Carbon pathways for transport in the city regions

Appendices

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1. Introduction

These appendices have been prepared by Atkins for the Passenger Transport Executive Group (***pteg***) to present the supporting information to the "carbon pathways for transport in the city regions" briefing document.

1.1 The study

Atkins was commissioned by ***pteg*** at the end of 2009 to develop the "carbon pathways for transport in the city regions" briefing document and supporting evidence.

The study aims to provide decision makers in the city regions with advice on the best course of action to reduce carbon emissions from the transport sector in metropolitan areas (outside London).

1.1.1 Study brief

The objective of the study is to provide transport policy makers in the city regions with guidance on the best course of action to reduce carbon emissions from the transport sector in the most timely, cost-effective and realistic way.

The study considers the following key points:

- likely developments in Government policies on carbon reduction in general; transport policy; and other relevant policy areas, such as energy;
- the way in which the affordability and performance of low carbon technologies in the transport sphere are likely to develop;
- the available evidence on the relative costs and efficacy of the different policy options available to city region transport policy makers;
- relative efficacy, costs and timescales for carbon reduction initiatives from non-transport sectors in the city regions; and
- the availability of resources and the way in which governance of the city regions might evolve (both in general and specifically for transport).

1.1.2 Study area

The study brief identified the city regions as the focus of the study. The Local Government Improvement and Development Agency[1] describes current city region activity in England as follows[2]:

- city regional activity in the eight Core Cities of
    - Birmingham, Coventry and the Black Country
    - Greater Bristol
    - Leeds City Region
    - Liverpool City Region
    - Manchester City Region;
    - Tyne & Wear City Region;
    - Nottingham, Derby and Leicester (Three Cities); and
    - Sheffield City Region; as well as

[1] Formerly known as Improvement and Development Agency for local government (IDeA)
[2] Source: IDeA website, March 2010

- additional city regional activity in the following areas
    - East of England six cities (Peterborough, Luton, Ipswich, Norwich, Colchester and Southend-on-Sea);
    - Hull and Humber Ports;
    - Lancashire;
    - South Hampshire; and
    - Tees Valley.

City regional activity therefore covers a wide range of local authorities and areas and, as the study was undertaken on behalf of the Passenger Transport Executive Group (***pteg***), the decision was made to focus on Metropolitan areas within the city regional context. This also enabled the study to make use of data available at local authority or metropolitan area levels. The study therefore examines transport and carbon emissions in the local authority areas of the six Integrated Transport Authorities and Passenger Transport Executives as presented in Table 1.1 below.

Table 1.1: Study areas

Areas within study scope	ITA/PTE	Wider city region
Greater Manchester (Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford, Wigan)	GMITA/GMPTE	Greater Manchester City Region (ten metropolitan Districts)
Merseyside (Knowsley, Liverpool, Sefton, St Helens, Wirral)	Merseytravel	Liverpool City Region (five Merseyside Districts and Halton)
South Yorkshire (Barnsley, Doncaster, Rotherham and Sheffield)	SYITA/SYPTE	Sheffield City Region (four South Yorkshire Districts as well as parts of Derbyshire[3] and Nottinghamshire[4])
Tyne and Wear (Gateshead, Newcastle, South Tyneside, Sunderland and North Tyneside)	Tyne & Wear ITA and Nexus	Tyne & Wear City Region (five Tyne & Wear Districts as well as parts of Durham and Northumberland)
West Midlands Metropolitan area (Birmingham, Coventry, Dudley, Sandwell, Solihull, Wallsall, Wolverhampton)	Centro	Birmingham, Coventry and the Black Country City Region (seven West Midlands Districts)
West Yorkshire (Bradford, Calderdale, Kirklees, Leeds and Wakefield)	WYITA/WYPTE (Metro)	Leeds City Region (five Metropolitan Districts as well as Barnsley, York and parts of North Yorkshire[5])

This scope reflects the importance of the metropolitan areas in terms of economic activity and employment (as summarised in Table 1.2) as well as the scale of transport problems which are often greatest in larger cities. For example, over 65% of the £1.8 billion hours lost journey time due to congestion in 2000 was in large cities[6].

[3] North East Derbyshire, Derbyshire Dales, Chesterfield and Bolsover
[4] Bassetlaw
[5] Craven, Harrogate and Selby
[6] Source: An Analysis of Urban Transport, Cabinet office Strategy Unit, November 2009

Table 1.2: GVA and employment in urban areas[6]

Urban area	GVA (2006, in £ million)	Employment (2006)
Greater London	234,989	5,148,000
West Midlands	44,865	1,429,000
Greater Manchester	44,782	1,420,000
West Yorkshire	37,621	1,197,000
Tyne & Wear	18,952	588,000
South Yorkshire	18,789	659,000
Merseyside	18,429	652,000
Cumulative percent of total GVA/employment in England	*42% (18% without Greater London)*	*40% (22% without Greater London)*

1.1.3 Emissions considered

The study considers emissions from the transport sector only and other sectors are only considered to enable a cross-sector comparison of possible emission reduction initiatives. Transport sector emissions considered here exclude those from the aviation and shipping sectors.

The study considers CO_2 emissions only as they make up about 99% of domestic transport emissions in the UK. The remaining 1% consists mainly of methane and nitrous oxide[7].

When considering transport emissions, only tailpipe emissions and the transfer of tailpipe emissions to the power sector (for example through the take up of electric vehicles and additional rail electrification) are considered. The study does not consider whole life cycle emissions of vehicles, fuels and energy used or transport infrastructure. These emissions are, by convention, allocated to other sectors. It is also important to note that whole life emissions for vehicles and fuels might be allocated to other countries, for example a large proportion of emissions linked to the manufacturing of vehicles used in the UK would not be allocated to the UK but to the country of production.

Modelling work, including business as usual and forecasting scenarios, was undertaken for 2016 and 2022. These years were chosen as:

- 2016 marks the end of the first five year period of the third Local Transport Plan which Integrated Transport Authorities and local authorities are currently developing; and
- 2022 marks the end of the UK's first three Carbon Budgets as set by the Government with the advice of the Committee on Climate Change, as required by the Climate Change Act 2008.

[7] Source: Impact Assessment of the Carbon Reduction Strategy for Transport, DfT, July 2009

1.2 Structure of appendices

These appendices contain supporting evidence to be used in conjunction with the briefing document.

Following this introduction, the appendices are structured as follows:

- ***Section Two*** sets the **context for transport and climate change in the city regions** by providing an overview of the main policy framework for transport and carbon in the city regions, including information on the governance framework for transport and on the role of transport as a source of carbon emissions in the metropolitan areas;
- ***Section Three*** presents **individual transport interventions** which could be implemented in the city regions and evidence of their impact on transport sector carbon emissions as well as consideration of cost implications and deliverability;
- ***Section Four*** introduces **two carbon emission mitigation scenarios** for transport in the city regions and presents the results of the modelling work in terms of carbon emission reduction by 2016 and 2022;
- ***Section Five*** describes the potential **role of non-transport interventions** in reducing carbon emissions in the city regions and how this compares with transport sector interventions; and
- ***Section Six*** presents **recommendations for the development of a strategy to reduce transport sector carbon emissions in the city regions**, supported by the analysis of current best practice examples.

1.3 Acknowledgments

This report has been prepared by Atkins, with the support of Jillian Anable from the University of Aberdeen and in liaison with the ***pteg*** team and the ***pteg*** Sustainability Group. The report includes information provided by a range of stakeholders consulted during the study. We are grateful for the time and the information provided by those contacted.

We stress however that the views expressed in this report are those of the consultants and do not represent official policy of ***pteg***, its constituent members or any other city region partners and stakeholders until such time as explicitly endorsed and agreed.

1.4 Key climate change concepts and glossary

1.4.1 Key climate change concepts

Climate change adaptation	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (Source: IPCC).
Climate change mitigation	Human interventions to reduce the sources or enhance the sinks of greenhouse gases (Source: IPCC).
GHG/CO_2/CO_2e emissions	GHG emissions or CO_2 equivalent (CO_2e) is shorthand for emissions of any of the basket of greenhouse gases that are responsible for climate change (mainly carbon dioxide, methane, fluorinated gases, nitrous oxide). Emissions can be expressed in CO_2e which is a unit of measurement that takes account of the global warming contribution of greenhouse gases and compares it with the global warming potential of carbon dioxide (CO_2). 1 kg of CO_2 equals 1 kg of CO_2e.
Cumulative nature of emissions	Greenhouse gases remain in the atmosphere and contribute to global warming long after they are emitted (in most cases, for a century or more), so cumulative emissions are an important measure of an area's contribution to climate change (Source: Pew Centre on Global Climate Change).
Rebound effect	Rebound effects are responses to mitigation measures which tend to offset the intended impact of these measures. For example, in the case of the promotion of low carbon vehicles, the intention is to reduce fuel consumption and hence carbon emissions but the public's response can be to drive more often and further as the cost of driving decreases. Similar rebound effects can be identified when measures result in mode shift to public transport, walking or cycling, which in turn releases road space in previously congested areas and might attract additional road users who benefit from improved journey times.
Tailpipe emissions	GHG/CO_2 emitted by vehicles when their engine is running (at the tailpipe).
Transport sector emissions	Reporting conventions identify emissions from road transport (private vehicles, buses, road freight), diesel rail services, aviation and shipping emissions as transport sector emissions. Emissions associated with the provision of electricity for rail services (including metro and tram systems) are traditionally reported under the power/energy sector.
Urban heat island effect	The urban heat island effect is due to the urban built environment acting as heat storage, lower density of heat absorbing natural environment and lower amount of water evaporation in the cities and higher levels of heat released from vehicles, factories and buildings, resulting in higher than average temperatures in large urban areas.

1.4.2 Glossary

BAU	Business as Usual
BREEAM	British Research Establishment Environmental Assessment Method
BSOG	Bus Service Operator Grant
CCA	Climate Change Agreement
CCC	Committee on Climate Change
CCL	Climate Change Levy
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
Centro	West Midlands Passenger Transport Executive and Integrated Transport Authority
CO_2	Carbon dioxide

CO_2e	Carbon dioxide equivalent
COP	Conference of Parties
CRC	Carbon Reduction Commitment now known as CRC Energy Efficiency Scheme
CRS	Carbon Reduction Strategy for Transport
DaSTS	Delivering a Sustainable Transport System
DCLG	Department of Communities and Local Government
DEC	Display Energy Certificate
DECC	Department of Energy and Climate Change
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
EDAP	Energy Descent Action Plan
EEDA	East of England Development Agency
EERM	East of England Regional (Transport) Model
EMIGMA	Emissions Inventory of the Greater Manchester Authorities
EPC	Energy Performance Certificate
ETS	Emission Trading Scheme
gCO_2	Grams of carbon dioxide
GHG	Greenhouse gases
GMPTE	Greater Manchester Passenger Transport Executive
GMTU	Greater Manchester Transportation Unit
HGV	Heavy Goods Vehicle
HTCM	Highways and Transportation Carbon Model
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
ITA	Integrated Transport Authority
IT Block	Integrated Transport Block
ITS	Institute for Transport Studies (University of Leeds)
JI	Joint Implementation
$ktCO_2$	Kilo tonnes of carbon dioxide
LAA	Local Area Agreement
LCCC	Low Carbon Community Challenge
LGV	Light Goods Vehicle
LTP	Local Transport Plan
MAA	Multi-Area Agreement
MACC	Marginal Abatement Cost Curve
Merseytravel	Merseyside Passenger Transport Executive and Integrated Transport Authority
Metro	West Yorkshire Passenger Transport Executive and Integrated Transport Authority (also see WYPTE)
$MtCO_2$	Million tonnes of carbon dioxide
NAEI	National Atmospheric Emissions Inventory
Nexus	Tyne & Wear Passenger Transport Executive
NI	National Indicator
NTEM	National Trip End Model
NTM	National Transport Model
OECD	Organisation for Economic Co-operation and Development
OPEC	Organisation of the Petroleum Exporting Countries
ppm	Parts per million

PTE	Passenger Transport Executive
PTEG	Passenger Transport Executive Group
REEAP	Resource and Energy Analysis Program Model
RES	Regional Economic Strategy
RFA	Regional Funding Advice/Allocation
RSS	Regional Spatial Strategy
RTFO	Renewable Transport Fuel Obligation
SA	Sustainability Appraisal
SEA	Strategic Environmental Assessment
SEI	Stockholm Environment Institute (University of York)
SYPTE	South Yorkshire Passenger Transport Executive
tCO_2	Tonnes of carbon dioxide
TEMPRO	Software which provides summaries of National Trip End Model forecast data
TfL	Transport for London
TrACE	Tracking action on carbon emissions (Energy Saving Trust)
TraCS	East of England Transport and Carbon Study
UKERC	UK Energy Research Centre
UNFCCC	United Nations Framework Convention on Climate Change
WebTAG	Transport Appraisal Guidance (web based)
WYPTE	West Yorkshire Passenger Transport Executive (also see METRO)

2. Transport and climate change in the city regions

This section provides information on the context for transport and carbon emissions in the city regions. It examines in turn:

- the challenges facing the city regions in terms of climate change adaptation and mitigation;
- the legal and policy framework surrounding carbon emissions and climate change;
- the role of the transport sector as a contributor to carbon emissions in metropolitan areas; and
- the current policy and governance framework for this sector.

The information presented here is focused on English city regions and metropolitan areas outside London. This aims to reflect the membership of ***pteg***. The main messages emerging from this analysis are however relevant for most large urban areas outside London.

2.1 Why act?

The science around climate change and the need to reduce greenhouse gas emissions is presented in detail in various published studies, including the 2007 Stern Review of the Economics of Climate Change[8]. This section aims to briefly highlight the challenges facing the city regions, summarising recent forecasts showing how the climate would potentially change and the issues surrounding future energy resources.

2.1.1 The changing climate will affect the city regions

Recently published projections from DEFRA, summarised in Table 2.1, show that the metropolitan areas could be at risk of significant changes in temperatures and precipitations under a medium emissions scenario, where technological advances are used to reduce emissions[9]. For example, all regions could see a rise in winter mean precipitations of between 4 and 6% during the 2020s. These additional precipitations could have significant impact on the transport network[10].

Climate change impacts are even more significant when considering predictions for the 2050s and 2080s, with predicted increases in summer mean maximum temperature between 3.1°C (Yorkshire and Humber 2050s) and 5.2°C (West Midlands 2080s) and increases in winter mean precipitations of 11% (North East and Yorkshire & Humber 2050s) to 17% (West Midlands 2080s).

It is also important to note that additional impacts of a changing climate are predicted to include rising sea levels, sudden shifts in weather patterns (often localised), flooding events and decreases in water availability in some areas[11]. In urban areas, higher global temperatures will

[8] Available at www.hm-treasury.gov.uk/stern_review_report.htm

[9] Based on the Intergovernmental Panel on Climate Change (IPCC) A1B scenario. The A1 scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies) – Source: IPCC (www.ipcc.ch/ipccreports/tar/wg1/029.htm#storya1)

[10] An interactive Google Earth map showing the impacts of a 4°C world is available through http://decc.gov.uk/en/content/cms/news/FCO/FCO.aspx

[11] For a comprehensive review of climate change impacts, see The Stern Review of the Economics of Climate Change, Part II (www.hm-treasury.gov.uk/stern_review_report.htm)

potentially enhance the urban heat island effect[12], resulting in even higher temperatures in large urban areas in the summer.

Table 2.1: Predicted impacts of climate change on UK regions[13]

Predicted impacts	North East	North West	West Midlands	Yorkshire and Humber
2020s				
Increase in winter mean temp	**1.2°C** *(0.5 to 2.1°C)*[14]	**1.2°C** *(0.5 to 2.0°C)*	**1.3°C** *(0.6 to 2.1°C)*	**1.3°C** *(0.6 to 2.1°C)*
Increase in summer mean temp	**1.5°C** *(0.6 to 2.5°C)*	**1.5°C** *(0.6 to 2.5°C)*	**1.5°C** *(0.5 to 2.6°C)*	**1.3°C** *(0.5 to 2.3°C)*
Increase in summer mean daily max temp	**1.9°C** *(0.3 to 3.5°C)*	**1.9°C** *(0.4 to 3.5°C)*	**2.1°C** *(0.5 to 3.9°C)*	**1.7°C** *(0.5 to 3.1°C)*
Change in winter mean precipitation	**4%** *(-4 to 14%)*	**6%** *(-1 to 14%)*	**5%** *(-3 to 14%)*	**4%** *(-3 to 13%)*
Change in summer mean precipitation	**-6%** *(-19 to 8%)*	**-8%** *(-23 to 9%)*	**-7%** *(-23 to 12%)*	**-8%** *(-24 to 10%)*
2050s				
Increase in winter mean temp	**2.0°C** *(1.1 to 3.1°C)*	**1.9°C** *(1.0 to 3.0°C)*	**2.1°C** *(1.2 to 3.2°C)*	**2.2°C** *(1.1 to 3.4°C)*
Increase in summer mean temp	**2.5°C** *(1.2 to 4.1°C)*	**2.6°C** *(1.2 to 4.1°C)*	**2.6°C** *(1.2 to 4.4°C)*	**2.3°C** *(1.1 to 3.9°C)*
Increase in summer mean daily max temp	**3.2°C** *(1.0 to 5.7°C)*	**3.3°C** *(1.0 to 5.8°C)*	**3.6°C** *(1.3 to 6.5°C)*	**3.1°C** *(1.2 to 5.4°C)*
Change in winter mean precipitation	**11%** *(1 to 24%)*	**13%** *(-1 to 27%)*	**13%** *(2 to 27%)*	**11%** *(1 to 24%)*
Change in summer mean precipitation	**-15%** *(-30 to 1%)*	**-18%** *(-36 to 1%)*	**-17%** *(-37 to 6%)*	**-19%** *(-36 to 1%)*
2080s				
Increase in winter mean temp	**2.6°C** *(1.4 to 4.1°C)*	**2.6°C** *(1.4 to 4.1°C)*	**2.9°C** *(1.6 to 4.4°C)*	**3.0°C** *(1.6 to 4.6°C)*
Increase in summer mean temp	**3.7°C** *(2.0 to 5.8°C)*	**3.7°C** *(2.0 to 5.9°C)*	**3.7°C** *(2.0 to 6.1°C)*	**3.3°C** *(1.7 to 5.4°C)*
Increase in summer mean daily max temp	**4.7°C** *(1.6 to 8.2°C)*	**4.8°C** *(1.6 to 8.3°C)*	**5.2°C** *(2.1 to 9.1°C)*	**4.3°C** *(1.9 to 7.6°C)*
Change in winter mean precipitation	**14%** *(2 to 32%)*	**16%** *(3 to 34%)*	**17%** *(3 to 38%)*	**15%** *(2 to 33%)*
Change in summer mean precipitation	**-18%** *(-36 to 1%)*	**-22%** *(-43 to 0%)*	**-20%** *(-44 to 6%)*	**-23%** *(-44 to 0%)*

[12] The urban heat island effect is due to the urban built environment acting as heat storage, lower density of heat absorbing natural environment and lower amount of water evaporation in the cities and higher levels of heat released from vehicles, factories and buildings.
[13] Source: UK Climate Projections 2009, Medium emissions scenario, DEFRA
[14] The range included here is defined as the range from the lowest to highest value of change for all emissions scenarios and all three (10, 50, and 90%) probability levels for each 30-year time period

The North East region recently undertook a Climate Change Adaptation Study[15] which identified the following impacts for the region:

- increased frequency of flooding from rivers, streams and the sea;
- increased adverse health and welfare effects during warmer summers and winters;
- increased incidents of wild fires and parkland fires;
- increased frequency of flooding from drainage systems;
- increase in infectious diseases in humans and livestock;
- increase in pests;
- increased damage to fabric and structure of buildings;
- loss of business / service productivity or continuity;
- increased pressure on emergency services;
- increased disruption to service continuity;
- increased pollution from contaminated land;
- increased erosion of the coastline;
- increased wildlife impacts on construction and maintenance activities;
- increased storm-related debris;
- increased footpath and cycle path erosion;
- changes in winter road maintenance regimes; and also
- increased business opportunities associated with adaptation.

An international consensus emerged from the United Nations Conference of Parties in Copenhagen in December 2009 that global temperature rises should be limited in average to a maximum of 2°C.This will require very significant cuts in emissions across the world and the UK has already set its carbon emission reduction targets to 2050 (see Section 2.2.3 below).

2.1.2 The city regions are also faced with important energy challenges

Although global energy use was set to fall in 2009, as a result of the economic crisis, demand will grow again through the recovery to resume its long term upwards trend. The International Energy Agency (IEA) predicts that, by 2030, global primary energy demand will be 40% higher than in 2007 (under the IEA's reference scenario, assuming no change in government policies[16]). Non OECD countries account for 90% of this increase[17].

The Agency estimates that "the world's energy resources are adequate to meet the projected increase through to 2030 and well beyond" but recognises that this will only be achieved at a high cost for the environment and will have significant impacts on energy security and economic development. The Agency notes that as "non-OPEC conventional oil[18] production peaks around 2010", most of the increased oil output will come from OPEC countries, with natural gas coming mainly from Russia, Iran and Qatar[17].

The availability of sufficient energy resources is however disputed, with some experts warning that global oil production has already peaked or will peak before 2020. A recent review of available

[15] North East Climate Change Adaptation Study, Sustaine, Royal Haskoning, UK Climate Impacts Programme, 2009 (www.adaptne.org)
[16] The Reference Scenario, as modelled by the Agency, puts the world on a course for doubling the concentration of greenhouse gases in the atmosphere to around 1 000 parts per million (ppm) of CO_2 equivalent by the end of this century. This would entail an eventual global average temperature increase of up to 6°C.
[17] World Energy Outlook 2009 Fact Sheet, International Energy Agency
[18] Including crude oil, condensate and natural gas liquids but excluding liquid fuels derived from oil sands, oil shale, coal, natural gas and biomass

evidence conducted by the UK Energy Research Centre (UKERC)[19] concluded that the date of peak production for conventional oil[18] "can be estimated to lie between 2009 and 2031". The Centre noted that "although this range appears wide in the light of forecasts of an imminent peak, it may be a relatively narrow window in terms of the lead time to develop substitute fuels".

In light of this conclusion, the UKERC identified the following policy implications:

- mitigating the impact of peak oil will be challenging due to "the scale of investment required and the associated lead times", especially as investment is harder to secure due to the economic crisis and existing energy infrastructure will also need renewing (including a large part of the UK's infrastructure in the coming years);
- if low carbon alternatives are not in place before oil prices start rising significantly, there will be strong incentives to exploit non-conventional fuels, potentially resulting in significant increases in greenhouse gases emissions (using coal to produce liquid fuels for example); and
- oil price volatility risks inhibiting large scale investment in low carbon alternatives as potential investors have to face uncertain returns on their investment.

The depletion of conventional oil sources will have important impacts for the metropolitan areas in terms of transport costs (to private businesses and consumers as well as to the public sector, notably through public transport subsidies). Current issues around fuel poverty will be exacerbated and risk to expand to result in "mobility poverty", where people on low incomes are not able to travel. This would have important consequences for the city regions economic development and equality objectives.

UK Industry Task-Force on Peak Oil and Energy Security

In February 2010, six UK companies (Arup, Foster + Partners, Scottish and Southern Energy, Solarcentury, Stagecoach Group and Virgin) joined together to launch the second report of the UK Industry Task-Force on Peak Oil and Energy Security (ITPOES).

The report, titled "The Oil Crunch - a wake-up call for the UK economy", finds that oil shortages, insecurity of supply and price volatility will destabilise economic, political and social activity within five years.

The Task-Force warns that the UK must not be caught out by the oil crunch in the same way it was with the credit crunch and states that policies to address Peak Oil must be a priority[20].

[19] Global Oil Depletion - An assessment of the evidence for a near-term peak in global oil production, UK Energy Research Centre, August 2009

[20] Source: Industry Task-Force on Peak Oil and Energy Security (http://peakoiltaskforce.net/)

2.2 Legal and policy framework

This section presents an overview of targets and mechanisms to reduce carbon emissions across all sectors, starting with the international framework set by the United Nations and including the European and national levels.

2.2.1 The global framework: United Nations Framework Convention on Climate Change

International targets

The Kyoto Protocol is a protocol of the United Nations Framework Convention on Climate Change (UNFCCC), with the goal of achieving the "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"[21]. All partaking nations commit themselves to tackling global warming and greenhouse gas emissions. The target agreed upon under the Kyoto Protocol was an average reduction of 5.2% from 1990 levels by the year 2012. 183 countries, including the United Kingdom, have ratified the agreement, representing over 64% of global carbon emissions[22].

With the Kyoto Protocol expiring in 2012, a Conference of Parties (COP15) was held in Copenhagen in December 2009 to discuss new legally binding international targets to succeed it. Following the negotiations, global action on climate change was agreed by a majority of leaders and countries as part of the "Copenhagen Accord".

Although the content of the Accord was seen as disappointing by many, including the UK Government[23], the deal was agreed by 49 countries that together account for over 80% of global emissions. It endorses the limit of 2°C warming and commits participating countries to make specific commitments to tackle emissions (initially by the end of January 2010, although this deadline was relaxed following the conference[24]). There were also significant financial commitments made by developed countries to help developing countries reduce emissions and adapt to a changing climate.

Negotiations at the international level will continue to replace the Kyoto Protocol when it expires in 2012, with the next Conference of Parties taking place in Mexico in December 2010.

At the 2009 G8[25] summit, the eight nations agreed to aim to limit global warming to 2°C and recognised that this would mean achieving an 80% reduction in carbon emissions from developed countries by 2050 (on 1990 levels).

International trading mechanisms

Trading (or offsetting) mechanisms allow emitters to pay someone else to make an equivalent saving on emissions somewhere else, often through low carbon projects in developing countries[26]. At the global level, there are currently two types of carbon markets in place to facilitate carbon offsetting:

- the compliance market – compliant with the mechanisms set out in the UN's Kyoto Protocol, which includes;
  - the Clean Development Mechanism (CDM), which allows developed countries[27] to offset their emissions by supporting emission reduction projects in developing countries; and

[21] United Nations (2005) The United Nations Framework Convention on Climate Change
[22] United Nations Framework Convention on Climate Change (2009) Kyoto Protocol: Status of Ratification, January 2009
[23] Ed Miliband Statement to the House on the Copenhagen climate change conference, 5th January 2009
[24] See for example "UN climate deadline turns out to be flexible", BBC website, 21st January 2010 (http://news.bbc.co.uk/1/hi/sci/tech/8471593.stm)
[25] The G8 countries are Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States
[26] "Carbon offsetting involves the funding of projects which reduce or avoid emissions equivalent to that you have emitted. Funding usually takes the form of purchasing credits which are equivalent to a certain amount of emissions reduced or avoided. These carbon savings must be in addition to the savings that would have happened anyway, without the funding. Projects reducing or avoiding emissions include hydro-electric power stations, biomass energy generation plants and wind farms". Source: A guide to carbon offsetting for the public sector, DECC, January 2010
[27] Kyoto Protocol Annex I countries

- Joint Implementation (JI), where developed countries[27] can buy credits for emission saving investment in other developed countries (the European Union has also established an Emission Trading System described below); and

- the non-compliance market – where credits which are not compliant with Kyoto and issued by unregulated bodies are traded.

2.2.2 The European framework

European targets

The European Union (EU) is committed to reducing greenhouse gas emissions by 20% by 2020 (on 1990 levels). Discussions are continuing to reach an agreement on a more demanding target to achieve a 30% cut in emissions by 2020. This stretched target is supported by the UK Government but is linked to reaching a solid agreement at the international level to ensure that all countries contribute to global cuts in emissions.

To achieve the 20% reduction target by 2020, the EU has agreed a package of interventions and sector specific targets, including increasing the share of renewable energy to 20% by 2020, cutting overall energy consumption by 20% by 2020 and expanding the EU Emission Trading Scheme (EU ETS - see below). The target of a 10% cut on 2005 levels by 2020 for sectors which are not included in the EU ETS (including transport, housing, agriculture and waste) has also been agreed.

The European Union Emission Trading System (EU ETS)

The EU ETS started in 2005. It is a mandatory cap and trade scheme which covers industry sectors with high emission levels such as electricity generation, iron and steel production, cement manufacturers and pulp and paper processing plants. In the UK, this represents about 40% of all greenhouse gases emissions. The ETS will also include the aviation sector from 2012. There are also proposals to include the shipping sector in the scheme by 2013, if no other international agreement to reduce shipping emissions can be reached in the coming years.

As a cap and trade scheme, the system works by establishing a capped overall amount of emissions, which is then reduced over time. Organisations which are part of the scheme need to reduce their emissions or buy credits allowing them to emit more from other participating organisations. Participants who are successful in reducing their emissions can sell their allowances on the carbon market created by the scheme.

The system has however been faced with issues linked to the volatility of credit prices, creating uncertainties for investment decisions and undermining confidence in the scheme[28].

[28] For more detail on issues facing the EU ETS, see for example the Memorandum submitted by the carbon Trust to the Environmental Audit Committee examining the role of carbon markets in preventing dangerous climate change in 2009 (www.publications.parliament.uk/pa/cm200910/cmselect/cmenvaud/290/9042105.htm)

2.2.3 UK Climate Change Act, carbon budgets and trading mechanisms

UK targets and policy framework

The Stern Review on the economics of climate change[29], published in 2006, recommended international action to keep the global average temperature rise below 2°C[30]. The Review concluded that the long run costs of global action to stabilise emissions to meet the 2°C target are expected to be around 1% of GDP by 2050, within a range of +/-3%. This estimated cost of action is substantially lower than the expected costs of "inaction", estimated at between 5% and 20% of global GDP now and forever. The Stern Review had a significant influence on the Climate Change Bill proposed in 2007, which became law as the Climate Change Act in 2008.

Information on the Climate Change Act targets, the carbon budgets and the UK Low Carbon Transition Plan is also included in Section 5, where the potential for carbon reductions across all sectors is explored in more detail.

Climate Change Act 2008[31]

The Climate Change Act became law in November 2008 and aims to set the UK on track to meet the commitments of the Kyoto Protocol and the EU emission reduction targets.

The headline target included in the Act is an 80% cut in greenhouse gas emissions by 2050 (on 1990 levels) across all sectors of the UK economy. The Act also introduces a carbon budgeting system which caps emissions over five-year periods, with three budgets set at a time, to help monitor progress towards the 2050 target. The first three carbon budgets run from 2008-12, 2013-17 and 2018-22 and are presented in Table 2.2.

The Act also established the Committee on Climate Change (CCC) as an independent expert body to advise the Government on the level of carbon budgets and on where cost-effective savings can be made. The CCC submits annual reports to Parliament on the UK's progress towards targets and budgets. The Government must respond to these annual reports, ensuring transparency and accountability on an annual basis.

Table 2.2: UK carbon budgets

Legislated carbon budgets	First budget 2008-12	Second budget 2013-17	Third budget 2018-22
Carbon budgets ($MtCO_2e$[32])	3,018	2,782	2,544
Percentage reduction below 1990 levels	22%	28%	34%
Traded sector budgets ($MtCO_2e$[32])	1,233	1,078	985
Non-traded sector budget (including transport sector - $MtCO_2e$[32])	1,785	1,704	1,559

The first CCC report to Parliament was published in October 2009[33]. The report is entitled "Meeting carbon budgets – the need for a step change" and included the following two key messages to Parliament and Government (alongside detailed analysis and recommendations for action)[34]:

[29] The Economics of Climate Change, The Stern Review, N. Stern, 2006
[30] The Stern Review includes evidence that this is equivalent to stabilising atmospheric concentrations of greenhouse gases at 450-550 ppm CO_2e. Evidence published since the Review suggests however that those concentrations might need to be even lower to maintain this target. For example the IPCC's Fourth Assessment Report (AR4), released in 2007, suggests that stabilisation at 400 ppm CO_2e could lead to a temperature rise of up to 2.5°C.
[31] UK Climate Change Act 2008 (www.opsi.gov.uk/acts/acts2008/ukpga_20080027_en_1)
[32] Million tonnes CO_2 equivalent (carbon dioxide equivalents describe, for a given mix and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential)
[33] Meeting carbon budgets – the need for a step change, CCC, October 2009
[34] The second report to Parliament "Meeting Carbon Budgets – ensuring a low-carbon recovery" was published in June 2010 and messages to Parliament and Government are similar to those in the October 2009 report

- "the significant emissions reductions produced by the recession could both produce an over rosy impression of progress against budgets and undermine steps to drive long-term reductions, in particular by reducing the carbon price within the EU ETS"; and
- "progress in reducing emissions in the five years before the first budget period, both overall and in most sectors, was far slower than now required to meet budget commitments. A step change in the pace of reduction is essential".

The UK Low Carbon Transition Plan[35]

In July 2009, the Government published the UK Low Carbon Transition Plan[36], which sets out how the UK will meet the interim target of a 34% cut in emissions by 2020 (on 1990 levels). By 2020, the Plan estimates that:

- "more than 1.2 million people will be in green jobs";
- "7 million homes will have benefited from whole house makeovers, and more than 1.5 million households will be supported to produce their own clean energy";
- "around 40% of electricity will be from low-carbon sources" (renewables, nuclear and clean coal); and
- "the average new car will emit 40%less carbon than now".

The Low Carbon Transition Plan was supported by three sector specific strategies published at the same time[35]:

- the UK Low Carbon Industrial Strategy[37];
- the Renewable Energy Strategy[38]; and
- the Carbon Reduction Strategy for Transport[39].

The Strategy for Sustainable Construction[40] was published earlier, in June 2008, aiming to provide clarity to business on the Government's position and making specific commitments by industry and Government to take the sustainable construction agenda forward. The strategy includes action points for the Government and industry in the areas of procurement, design, innovation, training and skills, regulation and progress monitoring and reporting.

Energy Act 2008 and Renewable Energy Strategy 2009

The Energy Act 2008[41] set out the framework to enable a shift to more sustainable energy and improved energy efficiency by:

- strengthening the Renewables Obligation[42];
- enabling government to introduce feed-in tariffs[43] for small scale renewable energy generation and a renewable heat incentive[44];

[35] Now potentially subject to review by the Coalition Government following the May 2010 General Elections
[36] UK Low Carbon Transition Plan, DECC, July 2009
[37] UK Low Carbon Industrial Strategy, BERR, July 2009
[38] Renewable Energy Strategy, DECC, July 2009
[39] Low Carbon Transport: A Greener Future – A Carbon Reduction Strategy for Transport, DfT, July 2009
[40] Strategy for Sustainable Construction, BERR, June 2008
[41] www.opsi.gov.uk/acts/acts2008/ukpga_20080032_en_1
[42] The Renewables Obligation (RO) supports investment in renewable electricity projects in the UK by placing an obligation on UK suppliers of electricity to source an increasing proportion of their electricity from renewable sources. The Renewable Energy Strategy, published on 15 July 2009, included announcements on expanding and extending the RO to enable it to deliver close to 30% renewable electricity or more by 2020.
[43] Feed-in tariffs are a per unit subsidy payment (p/kWh) for sub-5MW low carbon electricity generation. The scheme is designed to encourage non-energy professionals, including householders, to invest in small-scale generation. The fee-in tariffs will be funded by a levy paid by electricity suppliers which is expected to be passed through to final electricity consumers. Source: Impact Assessment of Feed-in Tariffs for Small-Scale, Low Carbon, Electricity Generation, DECC, February 2010

- introducing compulsory smart metering[45];
- encouraging the development of carbon capture and storage (clean coal)[46]; and
- strengthening decommissioning provisions for nuclear operators as well as offshore renewable, oil and gas.

The Renewable Energy Strategy introduced the headline target of 15% of energy to come from renewable sources by 2020. This represents an almost seven fold increase over a decade[47]. Broken down by sector, this target means that renewable sources will provide:

- 30% of UK electricity (from approximately 5.5%);
- 12% of UK heat (from less than 2%); and
- 10% of transport energy (from approximately 2.5%).

The delivery of the Energy Act and Renewable Energy Strategy is also supported by new planning measures implemented under the Planning Act 2008[48]. The key element of the Act related to carbon emissions and renewable energy[49] is the production by the Government of National Policy Statements for nationally significant infrastructure[50]:

Carbon Reduction Strategy for Transport 2009[35]

The Department for Transport's Carbon Reduction Strategy (CRS) states that "decarbonising transport is an essential part of building a low carbon future for Britain". To achieve this objective, it proposes to:

- support a shift to new technologies and fuels (by reducing emissions from cars, vans, road freight, buses, rail, aviation, shipping and using sustainable biofuels);
- promote lower carbon choices (through the provision of lower carbon public transport, the integration of transport modes, the promotion of sustainable modes, better information, addressing business travel and goods distribution and reducing the need to travel); and
- make use of market mechanisms to encourage a shift to lower carbon transport (through trading systems for aviation and shipping, fiscal measures and the price of public transport).

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[44] The renewable heat incentive consultation was launched in February 2010 and documents are available on DECC's website (www.decc.gov.uk/en/content/cms/consultations/rhi/rhi.aspx). The scheme is designed to support a range of technologies, including air and ground-source heat pumps (and other geothermal energy), solar thermal, biomass boilers, renewable combined heat and power, use of biogas and bioliquids and the injection of biomethane into the natural gas grid, at all scales, including households, businesses, offices, public sector buildings and industrial processes in large factories. Source: DECC, February 2010

[45] Smart meters are new electricity and gas meters which will provide information on users' energy consumption directly to the energy providers. Smart meters will also enable the introduction of flexible tariffs to incentivise consumption at times when energy demand is lower and the introduction of feed-in tariffs.

[46] Carbon Capture and Storage (CCS) has the potential to reduce CO_2 emitted from fossil fuel (including coal) power stations by up to 90%. CCS is a three-step process which includes: capturing the CO_2 from power plants and other industrial sources, transporting it, usually via pipelines, to storage points, and storing it safely in geological sites such as deep saline formations or depleted oil and gas fields. Source: DECC, February 2010

[47] From 2008 levels

[48] Now under review by the Coalition Government (www.opsi.gov.uk/acts/acts2008/ukpga_20080029_en_1)

[49] The Act also included created a new independent body, the Infrastructure Planning Commission, taking over responsibility for considering and deciding on applications for nationally significant infrastructure (including for example electricity generating stations generating more than 50 megawatts onshore and 100 megawatts offshore) but the Commission is to be abolished by the Coalition Government, with Ministers taking decisions on these applications.

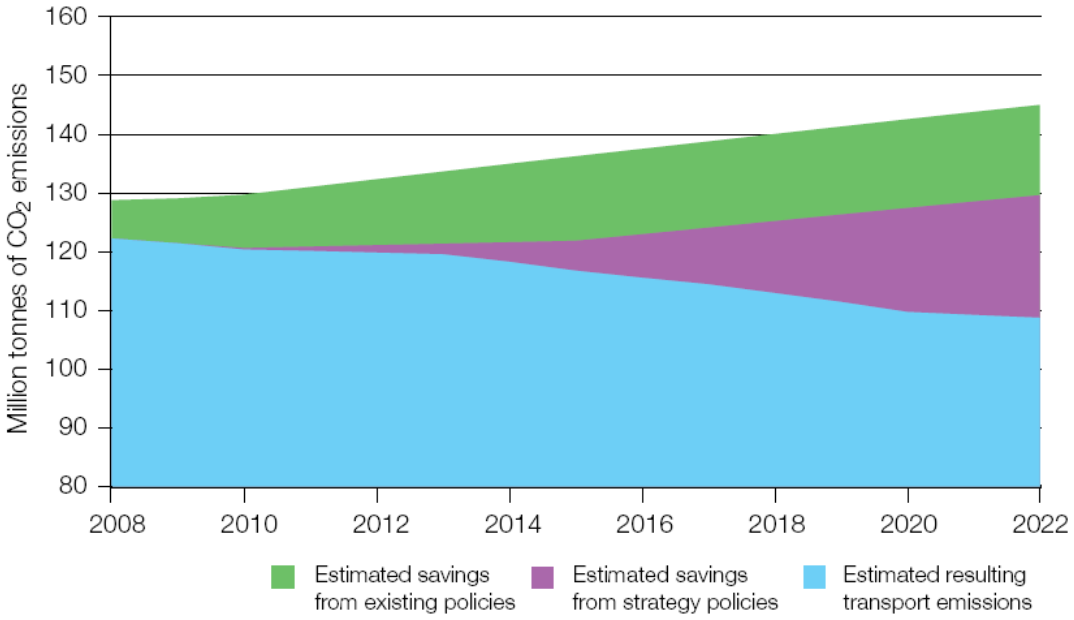
[50] Draft National Policy Statements (NPSs) for Energy Infrastructure were published in November 2009 for consultation until the end of February 2010. This includes: the Overarching National Policy Statement for Energy (EN-1), the NPS for Fossil Fuel Electricity Generating Infrastructure (EN-2), for Renewable Energy Infrastructure (EN-3), for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4), for Electricity Networks Infrastructure (EN-5), and for Nuclear Power Generation (EN-6). Source: Consultation on draft National Policy Statements for Energy Infrastructure, DECC, 2009
The Coalition Government will however undertake additional consultation on the Policy Statements. Source: www.decc.gov.uk/en/content/cms/news/pn10_080/pn10_080.aspx

As shown in Figure 2.1, the CRS aims to reduce transport sector emissions by an additional 17.7 $MtCO_2$ in 2020, on top of savings from existing policies (projected to achieve a 15 $MtCO_2$ reduction in 2020).

The CRS recognises that "Central Government cannot work alone in promoting lower carbon choices" and identifies regions and local authorities as "particularly important partners in influencing the pattern of journeys and development". The CRS therefore aims to enhance collaboration between the Government and regions/local authorities by:

- spreading skills and best practice – developing analytical tools, improving access to data sources and supporting knowledge and best practice sharing; and
- incentivising delivery – through Local Area Agreements (LAAs), Local Transport Plan (LTP) guidance and the Delivering a Sustainable Transport System (DaSTS) process.

Figure 2.1: Savings from existing policies and DfT's Carbon Reduction Strategy[51]



The DfT published its Transport Carbon Reduction Delivery Plan and Climate Change Adaptation Plan for Transport 2010 - 2012 in March 2010. The Delivery Plan describes how the Department will deliver the policies set out in the CRS[35].

Economic impact of climate change legislation

Analysis undertaken by Deloitte for the Manchester City Region and the North West region[52] shows that EU and UK climate change legislation is likely to have an impact on the area's economy, with "a cost of inaction across all sectors" but also "competitive benefits and cost reduction upsides for proactive business responses".

Headline results from the research show that a failure to adapt to these legislative changes could result in the city region losing "an estimated £21 billion in GVA over the next 12 years (by 2020), whilst the North West as a whole could lose an estimated £72 billion over the same period. This equates to annual growth of 0.3 and 0.4 percentage points below baseline in the city region and the North West respectively".

[51] Source: DfT analysis 2009, published in DfT Carbon Reduction Strategy, July 2009
[52] The economic impact of EU and UK Climate Change legislation on Manchester City Region and the North West, Deloitte, July 2008

Local Area Agreements and climate change

Local Area Agreements (LAAs) are the main vehicle through which government departments and local authorities agree priorities for improvement in local areas[53]. To date, around 100 local authorities in England have made CO_2 reduction a priority for their area, by opting to set a target on the basis of National Indicator 186 (Per capita reduction in CO_2 emissions in the local authority area) for their 2008/11 LAA. Two other indicators, NI185 and NI188, also relate directly to climate change and are described in more detail in Table 2.3 below.

Table 2.3: Summary of National Indicators directly linked to climate change[54]

Indicator	Description
NI 185	**Percentage CO_2 reduction from local authority operations** The aim of this indicator is to measure the progress of local authorities to reduce CO_2 emissions from the relevant buildings and transport used to deliver its functions and to encourage them to demonstrate leadership on tackling climate change.
NI 186	**Per capita reduction in CO_2 emissions in the local authority area** Action by local authorities is likely to be critical to the achievement of Government's climate change objectives. Local authorities are uniquely placed to provide vision and leadership to local communities by raising awareness and to influence behaviours. In addition, through their powers and responsibilities (housing, planning, local transport and powers to promote well-being) and by working with their Local Strategic Partnership they can have significant influence over emissions in their local areas. The indicator relies on centrally produced statistics to measure end user CO_2 emissions in the Local Area from business and public sector, domestic housing and road transport.
NI 188	**Planning to Adapt to Climate Change** This indicator is designed to ensure local authority preparedness to manage risks to service delivery, the public, local communities, local infrastructure, businesses and the natural environment from a changing climate, and to make the most of new opportunities. The indicator measures progress on assessing and managing climate risks and opportunities, and incorporating appropriate action into local authority and partners' strategic planning.

Table 2.4 overleaf summarises the take up of climate change National Indicators (NIs) across the metropolitan and city region authorities, showing that 28 of the 46 authorities considered have selected NI 186 (per capita reduction in CO_2 emissions) as part of their 2008/11 LAAs[55].

It also identifies additional carbon emission reduction targets adopted by these areas, for example within LTP2 or through the adoption of carbon reduction and climate change strategies. This considers targets to reduce CO_2 emissions for the local authority area rather than targets adopted with regard to local authority operations and buildings.

[53] Now potentially subject to review by the Coalition Government following the May 2010 General Elections
[54] Source: www.localpriorities.communities.gov.uk
[55] Eight authorities have selected NI185 and 13 have selected NI188

Table 2.4: Summary of local climate change targets in metropolitan/city region areas

Region/city region	PTE/Local authority	Selected climate change NIs (LAAs 2008/11)	Other climate change targets adopted[56]
North East Region	North East Climate Change Action plan[57]: "reduce CO_2 emissions in line with Government targets"		
Tyne and Wear City Region	Nexus, Gateshead, Newcastle Upon Tyne, North Tyneside, South Tyneside, Sunderland	NI186: selected by 2 out of 5 authorities NI 188: selected by 2 out of 5 authorities	
	Durham	NI 188 selected	
	Northumberland	NI 188 selected	
North West Region	Climate Change Action Plan for the North West – no specific carbon emission reduction targets (overall or for the transport sector)		
Liverpool City Region	Merseytravel, Halton, Knowsley, Liverpool, Sefton, St Helens, Wirral	NI186: selected by 2 out of 5 authorities NI 188: selected by 1 out of 5 authorities	Knowsley Climate Change Action Plan: Reduce domestic & commercial carbon emissions by 21.1% by 2021 (transport target not set)[58]
	Halton	NI 186 selected	
Manchester City Region	GMPTE, Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford, Wigan	NI185: selected by 2 out of 10 authorities NI186: selected by 6 out of 10 authorities NI 188: selected by 3 out of 10 authorities	LTP2 target: Limit the increase in CO_2 emissions to 4.5% from 2005 to 2010 Manchester's Climate Change Action Plan[59]: Reduce the city of Manchester's emissions of CO_2 by 41% by 2020 from 2005 levels
	Cheshire East	NI 186 selected	Cheshire East, Cheshire West and Chester and Warrington have adopted a joint Climate Change Action Plan for 2009-12 [60]
	Cheshire West and Chester	NI 186 selected	
	Warrington	NI 186 and NI 188 selected	
West Midlands / Birmingham City Region	West Midlands Regional Climate Change Action plan: "make substantial cuts at least in line with national and international targets"		
	Centro, Birmingham, Coventry, Dudley, Sandwell, Solihull, Walsall, Wolverhampton	NI185: selected by 2 out of 7 authorities NI186: selected by 4 out of 7 authorities NI 188: selected by 2 out of 7 authorities	Birmingham, Coventry and Black Country City Region committed to carbon neutrality from 2040[61] Birmingham Climate Change Strategy and Action Plan: reduce carbon emissions in Birmingham by 60% from 1990 levels by 2026 Climate Change Strategy for Coventry: 70% reduction in CO_2 emissions between 2003 and 2050 (interim target of 40% reduction by 2025)

[56] Many authorities have adopted strategies and targets to reduce emissions from their own operations, these targets are not recorded here. This table considered targets for the reduction of emissions in the authority's area, for the transport sector or across all sectors of the economy.
[57] Source: www.neccap.org
[58] Source: www.knowsley.gov.uk/residents/environment,-recycling,-waste/sustainable-development/climate-change.aspx
[59] Source: www.manchesterclimate.com/home
[60] Source: www.cwea.org.uk/climate-change-action-plan-2009-12
[61] Source: City Region Development Programme

Region/city region	PTE/Local authority	Selected climate change NIs (LAAs 2008/11)	Other climate change targets adopted[56]
			Walsall Climate Change Strategy and Action Plan: aims to support the UK Government's target of a 60% reduction in CO_2 emissions by 2050[62] Climate Change Strategy and Action Plan for Wolverhampton: reduce the city's CO_2 emissions by at least 35% by 2026 from 2005 levels (interim target of 12% reduction by 2012)
Yorkshire and Humber Region	Climate Change Plan for Yorkshire and Humber includes transport outcome: make "significant progress towards achieving the Accelerated scenario identified in the JMP/SEI report (2008)" – approx. 40% reduction in CO_2 emissions from land transport in 2021 (compared to business as usual scenario)[63]		
Leeds City Region	West Yorkshire PTE (Metro), Bradford, Calderdale, Kirklees, Leeds, Wakefield	NI185: selected by 1 out of 5 authorities NI186: selected by 4 out of 5 authorities NI 188: selected by 2 out of 5 authorities	LTP2 target: no increase in CO_2 emissions from 2004/05 to 2010/11
	North Yorkshire (Craven, Harrogate and Selby)	NI 185 and NI 186 selected	
	Barnsley (SYPTE)	NI 186 selected	
	York	NI 186 selected	
Sheffield City Region	SYPTE (Barnsley, Doncaster, Rotherham, Sheffield)	NI185: selected by 1 out of 4 authorities NI186: selected by 3 out of 4 authorities NI 188: selected by 1 out of 4 authorities	LTP2 target: Reduce CO_2 emissions by 12.5% by 2010 based on an aggregated position for all schemes assessed within LTP2
	Derbyshire (North East Derbyshire, Derbyshire Dales, Chesterfield, Bolsover)	NI 186 and NI 188 selected	Derbyshire Climate Change Strategy aims to reduce greenhouse gas emissions in Derbyshire to the levels set out in the Government's climate change act
	Nottinghamshire (Bassetlaw)	NI 186 selected	North Nottinghamshire LTP2 target: increase in vehicle CO_2 emissions limited to 5% increase between 2004 an 2010

[62] Strategy published in 2008 when Climate Change Bill included a 60% reduction target
[63] Achieving low carbon and sustainable transport systems in Yorkshire and Humber, SEI and JMP for the Yorkshire and Humber Regional Assembly, March 2008

The Nottingham Declaration

The Nottingham declaration is a voluntary pledge to address climate change, now signed by over 300 local authorities in England[64]. It includes a high-level, broad statement of commitment for Councils to:

- work with Central Government to contribute, at a local level, to deliver UK climate change targets;
- develop plans with partners and local communities to progressively address the causes and the impacts of climate change, according to local priorities;
- publicly declare the commitment to achieve a significant reduction of greenhouse gas emissions from the authorities' operations;
- encourage all sectors within the communities to take the opportunity to adapt the impacts of climate change to reduce greenhouse gas emissions; and
- monitor progress and publish results.

At the time of writing, all local authorities listed in Table 2.4 above are signatories to the Nottingham Declaration, as well as the West Midlands PTA/ITA and Merseytravel.

The Covenant of Mayors[65]

The Covenant of Mayors is a commitment by signatory towns and cities to go beyond the CO_2 reduction objectives of EU energy policy[66], which commits Member States to curb their CO_2 emissions by at least 20% by 2020, through enhanced energy efficiency and cleaner energy production and use.

Local authorities signing up to the Covenant commit to submitting their Sustainable Energy Action Plans (SEAPs) within the year following adhesion. The Action Plan shows how the authority will reach its CO_2 reduction target by 2020.

SEAPs cover the whole local authority area and it is anticipated that they will include actions in the following sectors:

- built environment, including new buildings and major refurbishment;
- municipal infrastructure (district heating, public lighting, smart grids, etc);
- land use and urban planning;
- decentralised renewable energy sources;
- public and private transport policies and urban mobility;
- citizen and, in general, civil society participation; and
- intelligent energy behaviour by citizens, consumers and businesses.

At the time of writing, local authorities within the metropolitan areas which have signed up to the Covenant of Mayors include Birmingham, Coventry, Gateshead, Kirklees, Manchester, Newcastle upon Tyne, North Tyneside, South Tyneside and Sunderland[67].

[64] Source: www.energysavingtrust.org.uk/nottingham
[65] Source: European Commission Energy (www.eumayors.eu/home_en.htm)
[66] As set in the EU Climate Action and Renewable Energy Package
[67] Local authorities in the North East were the first in England to sign up to the Covenant as a whole region (all 12 local authorities at the same time)

UK incentives and trading mechanisms

To complement the European Emission Trading Scheme, the UK has also established some incentives to improve energy efficiency and some trading mechanisms nationally. These mainly target energy consumption from building construction and use as well as industrial processes.

Building policies[68]

To support the zero carbon building targets[69] and the delivery of the Carbon Budgets, the following building policies and mechanisms have been introduced or further developed over the last few years.

Energy certificates (Energy Performance Certificates - EPCs and Display Energy Certificates - DECs) allow a building's energy performance to be measured consistently and objectively. This aims to help better performing buildings to attract a premium, thereby increasing the business case for energy efficient buildings. The certificates grade the performance of buildings on a scale from A to G. EPCs are required for the sale or rent of all buildings since October 2008. DECs must be displayed in buildings with a total useful floor area of more than 1,000m^2, where the occupier is a public authority or an institution that provides public services and is frequently visited by members the public.

Building regulations[70] were revised in 2006 to comply with the EU Directive on the energy performance of buildings (EU EPBD). The revisions to Part L of the regulations for England[71] set maximum carbon dioxide emissions for whole buildings. The regulations apply both to the construction of new buildings and renovation of existing buildings (with a total surface area over 1,000m²). For new buildings, Part L reduces carbon emissions by 25% from 2002 standards, which already reduced emissions by 15%. The net reduction of 40% from pre-2002 is often used as an indicator of improvement.

The Code for Sustainable Homes[72] was also introduced to improve the overall sustainability of new homes by setting a single national standard within which the home building industry can design and construct homes. The Code measures the sustainability of a home against nine design categories[73], rating the 'whole home' as a complete package, using a rating system from one to six stars. Assessments are carried out by accredited independent assessors.

BREEAM[74] is used in the UK to assess the environmental performance of new and existing non residential buildings on a five point scale, from "pass" to "outstanding". As for dwellings, BREEAM assessments are carried out by accredited independent assessors.

At present, various public sector organisations require Code for Sustainable Homes (CSH) or BREEAM assessments to be conducted and a minimum rating to be achieved for buildings they buy, lease, fund or manage. This includes[75]:

- Office of Government Commerce (BREEAM "excellent" for all new buildings);
- Department for Children, Schools and Families (conditioning capital funding to major new build and refurbishment projects achieving a BEEAM Schools "very good" rating);
- health authorities in the UK (new healthcare buildings to achieve "excellent" rating and refurbishments to achieve "very good" rating);

[68] Source: www.carbontrust.co.uk
[69] All new homes and schools to be zero carbon by 2016 and all non domestic new buildings to be zero carbon by 2019. For a definition of "zero carbon", see Definition of Zero Carbon Homes and Non-Domestic Buildings, DCLG, 2008 (consultation) and 2009
[70] Building regulations are currently under review, with consultation being undertaken in 2010, to enable the UK to meet its targets for zero carbon new housing and commercial buildings by 2016 and 2019 respectively
[71] Part J in Scotland and Part F in Northern Ireland
[72] The Code for Sustainable Homes - Setting the standard in sustainability for new homes, DCLG, February 2008
[73] Energy and CO_2 emissions, pollution, water, health and wellbeing, materials, management, surface water run-off, ecology and waste
[74] The British Research Establishment Environmental Assessment Method (www.breeam.org)
[75] Source: www.breeam.org, February 2010

- Welsh Assembly Government (BREEAM "excellent" rating or CSH Level 3 are core conditions for funding for new buildings); and
- local authorities (environmental standards included in supplementary planning guidance).

Climate Change Levy and Agreements[68]

The Climate Change Levy (CCL) came into effect in 2001 and is a charge on energy usage (lighting, heating and power) for the following sectors: industry, commerce, agriculture, public administration, and other services. The levy does not apply to the domestic and transport sector and sectors already subject to the EU ETS are also excluded[76].

The levy adds approximately 15% to typical energy bills but all revenue raised through the levy is recycled back to business through a 0.3% cut in employers' national insurance contributions, introduced at the same time as the levy, and support for energy efficiency and low carbon technologies.

To help energy-intensive organisations, the Government has negotiated Climate Change Agreements (CCAs) in the following sectors:

- Aluminium
- Cement
- Ceramics
- Chemicals
- Food & drink
- Foundries
- Glass
- Non-ferrous metals
- Paper
- Steel

These agreements give organisations an 80% discount from the Climate Change Levy, as long as they reach additional CO_2 reduction targets.

Carbon Reduction Commitment (CRC) Energy Efficiency Scheme

The CRC Energy Efficiency Scheme (formerly known as the Carbon Reduction Commitment) is a mandatory cap and trade scheme which started in April 2010 across the UK.

The scheme is designed to encourage organisations with high energy use[77], which are not already involved in the EU ETS, to improve their energy efficiency. It covers large public and private sector organisations (responsible for about 10% of the UK's emissions). This affects around 20,000 organisations, including many local authorities, banks, supermarkets, water companies and large private sector employers.

Participating organisations have to monitor their emissions (mainly related to energy use and excluding transport emissions) and purchase allowances for each tonne of CO_2 they emit. Organisations' performance will be published annually, showing the comparative performance of participants. The revenue raised from selling allowances will be "recycled" back to participants and their performance will affect how much revenue each organisation receives[78].

CRC Timetable

April 2010 - March 2011: 'Footprint Year', with the registration period closing in September 2010 and qualification year for the second phase of the CRC.

April 2011: First sale of allowances Participants can buy allowances from Government at a fixed price of £12/tCO_2. Participants will only have to purchase allowances to cover their forecast emissions for 2011/12.

2013: First capped phase: auctioning of carbon allowances begins.

[76] Source: Climate Change Levy – introduction, HM Revenue and Customs

[77] An organisation qualifies as a full participant in CRC if at any point during the qualification period, it had at least one half hourly meter (HHM) settled in the half hourly market and its 2008 annual electricity supply through all HHMs was at least 6,000 MWh. Organisations that had at least one HHM settled on the half hourly market, but whose annual energy supply is less than 6,000 MWh do not have to participate in CRC but do have to make an information disclosure. Source: The CRC Energy Efficiency Scheme User Guide, Environment Agency, Northern Ireland Environment Agency, Scottish Environment Protection Agency, 2009

[78] Source: The CRC Energy Efficiency Scheme User Guide, Environment Agency, Northern Ireland Environment Agency, Scottish Environment Protection Agency, 2009

2.3 The transport sector in the UK

This section focuses on the transport sector, considering the contribution of the sector to carbon emissions and relevant travel and emissions patterns in the metropolitan areas.

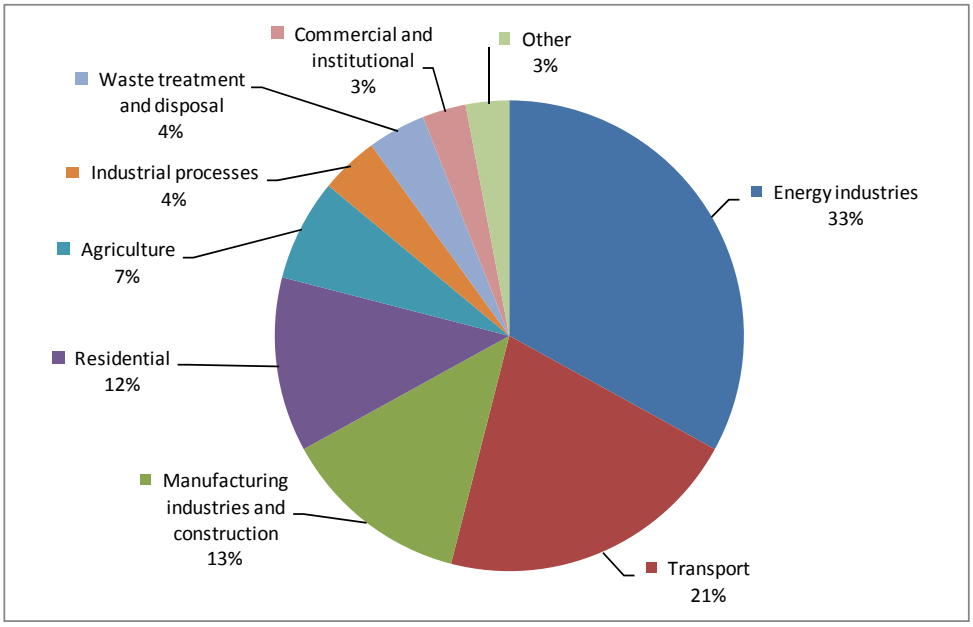
2.3.1 Transport contributes a quarter of UK domestic CO_2 emissions

Overview of transport sector emissions

99% of transport sector greenhouse gas emissions are CO_2 emissions

In 2007, transport represented 21% of the total domestic[79] GHG emissions in the UK, as shown in Figure 2.2 below, and 24% of domestic CO_2 emissions (131 million tonnes[80]).

Figure 2.2: Sources of domestic GHG emissions, UK (2007) [81]



'Other' includes fugitive emissions from fuels; agriculture and forestry fuel use; military aircraft and shipping; land use, land-use change and forestry (LULUCF).

When analysing greenhouse gas (GHG) emissions in the UK, emissions considered include carbon dioxide (CO_2), methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride[82].

When considering the transport sector however, almost 99% of domestic GHG emissions are CO_2 as shown in Table 2.5. This study therefore only considers CO_2 emissions.

[79] Including domestic emissions from road, rail, aviation and shipping
[80] Note: The IPCC source categories for transport exclude emissions from Military Aircraft and Shipping and Railways (stationary combustion). These are included in other sectors and in the UK total. The impact of including these gives transport an additional 3.52 Mt CO_2 in 2007. (This explains the discrepancy in totals between Table 2.5 and Table 2.6)
[81] Source: National Atmospheric Emissions Inventory (NAEI) - (IPCC categories) 2007
[82] In line with the definition of the greenhouse gas basket included in the Kyoto Protocol

Table 2.5: GHG and CO_2 emissions by sector (in million tonnes of CO_2)[83]

Sector	UK Total GHG Emissions		UK CO_2 Emissions		CO_2 as % of total GHG	
	2006	2007	2006	2007	2006	2007
Energy Supply	230.3	225.1	219.2	215.2	95.1%	95.6%
Business	99.4	96.8	90.5	88.1	91.0%	91.0%
Transport	135.5	136.7	133.6	134.9	98.6%	98.7%
Public	10.5	9.7	10.5	9.7	99.7%	99.7%
Residential	84.9	81.2	81.3	77.6	95.8%	95.6%
Agriculture	49.4	47.9	4.3	4.1	8.7%	8.6%
Industrial Process	16.4	17.7	13.1	14.3	79.7%	80.8%
Land Use Change	-1.8	-1.8	-1.8	-1.8	98.1%	98.0%
Waste Management	22.8	22.8	0.4	0.4	1.9%	2.0%
Total	**647.5**	**636.2**	**551.1**	**542.6**	**85.1%**	**85.3%**

Road transport is the main source of transport sector emissions

Table 2.6 shows the detailed classification of UK CO_2 emissions from the domestic transport sector, by source in 2007. This shows that road transport contributed 92.5% of all domestic transport CO_2 emissions in the UK in 2007.

Table 2.6: CO_2 emissions in the domestic transport sector [84]

Sources of transport sector CO_2 emissions	Million tonnes of CO_2			% of 2007 total CO_2 emissions
	1990	2006	2007	
Road transport	**109.5**	**120.4**	**121.6**	**22.4%**
Passenger cars	71.7	77.0	76.8	14.2%
Light duty vehicles	10.3	14.0	14.5	2.7%
Buses	3.3	2.8	3.0	0.6%
HGVs	23.3	25.4	26.3	4.8%
Mopeds and motorcycles	0.7	0.5	0.6	0.1%
LPG emissions (all vehicles)	0.0	0.4	0.4	0.1%
Other (road vehicles engines)	0.3	0.2	0.2	0.0%
Other transport	**7.3**	**10.4**	**9.7**	**1.8%**
Domestic aviation	1.2	2.3	2.1	0.4%
Railways - diesel trains	1.7	2.2	2.2	0.4%
Domestic shipping	4.1	5.5	4.9	0.9%
Other (aircraft support vehicles)	0.3	0.5	0.5	0.1%
Total domestic transport	**116.8**	**130.8**	**131.4**	**24.2%**
Total domestic UK emissions	**592.9**	**551.1**	**542.6**	**100.0%**

[83] Source: AEA Energy and Environment/Department for Climate Change (DECC) Office for National Statistics (Environmental Accounts) Annex B - 2008 UK provisional figures (by National Communication source category)
[84] Source: National Atmospheric Emissions Inventory (IPCC categories) 2007.

Domestic transport sector CO_2 emissions increased by 12.5% between 1990 and 2007, while overall UK domestic CO_2 emissions decreased by 8.5%[85]. CO_2 emissions from road transport increased by 11% over the same period as vehicle efficiency improvements were not able to compensate for the increase in kilometres travelled. Other notable increases in emissions from the transport sector over the 1990-2007 period include:

- 32% increase in railway sector CO_2 emissions (diesel trains only);
- 20% increase in domestic shipping CO_2 emissions; and
- 72% increase in domestic aviation CO_2 emissions.

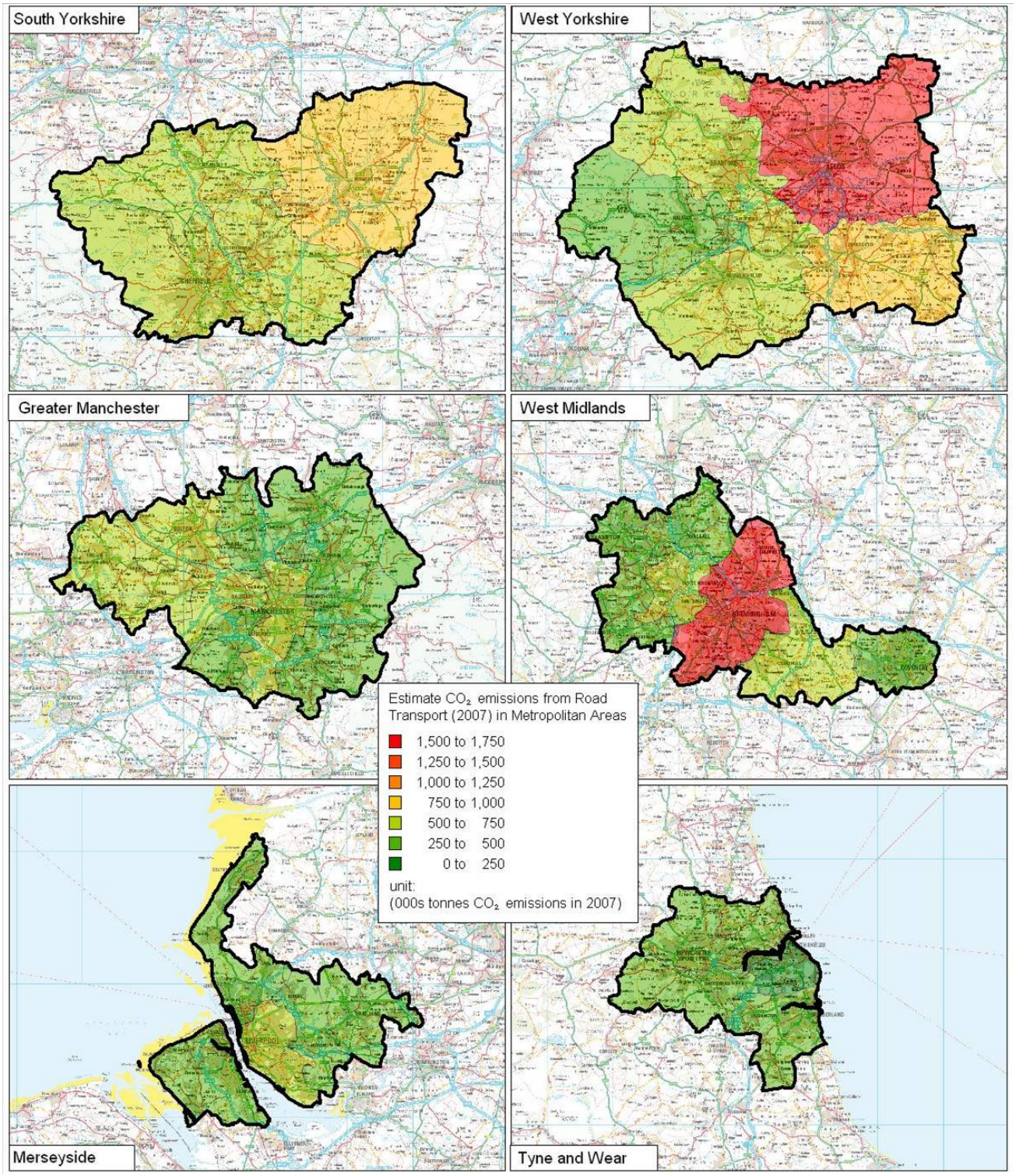
It is important to note that international aviation and shipping are excluded from the UK's total emissions estimate at present, as there is no internationally agreed way of reporting them. However, if they were included, emissions from both domestic and international aviation would make up 6.3% of the UK total CO_2 emissions, and emissions from domestic and international shipping would represent 2% of the UK total CO_2 emissions.

Road transport emissions in the city regions

Figure 2.3 shows road transport emissions for the metropolitan areas. The maps show important variations in the levels of emissions between local authorities within a same conurbation. This is linked to the number of residents and people accessing the area, the level of use of the local road network but also, importantly, to the impact of emissions from the motorway network as shown in Table 2.7.

[85] Although this has been dampened by the recession as shown in the Committee on Climate Change second report to Parliament (www.theccc.org.uk/reports/progress-reports/2nd-progress-report)

Figure 2.3: CO_2 emissions from road transport in metropolitan areas (2007)[86]



[86] Source: Local and Regional CO2 Emissions Estimates for 2005-2007, AEA

Table 2.7: Sources of transport sector CO_2 emissions in metropolitan areas [87]

Metropolitan area (PTE)	**Local authority**	**CO_2 emissions** (in '000 tonnes)		
		Motorway emissions	Total transport emissions	Motorway as % of total
South Yorkshire (SYPTE)	Barnsley	175	521	33.5%
	Doncaster	443	932	47.6%
	Rotherham	237	595	39.8%
	Sheffield	109	697	15.6%
West Yorkshire (Metro)	Bradford	15	619	2.4%
	Calderdale	161	437	36.9%
	Kirklees	273	728	37.5%
	Leeds	617	1,708	36.1%
	Wakefield	407	808	50.4%
Greater Manchester (GMPTE)	Bolton	139	530	26.1%
	Bury	236	472	50.1%
	Manchester	167	704	23.7%
	Oldham	49	269	18.1%
	Rochdale	273	488	55.9%
	Salford	303	624	48.6%
	Stockport	124	469	26.4%
	Tameside	100	297	33.9%
	Trafford	100	387	25.7%
	Wigan	163	520	31.3%
West Midlands (Centro)	Birmingham	213	1,552	13.7%
	Coventry	51	480	10.6%
	Dudley	58	461	12.5%
	Sandwell	160	542	29.4%
	Solihull	258	610	42.3%
	Walsall	131	429	30.5%
	Wolverhampton	-	313	0.0%
Merseyside (Merseytravel)	Knowsley	102	353	28.8%
	Liverpool	6	607	0.9%
	Sefton	28	301	9.4%
	St. Helens	148	351	42.1%
	Wirral	104	449	23.1%
Tyne & Wear (Nexus)	Gateshead	29	500	5.7%
	Newcastle upon	12	481	2.5%
	North Tyneside	-	341	0.0%
	South Tyneside	3	202	1.3%
	Sunderland	11	493	2.3%
UK Total		**31,613**	**136,361**	**23.2%**

[87] Source: AEA for DECC, Local and Regional CO_2 emissions estimates for 2005-2007

How does the UK compare with other European countries?

Table 2.8 shows CO_2 emissions from domestic transport, compared to total domestic CO_2 emissions across 15 European countries. The contribution of the transport sector to overall domestic CO_2 emissions varies between the countries presented here, with the share of transport emissions in the UK close to the European average (for these 15 countries).

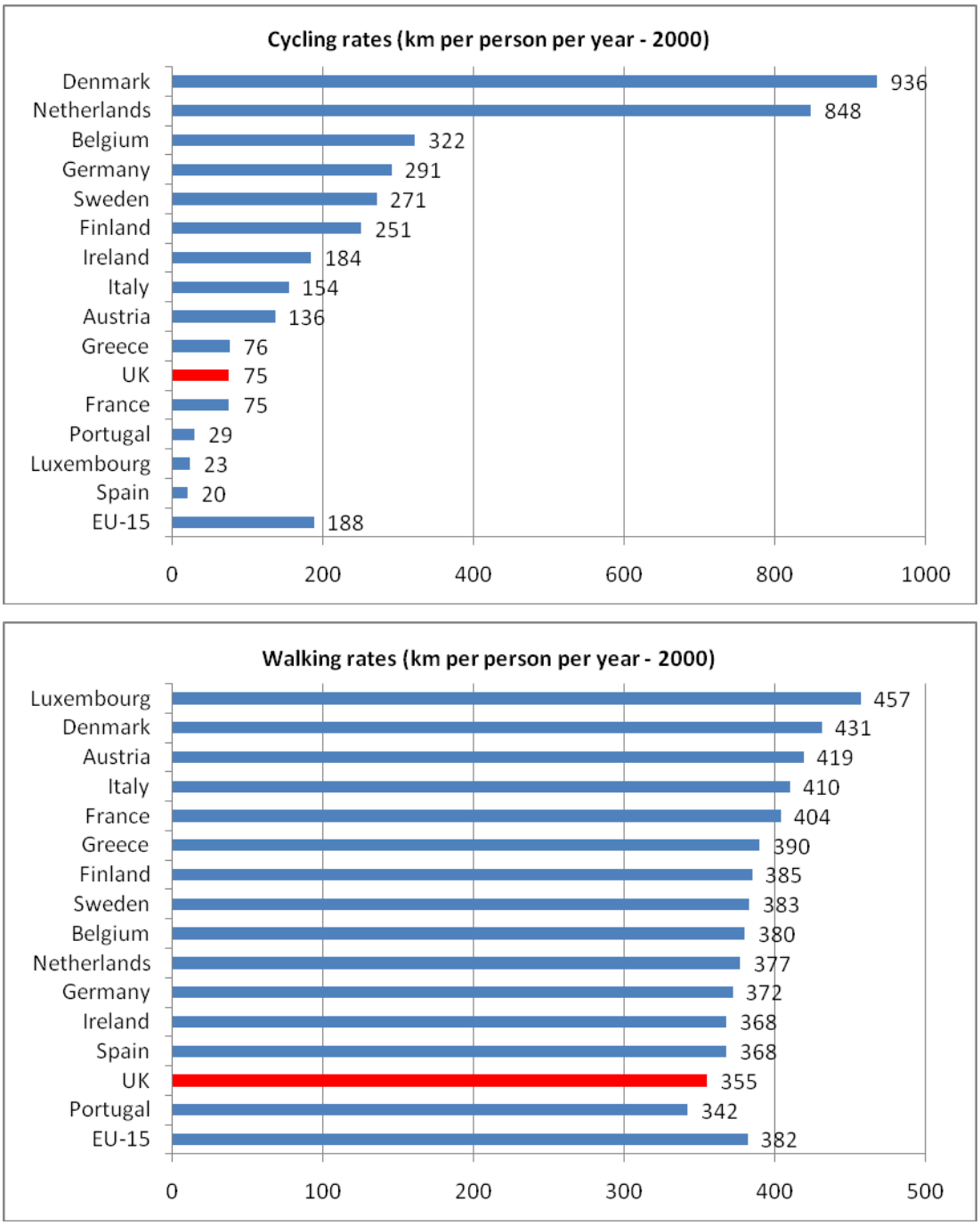
Table 2.8: Domestic CO_2 emissions in 15 European Union countries [88]

EU 15 countries	Million tonnes of CO_2		Transport in % of all sources	% of EU-15 transport total[89]
	Domestic transport	All sources[90]		
Luxembourg	7.0	12.1	57.8%	0.8%
Sweden	20.0	51.5	38.8%	2.3%
France	139.1	408.7	34.0%	16.2%
Portugal	19.3	64.0	30.1%	2.2%
Austria	22.8	77.3	29.5%	2.7%
Spain	105.6	359.6	29.4%	12.3%
Irish Republic	13.5	47.3	28.5%	1.6%
Italy	128.5	488.0	26.3%	15.0%
UK	**131.0**	**557.9**	**23.5%**	**15.3%**
Denmark	13.4	58.2	23.0%	1.6%
Greece	23.4	109.7	21.3%	2.7%
Belgium	25.2	119.1	21.2%	2.9%
Netherlands	35.6	172.2	20.7%	4.2%
Finland	13.7	66.1	20.1%	1.6%
Germany	160.6	880.3	18.2%	18.7%
EU-15 total	**858.7**	**3474.0**	**24.7%**	**100.0%**

[88] Source: National Inventory Submissions to UNFCCC in 2008. (2006 data)
[89] Note: This is strongly influenced by population figures
[90] Note: the Land Use change category has been excluded here as treatment of this category can differ between countries

These overall emission levels from the transport sector however hide strong differences between the 15 countries, for example relating to transport modes and the use of active modes (walking and cycling) as shown in Figure 2.4. This shows that the UK is well below the European (15 countries) average in terms of distances covered by walking and cycling.

Figure 2.4: Cycling and walking rates in 15 European Union countries[91]



[91] Source: Climate for a transport change. TERM 2007: Indicators tracking transport and environment in the European Union. (2000 data)

How does our transport behaviour contribute to CO_2 emissions?

An analysis of recent sources of UK transport data goes some way to explain the trends in CO_2 emissions from the transport sector highlighted above. The following sections consider how and why we travel, analysing metropolitan level data where possible or regional and national trends where metropolitan level data was not available.

"Leisure trip" represent almost 50% of all trips

Travelling is usually a means to an end and Table 2.9 shows that the majority of trips undertaken in the regions within which the metropolitan areas are located are linked to shopping (20 to 22% of trips), visiting friends (16 to 18%) and commuting (15 to 16%). These figures in the North East, North West, Yorkshire and Humber and West Midlands regions are similar to the English average.

The importance of "leisure trips" (defined here as a broad category including shopping, visiting friends, sports & entertainment and holiday & day trips) is to be noted. This type of travel is currently not often considered as important as travel to work and on business when planning for transport infrastructure or services or implementing behaviour change programmes but represents almost 50% of the trips undertaken in England and the regions considered here.

Table 2.9: Trip purpose by region (number of trips/percentage of trips), 2008 [92]

Regions (with metropolitan areas)	Commuting	Business	Education	Shopping	Personal business	Escort	Visiting friends	Sport & entertainment	Holidays & day trips	Other – incl. just walk	All purposes
North East	163 (16%)	26 (3%)	54 (5%)	218 (22%)	106 (11%)	122 (12%)	163 (16%)	59 (6%)	41 (4%)	43 (4%)	994
North West	161 (15%)	37 (3%)	72 (7%)	229 (21%)	114 (10%)	152 (14%)	185 (17%)	68 (6%)	36 (3%)	46 (4%)	1,101
Yorkshire & Humber	159 (15%)	35 (3%)	68 (6%)	217 (21%)	107 (10%)	142 (13%)	193 (18%)	64 (6%)	33 (3%)	39 (4%)	1,058
West Midlands	155 (15%)	34 (3%)	68 (7%)	213 (20%)	103 (10%)	150 (14%)	182 (17%)	62 (6%)	39 (4%)	37 (4%)	1,043
England	**161 (15%)**	**36 (3%)**	**64 (6%)**	**213 (20%)**	**108 (10%)**	**144 (14%)**	**170 (16%)**	**67 (6%)**	**39 (4%)**	**42 (4%)**	**1,044**

[92] Source: Regional Transport Statistics, DfT, 2008

Car travel dominates with almost ¾ of commuters getting to work by car in the city regions

Figure 2.5 shows that approximately 80% of miles travelled are by car in the UK and that this proportion has not changed much since 1995, apart from a slight increase in rail travel as shown in more detail in Figure 2.6.

Figure 2.5: % distance travelled by all modes (1995-2008)[93]

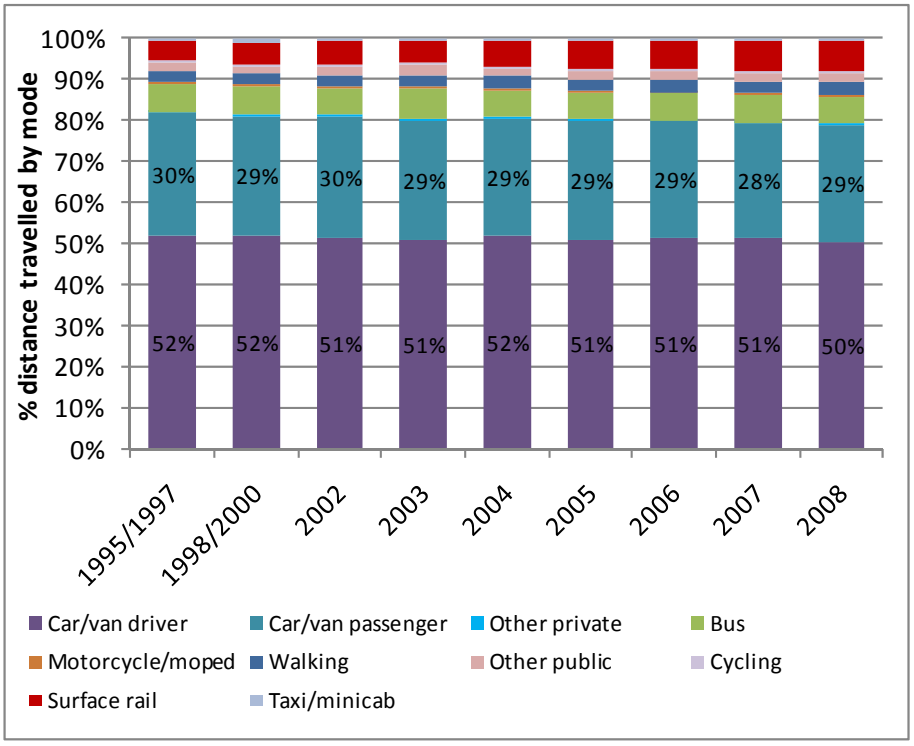
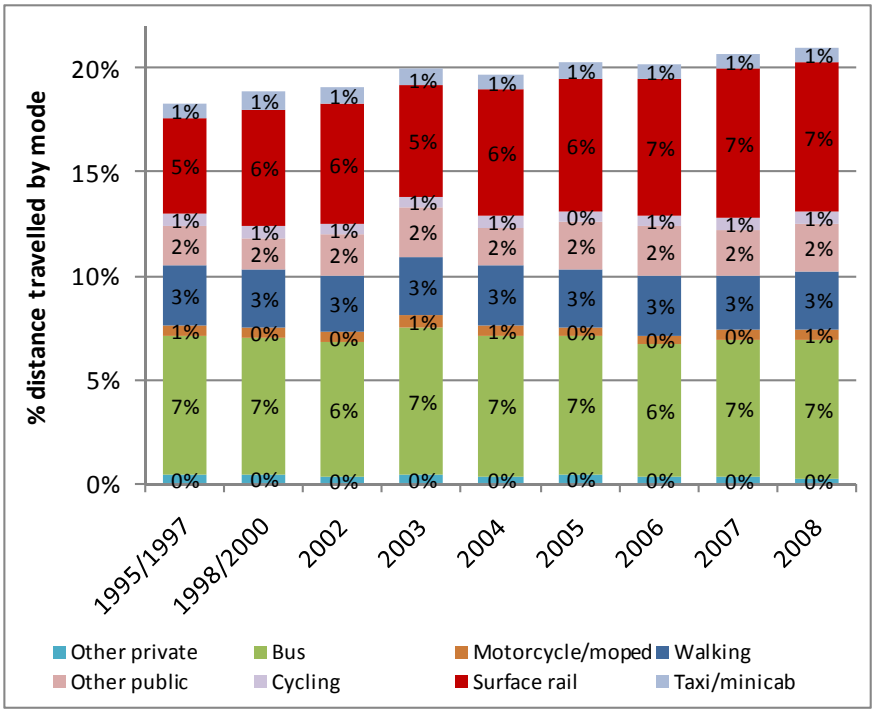


Figure 2.6: % distance travelled by non-car modes (1995-2008)[93]



[93] Source: National Transport Statistics, DfT (2009)

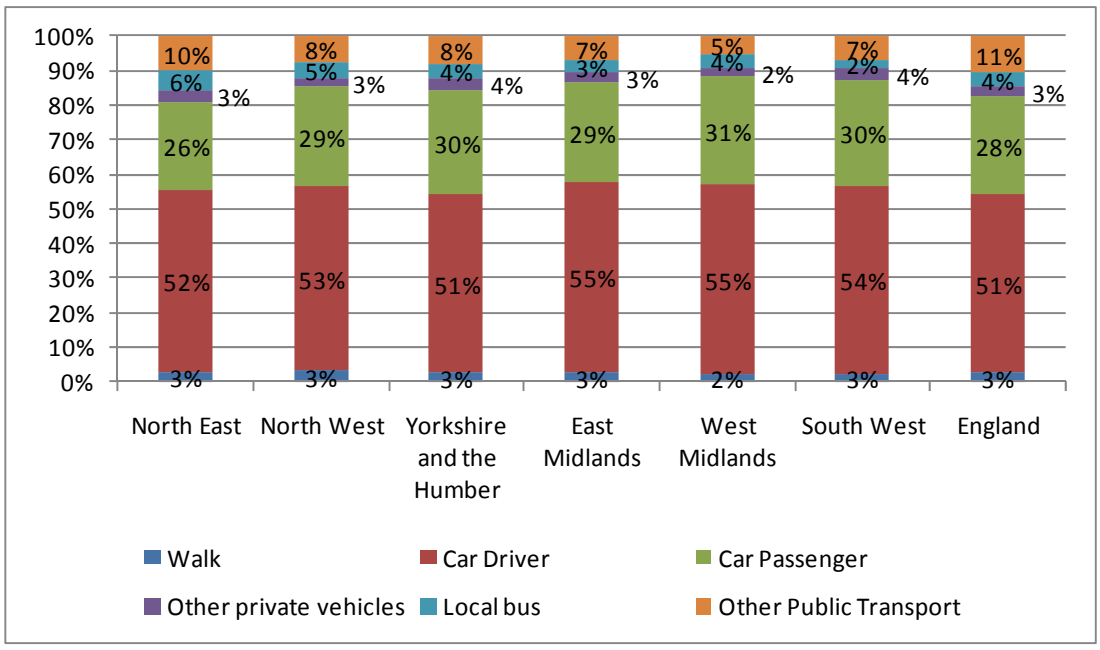
Table 2.10 and Figure 2.7 show the average distance travelled by mode within the regions where the metropolitan areas are located for 2005/06. The average person in the UK travelled just over 7,000 miles in the course of the year. Yorkshire and Humber residents were close to the national average. West Midlands and North West average annual mileage was approximately 6% lower than the national average. The average annual distance travelled in the North East was almost 14% lower than the English average.

More than 50% of miles travelled are as car driver across the regions, with a further 26 to 31% of mileage as a passenger. The West Midlands has the highest proportion of distance travelled as a car driver (55%) and as a car passenger (31%). Public transport represented only 9 to 16% of mileage per annum, with the North East region showing the highest proportion of mileage undertaken by public transport.

Table 2.10: Distances travelled by region (in miles per person per year) [96]

Regions (with metropolitan areas)	Walk	Car driver	Car passenger	Other private vehicles	Local bus	Other public transport	All modes
North East	188	3,212	1,577	206	338	620	6,140
North West	215	3,562	1,919	183	303	505	6,687
Yorkshire & Humber	203	3,681	2,183	257	294	574	7,192
West Midlands	165	3,648	2,082	157	288	341	6,681
England	**202**	**3652**	**2027**	**209**	**277**	**769**	**7,137**

Figure 2.7: Distance travelled by mode (% of total distance per person per year)



East Midlands and South West regions included here for comparison purposes.

Distances travelled per year have remained broadly stable, within the bands of 6,950 and 7,250 miles per person per year over the 1997 to 2008 period, with total distances decreasing slightly since 2005[94].

[94] Source: National Transport Statistics, DfT, 2009

Table 2.11 shows modes of transport to work in 2008. To better understand how this varies between metropolitan/urban and rural areas, the urban centres have been disaggregated from the regional results and the metropolitan areas are highlighted in grey.

This shows that although metropolitan areas have a high proportion of car based commuting (between 70 and 74%); they have a lower proportion of people driving to work than the rest of their regions. Metropolitan areas also have a higher proportion of commuters using buses and trains to travel to work (between 12 and 16% against 10 to 12% across the regions). However the proportion of people cycling and walking to work is generally lower in metropolitan areas (with the exception of South Yorkshire).

The data also highlights the strong difference in mode share for commuting journeys between London (including outer London) and the rest of England, including the metropolitan areas.

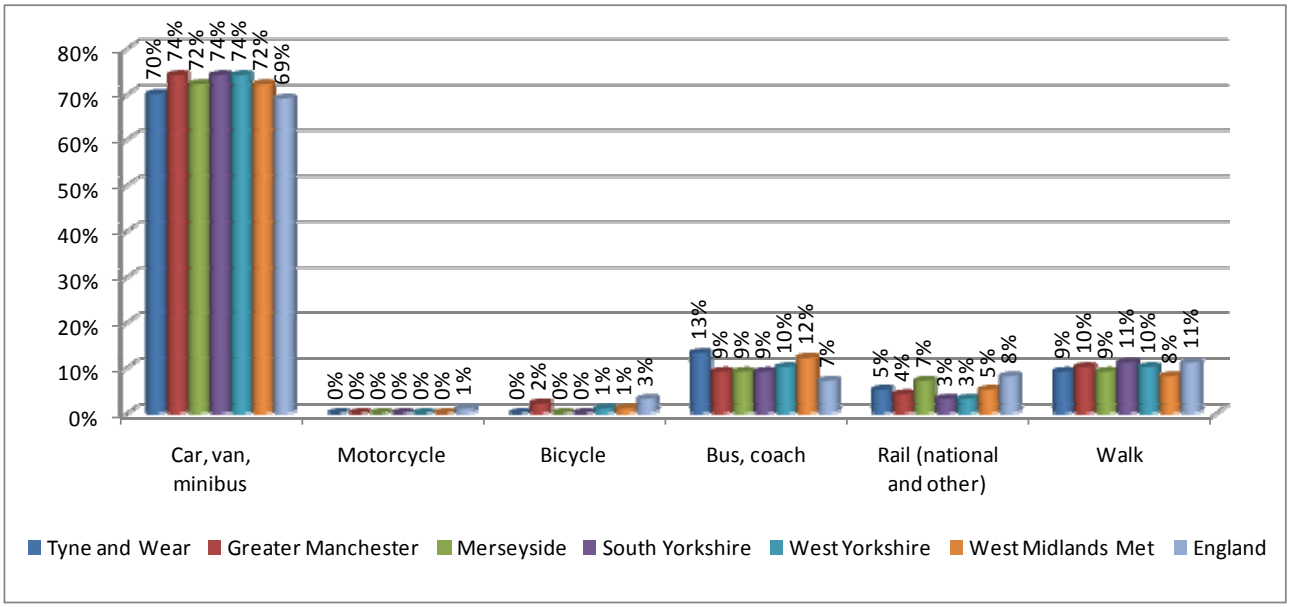
Table 2.11: Modes of travel to work by region (October to December 2008)[95]

Regions and metropolitan areas (PTEs)	Number in employment (000s)	Car, van, minibus	Motor cycle	Bicycle	Bus, coach	Rail (national & other)	Walk
North East	**960**	**76%**	**0%**	**1%**	**9%**	**3%**	**10%**
Tyne and Wear (Nexus)	458	70%	0%	0%	13%	5%	9%
Rest of North East	503	82%	0%	0%	5%	0%	11%
North West	**2,691**	**76%**	**0%**	**2%**	**7%**	**3%**	**11%**
Greater Manchester (GMPTE)	1,025	74%	0%	2%	9%	4%	10%
Merseyside (Merseytravel)	464	72%	0%	0%	9%	7%	9%
Rest of North West	1,202	79%	0%	3%	4%	1%	12%
Yorkshire & Humber	**2,046**	**75%**	**1%**	**3%**	**8%**	**2%**	**11%**
South Yorkshire (SYPTE)	483	74%	0%	0%	9%	3%	11%
West Yorkshire (Metro)	884	74%	0%	1%	10%	3%	10%
Rest of Yorkshire & Humber	679	76%	0%	5%	5%	0%	11%
East Midlands	**1,743**	**77%**	**0%**	**4%**	**6%**	**1%**	**12%**
West Midlands	**2,087**	**76%**	**1%**	**2%**	**7%**	**3%**	**10%**
Metropolitan County (Centro)	1,009	72%	0%	1%	12%	5%	8%
Rest of West Midlands	1,078	80%	0%	3%	3%	1%	12%
East of England	**2,159**	**76%**	**1%**	**5%**	**4%**	**2%**	**11%**
London	**3,450**	**35%**	**2%**	**3%**	**14%**	**38%**	**8%**
Central London	1,251	12%	2%	3%	13%	65%	5%
Rest of Inner London	901	29%	3%	5%	15%	37%	10%
Outer London	1,298	62%	1%	2%	13%	12%	9%
South East	**3,399**	**76%**	**1%**	**4%**	**4%**	**4%**	**11%**
South West	**2,138**	**75%**	**1%**	**4%**	**4%**	**2%**	**14%**
England	**20,674**	**69%**	**1%**	**3%**	**7%**	**8%**	**11%**

[95] Source: Labour Force Survey – Office of National Statistics

Figure 2.8 compares modes of transport to work for the metropolitan areas to the English average (which is skewed by the influence of London where a larger proportion of people commute by public transport).

Figure 2.8: Modes of travel to work in metropolitan areas (October to December 2008)



Car ownership is still growing

Table 2.12 and Figure 2.9 show car ownership figures across the regions considered by the study (with metropolitan areas), providing a comparison of car ownership in 1996 and 2006. It is clear from this table that across the regions considered, as well as across England, the number of households with more than one car has significantly increased whereas the number of households with no car has significantly reduced.

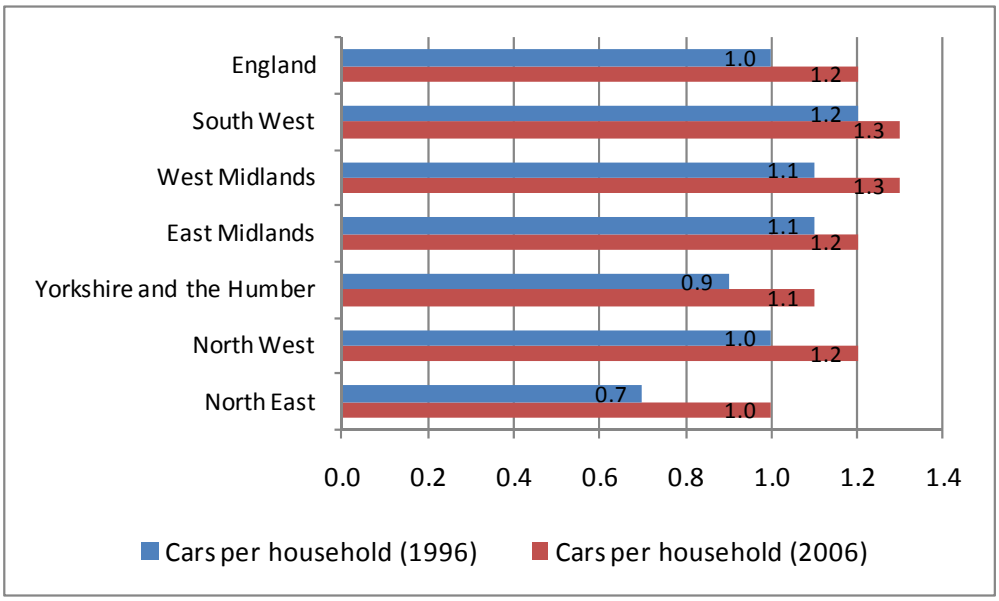
The region with the lowest level of car ownership remains the North East (with 31% of households without a car in 2006, down from 44% in 1996). The North East also remains the region with the lowest number of households with more than one car although there has been a rapid growth in car ownership in the region. The region showing the highest level of car ownership is the West Midlands (with 1.3 cars per household in 2006).

Table 2.12: Car ownership by region (1996/2006) [96]

Regions (with metropolitan areas)	**No car**		**One car**		**Two or more cars**		**Number of cars per household**	
	1996	2006	1996	2006	1996	2006	1996	2006
North East	44%	31%	39%	45%	17%	23%	0.7	1.0
North West	31%	27%	45%	43%	24%	31%	1.0	1.2
Yorkshire & Humber	33%	25%	46%	45%	21%	30%	0.9	1.1
West Midlands	31%	23%	43%	42%	26%	36%	1.1	1.3
England	**29%**	**24%**	**45%**	**44%**	**25%**	**33%**	**1.0**	**1.2**

[96] Source: Regional Transport Statistics, DfT, 2008

Figure 2.9: Number of cars per household (1996/2006) comparison

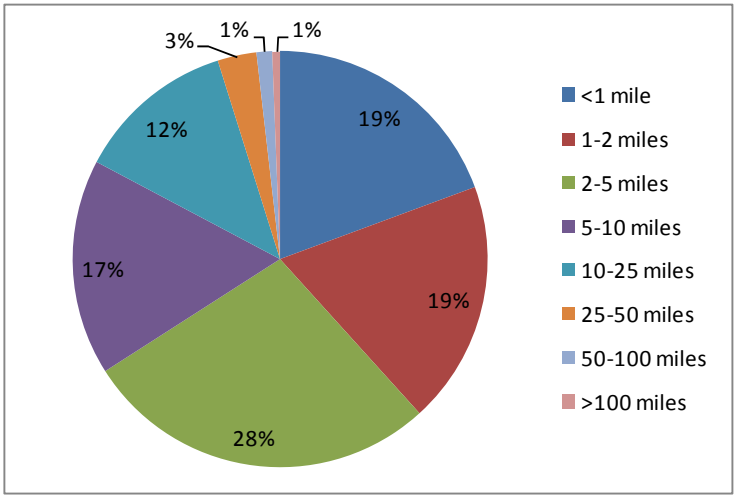


East Midlands and South West regions included here for comparison purposes.

The majority of trips are under 5 miles but most are undertaken by car

Figure 2.10 shows that the majority of trips undertaken in the UK are under 5 miles (66%), with 19% of trips being less than 1 mile. 44% of trips are of 5 miles or more with only 2% above 50 miles leading to an average trip length in the UK of 7 miles for 2008, as shown in Figure 2.11. This also shows that the 2008 average trip length was down from 7.3 miles in 2007 but with a general upward trend over the last 10 years.

Figure 2.10: Trip lengths (2008)[97]



[97] Source: National Transport Statistics, DfT, 2009

Figure 2.11: Average trip length (1995-2008)

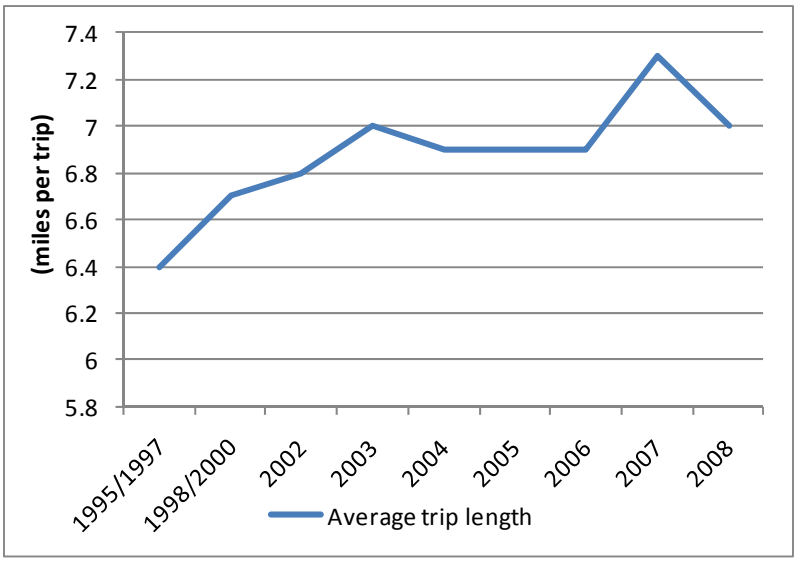
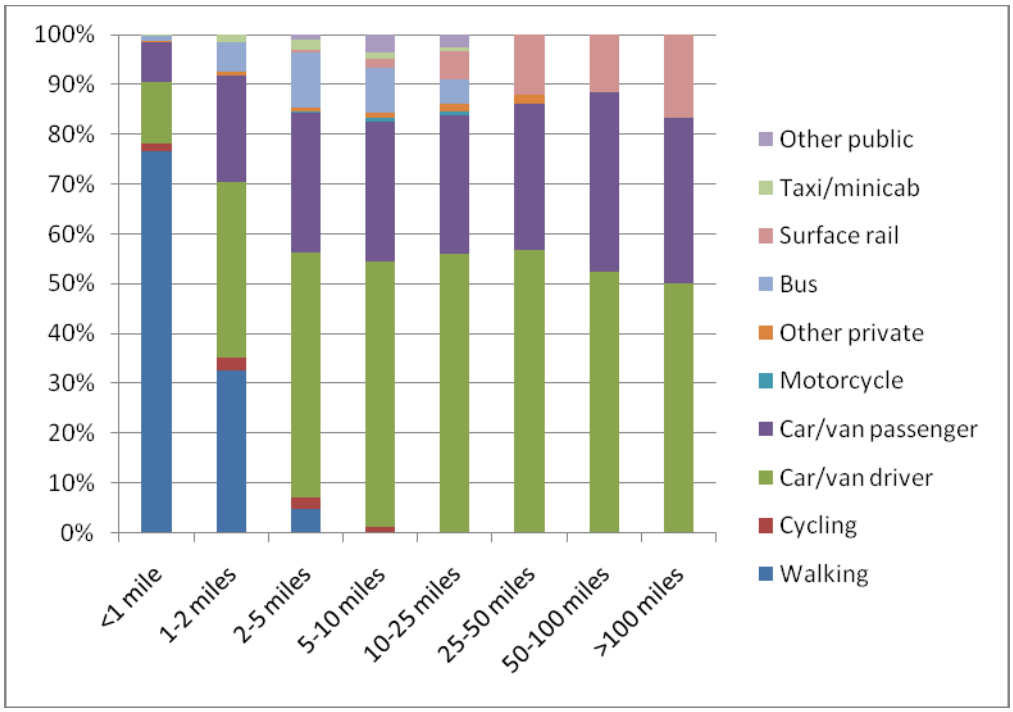


Figure 2.12 shows the disaggregation of journey length by mode and clearly highlights that longer journeys are generally made by car (above 80%). It is however important to note that over 50% of trips between one and two miles are undertaken by car, as a driver or a passenger, on distances which could easily be covered walking or cycling.

Figure 2.12: Trip lengths by mode (2008)[98]



[98] ibid

Figure 2.13 below highlights the average trip length disaggregated by journey purpose. This shows that people travel longer distances for leisure activities and business trips, with the average commuting trip at 8.6 miles in 2008.

Figure 2.13: Average trip length by trip purpose (2008)

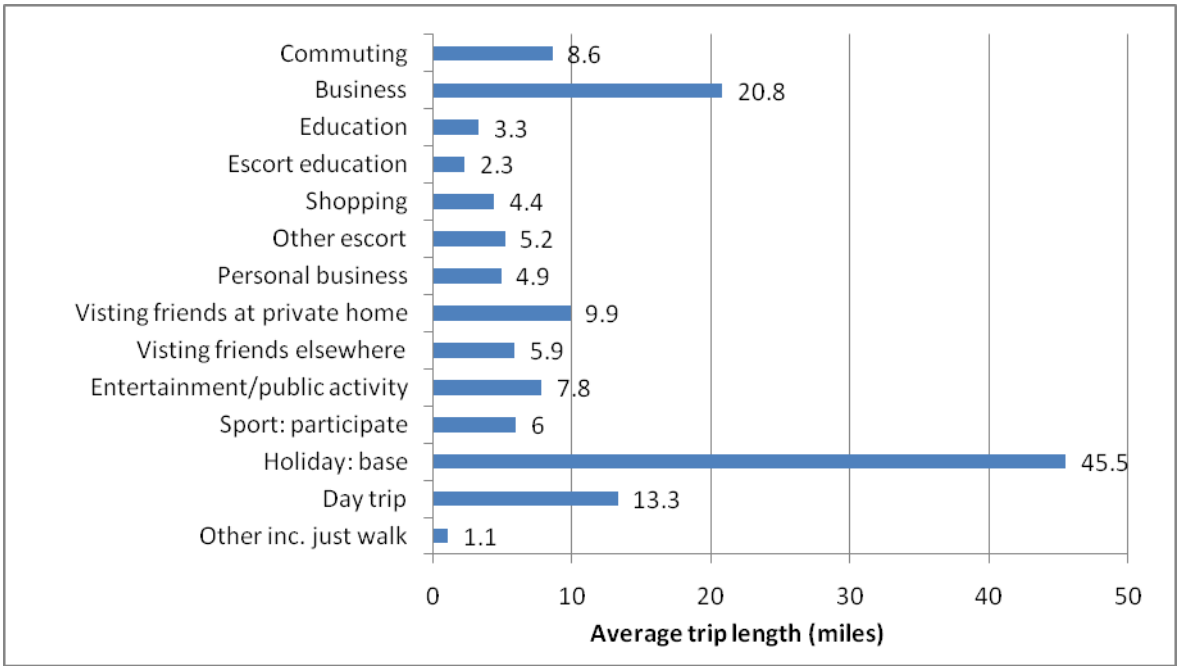


Table 2.13 below shows further disaggregation of the annual car mileage by trip purpose. Commuting and other private (including leisure) mileage by car has remained largely constant and only business mileage shows a more significant decrease over the period.

Table 2.13: Annual car mileage by trip purpose[99]

Year	Business mileage	Commuting mileage	Other private mileage	Total
1995/1997	1,710 (18%)	2,830 (29%)	5,160 (53%)	9,700
1998/2000	1,590 (17%)	2,940 (31%)	5,030 (53%)	9,550
2002	1,250 (14%)	2,780 (30%)	5,140 (56%)	9,170
2003	1,230 (13%)	2,840 (31%)	5,160 (56%)	9,230
2004	1,140 (12%)	2,850 (31%)	5,170 (56%)	9,160
2005	1,090 (12%)	2,840 (32%)	5,060 (56%)	9,010
2006	1,040 (12%)	2,770 (32%)	4,960 (57%)	8,770
2007	1,070 (12%)	2,740 (31%)	5,060 (57%)	8,870
2008	1,020 (12%)	2,640 (30%)	5,040 (58%)	8,690

[99] ibid

We spend more time travelling to work in metropolitan areas

Figure 2.14 and Table 2.14 show the duration of trips to work in the regions and more specifically in the metropolitan areas (highlighted in grey in the table). The proportion of trips to work taking under 20 minutes or less is generally similar across the metropolitan areas and close to the English average (42%), with the notable exceptions of Tyne & Wear (45%) and the West Midlands metropolitan area (37%).

Metropolitan areas show a lower proportion of trips taking 20 minutes or less when compared to their surrounding area (37 to 45% compared to 52 to 54% in the surrounding areas). This is linked to congestion issues, distances travelled and higher use of public transport.

Duration of trips to work in the metropolitan areas remain however shorter than trips to work in the London area (with 85% of trips taking under 90 minutes for central London compared to 97 to 99% of trips to work completed under 90 minutes for the metropolitan areas).

Figure 2.14: Duration of trips to work in metropolitan areas (percentage of trips)[100]

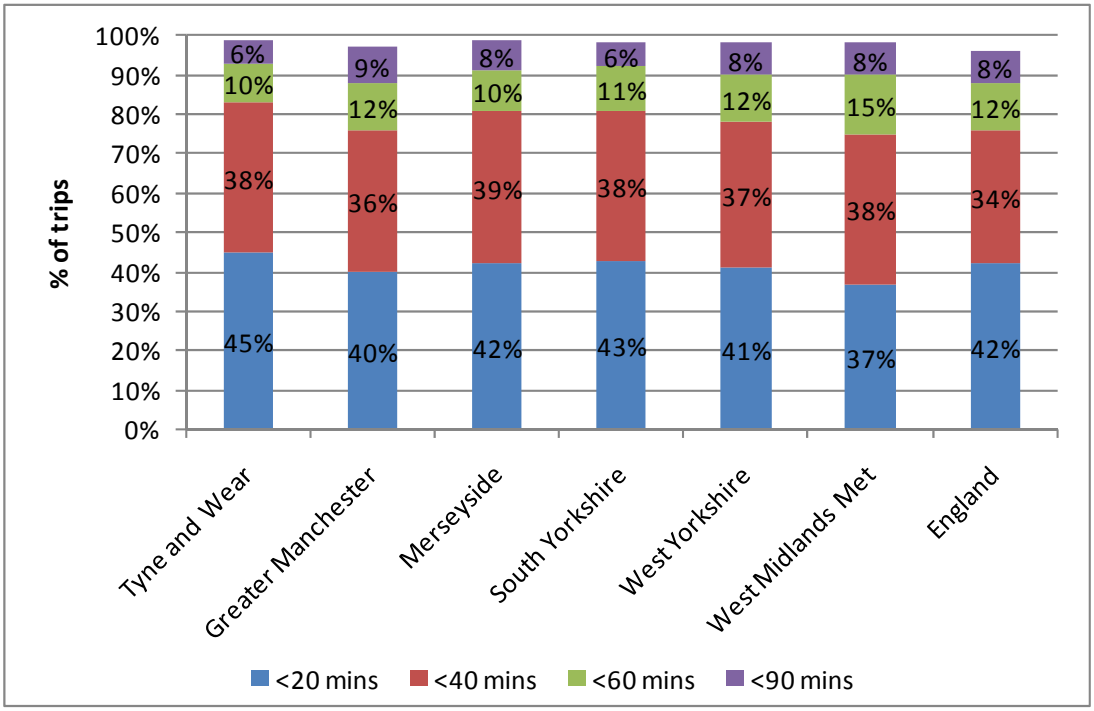


Table 2.14: Duration of trips to work (cumulative percentage of trips to work)

Workplace location	Cumulative percentage of trips			
	under 20 minutes	under 40 minutes	under 60 minutes	under 90 minutes
North East	50	86	95	99
Tyne and Wear	45	83	93	99
Rest of North East	54	90	97	99
North West	46	82	91	98
Greater Manchester	40	76	88	97
Merseyside	42	81	91	99
Rest of North West	52	86	95	99
Yorkshire & Humber	45	81	92	98
South Yorkshire	43	81	92	98
West Yorkshire	41	78	90	98

[100] Source: Regional Transport Statistics, DfT, 2008

Workplace location	Cumulative percentage of trips			
	under 20 minutes	under 40 minutes	under 60 minutes	under 90 minutes
Rest of Yorkshire & Humber	52	86	94	99
East Midlands	49	85	95	99
West Midlands	46	81	92	98
Metropolitan area	37	75	90	98
Rest of West Midlands	55	87	95	98
East of England	49	83	92	98
London	17	46	67	90
Central London	5	28	54	85
Rest of Inner London	17	48	68	91
Outer London	31	65	80	94
South East	47	81	91	97
South West	50	85	94	98
England	**42**	**76**	**88**	**96**

We spend £50/week in average on private transport and only £5/week on bus and rail fares

Figure 2.15 shows the weekly expenditure on transport per household for Great Britain in 2007. The average expenditure per household is shown to be just above £50 per week on private vehicle costs only (motor vehicles and bicycles). The largest weekly outgoings are fuel (£18.30) and the initial purchase of vehicles equating to an average of £22.80 per week.

Figure 2.15: Household expenditure on motoring and cycling (2007, £ per week)[101]

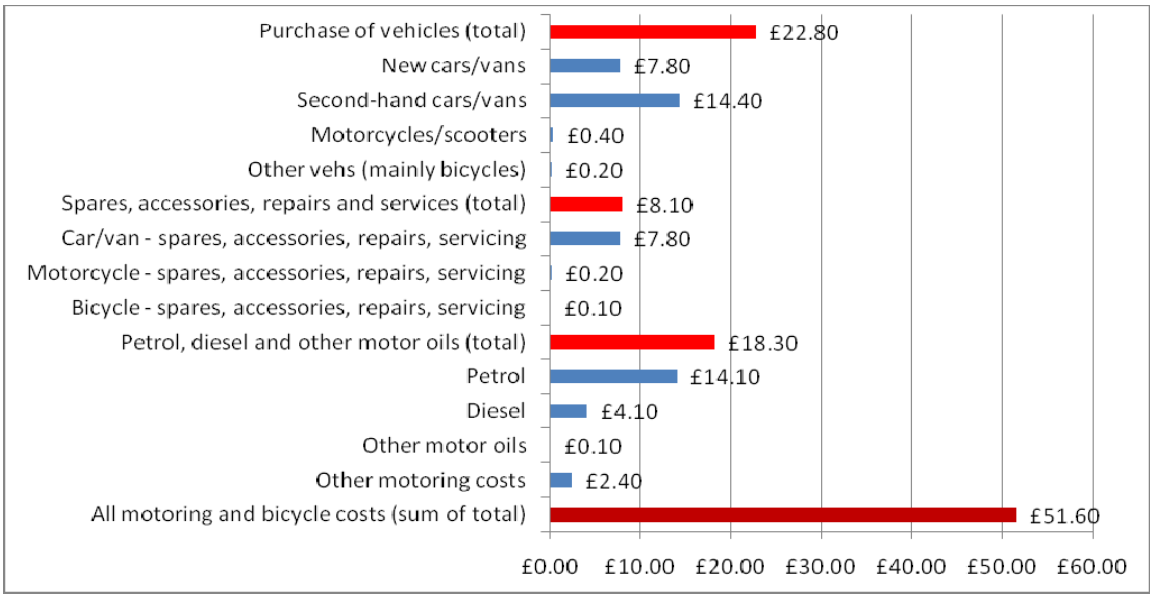


Figure 2.16 summarises the weekly expenditure on transport per household in Great Britain (2007) for transport services, which includes public transport and air fares. This shows a total average expenditure on transport services just above £10. This represents about a fifth of private transport expenditure but drops down to £5 per week when considering bus, metro and train fares only. The largest outgoings are for air travel (£5.10) and rail and tube fares (£2.50).

[101] Source: National Transport Statistics, DfT, 2009

Figure 2.16: Household expenditure on transport services (2007, £ per week)[102]

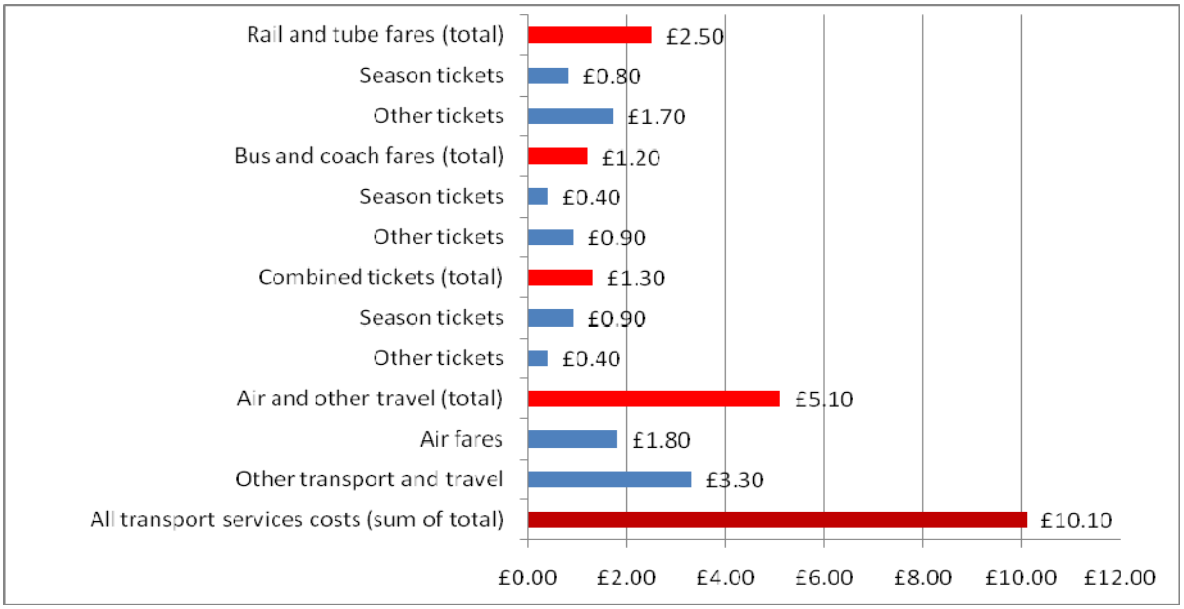


Table 2.15 below compares total weekly household expenditure and transport costs over the 2000 to 2007 period. When adjusted for inflation, these figures show a decline in the total weekly outgoings for transport (6.3% over the 2000-2007 period). The share of transport in the total weekly expenditure remained relatively constant over the period, between 13.5 and 14.5%.

Table 2.15: Household expenditure and transport costs (2000-2007, £ per week)[103]

Expenditure	2000/01	2001/02	2002/03	2003/04	2004/05	2006	2007
All motoring and cycling costs (total)	£47.30	£49.40	£50.70	£51.90	£51.40	£50.90	£51.60
All transport services costs (total)	£8.60	£8.40	£8.50	£8.80	£8.10	£9.90	£10.10
All transport expenditure[104]	£55.90	£57.80	£59.20	£60.70	£59.60	£60.80	£61.70
All household expenditure	£385.70	£398.30	£406.20	£418.10	£434.40	£449.00	£459.20
% of household expenditure on transport	14.50%	14.50%	14.60%	14.50%	13.70%	13.50%	14.50%
Key transport expenditure totals							
Motoring costs	£55.10	£58.50	£61.70	£62.40	£62.60	£61.40	£62.00
Fares and other travel costs	£9.50	£9.50	£9.70	£9.60	£9.50	£10.90	£10.90
All transport and travel	£64.50	£68.00	£71.40	£72.00	£72.10	£72.30	£72.90
Adjusted for general inflation: 2007 prices							
Motoring costs	£66.40	£68.80	£71.80	£70.60	£68.70	£63.70	£62.00
Fares and other travel costs	£11.40	£11.10	£11.30	£10.90	£10.40	£11.50	£10.90
All transport and travel	£77.80	£79.90	£83.10	£81.50	£79.10	£75.20	£72.90

[102] Source: National Transport Statistics, DfT, 2009
[103] ibid
[104] All transport expenditure category excludes motor vehicle insurance and taxation, and boat purchase and repairs.

Freight vehicles and light vans contribute 15% of urban traffic

Freight vehicles and light vans contribute significantly to urban traffic. Light vans and goods vehicles represented 15.6% of vehicle kilometres travelled by motorised road traffic on urban A roads in 2008 (12.1% by light vans) and 14.8% of vehicle kilometres by motorised road traffic on minor urban roads (13.3% by light vans)[105].

The number of light vans in Great Britain has increased significantly over the 1998-2008 period, from 2.3 million to 3.2 million. Light vans represented 9.5% of all licensed motor vehicles in Great Britain in 2008. This also translates in a significant increase in vehicle kilometres travelled by vans (from 50.8 billion in 1998 to 68.1 billion in 2008), representing 13.4% of all vehicle kilometre from motor vehicles in 2008[106]. Analysis undertaken by the cabinet Office Strategy Unit shows that light vans have accounted for approximately half of urban traffic growth between 1997 and 2008[107].

When considering freight transport by road within the UK, the metropolitan areas are at the origin of 16% of volume lifted. The majority (between 63.6 and 75%) of goods lifted from the metropolitan areas have the area's wider region for destination, as shown in Table 2.16. Table 2.17 takes the distance over which goods are transported by road and shows that between 28.8 and 39.6% of tonne-km originating from the metropolitan areas have their wider region for destination.

Table 2.16: Freight transport by road - goods lifted by origin and destination of goods (2007)[108]

Origin of goods (Functional Metropolitan Areas)	**Destination**	**Million tonnes**	**Percentage**
From Tyne &Wear	to North East region	18	75%
	to rest of UK	6	25%
From Manchester	to North West region	50	73.5%
	to rest of UK	18	26.5%
From Merseyside	to North West region	26	68.4%
	to rest of UK	12	31.6%
From South Yorkshire	to Yorkshire & Humber region	28	63.6%
	to rest of UK	16	36.4%
From West Yorkshire	to Yorkshire & Humber region	48	69.6%
	to rest of UK	21	30.4%
From West Midlands metropolitan area	to West Midlands region	46	67.6%
	to rest of UK	22	32.3%
Total goods lifted within the UK		*1,951*	
Proportion of goods from metropolitan areas			*16%*

[105] Source: Road Statistics 2008 - Traffic, Speeds and Congestion
[106] Source: Road Freight Statistics, 2008
[107] An analysis of urban transport, Cabinet Office Strategy Unit, November 2009
[108] Source: Regional Transport Statistics 2008

Table 2.17: Freight transport by road - goods moved by origin and destination of goods (2007)[108]

Origin of goods (Functional Metropolitan Areas)	Destination	Million tonne-kms	Percentage
From Tyne &Wear	to North East region	620	28.9%
	to rest of UK	1,523	71.1%
From Manchester	to North West region	2162	39.6%
	to rest of UK	3296	60.4%
From Merseyside	to North West region	1015	28.8%
	to rest of UK	2,508	71.2%
From South Yorkshire	to Yorkshire & Humber region	1377	36.1%
	to rest of UK	2440	63.9%
From West Yorkshire	to Yorkshire & Humber region	1,777	32.2%
	to rest of UK	3,748	67.8%
From West Midlands metropolitan area	to West Midlands region	1,960	32.6%
	to rest of UK	4044	67.4%
Total volume (tonne-km) within the UK		165,615	
Total volume (tonne-km) from metropolitan areas		26,470	
Proportion of volume from metropolitan areas			16%

2.4 Governance in low carbon city regions

Reducing carbon emissions, from the transport sector or any other sector of the economy, provides significant economic and social opportunities as well as challenges.

The Local Transport Act 2008[109] defines the nature of the *"duty to develop transport policies"* for Integrated Transport Authorities and local transport authorities, highlighting the need for them to:

"have regard to any guidance issued (…) by the Secretary of State, with respect to mitigation of, or adaptation to, climate change or otherwise with respect to the protection or improvement of the environment".

This section examines which organisations currently hold the relevant levers and powers to achieve cuts in carbon emissions, focusing on the transport sector. It also analyses the type of interventions which will be required (and are presented and modelled in the next sections) and how governance arrangements can potentially help or hinder their delivery.

2.4.1 Who is in charge?

Table 2.18 summarises how levers to influence carbon emissions are split between the local, metropolitan, city regional and regional[110] level, focusing on the transport sector in the Metropolitan areas. As highlighted by recent analysis from the Cabinet Office Strategy Unit[111], "**in metropolitan areas, no single body is responsible for ensuring that public transport and road networks are working effectively across the conurbation as a whole**". This analysis is also relevant when considering the reduction of carbon emissions from the transport sector.

It is also important to note the roles of the Highways Agency which operates trunk roads serving the metropolitan areas and bus and rail operators which provide both local and national services.

If metropolitan areas are to deliver significant cuts in carbon emissions, in line with UK Carbon Budgets, the various partners will have to work together to use existing levers efficiently. This is especially important to achieve cuts in carbon emissions from the transport sector due to:

- the need to avoid displacing transport emissions between areas (for example, a Park & Ride scheme at the periphery of a metropolitan area could result in lower traffic levels and hence emissions in the urban area but additional traffic to and from the Park & Ride, at the periphery);
- the need to lock-in any emission savings achieved through targeted interventions and reduce the risk of rebound (for example, the take-up of hybrid and electric vehicles will potentially result in additional traffic as the cost of driving is reduced[112]);
- the nature of travel patterns to and from metropolitan areas, with many trips starting and ending outside the urban area; and
- the challenging nature of the UK targets which require all sectors to achieve very significant cuts in emissions, as early as possible[113].

[109] Local Transport Act 2008, Part 2, Section 8
[110] Subject to significant changes as a result of the change of Government following the May 2010 General Elections
[111] An analysis of urban transport, Cabinet Office Strategy Unit, November 2009, supported by analysis from the Commission for Transport (CfIT), Moving forward: better transport for City Regions, CfIT, 2007
[112] Supported by the analysis undertaken by the DfT for the Carbon Reduction Strategy for Transport and presented in the Carbon Reduction Strategy Impact Assessment, DfT, July 2009 and by modelling undertaken for this study showing that the low carbon vehicle intervention modelled would result in an increase of over 4% in vehicle kilometres by cars and vans in 2022 if no changes are made to fuel/electricity costs or taxation
[113] CO_2 emissions are cumulative. This means that CO2 released in the atmosphere accumulate, with a lifetime between 50 and 200 years for greenhouse gases like CO_2.

Table 2.18: Who is responsible for reducing carbon emissions in the city regions?

<table>
<tr><th rowspan="2">Level of governance</th><th rowspan="2">CO_2 reduction targets</th><th colspan="4">Key levers to influence emissions from[114]</th></tr>
<tr><th>Private vehicles and freight</th><th>Public transport (bus and train)</th><th>Energy production</th><th>Buildings and industry</th></tr>
<tr><td rowspan="2">Metropolitan Districts</td><td rowspan="2">LAA targets and NIs
LTP2/LTP3
Climate change strategy</td><td colspan="4">Local land use planning policies and decisions</td></tr>
<tr><td colspan="2">Local transport policy (LTP), including parking, road space allocation, charging infrastructure, traffic management, Smarter Choices, etc.</td><td>Local renewable energy production (e.g. from waste but also transport infrastructure)</td><td>Energy efficiency programmes (e.g. Low Carbon Community Challenge)</td></tr>
<tr><td>ITAs</td><td>LTP2/LTP3 (in partnership with Districts)</td><td colspan="2">Through LTP3 strategy</td><td>Potential to use transport infrastructure to produce renewable energy</td><td>No influence</td></tr>
<tr><td>PTEs</td><td>LTP2/LTP3 (in partnership with Districts)</td><td>Indirect influence through attractiveness of public transport services provided</td><td>Tendered bus services, Bus Quality Partnerships, Quality Contracts[115], Rail franchises (specification of local franchise or input into national specifications)
Bus efficiency (e.g. Green Bus Fund)</td><td colspan="2">Limited influence through management of own operations</td></tr>
<tr><td>City regions (Leaders)</td><td>City Region Strategy (if CO_2 included)</td><td colspan="4">Strategic cross sector priorities (including on land use planning and investment across sectors)</td></tr>
<tr><td>Regions (RDAs and Leaders Boards)</td><td>Regional strategies, including climate change</td><td colspan="4">The regional tier is subject to significant changes following the May 2010 General Elections and the abolition of regional planning powers as well as structural changes (Leaders Boards and RDAs)</td></tr>
<tr><td>Central Government</td><td>Climate Change Act and Carbon Budgets (and supporting legislation)
Low Carbon Transition Plan (and supporting strategies)
National Planning Policy Statements</td><td colspan="4">Regulation, standards (e.g. BREEAM) and trading mechanisms (e.g. CRC)
Taxation and fiscal penalties/incentives (e.g. fuel tax, BSOG[116])
Allocation of funding for investment (e.g. Major Scheme funding)
Land use planning and investment decisions for major strategic infrastructure
Strategic roads (Highways Agency) and rail (franchises)</td></tr>
</table>

[114] Emissions considered here are for the local area and do not include the organisation's own operational emissions. It is also important to note that all organisations included in the table have an additional opportunity to influence cross-sector emissions through their procurement policies.
[115] Subject to review by the Coalition Government
[116] Bus Service Operator Grant

2.4.2 What governance for low carbon city regions?

Section 4 presents an assessment of the impact on transport sector carbon emissions of a long list of potential interventions which could be implemented or supported by the city regions.

Amongst these measures, many will require close joint working between ITAs, PTEs and metropolitan districts, as well as operators and other city region partners including Network Rail or the Highways Agency. For example, the roll out of Smarter Choices programmes to selected areas within the conurbations will require the support of all partners to deliver the relevant information and incentives as well as targeted improvements to transport infrastructure and services where required.

Many will also require the participation of local authorities and partners responsible for transport planning and delivery in the wider city regions. For example, the provision of electric charging points will need to be planned to serve users who travel into urban areas from more rural areas where the provision of alternative means of transport might not be viable.

Some interventions, although mainly considered here for their potential impact on carbon emissions, would deliver benefits in other areas such as health and active lifestyles or wider environmental or social objectives (air quality, reduction of inequalities, accessibility). At a time when public sector organisations face significant budget cuts, city region partners will need to consider joint working and budget alignment opportunities.

Many interventions assessed in the following sections also require revenue (rather than capital) funding which is generally identified as more difficult to secure for transport interventions within local authorities. This could require local authorities and their partners in the city regions to consider other potential sources of funding including through increased parking charges, workplace parking levy or road user charging/tolling schemes.

3. Where are the city regions at?

This section considers how emissions in the city regions will evolve in the period up to 2022 if no additional action is taken to reduce transport sector emissions. This analysis considers land based transport emissions only (excluding aviation and shipping).

Private vehicle emissions analysis is based on National Travel Survey and National Transport Model data provided by the DfT as well as information included in the Department's Carbon Reduction Strategy (CRS) and the related Impact Assessment. The CRS is also the source of the assumptions used for rail, whilst the assumptions for bus emissions were drawn from the Committee on Climate Change (CCC)[117].

3.1 Business as usual in the city regions

3.1.1 Background

Private road vehicles (cars, motorcycles, vans and HGVs) were responsible for 90% of UK domestic transport emissions in 2007. Bus and rail made relatively minor additional contributions of 2.3% and 1.7% respectively[118]. The combined emissions for all land transport modes amounted to approximately 120 $MtCO_2$.

The CCC reports that demand for passenger car travel grew by 20% nationally between 1990 and 2006[117]. However, carbon emissions have stayed broadly static over the same period as demand growth has been offset by substantial improvements in vehicle efficiency, driven by EU, national and manufacturer action. The CCC suggests that car demand is on a path of 1% growth per annum. The growth in emissions resulting would depend on the scale of ongoing efficiency improvements.

The evidence for the van fleet is less clear but the CCC suggests a growth trend of 2% per annum and no clear evidence of efficiency improvements, largely due to a lack of a strong policy framework beyond the car fleet. The potential for emission growth from this sector (which already accounts for 15% of transport emissions reported by NAEI) is therefore substantial.

Growth in emissions from HGVs is likely to be slower both as a result of slower demand growth and ongoing steady efficiency improvements of 0.8-1% per annum. However the sector currently accounts for 19% of transport emissions reported by NAEI and will remain a significant emitter.

3.1.2 Trajectory for the city regions

The **business as usual trajectory** for the city regions takes measures included in the DfT's CRS Baseline (measures which are already in place or assumed to be in place under the Government's baseline scenario presented as the "do nothing scenario" in the CRS[119]) into account. It also takes rebound effects into account where changes to costs, journey times or congestion levels achieved through the implementation of baseline measures might result in more vehicle kilometres travelled. The rebound effect in the business as usual scenario for the city regions is mainly linked to the lower cost of driving more efficient vehicles.

This modelling work **shows that transport sector emissions** (excluding aviation and shipping) **in the conurbations are set to decrease over the period to 2022, from 18.7 $MtCO_2$ in 2007 to 18.3 $MtCO_2$ in 2016 and 16.2 $MtCO_2$ in 2022** (tailpipe emissions only). **This is mainly due to improvements in car efficiency over the period, resulting in reduced emissions from cars**

[117] Building a low carbon economy – the UK's contribution to tackling climate change, CCC, December 2008
[118] Source: National Atmospheric Emissions Inventory (IPCC categories) 2007
[119] This includes the transport sector measures identified in the 2006 Climate Change Programme (CCP): Voluntary Agreements package to improve new car efficiency (to 2009), Renewable Transport Fuel Obligation (RTFO), existing Smarter Choices programme, existing Sustainable Distribution programme, increases in fuel duty rates announced up to and including Budget 2009, rail efficiency measures as set out under the "business as planned" scenario in the Carbon Pathways Analysis 2008.

(although dampened by the rebound effect linked to the lower cost of driving[120]). **Emissions from LGVs (vans) are set to increase by approximately 20% over the period 2007-2022.** Although less significant in absolute terms, emissions from diesel trains are also set to increase significantly (approx. 30%) due to the provision of additional services.

Emissions associated with the production of the energy used to power electric trains and trams are traditionally not reported in the transport sector[121] but rather in the energy/industry sector. Baseline emissions for these services therefore do not appear in the business as usual figures shown here. Power/industry sector emissions are only shown in this analysis when they result from the transfer of current transport sector emissions to the power/industry sector through the development of electric vehicles and the provision of additional electric rail services.

As shown in Table 3.1, the switch to electric vehicles will result in some transport sector emissions transferring to the power sector. These are identified under the "electric" column in the table. When these emissions are factored in, business as usual in the city regions would result in land transport emissions reducing by 9% when compared to 2007 levels but remaining above 1990 levels (17 $MtCO_2$ in 2022 compared to 16.4 $MtCO_2$ in 1990). Emissions from the power sector included here are assessed on the basis of the current carbon intensity of the UK energy mix and these emissions could be lower by 2022 as additional renewable energy generation capacity becomes available.

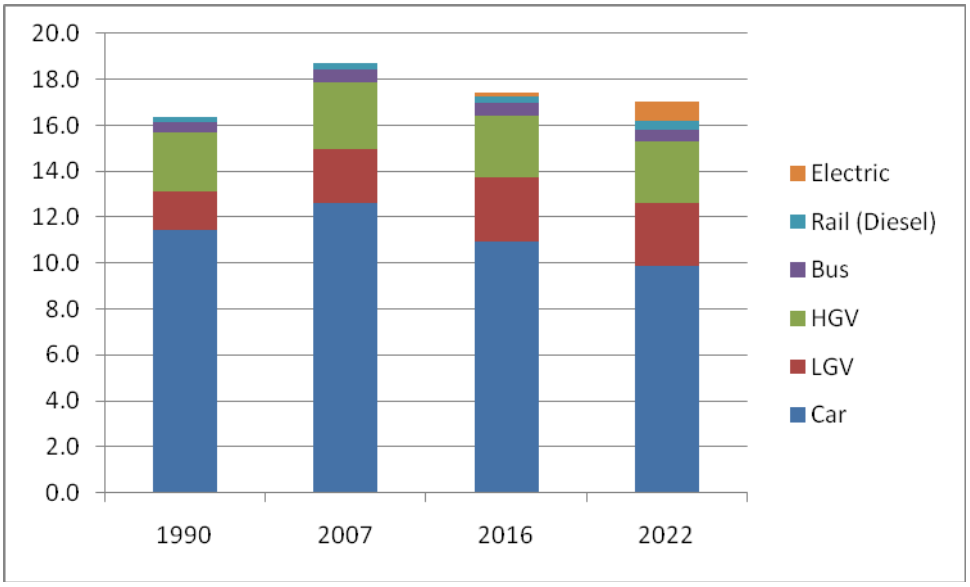
This analysis shows the importance of tackling emissions from cars, which still represent the largest contributor to land based transport emissions in the city regions in 2022 (over 60% of CO_2 emissions). **It also highlights the lack of progress in terms of overall emissions from HGVs, buses and diesel rail in the city regions under a business as usual scenario and identifies the growing contribution to emissions made by the LGV fleet in urban areas.**

Table 3.1: Business as usual land transport emissions in metropolitan areas ($MtCO_2$ per annum)

Transport mode	1990	2007	2016		2022	
			Tailpipe	Electric[122]	Tailpipe	Electric[122]
Car	11.5	12.6	10.95	0.10	9.89	0.71
LGV	1.7	2.3	2.80	0.04	2.72	0.14
HGV	2.5	2.9	2.70	0	2.66	0
Bus	0.48	0.5	0.53	0	0.53	0
Rail (diesel)	0.22	0.3	0.31	0	0.40	0
Total	**16.4**	**18.7**	**17.28**	**0.14**	**16.20**	**0.85**

[120] This assumes that no new tax is introduced on fuel or electricity used by cars during the period to 2022
[121] Under the agreed reporting protocol used by the IPCC, DEFRA and NAEI
[122] Based on current carbon intensity of energy mix

Figure 3.1: Business as usual land transport emissions in metropolitan areas ($MtCO_2$ per annum)



3.2 Methodology

This section presents an overview of the methodology used to model the business as usual scenario for the city regions. It also summarises how the model was then used to assess the impact of interventions and scenarios presented in the following sections (Sections 4 and 5).

3.2.1 Modelling

Modelling undertaken for this study was conducted through Atkins' Transport Carbon Calculator, a spreadsheet based model which takes the following data and factors into account:

- travel demand, based on information from a range of sources, particularly the information on trip numbers by purpose, mode and geographic area available in the DfT's National Trip End Model (available through the TEMPRO software), along with information on characteristics such as trip length from the National Travel Survey, National Transport Model, Census journey to work data and relevant research reports;
- private vehicle estimates were developed using DfT's estimates of traffic growth in the area from Road Traffic Statistics for Local Authorities[123];
- estimates of average changes in carbon intensity of travel by car, van and HGV as described in the CCC report[124]; and
- NAEI national trends for England for rail and bus emissions.

This information is then used to develop a representation of travel demand in the areas considered, divided into a large number of segments and disaggregated according to key influences on:

- greenhouse gas emissions (including volume and speed of movement, type/efficiency of vehicle, and type of fuel); and
- likely responses to proposed mitigation measures (including journey purposes, journey costs, availability of alternative modes of transport and the related issue of area type).

[123] www.dft.gov.uk/pgr/statistics/datatablespublications/roadstraffic/traffic/rtstatisticsla
[124] Meeting Carbon Budgets - the need for a step change, Progress report to Parliament, Committee on Climate Change, October 2009

As an example, the model includes estimates of the number of road vehicle kilometres in the business as usual scenario associated with:

- different vehicle types;
- area types (for instance rural and different scales of urban, with implications for available travel alternatives);
- road types (with implications for speed of travel); and
- purposes (with implications for travel alternatives and costs).

Table 3.2 below summarises the key assumptions used in the analysis and modelling.

Table 3.2: Key modelling assumptions

Assumption	Source
Traffic growth to 2022	DfT's National Trip End model (available through the TEMPRO software), along with information on characteristics such as trip length from the National Travel Survey, National Transport Model, Census journey to work data and relevant research reports
Rebound effect (to represent tendency to travel more as travel costs decrease)	DfT's NTM assumptions on changes in responses through time Modelled directly as a change in vehicle kilometres in response to a change in travel cost
Emissions factors	Average speed emissions factors per km by vehicle type (Source: Committee on Climate Change Report December 2008) Variation with Speed (Source: NAEI and EU Corinair speed/emissions functions by vehicle type)
Fleet composition through time	Committee on Climate Change Report, December 2008 (based on consultation with industry experts) and update in the first Annual Review in October 2009, along with additional assumptions for the years 2022 to 2031, based on the BERR 2008 Review of the Potential for Uptake of Electric Vehicles
Vehicle operating costs	WebTAG and Committee on Climate Change assumptions on costs and taxes per km for petrol, diesel and electric cars and DfT's CRS assumptions on the relative costs of biofuels and petrol/diesel

Results for the business as usual analysis were validated against NAEI estimates for the metropolitan areas for 2007. Results of this validation process are presented in Table 3.3. The comparison between the two sources shows that the spreadsheet estimates are within 10% of the NAEI estimates. This is considered to be a good level of fit and therefore gives confidence that the model is robust.

Table 3.3: Model validation, comparison of road transport emissions 2007

Data source	CO_2 emissions ($MtCO_2$ p.a.)
NAEI estimate (incl. bus)	20.3
Spreadsheet model (roads)	18.4
Comparison	91%

The detail and disaggregation available in the dataset helped ensure that the estimated impacts of interventions reflect conditions in the metropolitan areas. The study team was thus able to directly apply the demand changes suggested by the evidence to the relevant components of demand (for instance trips for residents of small settlements to represent community hubs).

The impact of measures assessed was reflected in the spreadsheet model by using the available evidence to make a series of judgements on the type and number of trips each measure would affect and the likely scale of impact. Similarly the evidence on potential secondary and rebound

type effects and differential long and short run effects were reflected through further assumptions and adjustments to the relevant demand segments.

Analysis conducted for this study does not take greenhouse gases other than CO_2 into account and does not consider embodied or construction emissions which would be emitted as a result of the implementation of the interventions or scenarios.

3.2.2 Interventions selection and evidence

A long list of interventions, presented in Section 4, was developed by the study team and discussed by the ***pteg*** Sustainability Group in February 2010.

The session with the ***pteg*** Sustainability Group aimed to:

- review the long list of options, identify any gaps, actions already undertaken and evidence of the impacts of interventions;
- develop and agree two carbon reduction scenarios (packages of measures) to be modelled for the Carbon Pathways study; and
- gather information on the work already undertaken by the PTEs to develop carbon reduction strategies and measure the impact of their policies.

In developing and assessing the interventions and scenarios, account was taken of the work already undertaken in the city regions as well as the growing body of literature on climate change mitigation measures at the local, national and international levels. Key references include:

- National Atmospheric Emissions Inventory (NAEI) data;
- DfT's Carbon Reduction Strategy (CRS) and Carbon Pathways Analysis;
- work undertaken by the Committee on Climate Change (CCC);
- databases providing information and case studies on the impacts of different types of transport schemes such as KonSULT, VTPI and IMPACT;
- evidence available from research by the UK Energy Research Centre into the carbon impacts of different transport scheme types;
- UK and other government publications (including the Stern Review, King Review, Energy White Paper and associated Energy Measures report and Cenex/Arup report on the scope for electric vehicles); as well as
- research documents such as the Commission for Integrated Transport (CfIT) report on Transport and Climate Change and the Low Carbon Transport Policy for the UK report from MRTU.

4. Reducing carbon emissions through transport interventions

This section considers how carbon emissions from the transport sector can be reduced in the city regions, providing an analysis of the abatement potential, cost and deliverability of individual options before presenting results from abatement scenarios modelled for the city regions.

4.1 Assessment of individual interventions

This section presents the assessment of the potential for achieving carbon emission reductions through the implementation of a range of individual measures.

4.1.1 Carbon emission reduction (abatement)

Table 4.2 presents the long list of mitigation measures modelled for this study. The table describes each individual measure, gives an indication of the impact of the measure on carbon emissions from the transport sector and presents the evidence and modelling assumptions which underpin these results. Table 4.1 summarises the criteria used to assess the impact of each individual measure.

Table 4.1: Assessment criteria

Impact	Criteria
High	Achieves reduction in emissions equal or superior to 2% when compared to BAU emissions in 2022
Medium	Achieves reduction in emissions equal or superior to 1% but inferior to 2% when compared to BAU emissions in 2022
Low	Achieves reduction in emissions inferior to 1% when compared to BAU emissions in 2022

The long list of measures considers the following types of interventions in turn:

- more efficient vehicles and low carbon vehicles;
- lower carbon fuels;
- traffic management;
- efficient driving practices;
- providing attractive low carbon alternatives;
- encouraging the use of low carbon alternatives; and
- reducing the need to travel.

It is important to note that, in reality, most of these interventions would not be delivered in isolation but rather would be implemented as packages of measures, with the mix of interventions devised to ensure that they support each other and manage any potential rebound effect. For example, the low carbon vehicle intervention modelled[125] would result in an increase of over 4% in vehicle kilometres by cars and vans in 2022 (over 4.5% by cars and nearly 1.5% by vans) if no changes are made to fuel/electricity costs[126] or taxation. The impact of packages on transport sector emissions in the city regions is considered in Section 4.2.

[125] Supporting electric vehicles so that proportion of electric vehicles and hybrids in fleet doubled in 2022 and proportion of small vehicles increased by 25% at the expense of medium and large vehicles
[126] Based on CCC assumptions

Some interventions which are currently part of traditional transport planning policies or discussed in metropolitan areas have not been included in this modelling exercise. This includes the following as shown in Table 4.2 below:

- increases in the use of biofuels - the use of biofuels by buses is covered in the "improvement in bus fleet efficiency" measure but no additional biofuel use was considered as the PTEs and local authorities would not have the powers to increase the use of biofuels across the fleet and care needs to be taken when considering increases in the use of biofuels which could result in disproportionate impacts on other environmental and social issues;
- traffic calming in urban areas, including 20mph limits in selected zones or area wide – this was not modelled as an individual measure due to the lack of evidence of impacts on transport sector emissions. The lower speeds could potential directly result in higher emissions per vehicle kilometre for traditional vehicles (this decreases with the take up of hybrid and electric vehicles) but indirectly in lower emissions through additional mode shift to walking and cycling;
- freeze on road building/improvements, using congestion to manage demand – this is considered in our business as usual analysis as the baseline trajectory does not account for any additional road building/capacity;
- high occupancy lanes (potentially including Park & Share sites) – this was not modelled due to the lack of evidence of impacts on transport sector emissions. This type of intervention could result in higher emissions from remaining vehicles as road capacity for cars is lower (although in terms of additional emissions, this issue decreases with the take up of hybrid and electric vehicles) but also in reduced emissions through additional mode shift or increase vehicle occupancy;
- high speed rail network – current proposals are a long term prospect for some of the urban areas considered here. It was assumed that services on a high speed network would not be available in 2022 and such services were therefore not included in this modelling exercise;
- congestion charging (designed as a local charge targeting congested urban areas through cordon or area type charge) - congestion charging is designed to address congestion issues rather than reducing carbon emissions and research shows that it would be likely to result in an increase in emissions (or have a neutral impact on emissions) through the rerouting of traffic avoiding the congestion charge zones. This is different from the likely impact of a national charge per kilometre system but such a system is not within the power of local authorities/ITAs/PTEs to implement and was therefore not considered here.

It is also important to note that not all interventions modelled here would reach their maximum potential impact on CO_2 emissions from the transport sector within the timescales set for this study (2022). This is for example the case with land use planning policies such as reviewing development location and increasing densities which would have an impact on carbon emissions from transport use in the long term.

Table 4.2: Individual interventions abatement analysis – Evidence summary table

Interventions	Abatement potential (2022)	Abatement evidence
More efficient vehicles and low carbon vehicles		
Public sector procurement of low carbon vehicles for own fleet	**Low**	**Measure proposed** ITAs/PTEs and local authorities in metropolitan areas support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (excludes bus and train fleet considered in separate measures) through financial incentives, procurement policies, etc. **Evidence of impact** International Energy Agency (IEA) estimates suggest that advanced engine technologies and improvements in tyres, aerodynamics, lights and appliances could increase petrol and diesel fuel efficiencies of LDVs by up to 47% and by over 50% if hybrid technologies are used to capture energy lost in deceleration and braking – Source: CCC December 2008 The King Review provides some estimates of the efficiency gains that can be achieved through different technological improvements. In the short term, King suggests that improvements to engine and non-propulsion technologies could result in a 30% emissions reduction for the average new car within a timescale of 5 to 10 years. In the long term, full electric or hydrogen-powered vehicles would have zero tank-to-wheel emissions (that is, emissions produced from driving the car) but the well-to-wheels emissions (emissions associated with producing the fuel and transporting it to the filling station) would only be zero if the electricity and hydrogen were produced using zero-carbon fuels - Source: King Review 2007 CCC scenario modelling assumes that new cars' emission levels will decrease to an average of 142gCO_2/km by 2012, 110 gCO_2/km by 2017 and 95 gCO_2/km by 2020 and that the number of electric cars in the overall fleet will increase to 22,000 by 2012, 640,000 by 2017 and 2.6 million by 2022, with electric or plug-in hybrid cars representing up to 20% of cars purchased in 2020. – Source: CCC October 2009 **Modelling assumptions** Size of fleet affected: public sector fleet (cars and LCVs) assumed to represent 1% of total vehicles fleet in metropolitan areas, with a further 1% allowance included to account for the sector's influence on the 'grey fleet' driven by their employees and those vehicles operated by contractors (based on OGC data on size of public sector fleet) Fleet characteristics before and after: public sector fleet is made 2 years newer than average (based on DfT's CRS) and the proportion of small cars increases by 50% (proportion of small cars changes from 28% to 42%, medium cars from 57% to 46% and large cars from 16% to 13%) Average composition and annual travel distance for public sector fleet assumed to match average for study area so measure influences 1.8% of car and LGV traffic in area (assuming 10% traffic is through and unaffected by local fleet measures)
Support to take up electric and plug-in hybrid vehicles (cars and vans mainly) through provision of charging points and/or financial incentives (e.g. parking policies)	**High**	**Measure proposed** ITAs/PTEs and local authorities in metropolitan areas support an earlier than average take up of electric vehicles across the fleet in their area through the provision of charging points (public car parks, support for installation at workplaces, etc) and financial incentives (such as cheaper/free car parking for electric/low emission vehicles) **Evidence of impact** An electric vehicle uses around 0.2 kWh/km. Given that the current carbon intensity of electricity production in the UK is around 515g CO_2/kWh, an electric car is currently a low-carbon car, producing just over 100g CO_2/km. Some conventional cars are capable of a better carbon performance even when accounting for emission from production of fuel; but, as the carbon intensity of electricity falls, electric cars will reach lower emission levels which conventional internal combustion engines will not achieve –

Interventions	Abatement potential (2022)	Abatement evidence
		Source: CCC October 2009 *No direct evidence on the impact of the provision of charging points or specific financial incentives available* **Modelling assumptions** Size of fleet affected: whole car and LCV fleet in metropolitan areas Fleet characteristics before and after: Assumes the proportion of small cars increases by 10% in 2016 (proportion of small cars changes from 27% to 30% medium cars from 57% to 55% and large cars from 16% to 15%) and proportion of electric and plug-in hybrids in the fleet doubled relative to the baseline scenario. 2022 - proportion of small cars increases by 25% (28% to 35% with medium cars decreasing from 57% to 51% and large cars from 16% to 14%) and proportion of electric and plug-in hybrids in the fleet doubled. Characteristics of affected journeys: all journeys
Improvement in bus fleet efficiency (e.g. low carbon buses, electrification of public transport)	**Low** (Medium ambition scenario)**/ Medium** (High ambition scenario)	**Measure proposed** Improvements in bus fleet efficiency in the metropolitan areas, secured through financial incentives such as BSOG, supported services procurement criteria, Green Bus Fund, Quality Partnership and contracts, resulting in higher level of investment in more efficient vehicles. This also includes use of biofuels and driver training. **Evidence of impact** Low carbon buses are defined by the Government as emitting at least 30% less greenhouse gases than a normal diesel bus. They are also significantly more fuel efficient yet they account for less than 0.2% of buses (and almost all of these are in London.) Source: LowCVP, July 2009 Bus fleet assumptions based on 2009 TTR report for PTEG - Medium ambition scenario 2.2 for 2012/13 and scenario 2.3 for 2015/16, assuming 10% replacement of bus fleet per annum. The TTR study shows that this results in a 7% decrease in "life-cycle carbon emissions" in 2011/12 and a 18% decrease in 2015/16 (on 2007/08 levels) - High ambition scenario 3.2 and 3.4 for 2012/13 and 2015/16 respectively assume a 16.5% replacement per annum and result in a 9% decrease in "life-cycle carbon emissions" in 2011/12 and a 25% decrease in 2015/16 (on 2007/08 levels) **Modelling assumptions** TTR 2009 Medium and High Ambition scenarios, extended to 2022 assuming continuation of the recorded trend in fleet turnover and replacement patterns - operational emissions only
Support to taxi/private hire vehicles drivers for switch to more efficient/low carbon vehicles	**Low**	**Measure proposed** Local authorities and ITAs/PTEs support and incentivise the switch to low carbon vehicles for taxi/private hire vehicles drivers on the metropolitan areas (financial incentives, licensing rules e.g. age limit and emission levels for new licenses , access to city centre zones) **Evidence of impact** As for "Public sector procurement of low carbon vehicles for own fleet" *No direct evidence of impact of taxi/private hire sector specific measures available* **Modelling assumptions** Number of vehicles affected: 45,000 taxis and PHV licensed in metropolitan areas in 2007 (PTE areas), representing 20% of the GB fleet (England, Scotland and Wales) – Source: Taxis and Private Hire Vehicles 2006/07 - Supplementary document, DfT 2007.

Interventions	Abatement potential (2022)	Abatement evidence
		Resulting in total of 56,400 vehicles by 2016 and 65,600 vehicles by 2022 if growth similar to 2005-2007 period is assumed Fleet characteristics before/after: Assumes the whole taxi and private vehicles hire fleet is made 2 years newer than the average Vehicle kilometres affected: Taxis and PHVs in GB drive about 3 million miles per annum (4.83 million kilometres) with passengers in 2016 and 2022 of which 20% or 0.966 million kilometres is assumed to be in the metropolitan areas (see above). Assume travel a further 75% of occupied distance unoccupied and that the proportion of large cars in the taxi fleet is 2.5 times the proportion in the average fleet (all taken from small vehicles so medium remains unchanged)
Rail electrification (focus on local rail)	**Low**	**Measure proposed** ITAs/PTEs and local authorities obtain funding and support for further electrification of railway lines serving their areas. *The electrification of bus routes (trolley buses) is not considered here but in the provision of improved public transport infrastructure – results from early Leeds NGT modelling show increases in CO_2 emissions* **Evidence of impact** Even given the current average carbon intensity of electricity generation, electric rail is much more carbon efficient than diesel rail, with emissions of around 50gCO_2/passenger-km compared to 75 for diesel. This advantage will increase as electricity is decarbonised. An accelerated programme of electrification could therefore deliver significant emissions reduction. Source: CCC December 2008 **Modelling assumptions** Network Rail Electrification Draft Strategy identifies a number of 'gaps' in the electric rail network within the PTE areas that could potentially be filled to allow increased electrification, particularly of passenger rail services. A number of them (such as the Manchester Deansgate to Liverpool via Chat Moss route) rank fairly highly in the broad assessment of options in the list but none feature in the core strategy. The modelling illustrates the potential scale of impact if a scheme was implemented that achieved electrification of 10% of current diesel rail kilometres - following the assumption (quoted in the CRS Impact Assessment) that electric trains typically emit 30% fewer CO_2 emissions than equivalent diesel trains
Rail efficiency, including increased use of regenerative braking on trains	**Low**	**Measure proposed** ITAs/PTEs and local authorities work with rail (including metro) and tram operators to improve the efficiency of rail services, including regenerative braking biofuels, onboard and trackside energy storage, more stringent efficiency specifications for new diesel trains. Targets for improved efficiency can also be included in franchise agreements. **Evidence of impact** Currently 60% of the electric train fleet is capable of using regenerative braking but only 20% uses this capability. However, significant progress is now being made by Network Rail and train operators in enabling a wider range of rolling stock to regenerate. Source: DfT Low Carbon Transport Innovation Strategy, 2007 A 15–20% reduction in the energy required to move electric passenger trains is being achieved through regenerative braking on the overhead AC electrified network. Re-engineering the current high-speed train (HST) fleet with modern engines has reduced fuel consumption by 17%3. Diesel-battery hybrid technology is being demonstrated on one of the industry's high speed trains. In Japan, this technology has demonstrated fuel savings of 20%. Operators of diesel freight locomotives have achieved a 3–5% reduction in fuel consumption by shutting down engines when stationary for more than 15 minutes. Other initiatives to reduce fuel consumption include automatic shut-down devices, and re-engineering of fuel injection systems. Energy storage and fuel conversion technologies for portable fuels on board trains, such as fuel cells, are being investigated and could deliver reductions in CO_2 emissions. Freight train lengthening and higher, constant and passenger train-compatible running speeds are ways to reduce CO_2 emissions. A 10% reduction in traction energy demand is considered to be achievable in the short term by initiatives such as

Interventions	Abatement potential (2022)	Abatement evidence
		reducing the stabling load of electric trains and energy-efficient driving, along with energy metering and optimisation of off-peak train lengths. There is some further scope to consider biofuel for passenger and freight train fleets. Source: The Case for Rail, RSSB, 2007 **Modelling assumptions** Energy savings achieved/current energy use: Future increases in energy use and proportionate efficiency savings for diesel and electric rail assumed to be equivalent to those forecast by the rail industry forecast under the 'Business As Planned' scenario presented in the Rail Industry's Submission to the Committee on Climate Change, March 2008. Local split between diesel and electricity use for local trains reported in AEA Carbon Footprinting report also assumed to apply if consider regional trains. Forecast electric train efficiency savings also assumed to apply to trams (using AEA data on baseline energy use and assuming no change in use through time)
Lower carbon fuels		
Producing low carbon energy from the transport network/assets	**Low**	**Measure proposed** Local authorities and ITAs/PTEs develop renewable energy regeneration on land available within the transport infrastructure (for example at Park & Ride sites) **Modelling assumptions** Assume 10 5kWh wind turbines and 100m2 of photovoltaic cells (equiv to 25 typical domestic installations) produce 131Mwh (BWEA) and 10MWh (EST) of energy per annum respectively in each metropolitan. Assume current carbon intensity of electricity (NB this assessment ignores the embodied carbon of the renewable technology)
*Increase in the use of biofuels – **not modelled***	*Not modelled*	*The use of biofuels by buses is covered in "Improvement in bus fleet efficiency" above. No additional biofuel use is considered here as the PTEs and local authorities would not have the powers to increase the use of biofuels across the fleet.*
Traffic management		
Active/improved traffic management (including managed motorways, green waves, ramp metering, coordination of street works)	**Low**	**Measure proposed** Local authorities and ITAs/PTEs (in partnership with the Highways Agency) implement active traffic management systems main urban roads where congestion is an issue to improve traffic flows. Urban Traffic Control systems and improved coordination of street works also result in improved traffic flows on main roads. **Evidence of impact** The M42 Active Traffic Management Scheme operated by the Highways Agency over a 17km stretch of the motorway, introduced technology that manages the volume of traffic by responding to traffic flows and introducing variable mandatory speeds where appropriate to reduce traffic flow breakdown. The scheme also deploys the hard shoulder as a running lane to provide additional capacity during periods of congestion and incidents. Following implementation of the scheme in September 2006, many operational benefits have been realised including improved road capacity, improved journey time reliability, reduced incident rates and, significantly, reductions in vehicle emissions. In fact, vehicle emissions of the most harmful gases have been reduced by between 4 and 10 %. Fuel consumption and CO_2 emissions have also reduced by 4%. Source: ICE – The State of the Nation Report – West Midlands **Modelling assumptions** Road type affected: urban motorways and trunk roads in metropolitan area Road lengths affected: assume 50km of links that experience V/C of more than 85% in the AM peak are treated with technology that smoothes flows to between 30 and 50mph (smoothing stop-start travel and intermittent higher speeds) and 100km in 2022.

Interventions	Abatement potential (2022)	Abatement evidence
Stricter enforcement of speed limits	**Medium**	**Measure proposed** Local authorities and ITAs/PTEs work in partnership with the Police to enforce existing speed limits more strictly, possibly through average speed cameras. No blanket reduction in maximum speed limits on main roads is proposed here as this would the responsibility of Central Government **Evidence of impact** Measurements undertaken in 2003 showed that: - 58% of cars, 54% of motorcycles and 53% of HGVs exceeded the 30 mph limit - 27% of cars and 36% of motorcycles exceeded the 40 mph limit - 57% of cars and 59% of motorcycles exceeded the 70 mph speed limit on motorways. Source: DfT, Speed Know your Limits, 2004 Fuel efficiency falls significantly as car, van or HGV speeds are pushed above optimal levels. A typical petrol fuelled car driven at 70mph emits about 19% more gCO_2/km than when driven at 50mph. The CCC estimates that enforcing the existing speed limit would produce annual emissions reductions of over $3MtCO_2$ in 2020. Reducing the speed limit to 60mph on motorways and A-roads where the speed limit is currently above this would result in an additional $2MtCO_2$ emissions reduction in 2020. Source: CCC December 2008 Report **Modelling assumptions** Road type affected: all roads in metropolitan areas with mph limits between 40 and 70 mph (sliding scale) Speed change: Assumes 80% - 95% compliance i.e. 80% of those previously speeding in 40mph-50mph limit areas no longer do, 90% of those in 60 mph limits and 95% of those in 70mph limits *Note: possible rerouting and suppression effects are not accounted for*
*Traffic calming in urban areas, including 20mph limits in selected zones or area wide – **Not modelled as an individual measure** due to lack of evidence of direct impact on emissions (considered as supporting measure in roll out of Smarter Choices)*	*Not modelled*	***Evidence of impact*** *The average traffic flow reduction in the 20mph zones studies was 27% but this included zones where a bypass was open (between a 4 and 23% reduction in flow excluding bypassed areas). The average traffic increase in surrounding areas was 12% (between 4 and 23% excluding bypassed areas). Average speeds fell by 9.3 mph. Schemes included "vertical" measures. Review of traffic calming schemes in 20mph zones, TRL, 1996* *Portsmouth blanket 20mph scheme (no vertical measures) early evaluation shows overall 0.9mph reduction in speed (this change is not statistically significant) but 7mph reduction in speeds in areas where average speeds were above 24mph before (statistically significant). No data on change in traffic flows available yet. Source: Portsmouth City Council, 20 mph Scheme Interim Evaluation, Atkins for DfT, 2009* *The effect of traffic calming on air pollution has shown to be less when vehicle speeds are at 30mph than at 50mph however the style of driving has a great impact upon this. In Buxtehude, Germany, monitoring of vehicle emissions before and after the implementation of traffic calming indicated a reduction in carbon dioxide levels of 20%, a reduction in hydrocarbon of 10% and a reduction in nitrogen oxide of 33%. Source: A Review of Traffic Calming Techniques, T. Harvey(HETS), published by ITS Leeds, 2007*
*Freeze on road building/improvements, using congestion to manage demand **– not modelled***	*Not modelled*	***This is not modelled as a measure as this would be the equivalent of business as usual*** ***Evidence of impact*** *"Traffic congestion tends to maintain equilibrium. Congestion reaches a point at which it constrains further growth in peak-period trips. If road capacity increases, the number of peak-period trips also increases until congestion again limits further traffic growth.*

Interventions	Abatement potential (2022)	Abatement evidence
		The additional travel (generated traffic) consists of diverted traffic and induced vehicle travel. Research indicates that generated traffic often fills a significant portion of capacity added to congested urban road". Source: Generated Traffic and Induced Travel, Implications for Transport Planning, 2009
Road surfaces designed to reduce fuel consumption through resurfacing programme	**Low**	**Measure proposed** Local Authorities and ITAs/PTEs make use of road resurfacing programmes to provide road surfaces with lower rolling resistance (Note: potential implications on road safety and emissions/environmental impacts of the techniques used would need to be investigated further) **Evidence of impact** At a constant speed of 100 km/h a passenger car needs ~50% of his fuel to overcome rolling resistance (and 50% air drag). At a constant speed of 80 km/h a truck needs ~40% of his fuel for rolling resistance. In all driving conditions in average 25% of the fuel consumption of a passenger car is needed to overcome rolling resistance (75% air drag and acceleration) Energy efficient tyres (-20% rolling loss) can reduce the fuel consumption of a car by ~5%. **Rolling resistance for same tyres on stiff road surfaces can differ +/- 15% depending on the surface texture**. Source: Rolling Resistance of Tyres on Road Surfaces - Procedures to Measure Tyre Rolling Resistance, Glaeser, Federal Highway Research Institute, 2005 In urban areas, principal roads are currently resurfaced in average every 28 years, non-principal roads every 39 years and unclassified roads every 61 years (average across all road classes is resurfacing every 52 years in urban areas). Source: ALARM, Annual Local Authority Road Maintenance Survey 2009, Asphalt Industry Alliance **Modelling assumptions** Between 2010 and 2016 nearly 18% of principal and trunk road, 14% of non principal road and 8% of unclassified road resurfaced. By 2022 39%, 28% and 18%. Percentage change in consumption by vehicle type: Assumes a 2% reduction in fuel consumption for all vehicle types travelling on affected roads.
High occupancy lanes (potentially including Park & Share sites) – ***Not modelled as individual measure*** *due to lack of evidence of direct impact on emissions (considered as supporting measure in roll out of Smarter Choices)*	*Not modelled*	**Evidence of impact** The evaluation of the A647 Stanningley Road HOV lane undertaken by Leeds City Council shows that - Morning peak traffic flows: Immediately after opening there was significant driver avoidance of the A647 and traffic flow fell by 20 per cent. By late 1999, traffic flows had returned to 1997 levels in both the peak hour and the operational period. - Evening peak traffic flows: Traffic flow in the operational period (16:00 to 19:00) fell by 10 per cent at scheme inception, but returned to the 'before' level by June 1999. By June 2002 traffic flow had increased by a further 14 per cent in the three hour period. - Occupancy: In 1997, 30 per cent of cars carried two or more occupants. One third of vehicles (including buses) carried two-thirds of people travelling in the corridor in the morning peak period. The number of high occupancy vehicles using the A647 in the period 07:00 to 10:00 increased by 5 per cent between 1997 and 1999. Given that 1997 and 1999 flows were similar, the implication is that there was an exchange of HOV and non-HOV traffic between the A647 and parallel routes. Average car occupancy rose from 1.35 in May 1997 to 1.43 by June 1999 and 1.51 in 2002. - Journey times: Morning peak journey time savings for buses and other high occupancy vehicles were 4 minutes comparing June 1997 and June 1999 data. Over the same period there was a reduction of 1½ minutes in non-HOV journey times. Source: Bus Priority, The Way Ahead, DfT, 2006

Interventions	Abatement potential (2022)	Abatement evidence
Efficient driving practices		
Driving training programme (eco-driving) for car drivers (including taxi drivers), bus drivers, train drivers and HGV/van drivers & awareness and incentivised campaigns to improve driving efficiency (motoring package including idling campaigns, information/discount on low rolling resistance tyres, tyre pressure monitoring tools and gear shift indicators)	**High**	**Measure proposed** Local authorities and ITAs/PTEs implement driver training programmes supplementing national campaigns to achieve a higher level of training and awareness amongst drivers in the metropolitan areas. (Note: Most HGV and bus drivers will be trained in the coming years through driver certificate requirements implemented at the national level) This is complemented by awareness raising and promotional programmes supplementing national initiatives to encourage efficient use of vehicles (cars and vans mostly) **Evidence of impact** Evidence suggests that average fuel efficiency can be improved by 5-10% when the range of eco-driving principles are adopted. Source: CfIT, Transport and Climate Change, 2007 SAFED programmes for van and HGV drivers show typical fuel savings during training of 10%, although it is not clear how much of this is retained during normal operation – Source: DfT With 1% of car drivers per year adopting eco-driving behaviour, this results in emission reductions of 0.3 $MtCO_2$ by 2020. 100% HGV driver uptake of eco-driving (resulting from the HGV driver certification scheme) from 2014 will result in emissions reduction of 1$MtCO_2$ by 2020. Source: CCC December 2008 Report. Tyre under-inflation (maintenance by drivers) has a big influence on rolling resistance; reduction from 2 bar to 1,4 bar: 20% increase in rolling resistance. Source: Rolling Resistance of Tyres on Road Surfaces - Procedures to Measure Tyre Rolling Resistance, Glaeser, Federal Highway Research Institute, 2005 **Modelling assumptions** Percentage of savings achieved by vehicle type: 10% saving for conventional cars, 5% for new generation and 2.5% for hybrids, 3% savings for LGVs Number of drivers targeted: 80% of car drivers and 40% of van drivers, assumed they are all retrained every 5 years Assume 62% achieved by 2016 in line with CCC October 2009 assumptions on uptake
Freight efficiency through operational improvements, including freight consolidation centres, Freight Quality Partnerships, route optimisation, and delivery management programmes	**Low**	**Measure proposed** Local authorities and ITAs/PTEs work with freight sector partners (through Freight Quality Partnerships) to provide and encourage the use of freight consolidation centres, route optimisation and with businesses to reduce the frequency of deliveries to their sites. **Evidence of impact** Consolidation centres aim to reduce the amount of vehicles travelling into urban areas by consolidating multiple loads into single shipments, providing a way for operators to efficiently service urban areas. The London Construction Consolidation Centre (LCCC), based in Bermondsey (partnership between Transport for London, Wilson James Ltd, Bovis Lend Lease and Stanhope plc), provides a distribution centre and delivery service for construction materials to projects in central London. In the 18 months since it opened, the LCCC achieved an estimated 73% saving in CO_2 emissions across its four delivery sites as well as easing congestion with a 70% reduction in delivery vehicles. Source: DfT Freight Best Practice, 2007 London Heathrow retail consolidation centre (supplying all shops at Terminals 1, 2, 3 & 4) was estimated to result in 87,000 vehicle kilometres saved in 2003, and 144,000 vehicle kilometres saved in 2004. Bristol Broadmead consolidation centre was estimated to have achieved a 68% reduction in vehicle trips into Bristol centre for retailers in the scheme. Between May 2004 and October 2005, this was estimated to have saved 42,772 vehicle km. Source: Urban Freight Consolidation Centres Final Report, University of Westminster for DfT, 2005

Interventions	Abatement potential (2022)	Abatement evidence
		Optimising Vehicle Routing – since January 2002, staff at Transco's National Distribution Centre in Birmingham have recoded all instances where additional vehicles have not been required. In the first six months of this scheme there were 180 occasions when existing scheduled vehicles were used instead, avoiding 360 journeys, saving 24,000 miles. Source: DfT Freight Best Practice, 2008 **Modelling assumptions** Assuming one consolidation centre in each metropolitan area achieving savings of 80,000 vehicle km per annum each. 4 in place by 2016. No growth in vehicle km saved by each centre through time as assumed constrained by potential of centre. Assume more widespread improved operational organisation allows the use of smaller vehicles on some trips to the Conurbation Inner/Big and Large - represented as 5% of trips being made by artic vehicles >33tonnes made by vehicles < 33t and 5% of those made by rigids >7.5t in the Ref Case now by vehicles <7.5tonnes
Providing attractive low carbon alternatives		
Provision of improved cycle infrastructure including cycle routes/lanes, cycle parking facilities and cycle rental schemes (potentially supported by measures such as car free zones and 20mph areas)	**High**	**Measure proposed** Local authorities and ITAs/PTEs deliver significant improvements in cycling infrastructure and facilities potentially supported by lower speed limits and car free zones **Evidence of impact** Analysis by Wardman et al (2007) indicates that an integrated program of improved cycling conditions, financial incentives ($2-10 per day of cycling rather than driving) and improved trip-end facilities (bike parking and shower facilities) could increase British cycling rates from about 6% to more than 20% for commute trips under 7.5 miles, about half of which would displace car trips. The National Travel Survey (2007) shows that cycling accounts for 1% of all trips and 2% of trips of less than 2 miles. The average resident makes 14 cycle trips per year and travels a distance of 36 miles. The average length of a cycle trip is 2.4 miles. **Modelling assumptions** Assumes Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones achieve 15% mode share for cycling and all Urban Medium and Small areas double their current cycle mode share by 2022 (50% achieved by 2016) Assumes no trip shortening (i.e. previous car trips were the same length as new cycle trips), 50% of new cycle trips were previously made by car drivers and a 10% uplift on estimated abatement to reflect the fact that the car trips saved are all short with engines therefore operating at below average efficiency *Note: The impact of these physical measures is linked to Smarter Choices measures*
Provision of improved walking infrastructure (paths and shortcuts, crossing facilities, pavement width, signage, etc - potentially supported by measures such as car free zones and 20mph areas)	**Low**	**Measure proposed** Local authorities and ITAs/PTEs deliver significant improvements in walking facilities potentially supported by lower speed limits and car free zones **Evidence of impact** Analysis from Portland Oregon indicated that car mileage for households in highly pedestrian friendly environments were less than half than in pedestrian hostile neighbourhoods. The analysis suggested that the adoption of pedestrian-orientated design features would result in a 10% decline in local car mileage per household. Source: Dierkers et al (2005) CCAP Transportation Emissions Guidebook Part One: Land Use, Transit and Travel Demand Management, Centre for Clean Air Policy, as quoted in UK ERC Impact database **Modelling assumptions** Assumes Conurbation Inner, Conurbation Big and Conurbation Large, Conurbation Medium and Conurbation Small TEMPRO

Interventions	Abatement potential (2022)	Abatement evidence
		zones increase walk level by 25% (50% achieved by 2016) Assumes 33% of new walk trips were previously made by car drivers and a 10% uplift on estimated abatement to reflect the fact that the car trips saved are all short with engines therefore operating at below average efficiency
Provision of improved bus/rapid transit infrastructure and services (public transport priority, interchanges/Park & Ride, vehicles, shelters, VMS signs, Smartcard ticketing, etc)	**Low**	**Measure proposed** Local authorities and ITAs/PTEs deliver significant improvements in bus/rapid transit infrastructure/services and integration with other modes, including bus priority, interchanges, quality of vehicles, CCTV, improved shelter, provision of real time information, and Smartcard ticketing. **Evidence of impact** A study using multiple regression to determine effects of car ownership and mode choice on land use characteristics based on data from the UK National Travel Survey collected in 1989/91 and 1999/2001 identified that areas with bus services every 15 min are associated with a 4% decrease in the share of distance travelled by car compared with areas with buses every 30 min, and a 13% decrease compared with areas with less than one bus per hour. The study also found that areas over 13 minute walking distance to the nearest bus stop are associated with a 9% increase in the share of distance travelled by car compared with areas within 7-13 minutes to the nearest bus stop. Source: Dargay, Land Use and Mobility in Britain, 2009 as quoted in CCC October 2009 Progress Report Journey time savings are assumed to be achieved through investment in bus priority, namely bus lanes. In general a 2km stretch of bus lane is assumed to result in a 5% journey time saving while a 10% saving may be achieved if half the route has a bus lane along it. Source: CfIT, 2002. *(Note: this generally results in longer journey times for car users)* The Smart and Integrated Ticketing Strategy launched in December 2009 sets out the Government's goal for every area of England to have access to smart ticketing by 2020, estimating that the benefits of integrated smart ticketing (allowing travel across operators and modes) could be worth over £1bn per annum. To incentivise bus operators to install smart ticketing systems, the Government has also announced an 8% increase in the Bus Service Operator Grant (BSOG) if they have ITSO smartcard infrastructure on their buses. A recent survey commissioned by DfT indicated that integrated smart tickets have the potential to attract as many as 25% of current non-public transport users onto the system and that a pre-pay smartcard with a daily 'cap' could increase some individuals' trip rates by over 14%. Source: DfT news "£20M for smart ticketing in our cities within five years" (15/12/2009) Research commissioned by DfT shows that soft factors can have an influence on bus use and transfer from cars, with results showing the following elasticities: - Provision of audio announcements resulting in - 0.15% car demand transferring to bus - Provision of CCTV at bus stops resulting in - 0.31% - CCTV on buses resulting in - 0.39% - Climate control resulting in -0.15% - New bus shelters resulting in - 0.13% - New bus with low floor resulting in - 0.27% - New interchange facilities resulting in - 0.33% - On-screen displays resulting in - 0.11% - Real time passenger information resulting in - 0.21% - Simplified ticketing resulting in- 0.25%

Interventions	Abatement potential (2022)	Abatement evidence
		- Trained drivers resulting in - 0.34% Source: The Role of Soft Measures in Influencing Patronage Growth and Modal Split in the Bus Market in England, AECOM, 2009 **Modelling assumptions** Number of people affected by area type: improvements assumed to target current bus users and an equivalent number of current car users. 5% journey time saving assumed for bus/rapid transit users on corridors in/from Conurbation Inner, Conurbation Big, Conurbation Large, Conurbation Medium TEMPRO zones for journeys between 5 and 25 miles. Long term elasticity (0.27 to 0.53, varying by purpose, from TRL Practical Guide to Public Transport) applied to estimate increase in current bus patronage to estimate increase in passengers as a result of decrease in time. 25% of increased trips assumed to have switched from previous car driver trip (WebTAG) and trips removed from appropriate purpose/distance band for car driver trips to estimate vehicle kms removed by time of day. No allowance for increased PT provision.
Provision of improved express bus and coach services for medium to long distance trips and promotion of coach use for leisure trips	**Low**	**Measure proposed** ITAs/PTEs and local authorities support the development of additional medium to long distance coach routes from/in between the main urban centres to complement the rail offer (additional routes, lower fares, etc) **Evidence of impact** In 2007, there were more than 20,000 coaches on the road in the UK, travelling 1.3 billion km, nearly seven million people went on holiday by coach and there were 266 million day-trips by coach. Coaches are also important for business travellers, with more than one million business trips made by coach in 2007. Just a 10% rise in annual coach journeys could mean more than 17 million fewer car journeys (23.7 million divided by car occupancy rate of 1.58). Source: Britain's Coaches: Partnership and Passengers, Confederation of Passenger Transport, 2008 Coach travel accounts for 5.5 per cent of all tourist trips in the UK. Source: UK Tourism Survey and UK Day Visitor Survey, 2006 **Modelling assumptions** Assumes a 10% increase in annual coach trips with 25% of trips switched from car driver trips (for consistency with WebTAG) - remove from appropriate distance bands and purposes for car driver trips. Assume coach trips are bus trips over 15 miles (No allowance made for any additional coach journeys)
Replacement of some existing conventional bus services by smaller community transport services and demand responsive services	**Low**	**Measure proposed** ITAs/PTEs and local authorities work with operators, taxis and community transport providers to identify services which could be run with smaller vehicles or replaced by demand responsive transport, community services or taxis. **Evidence of impact** In rural areas, public transport provision can both require high subsidy and be inefficient in terms of carbon emissions, when there are low passenger loadings on services. The evidence shows that TaxiPlus services result in reduced carbon emissions from the use of better utilised small vehicles rather than conventional buses on some routes and at some times. Evidence from case studies shows that rural transport schemes (mostly taxi operated) catered for the following number of trips per annum: Rural wheels – 5,477, Devon Fare Car – 17,332, Connect2 Wiltshire – 25,234, North Sutherland – 1,785. Source: A New Approach to Rural Public Transport, CfIT, 2008 Research on public transport initiatives in rural areas, considering small vehicles and demand responsive transport provides the following information from case studies: - Cumbria Plus Bus catered for 12,000 journeys p.a. of which 34% previously used a car as a driver or a taxi, approximately 5% walked and 5% used another bus service and approximately 20% are new journeys (generated by the service) – the

Interventions	Abatement potential (2022)	Abatement evidence
		remaining users were getting lifts in a car - Wygglybus catered for 48,300 journeys per annum of which 21% previously used the car as driver or a taxi, approximately 5% walked and 5% used another bus service and approximately 35% are new journeys – the remaining users were getting lifts in a car Source: Rural Initiatives, Supplementary Information, LEK Consulting for CfIT, February 2002 A study by Diana et al showed that demand responsive transit (DRT) services appear more effective than the fixed-route services in minimizing emissions when the demand density is not excessive and a good level of service is sought. In particular, demand responsive services perform better in a ring-radial network and the possibility of using smaller vehicles allows them to outperform fixed route services. CO_2 emission savings were shown to be between 22 and 98% across a range of scenarios. Source: "Emissions of demand responsive services as an alternative to conventional transit systems" Diana et al, 2007 **Modelling assumptions** Assumes removal of 10 services across the Mets or 900,000 miles per annum (15 mile trip one way x 12 times a day one way x 5 days per week x 50weeks) and replacement by average car with 234,000 additional miles (25%) to account for new journeys. Average emissions factors for bus from BAU from PTEG AEA report, for average car from S1
Provision of car clubs	**Low**	**Measure proposed** Local authorities, ITAs/PTEs support the initial set up and further development of car clubs in urban areas (provision of convenient car parking spaces, financial support for set up costs of expansion investment) **Evidence of impact** A survey of UK car club members revealed that when people join a club, they make changes to the mileage they drive and the number of cars they own in their household. This results in savings of 0.7t CO_2 per year. This is based on sample data showing that members reduce their mileage by 53% from joining; 44.7% of member households get rid of a car or defer purchase; car club cars emit only 63% as much CO_2 as the cars which they replace; one car club car takes at least 5-11 private cars off the road; and the average car mileage of a car club member after joining is 10.5% of that of the average mileage of non-members (or car club members travelled 89% fewer miles in a car than non-members.) Source: CarPlus and TRL 2008 survey. **Modelling assumptions** Assumes membership reaches 5% of households in Conurbation Inner, Conurbation Big, Conurbation Large, Conurbation Medium TEMPRO zones Assumes that non car owners are twice as likely to be members. Based on current level of 30% of households without access to a car, this means non car owners represent 60% of car club members (Non car owner levels vary with area type and time) Members who previously owned a car reduce their (already lower than average) mileage by 2/3 on joining Car club cars are assumed to be 37% more efficient than private cars *Note: No business use included here to avoid double-counting with public sector procurement of low carbon vehicles and other fleet efficiency measures*
Provision of improved rail services	**Low**	**Measure proposed** ITAs/PTEs and local authorities work in partnership with operators, Network rail and the DfT to improve urban rail services to and between the metropolitan areas, including additional carriages and services, shorter journey times **Evidence of impact** Very limited evidence available on rail specific measures. Evidence similar to public transport evidence shown in bus/rapid transit improvements above.

Interventions	Abatement potential (2022)	Abatement evidence
		Modelling assumptions Number of people affected by area type: improvements assumed to target current rail users and an equivalent number of current car users. 5% journey time saving assumed for rail users to/from/within Conurbation Inner, Conurbation Big, Conurbation Large, Conurbation Medium TEMPRO zones. Long term elasticity (0.27 to 0.53, varying by purpose, from TRL Practical Guide to Public Transport) applied to estimate increase in current bus patronage to estimate increase in passengers as a result of decrease in time. 25% of increased trips assumed to have switched from previous car driver trip (WebTAG) and trips removed from appropriate purpose/distance band for car driver trips to estimate vehicle kms removed by time of day. No allowance for increased PT provision.
High speed rail ***– not modelled***	*Not modelled*	*High Speed Rail is a long term prospect for some of the urban areas considered here. It is assumed however that services on a high speed network would not be available in 2022 and such services are therefore not included in this modelling exercise.*
Development of rail/water freight capacity and promotion/incentives to secure shift from road freight	**Low**	**Measure proposed** Local authorities, ITAs/PTEs and operators work in partnership to improve the capacity of rail and water freight networks and encourage the use of rail and water alternatives **Evidence of impact** Between 1997 and 2004, rail increased its share of the freight market from 7% to 8%. The share of the market held by water-based services increased by a greater margin, from 21% to 24%. The Route Utilisation Strategy for freight, published by Network Rail (2006), forecasts a growth of just under 30% in rail freight tonnes by 2014-5, equivalent to an extra 240 freight trains per day (including empty return trips). The main growth is anticipated in deep-sea container traffic. Substantial investment in rail infrastructure (mainly on gauge clearance, loop lengthening and improved signalling) will be required to accommodate this forecast growth. Given the short average length of haul in the UK, the very low proportion of industrial premises connected to the rail network, the country's industrial mix and the heavy use of the rail network by passenger traffic, it is unlikely that rail will be able to capture more than 10-12% of total freight tonne-kms in the UK in the foreseeable future. The government has awarded Water Freight Grants since 2001 to encourage the use of shipping services where this yields a net environmental benefit. Between 2001 and 2005, a total of £28.3 million was spent on this scheme removing around 1.4 billion lorry-miles from UK roads. Most optimistic assumptions for CfIT for period 2004 to 2015 include: no change in HGVs tonne-kms, increase in vans tonne-kms (between 50 and 100%),up to 30% increase in rail freight tonne-kms, up to 10% increase in water freight tonne-kms, up to 10% increase in rail energy efficiency and no change in water energy efficiency Total growth in freight tonne-km between 7 (Scenario 1) and 11.4% (Scenario 2). Source: McKinnon for CfIT 2007 Within Greater Manchester, 29.5M tonnes (1,236 M tonne-kms) of freight p.a. are moved by heavy goods vehicle (HGV) and 88% of road goods traffic travels on the Primary Route Network (PRN – green-backed signs). Between Greater Manchester and other parts of the country, 32.4M tonnes of freight p.a, are lifted outside Greater Manchester and are moved into the county area. The equivalent figure for tonne kms is 4.466 M. In the opposite direction, 29.5M tons p.a. lifted within the county moves outside it, and the equivalent for tonne-kms is 4.465M. One-third of road freight tonnage in the county passes through the area without stopping. 3M tonnes of rail freight originate in Greater Manchester per annum and 2.8M tonnes of rail freight are received in Greater Manchester per annum. 154,000 tonnes p.a. of air freight are despatched from Manchester Airport plus 70,000 tonnes transhipped through the facilities by road (2004 calendar year). 1M tonnes of freight p.a. are moved by waterway (the upper reaches of the Manchester Ship Canal)

Interventions	Abatement potential (2022)	Abatement evidence
		and 15M tonnes p.a. are transported by pipeline Source: Greater Manchester Freight Strategy Version 5 **Modelling assumptions** Share of rail freight increases to 10% of surface freight by 2016 and 2022 (from 9% share in 2006), share of water freight increases to 27% in 2016 and 28% in 2022 (from 25% in 2006) and share of road freight goes down to 64% in 2016 and 63% in 2022 (from 66% in 2004) Share of air freight remains unchanged
Encouraging the use of low carbon alternatives		
Public transport concessionary fares and fare subsidies (for targeted groups)	**Low**	**Measure proposed** ITAs/PTEs and local authorities work with operators to implement lower fares for targeted groups (current high emissions groups, for example targeting car commuter and leisure use on specific corridors/in specific areas) **Evidence of impact** The scale of concession will affect the amount of change. Fare elasticities are likely to be -0.2 to -0.3 in the short run (-0.7 to -0.9 in the long run). Source: The demand for public transport: a practical guide TRL 593, 2004 Acutt reports that the halving of public transport fares is only forecast to cut car emissions by a little under 1.5%. The increase in demand for public transport services would increase emissions from public transport. Source: Acutt, M. & Dogson, J. 1996 - Policy instruments and Greenhouse Gas Emissions from Transport in the UK, Fiscal Studies, vol. 17, no. 2, pp. 65-82 as quoted in UK ERC Impact database An increase in patronage of public transport does not necessarily mean a reduction in fuel use. More fuel may be used carrying additional passengers who previously walked, or who were car passengers, than is saved by the number of car drivers attracted to use the bus. BTRE (2002) cites Philipson and Willis (1990) who found that, while free public transport for Adelaide (a 100% reduction in fares) would probably result in a 30% increase in patronage, only around half of riders are likely to come from cars and even less would have been drivers. Hence, it was estimated that car trips would decline by considerably less than 2%. Source: BTRE 2002 Greenhouse Policy Options for Transport, Bureau of Transport and Regional Economics, Australia, as quoted in UK ERC Impact database **Modelling assumptions** Number of people targeted by area type: fares are reduced for all trips in/from Conurbation Inner, Conurbation Big, Conurbation Large, Conurbation Medium TEMPRO zones for journeys between 5 and 25 miles. Long term elasticity (0.27 to 0.53, varying by purpose, from TRL Practical Guide to Public Transport) applied to estimate increase in current bus patronage to estimate increase in passengers as a result of decrease in time. 25% of increased trips assumed to have switched from previous car driver trip (WebTAG) and trips removed from appropriate purpose/distance band for car driver trips to estimate vehicle kms removed by time of day. Assumes 25% reduction in targeted fares No allowance for increased PT provision. Additional patronage assumed to be accommodated within services provided through investment measure

Interventions	Abatement potential (2022)	Abatement evidence
Roll-out of Smarter Choices initiatives and campaigns in targeted areas	**Medium**	**Measure proposed** ITAs/PTEs and local authorities implement a comprehensive package of targeted Smarter Choices measures including travel planning (workplaces, schools, leisure), personalised/individualised marketing, car sharing promotion, sustainable travel campaigns, teleworking, flexible working practices and variable/adjusted opening times for shops, services and schools, cycle for work schemes, marketing and awareness campaigns, public transport, walking and cycling information **Evidence of impact** The evaluation of the results of the three Sustainable Towns projects show that car driver trips per resident of the three towns taken together fell by 9% between 2004 and 2008, whilst car driver distance per resident fell by 5%~7% (trips of 50km or less). Car use per head also fell nationally in comparable (medium-sized) urban areas during this period, but by a much smaller amount: a change of -1.2% for car driver trips and -0.9% for car driver distance (NTS all trip lengths). Traffic count data showed variable results in different areas of the three towns, with overall reductions of the order of 2%, and more substantial reductions in inner areas, of the order of 7-8%, taking place prior to the economic downturn. Bus use grew substantially in Peterborough and Worcester during the period of the Sustainable Travel Town work, whereas it declined in Darlington. According to the household travel survey data, between 2004 and 2008, bus trips per resident of the three towns taken together increased by 10%~22% (trips of 50km or less), whereas, according to the NTS, there was a national decline of bus trips in medium-sized towns of 0.5% over the same period. According to the household travel survey data, between 2004 and 2008, cycle trips per resident of the three towns taken together increased by 26~30% (NTS shows a decline of cycle trips in medium-sized towns over a similar period). According to the household travel survey data, between 2004 and 2008, walk trips per resident of the three towns taken together increased by 10%~13% (NTS shows a decline in walk trips in medium-sized towns of at least 9% over a similar period). The travel behaviour change in the towns involved a combination of mode shift (with unchanged destination); switch of destination and mode (e.g. replacing a medium-length car trip with a shorter journey by foot, bike or bus); and trip evaporation (not making a trip at all). At the aggregate level, roughly 7% of the reduction in car use (including car driver and car passenger trips) was from a net reduction in trips. Source: The Effects of Smarter Choice Programmes in the Sustainable Travel Towns, Summary Report, Sloman at al. for DfT, 2010 **Modelling assumptions** Car driver kilometres decrease by 5% for all trips of 50 km or less in/from Conurbation Inner, Conurbation Big, Conurbation Large, Conurbation Medium TEMPRO zones *Note: Mode shift to public transport is assumed to take place within current service provision here (emissions from additional services are accounted for under the investment in public transport measure)*
Congestion charging (local charge targeting congested urban areas) ***– not modelled***	*Not modelled*	*Congestion charging is designed to address congestion issues rather than reducing carbon emissions and research shows that it would be likely to result in an increase in emissions (or have a neutral impact on emissions) through the rerouting of traffic avoiding the congestion charge zones. This is different from the likely impact of a national charge per kilometre system but such a system is not within the power of local authorities/ITAs/PTEs to implement.* ***Evidence of impact*** *The London Congestion Charge scheme has reduced congestion by 26% compared to 2002 levels, whilst bringing about increased use and effectiveness of public transport – in particular buses. TfL estimates that the traffic and speed changes observed within the zone have led to a 16.4% reduction in CO_2 emissions. Small increases in traffic flow were observed on the inner ring road (surrounding the charge zone) which has led to a proportionate increase in CO_2 emission. Source: TfL, Congestion*

Interventions	Abatement potential (2022)	Abatement evidence
		Charging Monitoring Report, 2007. *The CCC refers to modelling by the Department for Transport for the Committee on Climate Change, which suggests that a national road pricing system could reduce annual CO_2 emissions by around 5% in 2020. The CCC also refers to analysis by the RAC foundation on the effects of road pricing on carbon emissions in 2040, which suggests that an efficient national road pricing system would reduce annual CO_2 emissions by around 15% in that year. Source: CCC October 2009 Progress Report*
Low emissions zones (LEZ – targeting HGVs and large vehicles)	**Low**	**Measure proposed** Local authorities and ITAs/PTEs implement low emissions zones in the key urban centres for the metropolitan areas. It is assumed here that the zones would be implemented on the current London model, mainly targeting HGVs and other large vehicles and resulting in a stronger incentive for HGVs servicing the areas to be upgraded to more recent models. **Evidence of impact** London LEZ - During 2007, it is estimated that background change to the emissions performance of vehicles operating in Greater London reduced emissions of NO_X in Greater London by 7.1%; of NO_2 by 2.9%; of PM_{10} by 5.6%; of $PM_{2.5}$ by 6.5%, and of CO_2 by 2.0% – all with reference to this revised 'monitoring' base case. These empirically-based estimates of background change tend to be smaller than would otherwise be assumed using national-level projections – a potentially important finding that will be further investigated. Over and above this background change, it is estimated that operator pre-compliance with the requirements of the scheme reduced emissions in Greater London of NO_X by 1.4%; of NO_2 by 1.3%; of PM_{10} by 1.1%; and of $PM_{2.5}$ by 1.4%. Emissions of CO_2 remained largely unaffected by the scheme, as would be expected. Source London Low Emission Zone, Impacts Monitoring, Baseline Report, TfL, July 2008 **Modelling assumptions** Type of trips/area affected: HGV trips to Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones Assume that of vehicles to/from the central 1/3 of the Conurbation Inner (about 10% journeys) the HGV fleet size mix changes so that 20% of journeys previously made by artics > 33tonnes now made by artics < 33 tonnes and 20% of journeys previously made by rigids > 7.5 tonnes now made by rigids < 7.5 tonnes Assume 33% of traffic is through traffic (see evidence for Manchester freight above), varying by road type and that no. of vehicles serving the affected TEMPRO zones is in proportion to the number of jobs within the areas (about 85%) *Note: This measure would complement the incentives for low-carbon cars and vans and the freight efficiency measures (including freight consolidation centres & Freight Quality Partnerships)*
Workplace parking levy	**Medium**	**Measure proposed** Local authorities and ITAs/PTEs implement workplace parking levy schemes (a charge on employers providing free or relatively cheap workplace car parking) in metropolitan (urban) areas. Nottingham example: Nottingham's workplace parking levy (WPL) will start in April 2012 and only apply to employers within the City of Nottingham's administrative boundary that provide 11 or more liable parking places, including public sector employers apart from NHS premises and emergency services. All the money raised from the WPL will be invested into improving public transport in Nottingham. Source: Nottingham City Council, March 2010 **Evidence of impact** The Nottingham WPL business case states that employers are likely to split the cost of the WPL between themselves and their employees, with at least a third expected to pass some of the cost of the WPL on and over half expected to pass on 75-100% of the WPL. Employers are less likely to pass the cost of the Levy on to their customers: only 20% thought they might do this. Increased use of public transport, transfers to park and ride and other travel behaviour changes resulting from the WPL package will remove 2.5 million vehicles travelling to or from locations within the City of Nottingham administrative boundary in 2015,

Interventions	Abatement potential (2022)	Abatement evidence
		increasing to 2.8m by 2021. The impact of the WPL will also constrain growth in both the demand for car travel and traffic flows elsewhere in the conurbation, but particularly on routes into the city centre and in the approaches to the city from the south west. For example, the WPL package is expected to broadly halve the forecast increase in car journeys to city centre destinations from 15% between 2006 and 2021 to 8%. Growth in traffic flows on key radial routes outside the Ring Road in the south west sector of the city (measured using vehicle kilometres) is expected to be constrained to only 1% over this 15 year period. Source: Workplace Parking Levy Business Case, Nottingham City Council, April 2008 **Modelling assumptions** Number of employees/area type affected: 70% of commuting trips to Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones and 40% of trips to Conurbation Medium and Conurbation Small TEMPRO zones. Annual charge £600 in 2010 prices of which on average 75% passed onto employee equating to nearly £2 per working day. Impact on traffic estimated comparing cost to total travel costs by distance band and using long term elasticity of car demand to travel cost (from TRACE handbook)
Introduction or increase in parking charges (public car parks)	**Low**	**Measure proposed** Local authorities implement increases in car parking charges in urban areas within the conurbations. This is supplemented by stronger enforcement and parking restrictions (resulting in lower availability of on-street free parking). **Evidence of impact** Even modest parking fees can affect vehicle travel patterns. Price elasticity of travel with respect to parking price, ranges from -0.1 to -0.3 (a 10% increase in parking charged reduces trips by 1-3%). Pricing that applies to commuter parking tends to be particularly effective at reducing peak-period travel. Source: VTPI (citing Vaca and Kuzmyak, 2005) as quoted in UK ERC Impact database. **Modelling assumptions** Users affected by purpose: main purpose affected are commuting, leisure and business Scale of change and area types affected: 70% increase in car parking charges in Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones and 40% of trips to Conurbation Medium and Conurbation Small TEMPRO zones also assuming an increase of 50% in the number of drivers having to pay to park (through increased parking restrictions and enforcement). Reference Case percentages paying to park and average charge by purpose taken from National Transport Model defaults for Metropolitan Inner and Outer areas. Impact on traffic estimated comparing cost to total travel costs by distance band and using long term elasticity of car demand to travel cost (from TRACE handbook)
Reducing the need to travel		
Support and investment in local services and community hubs	**Low**	**Measure proposed** Local authorities, ITAs/PTEs and neighbouring authorities (commuting/leisure catchment) implement a range of land use planning and service development measures to reduce the need to travel to urban centres from more rural areas. This includes the provision of community hubs and the review of the location of services (work, education, health, shopping services), support the further development of high capacity internet, the provision of home delivery services and local collection centres **Evidence of impact** A study using multiple regression to determine effects on car ownership and mode choice on land use characteristics based on data from the UK National Travel Survey collected in 1989/91 and 1999/2001 found that areas a 'short walk' to amenities are associated with a 6% decrease in the share of distance travelled by car compared with areas a 'medium walk' to amenities, and an 11% decrease compared with areas a 'long walk' to amenities – Source: Dargay, Land Use and Mobility in Britain, 2009 as quoted

Interventions	Abatement potential (2022)	Abatement evidence
		in CCC October 2009 Progress Report **Modelling assumptions** Assumes that measures bring the average annual distance travelled by car by 50% of the population in towns of 3,000 to 10,000 inhabitants (Conurbation Tiny TEMPRO zones) 80% of the way towards the lower average distance travelled by residents of towns with 10,000 to 25,000 (Conurbation Small TEMPRO zones) inhabitants. Assume ratio of average car distance travelled between towns of 10-25,000 and 25-10,000 is the same within conurbations as elsewhere (i.e. approximately 85%) - adjust distribution by distance band of journeys within smaller towns accordingly
Review location of proposed new developments to reduce need to travel (linked to development of car free housing)	**Low**	**Measure proposed** Local authorities, working in partnership with ITAs/PTEs, use their planning powers to ensure that half of all new developments achieve Eco-Town standards in terms of mode share **Evidence of impact** A study by Ornetzeder et al (2008) looking at the effect of car-free housing in Vienna found that transportation's share of the household CO_2 emissions is lower for the car-free settlement (35%) than for the reference settlement (44%). The study concluded that the reference settlement had 33% higher CO_2 emissions per capita than the car-free settlement. On average, car-free households travel ten times as far by train as by car and bus. A survey of residents in the car-free settlement showed how moving to a settlement of this nature has changed mobility habits. For example, 41% of the respondents say that they have started to use their bicycle much more often than before (reference settlement: 22%) Source: The environmental effect of car-free housing: A case in Vienna, M.Ornetzeder et al. 2008 **Modelling assumptions** Scale of development: Based on TEMPRO assumptions Area type affected (household/GFA assumptions): Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones and Conurbation Medium TEMPRO zones Changes in trip making characteristics (e.g. from one TEMPRO area type to another, length, mode): Assumes changes in mode share from planned developments in TEMPRO zones selected to meet Eco-Town mode share targets for 50% of growth in Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones and Conurbation Medium TEMPRO zones between 2010 and 2022. Exemplar cited in DfT Eco-Town guidance – Vauban Quarter in Freiburg, Germany modal split: 23% walking, 27% cycling, 18% PT, 6% car passenger, 26% car drivers. Average trip length reduced to reflect increased density (assuming the same ratio between trip lengths for new denser areas and average Met areas as between Met areas and Large urban areas = 85%) and car driver trips removed from appropriate distance bands and purposes to estimate vehicle km impacts of altered mode split
Urban density increases (residential and business)	**Low**	**Measure proposed** Local authorities, working in partnership with ITAs/PTEs, use their planning powers to increase housing density in urban centres. **Evidence of impact** The density of development has an important effect on the distances travelled, the modes used and the energy profiles. Newman and Kenworthy (1989/1999) undertook a comparison of the transport energy profiles of 84 cities. Their powerful conclusion reached was that when urban density in the 58 wealthier cities was correlated with car passenger kms, urban density explained 84% of the variance. When energy use was correlated with activity intensity (persons and jobs per hectare) 77% of the variance was explained. Despite concerns over the methods used and the quality of the data, clear relationships have been established at the city level. A general conclusion is that an increase of 10% in local density results in a 0.5% decrease in vehicle trips and vehicle miles travelled (Ewing and Cervero, 2002). However, Hall (1998) showed that as people move form big dense cities to small less dense towns they travel more by car, but the distances may be shorter. Source: VTPI Online Encyclopedia

Interventions	Abatement potential (2022)	Abatement evidence
		Compacting developments reduces the vehicle distance travelled by 3%. Source: Solutions London and Wider South East Report. This is also in line with other reported case studies in the UK and US. **Modelling assumptions** Scale of development: Based on TEMPRO Area type affected (household/GFA assumptions): Conurbation Inner, Conurbation Big and Conurbation Large TEMPRO zones and Conurbation Medium TEMPRO zones Assumes relocation of planned growth so that 50% of new developments between 2010 and 2016/ and 2022 achieve no more than 20% car mode share - includes assumed relocation of 50% of development in Conurbation Tiny and Conurbation Rural TEMPRO zones to the more built up urban areas resulting in shorter average trip length and car driver mode share of no more than 20%. Average trip length reduced to reflect increased density (assuming the same ratio between trip lengths for new denser areas and average Met areas as between Met areas and Large urban areas = 85%) and car driver trips removed from appropriate distance bands and purposes to estimate vehicle km impacts of altered mode split

4.1.2 Cost, deliverability and responsibility

Additional analysis for the long list of individual measures presented above is included in Table 4.4. This considers the cost of individual measures as well as their deliverability and where the responsibility for implementing them would lie.

Cost evidence and assessment

The evidence presented in Table 4.4 aims to give an indication of the cost of implementing the measures, taking into account information available on the level of investment funding required, set up and operational costs supported by the public sector, but excluding private user/consumer costs, maintenance costs or private sector contributions.

Costs are presented as in the evidence reviewed (current prices at the time of evidence publication, not discounted) and an assessment of the level of cost compared to current transport budgets in the metropolitan areas is included. This is reflected by a classification of cost levels using the following criteria related to metropolitan area LTP2 Integrated Transport Block allocation[127], summarised in Table 4.3:

- low cost – 5% or less of LTP2 IT Block (less than £10 million per annum or £127 million for 2010 to 2022 period across the metropolitan areas or more than £1 per head of population per annum or £12 per head for 2010 to 2022 period);
- medium cost – between 5 and 25% of LTP2 IT Block (between £10 and £50 million per annum or between £127 and £635 million for 2010 to 2022 period across the metropolitan areas or between £1 and £5 per head of population per annum or £12 and £58 per head for the 2010 to 2022 period);
- high cost – above 25% of LTP2 IT Block; and
- cost neutral – where a measure would replace an existing interventions without additional cost to the public sector. Measures which could potentially generate additional revenue are also identified.

Table 4.3: Metropolitan areas LTP2 IT Block allocation

Metropolitan area	LTP2 Integrated Transport Block allocation (£,000s – December 2006)
Greater Manchester	£229,806
Merseyside	£170,516
South Yorkshire	£113,231
Tyne & Wear	£90,154
West Midlands	£247,081
West Yorkshire	£125,109
Total LTP2 IT Block allocation	*£975,897*
Total LTP2 IT Block allocation per annum (5 year period)	*£195,179*
Total LTP2 IT Block allocation per annum and per head (£)	*£17.60*
Equivalent total allocation for 2010-2022 period (13 years)	*£2,537,332.20*
Equivalent total allocation for 2010-2022 period per head (£)	*£228.79*

[127] As this is for comparison only, cuts announced following the June 2010 budget are not taken into account

Deliverability and responsibility

Table 4.4 also includes information on the level of deliverability of the individual measures considered. This gives an indicative assessment of the public and political acceptability of the measure as well as its practical feasibility (risk, technology, etc). Scores used in Table 4.4 include:

- high deliverability – no significant opposition to measure and no significant risks or technological challenges anticipated;
- medium deliverability – some opposition to measure and/or some risks or technological challenges anticipated but it should be possible to address these issues within the period;
- low deliverability – significant risk of strong opposition to measure and/or significant risks or technological challenges anticipated, which might not be resolved in the 2010-2022 period.

Table 4.4 also briefly considers which organisations would be responsible for implementing the measures considered.

Table 4.4: Individual interventions cost analysis – Evidence summary table

Interventions	Deliverability & responsibility	Cost level	Cost evidence
More efficient vehicles and low carbon vehicles			
Public sector procurement of low carbon vehicles for own fleet	**Deliverability**: high **Responsibility**: Public sector organisations trough fleet procurement	**Low**	**Measure proposed:** ITAs/PTEs and local authorities in metropolitan areas support an earlier than average switch to low carbon emissions vehicles for public sector fleet vehicles (cars and vans) through financial incentives, procurement policies, etc. **Cost assumptions:** In 2008, new cars (registration within the year) represent 7.44% of total UK car fleet. This equates to the full UK fleet being replaced every 13.5 years. For the fleet to get 2 years newer, the full replacement rate time needs to be reduced to 11.5 years and the proportion of new vehicles in the fleet to be increased to 8.7%. Assumptions on size of fleet: public sector fleet (in ownership or leasing) is 1% of total car and LGV fleet and further 1% of fleet included to represent influence over grey fleet Additional number of new vehicles over the 2009-2022 period approx. 1,700 across Met areas, supported at level of £4,000 per vehicle in public sector fleet and £1,000 per vehicle for grey fleet (incentive) Approx. total cost for 2010-2022 period (current price) is £4 million **Note:** This would result in significant fuel cost savings for the organisations using the vehicles although these savings are not estimated here
Support to take up electric and plug-in hybrid vehicles (cars and vans mainly) through provision of charging points and/or financial incentives (e.g. parking policies)	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs through LTP and other transport policies	**Medium**	**Measure proposed:** ITAs/PTEs and local authorities in metropolitan areas support an earlier than average take up of electric vehicles across the fleet in their area through the provision of charging points and financial incentives **Cost assumptions:** In 2008, new cars (registration within the year) represent 7.44% of total UK car fleet. This equates to the full UK fleet being replaced every 13.5 years. For the fleet to get 2 years newer, the full replacement rate time needs to be reduced to 11.5 years and the proportion of new vehicles in the fleet to be increased to 8.7%. Government support announced in Budget 2009 for purchase of low carbon cars: between £2,000 and £5,000 by vehicle. Assuming that support from the Mets is equivalent to £3,000 by car/van, total cost for 2010-2022 period (current price) would be approx. £239 million **Note:** This would result in significant fuel cost savings for users although these savings are not estimated here
Improvement in bus fleet efficiency (e.g. low carbon buses, electrification of public transport)	**Deliverability**: high **Responsibility**: ITAs/PTEs with support from Central Government	**High**	**Measure proposed:** Improvements in bus fleet efficiency in the metropolitan areas, secured through financial incentives such as BSOG, supported services procurement criteria, Green Bus Fund, Quality Partnership and contracts, resulting in higher level of investment in more efficient vehicles. This also includes use of biofuels and driver training. **Cost evidence:** Cost estimated by TTR in 2009 (Scenarios and opportunities for reducing greenhouse gases and pollutant emissions from bus fleets in PTE areas), based on the following scenarios: - Medium ambition scenario 2.2 for 2012/13 and scenario 2.3 for 2015/16 – approx. cost £836 million over 2010-2016 period - High ambition scenario 3.2 and 3.4 for 2012/13 and 2015/16 respectively – approx. cost £1,557 million over 2010-2016 period **Note:** This includes capital investment costs only and assumes that PTEs are the main source of funding. This would also result in significant fuel cost savings which are not estimated here.

Interventions	Deliverability & responsibility	Cost level	Cost evidence
Support to taxi/private hire vehicles drivers for switch to more efficient/low carbon vehicles	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs through LTP and other policies (licensing)	**Low**	**Measure proposed:** Local authorities and ITAs/PTEs support and incentivise the switch to low carbon vehicles for taxi/private hire vehicles drivers on the metropolitan areas (financial incentives, licensing rules e.g. age limit and emission levels for new licenses , access to city centre zones) **Cost assumptions:** Assumes the whole taxi and private vehicles hire fleet is made 2 years newer than the average with total taxi and PHV fleet at 45,000 in metropolitan areas in 2007, 56,400 vehicles by 2016 and 65,600 vehicles by 2022. Government support announced in Budget 2009 for purchase of low carbon cars: between £2,000 and £5,000 by vehicle. Assuming that support from the Mets is equivalent to £3,000 by taxi/PHV, total cost for 2010-2022 period (current price) would be approx. £29 million across the Mets **Note:** This would result in significant fuel cost savings for taxis and PHVs although these savings are not estimated here
Rail electrification (focus on local rail)	**Deliverability**: high **Responsibility**: Central Government and Network Rail with some input from ITAs/PTEs	**Medium**	**Measure proposed:** ITAs/PTEs and local authorities obtain funding and support for further electrification of railway lines serving their areas. **Cost assumptions:** Electrification costs are usually summarised as a rate per single track kilometre and the report "T633: Study on Further Electrification on the UK Railway" undertaken for the Department for Transport (DfT) by Atkins in 2007 quoted a range of rates from £500k to £650k. The modelling illustrates the potential scale of impact if a scheme was implemented that achieved electrification of 10% of current diesel rail kilometres. This is assumed to be achieved through the implementation of 6 electrification schemes similar to the Liverpool-Manchester electrification (approx. 50 km two way for which funding was announced in 2009) across the metropolitan areas
Rail efficiency, including increased use of regenerative braking on trains	**Deliverability**: high **Responsibility**: Central Government with some input from ITAs/PTEs, franchising PTEs	**Cost neutral**	**Measure proposed:** ITAs/PTEs and local authorities work with rail (including metro) and tram operators to improve the efficiency of rail services, including regenerative braking biofuels, onboard and trackside energy storage, more stringent efficiency specifications for new diesel trains. Targets for improved efficiency can also be included in franchise agreements. **Cost assumptions:** Estimated to be cost neutral as efficiency savings assumed here to be equivalent to those forecast by the rail industry under the 'Business As Planned' scenario presented in the Rail Industry's Submission to the Committee on Climate Change in March 2008.
Lower carbon fuels			
Producing low carbon energy from the transport network/assets	**Deliverability**: medium/high **Responsibility**: local authorities and ITAs/PTEs	**Low** (potentially revenue generating)	**Measure proposed:** Local authorities and ITAs/PTEs develop renewable energy regeneration on land available within the transport infrastructure (for example at Park & Ride sites) **Cost assumptions:** 10 5kWh wind turbines costing £50k each (including installation but excluding planning costs) – Source: Renewable UK Generate your own power: Your guide to installing a small wind system Photovoltaic cells generating 10MWh (10,000 kW) of energy per annum costing between £5,000 and £8,000 per kWp installed – Source: yougen.co.uk
*Increase in the use of biofuels – **not modelled***	*National measure*	*Not estimated*	*The use of biofuels by buses is covered in "Improvement in bus fleet efficiency" above. No additional biofuel use is considered here as the PTEs and local authorities would not have the powers to increase the use of biofuels across the fleet.*

Interventions	Deliverability & responsibility	Cost level	Cost evidence
Traffic management			
Active/improved traffic management (including managed motorways, green waves, ramp metering, coordination of street works)	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs through LTP, HA & Central Government	**Medium**	**Measure proposed:** Local authorities and ITAs/PTEs (in partnership with the Highways Agency) implement active traffic management systems main urban roads where congestion is an issue to improve traffic flows. **Cost evidence:** The M42 Active Traffic Management Scheme operated by the Highways Agency over a 17km stretch of the motorway cost £96.4 million (including infrastructure construction, equipment, control system and consultancy fees). This equates to a cost per km of motorway (both carriageways included) of £5.6m (outturn costs - covering the total cost of all of the design, development, delivery, construction, infrastructure and support costs from inception to maintenance handover). Cost of roll-out estimated to be between £3 and £4 million per km. *Source: Advanced motorway signalling and traffic management feasibility study, A report to the Secretary of State for Transport, DfT 2008* **Cost assumptions:** Assumes schemes implemented similar in cost to HA estimates and 100 km of active traffic management measures or equivalent delivered across metropolitan areas over the 2010-2022 period, at the approx. cost of £350 million (current price). **Note:** This would result in additional financial benefits to users in terms of fuel costs and journey time/reliability
Stricter enforcement of speed limits	**Deliverability**: medium **Responsibility**: local authorities and ITAs/PTEs, HA	**Medium**	**Measure proposed:** Local authorities and ITAs/PTEs work in partnership with the Police to enforce existing speed limits more strictly, possibly through average speed cameras. No blanket reduction in maximum speed limits on main roads is proposed here as this would the responsibility of Central Government **Cost assumptions:** Based on costs for national speed reduction and enforcement measure modelled for the UK for the DfT Carbon Reduction Strategy with total investment cost for compliance (speed cameras) estimated at £1,110 million. Cost for metropolitan areas (on proportion of population) estimated at £200 million. **Note**: This would result in fuel cost savings for users but also potentially in increased revenue through fines
Traffic calming in urban areas, including 20mph limits in selected zones or area wide – ***Not modelled as an individual measure***	***Deliverability**: medium* ***Responsibility**: local authorities and ITAs/PTEs through LTP*	***Low***	***Cost evidence:** Portsmouth blanket 20mph scheme (no vertical measures). The cost of implementing the scheme was £0.57million which came from the LTP capital expenditure programme. Source: Portsmouth City Council, 20 mph Scheme Interim Evaluation, Atkins for DfT, 2009* *Assuming schemes in metropolitan areas cover 60% of population, cost would be approx. £19 million*
Freeze on road building/improvements, using congestion to manage demand ***– not modelled***	***Deliverability**: low* ***Responsibility**: local authorities and ITAs/PTEs, HA & Central Government*	**No cost**	***Note:** This would result in additional journey costs (through congestion and additional journey time) unless demand can be reduced*

Interventions	Deliverability & responsibility	Cost level	Cost evidence
Road surfaces designed to reduce fuel consumption through resurfacing programme	**Deliverability**: medium **Responsibility**: local authorities and HA	**Low**	**Measure proposed:** Local Authorities make use of road resurfacing programmes to provide road surfaces with lower rolling resistance **Cost evidence:** No direct evidence of cost but can be compared to evidence on noise reduction measures. Two-layer porous asphalt surfaces used to reduce noise levels cost about 30 EUR/m² more than conventional surfaces. Source: www.silence-ip.org/site/index.php?id=119 Average costs for resurfacing are estimated at (source: www.n-somerset.gov.uk/Transport/Highways+and+streets/Repairs+and+maintenance/resurfacing.htm) - Surface dressing - Bitumen and chippings are used to restore skidding resistance and seal the road against surface water every five to seven years and costs around £1 per square metre - Planing - The old top layer is replaced with new material and costs between £3 and £5 per square metre - Total reconstruction - This fundamental rebuilding of a road costs £9 per square metre **Cost assumptions:** Assumes spend on low resistance road equivalent to spend on low noise surface in LTP1 period: £11.87 million over 5 years. Approx. £31 million across the metropolitan areas for 2010-2022 **Note**: This would also result in fuel cost savings for the users. Potential implications on road safety and emissions/environmental impacts of the techniques used would need to be investigated.
High occupancy lanes (potentially including Park & Share sites) – ***Not modelled as individual measure***	***Deliverability**: medium* ***Responsibility**: local authorities and HA*	*Not estimated*	**Evidence of impact:** The evaluation of the A647 Stanningley Road HOV lane undertaken by Leeds City Council shows that scheme implementation cost was £585,000 at 1998 prices Source: Bus Priority, The Way Ahead, DfT, 2006 **Note:** This could result in increases in journey time and cost for non HOV users
Efficient driving practices			
Driving training programme for car drivers (including taxi drivers), bus drivers, train drivers and HGV/van drivers & awareness and incentivised campaigns to improve driving efficiency	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs	**High**	**Measure proposed:** Local authorities and ITAs/PTEs implement driver training programmes supplementing national campaigns to achieve a higher level of training and awareness amongst drivers in the metropolitan areas. **Cost evidence:** Cost per driver (as in DfT Carbon Reduction Strategy) £60 **Cost assumptions:** Number of drivers targeted: 80% of car drivers and 40% of van drivers, assumed they are all retrained every 5 years. Results in cost of approx. £724 million (based on number of license holders) across the Mets for 2010 to 2022 **Note**: This would result in significant fuel cost savings for users which are not estimated here
Freight efficiency through operational improvements, including freight consolidation centres, Freight Quality Partnerships, route optimisation, and delivery management programmes	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs (through Freight Quality Partnerships)	**Low**	**Measure proposed:** Local authorities and ITAs/PTEs work with freight sector partners to provide and encourage the use of freight consolidation centres, route optimisation and with businesses to reduce the frequency of deliveries to their sites. **Cost evidence of impact:** London Heathrow – Retail: time savings for delivery companies were estimated to be worth £4,715 – assuming £20 per hour, which is equivalent to an annual saving of £245,000 based on the activity levels. Fuel savings were calculated to be worth £100 per week. Source: Urban Freight Consolidation Centres Final Report, University of Westminster for DfT, 2005 The London Construction Consolidation Centre (LCCC) project cost £3.2 million and involved a partnership between Stanhope PLC, Bovis Lend Lease, Wilson James and Transport for London (TfL). TfL funded

Interventions	Deliverability & responsibility	Cost level	Cost evidence
			£1.85 million, while the developers and construction companies funded the other £1.35 million. Source: London Construction Consolidation Centre, Final Report, TfL, October 2008 **Modelling assumptions:** Assuming one consolidation centre in each metropolitan area with a cost equivalent to the LCCC, assuming that all set up costs are borne by the public sector. This results in a cost of £19.2 million across the metropolitan areas. **Note**: Users would be asked to pay a contribution to the cost of running consolidation centres which would generate revenue for the area but this could result in increased handling costs for users, potentially offset by journey time reductions which are not estimated here
Providing attractive low carbon alternatives			
Provision of improved cycle infrastructure including cycle routes/lanes, cycle parking facilities and cycle rental schemes (potentially supported by measures such as car free zones and 20mph areas)	**Deliverability**: medium (requires significant road space reallocation) **Responsibility**: local authorities and ITAs/PTEs through LTP	**Medium**	**Measure proposed:** Local authorities and ITAs/PTEs deliver significant improvements in cycling infrastructure and facilities potentially supported by lower speed limits and car free zones **Cost evidence:** Cycling Demonstration Towns: Each town was granted funding at the level of about £5 per head per year, matched locally, such that total investment was about £10 per head per year. A partial cost-benefit analysis, taking account only of benefits due to reduced mortality, suggested that for each £1 invested, the value of decreased mortality was £2.59. Source: 'Lift Off' for Cycling, Cycling Demonstration Towns Report, Cycling England, 2009 **Modelling assumptions:** Assumes £10 spent per annum and per resident across the metropolitan areas over the first 5 years and then £5 per head per annum for remainder of 2010-2022 period, equivalent to cost across metropolitan area of approx. £610 million **Note**: This would result in significant health benefits which are not estimated here. This investment would in practice be linked to Smarter Choices measures
Provision of improved walking infrastructure (paths and shortcuts, crossing facilities, pavement width, signage, etc - potentially supported by measures such as car free zones and 20mph areas)	**Deliverability**: medium (requires significant road space reallocation) **Responsibility**: local authorities and ITAs/PTEs through LTP	**Medium**	**Measure proposed:** Local authorities and ITAs/PTEs deliver significant improvements in walking facilities potentially supported by lower speed limits and car free zones **Cost assumptions:** Limited evidence so assumes similar level of spend as for cycling improvements: £10 spent per annum and per resident across the metropolitan areas over the first 5 years and then £5 per head per annum for remainder of 2010-2022 period, equivalent to cost across metropolitan area of approx. £610 million
Provision of improved bus/rapid transit infrastructure and services (public transport priority, interchanges/Park & Ride, vehicles, shelters, VMS signs, Smartcard ticketing, etc)	**Deliverability**: medium **Responsibility**: local authorities and ITAs/PTEs working with DfT	**High**	**Measure proposed:** Local authorities and ITAs/PTEs deliver significant improvements in bus/rapid transit infrastructure/services and integration with other modes, including bus priority, interchanges, quality of vehicles, CCTV, improved shelter, provision of real time information, and Smartcard ticketing. **Cost assumptions:** Assumes implementation of 150km of new/enhanced bus priority corridor in each conurbation at a cost of £500,000 per km (two way), equivalent to £75million per metropolitan area for the period 2010-2022 Assumes further investment in mass transit and bus improvements costing £300million per metropolitan area over the period 2010-2022

Interventions	Deliverability & responsibility	Cost level	Cost evidence
Provision of improved express bus and coach services for medium to long distance trips and promotion of coach use for leisure trips	**Deliverability**: high **Responsibility**: ITAs/PTEs	**Low**	**Measure proposed:** ITAs/PTEs and local authorities support the development of additional medium to long distance coach routes from/in between the main urban centres to complement the rail offer **Cost assumptions:** Very limited cost evidence. Assumes requires support equivalent to 5% of LTP1 revenue spend on bus services across the metropolitan areas, equivalent to £70 million over period
Replacement of some existing conventional bus services by smaller community transport services and demand responsive services	**Deliverability**: high **Responsibility**: ITAs/PTEs	**Cost neutral**	**Measure proposed:** ITAs/PTEs identify services which could be run with smaller vehicles or replaced by demand responsive transport, community services or taxis. **Cost assumptions:** Assumes to be cost neutral or even resulting in cost savings
Provision of car clubs	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs through LTP	**Low**	**Measure proposed:** Local authorities, ITAs/PTEs support the initial set up and further development of car clubs in urban areas (provision of convenient car parking spaces, financial support for set up costs of expansion investment) **Cost assumptions:** Cost assumption based on subsidy for Edinburgh car club doubled for the Mets and applied per head for an initial period of 5 years, resulting in a cost of approx. £2.5 million across the metropolitan areas
Provision of improved rail services	**Deliverability**: medium **Responsibility**: local authorities and ITAs/PTEs working with DfT and Network Rail	**Medium**	**Measure proposed: I**TAs/PTEs and local authorities work in partnership with operators, Network rail and the DfT to improve urban rail services to and between the metropolitan areas **Cost assumptions:** Assumes allowance of £100 million per conurbation to support rail improvements over the 2010-2022 period
High speed rail ***– not modelled***	*National measure*	*Not estimated*	*High Speed Rail is a long term prospect for some of the urban areas considered here. It is assumed however that services on a high speed network would not be available in 2022 and such services are therefore not included in this modelling exercise.*
Development of rail/water freight capacity and promotion/incentives to secure shift from road freight	**Deliverability**: medium **Responsibility**: local authorities and ITAs/PTEs working with DfT	**Medium**	**Measure proposed:** Local authorities, ITAs/PTEs and operators work in partnership to improve the capacity of rail and water freight networks and encourage the use of rail and water alternatives **Cost evidence:** Over the past ten years, the volume of rail freight has increased by 50% and rail now handles 11.5% of freight moved in the UK. This has required around £1.5 bn of private sector investment and it is assumed that this figure has been matched by public sector contributions : Source: railfuture.org If current projections for encouraging water freight are maintained, this would lead to £400 million spend in England to 2031. Source: Freight Best Practice **Cost assumptions:** Level of investment assumed to be similar to data presented above for metropolitan areas for rail, resulting in approx. cost of £350 million for the 2010-2022 period. Assumptions for water freight result in spend of approx. £41 million across the metropolitan areas over 2010-2022

Interventions	Deliverability & responsibility	Cost level	Cost evidence
Encouraging the use of low carbon alternatives			
Public transport concessionary fares and fare subsidies (for targeted groups)	**Deliverability**: high **Responsibility**: ITAs/PTEs	**High**	**Measure proposed:** ITAs/PTEs and local authorities work with operators to implement lower fares for targeted groups **Cost assumptions:** 25% reduction in passenger revenue for journeys between 5 and 25 miles in Met areas, this results in approx. cost of £84 million per annum across the metropolitan areas **Note:** This assumes that additional patronage is accommodated within services provided through investment measure
Roll-out of Smarter Choices initiatives and campaigns in targeted areas	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs	**High**	**Measure proposed:** ITAs/PTEs and local authorities implement a comprehensive package of targeted Smarter Choices measures **Cost evidence:** The estimated outturn costs of the programme were £10 per person per year (roundly £11 at November 2009 prices). Source: The Effects of Smarter Choice Programmes in the Sustainable Travel Towns: Summary Report, Lynn Sloman et al. Report to the DfT, 2010 **Cost assumptions:** Assumes £11 per person spent across metropolitan areas over a 5 year period and then down to £7 per person for remainder of 2010-2022 period, resulting in approx. cost of £1,231 million across the areas **Note:** Mode shift to public transport is assumed to take place within current service provision
Congestion charging (local charge targeting congested urban areas) ***– not modelled***	***Deliverability****: low* ***Responsibility****: LAs & ITAs/PTEs*	*Not estimated*	*Congestion charging is designed to address congestion issues rather than reducing carbon emissions*
Low emissions zones (LEZ – targeting HGVs and large vehicles)	**Deliverability**: medium **Responsibility**: local authorities and ITAs/PTEs	**High**	**Measure proposed:** Local authorities and ITAs/PTEs implement low emissions zones in the key urban centres for the metropolitan areas. **Cost evidence of impact:** In Transport for London's Report to the Mayor in April 2007, following public consultation, scheme set-up costs were estimated at £50 million. Operating costs were estimated at £80 million (present value to 2015/16) while the scheme was estimated to generate £5m to £7m per year in revenues. Source London Low Emission Zone, Impacts Monitoring, Baseline Report, TfL, July 2008 **Modelling assumptions:** Assumes scheme costs at ¾ of London LEZ costs for each metropolitan area and operating costs over 7 year period (scheme lifetime), resulting in approx. £645 million across the metropolitan areas for the 2010-2022 period **Note**: This measure would potentially generate revenues through fines (at least initially) as well as significant health benefits which are not estimated here.
Workplace parking levy	**Deliverability**: medium **Responsibility**: local authorities and ITAs/PTEs	**Revenue generating**	**Measure proposed:** Local authorities and ITAs/PTEs implement workplace parking levy schemes in metropolitan (urban) areas. **Cost evidence:** The current forecasts suggest the WPL will generate a net income of £91.7m over the period (2020 to 2030) in 2005 NPV terms which can be used for supporting public transport development in the region. Source: Workplace Parking Levy Business Case, Nottingham City Council, April 2008
Introduction or increase in parking charges (public car parks)	**Deliverability**: medium **Responsibility**: local authorities	**Revenue generating**	**Measure proposed:** Local authorities implement increases in car parking charges in urban areas within the conurbations. This is supplemented by stronger enforcement and parking restrictions.

Interventions	Deliverability & responsibility	Cost level	Cost evidence
Reducing the need to travel			
Support and investment in local services and community hubs	**Deliverability**: high **Responsibility**: local authorities and ITAs/PTEs in partnership with service providers	**Low**	**Measure proposed:** Local authorities, ITAs/PTEs and neighbouring authorities implement a range of land use planning and service development measures to reduce the need to travel to urban centres from more rural areas. This includes the provision of community hubs and the review of the location of services **Cost assumptions:** Assumes cost of £100,000 per hub needed as capital investment to start with and £15,000 per annum for maintenance. Assumes investment equivalent to 20 hubs are implemented in each metropolitan area over 2010-2022 period, resulting in approx. £35.4 million across the metropolitan areas for the 2010-2022 period
Review location of proposed new developments to reduce need to travel	**Deliverability**: medium **Responsibility**: LAs	**Cost neutral**	**Measure proposed:** Local authorities, working in partnership with ITAs/PTEs, use their planning powers to ensure that half of all new developments achieve Eco-Town standards in terms of mode share
Urban density increases (residential and business)	**Deliverability**: medium **Responsibility**: local authorities	**Cost neutral**	**Measure proposed:** Local authorities use their planning powers to increase housing density in urban centres. **Note:** increases in density would potentially result in increase land costs in urban areas

4.1.3 Summary of top abatement measures

Table 4.5 below presents a summary of the assessment of individual interventions in terms of their abatement potential and cost (investment and operational costs for public sector only). High and medium abatement potential and neutral or low costs are highlighted in green.

Table 4.5: Summary of abatement and cost assessment

Interventions	Abatement potential (2022)	Cost
More efficient vehicles and low carbon vehicles		
Public sector procurement of low carbon vehicles for own fleet	**Low**	**Low**
Support to take up electric/pug-in hybrid vehicles (cars and vans mainly) through provision of charging points and/or financial incentives	**High**	**Medium**
Improvement in bus fleet efficiency	**Low / Medium**	**High**
Support to taxi/private hire for switch to more efficient/low carbon vehicles	**Low**	**Low**
Rail electrification (focus on local rail)	**Low**	**Medium**
Rail efficiency, including increased use of regenerative braking on trains	**Low**	**Cost neutral**
Lower carbon fuels		
Producing low carbon energy from the transport network/assets	**Low**	**Low**[128]
Traffic management		
Active/improved traffic management	**Low**	**Medium**
Stricter enforcement of speed limits	**Medium**	**Medium**
Road surfaces designed to reduce fuel consumption	**Low**	**Low**
Efficient driving practices		
Driving training programme (eco-driving) & awareness campaigns	**High**	**High**
Freight efficiency through operational improvements	**Low**	**Low**
Providing attractive low carbon alternatives		
Provision of improved cycle infrastructure	**High**	**Medium**
Provision of improved walking infrastructure	**Low**	**Medium**
Provision of improved bus/rapid transit infrastructure and services	**Low**	**High**
Provision of improved express bus and coach services for medium to long distance trips and promotion of coach use for leisure trips	**Low**	**Low**
Replacement of some existing conventional bus services by smaller community transport services and demand responsive services	**Low**	**Cost neutral**
Provision of car clubs	**Low**	**Low**
Provision of improved rail services	**Low**	**Medium**
Development of rail/water freight capacity and promotion/incentives	**Low**	**Medium**
Encouraging the use of low carbon alternatives		
Public transport concessionary fares and fare subsidies (targeted groups)	**Low**	**High**
Roll-out of Smarter Choices initiatives and campaigns in targeted areas	**Medium**	**High**
Low emissions zones (LEZ – targeting HGVs and large vehicles)	**Low**	**High**
Workplace parking levy	**Medium**	**Revenue generating**
Introduction or increase in parking charges (public car parks)	**Low**	
Reducing the need to travel		
Support and investment in local services and community hubs	**Low**	**Low**
Review location of proposed new developments to reduce need to travel	**Low**	**Cost neutral**
Urban density increases (residential and business)	**Low**	**Cost neutral**

[128] Potentially revenue generating depending on installation and possibility to benefit from ROCCs or feed in tariffs

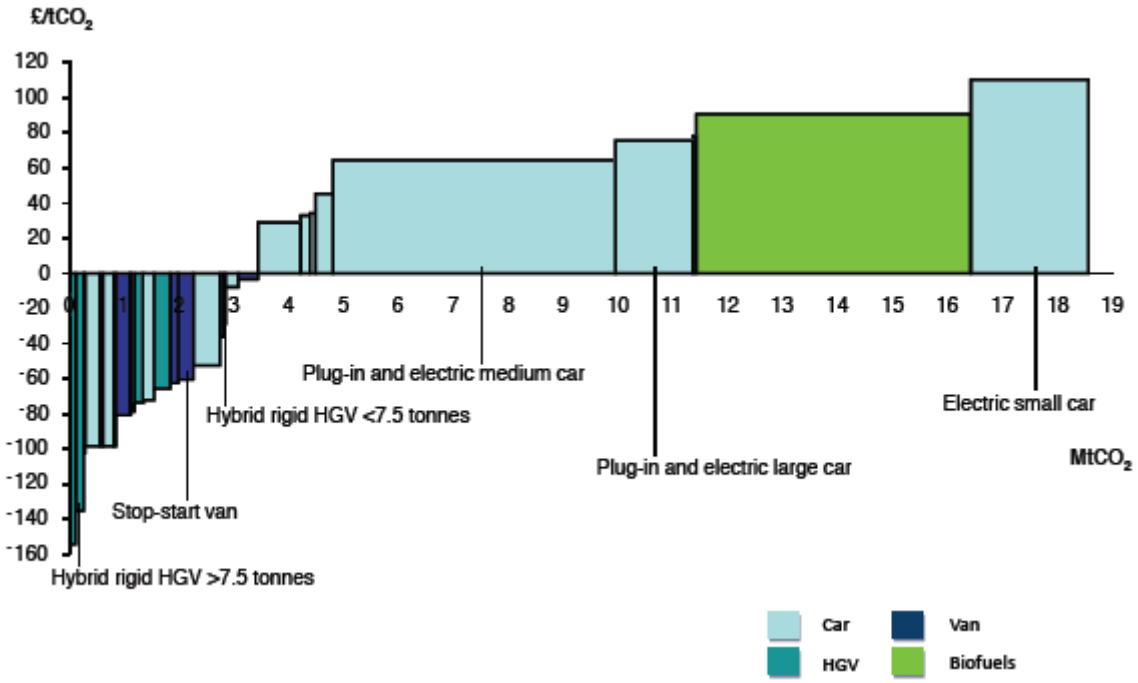
Figure 4.1 below presents a summary of marginal abatement analysis undertaken by the CCC for road transport interventions (for more information on marginal abatement analysis, see section 5.2 below). This mainly considers interventions which are to be implemented at the national or even international levels but shows the importance of vehicle efficiency gains through technology in achieving carbon emission reductions.

This is reflected in the analysis undertaken for the city regions, where **support to low carbon vehicles** achieves high levels of abatement alongside other interventions including:

- **stricter enforcement of speed limits;**
- **driver training programme (eco-driving) & awareness campaigns;**
- **provision of improved cycle infrastructure;**
- **roll-out of Smarter Choices initiatives and campaigns in targeted areas;**
- **improvements in bus fleet efficiency; and**
- **the introduction of workplace parking levy schemes (or similar demand management mechanisms)**.

It is however important to note that the assessment of the impact of individual measures needs to be considered with caution as in reality, measures would need to be implemented as packages of schemes supporting each other and this might achieve higher levels of emission savings. A scenario modelling approach also allows for potential rebound effects to be taken into consideration, as presented in the following sections.

Figure 4.1: Marginal abatement cost curve for road transport (2020, social perspective – source: CCC[129])



[129] Building a low carbon economy – the UK's contribution to tackling climate change, CCC, December 2008. A social perspective MACC includes Net Present Value calculations which use the social discount rate (3.5%, in line with HM Treasury guidance) and treat taxes as transfers (i.e. consumers face social costs, as taxes paid form spending by government). This represents a typical economic analysis.

National priorities - Committee on Climate Change recommendations for transport[130]

The CCC proposes the following key indicators to assist in monitoring carbon reductions in the transport sector:

- reduce carbon intensity of new cars to 130gCO_2/km in 2015 and 95 gCO_2/km in 2020;
- 240,000 electric cars and plug-in hybrids delivered through pilot projects by 2015, and 1.7 million by 2020; and
- 3.9 million drivers trained and practicing eco-driving techniques by 2020.

These would be supported by a package of transport policies which would include:

- a comprehensive strategy for rolling out electric cars and plug-in hybrids, including a funded plan for charging infrastructure, and large-scale pilots;
- the phased roll-out across the UK of Smarter Choices to encourage better journey planning and more use of public transport; and
- a new strategy to ensure that transport and land-use planning decisions fully reflect the implications for transport emissions.

The CCC also identifies how Intelligent Transport Solutions related to speed limit enforcement could play a role in carbon reduction. This would include a greater use of speed cameras or average speed cameras and the use of Intelligent Speed Adaptation (ISA) technology. The CCC states that enforcing the existing 70mph speed limit by such means will reduce carbon emissions, with further savings possible if the speed limit was reduced to 60mph.

The Green Bus Fund in the city regions

The Government announced the allocation of Green Bus Fund grant to encourage and help bus operators and local authorities to buy new low carbon buses in December 2009. The funding aims to enable bus operators and councils to fund the up-front cost of buying low carbon buses, to encourage bus technology and to stimulate the market for low carbon buses.

Winners in the city regions include:

- Greater Manchester Passenger Transport Executive – 66 buses
- Stagecoach Manchester – 30 buses
- First West and North Yorkshire – 22 buses
- West Midlands Travel Limited (part of National Express Group) – 20 buses
- First Manchester – 14 buses
- Cumfybus Limited (Merseyside) – 13 buses
- Nexus (Tyne and Wear PTE) – 8 buses

A new £15 million second round was launched in July 2010, with proposals from bus operators and local authorities to be submitted in October 2010[131].

South Yorkshire ECO Stars Scheme

The ECO Stars Scheme (Efficient and Cleaner Operations) is a free, voluntary scheme managed by four South Yorkshire local authorities (Barnsley, Doncaster, Rotherham, Sheffield), along with the South Yorkshire Passenger Transport Executive (SYPTE), under the banner of the South Yorkshire Local Transport Plan Partnership. In addition, NHS Barnsley supports the scheme due to the potential public health benefits across all communities in South Yorkshire.

The scheme is designed to provide recognition, guidance and advice to operators of goods vehicles, buses and coaches across South Yorkshire. The scheme provides operators with support in assessing the efficiency of individual vehicles and fleets.

The scheme is open to operators of all types of commercial vehicles (light goods vehicles, heavy goods vehicles, buses and coaches), across all sectors of activity (own account, hire and reward, private and public sectors, retail, haulage, industrial, parcels, community transport, local registered bus services, longer distance coach services etc) and all sizes.

[130] Meeting Carbon Budgets - The need for a step change, Committee on Climate Change, October 2009 supported by the second CCC report to Parliament Meeting Carbon Budgets – ensuring a low-carbon recovery, June 2010

[131] Source: www.dft.gov.uk/pgr/regional/buses/greenbusfund/

4.2 Mitigation scenarios for the city regions

As previously stated, the individual interventions presented above would not in practice be implemented in isolation but rather as packages developed through city regional or local policies such as Local Transport Plans, with the support of Central Government.

This section therefore considers the impact of scenarios including the measures described above. Two scenarios were assessed. Scenario 1 considers the impact of all interventions listed above when implemented together in a coordinated manner across the city regions. Scenario 2 considers how the city regions (local authorities, ITAs and PTEs) can reduce transport sector emissions by assessing the impact of measures which would be implemented locally by city regional partners.

4.2.1 Packages will enable the delivery of greater benefits

Scenarios considered for the modelling exercise are consistent with the package approach which would be required to deliver significant cuts in emissions. The package approach is required for the following reasons:

- some measures require supporting interventions to succeed in terms of emission reduction, for example Smarter Choices aiming to achieve mode shift requires the provision of some public transport, cycling and walking infrastructure and services and measures aiming to increase the take-up of plug-in hybrid and electric vehicles will need to be supported by investment in charging infrastructure;
- a mix of measures can ensure that packages are more acceptable to the public, for example, where car parking charges might be raised but it is possible to show that the revenue is reinvested in high quality public transport or cycling infrastructure; and
- some measures might result in unintended consequences which other measures will help mitigate, for example, Smarter Choices interventions resulting in mode shift might need the support of demand management measures (road space reallocation, charging mechanisms) to ensure that the lower levels of traffic do not encourage other users to start using the car (rebound effect[132]).

4.2.2 Scenario 1 – Impact of all measures combined

Scenario 1 includes all the measures described (and assessed) in Table 4.2. Some of these measures would be implemented by the city regions, through the work of local authorities, ITAs and PTEs, and some would require interventions from Central Government (for examples where interventions modelled are assumed to be implemented on motorways and trunk roads).

Scenario 1 measures modelled as a package of interventions achieve a significant reduction in emissions from land transport in the city regions, as shown in Table 4.6 and Figure 4.2.

When compared to the business as usual scenario for the city regions in 2022, Scenario 1 achieves an overall reduction in land based tailpipe transport emissions of 23%, including:

- **a 26% reduction in car emissions;**
- **a 20% reduction in LGV emissions, reversing the trend in growing LGV emissions noted under the business as usual scenario;**
- **a 10% reduction in HGV emissions;**
- **a 37% reduction in bus emissions; and**
- **a 20% reduction in diesel rail emissions, also reversing the business as usual trend.**

[132] As noted above, the low carbon vehicle intervention modelled for this study would result in an increase of over 4% in vehicle kilometres by cars and vans in 2022 if no changes are made to fuel/electricity costs or taxation

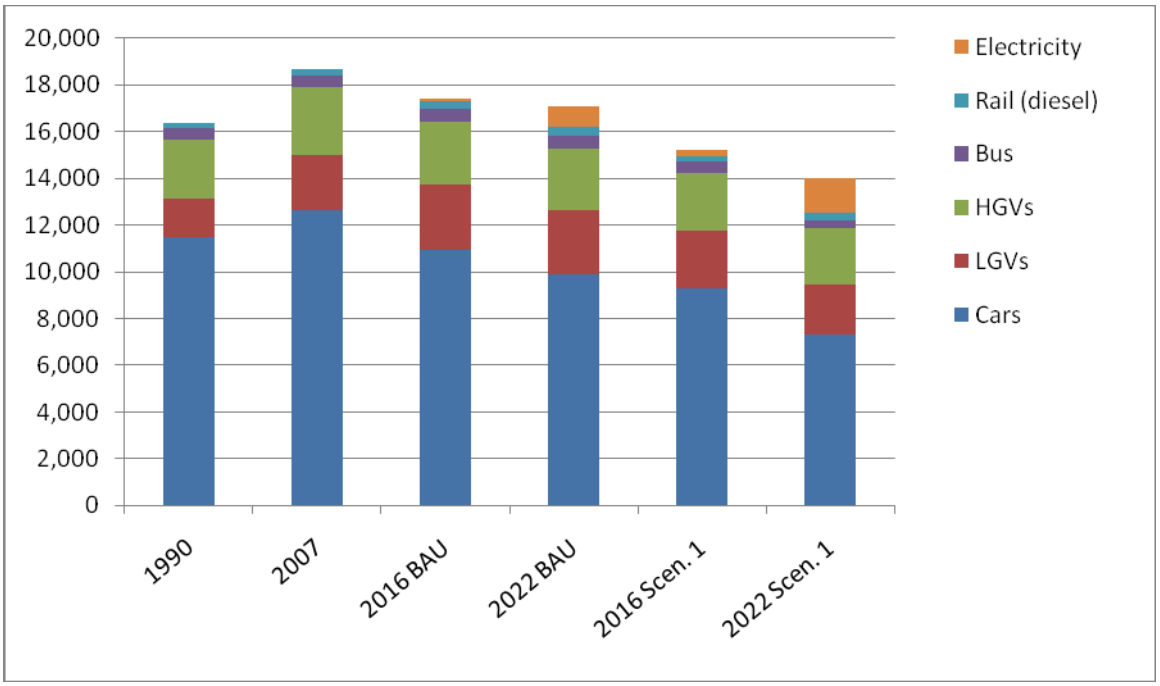
This equates to an 18% reduction in 2022 emissions between the business as usual and Scenario 1 when emissions from electricity used in land based transport (under current carbon intensity) are taken into account.

When compared to 1990 levels, the reduction in emissions when considering tailpipe emissions only **is 24% in 2022** and 15% when considering emissions from electricity used in land based transport (under current carbon intensity).

Table 4.6: Scenario 1 - land transport emissions in metropolitan areas ($ktCO_2$ per annum)

Emission source	Business as usual				Scenario 1	
	1990	2007	2016	2022	2016	2022
Tailpipe emissions						
Cars	11,462	12,633	10,948	9,892	9,296	7,296
LGVs	1,681	2,349	2,796	2,716	2,448	2,163
HGVs	2,529	2,891	2,697	2,663	2,489	2,403
Bus	477	527	527	527	460	333
Rail (diesel)	216	293	313	402	252	320
Total tailpipe	*16,364*	*18,694*	*17,281*	*16,201*	*14,946*	*12,515*
Emissions from electricity generation (assuming current carbon intensity)						
Cars	n/a	n/a	102	712	204	1,208
LGVs	n/a	n/a	35	140	65	257
HGVs	n/a	n/a	0		0	0
Bus	n/a	n/a	0		0	0
Rail (diesel)	n/a	n/a	0		6	7
Total electricity	n/a	n/a	*138*	*852*	*275*	*1,472*
Total emissions	**16,364**	**18,694**	**17,419**	**17,053**	**15,221**	**13,987**

Figure 4.2: Scenario 1 - land transport emissions in metropolitan areas ($ktCO_2$ per annum)



4.2.3 Scenario 2 – What can city regions achieve?

Scenario 2 considers the measures listed in Table 4.2 but excludes:

- changes to speed limits on motorways and trunk roads;
- changes to road surfaces on motorways and trunk roads;
- Active Traffic Management on motorways and trunk roads;
- improvements to rail efficiency and rail electrification; and
- rail service improvements which would not be implemented by city region partners.

Considering a package of interventions which could potentially be implemented by city region partners themselves, Scenario 2 achieves significant reductions in CO_2 emissions from land based transport, representing almost 80% of the reductions achieved for tailpipe emissions through Scenario 1, as shown in Table 4.7 and Figure 4.3. This shows the key role that city region partners (local authorities, ITAs and PTEs) can play in reducing land based transport sector emissions in the city regions.

When compared to the business as usual scenario for the city regions in 2022, Scenario 2 achieves an overall reduction in land based tailpipe transport emissions of 18%, including:

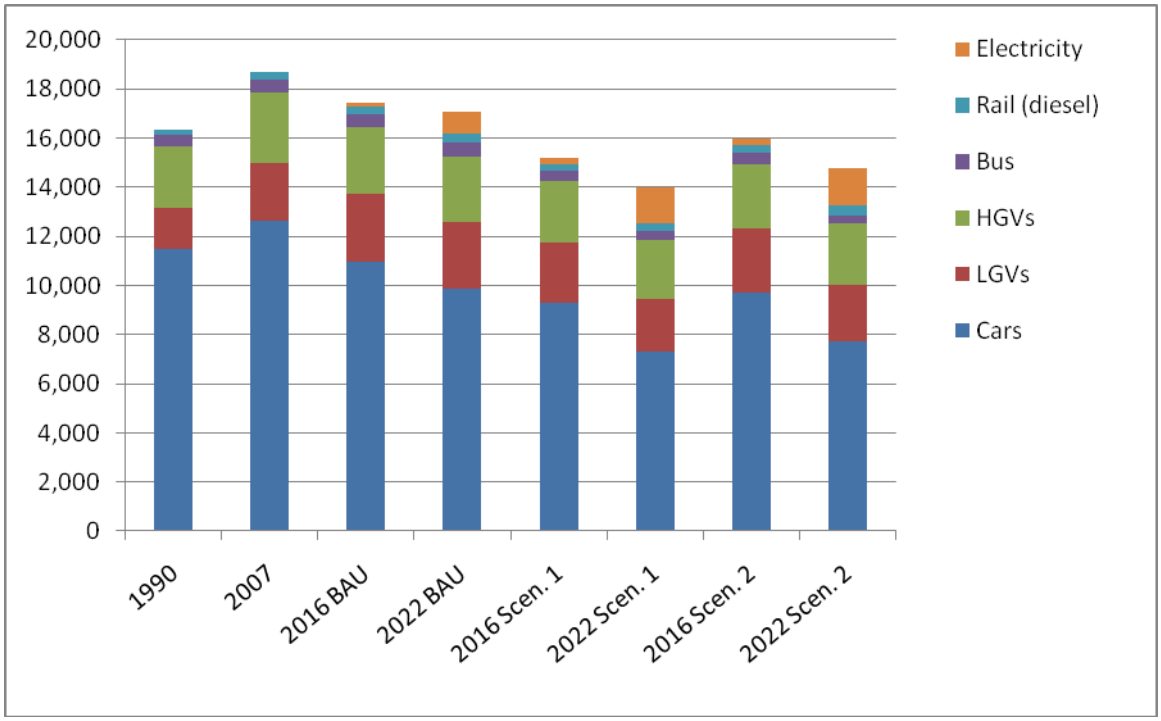
- a 22% reduction in car emissions;
- a 16% reduction in LGV emissions;
- a 5% reduction in HGV emissions; and
- a 37% reduction in bus emissions, as for Scenario 1 as these measures would be fully implemented by the city region partners, mostly through the PTEs.

Diesel rail emissions are however shown to grow by 3% under this scenario as city region partners would not be able to deliver additional rail electrification and national level efficiency savings and some transfer from road freight to rail freight would occur.

Table 4.7: Scenario 2 - land transport emissions in metropolitan areas ($ktCO_2$ per annum)

Emission source	Business as usual				Scenario 1		Scenario 2	
	1990	2007	2016	2022	2016	2022	2016	2022
Tailpipe emissions								
Cars	11,462	12,633	10,948	9,892	9,296	7,296	9,710	7,709
LGVs	1,681	2,349	2,796	2,716	2,448	2,163	2,625	2,292
HGVs	2,529	2,891	2,697	2,663	2,489	2,403	2,596	2,523
Bus	477	527	527	527	460	333	460	333
Rail (diesel)	216	293	313	402	252	320	320	414
Total tailpipe	*16,364*	*18,694*	*17,281*	*16,201*	*14,946*	*12,515*	*15,712*	*13,270*
Emissions from electricity generation (assuming current carbon intensity)								
Cars	n/a	n/a	102	712	204	1,208	211	1,256
LGVs	n/a	n/a	35	140	65	257	68	268
HGVs	n/a	n/a	0		0	0	0	0
Bus	n/a	n/a	0		0	0	0	0
Rail (diesel)	n/a	n/a	0		6	7	0	0
Total electricity	n/a	n/a	*138*	*852*	*275*	*1,472*	*279*	*1,525*
Total emissions	**16,364**	**18,694**	**17,419**	**17,053**	**15,221**	**13,987**	**15,992**	**14,795**

Figure 4.3: Scenario 2 - land transport emissions in metropolitan areas ($ktCO_2$ per annum)



These results equate to a 13% reduction in 2022 emissions between the business as usual and Scenario 2 when emissions from electricity used in land based transport (under current carbon intensity) are taken into account.

When compared to 1990 levels, the reduction in emissions when considering tailpipe emissions is 19% in 2022 and 10% when considering emissions from electricity used in land based transport (under current carbon intensity).

4.3 Mitigation timeline for the city regions

Amongst the interventions considered in Scenarios 1 and 2, **most would be possible to implement from 2010/11**, for example through LTP3, and delivery **and associated impacts would build up over the period to 2016 and 2022**. This is the case for the following interventions:

- driver training programme (eco-driving), with drivers attending a refresher course every five years;
- improvement in bus fleet efficiency;
- rail efficiency, including increased use of regenerative braking on trains;
- producing low carbon energy from the transport network/assets;
- active/improved traffic management;
- stricter enforcement of speed limits;
- freight efficiency through operational improvements;
- provision of improved cycling and walking infrastructure;
- provision of improved express bus and coach services for medium to long distance trips and promotion of coach use for leisure trips;
- replacement of some existing conventional bus services by smaller community transport services and demand responsive services;
- provision of car clubs;
- development of rail/water freight capacity and promotion/incentives;
- public transport concessionary fares and fare subsidies (targeted groups);

- roll-out of Smarter Choices initiatives and campaigns in targeted areas;
- low emissions zones (LEZ – targeting HGVs and large vehicles);
- introduction or increase in parking charges (public car parks); and
- support and investment in local services and community hubs.

Some interventions would probably require a longer lead time before implementation (linked to funding and statutory processes) or would need to be aligned with other planning timescales (for example rail planning timelines and rail franchises or land use planning timelines). This includes:

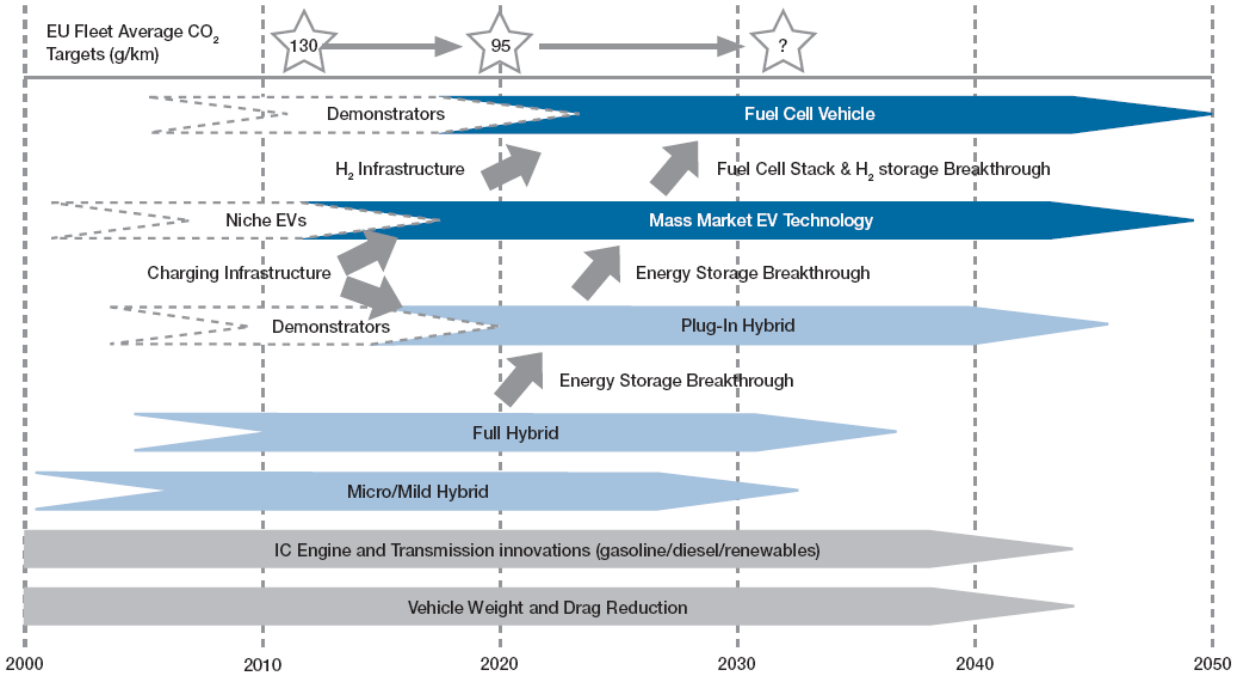
- rail electrification (focus on local rail);
- provision of improved rail services;
- provision of improved bus/rapid transit infrastructure and services;
- workplace parking levy (or similar demand management intervention);
- review location of proposed new developments to reduce need to travel; and
- urban density increases (residential and business).

Land use planning measures as well as some other interventions listed here would also result in lower transport sector carbon emissions in the longer term, after 2022.

The potential for road resurfacing activity to include consideration of new surfaces which would reduce fuel (or energy) consumption could be aligned with existing road resurfacing programme, with evidence showing that in the city regions, 39% of principal and trunk roads, 28% of non principal roads and 18% of unclassified roads would probably be resurfaced during the period 2010 to 2022.

The timeline for the roll-out of electric and hybrid vehicles as assessed by Government is shown in Figure 4.4 below. This is consistent with analysis undertaken by the Committee on Climate Change which shows that electric or plug-in hybrid cars could represent 20% of new vehicles purchased in 2020.

Figure 4.4: Technology roadmap as published in Ultra-Low Carbon Vehicles in the UK[133]



[133] Ultra-Low Carbon Vehicles in the UK, DfT, BERR and DIUS, April 2009

Vehicle fleet interventions considered in this modelling exercise include:

- support to take up electric and plug-in hybrid vehicles (cars and vans mainly) through provision of charging points and/or financial incentives;
- public sector procurement of low carbon vehicles for own fleet; and
- support to taxi/private hire for switch to more efficient/low carbon vehicles.

These measures are seen as necessary to support the take up of low carbon vehicles in the city regions and potentially achieve a higher take-up at an earlier stage when compared with the rest of the UK.

As the take-up of electric and plug-in hybrid vehicles increases, the performance of some interventions, in terms of CO_2 emission reduction, reduces. As vehicles become more efficient and the electricity mix is assumed to achieve lower carbon intensity (through the use of renewable and low carbon sources), measures such as driver training, Smarter Choices or land use planning changes, which aim to reduce the number of miles driven or improve fuel consumption reduce emissions less than at the start of the period considered, when they target travel by less carbon efficient means. Another factor to consider is the impact of congested networks on tailpipe emissions, which becomes less of an issue with electric or plug-in hybrid vehicles or even with newer vehicles using stop start technology.

5. Reducing carbon emissions through non-transport interventions

Transport is not the only sector where reductions in carbon emissions can be achieved. This section considers how other sectors are contributing to emission reduction targets.

5.1 The scale of the challenge

It is important to keep the scale of the challenge in mind when considering potential interventions to achieve cuts in carbon (and other greenhouse gases) emissions. Figure 5.1 below summarises this challenge by showing:

- the total UK emissions for reference year 1990;
- the progression since 2000 (in red);
- the first three carbon budgets (in green); and
- the 2050 target (in yellow) as adopted by the UK under the 2008 Climate Change Act.

The 80% reduction target adopted for 2050 means achieving a reduction from 776.2 $MtCO_2e$ emitted in 1990 to 155.24 $MtCO_2e$ in 2050.

Figure 5.1: UK GHG emissions and carbon budgets ($MtCO_2e$, source: DECC)

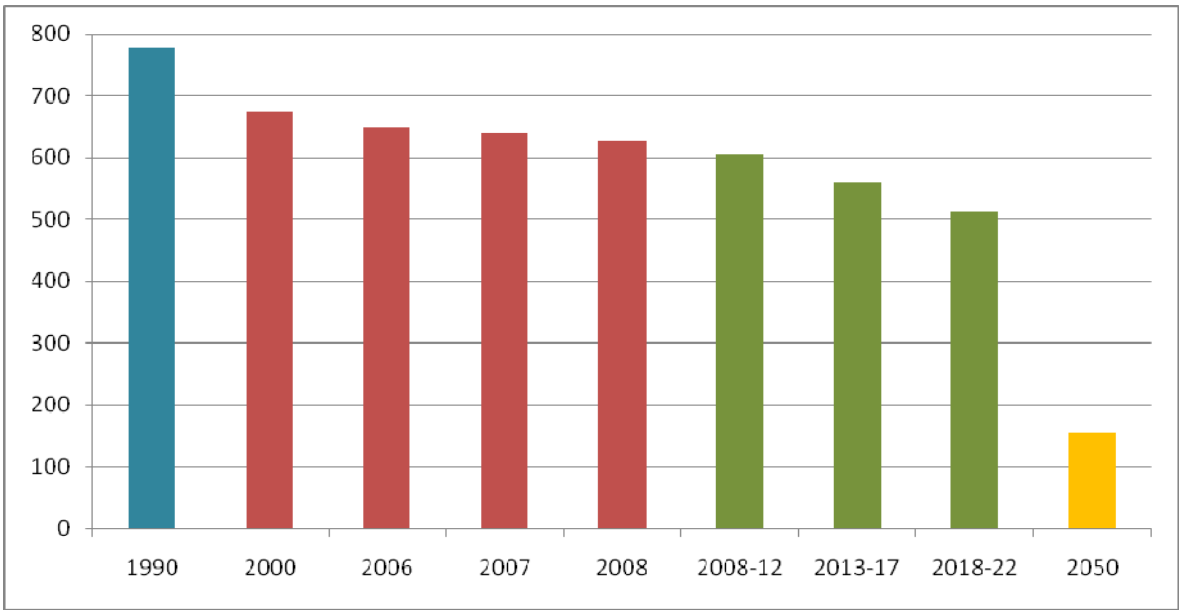


Figure 5.2 and Figure 5.3 show how the different sectors of the UK economy contribute to current levels of emissions by source sector and by end user sector respectively.

The largest contributor by source is the energy sector (219.7 $MtCO_2e$ in 2008), followed by the transport sector. In 2008, the transport sector represented 131.9 $MtCO_2e$ by source and 149.9 $MtCO_2e$ when emissions were considered by end user sector. This is the equivalent of 85% of the 2050 target for the UK (97% by end user sector).

When considering emissions by end user sectors, the largest emitting sector is the business sector (192.7 $MtCO_2e$ in 2008), followed by the residential sector (153 $MtCO_2e$ in 2008) and the transport sector. These three sectors contributed 79% of UK greenhouse gases in 2008.

This analysis clearly shows that in order to achieve an 80% cuts in emissions by 2050, very significant savings will be required across the business, residential and transport sector. When considering the source of emissions, it is clear that "decarbonisation of the power sector is key to achieving emissions reduction targets", as stated by the Committee on Climate Change in its 2008 report[134].

Figure 5.2: UK GHG emissions by source ($MtCO_2e$, source: DECC)

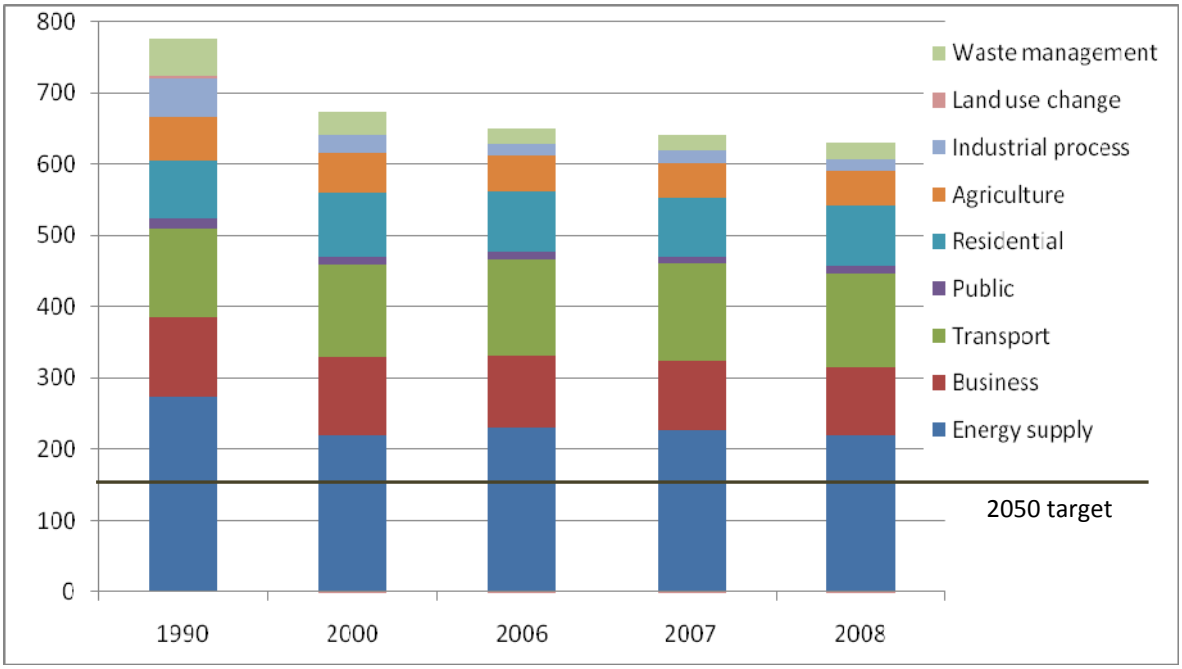
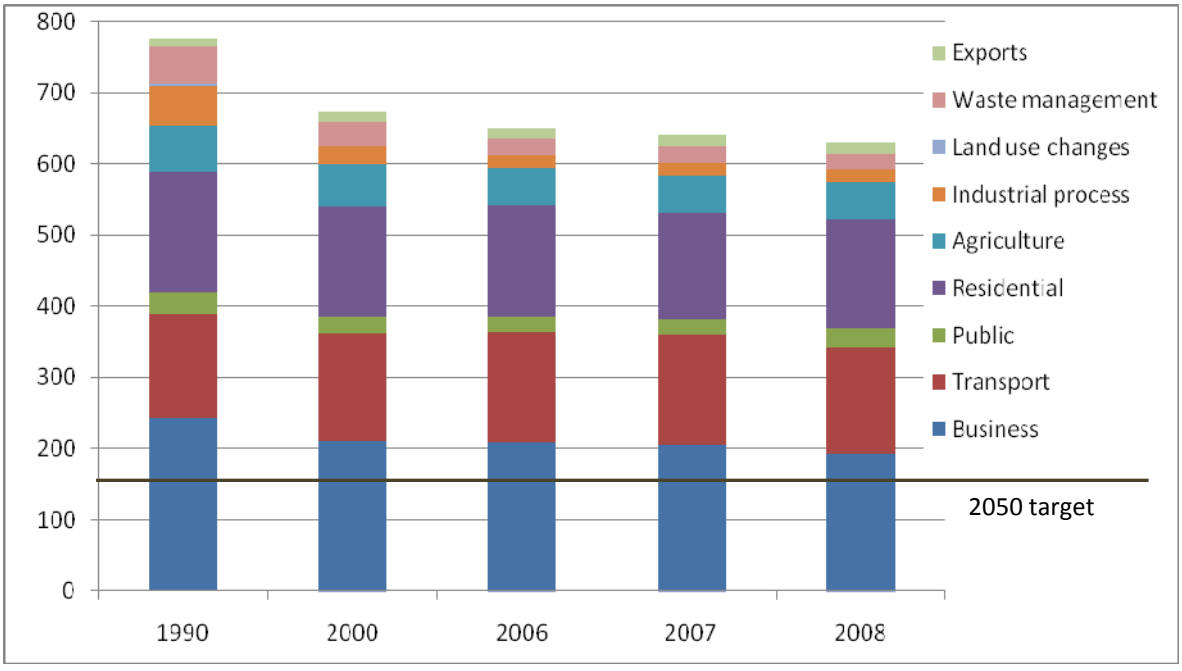


Figure 5.3: UK GHG emissions by end user ($MtCO_2e$, source: DECC)



[134] Building a low-carbon economy, the UK's contribution to tackling climate change, Committee on Climate Change, 2008

5.2 Comparing transport sector interventions with interventions in other sectors

To compare the cost and abatement potential across sectors, the Committee on Climate Change produced Marginal Abatement Cost Curves (MACCs) one of which was reproduced in the UK Low Carbon Transition Plan Analytical Annex and is shown in Figure 5.4.

MACCs allow various interventions to be compared on the basis of:

- their overall potential for reducing carbon emissions, represented on the horizontal axis, with the width of the bar representing the amount of emissions saved; as well as
- their cost effectiveness, with the vertical axis representing the cost per tonne of CO_2e saved. In this case, the total cost taken into account includes the cost to users and consumers, resulting in some interventions showing a negative cost due to savings accrued by users and consumers. This is for example the case for eco-driving training where a small initial investment in the cost of a training course is rapidly offset by fuel cost savings experienced by the driver.

Figure 5.4: Marginal abatement cost curve in the non traded sector (Source: CCC 2008)

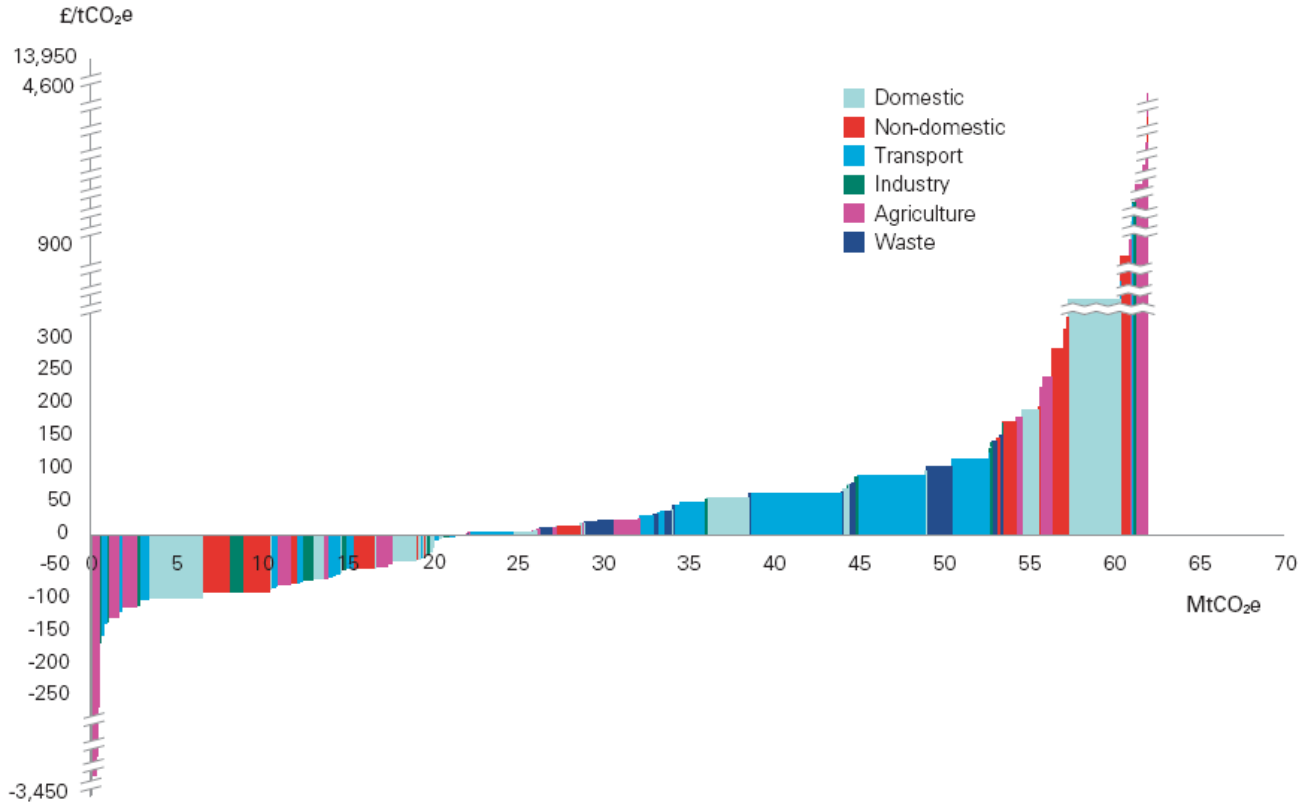


Figure 5.4 shows how a range of transport sector interventions assessed by the CCC perform against various interventions in other sectors. It clearly shows several transport sector interventions with a negative overall cost and some impact on emission levels overall although transport sector measures which deliver the largest carbon emission savings appear to cost in the range of £0 to £150 per tonne of CO_2e saved.

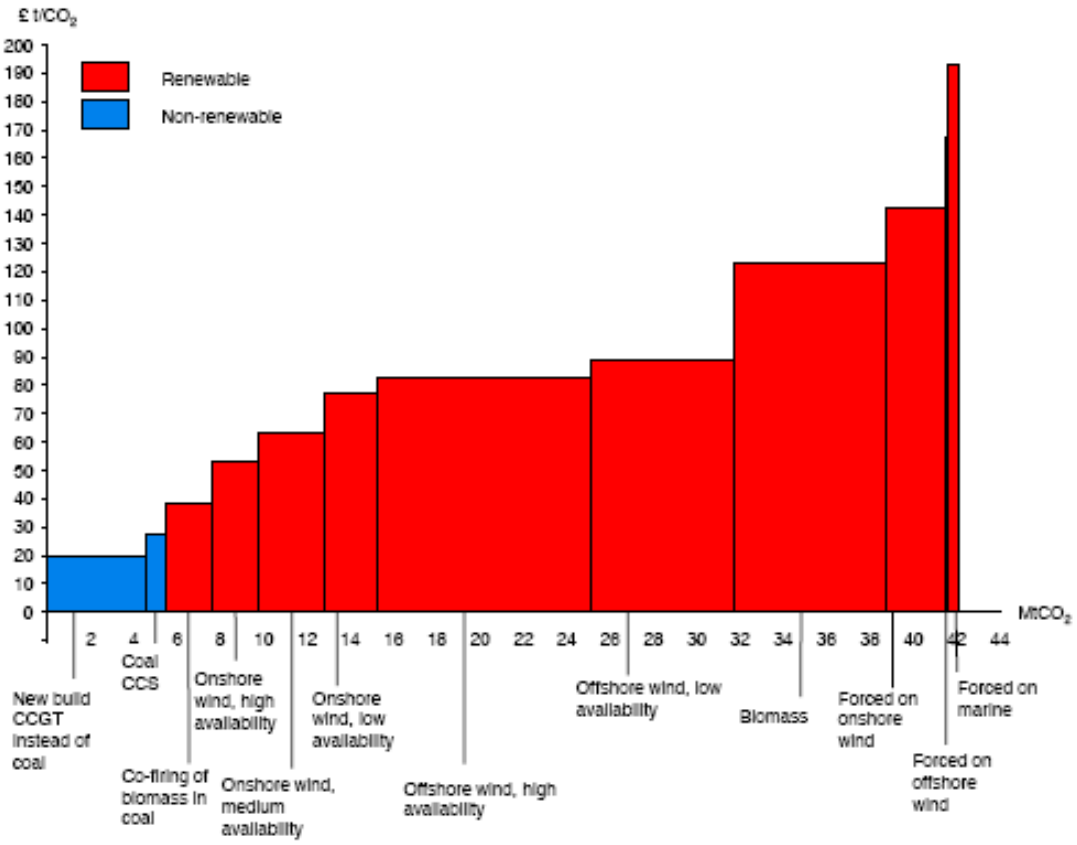
This shows that many transport sector interventions are at least as cost effective as interventions in other sectors, reinforcing the argument for action in the transport sector alongside other sectors to progress towards the challenging Climate Change Act targets.

Figure 5.5 presents a more detailed MACC for the power sector, as included in the CCC's 2008 report[134]. This illustrates abatement potential and cost per tonne of CO_2e saved for a range of power sector interventions under the CCC's Scenario 1. This scenario assumed the full success of the UK Renewable Energy Strategy, achieving in excess of 30% electricity from renewables by 2020, with one CCS demonstration coal plant by 2014 and no new conventional coal build

(through carbon pricing). This shows power sector interventions have the potential to achieve significant cuts in CO_2 emissions, at a cost ranging from £20 to £200 per tonne of CO_2 saved which reflects the significant level of investment required to build renewable energy production capacity in the UK.

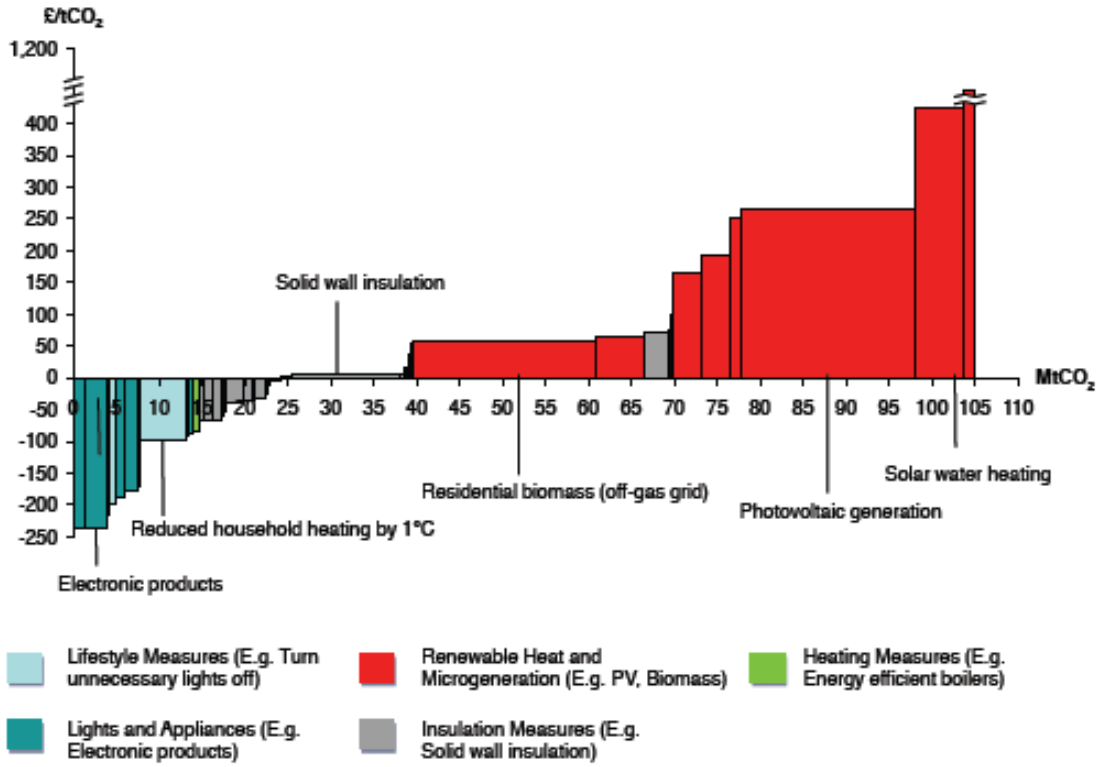
Figure 5.6 shows a similar analysis as undertaken by the CCC for its 2008 report[134] for residential sector interventions. This shows how changes to product specifications and lifestyle measures (such as reducing heating in houses) can achieve significant cuts in emissions whilst resulting in a financial benefit for the user. The significant abatement potential of insulation measures, at a relatively low cost, is also highlighted. MAC curves for road transport measures assessed by the CCC in 2008 are included in Section 4.1.

Figure 5.5: Power sector MACC (CCC Scenario 1, Source: CCC 2008)[135]



[135] CCGT: Combined Cycle Gas Turbine. CCS: Carbon Capture and Storage. 'Forced on' plant refers to plant which is built despite the existence of enough generation capacity on the system (e.g. to meet a target). It therefore displaces existing plant rather than new plant.

Figure 5.6: Residential sector MACC – technical potential in 2020 (Source: CCC 2008)



5.3 How will other sectors contribute?

5.3.1 The UK Government Low Carbon Transition Plan

The UK Government published its Low Carbon Transition Plan in 2009. The Plan aims to reduce UK emissions by around 700 $MtCO_2e$ for the 2008 to 2022 period, as shown in Figure 5.7.

Interventions planned to achieve this level of savings include:

- the EU Emission Trading Scheme (for traded sectors, aiming to achieve savings of 402.9 $MtCO_2e$ between 2008 and 2022);
- transport sector measures (saving 111.5 $MtCO_2e$ over 2008-2022 period) including
  - low carbon emission standards for cars and vans (EU regulation) and complementary efficiency measures for cars,
  - additional use of renewable fuels (10% by energy by 2020),
  - low carbon buses and SAFED training for bus drivers;
  - low rolling resistance tyres for HGVs;
  - rail electrification (and efficiency measures summarised in Figure 5.8);
- interventions targeting households emissions (saving 85.9 $MtCO_2e$ over 2008-2022 period) such as domestic energy efficiency package, product policy, Zero Carbon Homes, smart-metering and better billing and Community Energy Saving Programme;
- measures for business and the public sector (saving 24.5 $MtCO_2e$ over 2008-2022 period) including “non-energy intensive business and public sector package”, one-off interest free public sector and SMEs loans, product policy, Energy Performance of Buildings Directive (EPBD) and smart-metering for SMEs, as well as “energy intensive business package”;
- renewable heat (saving 54.4 $MtCO_2e$ over 2008-2022 period);
- increased landfill tax, diverting food waste and wood away from landfill (saving 5.8 $MtCO_2e$ over 2008-2022 period); and
- interventions targeting the agriculture sector (saving 15 $MtCO_2e$ over 2008-2022 period) through crop management and fertiliser use, enteric fermentation and methane and manure management.

The policies modelled for the Low Carbon Transition Plan place the emphasis on reductions in emissions from the power and industry sectors (traded sectors) followed by a significant contribution from the transport sector. The Plan notes however that policies need to remain flexible and market based to encourage the take up of the lowest cost measures by harnessing individual investment decisions.

Figure 5.7: UK Low Carbon Transition Plan, impact of package of policy measures on UK GHG emissions ($MtCO_2e$, Source: UK Low Carbon Transition Plan, DECC)

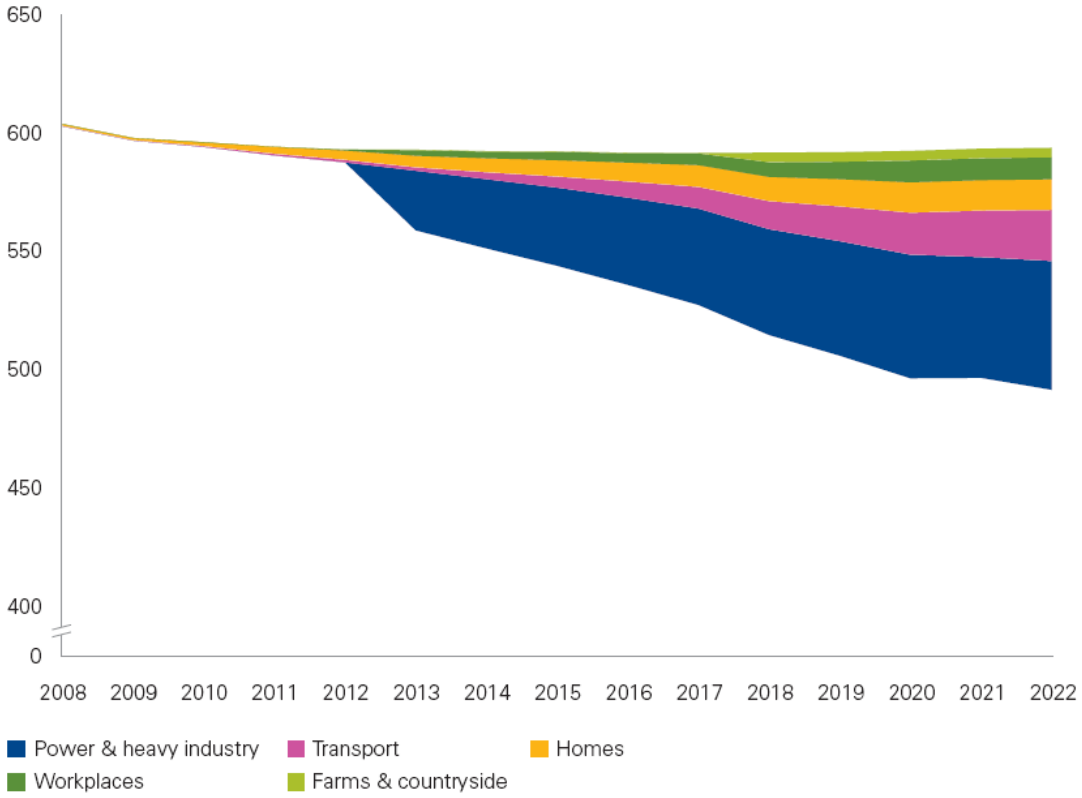
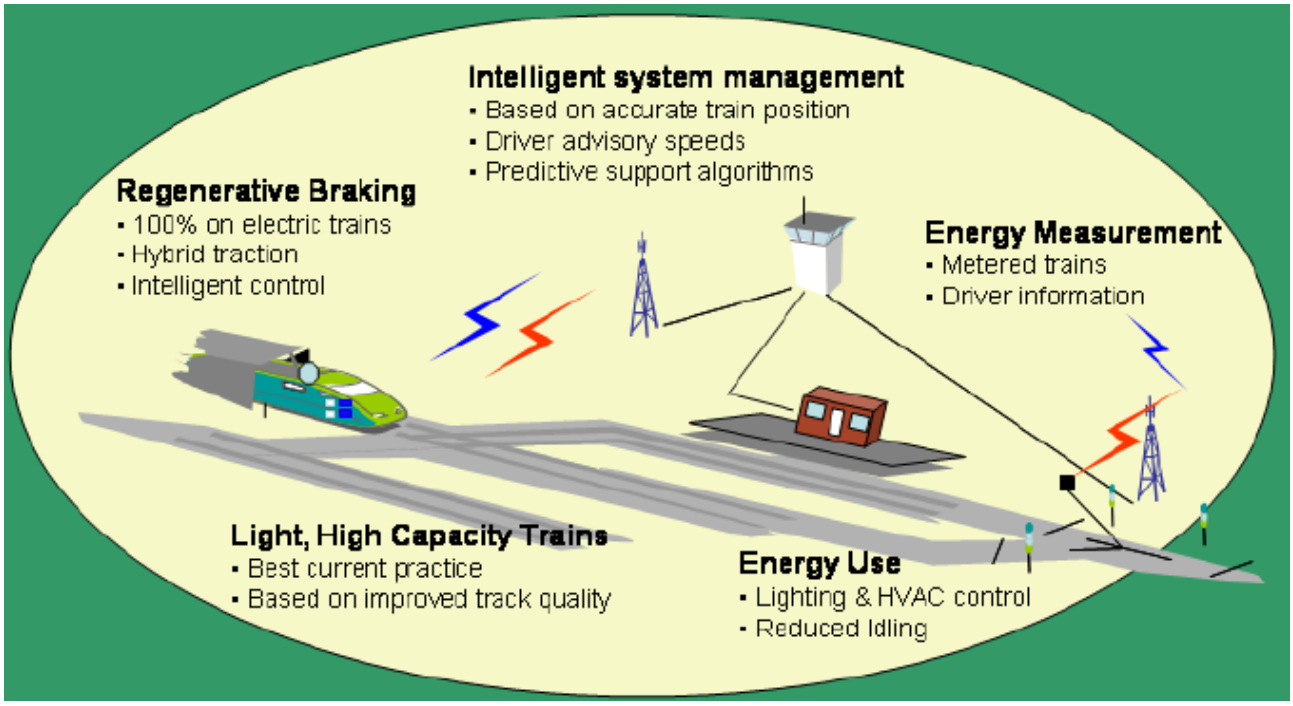


Figure 5.8: The low carbon railway of the future[136]



[136] Source: Rail Transport Submission to the Committee on Climate Change, May 2008

5.3.2 Advice from the Committee on Climate Change

In its 2009 report to Parliament[137], the Committee on Climate Change (CCC) notes that *"emissions reductions in recent years have been very modest. Going forward, a step change is required if carbon budgets are to be achieved"*.

The CCC sets a list of indicators and "required policy strengthening to deliver budgets" including:

- **power sector** policy strengthening and milestones
  - wind generation - key decisions on power transmission access and investment by 2010;
  - nuclear generation - key outstanding policy milestones include: issuing a national policy statement by 2010, approval of first planning applications by 2011 to allow commencement of construction by 2012/13;
  - Carbon Capture and Storage (CCS) generation - the Government should announce now that a financing mechanism to support roll-out will be put in place following the demonstrations (e.g. no later than 2016) and provide a very clear signal now that the role for any conventional coal plant remaining beyond the early 2020s would be very limited.
  - power market reform - options to strengthen incentives for investment in low-carbon technologies (e.g. carbon price underpin, low-carbon obligation, emissions performance standard, etc.) should be seriously considered.
- **buildings and industry**
  - new approach to efficiency in residential buildings developed in 2010-2011 for implementation from 2012, based on a whole house approach, a street by street neighbourhood approach with a delivery role for local government in partnership with energy companies, an appropriate balance between 'pay as you save' and subsidised funding;
  - renewable heat, with the introduction of a Renewable Heat Incentive;
  - energy efficiency improvement in the non-capped sectors, including all non-residential buildings to have an Energy Performance Certificate (EPC) in place by the end of the second budget period, minimum ratings set for all non-residential buildings, roll-out of Display Energy Certificates (DECs) to all non-residential buildings and additional support to SMEs;
- **transport** policy strengthening
  - policy for new cars to incentivise the purchase of low carbon cars, with Government-sponsored pilot projects to aim to achieve 240,000 electric cars on the road by 2015 on the way to 1.7 million by 2020;
  - roll out of Smarter Choices; and
  - integrated land use and transport planning, targeting the 3 million new houses which will be built in the UK in the period to 2020.

Although most of the measures included in the UK Low Carbon Transition Plan are national initiatives, the advice from the CCC includes more measures which although initiated at the national level will require local delivery. At the local level, partners are also starting to work in an integrated manner to reduce carbon emissions across several sectors through partnership working and local community programmes.

[137] Meeting Carbon Budgets, the need for a step change, Progress report to Parliament, Committee on Climate Change, 2009, supported by the second CCC report to Parliament Meeting Carbon Budgets – ensuring a low-carbon recovery, June 2010

Advice on sectoral action in the North East

AEA undertook the North East Greenhouse Gas Emissions Study on behalf of the North East Regional Assembly in 2008. The study notes key areas for action at the regional and local levels.

"*The emissions performance of existing dwellings will largely determine the extent of further emissions reductions. The current Action Plan priorities to tackle sustainable communities and regeneration are aligned very closely with a vigorous approach to emissions mitigation in the existing domestic stock. Their scale and scope must be greatly increased for them to be commensurate with the scale of the challenge.*

The Regional Economic Strategy is also the appropriate home for further, and faster, regional action on industrial CO_2 emissions. Programmes such as the Energy Resource Efficiency programme and its forthcoming replacement activity are an appropriate response to these challenges. This area of activity must be seen as a key priority for the region.

In the face of rising road transport emissions and uncertainty over the policy approach at national level there seems to be a clear opportunity for the North East to strengthen its resolve to transport emissions reductions. The current suggested CCAP action to "Research, develop and implement large-scale H_2 fuel cell systems" is illustrative of the type of initiative that could add strength and vision to the region's response to road transport emissions. In addition the region should be seeking to increase the profile and effect of other transport policy actions such as modal shift, which will have positive effects on emissions and a variety of other policy goals, such as obesity and accessibility".

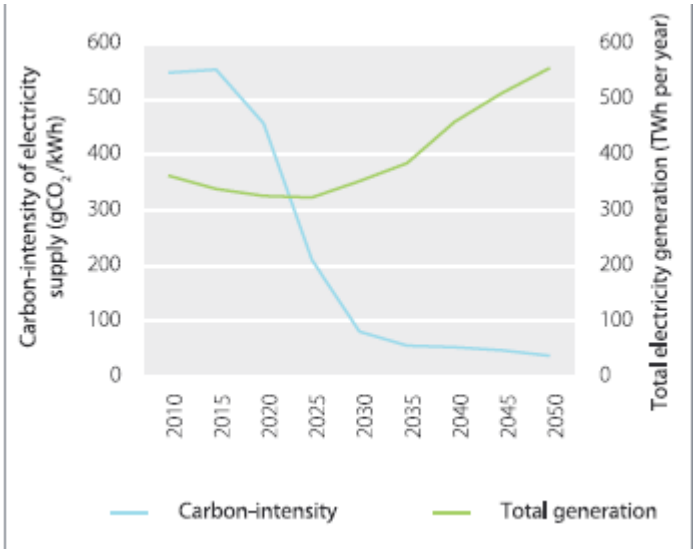
5.4 Transport depends on improvements in the power sector

As shown in Section 4.2 above (see Table 4.7 and Figure 4.3), by 2022, more than 10% of land based transport sector emissions in the metropolitan areas could be transferred to the power sector as more electric vehicles are used.

This assumes that the carbon intensity of the energy used by these vehicles remains at its current levels and could therefore represent a much smaller portion of land based transport emissions if the power sector is able to provide significantly more low carbon energy over the next 10 years.

Forecasts from the CCC shown in Figure 5.9, anticipate a very strong fall in carbon intensity for the electricity used in the UK, from approximately 550 gCO_2/kWh in 2010 to less than 50 gCO_2/kWh in 2045. This decline is however not forecast to start before 2015 as the power sector requires time to develop and implement renewable and low carbon energy infrastructure.

Figure 5.9: Declining carbon-intensity and increasing generation of electricity to 2050 (Source: CCC[138])



[138] Meeting Carbon Budgets, the need for a step change, Progress report to Parliament, CCC, 2009

5.5 Integrated approaches to emission reduction

This section considers how the transport sector could contribute to renewable energy production and management before presenting a few examples of integrated approaches to emission reduction.

5.5.1 How can the transport sector support low carbon energy?

Activities conducted within the transport sector can contribute to reduction in emissions which would be attributed to other sectors, principally the energy sector. Two possible contributions from the transport sector are considered here in the form of renewable energy generation using transport infrastructure and potential support to grid management through the use of electric and plug-in hybrid cars in the future.

Renewable energy generation

Some transport infrastructure, existing or in development, could be suitable to support renewable energy generation.

Some Park & Ride sites already include small scale wind power generation, often as required through the planning process in the local area. An example is the Sandon Park & Ride in Chelmsford where a 6kW turbine has been installed which saves an estimated 4.1 tonnes of CO_2 per annum by generating approximately 10,000kWh of electricity (around 12% of the site's power consumption). The site at Sandon, also uses an underground heat source pump to provide the hot water and heating in the terminal building[139].

It is however possible to envisage Park & Ride sites being used to contribute more significantly to renewable energy generation by installing medium scale wind turbines if the location is judged suitable. For example, a 500kW wind turbine would typically generate from 800 to 1000 MWh per annum (dependant on the site, turbine location, tower height and local wind conditions).

Based on currently available data for the new Nissan Leaf electric vehicle, one 500kW wind turbine would produce enough energy per annum to run approximately 400 Leaf electric cars (based on an average of 10000 miles per car per annum) or provide electricity for around 230 typical UK households.

To give a sense of scale, a 500kW turbine would typically be mounted on a 40 to 50 metre tower and have a 60 to 75 metre maximum tip height. Such a turbine would be well rewarded through the forthcoming feed in tariffs starting in April 2010[140].

As a comparison 500kW of solar photo voltaic installation would require around 4000m^2 (dependant on technology type/PV efficiency) and would generate approximately 375 MWh. This would generate enough energy to run approximately 150 Leaf electric cars or around 80 typical households (based on 4500kWh/annum).

Supporting grid management

In 2008, the King Review of Low Carbon Cars[141] identified plug-in hybrids and electric cars as major contributors to the decarbonisation of road transport over the medium to long term. Demand on the grid for other uses, considered with the current carbon intensity of electricity depending on time of day mean that the best time for electric vehicles to be charged would be in the off-peak period, when there is spare capacity (through Smart Grid technology). Measures will therefore need to be implemented to encourage charging during off peak periods, potentially through smart-metering. These measures would also help to spread the electricity demand more evenly over the day, reducing the need for excess generation capacity.

Vehicle to grid technology (V2G) is also being considered where the electricity grid would be able to tap into power stored in the batteries of hybrid and electric vehicles to balance fluctuations in

[139] Source: Essex County Council, 2009
[140] Above 500kW will not really benefit beyond existing Renewables Obligation Certificates (ROCs)
[141] The King Review of Low-Carbon Cars Part II: recommendations for action, March 2008

demand and supply. This ability would become more important as the share of renewable energy increases with some sources fluctuating with weather conditions. The University of Delaware is currently experimenting with such a system, with three electric cars connected to the grid[142]. V2G could also potentially make the purchase of a hybrid or electric vehicle more attractive as owners who plug their vehicle into the grid could be financially rewarded.

5.5.2 Integrated approaches to emission reduction

Integrated approaches to emission reduction at the local level, aiming to achieve savings across sectors, are being encouraged by Government through the Low Carbon Community Challenge (DECC) and the Local Carbon Frameworks (DCLG). Some local communities are also developing their own cross-sector carbon reduction programmes, for example through the Transition Towns movement. These integrated approaches could potentially deliver higher levels of emission savings by encouraging and facilitating significant changes in overall behaviours within communities.

Low Carbon Community Challenge

The Low Carbon Community Challenge (LCCC) is a two-year research programme launched by DECC in February 2010[143]. The programme is designed to test delivery options for achieving ambitious cuts in carbon emissions at community level by providing financial and advisory support to 20 test-bed communities. Amongst the communities selected for the programme, many have chosen to focus on home insulation and renewable micro-generation initiatives but some also chose a more holistic approach, considering carbon savings to be achieved across sectors in their local area, as shown by the three examples described below[144].

Reepham, Norfolk

LCCC funding will allow Reepham to reduce its CO_2 emissions by 127 tonnes per year by using a community fund to deliver a comprehensive range of projects which target; energy efficient renovation, renewable generation, transport, behavioural change & food initiatives.

The programme includes the development of a local community car club which has now been extended to Norwich as well as a trial of biofuels for domestic boilers and the Reepham Insulation Project (R.I.P. CO_2).

Lammas Low Impact Initiatives Ltd, Glandwr, Pembrokeshire

The focus of the LCCC funded programme is a community hub building which will become a hub for the village and a centre for education on low impact living for the wider world. This is to be delivered as part of an eco-village also including 9 eco-smallholdings and a campsite

Hook Norton, near Banbury, Oxfordshire

The LCCC funding will support the 2,500 strong local community to:

- install a heat recovery system, and solar panels as well as a ground source heat pump at the local primary school;
- provide interest free loans for a whole-house retro-fit of six homes;
- insulate 40 homes and install solar thermal panels on a further 20;
- acquire two community electric pool cars; and
- put a bio-diesel tank in the local brewery to supply bio-diesel fuel for the vehicles of 50 households.

[142] Source: University of Delaware, March 2010
[143] Potentially subject to review by the Coalition Government following the May 2010 General Elections
[144] Source: DECC, March 2010

Local Carbon Frameworks

The Department of Communities and Local Government (DCLG) recently announced the Local Carbon Frameworks trials with nine local authorities and partnerships[145]:

- Bournemouth, Poole and Dorset Multi-Area Agreement (MAA);
- Haringey;
- Manchester;
- Nottingham;
- Plymouth.
- Bristol;
- Leeds City Region;
- Northumberland;
- Oxford; and

The potential for local authorities to go further than their current responsibilities around climate change was proposed in the Strengthening Local Democracy Consultation. The document made the case for using greater opportunities for local leadership on climate change to put local government at the heart of high quality, innovative public services.

Authorities taking part in the trials will be expected to:

- set out a clear set of targets for action and a route for progress and milestones;
- develop a clear evidence based strategy for how carbon reductions can be achieved;
- produce a delivery plan involving all partners, including those outside the formal strategic partnership.

Plans might set out what action is needed on issues spanning recycling, energy efficiency, wind power, transport and more. These plans will be set out in a prospectus to be negotiated and agreed with Government, with the councils taking forward the delivery and reporting on their achievements. Local authorities will also be able to use their prospectus to set out an 'ask' of Central Government, to secure additional help and support, although Councils are expected to maximise the use of their existing freedoms and flexibilities.

Transition Towns – an example of a community led initiative

Transition Towns/Initiatives are initiated by communities who decide to work together over the issues of peak oil and climate change. The work undertaken by the groups generally include[146]:

- awareness raising around the issues and principles of the transition model;
- connecting with existing groups within the community, local government and other Transition Initiatives;
- forming groups to consider the key areas of food, energy, transport, health, quality of life, economics and livelihoods; and
- launching an Energy Descent Action Plan (EDAP) over a 15 to 20 year timescale, defined and implemented by the community.

In the metropolitan areas, examples of Transition Initiatives include West Kirby and Liverpool South. The Liverpool South Initiative includes working groups on[147]:

- allotments;
- transport;
- local food;
- community composting;
- media;
- low-impact community; and
- energy;
- local economy;
- health and wellbeing.

[145] Source: DCLG, March 2010, potentially subject to review by the Coalition Government following the May 2010 General Elections
[146] Source: www.transitionnetwork.org, March 2010
[147] Source: http://transitiontowns.org/Liverpool-South/Liverpool-South, March 2010

6. Developing a strategy for transport sector emission reduction in the city regions

This section presents the different stages the city regions will need to consider when developing their carbon emission reduction strategies for the transport sector and includes examples of methodologies and tools currently used by local authorities and organisations in the UK.

6.1 Understanding the baseline and business as usual trajectories

The first step in the development of any carbon reduction strategy requires the organisation or partners developing the strategy to understand how much carbon emissions are emitted in their area and how these are emitted. It is also important to understand how these emissions would evolve in future years under a business as usual scenario and how this would compare with local, regional or national targets.

Considering how emissions will evolve in the future enables local areas to take planned growth in housing or employment into account when planning for carbon emission reduction interventions. For example, an area with strong population growth or high levels of investment planned for industry sectors or ports will show a stronger increase in future levels of emissions from the transport sector than an area where limited growth is planned.

Baseline and trajectories for the North East

AEA undertook the North East Greenhouse Gas Emissions Study on behalf of the North East Regional Assembly in 2008. The study reviews the evolution of greenhouse gases emissions across all sectors of the North East from 1990 and provides estimates of future trajectories. Key points from the study are summarised below.

"In 1990 the inventory estimates that, in the North East, the total CO_2 equivalent (based on their 'Global Warming Potential') for all six greenhouse gases was over 70 million tonnes. Over 50% of the CO_2 equivalent related to CO_2, in 1990, and the majority of the CO_2 related to industry.

By 2005 the CO_2 equivalent drops to just over 40 million tonnes, with most of the reduction coming from the industrial sector. For 2005 over 80% of the CO_2 equivalent is related to CO_2. The large decrease in emissions between 1990 and 2005 is due primarily to reductions from the industrial sector (driven by a huge drop in N_2O emissions from the Invista Redcar and Cleveland plant, as well as a number of plant closures). Other decreases come from fuel switching to gas in all energy sectors.

After 2005 decreases are seen from the residential and industrial sector (relating to switching to gas and energy efficiency). By 2020 there is little difference in total CO_2 equivalent compared to 2005. The reductions from the residential and industrial sector are offset by the increase in emissions from other sectors, mainly shipping".

In the case of the city regions, the following key factors will need to be considered:

- planned level of growth in population, housing, jobs and related economic and transport activities;
- specific focus of future growth which might result in increases in emissions (transport sector for example linked to harbour or airport activity, heavy industry, etc);
- economic trends such as increases in income which currently often translate into increases in car ownership and distances travelled.

Transport sector baseline and trajectories for the East of England

The East of England Development Agency (EEDA) commissioned Atkins to undertake the Transport and Carbon Study (TraCS) for the region in 2008/09. An important part of the study was to quantify the impact of transport on carbon emissions in the region, including consideration of road based transport as well as aviation and shipping.

The results of this analysis for 2031 show that, under a business as usual scenario, the region will experience a 33% increase in transport sector carbon emissions (from 2006 levels). This is in large part due to the strong economic and population growth planned for the region and this is reflected in the more modest increase in transport sector emissions per head over the period, from 3.1MtCO_2 in 2006 to 3.3 MtCO_2 in 2031.

EMIGMA

The Greater Manchester Transportation Unit (GMTU) was commissioned, on behalf of the Greater Manchester Local Authorities, to undertake an update of the emissions inventory for the area (EMIGMA) for a base year of 2006. The 2006 EMIGMA database covers an area of 1272 km2 encompassing the ten administrative districts of Greater Manchester. The inventory contains information on the emissions of pollutants identified in the UK's Air Quality Strategy from all identifiable sources in the area. The emissions sources are grouped into three broad categories:

- stationary point sources - predominantly industrial processes;
- mobile line sources - road, rail and air transportation; and
- area sources - other influential sources, such as domestic emissions. These sources are essentially population based and include, for example, combustion and solvent usage as well as related emissions from domestic buildings.

The database allows the magnitude and spatial distribution of emissions across Greater Manchester to be investigated and enables the relative importance of different sources of air pollution to be examined. The emissions data has a further role in providing the basis for dispersion modelling exercises and air quality management planning. In conjunction with transport models, it also provides the basis for forecasting air quality and determining the effects of changes in land use planning and transportation policies.

6.2 Monitoring progress

Any carbon emission reduction strategy will also require a monitoring process to ensure that outputs included in the strategy are delivered and that these outputs result in actual carbon emission savings for the area.

Evaluation and monitoring frameworks

Guidance on evaluation and monitoring processes design is available from DfT and other Government departments.

For example on Better Use Interventions (including cycling and walking infrastructure, bus priority and management, high occupancy vehicle lanes, traffic calming and urban traffic control, travel plans, car clubs and sharing schemes, information and marketing material), the DfT published Evaluation of Better Use Interventions - Evaluation Framework Report in October 2009[148] (prepared by AECOM).

[148] www.dft.gov.uk/pgr/evaluation/evaluationguidance/existingnetworks/frameworkreport.pdf

6.2.1 Keeping track of outputs

The need to keep track of interventions and initiatives delivered in an area, often by a wide range of organisations and partners, has been highlighted in relation to the implementation of Smarter Choices programmes at the March 2010 ***pteg*** Smarter Choices conference.

This requirement also applies to carbon reduction interventions (as well as to interventions which result in increases in emissions). Research into local authorities' approach to climate change in the transport sector undertaken on behalf of DfT in 2010[149] shows that local authorities and PTEs generally monitor interventions implemented under specific programmes (such as LTP) but that it is difficult for an authority or a city region to keep track of all programmes and initiatives which have an impact on transport sector emissions (both positive and negative) as they are often implemented by different teams or organisations and under different budgets and overarching objectives.

Some local authorities are using or planning to use the Energy Saving Trust TrACE (Tracking action on carbon emissions) tool to record CO_2 saving evidence for NI 186. The tool aims to record progress against the NI 186 target and to provide a coherent evidence base to the Audit Commission for Comprehensive Area Assessments. The Energy Saving Trust is also developing systems to combine and aggregate the data so that local, regional and national comparisons can be made and to help in the identification of good practice and national progress.

The TrACE transport input page is shown in Figure 6.1. It prompts users to identify local priorities and partnership working arrangements, as well as actions undertaken in a range of areas including behaviour change programmes and interventions, improvements to public transport and cycling infrastructure and services, demand management mechanisms such as road pricing or parking charges and new vehicle technologies.

The TrACE tool also includes pages to track actions with regard to "strategy", the domestic sector, "public sector and community", "business and industry" and "low carbon and renewable energy" and provides a useful framework for authorities to record the interventions they are implementing to address greenhouse gases emissions in the area. This might however not be sufficient to keep track of all initiatives implemented, assess or measure their actual impact on emissions and set these impacts against background trends which will influence business as usual trajectories.

6.2.2 Measuring outcomes

Most of the local authorities which have selected NI 186 (reduction in carbon emissions per head in the local area) within their set of Local Area Agreement indicators rely on local CO_2 emission data published by DEFRA to monitor progress on this indicator.

Although the reliance on this nationally produced dataset offers some advantages such as the ability to benchmark results and consistency with national emission data, there are issues linked to the dataset in its current form including:

- delays in data release mean that interventions to reduce emissions would need to take place two years earlier to show up within the data released in any given year;
- rural areas have expressed concerns with the methodology used to calculate transport emissions based on national averages, which results in very high transport emission per head in rural areas; and
- the data fails to reflect results achieved through local interventions and can sometimes be misleading if the wider context is not fully understood, for example in the case of reductions in CO_2 emissions being reported through NI186 monitoring but which might be due to the closure of important employment sites in the area rather than efficiency improvements or changes in behaviours.

[149] Local and Regional Climate Change Research, 2010, Atkins with AEA, Leeds ITS, MVA and TRL for DfT, published in July 2010 (www.dft.gov.uk/pgr/regional/policy/climatechange/)

Figure 6.1: TrACE transport input page (source: Energy Saving Trust)

Section 1 - Sector context, partnerships and supporting data	☑ Tick here to show or hide Section 1	Guidance on data entry
1 Local context, priorities and choices:		
a Describe here your key priorities for actions in the transport sector. This field can be used to provide the current and past context for the choices of activities, direction and progress illustrated in the detailed recording in section 2 below.		
2 Partnerships working on reducing transport carbon emissions		
a Does the LSP include local transport providers?		
b If yes, list the transport organisations committed to this partnership:		
c Does the LA/LSP have targets related to improving public transport and/or encouraging modal shift?		
d If yes, what is the target?		
c Does the Local Transport Plan contain policies and measures aimed to reduce carbon emissions?		
d If yes, provide brief details of these policies and measures including the timeframes for these to be implemented.		Use the details entered in strategy sheet as shown here or replace with other text instead
3 Supporting data - Local 'market research'		
a Describe your use of data and other information to aid prioritising of actions and high level monitoring of progress		Include details of surveys and data collection activities
b Is traffic routinely monitored in the LA area?		The Highways Agency, County Council may be able to provide detail of monitoring activities.
c Are different vehicle types counted separately?		
d Are travel surveys undertaken regularly (e.g. stopping travellers to ask questions about origin and destination etc)?		
e Other datasets used / comments.		

Section 2 - Detailed actions Use the tick boxes to show and hide further questions on each topic. Questions cannot be hidden once data have been entered.	Actions and results acheived for the last financial year: 2008/09	Predicted achievement in LAA period 2008 - 2011	Units (where applicable)	Guidance on data entry
1 Transport behaviour change campaign				
a Is the LA (or LSP) running a campaign aimed at the general public to promote behaviour change to reduce transport emissions?	☐			
2 Travel plans for council staff				
a Is the LA (or LSP) running an initiative to produce travel plans for council staff?	☐			
3 Travel plans for other organisations (not schools)				
a Is the LA (or LSP) running an initiative to produce travel plans for other public or private sector organisations?	☐			
4 Travel plans for schools				
a Is the LA (or LSP) running an initiative to produce travel plans for schools?	☐			
5 Travel plans for the general public				
a Is the LA (or LSP) running an initiative to produce travel plans for members of the general public?	☐			
6 Car sharing networks (lift share / car pool)				
a Does a car sharing scheme exist in the LA?	☐			
7 Car club (WhizGo, StreetCar etc)				
a Does a car club exist in the LA allowing flexible self-service car rental?	☐			
8 Public transport improvements (including park and ride)				
a Is the LA (or LSP) working to improve public transport provision in the LA area?	☐			
9 Road pricing / congestion charge				
a Has a road pricing or congestion charge scheme been implemented in the LA area?	☐			
10 Parking restrictions / carbon rated parking permits				
a Has a parking restriction / carbon rated parking permits scheme been implemented in the LA area?	☐			
11 Cycle path and footpath improvements				
a Is the LA (or LSP) working to improve cycle paths or footpaths in the LA area?	☐			
12 Cycle hire scheme				
a Does a cycle hire scheme exist in the LA area?	☐			
13 New vehicle technologies				
a Have LA or other organisation fleets been retro-fitted or replaced with new technologies (alternative fuels etc)	☐			
14 Other action in transport sector				
a Tick here to record information on an activity that cannot be described in the sections above?	☐			This may include actions related to road haulage, fuel efficient driving or infrastructure projects such as availability of LPG at garages or electric recharge points

City regions and local authorities could supplement DEFRA data by monitoring the following indicators which are closely related to transport sector emissions:

- person trip-making (via household surveys);
- vehicle kilometres, types and speeds (via household surveys and traffic counts);
- fuel sales.

In theory, each of these indicators could be used in a local calculator which could be calibrated to local conditions by taking account of local vehicle speeds on different road types as well as local vehicle fleet mix and age.

In recognition of the difficulties and limitations attached to the use of NI186 data, some local authorities had developed their own procedures in relation to the monitoring of transport sector emissions. For example, Norfolk County Council developed a CO_2 monitoring tool for its LTP2, which is based on DEFRA data for NI 186 monitoring but is adapted to account for transport sector emission savings from LTP2 policies and schemes and any changes in the composition of the private vehicle fleet in the local area. Although this approach enables the local authority to claim carbon emission savings from its transport programme, the reliability of monitoring data produced is limited as the impact of individual measures is often taken into account independently of potential rebound effects (within the transport sector or from other sectors) and background traffic growth. It also fails to account for increases in emissions potentially resulting from some LTP interventions (by providing additional capacity or failing to address rebound effects).

6.3 Planning for emission reductions

Other authorities and areas have concentrated on a different but related approach by assessing the impact of proposed policies and programmes before they are implemented. This is of particular relevance for the current DaSTS and LTP processes where transport options are being generated against the five main goals set by DfT[150] and regional goals selected locally.

The following sections present an overview of methodologies currently being used to assess the impact of individual interventions, programmes of interventions in the transport sector and across sectors.

6.3.1 Assessing the impact of individual interventions

It is important to understand how proposed interventions such as road schemes, Smarter Choices programmes, traffic management, etc will impact on local emissions, including CO_2. This enables scheme promoters and programme managers to understand the scale of carbon emission reduction (or increase) which can be achieved by implementing specific initiatives.

Most transport authorities currently developing their LTP3 policies rely on the Strategic Environmental Assessment (SEA) and Sustainability Appraisal (SA) process to undertake a qualitative assessment of the impact on carbon emissions of the proposed measures. Guidance to undertake the process is available from the DfT through WebTAG (Unit 2.11) and most authorities are anticipating to qualify environmental effects of proposed LTP policies qualitatively, using a traditional 7 point scale (from “large beneficial” to “large adverse”) although some are considering using modelling data to try to quantify the impacts.

There is often evidence available of similar initiatives implemented elsewhere and their impact on traffic levels, vehicle mix or CO_2 emissions as shown in Section 4.1.1 (Table 4.2) above. When considered with cost evidence (Table 4.4), Marginal Abatement Cost Curves (MACCs) can be developed to compare the cost per tonne of CO_2 abated and the potential for carbon reduction of each individual measure. MACCs prepared by the Committee on Climate Change are shown in Figure 5.5 and Figure 5.6 for example.

[150] Economic growth; tackling climate change; safety, security and health; equality of opportunity; quality of life and a healthy natural environment.

MACCs can be presented in different format including:

- public sector cost MACCs, which are a simplified version considering the public sector investment and running costs only but do not consider the financial impacts on the private sector or individuals (for example longer journey times or increased fuel costs);
- social perspective MACCs, corresponding to a traditional economic analysis, which include Net Present Value calculations using a social discount rate in line with HM Treasury guidance and treating taxes as transfers (i.e. consumers face social costs, as taxes paid form spending by government); and
- private MACCs, which consider private capital cost annualisation using a private weighted average cost of capital and include taxes (consumers pay the actual retail price including VAT).

MACCs provide a useful tool to develop schemes and programmes when the overarching objective is the reduction of greenhouse gases emissions. Relying on MACCs alone however can lead to the following issues:

- MACCs do not account for synergies and/or conflicts between measures and initiatives, for example, an initiative such as workplace travel planning modelled on its own would produce lower levels of mode shift and carbon emission reduction than a package of measures where workplace travel planning is supported by wider Smarter Choices programmes as well as targeted infrastructure improvements;
- MACCs account for carbon (or greenhouse gases) abatement and costs alone and do not relate to other objectives which might motivate investment in transport and land use initiatives such as economic growth or the reduction of social inequalities;
- MACCs are usually prepared for carbon (or greenhouse gases) reduction measures only and ignore other initiatives which might result in increases in emissions (for example, a MACC might be presented for a travel planning programme in an area but the context of low parking charges and increases in capacity on the road network will be ignored as it is not part of the measure assessed);
- MACCs are usually presented as the picture of various initiatives' performance for a given year/period and fail to represent the progression in emission savings and to show which measures will deliver early savings.

6.3.2 Scenario modelling

To address the potential disconnect between options under the MACC approach, some areas have opted for a scenario based approach to assessing the impact of proposed policies where packages of interventions are assessed together over a chosen period of time.

In recent research undertaken for DfT[151], local authorities in England were found to be using a variety of approaches to scenario modelling with the following distinguishing features:

- the ability (or lack of ability) to test alternative land-use scenarios;
- how future car ownership patterns and vehicle/fuel mix is taken into account (if at all);
- the ability (or lack of) to incorporate the consideration of road network speeds into emission calculations;
- the ability to model all types of interventions including behaviour change and public transport.

Some areas have used cross-sector models which include consideration of the transport sector, whilst others have developed assessment methodology focused on the transport sector before relating findings to targets and initiatives for other sectors. Studies to date have in general adopted one of the following approaches to scenario modelling:

[151] Local and Regional Climate Change Research, 2010, Atkins with AEA, Leeds ITS, MVA and TRL for DfT, published in July 2010 (www.dft.gov.uk/pgr/regional/policy/climatechange/)

- backasting - some studies start with a given target (for example the 80% reduction target by 2050 included in the Climate Change Act 2008) and identify measures and interventions required to achieve this target; and
- forecasting – where partners develop packages of interventions which could potentially be implemented in the area and use the assessment process to better understand how far this will take them in terms of carbon emission reductions.

Backcasting

Examples of recent backasting studies include the VIBAT projects conducted by a consortium of universities and private sector partners[152]. The project included a backasting study for London as well as a UK wide project.

For the UK wide project, the research team started by setting targets for 2030 and forecasting the business as usual scenario over that period. The team then described the transport system in 2030 which would meet the reduction target adopted. This allowed for innovative packages of policy measures to be developed when imagining what a low carbon future would be like. Policy packages are then assembled to show the path from the business as usual trajectory to the 2030 target.

This method allows for trend-breaking analysis to take place by highlighting the policy and planning choices to be made to reach the chosen target. It can however sometimes be difficult to present the resulting policy packages as potential policies to be adopted by stakeholders as they can seem too radical and difficult to implement in early years.

Encouraging Walking and Cycling - UK Engineering and Physical Sciences Research Council[153]

Ongoing research funded by the UK's Engineering and Physical Sciences Research Council is examining ways in which more people might be encouraged to walk and cycle in the future, what steps are needed to support this and how to improve the experience for existing users.

The initial phase of the research has looked at developing three visions or future scenarios for 2030. Two of these consider future circumstances where change from the present has been generated through choice and a desire on the part of society for alternatives to the current situation in our urban areas; the third has in part been forced upon society by external constraints, in this case a fuel crisis, so the vision represents one way in which society might choose to adapt to this circumstance.

Forecasting

Some areas are using forecasting models and tools to assess the impact of proposed measures or packages of measures on carbon emissions from the transport sector. Examples of approaches used recently or under development include:

- East of England Transport and Carbon Study (TraCS) - The East of England region used outputs from its regional transport model (East of England Regional Model - EERM) to support analysis undertaken in 2008/09 for TraCS. Outputs from the transport model represented emissions from strategic trips and the influences upon them of measures altering infrastructure and journey costs. This was supplemented by a spreadsheet model developed to reflect the influence of short trips, modes and measures not fully incorporated in EERM. Results were carefully combined to avoid double counting and take potential interactions into account;
- Bristol Highways and Transportation Carbon Model (HTCM) – currently under development, the model will use outputs from the Greater Bristol Modelling Framework (data on traffic volumes, speeds and fleet composition) to estimate the quantity and monetary cost of

[152] See www.vibat.org/index.shtml
[153] See http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/G000468/1

operational carbon emissions generated by public and private transport land vehicles under proposed transport scenarios;

- Plymouth Paramics Model - Plymouth City Council uses S-Paramics traffic flow micro-simulations to simulate a travel-to-work area extending to a radius of around 10-12 miles from the city centre. This is combined with data from a complete cordon of traffic counters and a network of air quality monitoring stations. The system can calculate robust estimates of fuel use in the different scenarios simulated, which are then converted to emissions estimates and could be used by the Council to both predict and validate emissions reductions from different measures, subject to further calibrating work being undertaken;
- Cambridgeshire LTP2 Spreadsheet Model – Cambridgeshire County Council developed a spreadsheet model to assess the impact of proposed LTP2 measures. The model takes the published DEFRA figures and TEMPRO growth predictions into account and attempts to quantify the impact of Cambridgeshire's LTP2 programme using assumptions about future changes in the vehicle fleet. The model has been used to produce 'do nothing' and LTP2 CO_2 emissions estimates, and was used to set Cambridgeshire's LTP2 road transport emission target; and
- Transport for London (TfL) CO_2 tool – TfL originally developed its Excel-based tool to model the impact of Climate Change Action Plans being developed in London. It has since been updated and has been used to look at the effect of ground-based transport policies on long-term CO_2 emissions. The tool considers savings from TfL's operations as well as emissions from road transport (including buses and taking account of vehicle speeds), rail and ground-based aviation emissions. Examples of interventions modelled through the tool include uptake of electric/hybrid vehicles/buses, eco-driving training, Smarter Choices programmes and demand management measures. Planned updates to the model include the use of new speed assumptions based upon London drive cycles, and the addition of sub-regional modelling[154].

6.3.3 Carbon footprinting and cross sector modelling

Carbon footprinting

Carbon footprinting is generally understood to include emissions associated with an activity or a product over its life cycle, meaning that embodied emissions are also taken into account. For example, with the backasting and forecasting approaches described above, the impact of transport sector interventions on the number, speeds and types of vehicles is taken into account but the emissions associated with the production of new low carbon vehicles are generally not considered. A carbon footprinting approach would aim to include these emissions in the analysis.

Carbon Footprinting of Policies, Programmes and Projects

AEA produced a review of methodologies, guidelines and available data leading to recommendations on the potential *"approaches to the carbon footprinting of PTE projects"*. The study was conducted on behalf of ***pteg*** and published in March 2009, concluding that *"there is limited off the shelf guidance or best practice for carbon footprinting the overall plans, policies and programmes of PTEs – in particular on the construction of the public transport infrastructure"*. AEA identified *"a number of ways in which the PTEs could contribute to this area: the use of a carbon calculator to assess the potential impact of schemes, the undertaking of real life case studies and procuring in a low carbon way – placing an onus on suppliers to provide information on their lower carbon activities".*

Carbon footprinting is a more comprehensive approach to estimating the impact of interventions on emissions. The drawback is that the approach requires significant levels of details with can be very time consuming and data intensive.

[154] Also see research undertaken by Leeds ITS on Personal Transport Emissions within London: Exploring policy scenarios and carbon reductions up to 2050, Harwatt, H., Tight, M., Timms, P., Institute for Transport Studies International Journal of Sustainable Transportation, April 2010

Cross sector modelling

Some studies and areas have already made use or are planning to make use of greenhouse gas emissions models which take all sectors of the economy into account. Two examples of such tools are described below.

The **Resource and Energy Analysis Program Model** (REEAP) was developed by the Stockholm Environment Institute (SEI) and includes a regularly updated database of all the carbon footprint data in the UK and a module for policy and scenario analysis, providing the following functions (for all local authorities and regions in the UK):

- footprint data by production sector;
- footprint by household consumption category;
- time series emissions data from 1992-2004 by region;
- a comparison tool across geographies;
- a composite region function to join local authorities or regions;
- update data function where baseline data can be changed; and
- future scenario creation and analysis and evaluation of scenarios and results display.

The model was used to support analysis undertaken for the Yorkshire and Humber Region in 2008.

Stepping off the gas - Achieving low carbon and sustainable transport systems in Yorkshire and Humber, SEI and JMP on behalf of the Yorkshire and Humber Regional Assembly, 2008

"This research sought to identify 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 was undertaken by modelling the carbon impact of a far reaching programme of transport investment and interventions in the period from 2011 to 2020,way beyond the scale of current practice in the region.

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."

Vantage Point is a tool for modelling carbon reduction scenarios over time developed by Carbon Descent. It has been designed specifically for local authorities to develop scenarios to inform climate change or similar strategies. The tool allows the user to:

- set baseline emissions levels for the Local Authority;
- define carbon reduction targets for a given year;
- set interim reduction targets for any number of key years on a linear or non-linear basis;
- adjust the targets to allow alterations in population growth, rates of demolition, new build and changes in transport emissions;
- analyse a mix of technologies and measures applied to transport, domestic and non-domestic buildings to achieve the targets; and
- group these mixes into reduction scenarios and compare against a number of factors such as heat and power produced by technology, CO_2 reductions and projected per capita emissions, net present value, capital costs and total gas and biomass consumption.

6.4 Recommendations for the city regions

This section formulates a set of recommendations for city regions which are preparing their transition to a low carbon economy and considering how to deliver low carbon transport.

6.4.1 Understanding the baseline and setting targets

Business as usual analysis undertaken for the city regions shows that land based transport emissions should decrease in the period to 2022, although not to below 1990 levels. Understanding how various vehicle types and trips contribute to these emissions is important for the city regions to be able to develop successful mitigation strategies. For example, the share of emissions from vans and the role of "leisure" trips are highlighted as areas for concerns.

When considering transport sector emissions, it is simpler to focus on CO_2 emissions as they form the large majority of greenhouse gases emissions. It is however important for the city regions to consider air quality issues and CO_2 reduction in an integrated manner to avoid the potential for unintended consequences. Although their influence on these emissions is limited, the city regions should also monitor and consider emissions from the aviation and shipping sectors to establish a more comprehensive picture of transport emissions in their area.

Gaining a better understanding of the transport sector baseline and business as usual trajectory will also help the city regions when developing an integrated approach to greenhouse gas emission reduction across the various sectors. This should allow authorities to set challenging but achievable emission reduction targets for the transport sector as well as the domestic and industry sectors.

NI186 monitoring data provided by DEFRA is used by most authorities within the city regions to monitor transport emissions at present although issues have been identified related to the use of this data and some areas might consider using local data to better monitor the impact of local policies on emissions in the area.

6.4.2 Investing to deliver low carbon transport in the city regions

Analysis from DECC and the CCC referenced in previous sections shows that reductions in greenhouse gas emissions are required across all sectors if the Climate Change Act and Carbon Budget targets are to be achieved.

Detailed analysis of individual transport interventions across a range of approaches including more efficient vehicles, driving practices and low carbon fuels, traffic management, the provision of attractive low carbon alternatives and initiatives aiming to reduce the need to travel shows that the most efficient interventions (amongst those modelled) in terms of carbon emission reduction from land based transport in the city regions are:

- support to the switch to more efficient, low carbon vehicles;
- provision of eco driving training;
- enforcement or reduction of speed limits (to 60 mph or below);
- roll out of Smarter Choices;
- investment in cycling infrastructure; and
- introduction of workplace parking levy (or similar demand management schemes).

This list is not definitive and many other measures including those identified through this study an also contribute to reductions in transport sector carbon emissions. If the city region partners are to deliver significant carbon savings they will need to prioritise investment towards those measures which deliver the highest savings. This might require difficult decisions as interventions required for CO_2 reduction might conflict with other city region objectives or investment in lower achieving initiatives might need to be reduced.

When the potential of the individual measures considered is assessed through scenario modelling, considering interventions as they would be implemented within a carbon reduction package, the

study shows that emissions from land based transport in the city regions can be reduced significantly, to 25% below 2007 levels (15% below 1990 levels) by 2022 (considering tailpipe emissions only). This analysis also shows the importance of the role of city region partners, as 80% of this reduction can be achieved through local and city regional initiatives.

The modelling exercise also shows that the transport sector becomes more reliant on the power sector delivering low carbon energy as the take up of electric and plug-in hybrid vehicles increases. It is important to note however that the transport sector can also support this change by contributing to renewable energy production and enabling vehicle to grid technology. Integrating transport sector interventions with initiatives in other sectors could also potentially deliver additional reductions in emissions by encouraging behaviour change across the sectors.

To decide on the best strategies for investment, city regions need to be able to assess the impact of proposed measures and package of measures on emissions in their area. This can be done with the support of (transport) models but often requires additional analysis and the use of assumptions which are not currently consistent between local authorities and city regions in the UK. The DfT is considering how this could be improved but if no support is provided by Central Government to enable a consistent carbon assessment of LTP and DaSTS options, city region partners might need to agree a common approach across metropolitan areas. This would enable benchmarking between areas as well as deliver efficiency and consistency.

North East England – The UK's first Low Carbon Economic Area for Ultra Low Carbon Vehicles[155]

The North East region has been selected to become the first Low Carbon Economic Area for Ultra Low Carbon Vehicles in the UK. This builds on the region's strength in the automotive sector: the region produces one in three of all conventional cars currently made in the UK and is home to the world's largest producer of light electric commercial vehicles – Smiths Electric Vehicles, based in Washington, Tyne and Wear.

The Electric Vehicle Accelerated Development in the North East – EVADINE project commences in 2010 with a budget of £10.7m. Running for 4 years, the EVADINE project will monitor EV use in a real-life demonstration of 35 vehicles including Nissan Leafs, Ford Connects, Smith EVs and more.

Up to 1200 electric vehicle charging points are to be created in the region which will be the first UK region with a comprehensive battery charging infrastructure.

The region is also home to the UK National Low Carbon Vehicle R&D Centre (Budget: £4.2m), The National Low Carbon Vehicle Training Centre (Budget: £8.4m), Turbine Way Business Park for EV and Ultra Low Carbon Vehicle technologies. Nissan is building its £200 million European battery mother plant in Sunderland.

6.4.3 Delivering low carbon transport in the city regions

Although the analysis undertaken shows that city region partners (local authorities, ITAs and PTEs) could potentially deliver almost 80% of the carbon reduction modelled for 2022 in land based transport emissions, this will only be achieved through strong partnership working.

The interventions modelled often combine investment in road (including walking and cycling) and public transport infrastructure alongside improvements to services, demand management and behaviour change initiatives. The mix of initiatives is important as well as the timing for delivery as city regions will need to avoid the displacement of emissions to neighbouring corridors or areas and contain potential rebound effects (arising from reduction in congestion or driving costs)[156]. Partnership work will also need to include organisations such as the Highways Agency, Network

[155] Source: ONE North East

[156] For example, the low carbon vehicle intervention modelled in Scenario 1 would result in an increase of over 4% in vehicle kilometres by cars and vans in 2022 (over 4.5% by cars and nearly 1.5% by vans) if no changes are made to fuel/electricity costs or taxation

Rail, public transport operators, airports and ports if transport sector emissions are to be managed across the area.

This partnership approach will also enable city regions to develop coordinated approaches to monitoring transport emissions across their area; potentially supplementing NI 186 data provided by DEFRA and DECC with local data using traffic monitoring information or residents surveys for example. This bottom up approach should enable improved monitoring of the effect of local initiatives on overall levels of emissions in an area as well as closer monitoring of the impact of selected interventions.