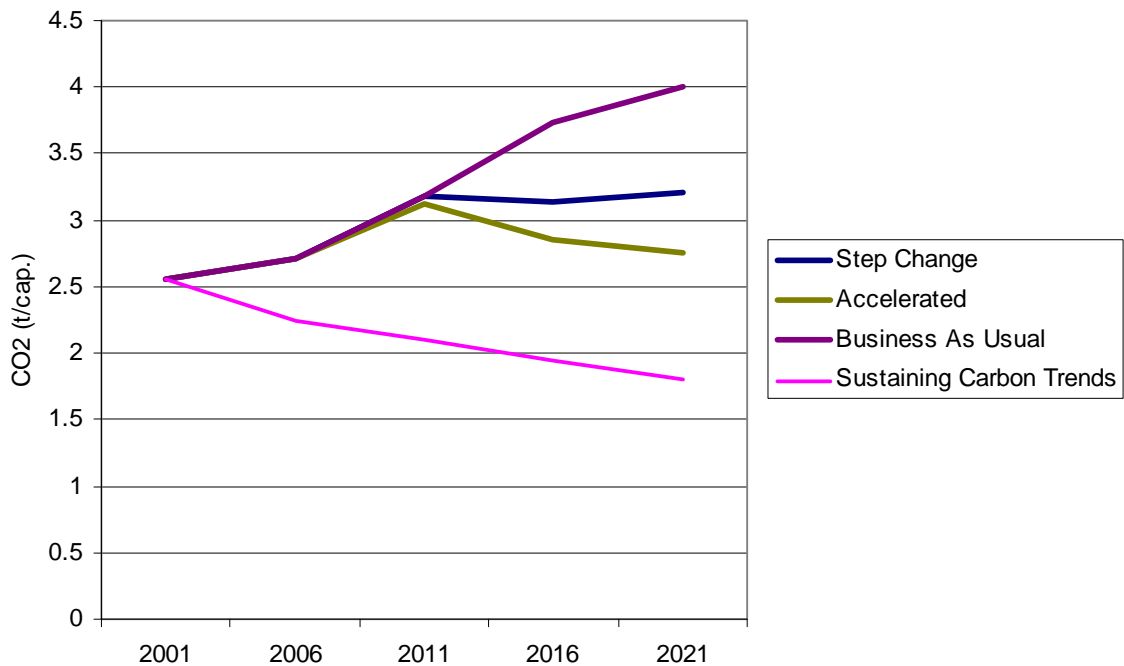
7.7 Crucial to understanding the outputs of the modelling and this research is the fact that both of the “do something” scenarios for the future represent a significant step change in the scale of transport investment and delivery over the period 2011 to 2021. Both the *Step Change scenario* and the *Accelerated scenario*, whilst identifying transport interventions that are practical, deliverable and have the potential to deliver changed behaviour, include combinations of intervention that goes way beyond the scope of current investment levels, or indeed the capability of existing regional and local structures in terms of delivery.

7.8 It is worth at this point repeating the comparison of the results of the modelled outputs with the *Stabilising Carbon Trends scenario* from the 2007 publication from the Assembly (shown in Figure 7.1 overleaf). This amply demonstrates that the current level of policy intervention in transport within the region results in a direction of travel for carbon emissions from transport that is continuing to grow in the “wrong” direction. Even when the significant programmes of interventions and investments are modelled, whilst there is a change in direction of the graph, it does not come remotely close to reducing the carbon emissions from transport to a level that reaches the line representing the *Stabilising Carbon Trends scenario*. That said, the fact that the programmes of transport interventions modelled, with accelerated implementation, do change the direction of travel of carbon emissions from land transport sources, and flatten out the growth in emissions from the

Yorkshire and Humber region, thereby demonstrating that transport can and does have a significant role in delivering a low carbon future for the region.

- 7.9 It is also pertinent to remember that the *SCT scenario* is a hypothetical scenario that assumes that there would be no additional growth in aviation or consumption of consumables. This is a challenging scenario which runs counter to the national agenda rather than being within the sphere of direct regional influence, and does not account for realism in delivery. It may therefore appear unrealistic when compared with the scenarios derived from practical transport measures in this commission.

Figure 7.1 Comparison of modelled CO₂ emissions from all scenarios with respect to the Stabilising Carbon Trends (SCT) scenario



- 7.10 As is demonstrated in Chapter 6, public acceptability of the range of measures used in the modelling of land transport interventions within this research is not at present universal. Nor are some additional measures that may be considered in addition to those modelled, that do not currently feature within the suite of tools available to the region likely to be acceptable to all. Measures such as forms of road user charging, increased parking charges, higher taxation on travel and fuel, the introduction of personal carbon credits and other measures that help discourage travel are all likely to receive significant opposition in establishing public acceptability.
- 7.11 The suite of measures modelled is unlikely to meet with universal success within current regional prioritisation mechanisms, not least in deliverability terms. ***This not only reflects the difficulty of achieving consensus over the acceptability of some of the more controversial elements, but also the fact that the scale of implementation required to deliver the interventions modelled within this research far outstrips that available to region at the present time.*** This is both in terms of the funding available, but also in terms of the capacity and human resources available to deliver such a large series of interventions within the timescale modelled.
- 7.12 This modelling includes the affects of aviation on carbon emissions from transport. This is an important and significant element of transport sector emissions, as is amply demonstrated in

Chapter 6. Aviation is responsible for a growing proportion of transport carbon emissions, and so policy instruments will need to be applied to aviation, as they have been applied in the modelling here to land transport. Such instruments are not likely to be within the direct control or influence of the region.

The role of other sectors

- 7.13 The evidence from this research and the modelled results suggests that the transport sector is unlikely to achieve the levels of carbon emission reduction required to deliver a low carbon future in Yorkshire and the Humber. Existing transport policies and even significant adoption of more radical, and potentially unpopular transport policies, are unlikely to deliver transport's "share" of required reductions.
- 7.14 The region may therefore need to look to other sectors, where remediation measures may be easier to implement, both in technical and political terms, to achieve significant carbon emission reductions, especially in the short term.

Low carbon transport in the wider context

- 7.15 Whilst there is a need for carbon emission reduction targets from transport to be delivered, this needs to be balanced with the need for transport policy to contribute to the delivery of a wide range of social, economic and environmental objectives across the region. Decision makers across the region need to consider a number of aspects, including public acceptability and the ongoing desire of the population for continuing economic prosperity.

Appendix A

REAP

REAP

Explanation of REAP model

The Resources and Energy Analysis Programme (REAP) is a software tool developed by SEI, and can be used for the assessment, development and appraisal of the implementation of policy as well as a tool to formulate strategies for local, regional and national government.

The basis of the REAP model is an Input-Output (IO) table and uses economic returns from companies provided by the Treasury to construct a complete picture of the UK economy including all 'inputs' (domestically produced goods and imports) and all 'outputs' (domestic final consumption and exports). This matrix ensures that the complete supply chain of all products is taken into account.

In addition, REAP contains a database of environmental indicators available from the Environmental Accounts produced by the Office of National Statistics (ONS) for every local authority, government region and devolved nation in the UK. It provides baseline data which can be updated and monitored over time for:

- Carbon dioxide and greenhouse gas emissions,
- Air pollutants and heavy metals,
- Ecological Footprints and material flows.

These indicators are region-specific, comparable, and standardised, and when combined with the IO table, measure the impact of changes in the consumption activities of individuals. They take into account the direct and indirect pressures of the consumption of products and services throughout the economic supply chain. The important clarification here is the apportionment of the impact to the consumer (final demand – private households, government, capital investment) and includes intermediate impacts as well. This approach differs from most other tools which measure the CO2 emitted from production and direct fuel processes within a given region (known as the producer, or territorial responsibility).

Goods and services used by business are classified as an 'intermediate consumption' activity. This means that the environmental consequences of business activity are attributed to households, government or capital investment or to exports from the UK.

To put it in simplistic terms, when someone buys a loaf of bread, REAP takes into account the emissions arising from growing the wheat (which may be in a different country), processing it into flour, baking in an oven and transporting it to a shop as well as the energy used for lighting in the shop through the emission for that person.

For each local authority, the average spending per person by household activity (apart from domestic energy consumption) is broken down by Acorn socio-economic group. Because Acorn groups are assumed to behave the same way wherever they live, local authorities need to be able to update their baseline data based on the influence of local policy and conditions. In REAP this is done using the update data functions and scenario manager.

REAP's scenario manager can be applied to a wide range of policy areas including transport, food, housing, energy and planning. It can be used to assess the potential impact of regional strategies and

policies against targets and objectives comparing alternative pathways of development and to monitor the actual impact of policies over time. REAP can model scenarios up to 2050.

Modelling in REAP

Scenarios are developed in REAP through changes in the 'functional units' which are essentially variables (numbers that can change over time) describing a particular policy area, such as for example transport, food, or domestic energy. An example of a functional unit is the average number of passenger kilometres travelled by car in the Hambleton district. When a functional unit is changed, the REAP model calculates the corresponding impact on the carbon dioxide emissions in that area.

Functional units can be used to update the baseline situation (2001) and can be used to develop scenarios for policy interventions which have an impact up to any given future year.

For transport, the following functional units can be updated:

- Average passenger km travelled per person by mode of transport (car, taxi, motorcycle, bus, train or plane);
- Percentage occupancy by mode of transport;
- Vehicle ownership per 1000 people; and
- Fuel efficiency of each mode of transport.

Scenarios are visions of the future and rely on the knowledge and insight of trends, reactions of consumers as well as knowledge regarding the limits and thresholds of different variables. Much of this information is available in the published literature. Each scenario to be evaluated using REAP is comprised of a set of changes applied to the functional units.

REAP enables the user to specify how each functional unit will change from the baseline year over time using several techniques:

- Growth rates can be set as a percentage increase or decrease over a specific time period;
- A value can be entered for a particular variable in a step function;
- REAP can interpolate values between two years; or
- A hybrid version combining all three functions.

Scenarios can be applied to different local authorities or government regions and the results can be compared.

Fuel Price Fluctuations

REAP is based on a static, single-region, open, basic-price, 76-sector industry-by-industry input-output model of the UK economy, augmented with a database of environmental, social and economic indicators. The IO model behind REAP includes the oil industry as a sector and has a complete understanding the prices related to other sectors. This is reflected in the total output in monetary terms for each production category modelled in REAP (76 categories) based on market prices. The assumption here is that the market prices includes the cost of oil in its production.

Future oil price fluctuations cannot be modelled in REAP as it would require a full econometric analysis involving having detailed knowledge of price/supply elasticities for each production and consumption category as well as the propensity to substitute alternative sources of energy on the production side and to for products on the consumption side. There is huge potential for error in this and is beyond the scope of REAP.

In addition to oil price fluctuation the model does not allow for changes in the price of carbon or the effect of the EU Emission Trading Scheme. Also, whilst market price is of major importance factors such as non-energy resource scarcity could equally be important.

Business and business transport

UK consumption activities are split at the top level into four 'final demand categories' within the model. These are private households, government, capital investment and exports. The use of goods and services by business is classified as an 'intermediate consumption' activity. This means that the environmental consequences of business activity are attributed to final demand products consumed by households, government or capital investment or to exports from the UK. By saying this we imply that no or hardly any business activity would occur unless there was a final demand for it even when businesses buy goods and services from other businesses. This intermediate consumption is derived from the need to fulfil the demands of households (or government).

Freight

Within the model in REAP it is not possible to output results for the carbon emissions related to freight as these are classified as intermediate demand. However, it would be possible to undertake structural path analysis of individual products in an external model to estimate these emissions by aggregating each freight component throughout the supply chain (of that particular product). This was not original intention of the project and so was not conducted in this study.

District Categorisation

District Categorisation

District	Category
Barnsley	Town
Bradford	Town
Calderdale	Town
City of Kingston upon Hull	City
Craven	Rural
Doncaster	Town
East Riding of Yorkshire UA	Rural
Hambleton	Rural
Harrogate	Town
Kirklees	Town
Leeds	City
North East Lincolnshire UA	Town
North Lincolnshire UA	Rural
Richmondshire	Rural
Rotherham	Town
Ryedale	Rural
Scarborough	Town
Selby	Rural
Sheffield	City
Wakefield	Town

Case Study Details

Case Study Details

Bus Rapid Transit

Dublin, Ireland

Description

The Dublin scheme consists of with-flow bus priority lanes, together with traffic signal priorities on nine radial corridors into the city. Additional measures include improved waiting facilities with real-time passenger information, an upgraded bus fleet with low-floor, air-conditioned vehicles, restrictions on parking on the priority routes and staff trained in customer care.

Case study results

Between 1997 and 2003, total person trips by car reduced by 26% and total person trips by bus increased by 61%.

Reference

Booz Allen Hamilton (2006) International Approaches to Tackling Transport Congestion, Paper 10 (Final): Traffic Management - Road Space Reallocation, Victorian Competition and Efficiency Commission.

Available from: www.vcec.vic.gov.au (accessed 14th January 2008)

Modelling Methodology

Results were applied to all car and bus trips.

Smartcard

Belfast, Northern Ireland

Description

Belfast currently has a smartcard scheme covering both concessionary and commercial tickets. The ticket machine data was made available for the same months in 2002 and 2003, which allowed a comparison before and after the smartcard scheme was introduced.

Case study results

Analysis of the data showed that smartcards contributed to an increase in patronage of around 2%.

Reference

Metro and SYPTE (2003) YORCARD Regional Smartcard Ticketing: Annex E for the South Yorkshire and West Yorkshire Local Transport Plans

Modelling Methodology

Results were applied to all bus trips.

Light Rail

Tyne and Wear, Manchester, Sheffield, Birmingham, Nottingham

Description

Light rail systems currently exist in Tyne and Wear, Manchester, Sheffield, Birmingham and Nottingham (the Docklands Light Rail and Croydon Tramlink systems were excluded due to the differing operating conditions in London). Each system has been operational for a different length of time; however the Appendix to the Pteg report 'What Light Rail Can Do for Cities' provided the length of track and passenger trips made on each system from 2002 – 2003. Using this data, it was possible to derive the average number of passenger journeys per kilometre of track.

Case study results

On average, on the light rail systems outside of London, there are 430,000 passenger journeys per year, per kilometre of track.

On average, on the same networks, 17% of trips were previously made by car.

References

Steer Davies Gleave (2005) What Light Rail Can Do for Cities, A Review of Evidence, Final Report, Passenger Transport Executive Group.

Steer Davies Gleave (2005) What Light Rail Can Do for Cities, A Review of Evidence, Final Report: Appendices, Passenger Transport Executive Group.

Available from: <http://www.pteg.net/LightRailCentre/03-Whatlightrailcandoforcities.htm> (accessed 14th January 2008)

Modelling Methodology

Total trips and distance travelled by tram, based on the length of track to be introduced, were calculated. 17% of the distance travelled by tram (which was previously travelled by car) was then subtracted from the total distance travelled by car for all purposes.

Rail Improvements

West Yorkshire

Description

As part of the baseline data collected to support the Yorkshire and Humber Route Utilisation Strategy, Network Rail have collected patronage growth data in West Yorkshire from 1996 – 2006. As part of this data, a comparison has also been made between the Airedale Line and the other lines in West Yorkshire. Since the Airedale Line has been electrified, this data was used to show the difference which can be made through this rail improvement.

Case study results

The data showed that patronage growth on the Airedale Line was 44% higher than on the other lines in West Yorkshire.

In order to ascertain how much of this passenger growth was previously by car, two further pieces of research were consulted. 'What Light Rail Can Do for Cities' states that typically, 20% of light rail users transfer from car. The 'Smarter Choices - Changing the Way We Travel' report (Public Transport Information and Marketing section) quotes a number of pieces of research which provide the proportion of

bus users who switched from car on several quality partnership routes throughout England. The average from these case studies was again 20%. Hence 20% was considered to be a robust figure for the percentage of new rail passengers who switched from car use.

References

Network Rail (2007) Yorkshire and Humber Route Utilisation Strategy Baseline Data: Yorkshire and Humber Passenger Flows, Network Rail

Available from: www.networkrail.co.uk (accessed 15th January 2008)

Steer Davies Gleave (2005) What Light Rail Can Do for Cities, A Review of Evidence, Final Report, Passenger Transport Executive Group.

Available from: <http://www.pteg.net/LightRailCentre/03-Whatlightrailcandoforcities.htm> (accessed 14th January 2008)

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel: Public Transport Information and Marketing, DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

Modelling Methodology

In order to derive how much of the population in each district would be affected by electrification, the population of the area surrounding each railway station within each district was noted. For urban centres, the population was not taken into account as accounting for all of the population surrounding, for example, Leeds train station would over exaggerate the benefit of the improvement. The population surrounding train stations was then calculated as a percentage of the total population of each district, and this was adopted as the total population likely to be affected by the improvement.

Results were applied to all train trips and 20% of trips (which were previously travelled by car) were then subtracted from the total distance travelled by car for all purposes.

Workplace Travel Plans

Various, England

Description

The 'Smarter Choices - Changing the Way We Travel' report (Workplace Travel Plans section) refers to a number of pieces of research detailing the reduction in car trips which may be achieved through workplace travel plans both in the UK and abroad. The reductions ranged from 6% - 25% depending on the measures contained within the plan. The 'Guidance on the Assessment of Travel Plans' report also suggests reductions in car trips from 3% - 30% depending on the measures implemented. Furthermore, the DfT report 'Making Travel Plans Work: Research Report' contains monitoring data from 21 best practise workplace travel plans from around the country, and this research gives an average reduction in car trips of 18%. This research also provides increases in public transport use and car sharing as a result workplace travel plans.

Case study results

Combining all of this evidence, a reduction of 20% for well implemented travel plans was assumed. The average increase in public transport use (excluding two outliers), using the Smarter Choices report, was 148% and in car sharing (excluding outliers) was 33%.

References

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel: Workplace Travel Plans, DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

DfT (2005) Guidance on the Assessment of Travel Plans, DfT

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2002) Making Travel Plans Work: Research Report, DfT

Both available from: www.dft.gov.uk/?view=Filter&t=travel+plans&pg=1 (accessed 15th January 2008)

Modelling Methodology

Using data from the National Statistics documents 'UK Business: Activity, Size and Location -2007', the percentage of businesses with over 20 employees was calculated for each district. This percentage was then multiplied by the population of each district to find the number affected by the measure. The results were applied to car and bus commuting trips (which then accounts for people in the population that do not work).

Home Working and Teleworking

Netherlands, Germany

Description

The 'Smarter Choices - Changing the Way We Travel' report (Teleworking section) details the effectiveness of teleworking in reducing car trips and distance travelled, through several pieces of research from around the world. The most useful case studies for the low carbon strategy model were those which detailed the reduction in total trips amongst teleworkers. There are two such case studies in the Smarter Choices report.

Case study results

In the Netherlands, teleworkers' overall number of trips fell by 17% compared to the number of trips made before the teleworking began. In Germany, people who began teleworking reduced their trips by 19%. Hence, an average of this, 18% was used in the model.

Reference

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel: Teleworking, DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

Modelling Methodology

The Smarter Choices report quotes two studies which suggest that the potential for teleworking in the employed population could be 23 – 40% (but it does still depend on to what extent jobs become more information related), so an average of this, 31%, was adopted. Furthermore, the report also states that 7% of the population were already working from home for at least one day per week in 2001, so the *additional* potential for teleworking was calculated to be 24%.

Using Census and travel to work data, the total percentage of the population commuting to work in each district was calculated. The percentage affected by the intervention was then calculated as the additional potential for teleworking multiplied by the population commuting to work.

Results were applied to all trips by car, bus and rail (as the research applied to all trips made by teleworkers).

Travel Awareness and Education

York, Nottingham, Brighton

Description

The travel awareness campaign in York consisted of a sustained campaign (rather than short burst events), aimed towards the whole city, mainly encouraging walking and cycling through advertisements on the back of buses, city centre parking tickets, out-of-town cinema tickets etc. Campaigns were also linked to infrastructure improvements such as new cycle lanes.

In Nottingham, the 'Big Wheel' brand was established as part of their travel awareness campaign and was used on timetables, school travel plan packs, workplace travel plan information, postcards, posters etc. At the same time, the largest bus operator also refreshed its marketing alongside the council, offering multi-operator interchange information at bus stops, city sector guides, themed maps and information in a variety of formats.

In Brighton, a long standing partnership between the council and the bus operator exists which aims to make the bus network easy to use. Elements of their approach include 'Metro' service branding, flat fares, a customer service culture, 'Bus Times' publication giving information about services from all operators, a one-stop-travel shop and a telephone helpline.

Case study results

In York, it is estimated that the campaign reduced car use in the city between 0.17% and 2.4%. Hence an average reduction of 1.3% was adopted.

In Nottingham, the campaign achieved a 1.8% increase in passenger journeys per year, where previously there had been a decline of 1% per year. In Brighton, bus passenger growth was 5% per year, on average. Hence an increase of 4% per year was adopted.

Reference

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel (Travel Awareness Campaigns and Public Transport and Information Marketing sections), DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

Modelling Methodology

Results were applied to all car and bus trips.

Personalised Journey Planning

Various, UK

Description

The DfT report 'Making Personalised Travel Planning Work: Case Studies' provides a summary of the key personalised travel planning projects which have taken place in the UK and Australia recent years. In each case study area, the report provides details of what the project consisted of as well as the impacts achieved.

Case study results

For the low carbon strategy model, an average of all available UK data regarding changes in car driver, car passenger and public transport trips was used. On average, car driver trips reduced by 10%, car passenger trips reduced by 8% and public transport trips increased by 12%.

Reference

DfT (2007) Making Personalised Travel Planning Work: Case Studies, DfT

Available from: www.dft.gov.uk/pgr/sustainable/travelplans/ptp/ (accessed 16th January 2008)

Modelling Methodology

Results were applied to all car and bus trips.

School Travel Plans

Various, England

Description

The 'Smarter Choices - Changing the Way We Travel' report (School Travel Plan section) details the effectiveness of school travel plans in reducing car use in several local authority areas in England.

Case study results

The report concludes that an 8-15% reduction in car use may be achieved in schools where 'travel work has developed sufficiently that it could be expected to have made an impact' (DfT, 2004). Hence an average of this, 12%, was used in the model.

Reference

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel (School Travel Plans section), DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

Modelling Methodology

The School Travel Plan Co-ordinator for Yorkshire and Humber has advised that 64% of schools currently have travel plans. Hence the results were applied to the schools trips of the remaining 32%. In addition, the proportion of education trips made by bus with respect to other sustainable modes (walk, cycle, bus) was calculated, and an equivalent increase in bus use was applied.

Home Shopping

Two studies, UK

Description

The 'Smarter Choices - Changing the Way We Travel' report (Home Shopping section) provides a summary of the nature, scale and scope of home shopping, as well as its possible implications for transport.

Case study results

Two studies in the report conclude that grocery home shoppers make on average, 3.5 fewer car journeys per month. Combined with National Travel Survey data, this equates to a 19% reduction in shopping trips.

Reference

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel (Home Shopping section), DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

Modelling Methodology

Results were applied to car and bus shopping trips.

Car Clubs

Various

Description

The 'Smarter Choices - Changing the Way We Travel' report (Car Clubs section) provides a summary of the growth in car clubs, their target market and the current scale and scope of car clubs both in the UK and abroad. Through a number of case studies, it was possible to calculate the average percentage reduction in annual car mileage per car club member.

Furthermore Carplus has also carried out research into the reduction in car mileage which can be achieved through joining a car club.

Case study results

The Smarter Choices report gave reductions of 33%, 27% and 25% in three different case studies and the Carplus research gave a 50% reduction in car mileage. Hence a reduction of 30% was adopted in the model.

References

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel (Car Clubs section), DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

www.carplus.org.uk/carclubs/car-clubs-&-carbon-savings.htm (accessed 16th January 2008)

Modelling Methodology

Results were applied to car mileage for all purposes.

Car Share

Milton Keynes

Description

The car share scheme in Milton Keynes is primarily aimed towards commuters and was launched with substantial publicity. To qualify, two registered sharers must display their individual but linked permits together in the windscreen of the vehicle.

Benefits include:

- Free parking in central Milton Keynes (both standard and 'prime' sites –usually 20p and 80p per hour respectively);

- Sharers also receive discounts on the bus services (typical fares of over £1 are reduced to 55p); and
- There is a 'Gold card' which gives extra benefits for heavy users.

Case study results

Of the 1200 members registered in summer 2003, over 90% were routinely using the scheme (1080). This equates to a 34% increase in car sharing amongst the 11,658 car drivers and passengers entering Milton Keynes in the peak hour before the scheme was implemented.

Reference

Cairns, S., Sloman, L., Newson, C., Anable, J., & Goodwin, P. (2004) Smarter Choices - Changing the Way We Travel (Car Sharing section), DfT

Available from: www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/ (accessed 15th January 2008)

Modelling Methodology

Results were applied to commuting car trips.

HOV Lane

Leeds

Description

A High Occupancy Vehicle (HOV) lane was introduced on the A647 Stanningley Road and Stanningley By-Pass in 1998. Stanningley Road and Stanningley By-Pass form the principal radial route to the west of Leeds city centre and are part of the route linking Leeds and Bradford. The HOV lane is available to buses, coaches, other vehicles carrying 2 or more people, motorcycles and pedal cycles. Goods vehicles over 7.5T are not permitted to use the lane. The lanes operate in the morning and evening peak periods (07:00 – 10:00, 16:00 – 19:00) on Mondays to Fridays. The scheme also included police enforcement lay-bys, speed cameras, improved street lighting, improvements at bus stops, pelican crossings with tactile paving, anti-skid surfacing and changes to traffic circulation on side roads.

Case study results

Average car occupancy rose from 1.35 in May 1997 to 1.43 by June 1999 and 1.51 in 2002 (12% increase in total) and bus patronage increased by one per cent in the first year of operation.

Reference

DfT (2006) Bus Priority – The Way Ahead: Resource Pack Edition 2, DfT.

Available from: www.dft.gov.uk/pgr/regional/buses/bpf/busprioritythewayahead12/ (accessed 16th January 2008)

Modelling Methodology

Results were applied to car and bus commuting trips.

Mileage Road User Charging

UK

Description

In 2003, the Government commissioned a study to examine how charging for road use could help make better use of current road capacity. As part of the study, the impact on traffic and congestion of various pricing regimes was examined. In addition, more detailed analysis of a marginal social cost scenario with 10 prices and a maximum charge of 80p/km was also carried out. As part of this analysis, the impact on mode choice by journey purpose was presented.

Case study results

For commuting, educational and personal business trips, car driver trips reduced by 4%, car passenger trips increased by 8%, bus trips increased by 2% and train trips increased by 5%.

For recreational trips, car driver trips reduced by 7%, car passenger trips increased by 10%, bus trips increased by 5% and train trips increased by 14%.

Reference

DfT (2004) Feasibility Study of Road Pricing in the UK: Annex B Modelling Results and Analysis, DfT

Available from: www.dft.gov.uk/pgr/roads/roadpricing/feasibilitystudy/studyreport/ (accessed 16th January 2008)

Modelling Methodology

Results were applied to car, bus and train trips according to the classification used in the DfT report (see above).

Congestion Charging

London

Description

The scheme consists of a fixed charge for driving / parking in central London in a motorised vehicle (buses, taxis and motorbikes excepted) between 07.00 and 18.30 Monday to Friday. The zone is clearly indicated by signs, on-road markings and publicity.

Case study results

Monitoring of the scheme indicated that traffic levels in the zone had reduced by 18%. Social and behavioural surveys undertaken showed that of these, around 55% changed to public transport use.

Reference

TfL (2004) Congestion Charging: Second Impacts Monitoring Report, TfL

Available from: www.tfl.gov.uk/assets/downloads/Impacts-monitoring-report-2.pdf (accessed 16th January 2008)

Modelling Methodology

Data from a presentation given by the Head of Transport Policy at Leeds City Council, showed that only 30% of trips crossing the cordon into Leeds (from outside of the outer ring road) actually terminated in the city centre. Hence this was adopted as the proportion of trips that may be affected by the measure.

Results were applied to car, bus and train commuting trips (as the charge was assumed to apply in peak hours only and hence affect mainly commuters).

Car Free Zones

Oxford

Description

The Oxford Transport Strategy was a six year programme to reduce congestion, improve the urban environment and quality of life Oxford. The central aim of the strategy was to shift private car trips to bus cycle, and foot. In 1999, central area access restrictions were implemented which consisted of:

- Bus priority route around the central area, pushing general traffic further out of the city centre;
- The major shopping street was closed to all traffic;
- Other key routes were closed to through traffic or only allowed daytime access for cyclists, buses and taxis;
- City centre cycle route were improved; and
- 350 extra cycle parking spaces were provided.

Case study results

Between 1999 and 2002, traffic into the city centre reduced by an average of 18% and bus patronage increased by 8-9%.

References

DfT (2005) Encouraging Walking and Cycling: Success Stories – Chapter 1, DfT.

Available from: www.dft.gov.uk/pgr/sustainable/walking/success/ (accessed 16th January 2008)

DfT (2006) Bus Priority – The Way Ahead: Resource Pack Edition 2, DfT.

Available from: www.dft.gov.uk/pgr/regional/buses/bpf/busprioritythewayahead12/ (accessed 16th January 2008)

Modelling Methodology

As with congestion charging, it was assumed that 30% of trips were destined for town / city centres (assuming that the Leeds City Council data applied to journeys to towns and cities across the region).

Results were applied to all car and bus trips.

Land Use Planning in New Household Schemes

Camden, London

Description

Camden is a local authority within Central London highly accessible by public transport. The council has a policy in favour of car free housing, where the developer will sign up to it via a section 106 agreement. Schemes should have no on-site car parking spaces and residents of car free housing schemes are not

eligible for on street car-parking permits and are not allowed to park in a council owned car parks (with exemptions for disabled drivers).

Case study results

Camden estimates that the 242 agreed schemes, covering 2,330 dwellings, will save around 4,660 car trips per day (equivalent to 730 trips per household per year).

Reference

DfT (2005) Encouraging Walking and Cycling: Success Stories – Chapter 1, DfT.

Available from: www.dft.gov.uk/pgr/sustainable/walking/success/ (accessed 16th January 2008)

Modelling Methodology

The predicted growth in household numbers was derived for each district from the Sub-Regional Household Projection figures (2004 based). The number of people per household was also calculated using the population and household figures. Hence, the number of people affected was calculated as the number of new houses multiplied by the number of people per household.

Case study results were then applied to car trips amongst this group.

Scenarios

Scenarios

Step Change Scenario

2016	Percentage of target group affected		
Measure	City	Town	Rural
Bus priority	50	40	0
Regional smartcard	100	100	100
Rail improvements	100	50	0
Workplace travel plans	45	45	45
Home working and teleworking	25	50	50
Travel awareness and education	50	50	50
Personalised journey planning	22.5	22.5	10
School travel plans	50	50	50
Grocery home shopping	7.5	7.5	2
Car clubs	5	5	1
Carshare	50	50	50
HOV lane	50	40	0
Mileage road user charging	0	0	0
Congestion charging in urban centres	100	0	0
Car free zones	100	0	0
Land use planning	100	50	50

2021	Percentage of target group affected		
Measure	City	Town	Rural
Bus priority	25	10	0
Regional smartcard	0	0	0
Rail improvements	0	50	0
Workplace travel plans	45	45	45
Home working and teleworking	25	50	50
Travel awareness and education	50	50	50
Personalised journey planning	22.5	22.5	10
School travel plans	50	50	50
Grocery home shopping	7.5	7.5	2
Car clubs	5	5	1
Carshare	50	50	50
HOV lane	25	10	0
Mileage road user charging	0	0	0
Congestion charging in urban centres	0	0	0
Car free zones	0	100	0
Land use planning	100	50	50

[Note: Light Rail was only included in the accelerated scenario]

Accelerated Scenario

2016	Percentage of target group affected		
Measure	City	Town	Rural
Bus priority	50	50	10
Regional smartcard	100	100	100
Rail improvements	100	100	100
Workplace travel plans	90	90	90
Home working and teleworking	30	100	100
Travel awareness and education	100	100	100
Personalised journey planning	45	45	15
School travel plans	100	100	100
Grocery home shopping	15	15	7.5
Car clubs	10	10	2
Carshare	100	100	100
HOV lane	50	50	10
Mileage road user charging	100	100	100
Congestion charging in urban centres	0	0	0
Car free zones	100	100	0
Land use planning	100	100	100

2021	Percentage of target group affected		
Measure	City	Town	Rural
Bus priority	25	25	10
Regional smartcard	0	0	0
Rail improvements	0	0	0
Workplace travel plans	0	0	0
Home working and teleworking	30	0	0
Travel awareness and education	0	0	0
Personalised journey planning	15	15	15
School travel plans	0	0	0
Grocery home shopping	0	0	7.5
Car clubs	0	0	0
Carshare	0	0	0
HOV lane	25	25	10
Mileage road user charging	0	0	0
Congestion charging in urban centres	0	0	0
Car free zones	0	0	0
Land use planning	100	100	100

In addition, light rail systems were implemented in 2021 as follows:

- Leeds – 28km (length of proposed Supertram)
- Hull – 20km (slightly less than Leeds assumed)
- Sheffield – 3km (extension to current system)
- Rotherham – 3km (extension to current system)

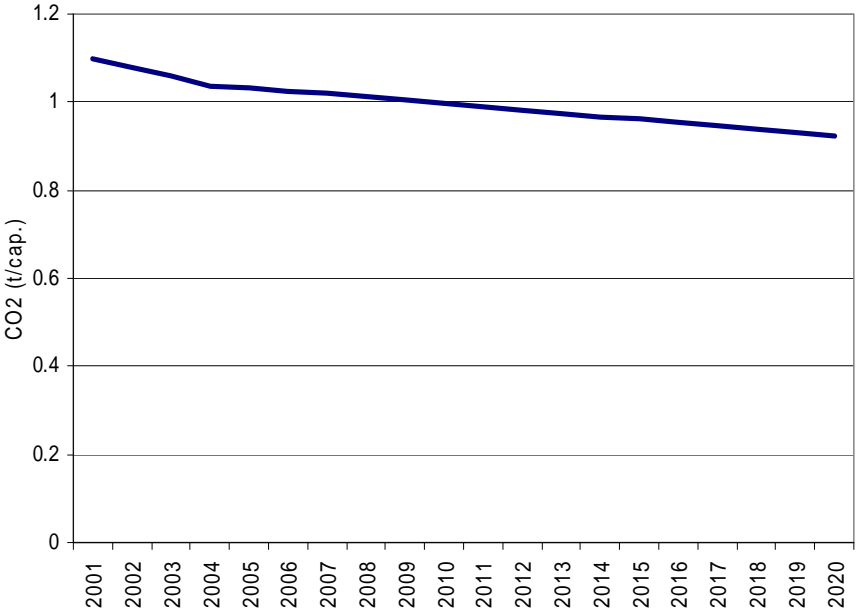
Business as Usual Scenario

Business as Usual Scenario

Firstly, in Figure E1, the impact of technological improvements from vehicles in line with national developments is shown. This will result in a 14% reduction in CO₂ emissions. This underlying trend will influence all of the modelled impacts in each of the three scenarios, as the influence of regional policy on vehicle technology is nil.

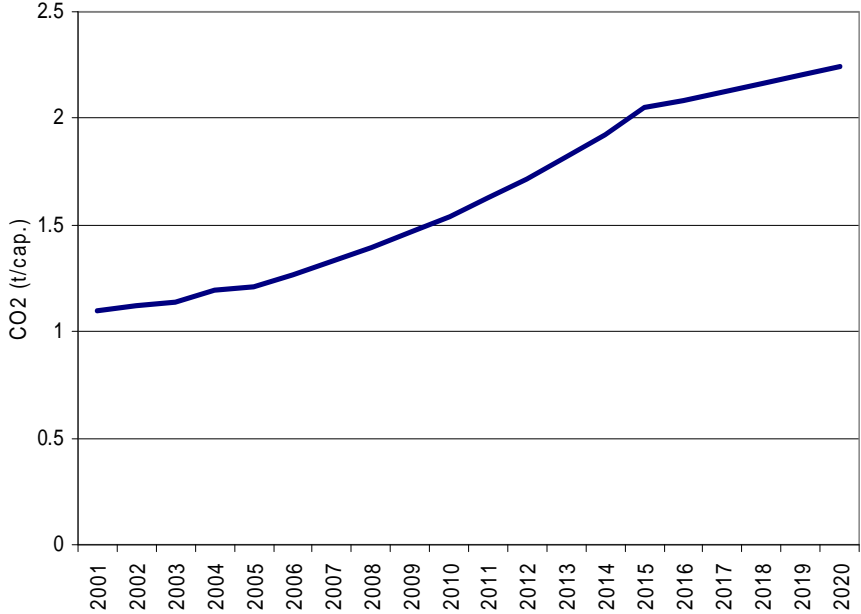
Vehicle manufacturers will continue to improve engines to reduce carbon dioxide emissions over the period to 2020, and this is shown below.

Figure E1 Direct CO₂ emissions from car, bus and train use in Yorkshire and the Humber accounting for technological improvements



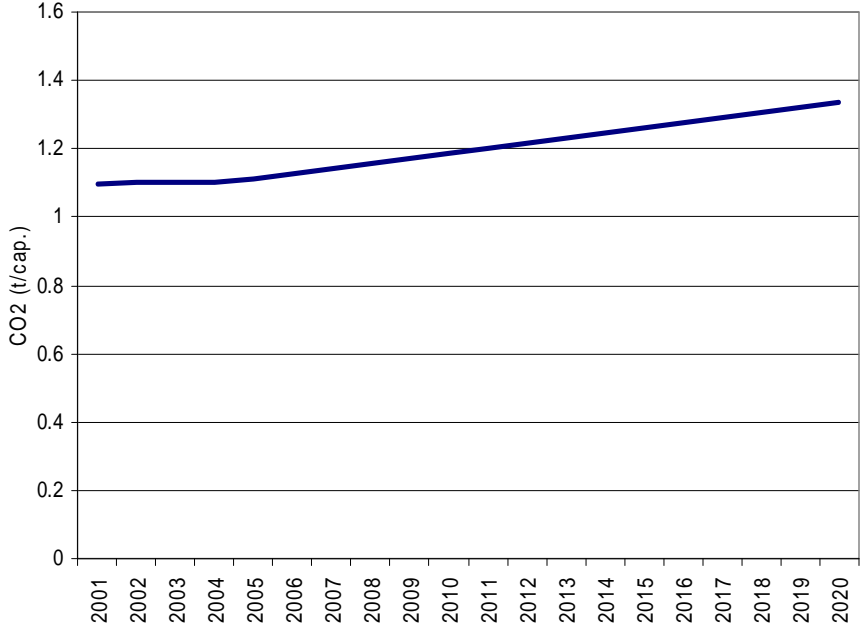
Conversely, Figure E2 shows the influence of the trend of decreasing occupancy levels in vehicles with current policies. This will result in a doubling of CO₂ emissions by 2020. In the absence of robust vehicle occupancy data for the whole of the region, this is based upon national trends of vehicle occupancy. Where data is available within the region, it is consistent with national trends, showing reduced average occupancy levels over time, especially with respect to car occupancy levels.

Figure E2 Direct CO₂ emissions from car, bus and train use in Yorkshire and the Humber accounting for changes in vehicle occupancy



Finally, Figure E3 below shows the influence of the trend of distances travelled with current policies. Increasing distances travelled by residents of the region will result in a 21% increase in CO₂ emissions by 2020.

Figure E3 Direct CO₂ emissions from car, bus and train use in Yorkshire and the Humber accounting for distance travelled by mode



Appendix F

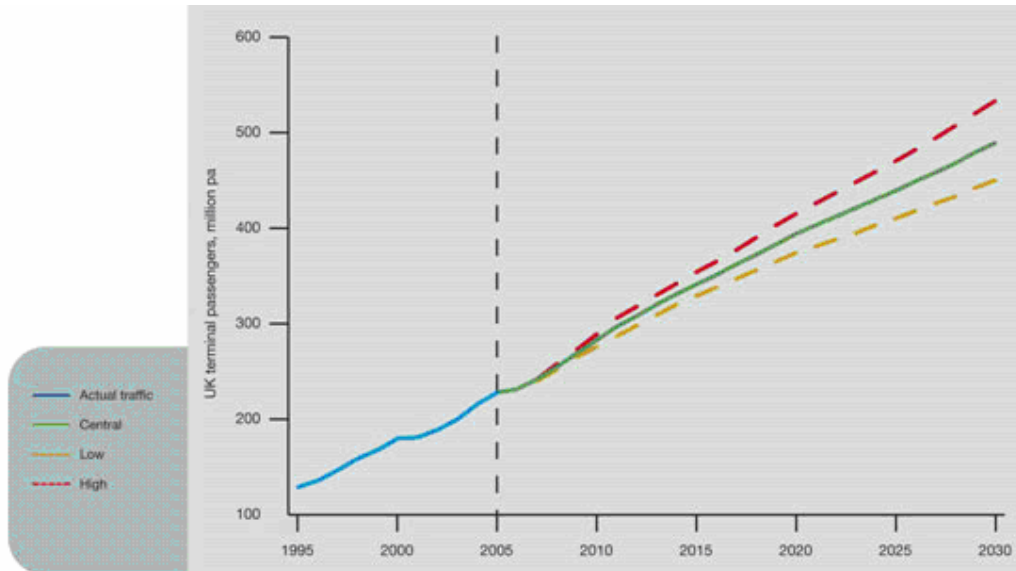
Aviation Issues

Aviation Issues

UK Forecasts in Demand for Aviation

UK demand for air travel is forecasted to grow from 228 million passengers per annum (mppa) in 2005 to 495 mppa in 2030 based on an assumption that any climate change costs are paid by passengers and capacity is unconstrained¹. If growth is constrained because of restrictions on new runways and terminals, demand reduces in 2030 to 480 mppa.

Figure F1: UK Growth in Air Passengers 1995 - 2030²



The key drivers for this growth include higher incomes, ownership of second homes abroad, more leisure time, older and more affluent retired population, access to cheap flights and additional services from regional airports.

New markets for air travel are emerging in addition to the traditional package holiday. People are taking more frequent short breaks to watch sports, to visit friends and relatives, for medical treatment and the increased migrant population returning home³.

¹ Department for Transport (2007) UK Air Passenger Demand and CO₂ Forecasts, Department for Transport.

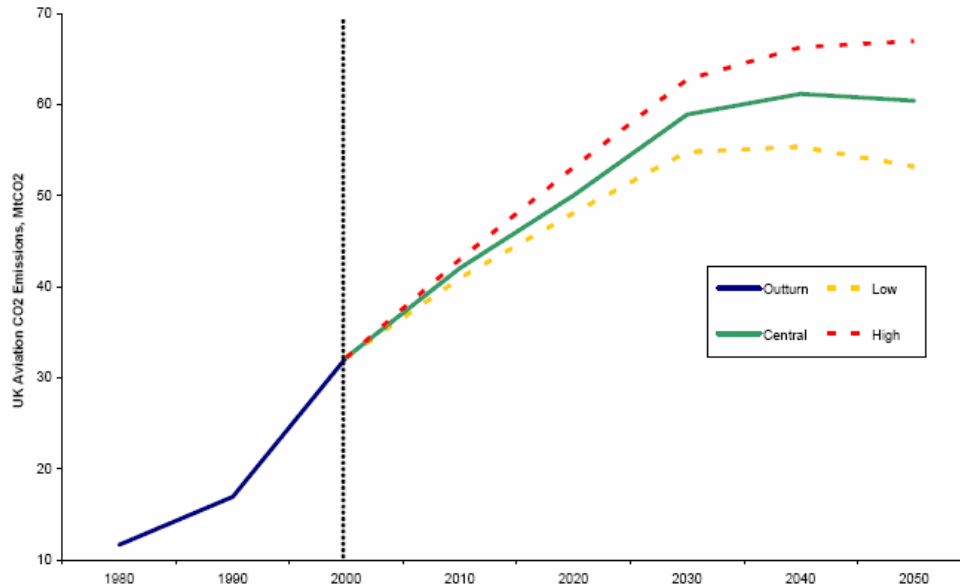
² Ibid 4.

³ Civil Aviation Authority (2007); A. CAP 775 Air Services at UK Regional Airports An Update on Developments, Civil Aviation Authority

UK Emissions from Aviation

The UK's CO₂ emissions from aviation have risen from 12 million tonnes (Mt) of CO₂ in 1985, to 21 Mt CO₂ in 1995 and 37.5 Mt CO₂ in 2005. This is illustrated in Figure F2 below⁴.

Figure F2 UK CO₂ emissions from aviation⁵



Furthermore, emissions are forecast increase to 59 Mt CO₂ in 2030. After 2030, the growth in emissions is projected to slow, partly due to capacity constraints slowing demand growth. By 2050 emissions are projected to flatten and reach 60Mt CO₂⁶ (these figures take into account oil and carbon dioxide prices and projections in GDP).

In order to accomplish the government's overall target of reducing CO₂ emissions to 60 per cent of 1990 levels without curtailing aviation growth, it will require other sectors (industry and individuals) to make significant reductions or totally "decarbonise"⁷.

UK Aviation Policy

The Future of Air Transport White Paper (ATWP), published by the Department for Transport (DfT) in December 2003 recognises the importance of aviation to our national and regional economies and takes the stance that a balanced approach to aviation growth is required but the impacts of airports on those who live nearby and on the natural environment should be reduced or minimised⁸.

With air passenger growth rates rising over the next thirty years, the capacity of many airports will be reached and the White Paper outlines the future capacity increases required to accommodate this growth

⁴ Department for Transport (2007) UK Air Passenger Demand and CO₂ Forecasts, Department for Transport

⁵ Ibid, 5.

⁶ Ibid, 5.

⁷ Anderson, K. and Bows, A. (2007) Policy clash: Can projected aviation growth be reconciled with the UK Government's 60% carbon-reduction target? Transport Policy. Volume 14, Issue 2, March 2007, Pages 103-110

⁸ DfT (2003) The Future of Air Transport White Paper, Department for Transport

across the UK. This includes new runways at Birmingham, Edinburgh, Stansted and Heathrow airports, and expanding infrastructure, e.g. new terminals, apron and runway extensions.

In particular, to reduce congestion in the South East and to promote regional development, the White Paper suggests people should be encouraged to use local airports by increasing the choice of routes available, especially direct to long and short haul destinations as well as improving services⁹. This approach would see an increase in passengers utilising Yorkshire and Humberside airports.

Demand for Aviation in Yorkshire and Humberside

There are three main airports located in the region, namely Leeds-Bradford, Humberside and Robin Hood Airport Doncaster Sheffield (see Figure F3). The number of passengers and carbon dioxide emissions from each airport in 2005 is shown in Table F4.

Figure F3 Map of Airports in Yorkshire and Humber Region



Leeds Bradford Airport is the largest airport in the Yorkshire and Humber region. Its growth is largely attributable to no-frills services operating out of the airport in addition to scheduled services. The Air Transport White Paper supported a 300 metre runway extension with accompanied measures to minimise and mitigate noise impacts but there are no plans for this before 2016. Leeds and Bradford City Councils recently sold their combined 80 per cent stake in the airport.

Robin Hood Airport Doncaster Sheffield, formerly RAF Finningley, became a civil airport in 2005. Passenger numbers have increased from 600,000 (after 8 months opening) to 900,000 in 2006. It flies to more than 45 destinations including some long-haul flights to Canada, Florida and Mexico.

Humberside Airport is a relatively small airport and provides limited scheduled and charter passenger services to a number of short haul destinations. It also operates freight and helicopter services to the North Sea oil and gas platforms.

⁹ Ibid, 64.

Table F4: Passenger Movements at Yorkshire and Humberside Airports 1990-2005¹⁰

Airport	Millions of Passengers per annum (mppa)		Carbon Dioxide
	1990A	2006A	Mtonnes
Leeds Bradford	0.8	2.9	0.2
Robin Hood	-	0.9	<0.1
Humberside	0.1	0.5	<0.1

Predominantly, people from Yorkshire and Humberside make up the majority of passengers flying from airports in the region. In addition to these airports, people fly from Manchester, Teesside, Newcastle, and to a lesser extent, from those in the South East (Heathrow, Gatwick, Luton, Stansted). Full passenger figures for Yorkshire and Humber residents are shown in the table below. The main airport outside the region is Manchester airport, used for both short and long haul flights as well as for interconnections for long haul flights from London airports or other major European hubs (Paris, Frankfurt, Schipol).

Table F5: Origin and Destination of Yorkshire Humberside Passengers 2005¹¹

Airport	Origin/Destination YH Passengers	
	Numbers ('000s)	% of Total at Airport
Manchester	4,226	20.1
Leeds Bradford	2,316	93.8
Heathrow	425	1.0
Humberside	506	95
Durham Tees	108	12.6
Newcastle	180	3.6
Gatwick	169	0.6
Stansted	326	1.7
Luton	108	1.6

Policy Measures for Aviation in Yorkshire and Humberside

Very little can be done at a regional level to reduce the emissions from air travel as it is largely determined by international and national policy. Passenger demand growth rates may decline without any policy intervention as the market matures quicker than expected or due to general economic decline which causes people to become more cautious with money. Security as well as health and safety issues related to aviation can also affect demand. However, the region can still aim to reduce emissions related to surface activities, in particular through airport operation and passenger surface access.

Following the ATWP, airport operators are required to produce "master plans" to outline the strategic framework for the approach to development and the growth of the airport, including how they will address environmental issues. Airport master plans need to be developed by airports handling more than 1 million passengers (which currently excludes Humberside). These do not have a statutory status but are expected to be considered in the preparation of regional and local policies and planning decisions.

These master plans include work place travel plans and plans for improvements in surface access. These include a statement on how airport emissions are managed by the airport operating company.

¹⁰ Civil Aviation Authority (2007); A. CAP 775 Air Services at UK Regional Airports An Update on Developments, Civil Aviation Authority B. Department for Transport (2007) UK Air Passenger Demand and CO2 Forecasts, Department for Transport

¹¹ Civil Aviation Authority (2006), CAA Passenger Survey Report 2005, CAA Economic Regulation Group, Civil Aviation Authority

Transport demand management policies which reduce surface emissions of CO₂ primarily from cars can be applied to airports. As the airports in the region primarily serve Yorkshire and Humberside citizens (as modelled by REAP), they will have a direct effect in reducing overall emissions from the region.

One form of demand management policy is to increase the cost flying. In the UK, Air Passenger Duty (APD) is applied on tickets to all domestic and international destinations departing in the UK. In February 2007, APD was doubled to £10 for domestic trips and EU destinations and £40 for other destinations to cover the environmental/climatic impact of airlines. This generates approximately £2 billion in government revenue and is estimated to reduce passenger number by 4 per cent.

The Government now intends to reform the taxation of aviation to send better environmental signals and ensure aviation makes a greater contribution to covering its environmental costs. Therefore from 1 November 2009, the Government proposes to replace APD with a duty payable per plane rather than per passenger.

Aviation and Global Climate Change

The Intergovernmental Panel on Climate Change (IPCC) recognised aviation as being of major importance for the global climate following publication of its report "Aviation and the Global Atmosphere"¹² At international and inter-governmental levels, work on assessing the scale and impact, as well as devising applicable policies to reduce its climatic impact, has been undertaken under the auspices of the United Nations through the Framework Convention on Climate Change (UNFCCC) and at the International Civil Aviation Organization (ICAO). It should be noted that in compiling national greenhouse gas inventories as required by international law under the UNFCCC, only aviation emissions from domestic aviation are reported in national accounts. International aviation is only included as a memo item in the inventory.

The IPCC report used the metric 'radiative forcing of climate' as a way of assessing the overall impact of aviation. This is a globally averaged measure of the imbalance in radiation caused by the addition of an activity or emission, in this case aviation's greenhouse gas emissions. The IPCC calculated the 'radiative forcing index' (RFI) for aviation at 2.7¹³. This means that emissions by aviation in the atmosphere are 2.7 times stronger than those emitted on the ground taking into account the warming effect of non-carbon emissions released at altitude. Since the report was published, further scientific evidence has reduced the RFI to 1.9¹⁴ but this does not include the effects of cirrus clouds. The RFI is also referred to as the 'uplift factor' and is often not included in the estimates of total aviation emissions because of some degree of scientific uncertainty.

Aviation's impact on global warming will continue to grow due to global demand growth at 5.9% per year¹⁵ and account for as much as 6% of total radiative forcing from human activities by 2050¹⁶. Internationally, the impact of aviation's atmospheric greenhouse gas emissions can be reduced through improved air traffic management which reduces congestion in the air and on the ground, through improvements in technology leading to more efficient engines and better aerodynamics and through airline operations, i.e. reducing excess weight on-board aircraft. However, these improvements will be insufficient to match the emission increases due to the phenomenal global growth.

¹² IPCC (1999) Aviation and the Global Atmosphere: A Special Report of the Intergovernmental Panel on Climate Change, Cambridge University Press

¹³ Ibid

¹⁴ Sausen, R., Isaksen, I., Grewe, V., Hauglustaine, D., Lee, D. S., Myhre, G., Kohler, M. O., Pitari, G., Schumann, U., Stordal, F. & Zerefos, C. (2005) Aviation radiative forcing in 2000: An update on IPCC (1999). Meteorologische Zeitschrift, 14 (4), 555-561.

¹⁵ IPCC (2007) Fourth Assessment Report Working Group III Report "Mitigation of Climate Change". Chapter 5. transport and Its Infrastructure. WMO and UNEP, Switzerland.

¹⁶ Royal Commission on Environmental Pollution (2002) The Environmental Effects of Civil Aircraft in Flight. RCEP

Modelling Aviation in REAP

The way REAP considers aviation is to allocate emissions for non-business flights only on a per capita basis which means that the airport from which flights are taken is largely irrelevant (business travel is included in intermediate consumption).

Therefore, REAP takes into account the burden of responsibility for emissions which may be made at airports in other regions (e.g. North West including Manchester and John Lennon airports). REAP also allocates CO₂ emissions from tourists to the region as a negative contribution to total CO₂ emissions. Consequently, these emissions are apportioned to the country of the passenger's residence and are therefore not counted in the total for Yorkshire and Humberside.

The data modelled in REAP includes:

a) International and domestic demand - the kilometres travelled per person per year (PKMS) for international and domestic air travel and includes commuting and all personal travel but not business travel.

Baseline value for Yorkshire and Humberside ¹⁷

International:	3969.293 pkms
Domestic:	93.486 pkms

b) Passenger occupancy rates - actual occupancy of aircraft (a fully occupied aircraft would have a value of 100%; so an occupancy of 30%, for example, indicates that less than a third of the available seats / spaces are actually used):

Baseline value for Yorkshire and Humberside ¹⁸

International:	69 per cent
Domestic:	69 per cent

c) Annual growth rates - the international and domestic aviation growth rates used for the scenarios in REAP follow national trends:

Baseline value for Yorkshire and Humberside ¹⁹

International:	4.5 per cent per annum
Domestic:	3.6 per cent annum

Whilst the 'uplift' factor to account for contrails and other gases released by aircraft in the atmosphere is recognised as a major contribution to the global warming impact from aviation, only a modest factor of 1.14 is currently modelled in REAP due the level of scientific certainty known when the software was developed. However, it is clear from the results presented below that aviation has a significant effect on total transport emissions.

Table F6 shows the modelled results for aviation inclusive of the uplift factor used by Defra after Sausen et al²⁰ (2005). The results show that under the Business As Usual scenario that carbon emissions from aviation will increase by 140 per cent between 2001 and 2021.

¹⁷ Civil Aviation Authority (2001) UK Airport Statistics: 2001, Civil Aviation Authority

¹⁸ Department for Transport (2002) Transport Statistics Bulletin: National Travel Survey 2002, Department for Transport

¹⁹ Department for Transport (2003) The Future of Air Transport White Paper, Department for Transport

Table F6 Total CO₂ (Mtonnes) Emissions Yorkshire and Humberside in the *Business As Usual Scenario* for Aviation with Uplift of 1.9

	2001	2011	2016	2021	% change 2001-2021
Total CO ₂ all land-based transport (excluding aviation)	10.4	12.3	14.2	14.4	+39%
Total CO ₂ from aviation without uplift	2.0	3.1	3.8	4.8	+140%
Total CO ₂ from aviation with uplift	3.8	5.8	7.3	9.0	+140%
Total CO ₂ including all land-based transport and all aviation with uplift	14.1	18.1	21.4	23.5	+66%

Finally, it should be noted that general aviation and military aircraft emissions are not included in the modelling as no reliable data was available for the region. In terms of future emissions from these sources, general aviation emissions are likely to increase due to higher disposable incomes and more leisure time. Military decreases are presumed due to budget cuts and flying restrictions as well as improvements in airframe and engine efficiency leading to reduced fuel consumption.

²⁰ Sausen, R., Isaksen, I., Grewe, V., Hauglustaine, D., Lee, D. S., Myhre, G., Kohler, M. O., Pitari, G., Schumann, U., Stordal, F. & Zerefos, C. (2005) Aviation radiative forcing in 2000: An update on IPCC (1999). *Meteorologische Zeitschrift*, 14 (4), 555-561.

Appendix G

RFA Assessments

RFA Assessments

The Regional Funding Allocations (RFA) methodology for transport in the region looks at how interventions will deliver regional policy, whether they represent value for money, and are affordable and deliverable.

This appendix includes assessments of six theoretical schemes that represent the types of interventions included within the carbon modelling undertaken as part of this study. The assessments have been undertaken without the detailed evidence base that is usually available when schemes are being assessed for inclusion in the region's transport priorities, and are therefore indicative only. The assessments included here are based upon similar proposals where possible.

The geographical location of schemes is purely theoretical, and in no way reflects the likelihood of such schemes being brought forward for delivery, or acceptance of such proposals in the locations identified.

Essentially, all of the six interventions examined under the RFA framework fully accord with, and should contribute as a group to the delivery of, the wider policies of the region. Both the value for money and deliverability assessments are very difficult to identify with accuracy without a detailed scheme.

Hull High Occupancy Vehicle Lanes

Scheme Description

A series of high occupancy vehicle lanes on the principal radial roads into Hull.

Context and Objectives

Context

Although Hull has witnessed a significant increase in car ownership over the last 30 years, figures are well below the national average for England and Wales. Comparing the figures for Hull with the national picture suggests that there is considerable scope for car ownership to increase still further in Hull, and the trend over the past 30 years suggests this is likely to occur.

The effect of decreasing population in recent years has been balanced by:

- An increase in the number of people living outside Hull and commuting in to the City; and
- An increase in levels of car ownership across the City. TEMPRO suggests that car ownership levels are predicted to rise by approximately 25% between 2001 and the end of the LTP2 period in 2011.

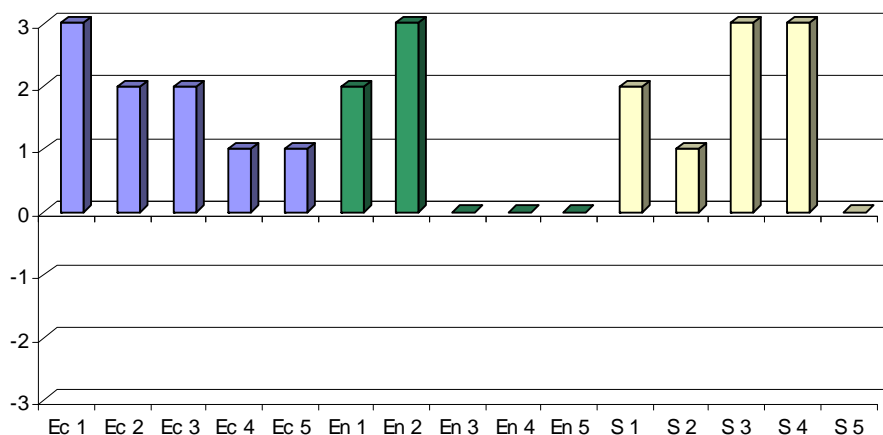
Bus passenger numbers in Hull continue to buck the national trend and show an increase.

Objectives

- Increase car occupancy by encouraging car sharing
- Provide priority for buses, other high occupancy vehicles, motorcycles and cycles
- Reduce the number of accidents and casualties

Consequences of not delivering the scheme

HOV Lane



Criteria	Score
EC 1: Key Spatial Priority Aims	3
EC 2: Knowledge base	2
EC 3: Growth potential/ competitiveness/ productivity	2
EC 4: National and International trade	1
EC 5: Regeneration of former industrial areas and brownfield site	1
EN 1: Local air quality	2
EN 2: Climate change	3
EN 3: Natural environment	0
EN 4: Environmental significance	0
EN 5: historical, cultural and archaeological value	0
S 1: Urban and rural renaissance	2
S 2: Health	1
S 3: Access to basic goods services and amenities	3
S 4: Economic inclusion	3
S 5: Crime and security	0

Value for Money

BCR: unknown

Additional value for money information:

Affordability

Total Scheme Cost: unknown

Deliverability

- It is very likely that a **compulsory purchase order** (CPO) will be required
- A **Public Inquiry** is likely to arise from objections to traffic regulation orders (TROs), CPOs or planning matters

Risk to stakeholder/public acceptance

- May encounter some resistance in public consultation

Leeds Congestion Charge in Urban Centre

Scheme Description

The aim of the scheme is to provide a congestion charging zone around the urban centre of Leeds.

The scheme would use an ANPR system with a network of camera sites monitoring every entrance and exit to the congestion charging zone along the boundary road and monitoring journeys made within the charging zone.

Context and Objectives

Most of the strategic roads in Leeds city region are congested at peak times particularly the ring roads and radial corridors in the main urban centres.

The worsening congestion has led to deterioration in journey time reliability. Any further traffic growth will exacerbate existing problems and environmental conditions.

Structural changes to the economy and society have also had a major impact on both demand for travel and attractiveness of different modes for particular journeys.

Congestion is now beginning to place serious constraints on the level of investment and economic growth in the city region, which will limit its contribution to productivity in the North and the UK as a whole.

The main objective of the scheme is to reduce congestion, increase accessibility and improve the environment.

The subobjectives are:

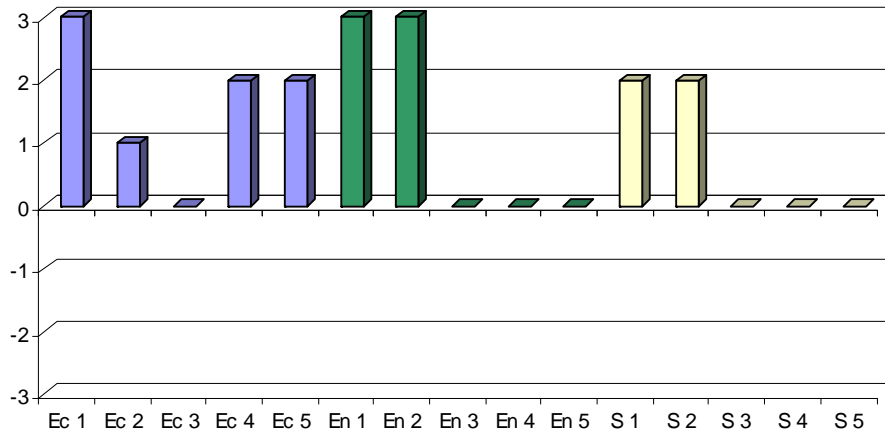
- To reduce the traffic volumes in the urban centre of Leeds
- Reduce emissions of carbon dioxide and pollutants hazardous to health
- Improve the urban environment
- Raise funds for investment in Leeds transport system

Consequences of not delivering the scheme

Congestion levels will rise, and the ability of the City Region to deliver its Transport Vision fully will be compromised with a consequent effect on the economy of the sub-region and potential damage to growth.

Local environmental problems such as poor air quality will remain.

Congestion Charging



Criteria	Score
EC 1: Key Spatial Priority Aims	3
EC 2: Knowledge base	1
EC 3: Growth potential/ competitiveness/ productivity	0
EC 4: National and International trade	2
EC 5: Regeneration of former industrial areas and brownfield site	2
EN 1: Local air quality	3
EN 2: Climate change	3
EN 3: Natural environment	0
EN 4: Environmental significance	0
EN 5: historical, cultural and archaeological value	0
S 1: Urban and rural renaissance	2
S 2: Health	2
S 3: Access to basic goods services and amenities	0
S 4: Economic inclusion	0
S 5: Crime and security	0

Value for Money
 BCR: 1.1 - 3

Additional value for money information:

Affordability
 Total Scheme Cost: unknown

- Deliverability**
- Local political opposition
 - Unlikely to gain public support

North East Lincolnshire Personalised Travel Planning

Scheme Description

The travel choices that people make can have significant and far reaching impacts on our lives, our communities and the planet. The real challenges of climate change and obesity are in part attributable to lifestyle factors, including the way we choose to travel. North East Lincolnshire Council aims to create a transport system that provides real choice and quality alternatives to the car that people will want to use.

It is recognised, however, that sometimes communication, persuasion and incentives will be necessary to change people's car use behaviour. This scheme sets out how the Council and its partners aim to encourage and support increasing numbers of people in using public transport, car sharing, walking and cycling through direct targeted information for individuals.

The scheme will be delivered in residential areas. Householders will be contacted by phone, post or by personal visits to identify information and resources that can assist them in making sustainable travel choices. A bespoke set of information is then assembled and provided for that person.

Context and Objectives

Context

Congestion has a negative impact upon economic performance and quality of life.

Reducing congestion is highlighted as a key element in the regeneration of North East Lincolnshire, and it is acknowledged that as traffic continues to grow, combined with the expansion in port activity, this issue will become more important locally.

Compared with other urban areas the number of people who use public transport is relatively low and is declining faster here than in other parts of the region. Only 8% of the local labour force use buses or trains to get to work compared with 12% in Doncaster and 13% in urban Rotherham.

The Council recognises that car use brings many benefits, including greater access to healthcare, leisure facilities and employment and education opportunities. Moreover, car use can bring greater spontaneity, flexibility and independence. However, the increasing problems of local congestion and air pollution, poor health and climate change will be alleviated if people can be encouraged to use their cars more thoughtfully. Personal benefits such as improved health can also accrue.

Objectives

- Reduce car use, which leads to lower road capacity requirements, reduced emissions of local air pollutants and greenhouse gases, fewer road casualties and lower private vehicle running costs for the individual.
- Increased walking and cycling
- Increased public transport use
- Increased viability of local shops and businesses

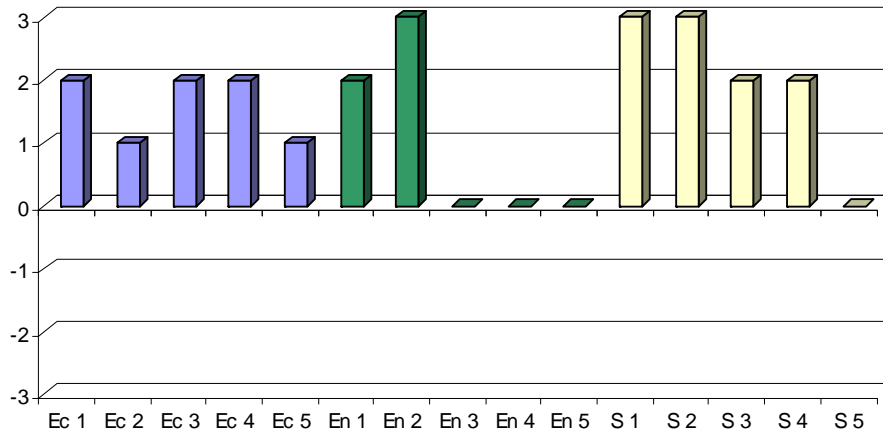
Consequences of not delivering the scheme

Increasing congestion

Declining public transport use

Poor local air quality

PTP



Criteria	Score
EC 1: Key Spatial Priority Aims	2
EC 2: Knowledge base	1
EC 3: Growth potential/ competitiveness/ productivity	2
EC 4: National and International trade	2
EC 5: Regeneration of former industrial areas and brownfield site	1
EN 1: Local air quality	2
EN 2: Climate change	3
EN 3: Natural environment	0
EN 4: Environmental significance	0
EN 5: historical, cultural and archaeological value	0
S 1: Urban and rural renaissance	3
S 2: Health	3
S 3: Access to basic goods services and amenities	2
S 4: Economic inclusion	2
S 5: Crime and security	0

Value for Money

BCR: 5 – 10 (unknown long term benefits)

Additional value for money information:

Affordability

Total Scheme Cost: £2.25m (estimate)

Deliverability

Risk to stakeholder/public acceptance

Septicism of effectiveness from stakeholders

Importance of establishing a brand

Must be accompanied and supported by reliable and good quality infrastructure and public transport

North Yorkshire Promotion of Home Working

Scheme Description

North Yorkshire want to promote teleworking to employers through production of a teleworking toolkit for employers and setting up a teleworking centre for staff which will be made available to staff from any companies who register with the North Yorkshire Council.

Context and Objectives

Context

Based on the draft RSS allocations and predictions there is a significant imbalance between likely employment (in terms of both land availability and new jobs) and housing allocations with the potential significant employment growth in Leeds (and to a lesser extent York) not being matched by housing growth. Conversely, within North Yorkshire the housing growth is not matched by potential employment. Unless carefully managed through both the LDF process and through transport related interventions, this situation is likely to lead to a significant increase in crossboundary commuting, particularly in Harrogate and Selby Districts.

This low population density and the long travel distances, make providing and accessing key services, especially by public transport, extremely difficult.

There are approximately 230,000 jobs in the County yet around 275,000 economically active people. This is reflected in the fact that a significant proportion of the working population (over 32,000 or 12% of the total workforce) commute to employment in the nearby conurbations of West Yorkshire and Teesside and into the City of York.

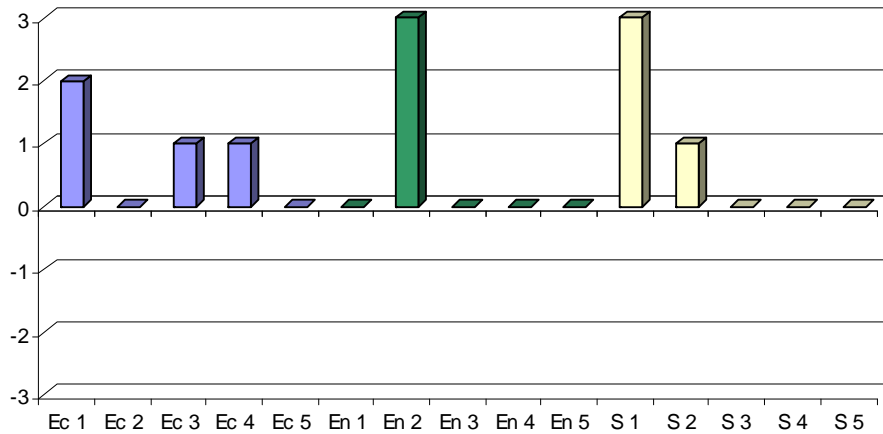
Objectives

- Reduce car use, which leads to lower road capacity requirements, reduced emissions of local air pollutants and greenhouse gases, fewer road casualties and lower private vehicle running costs for the individual.
- Increased viability of local shops and businesses
- Reduce journey to work distances
- Promote better work life balance for those living in North Yorkshire and working elsewhere in the region
- Improve productivity of North Yorkshire workforce

Consequences of not delivering the scheme

Increasing congestion
Poor local air quality
Increasing commuting times

Homeworking/Teleworking



Criteria	Score
EC 1: Key Spatial Priority Aims	2
EC 2: Knowledge base	0
EC 3: Growth potential/ competitiveness/ productivity	1
EC 4: National and International trade	1
EC 5: Regeneration of former industrial areas and brownfield site	0
EN 1: Local air quality	0
EN 2: Climate change	3
EN 3: Natural environment	0
EN 4: Environmental significance	0
EN 5: historical, cultural and archaeological value	0
S 1: Urban and rural renaissance	3
S 2: Health	1
S 3: Access to basic goods services and amenities	0
S 4: Economic inclusion	0
S 5: Crime and security	0

Value for Money

BCR: unknown

Additional value for money information:

Affordability

Total Scheme Cost: unknown

Deliverability

Risk to stakeholder/public acceptance

Scepticism of effectiveness from stakeholders and businesses

Must be accompanied by good quality support systems in participating businesses

South Yorkshire BRT

Scheme Description

The proposed scheme will deliver a series of new BRT corridors comprising:

- New purpose built busways, bus priority lanes on existing highway and sections of free running on existing highway
- High quality vehicles with sufficient capacity to provide a high volume rapid transit network. The scheme is currently proposed to be operated using “fr street car” vehicles
- Purpose built stops, providing a high quality waiting environment coupled with real time passenger information and off vehicle ticketing.

Context and Objectives

The key transport issues in the sub region are:

- Highway congestion issues at M1 Junctions 33 and 34 and the consequent impact on public transport and economic development;
- The area has been declared an Air Quality Management Area;
- The quality and availability of transport links into employment areas;
- Growing overcrowding on the Supertram system.

The objectives of the BRT scheme are:

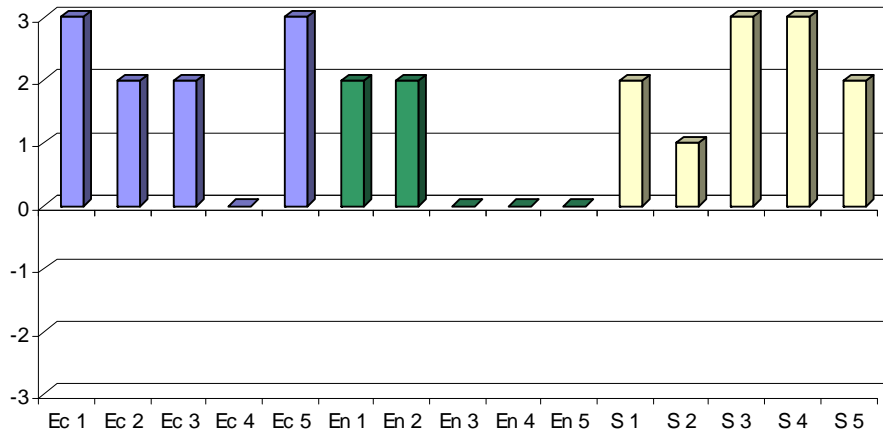
- To provide a step change in the quality, capacity, reliability and availability of public transport.
- To contribute to an integrated package of solutions to address rising congestion and poor connectivity within Sheffield.
- To provide support for existing and enable future economic development in the centre of Sheffield and in the surrounding development areas.
- To preserve and enhance environmental assets and improve local air quality.
- To achieve best value for money.

Consequences of not delivering the scheme

Not delivering the BRT network would result in

- Worsening traffic congestion and slower bus journey times
- Worsening tram overcrowding on the line between Sheffield
- An inability to develop significant areas of urban brownfield land
- Slower jobs growth
- Continuing inaccessibility to employment for those without access to a car or suitable public transport service
- Car use, congestion and the need for long stay car parking capping the development of this corridor
- Slower progress towards air quality targets in the AQMA

South Yorkshire BRT



Criteria	Score
EC 1: Key Spatial Priority Aims	3
EC 2: Knowledge base	2
EC 3: Growth potential/ competitiveness/ productivity	2
EC 4: National and International trade	0
EC 5: Regeneration of former industrial areas and brownfield site	3
EN 1: Local air quality	2
EN 2: Climate change	2
EN 3: Natural environment	0
EN 4: Environmental significance	0
EN 5: historical, cultural and archaeological value	0
S 1: Urban and rural renaissance	2
S 2: Health	1
S 3: Access to basic goods services and amenities	3
S 4: Economic inclusion	3
S 5: Crime and security	2

Value for Money

BCR: likely to be above 2 for a 60 year appraisal period

Additional value for money information:

Affordability

£40m per corridor (estimate)

Deliverability

Risk to programme and risk to cost

It is currently not clear if some sections of the network alignment will require the use of Compulsory Purchase Orders.

Yorkshire Smartcard

Scheme Description

Yorkshire smartcard is a fully interoperable contact-less smartcard ticketing system promoted by all local authorities and public transport operators in Yorkshire and Humber.

The scheme comprises three main elements: the smartcards used by passengers, the equipment used for encoding those smartcards and their verification on buses, trains and trams, and a back office which holds databases of the smartcards issued and their use.

Context and objectives

Marketing will provide increased visibility of innovations in public transport making public perception of public transport better.

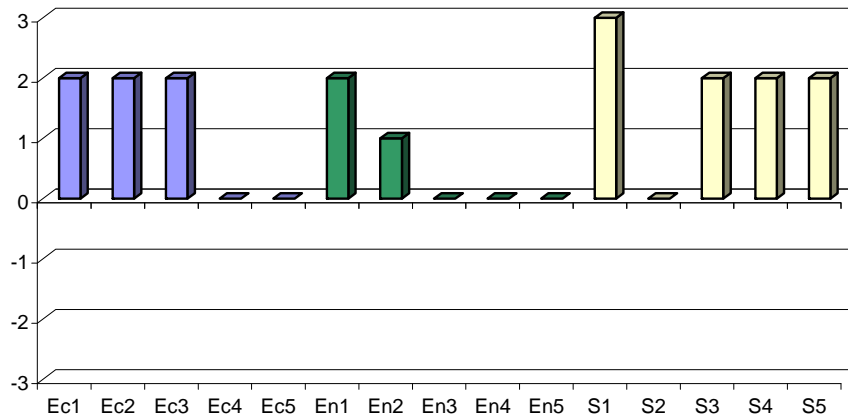
Tangible benefits will be low because by and large it has to be run with existing systems in parallel.

A semi-rigid plastic card, similar to a credit card, containing a microchip that stores value or user account information. Because of the microchip's capabilities and its compatibility with wireless technology, Smart cards can streamline fare payment, reduce customer service, administrative and maintenance costs, increase throughput, and decrease bus dwell times for transit operators. Non-transit applications of smart cards may also generate income for transit operators.

Objectives

- Improve customer service
- Provide better information about customer travel patterns
- Reduce opportunities for fraud
- Improve reliability of public transport
- Reduce journey times

Smartcard



Criteria	Score
EC 1: Key Spatial Priority Aims	2
EC 2: Knowledge base	2
EC 3: Growth potential/ competitiveness/ productivity	2
EC 4: National and International trade	0
EC 5: Regeneration of former industrial areas and brownfield site	0
EN 1: Local air quality	2
EN 2: Climate change	1
EN 3: Natural environment	0
EN 4: Environmental significance	0
EN 5: historical, cultural and archaeological value	0
S 1: Urban and rural renaissance	3
S 2: Health	0
S 3: Access to basic goods services and amenities	2
S 4: Economic inclusion	2
S 5: Crime and security	2

<p>Value for Money BCR: likely to be above 3</p>
<p>Affordability c. £46 million</p>
<p>Deliverability</p> <ul style="list-style-type: none"> • Hardware issues • Administration issues • Operation issues