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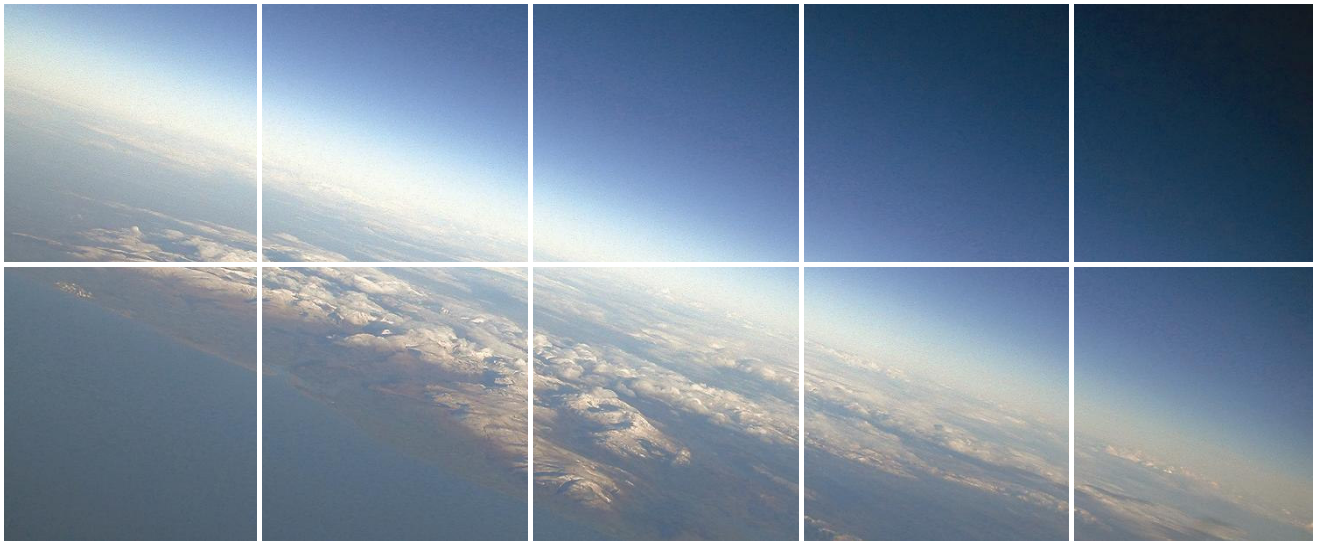

West Midlands Regional Carbon Dioxide Emissions Study

H. Peace

Report to West Midlands Regional Assembly (WMRA)

Restricted Commercial
ED43602
Final
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Customer	West Midlands Regional Assembly (WMRA)
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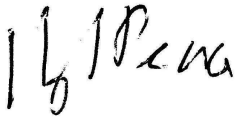
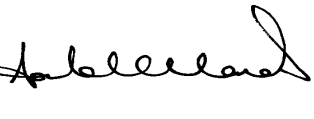
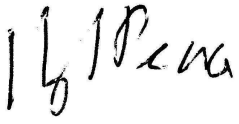
Author	Hazel Peace	
Reviewed by	Andy Lelland	
Approved by	Hazel Peace	
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Acronyms and definitions used in this report:

AEA	Abbreviated form of AEA Energy & Environment, a business name of AEA Technology plc
BERR	UK Department of Business, Enterprise, and Regulatory Reform
CCP	UK Climate Change Programme - incorporates data projections of UK greenhouse gases
C	Carbon
CAA	Civil Aviation Authority
CEH	Centre for Ecology and Hydrology
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent (i.e. GWP)
CH_4	Methane
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DTI	Department for Trade and Industry
DUKES	Digest of United Kingdom Energy Statistics
EA	Environment Agency
EU	European Union
EU EUTS	European Union Emissions Trading Scheme for CO_2 – incorporates large energy users such as industry and is likely to include aviation in the future
EWP	Energy White Paper, DTI key paper on future energy strategy
F-gases	Gases Containing Fluorine – group of greenhouse gases (HFC, PFC, SF_6)
GHG	Greenhouse gas
GOWM	Government Office for the West Midlands
GWP	Global Warming Potential of Greenhouse Gases on a 100-Year Horizon used in the UK greenhouse gas inventory (Baggott *et al.* 2007)
GVA	Gross Value Added
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
IRS	Integrated Regional Strategy (now Regional Strategy)
km	Kilometre
LA	Local Authority
LTO	Landing/Take Off Cycle (aircraft)
LULUCF	Land Use, Land Use Change and Forestry - UK Emissions by Sources (positive emissions) and Removals by Sinks (negative emissions) due to Land Use, Land Use Change and Forestry Activities
ONS	Office of National Statistics
MOTTs	Mott MacDonald – transport consultants
MUA	Major Urban Areas
NAEI	National Atmospheric Emissions Inventory
NHPAU	National Housing and Planning Advice Unit
NRTF	National Road Traffic Forecast

N_2O	Nitrous Oxide
NO_x	Nitrogen Oxides ($NO+NO_2$)
PFC	Perfluorocarbon
REAP	Resource Energy Analysis Programme
RPB	Regional Planning Body
RSS	Regional Spatial Strategy
SF_6	Sulphur Hexafluoride
SWM	Sustainability West Midlands
TEMPRO	Trip End Model Presentation Programme (DfT model for transport)
UEP	Updated Energy Projection – DTI/BERR energy projections for various UK economic scenarios
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
Vkm	Vehicle Kilometres (the total number of kilometres travelled by all vehicles)
WMCIAP	West Midlands Climate Impacts and Adaptation Partnership
WMRA	West Midlands Regional Assembly
WMRSS	West Midlands Regional Spatial Strategy

Executive summary

Introduction

The West Midlands Regional Assembly (WMRA) has undertaken a partial revision of the West Midlands Regional Spatial Strategy (RSS2). As part of this revision work, WMRA asked AEA to develop carbon trajectories for various housing scenarios. This report discusses the methodology and results of the developed carbon trajectories.

Background

The Government's Climate Change Act contains a variety of provisions relating both to climate change mitigation and adaptation. The Act puts into statute the UK's targets to reduce greenhouse gases and carbon dioxide emissions through domestic and international action by at least 80 per cent by 2050 for greenhouse gases and at least 26 per cent by 2020 for carbon dioxide, against a 1990 baseline.

As a subset of national policy, regions such as the West Midlands are expected to adhere to these targets and within the West Midlands the WMRA and regional partners have produced the West Midlands Regional Climate Change Action Plan (December, 2007a). The Action Plan identifies the opportunities presented to the region through mitigation, adaptation and the impacts of climate change itself. Planning Policy Statement 1, 'Planning and Climate Change', requires that the West Midlands produce carbon trajectories for new residential and commercial developments as part of the revision to the Regional Spatial Strategy (RSS).

Therefore, the main aim of this project was to provide carbon dioxide emission estimates for the business-as-usual and following housing scenarios in 2026:

- RSS Phase 2 Preferred Option (RSS 2) - 365,600 additional houses by 2026.
- Nathaniel Lichfield & Partners (NLP) scenario 1 (NLP 1) - 417,100 additional houses by 2026.
- NLP scenario 2 (NLP 2) - 419,600 additional houses by 2026.
- 2020 NLP scenario 3 (NLP3) - 445,600 additional houses by 2026.

Ideally commercial emissions would have also been assessed, however, due to a lack of suitable data commercial projections have been based on UK trends only.

In addition, due to the wealth of UK projection data available for projecting emissions to 2020, an interim year of 2020 was also calculated.

As part of the project a desk review was undertaken of data sources available and the best technique to use to develop the emissions inventory, given the constraints of the project. The 2006 emissions have been compared with other datasets and the comparison is favourable, indicating an appropriate methodology.

This project has developed an 'End User' emissions inventory for CO_2 for:

- 2006;
- 2020 base from CLG derived data;
- 2020 RSS Phase 2 Preferred Option (RSS 2) with 365,600 additional houses compared to 2006;
- 2020 NLP scenario 1 (NLP 1) with 417,100 additional houses compared to 2006;
- 2020 NLP scenario 2 (NLP 2) with 419,600 additional houses compared to 2006;
- 2020 NLP scenario 3 (NLP3) with 445,600 additional houses compared to 2006;
- 2026 base from CLG derived data;
- 2026 RSS Phase 2 Preferred Option (RSS 2) with 365,600 additional houses compared to 2006;
- 2026 NLP scenario 1 (NLP 1) with 417,100 additional houses compared to 2006;
- 2026 NLP scenario 2 (NLP 2) with 419,600 additional houses compared to 2006; and
- 2026 NLP scenario 3 (NLP3) with 445,600 additional houses compared to 2006.

The emissions are based on an 'End User' inventory that has emissions from power stations and refineries reallocated to the energy user (for example the person who uses the electricity or fuel). The results discussed in this report have been based on the 'End User' totals.

The outputs of this project include this report and an Excel-based spreadsheet with detailed results. The data in the spreadsheet provides a more detailed sector breakdown and results by local authority.

Regional emissions

The total emissions for the 2006 baseline have been compared against future emissions in 2020 and 2026 for the following scenarios and the findings are summarised here in Figures 4-1 to 4-4 (reproduced here):

- the CLG derived data (Base);
- the RSS Phase 2 Preferred Option (RSS 2) with 365,600 additional houses compared to 2006;
- NLP scenario 1 (NLP 1) with 417,100 additional houses compared to 2006;

- NLP scenario 2 (NLP 2) with 419,600 additional houses compared to 2006; and
- NLP scenario 3 (NLP3) with 445,600 additional houses compared to 2006.

Figure 4-1: CO_2 Trends Per Key Sector

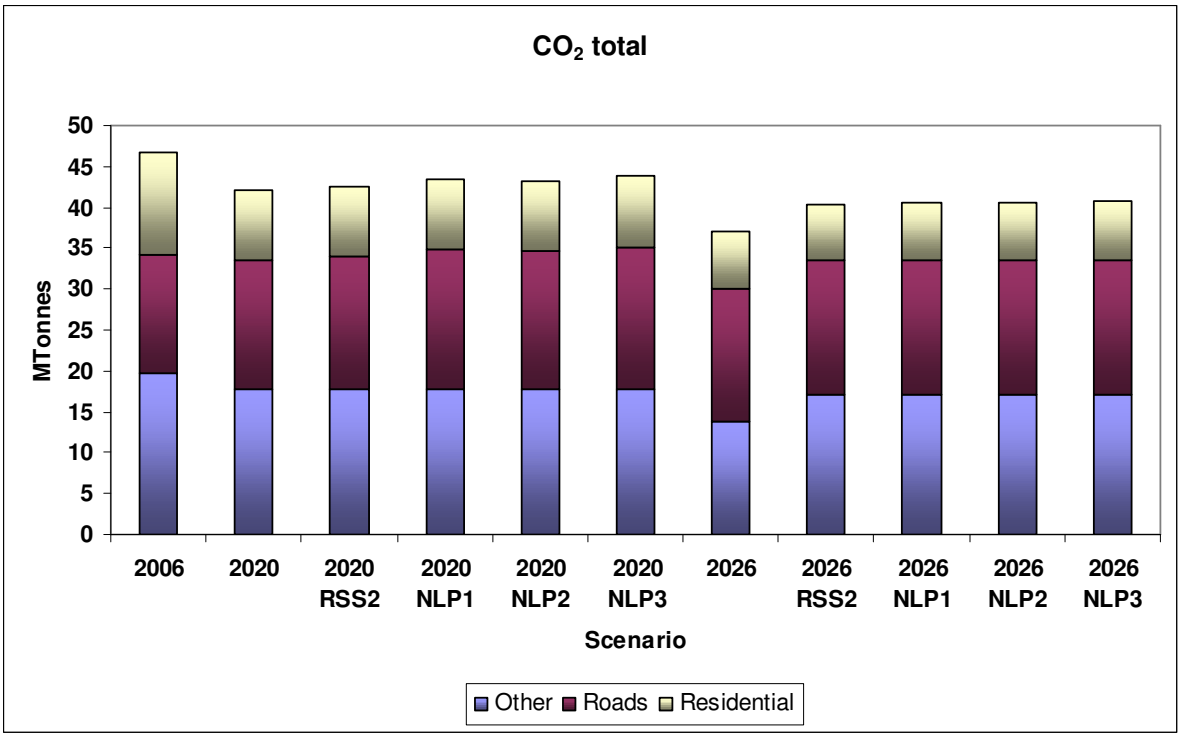


Figure 4-2: CO_2 Total Emissions and Implied Required Reduction

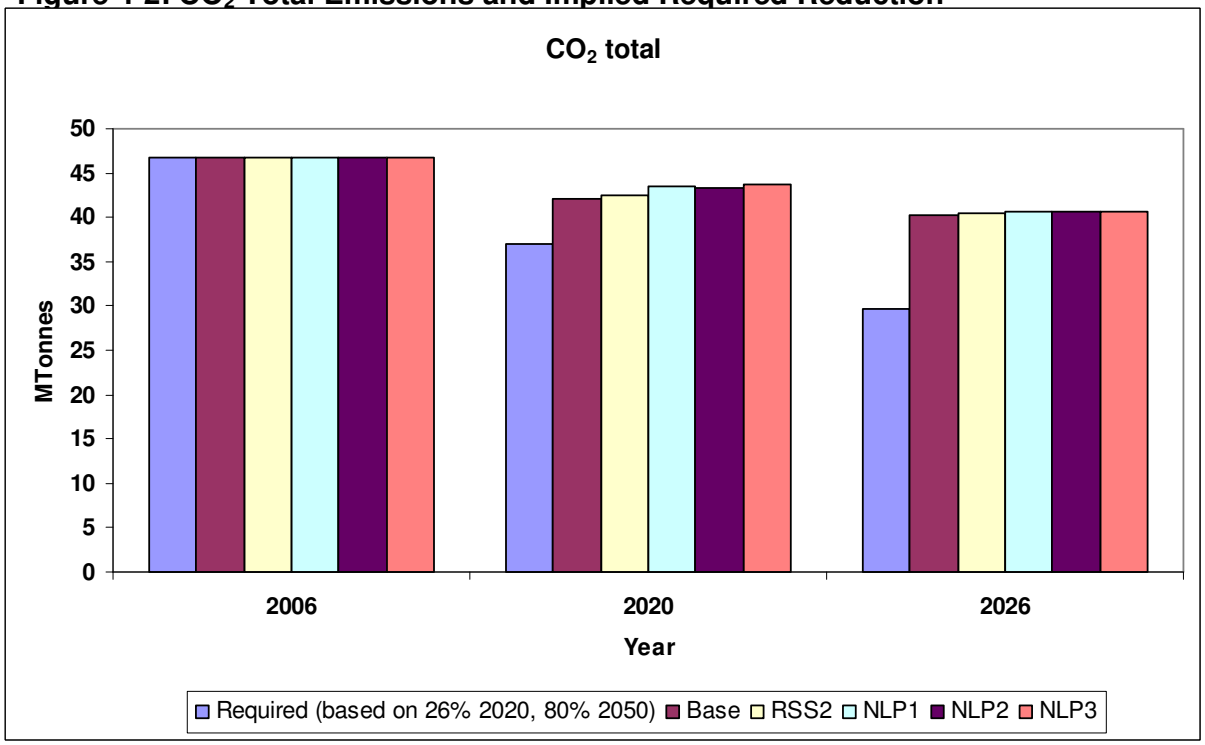


Figure 4-3: CO_2 Residential Emissions

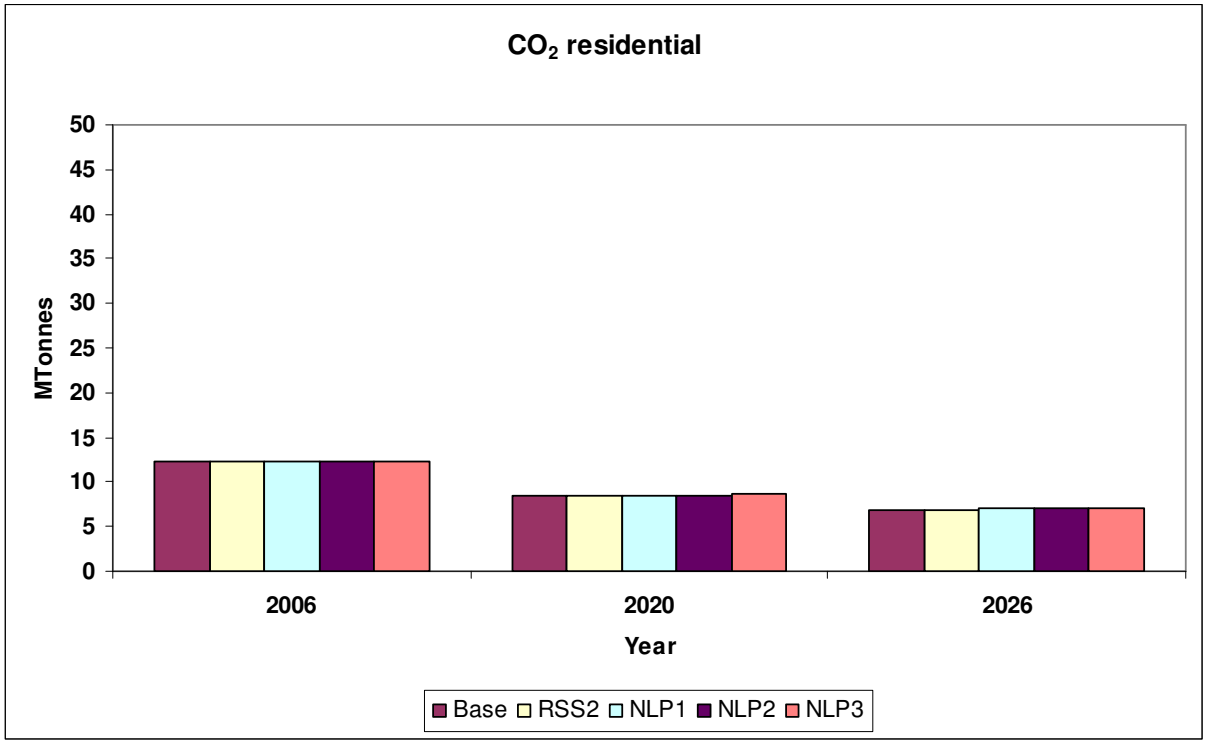
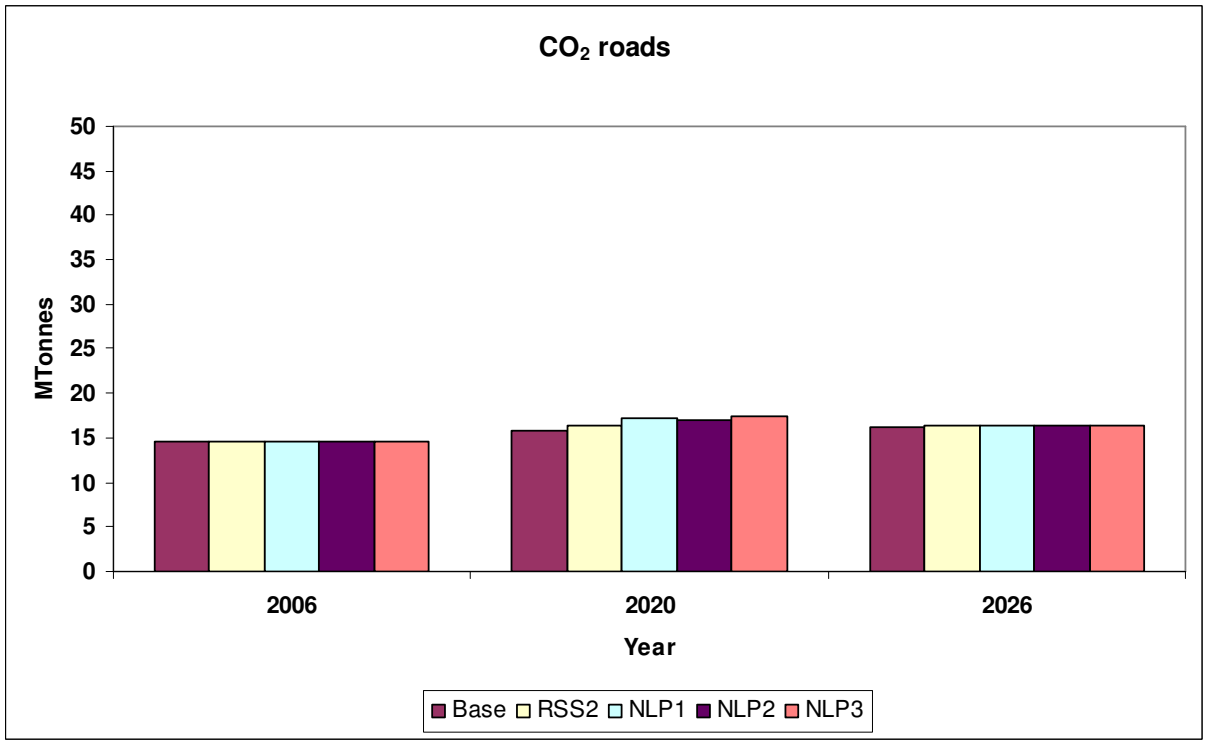


Figure 4-4: CO_2 Road emissions



Figures 4-1 to 4-4 depict the trends for total CO_2 emissions (4-1 and 4-2), residential emissions (4-3) and road transport (4-4). **The Figures indicate that emissions will decrease from the base year (2006) when projected into the future (2020 and 2026). This decrease is driven mainly by the national projections primarily in terms of fuel use and fuel efficiency. The national projections assume that National Policy measures will deliver an expected amount of carbon savings. The difference between the base case for the future years (2020 and 2026) and the various housing scenarios for the same future years is small.**

The required reduction in Figure 4-2 has been estimated by assuming that the West Midlands reduction in emissions from 1990 has been in line with the UK reductions (Jackson et al, 2008) to 2006. Therefore it is the additional reduction required from 2006 to meet the UK targets (assumed in this context to be 26% reduction by 2020 from 1990 and 80% reduction by 2050 from 1990) that has been used. For 2026 it has been assumed that the reduction to 2050 (80%) would apply. Therefore to meet these national targets, emissions in the West Midlands need to decrease by 21% by 2020 and 36% by 2026 compared to the 2006 baseline, further year on year reductions would then be needed to meet the 2050 80% target. These reductions are shown graphically in Figure 4-2.

As can be seen in Figures 4-1 to 4-4, from 2006 there is a projected decrease in total and residential emissions to 2020 and again a drop to 2026, primarily due to the assumed implementation of National Policy in terms of reducing carbon emissions, including for example, implementation of the Code for Sustainable Homes. However, emissions from road transport increase in 2020 and again in 2026 compared to 2006. The main decrease for future year totals is projected to come from residential emissions. From Figures 4-1 to 4-4 it can be seen that:

- Road transport is contributing significantly to the total CO_2 emissions in the region, note that this is the case for all sub-regions and local authorities.
- Under the future baseline scenarios the emissions are projected to decease by 4.7MT in 2020 and 6.4MT in 2026, this is driven mainly by the implementation of National Policy.
- With the RSS Phase 2 Preferred Option, total emissions only decrease by 4.2MT in 2020 and 6.3MT in 2026. This is due to the increase and distribution of housing.
- The residential emissions reduce by 5.5MT for both the RSS Phase 2 Preferred Option and the baseline in 2026 compared to 2006.
- Road transport emissions increase by 1.7MT for the RSS Phase 2 Preferred Option as opposed to 1.6MT in 2026 for the baseline, compared to 2006.
- The overall emission reductions from 2006 are smaller for the NLP scenarios (i.e. emissions are higher) compared to both the RSS Phase 2 Preferred Option and baseline, due to higher emissions in both the residential and road transport sectors compared to the other scenarios.

These Figures demonstrate that:

- the West Midlands faces a significant challenge in reaching National CO_2 reduction targets and that it is unlikely that existing National policies will meet these targets, and

- the RSS Phase 2 Preferred Option and various NLP scenarios do not support the climate change targets discussed in Section 2, The National Context.

Therefore, further significant and concerted policy action is required to meet this challenge, for which the revised Regional Spatial Strategy (and forthcoming Regional Strategy) should form a clear focus.

Alternative housing projections

Alternative projection methodologies for residential emissions have been considered in Data sources and methodology (Section 3):

Method 1, whose results are reported in Findings (Section 4) and summarised above, is based on detailed national fuel projections and assumes that emissions will reduce if National Policy savings are delivered.

However, it is possible that not all envisaged savings from National Policy will be realised and therefore alternative Methods 2 and 3 assume that existing dwellings have no change in emissions, due to either energy efficiency or fuel switching, and that new residential buildings are built in line with existing (i.e. Part L of Building Regulations – Method 2 and 3) and proposed (Method 2) planning regulations in terms of energy efficiency. Results from Methods 2 and 3 were not used further in this Study as they were not comparable to the UK carbon dioxide projections which assume fuel switching (i.e. increased gas use, less solid fuel use) and also assume energy efficiency improvements in older buildings.

The alternative Methods are compared in Figure 3-1 and in addition the equivalent CO_2 totals for each year and scenario are presented in Figure 3-2 for Method 3, the worst-case scenario.

Both Figures 4-2 and 3-2 demonstrate that the West Midlands is unlikely to meet National targets. This gap between national and West Midlands CO_2 emission projections will be considerably greater if National Policy measures do not have the expected impact in terms of reduced residential emissions.

Figure 3-1: Alternative housing scenarios CO_2 emissions

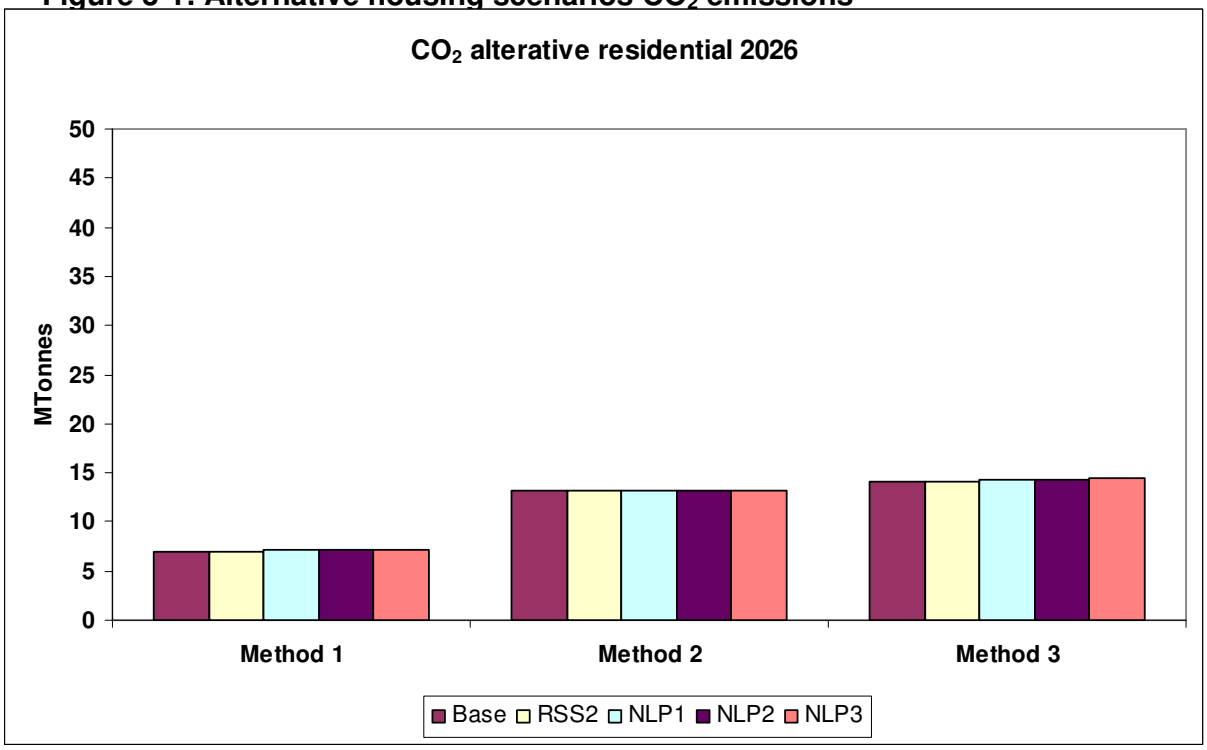
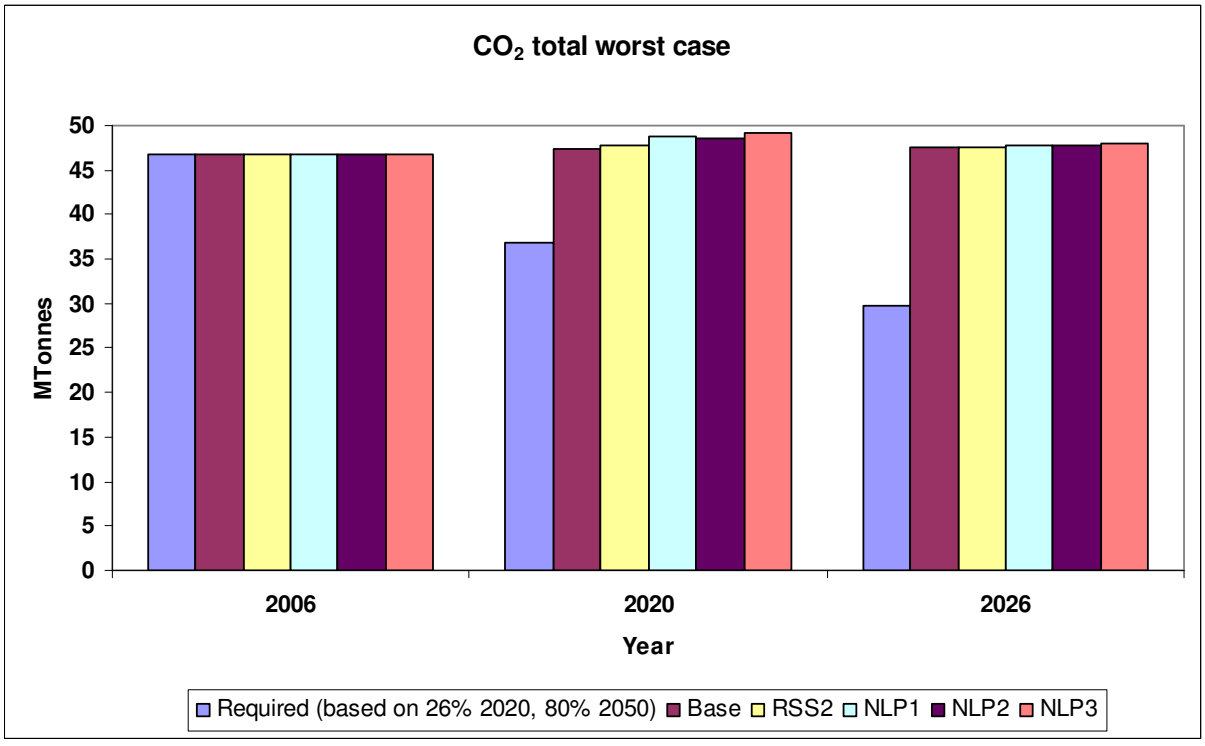


Figure 3-2: CO_2 Total worst case emissions and implied required reduction



Sub-regional variation of emissions

The Study also considered the impacts of sub-regional variations in impact, and rural and urban development patterns in the context of likely transport infrastructure. Figures 4-5 and 4-6 depict the road transport and residential emissions spatially in 2026. Very little difference is observed between the various housing scenarios in 2026 that can be shown visually, with the following exceptions:

- Dudley which has a decrease in emissions for the RSS Phase 2 Preferred Option (RSS2) and NLP scenarios compared to the base scenario for roads.
- Sandwell which has an increase in emissions for the RSS Phase 2 Preferred Option and NLP scenarios compared to the base scenario for roads.
- Birmingham which has an increase in emissions for the NLP scenarios compared to the base scenario for roads.
- Solihull which has a decrease in emissions for the NLP1 and NLP3 scenarios compared to the base scenario for roads.
- Wolverhampton which has an increase in emissions for the RSS Phase 2 Preferred Option and NLP scenarios compared to the base scenario for residential.
- Birmingham which has a decrease in emissions for the RSS Phase 2 Preferred Option scenario compared to the base scenario for residential.
- Coventry which has an increase in emissions for the RSS Phase 2 Preferred Option and NLP scenarios compared to the base scenario for residential.

The Study also considered the impacts of rural and urban development patterns in the context of likely transport infrastructure and how the various housing scenarios are likely to affect the regional targets. The local authorities were split into Major Urban Areas (MUAs) (WMRA, 2007c) and other areas to assist in this assessment.

Overall emissions per dwelling decrease for the MUAs for all scenarios compared to the base case, however, emissions increase for the non-MUAs for all scenarios compared to the base case.

The results in general imply that when the emissions are considered on a per dwelling basis where housing developments are based in the MUAs where there is access to public transport, then emissions are likely to decrease (per dwelling only). However, due to the actual increase in the number of dwellings this emission per dwelling decrease is eroded when considered in total.

Figure 4-5: Road transport emissions in 2026 (CO_2 Tonnes per year per kilometre)

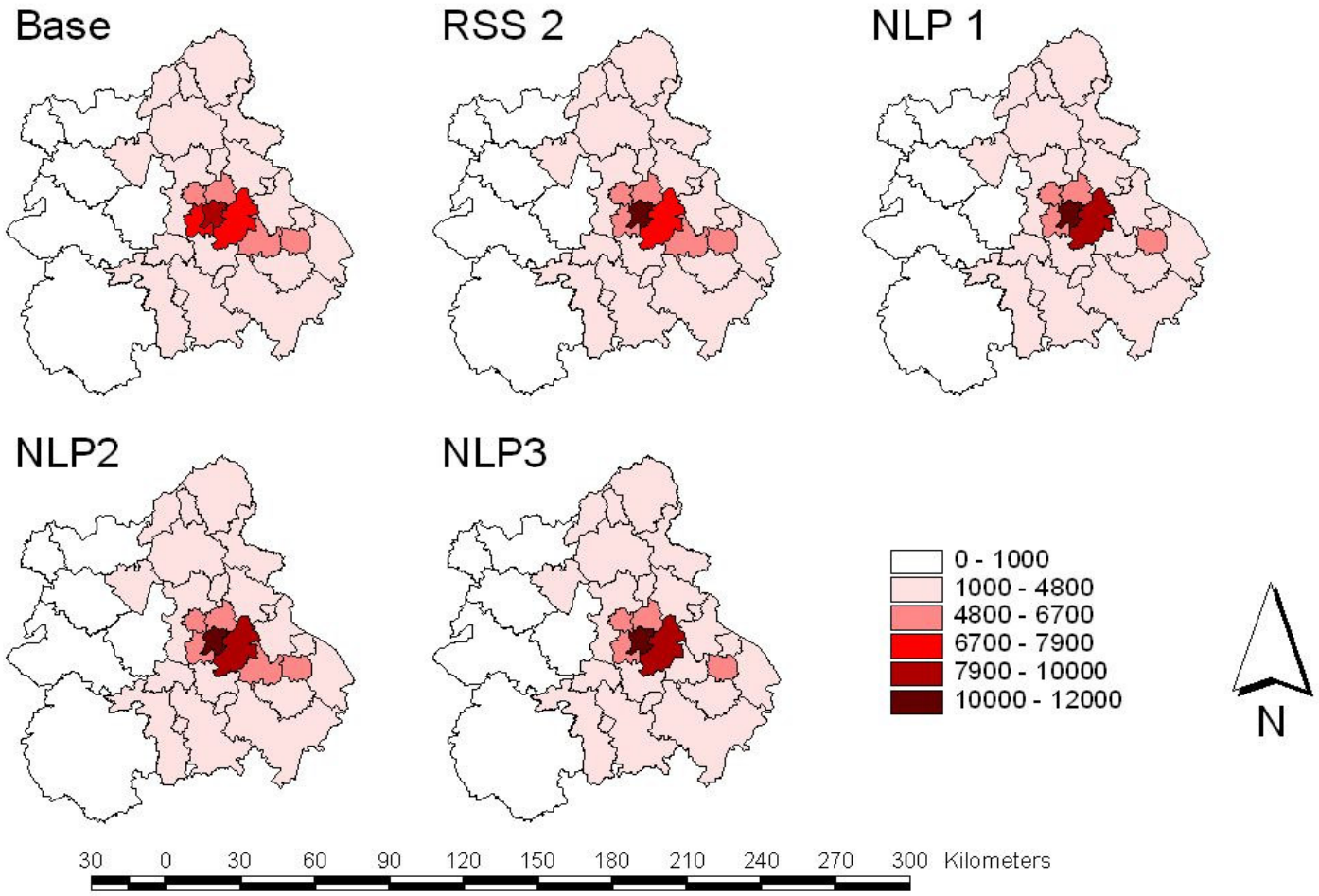
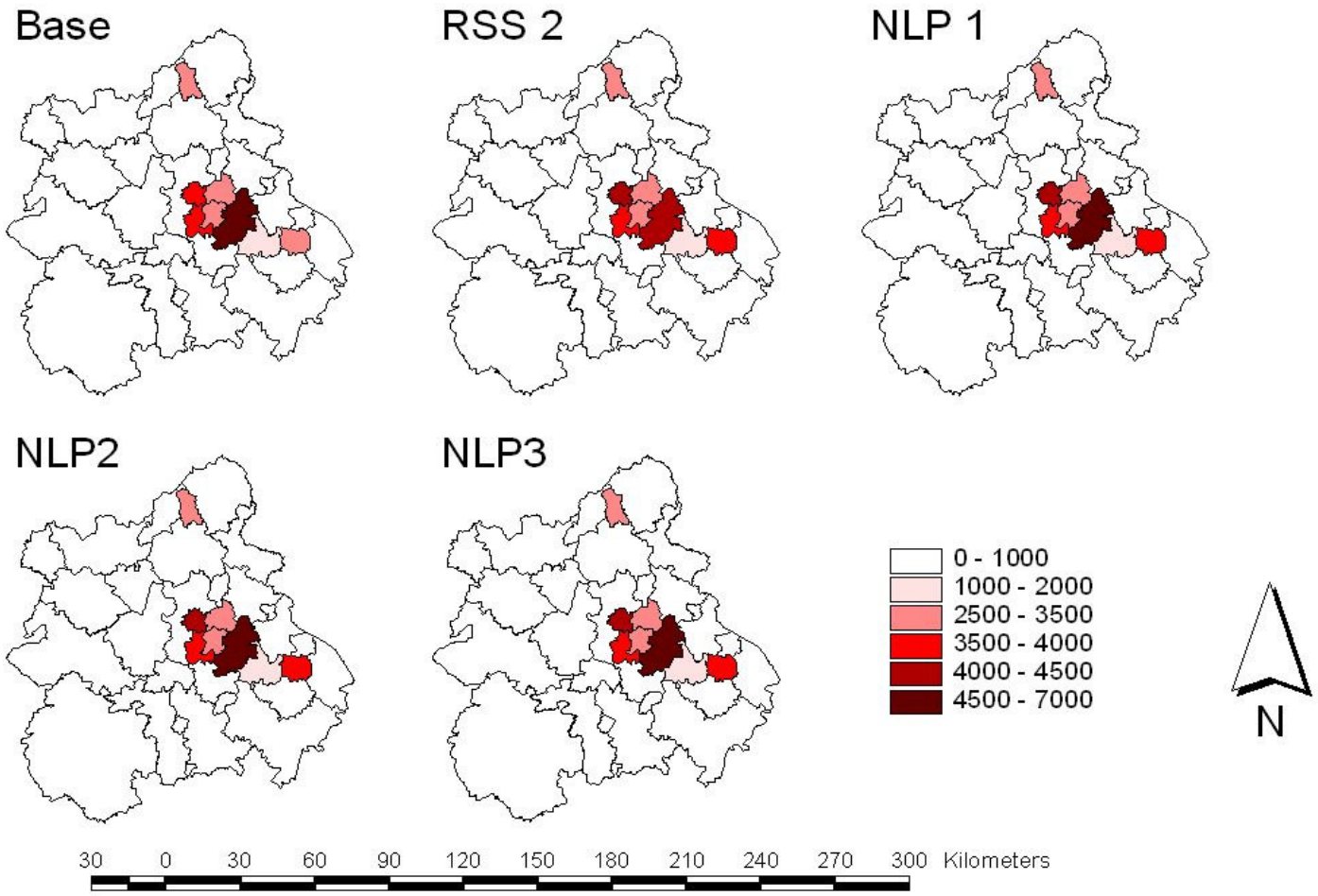


Figure 4-6: Residential emissions in 2026 (CO_2 Tonnes per year per kilometre)



Recommendations

To conclude the various housing scenarios are forecast to have little impact on CO_2 emissions in 2020 and 2026 compared to the baseline emissions for the same year. However, there is reduction in projected emission from the 2006 baseline to all future scenarios primarily due to the assumed implementation of National Policy.

Therefore, a number of recommendations are made in Recommendations (Section 5) that are reproduced below:

- Year on year reductions are necessary to aim to meet existing national targets, and any delay in reductions will result in further reductions being necessary in future year – there is a need to act urgently.

- The RSS is used to drive and encourage the uptake of existing and new national legislation with regard to energy efficiency of all new buildings.

- Where possible the RSS should seek to add planning restrictions to limit non-energy efficient new building.

- The RSS is used to drive and encourage the uptake of existing and new national legislation and initiatives with regard to energy efficiency of all existing buildings.

- Consideration be given in the RSS Phase 3 Revisions as to how the retro-fitting of energy efficiency measures could be encouraged in the existing building stock. For example, through a requirement that major refurbishments submit energy use assessments alongside planning applications.

- Regional and local authorities lead by example with their own stock.

- That new development is encouraged close to existing public transport links and discouraged where there is little public transport provision.

- Progress towards national and regional CO_2 targets is monitored against National Indicators including:

  Greenhouse gas emissions (No. 1).

  CO_2 emissions by end user (No. 2).

  Aviation and shipping emissions (No.3).

  Renewable electricity (No.4).

  Electricity generation (No.5).

  Household energy use (No.28).

  Road transport (No. 29).

  Private vehicles (No.30).

  Road freight (No.31).

  Manufacturing sector (No.32).

Service sector (No.33).

Public sector (No.34).

In relation to monitoring progress, it is suggested that:

- A single regional agency (for example the West Midlands Regional Observatory) has responsibility to develop and maintain an inventory of all sources of emissions within the area drawing on the most relevant available national and local data.
- Engage with stakeholders in the local authorities to ensure that the data they compile for their own Climate Change activities is comparable and consistent for the region as a whole. This would assist in data comparability across the sub-regions. It is suggested that each sub region and/or local authority has a champion with responsibility, which could facilitate future emission inventory updates.
- Secure agreements with data suppliers (including Local Authorities) to support data collation on an annual basis.
- Integrate data into the inventory to estimate the resulting CO_2 and make sure that emissions are not omitted or double counted.
- Produce an annual comparison report charting progress and methodological/data changes since previous publications.
- Provide ad-hoc support to the government departments and the public relating to data and trends for the Region.
- Update inventories as and when suitable data are available as part of the monitoring of indicators exercise.
- Review the scope, scale and coverage of the actions in this report on a regular basis.

Table of contents

1 Introduction

1.1 Climate Change and emission inventories

The Earth's climate is changing. Man-made carbon dioxide (CO_2) and other greenhouse gases emitted into the atmosphere are contributing to global warming. Even only modest rises in average global temperatures could lead to severe consequences over this century, including:

- Rises in sea level leading to increased threat to low-lying coastal areas.
- Enhanced risk of damage and injury from storms and flooding.
- Droughts and increased pressure on water resources.
- Increases in human health problems and mortality.
- Reduced crop yields.
- Damage to eco-systems and biodiversity.

There are six direct greenhouse gases (GHGs): carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and the three so called F-gases (gases containing fluorine); this collection of gases is referred to as the Kyoto basket. The Kyoto basket is dominated by CO_2 in terms of CO_2 equivalent emissions and therefore this study considers only CO_2. In order to quantify the amount of greenhouse gases within an area emission inventories are compiled. These inventories are based on the estimated amount of a particular gas that is emitted by a particular source (or set of sources) over a particular time period (i.e. 1 year). The sum of all the emission sources for a particular pollutant within a particular area is often referred to as an emission inventory.

In the UK, emissions of CO_2 account for approximately 85%[1] of total emissions, CH_4 approximately 8%, and N_2O approximately 6%. The majority of CO_2 comes from fuel combustion. Emissions of CH_4 are dominated by decomposing rubbish in landfill and from enteric fermentation in the stomachs of livestock. Nationally, emissions of N_2O are dominated by N_2O released from the breakdown of nitrogenous fertilisers applied to land, although there are also emissions from the transport sector (from N_2O generated in car catalytic converters) and from industry (from the production of adipic and nitric acid). The F-gases make a minor contribution, although their global warming potentials (CO_2 equivalent) are much greater than CO_2, CH_4 and N_2O. The relative importance of these individual gases in the West Midlands region is likely to be similar to the national situation, but not identical.

When considering a region such as the West Midlands, emissions can, in principle, be represented in two ways:

- At source (i.e. what comes out of a power stations stack).
- End user (i.e. power station emissions reallocated based on electricity consumption).

Many local authorities in the West Midlands will be familiar with the AEA produced Defra CO_2 estimates (King *et al.* 2008) and the related analysis to Support Climate Change Indicators for Local Authorities (AEA, 2007), which provides information to inform the proposals for new performance indicators on climate change. Both these data sets are to some extent (power stations and refineries) end user. These datasets are only available covering the projected years 2010 and 2020, for CO_2, with the exception of shipping and aviation.

As the focus of this Study is primarily on road transport and heating and lighting emissions (relating to the RSS proposed changes to housing and employment), and these sources are dominated by CO_2, only CO_2 has been considered in this study. As electricity related emissions are important when

[1] Calculated from the 2004 GHG inventory and excluding all LULUCF emissions and removals

considering lighting and heating and because the West Midlands region consumes more energy than it produces, this inventory is based on an 'End User' approach which incorporates emissions from power stations and refineries reallocated to the energy user (for example the person who uses the electricity or fuel).

1.2 West Midlands and Climate Change

'The Potential Impacts of Climate Change in the West Midlands` published by Sustainability West Midlands in 2004 realises the potential far-reaching effects climate change will have upon the West Midlands economy, society and environment. There are dangers that include an increased annual probability of flooding, coupled with increasing economic consequences. The West Midlands has a diverse landscape that has environmental and biodiversity importance reflected in protection measures ranging from Local Nature Reserves, Sites of Scientific Interest to Areas of Outstanding Natural Beauty. Damage from climate change to these natural resources will have far reaching economic and environmental impacts. Other negative impacts may include water supply problems, additional risks of economic impact due to effects on the transport infrastructure, and knock-on effects for the visitor economy in the region. These real risks illustrate that the region must play its part in mitigating and adapting to global climate change.

To help guide regional partners towards tackling climate change and contributing to the national energy policy goals, a partnership between the Government Office for the West Midlands (GOWM), WMRA, Advantage West Midlands, Natural England, and the Environment Agency produced a West Midlands Regional Climate Change Action Plan (December, 2007a). The Action Plan identifies the economic opportunities presented to the region through mitigation, adaptation and the impacts of climate change itself.

1.3 West Midlands Regional Spatial Strategy

In 2004 the Regional Spatial Strategy for the West Midlands Region (WMRSS) replaced the Regional Planning Guidance. The West Midlands Regional Assembly, as the Regional Planning Body (RPB), is responsible for the revision of the WMRSS to ensure that regional spatial policy fulfils the needs of the region. The RPB agreed to undertake this revision in three phases; the first of these was the Black Country Sub-Regional Strategy. Phase Two covers a range of policy areas, including an assessment of the amount of housing required across the region, a re-assessment of existing strategic employment land requirements, identification of strategic park and ride options, and development waste requirements. Phase Three will update the Quality of Life policies aswell as revising policies related to the provision of sites for gypsies and travellers, critical rural services, culture, sport and tourism, and minerals policy.

The National Housing and Planning Advice Unit (NHPAU) suggests in 'Developing a target range for the supply of new homes across England' (NHPAU, 2007), that the Government may be examining options to deliver between 408,000 and 460,000 dwellings in the West Midlands, between 2006 – 2026. This extends the submitted RSS Phase 2 Preferred Option, which makes provision for an additional 365,600 dwellings to be built in the West Midlands region over the same period. Nathaniel, Lichfield and Partner (NLP) undertook a study on behalf of the Government Office for the West Midlands (GOWM) looking into options to achieve development levels above those suggested in the West Midlands RSS Phase 2 Preferred Option and the allocation of the additional housing to the constituent local authorities in West Midlands.

Housing development under all options would have an impact on the carbon emissions of the region. The Government's Planning Policy Statement 1 (PPS1) Supplement 'Planning and Climate Change' states that regional policies should be shaped by carbon trajectories, considering how spatial strategies impact upon regional climate change targets.

Impact of housing development on carbon emissions

Changes to Building Regulations in England and Wales in 2006 (i.e. Part L) are intended to achieve substantial improvements in the energy efficiency of new houses compared to pre-1990 standards (CLG, 2007, pg 10). In 2006, the average 2-bedroomed semi-detached house built in 1970 was estimated as emitting 1.2MTC/yr compared to a house built to 2006 Building Regulations, which would only emit 0.2MTC/yr. Housing makes up 27% (CLG, 2007, pg8) of the UK's carbon emissions, so tackling housing emissions will make a significant impact on the UK's carbon goals.

The impact of housing development on carbon emissions may be mitigated through new housing policy enforcement. The Department for Communities and Local Government set out in 'Building a Greener Future; policy statement (CLG, 2007c) a three step plan to achieve zero carbon emissions from housing. The building regulations set out that new build dwelling in 2010 should show a 25% improvement on Part L in their energy/carbon performance; then in 2013 a similar 44% improvement; and finally in 2016 zero carbon dwellings.

Other policies for reducing the impact of housing development are numerous and varied, ranging from single policy implementation, such as introducing Ecohomes, through to combination policy implementation incorporating guidelines on improvement to building regulations, demolition rates and on-site renewables.

There is an inextricable link between the environmental impacts of housing development and transport. An increased population density in a particular area will inevitably lead to an overall increase in the areas private vehicle usage and freight usage of existing and new roads. Although the environmental impact of transport can be mitigated through the encouragement of development patterns that reduce the regular need to travel by private car.

1.4 Aims of this project

The main aim of this project was to provide carbon dioxide emission estimates for the business as usual and the various housing scenarios to 2026. In addition, due to the wealth of UK projection data available for projecting emissions to 2020, an interim year of 2020 was also calculated. As part of the project a desk review was undertaken of data sources available and the best technique to use to develop the emissions inventory, given the constraints of the project. The emissions inventory methodology and data sources are discussed in Data sources and methodology (Section 3). The results are presented in Findings (Section 4) and recommendations made in Recommendations (Section 5).

This project has developed an 'End User' emissions inventory for CO_2 for:

- 2006;
- 2020 base from CLG derived data;
- 2020 RSS Phase 2 Preferred Option (RSS 2) with 365,600 additional houses compared to 2006;
- 2020 NLP scenario 1 (NLP 1) with 417,100 additional houses compared to 2006;
- 2020 NLP scenario 2 (NLP 2) with 419,600 additional houses compared to 2006;
- 2020 NLP scenario 3 (NLP3) with 445,600 additional houses compared to 2006;
- 2026 base from CLG derived data;
- 2026 RSS Phase 2 Preferred Option (RSS 2) with 365,600 additional houses compared to 2006;
- 2026 NLP scenario 1 (NLP 1) with 417,100 additional houses compared to 2006;
- 2026 NLP scenario 2 (NLP 2) with 419,600 additional houses compared to 2006; and
- 2026 NLP scenario 3 (NLP3) with 445,600 additional houses compared to 2006.

The emissions are based on an 'End User' inventory that has emissions from power stations and refineries reallocated to the energy user (for example the person who uses the electricity or fuel). The results discussed in this report have been based on the 'End User' totals.

The final outputs in terms of this project are this report and an Excel-based spreadsheet with the detailed results in.

1.5 Structure of the Report

In summary the structure of the report reflecting the core tasks is as follows:

Chapter 1 Presents the background to the project and the structure of the report.

Chapter 2 Discusses the existing national strategic context and the regional targets.

Chapter 3 Summarises the methodology used and data sources for the emissions inventory.

Chapter 4 Presents the West Midlands carbon dioxide gas estimates and trends.

Chapter 5 Lists recommendations and proposed monitoring.

2 The national context

The Climate Change Act

The Government's Climate Change Act[2] contains a variety of provisions relating both to climate change mitigation and adaptation.

Perhaps of most significance for this study are the following provisions:

- The Act puts into statute the UK's targets to reduce greenhouse gas emissions through domestic and international action by at least 80 per cent by 2050 and reduce carbon dioxide emissions by at least 26 per cent by 2020, against a 1990 baseline.
- Five-year carbon budgets, which will set binding limits on carbon dioxide emissions ensuring every year's emissions count. Three successive carbon budgets (representing 15 years) will always be active, providing the best balance between predictability and flexibility.
- Emission reductions purchased overseas may be counted towards the UK's targets, consistent with the UK's international obligations.

Planning Policy Statement 1 and associated documents

Planning Policy Statement (PPS) 1 (ODPM, 2005) requires that attention should be given to sustainable development issues, including climate change.

The subsequent "Planning and Climate Change: Supplement to PPS1" document (CLG, 2007a), and the associated Companion Guide (CLG, 2007b), takes this commitment further and requires that:

- "Tackling climate change is a key Government priority for the planning system. The ambition and policies in this PPS should therefore be fully reflected by regional planning bodies in the preparation of Regional Spatial Strategies, by the Mayor of London in relation to the Spatial Development Strategy in London and by planning authorities in the preparation of Local Development Documents. Similarly, applicants for planning permission should consider how well their proposals for development contribute to the Government's ambition of a low-carbon economy and how well adapted they are for the expected effects of climate change. Applicants and planning authorities should bear in mind that the policies in this PPS are capable of being material to decisions on planning applications".

The working draft Companion Guide provides practical guidance and support for the implementation of the policies in this PPS supplement.

Building Regulations and the Code for Sustainable Homes

The Code for Sustainable Homes (CSH)[3] is a new (May, 2008) national standard for the sustainable design and construction of new homes. It is designed to sit alongside the Building Regulations and the planning system. Initially voluntary, in February 2008 the Government confirmed that a mandatory rating against the Code was to be implemented from May 2008.

[2] Further information at: http://www.defra.gov.uk/environment/climatechange/uk/legislation/index.htm
[3] Further information at:
http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/englandwales/codesustainable/

The Code measures the sustainability of a new home against nine categories of sustainable design, rating the 'whole home' as a complete package. The Code uses a 1 to 6 star rating system to communicate the overall sustainability performance of a new home. The Code sets minimum standards for energy and water use at each level and, within England, replaces the EcoHomes scheme, developed by the Building Research Establishment (BRE).

Principally, it is a response to the need for further improvement in the energy efficiency of new buildings, to both mitigate and adapt to climate change. To a certain extent the Code also reflects calls from the construction industry for greater clarity and direction for the Building Regulations. It is intended that the Code will set the future direction of the Building Regulations for the next 10 years, with the Government having set a target of all new build homes being zero carbon by 2016.

2.1 The links between policies and trajectories

2.1.1 Lessons from the national context

It is worth reflecting on the current national context and how the UK as a whole is achieving emissions reductions over time. The UK experience to date shows that GHG reduction policies and measures originally put in place were:

- Not broad enough in scope.
- Less effective than originally envisaged.

The UK's overall approach to emissions reductions and other aspects of climate change is set out within the Climate Change Programme 2006 (HM Government, 2006). Chapter 10 of the Programme ("Bringing It All Together") sets out a series of 'Existing Measures' and 'Additional Measures' (brought together in Table 2-1) which, taken together, were estimated to lead by 2010 to:

- A reduction in the UK's emissions of the basket of greenhouse gases on which the Kyoto target is based to 23 – 25 per cent below 1990 levels.
- A reduction in the UK's carbon dioxide emissions to 15 – 18 per cent below 1990 levels.

At the time of issue of the 2006 Climate Change Programme it was apparent that the national measures currently in place until that time would significantly undershoot the then trajectory for UK CO_2 emissions to 2010. Indeed the Climate Change Programme acknowledged this by stating that, by 2010 "emissions of carbon dioxide would be reduced to around 10.6 per cent below 1990 levels with existing measures".

The current national Programme of carbon saving measures remains extremely unlikely to achieve the level of CO_2 savings required to satisfy the *original* domestic goal of a 20% cut over the period 1990 to 2010, despite the inclusion of further national measures (contained in Table 2-1) within the UK's emissions reduction portfolio.

These aspects of the national context are important for the following reasons:

- GHG emissions reduction commitments may fail to be met because the policies and measures in place are not broad enough in scope; the 'remedial' additional measures put in place within the 2006 UK Programme sought to address this issue.
- GHG emissions reduction commitments may fail to be met because the measures in place are less effective than originally envisaged; the preparation of a regional inventory may help to ensure a better understanding of the effectiveness of measures.

This in turn suggests a more general, if perhaps obvious, conclusion, namely that:

Achievement of a significant level of GHG emissions reduction requires ambition and pushing the boundaries. Business as usual approaches to achieving targets are likely to be insufficient in the face of barriers to their achievement.

Table 2-1: The Carbon Saving Value of Measures within the UK Climate Change Programme

Measures	Carbon Savings in 2010 (MtC)
Energy Supply	
Renewables Obligation	2.5
Subsidy for biomass heat	0.1
Second phase of EU emissions trading scheme	3.0 – 8.0
Business	
Climate Change Levy	3.7
UK Emissions Trading Scheme	0.3
Carbon Trust	1.1
Building Regulations 2002	0.4
Building Regulations 2005	0.2
Climate Change Agreements	2.9
Carbon Trust further support for SMEs	0.1
Other measures to encourage or support SMEs	0.1
Transport	
Voluntary Agreements Package, including VED changes	2.3
Wider transport measures	0.8
Sustainable distribution in Scotland and Wales	0.1
Fuel duty escalator	1.9
Renewable Transport Fuel Obligation (RTFO)	1.6
Future voluntary agreement with car manufacturers	0.1
Domestic	
Energy Efficiency Commitment (EEC) (2002-05)	0.4
Energy Efficiency Commitment (EEC) (2005-08)	0.6
Energy Efficiency Commitment (EEC) (2008-11)	0.6
Building Regulations 2002	0.7
Building Regulations 2006 including 2005 condensing boilers update	0.8
Warm Front and fuel poverty programmes	0.4
Market Transformation including appliance standards and labelling	0.2
Increased activity in EEC (2008-2011)	0.5
Provision of advice to replace inefficient boilers and implement EPBD	0.2
Package of measures to improve energy efficiency in buildings	0.1
Better billing and metering	0.2
Products Policy – consumer info and standards for energy-using products	0.2
Agriculture	
Woodland Grants Scheme (England)	0.2
Woodland planting since 1990 (Scotland)	0.5
Strategy for non-food crops	0.1
Public Sector	
Central Government, NHS, UK universities and English schools including Carbon Trust activities	0.2
Additional effort by local authorities	0.2
Revolving loan fund for the public sector	0.1
Actions by Devolved Administrations	0.3
Other Measures	0.1
TOTAL	**24.1 – 29.1**

2.2 West Midlands targets

The West Midlands Climate Change Action plan sets out how the region can work towards meeting the challenges of climate change. The RSS and other regional documents are important drivers in meeting climate change targets. As noted above, if the UK finds meeting its GHG targets difficult then this will make the meeting of regional targets that are based on the national target equally difficult.

Within the context of this Study the relevant targets that the West Midlands has developed relate to energy, and are listed in the Regional Energy Strategy (WMRA et al, 2004). These targets are reproduced below:

- Industry: Reduce CO_2 emissions by 2.4 Mt (18%) by 2010 and an additional 4.3 Mt (32%) by 2020.
- Commercial and public sector: Reduce emissions by 2.0 Mt (36%) by 2010 and an additional 1.5Mt (26%) by 2020.
- Domestic: Reduce emissions by 2.4 Mt (19%) by 2010, and an additional 3.7 Mt (29%) by 2020.
- Transport: Stabilise emissions by 2010 and reduce by 0.7 Mt (7%) by 2020.

It is useful to consider the results of this study, presented in Findings, Section 4, in the context of these targets.

3 Data sources and methodology

3.1 Overview of methodology

As discussed in the Introduction (Section 1), the main aim of this project was to provide a carbon dioxide emissions inventory for the West Midlands for 2006, with projections forward to 2020 and 2026 to assess the impact of various RSS housing scenarios. In addition, a 'Base' scenario was considered, which is based on the increase in housing from 2006 to 2026 based on the CLG forecasts from 2006 to 2026 (http://www.communities.gov.uk/news/corporate/707319).

Due to data availability the methodology used for each key year is slightly different and therefore these have been explained in separate sections where relevant.

The UK NAEI is used as the main basis for UK emissions, including the UK Greenhouse Gas Inventory (GHGI) and therefore to undertake this study data was extracted, for most sources, from the UK NAEI (National Atmospheric Emissions Inventory) for 2005. This was the most recent year for which spatial data for the West Midlands was available and also because 2005 has been used as the reference year for National projections data (e.g. recent BERR UEP30 (2008) energy and carbon projections). The NAEI is discussed in more detail in Data sources and projection to 2006 (Section 3.3) below and Appendix 1. The 2005 emissions have been used as the base year from which projections to 2020 and 2026 have been made. The methodology is summarised at the end of this Chapter in Table 3-3 and further background is provided in the following sub-sections.

The UK emission projections are in general based on the central central scenario (central Energy White Paper policy and central fuel prices) (BERR, 2008) and therefore include emissions reductions resulting from National Policy that relate to that scenario, as depicted in Table 3-1 below.

Table 3-1: Illustrative carbon savings (percent) based on UEP30 central central scenario

Sector	Policy	2010	2015	2020
Energy supply	CCS demonstration project	0.00	0.00	0.96
	Changes to Renewables Obligation	0.38	1.35	1.54
	Total Energy Supply	0.38	1.35	2.50
Business	Carbon reduction Commitment	0.00	6.15	12.31
	Products policy	3.08	7.69	13.85
	Energy Performance of Buildings Directive	0.00	3.08	4.62
	Business Smart Metering	1.54	3.08	3.08
	Total business	4.62	20.00	35.38
Transport	Future Voluntary Agreements	0.25	1.78	4.33
	Total transport	0.25	1.78	4.33
Residential	Better billing	0.00	0.43	0.43
	Real time displays and Smart metering	0.43	0.87	0.43
	Product policy	0.87	2.16	3.90
	Supplier obligation	0.00	7.79	15.15
	CLG- Zero carbon homes	0.00	0.00	5.19
	Energy Performance of Buildings Directive	0.00	0.87	1.73
	Total residential	1.30	11.69	26.84
Public sector	Carbon Reduction Commitment	0.00	1.54	3.08
	Carbon neutral government	0.00	1.54	3.08
	Products policy	0.00	1.54	3.08

	EPBD- Energy Performance Buildings Directive	0.00	3.08	4.62
	Total public sector	0.00	7.69	13.85
TOTAL EXCLUDING EU ETS		0.66	3.96	8.57
EU ETS illustrative level of effort		6.59	7.91	9.23
TOTAL		7.25	11.87	17.80

In general, the projections for this study have been estimated using the BERR UEP30 central central scenario for the UK (2008) on a fuel-by-fuel basis per sector in line with the sectors change in a particular fuel use compared to 2005, the base year (detailed BERR data is included in the spreadsheet).

However, for those sectors that were of importance in this study (household and road transport), the projections have been based on local data.

Ideally commercial combustion would have been based on local data as well, however, the available data consisted of additional land requirements (quantity) and number of employees. Presumably, many of the new commercial buildings would be based on existing sites (i.e. brown field) as well as on the additional land and therefore it was not known what commercial existing buildings were likely to be used and what would be new build.

In addition, the traffic data was supplied with employee data for with and without the RSS Phase 2 Preferred Option scenario. For most local authorities areas there was no change in employee numbers associated with the RSS Phase 2 Preferred Option scenario. Therefore it was decided to keep the commercial projections in line with the rest of the UK.

3.2 Emission Boundaries

In order to align the estimates for CO_2 with different available datasets, such as the Local Authority Performance Framework 186 CO_2 community indicator, the spreadsheet database includes 2 different 'totals': a 186 consistent estimate; and an with 'End user' total (i.e. emissions from power stations and refineries reallocated to the users of the produced energy). The spreadsheet allows the user to see directly which source sectors are included in each total. The source sectors included in each of the totals are summarised in End-user (Sections 3.2.1) and Indicator 186 (Section 3.2.2). It should be noted that the results presented here are not the same as the Local Authority CO_2 Defra datasets and have been calculated independently.

3.2.1 End-user

The 'End User' totals include the following sources with their emissions at the point of release, with a contribution of emissions from refineries and power stations added proportional to the energy consumed. This "End User" element is estimated based on the national ratio for the particular sector and fuel. The following totals are reproduced in this report and the spreadsheet database:

- Domestic fuel use (by fuel type), plus end user element, includes electricity.
- Light industry and commercial fuel use (by fuel type), plus end user element, includes electricity.
- Public sector fuel use (by fuel type), plus end user element, includes electricity.
- Agricultural fuel use (by fuel type), plus end user element, includes electricity.
- Heavy industry fuel use (by fuel type), plus end user element, includes electricity.
- Industrial process emissions.
- Household products.

- Road transport by fuel type and separately for major and minor roads (based on fuel consumed in the region and not on vehicle ownership or fuel sold in the region), plus end user element.
- Rail, plus end user element.
- Shipping (split by international and domestic), plus end user element.
- Non-military aviation (split by fuel type and international and domestic), plus end user element.
- Other transport (Off road) not rail, aviation or shipping, plus end user element.
- Waste.
- Agriculture and nature (this is mapped based on land use maps).
- F-gases based on estimated regional use.

3.2.2 Indicator 186

In order to align the estimates for CO_2 with the Local Authority Performance Framework 186 CO_2 community indicator, totals calculated in this report and the spreadsheet database for CO_2 include:

- Domestic fuel use (by fuel type), plus end user element, includes electricity.
- Light industry and commercial fuel use (by fuel type) for non EU-ETS sources, plus end user element, includes electricity.
- Public sector fuel use (by fuel type) for non EU-ETS sources, plus end user element, includes electricity.
- Agricultural fuel use (by fuel type), plus end user element, includes electricity.
- Heavy industry fuel use (by fuel type) for non EU-ETS sources, plus end user element, includes electricity.
- Industrial process emissions for non EU-ETS sources.
- Household products.
- Road transport by fuel type and separately for A roads (not motorways) and minor roads (based on fuel consumed in the region and not on vehicle ownership or fuel sold in the region), plus end user element.
- Other transport (Off road) not rail, aviation or shipping, plus end user element.
- Waste.

3.3 Data sources and projection to 2006

3.3.1 NAEI

The UK NAEI is used as the main basis for UK emissions and therefore to undertake this study data was extracted, for most sources, from the UK NAEI (National Atmospheric Emissions Inventory) for 2005. This was the most recent year for which spatial data for the West Midlands was available and also because 2005 has been used as the reference year for National projections data (e.g. recent BERR UEP30 (2008) energy and carbon projections).

The 2005 1km by 1km spatially resolved NAEI emissions have been used as a basis for all years and have been extracted from the NAEI by fuel type, sector and local authority. Those sources covered by the NAEI 2005 are listed below. Those sectors that have been derived separately are described in the

following sections. The emissions were then factored based on the DUKES (BERR, 2007) fuel use to 2006 per sector and fuel type for combustion as described in Projections to 2020 and 2026 (Section 3.4), other emissions were factored as described for the future years based on the relevant statistic (as described in the relevant section) or the UK GHGI in 2005 (Baggott et al, 2007) and 2006 (Jackson et al, 2008) as described in Projections to 2020 and 2026 (Section 3.4).

- Domestic fuel use (by fuel type), note that gas use is based on 2004 distributions though.
- Light industry and commercial fuel use (by fuel type).
- Public sector fuel use (by fuel type).
- Agricultural fuel use (by fuel type).
- Heavy industry fuel use (by fuel type).
- Industrial process emissions.
- House hold products.
- Rail.
- Other transport (Off road) not rail, aviation or shipping.
- Waste.

3.3.2 Agriculture and nature

Land Use, Land Use Change & Forestry (LULUCF) CO_2 data has been taken from the LA CO_2 Defra dataset for 2005 and 2006 (King et. al. 2008), which in turn is based on the estimates for Land Use Change and Forestry undertaken by the Centre for Ecology & Hydrology (CEH, 2006). This sector differs from others in the UK GHGI in that it contains both sources (positive) and sinks (negative) emissions of carbon dioxide. For example a growing tree acts as a sink as it absorbs carbon.

3.3.3 End user

End user emissions relating to oil refineries have been assumed to be the same proportion of fuel burnt emissions per sector per fuel as the rest of the UK in 2005 (i.e. those derived for the Defra CO_2 dataset (King et. al., 2008)). These ratios (over 100) were supplied as a series of factors per fuel type and sector by the NAEI team. Emissions are presented separately for 'End User' emissions in both this report and the spreadsheet database.

$$\text{LA sector end user 2006} = \frac{\text{LA sector at source 2006} \times \text{UK sector end user 2006 UK}}{\text{UK sector at source 2006}}$$

Where: LA sector end user 2006 is the end user emission estimate for the particular fuel and sector for the local authority.

LA sector at source 2006 is the actual emission generated within the local authority for the particular fuel and sector.

UK sector end user 2005 is the end user emission for the particular fuel and sector for the UK.

UK sector at source 2005 is the actual emission generated within the UK for the particular fuel and sector.

Electricity

Electricity emissions for 2005 and 2006 have been based on the electricity related emission estimates for both residential and non-residential in the LA CO_2 Defra dataset for 2006 (King et. al., 2008).

3.3.4 Road transport

The base data for 2006 was taken from the DfT vehicle kilometre data per local authority for 1993 to 2007 from http://www.dft.gov.uk/pgr/statistics/ as no 2006 data had been supplied. This traffic flow data is available separately for cars. In addition Mott MacDonalds supplied vehicle kilometre data for 2016 and 2026 for both the with and without the RSS Phase 2 Preferred Option by vehicle type (car, LGV, HGV) and road type (motorway, A road and minor roads) and local authority. It should be noted that both the Mott MacDonalds and DfT data was not available for all local authorities and was amalgamated in some cases to, for example, County level.

As the Mott MacDonalds data was not supplied for 2006, the Mott MacDonalds data for the 2016 without RSS Phase 2 Preferred Option scenario was used to further disaggregate the 2006 DfT traffic flow data by vehicle type and road type as the Dft data was not available at level of detail.

As the Mott MacDonalds 2016 and 2026 data was not directly comparable to the Dft 2006 data, to enable consistency between datasets the TEMPRO factors per local authority were then used to project the 2006 DfT traffic flow data to 2016, 2020 and 2026 (without RSS Phase 2 Preferred Option scenarios).

For 2016 and 2026 with RSS Phase 2 Preferred Option scenarios the Mott MacDonalds additional traffic flow relating to the with RSS Phase 2 Preferred Option scenario was then added directly to the DfT derived data. As the Mott MacDonald datasets only included the years 2016 and 2026 the 2020 additional traffic for the with RSS Phase 2 Preferred Option scenario was derived by interpolating the 2016 and 2026 additional Mott MacDonalds with RSS Phase 2 Preferred Option scenario traffic data.

These data and the associated derived data are reproduced in the accompanying spreadsheet in the 'Traffic – data in' and 'TEMPRO and NRTF factors' sheets. This data was used to enable a consistent approach to be used for all years and scenarios, which needed to take account of the differences in fleet mix and technology.

Emissions can be calculated if the traffic flow, fleet composition and average speed are known. Typical speeds for each road type were used (motorways - 112 km/h; A Roads - 96 km/h; Minor Roads - 48 km/h). As addition fleet splits were needed, to enable calculations of emissions, these were taken from the NAEI Fleet Composition Projections (NAEI, 2002; http://www.naei.org.uk/emissions/index.php). For each vehicle type, speed and technology a different emission factor was applied (NAEI, 2002; http://www.naei.org.uk/emissions/index.php). This resulted in emissions in terms of tonnes per year. End user emissions were also calculated based on the 2005 fuel based ratios as discussed in the previous section.

Therefore, road transport emissions are based on the estimated fuel consumed in the region and not on vehicle ownership or fuel sold in the region.

This methodology produced emission estimates for 2006, 2020 and 2026 with and without the RSS Phase 2 Preferred Option. However, the additional three NLP housing scenarios also had to be considered. The NLP scenario emissions were calculated by estimating the additional traffic associated emissions (with RSS Phase 2 Preferred Option – without) per unit of additional dwelling for with RSS Phase 2 Preferred Option scenario and then multiplying this up by the additional dwellings with the relevant NLP scenario per local authority. However, due to the supplied Mott MacDonalds data, which was limited by the scope of the traffic model used (it does not model the outlying Districts in detail – refer to Appendix 1 for further discussion) this methodology could not be used for Herefordshire, Stoke-on-Trent, Staffordshire and Shropshire. The traffic data for these Districts for the NLP scenarios was therefore assumed to be the same as the with RSS Phase 2 Preferred Option scenario and therefore any additional effect from changes in housing numbers could not been accounted for.

Emissions are presented separately for each local authority and fuel type in the accompanying spreadsheet, totals are presented in this report.

3.3.5 Aviation

The Civil Aviation Authority compiles an annual database of UK aircraft movements (CAA, 2007), which contains information on the number of aircraft movements for each airport in the UK. From this the NAEI estimates emissions for each aircraft type reported to CAA at each airport and also estimates the emissions from other airside emission sources. Therefore, data for 2005 were extracted from the NAEI for the landing and takeoff cycle and domestic and international departure cruise, and other airside emissions only for Birmingham and Coventry airports. Estimates were obtained for emissions from domestic and international flights separately, excluding inbound cruise emissions (i.e. departing cruise only emissions were included for consistency with UK policy). The 2005 data was assumed to be representative of 2006.

Birmingham airport emissions were allocated to Solihull, and Coventry was apportioned to Warwick. Emissions are presented separately for each local authority, split by domestic and international and fuel type in the spreadsheet, totals are presented in this report.

3.3.6 Dwellings

Dwelling data for the base scenarios was taken from the CLG data based 2004 projections (2008). For the RSS scenarios it was taken from the draft RSS Phase 2 Preferred Option (GOWM, 2007c) and NLP study (GOWM, 2008). Where further splits were necessary (i.e. only a county total was given) then the other data sources (RSS, CLG, NLP) were used to derive the individual local authorities split. As the RSS and NLP data was only supplied for 2006 and 2026, interim years were calculated based on linear interpolation.

3.4 Projections to 2020 and 2026

The UK Updated Energy Projections (UEP) 30 central central scenario (BERR, 2008) (i.e. central fuel prices, central impact of policies) forecasts to 2020 have been used to project most sectors. For 2026 the trend from the (UEP) 30 central central scenario (BERR, 2008) between 2015 and 2020 has been linearly extrapolated to 2026 by sector and fuel type to provide a basis for the same sectors. Those sectors not using the (UEP) 30 central central scenario (BERR, 2008) projections are road transport and aviation. The (UEP) 30 central central scenario (BERR, 2008) projections were not used for these two sectors as more detailed local data was available. In addition, the housing projections used a combination of Nation projection data disaggregated by the relative growth in households locally.

The following sections explain the methodology and data used for each sector. The examples are given for 2020, but the same equation has been used for both 2006 and 2026. The 2005 and 2006 fuel use data has been taken from DUKES (BERR, 2007).

In the Findings sections of this report the emission results are presented, however, the Findings section only includes one set of results for residential (domestic) emissions. The residential emissions reported in Findings are only related to the Method 1 discussed in Domestic fuel use (National Policy measures delivered), Methodology 1 (Section 3.4.3) and not to the alternative methods discussed in Domestic fuel use (Part L and beyond) Methodologies 2 and 3 (Section 3.4.4), this is because Method 1 is aligned with UK projections (which assumed implementation of national carbon saving measures), whereas Methods 2 and 3 did not align closely.

3.4.1 Industry (includes energy sector)

The change in industrial BERR fuel use data has been used to project the industrial emissions as most carbon emissions from industry are related to fuel use. The equation below is applied separately for the following:

- Energy.
- Iron and Steel process.
- Iron and Steel energy use (separately for each fuel type).
- Other industry process.
- Other industry energy use (separately for each fuel type).

LA 2020 = LA 2005 x (UK demand 2020/UK demand 2005)

= Current value x UK rate of change of fuel use x local scaling factor relative to national

Where: LA 2020 = Local authority process or specific fuel emissions in 2020.

LA 2005 = Local authority process or specific fuel emissions in 2005.

UK demand 2020 = UK specific fuel use (or total fuel use for process emissions) in 2020.

UK demand 2005 = UK specific fuel use (or total fuel use for process emissions) in 2005.

End user emissions have been based on the UK end user factor for the sector per fuel type in 2005 and applied to the 'At source' emissions in 2020.

The 2026 emissions are projected in a similar way, however, the trend between 2015 and 2020 has been linearly extrapolated to 2026 to derive the UK 2026 projections.

Emissions are presented separately for each local authority split by energy, iron and steel, and other, whether emissions are EU-ETS and fuel type in the spreadsheet database, totals are presented in this report. The underlying data used in the projections are also provided in the spreadsheet database.

3.4.2 End user

The same ratios from 2005 have been applied to all fuel use related emissions in 2020 and 2026 on a sector and fuel specific basis, using the same methodology as discussed in End user (Section 3.3.3).

Emissions are presented separately for each local authority split by sector and fuel type in the spreadsheet, totals are presented in this report.

Electricity

The BERR UEP 30 (2008) was used to obtain the electricity supply fuel consumption by fuel in 2020 and the same information taken from DUKES for 2005 and 2006 (BERR, 2007). The 2026 electricity demand was linearly extrapolated from the UEP 30 data. Similarly the UEP 30 data for UK power station emissions were extrapolated to 2026 (from 2020) to take account of power station fuel mix changes and the UK GHGI (Greenhouse Gas Inventory) for 2005 UK power station emissions were also obtained. Electricity demand data from BERR UEP 30 (2008) was then used to split the emissions from the power stations into residential and non-residential related electricity emissions for each year in the UK. The ratio of emissions between 2020 (or 2026) and 2005 for the two sectors (residential and non-residential) were used to estimate the 2020 (and 2026) electricity emissions per local authority using the following formula. This methodology takes account of the change in fuel mix used in power stations nationally, as based on the (UEP) 30 central central scenario (BERR, 2008) projections. It should be noted that in general emissions from power stations in the UK are falling due primarily to fuel mix, and demand is projected to decrease due to primarily energy efficiency. Therefore, the emissions per unit demand in the future decrease compared to 2005.

Residential:

LA 2020 = LA 2006 x (UK 2020/UK 2006) x ((LA households 2020/LA households 2006))

((UK households 2020/UK households 2006))

Non-residential:

LA 2020 = LA 2005 x (UK 2020/UK 2006)

Where: LA 2020 = Local authority sector emissions in 2020.

LA 2005 = Local authority sector emissions in 2005.

UK 2020 = UK sector specific electricity related emissions in 2020.

UK 2005 = UK sector specific electricity related emissions in 2005.

LA households 2020 = the number of households in the local authority in 2020.

LA households 2005 = the number of households in the local authority in 2005.

UK households 2020 = the number of households in the UK in 2020.

UK households 2005 = the number of households in the UK in 2005.

Emissions are presented separately for each local authority in the spreadsheet, totals are presented in this report. The underlying data used in the projections are also provided in the spreadsheet.

3.4.3 Domestic fuel use (National Policy measures delivered), Methodology 1

Domestic fuel use related emissions have been scaled on a fuel-by-fuel basis in line with the sectors UK fuel use change in 2020 relative to 2005 in BERR UEP 30 (2008) and DUKES (BERR, 2007). The 2026 fuel was extrapolated from the UEP 30 data. The 2020 data was then disaggregated for the region using housing data (ratio of LA/UK) from CLG (2008), the RSS (WMRA, 2007c) and NLP (GOWM, 2008). An example for gas is shown below:

$$\text{LA 2020} = \text{LA 2005} \times (\text{UK 2020}/\text{UK 2005}) \times \frac{((\text{LA households 2020}/\text{LA households 2005}))}{((\text{UK households 2020}/\text{UK households 2005}))}$$

Where: LA 2020 = Local authority domestic gas emissions in 2020.

LA 2005 = Local authority domestic gas emissions in 2005.

UK 2020 = UK domestic gas demand in 2020.

UK 2005 = UK domestic gas demand in 2005.

LA households 2020 = the number of households in the local authority in 2020.

LA households 2005 = the number of households in the local authority in 2005.

UK households 2020 = the number of households in the UK in 2020.

UK households 2005 = the number of households in the UK in 2005.

Emissions are presented separately for each local authority split by fuel type in the spreadsheet, totals are presented in this report. The underlying data used in the projections (demand, households, population) are also provided in the spreadsheet.

3.4.4 Domestic fuel use (Part L and beyond) Methodologies 2 and 3

As an alternative to Method 1 above a different approach was taken by assuming that existing dwellings have no change in emissions, due to either energy efficiency or fuel switching. However,

these results were not used further in the Study as they were not comparable to national projections which assume the delivery of national carbon saving policies.

These methodologies are based on assuming that the existing housing stocks emissions remain the same per unit dwelling, but the new dwellings are built in line with new domestic dwelling legislations:

1. From 2006 all new build will have a 40% reduction in emissions (Part L) (Method 2 and 3).
2. From 2010 all new buildings will have an additional 25% reduction on Part L (Method 2 only).
3. From 2013 all new buildings will have an additional 44% reduction on Part L (Method 2 only).
4. From 2016 all new buildings will be zero carbon (Method 2 only).

In order to calculate emissions therefore the following were calculated:

1. Emissions in 2006 per unit dwelling (i.e. 2006 emissions/dwellings).
2. 75% of 1 (i.e. 25% reduction in emissions per unit dwelling).
3. 56% of 1 (i.e. 44% reduction in emissions per unit dwelling).

In addition it was necessary to calculate the number of old dwellings for which the 2006 emissions per dwelling were relevant in, this was based on the annual demolition rates per local authority in the RSS (WMRA, 2007c):

1. 2006
2. 2009
3. 2012
4. 2015
5. 2016
6. 2020
7. 2026

Also the number of new dwellings built between:

1. 2006 and 2009 (i.e. apply Part L emissions per dwelling) – (Method 2 and 3).
2. 2010 and 2012 (i.e. apply 75% Part L emissions per dwelling) - (Method 2 only).
3. 2013 and 2015 (i.e. apply 56% Part L emissions per dwelling) - (Method 2 only).
4. From 2016 assume zero emissions for new build - (Method 2 only).

By summing the relevant emissions for both old and new dwellings for the relevant year and scenario the total domestic related emissions can be calculated. One problem with this methodology is that it does not take account of fuel switching (i.e. increased gas use, less solid fuel use) and assumes that there is no improvement in older buildings.

The results are compared with Method 1 below in Table 3-2 and Figure 3-1 and it can be seen that Methods 2 and 3 appear to overestimate emissions compared to the national residential UK emission projections, where it is assumed the National Policy measures will be delivered. Figure 3-2 reproduces Figure 4-2 from Findings (Section 4), but with the residential emissions calculated using the worst-case Method 3.

Table 3-2 demonstrates that under business-as-usual scenarios (Methods 2 and 3), carbon dioxide residential emissions in the West Midlands would actually increase. Figure 3-2 also demonstrates that the West Midlands is unlikely to meet National targets if National Policy measures do not have the expected impact in terms of reduced residential emissions.

Table 3-2: Emissions (T/yr) of CO_2

Source/method	Method 1	Method 2	Method 3	UK*
2006	12,391,854	12,391,854	12,391,854	84,700,000
2020 base	8,450,170	13,273,263	13,826,204	55,000,000
2020 RSS Phase 2 Preferred Option	8,407,646	13,245,382	13,776,742	N/A
2020 NLP1	8,543,018	13,310,086	13,907,458	N/A
2020 NLP2	8,542,556	13,311,527	13,910,369	N/A
2020 NLP3	8,608,536	13,343,702	13,975,369	N/A
2026 base	6,917,718	13,154,779	14,125,574	N/A
2026 RSS Phase 2 Preferred Option	6,910,324	13,126,898	14,108,795	N/A
2026 NLP1	7,062,253	13,191,603	14,295,532	N/A
2026 NLP2	7,061,502	13,193,043	14,299,691	N/A
2026 NLP3	7,134,905	13,225,218	14,392,547	N/A

*2005 not 2006 and does not include electricity, but note ratio for years.

Figure 3-1: Alternative housing scenarios CO_2

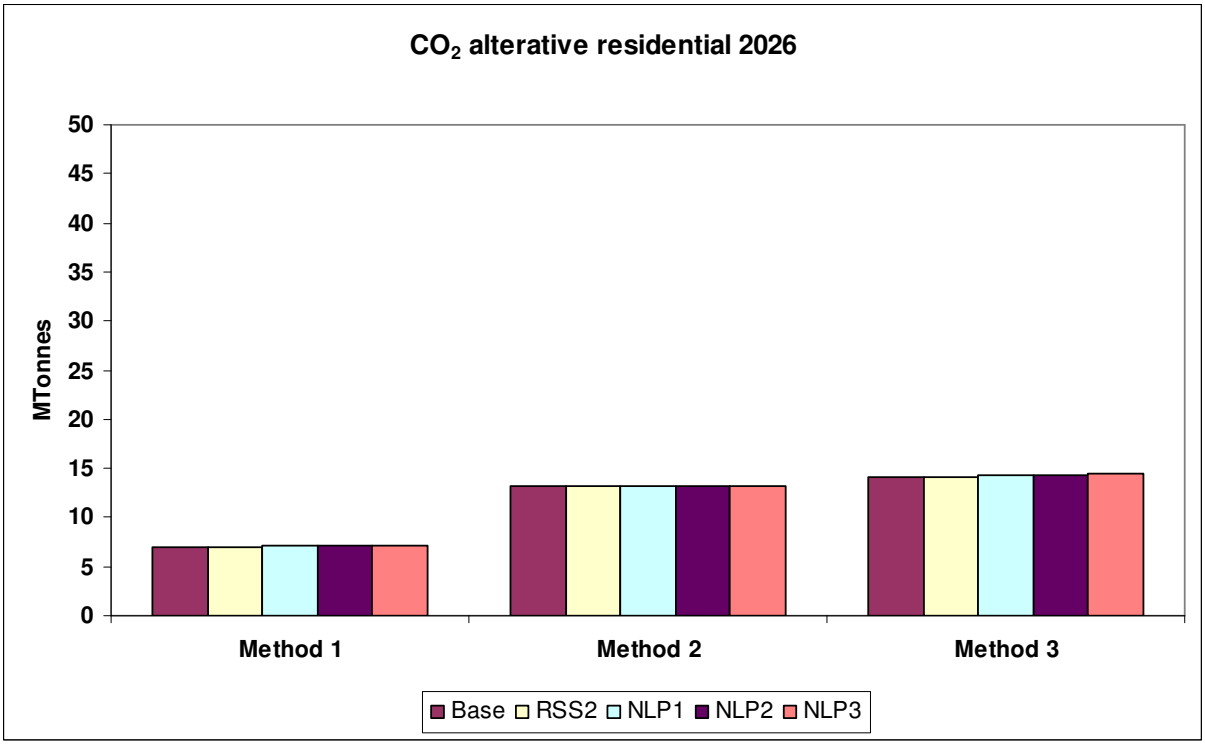
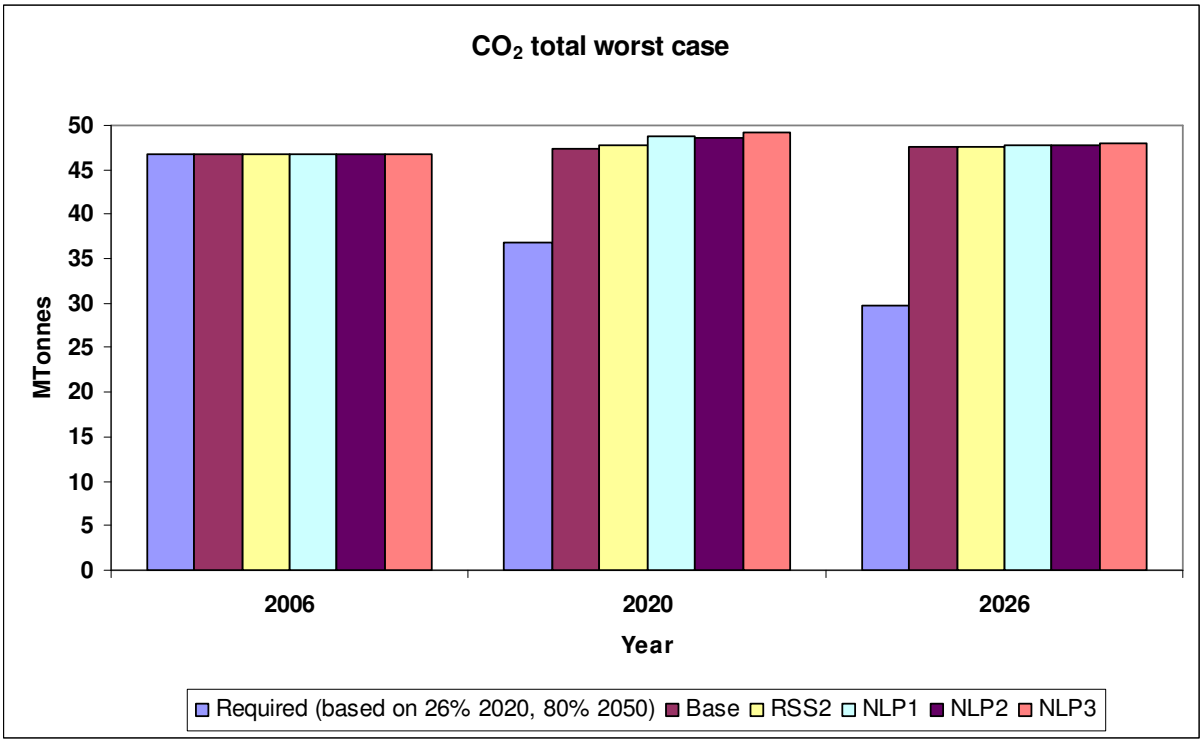


Figure 3-2: CO_2 Total worst case emissions and implied required reduction



3.4.5 Light industry and commercial and public sector fuel use

Light industry and commercial fuel use related emissions have been scaled on a fuel-by-fuel basis in line with the sectors UK fuel use change in 2020 relative to 2005 in BERR UEP 30 (2008) and DUKES (BERR, 2007). The 2026 estimates were extrapolated from UEP30. An example for gas is shown below:

LA 2020 = LA 2005 x (UK 2020/UK 2005)

Where: LA 2020 = Local authority light industry and commercial gas emissions in 2020.

LA 2005 = Local authority light industry and commercial gas emissions in 2005.

UK 2020 = UK service sector gas demand in 2020.

UK 2005 = UK service sector gas demand in 2005.

The 2050 emissions are assumed to remain the same as 2020 in absence of any specific projection data.

Emissions are presented separately for each local authority split by fuel type, whether emissions are under the EU ETS in the spreadsheet, totals are presented in this report. The underlying data used in the projections (demand) are also provided in the spreadsheet.

3.4.6 Agricultural fuel use

Agricultural fuel use related emissions have been scaled on a fuel-by-fuel basis in line with the sectors UK fuel use change in 2020 relative to 2005 in BERR UEP 30 (2008) and DUKES (BERR, 2007) in a similar manner to that described above except that the agricultural fuel demand data has been used as opposed to the service sector.

Emissions are presented separately for each local authority split by fuel type in the spreadsheet, totals are presented in this report. The underlying data used in the projections (demand) are also provided in the spreadsheet.

3.4.7 House hold products

Household products such as carbon in detergents and emissions from petroleum waxes are a relatively small source and therefore have been factored on the change in the number of households per local authority from CLG (2008) the RSS (WMRA, 2007c) and NLP (GOWM, 2008).

LA 2020 = LA 2005 x (LA households 2020/LA households 2005)

Where: LA 2020 = Local authority household product emissions in 2020.

LA 2005 = Local authority household product emissions in 2005.

LA households 2020 = the number of households in the local authority in 2020.

LA households 2005 = the number of households in the local authority in 2005.

Emissions are presented separately for each local authority split by fuel type in the spreadsheet, totals are presented in this report. The underlying data used in the projections (demand, households, population) are also provided in the spreadsheet.

3.4.8 Road transport

In addition to the method discussed in Road Transport (Section 3.3.4), it was also assumed that 10% of diesel use was as bio-diesel and therefore was carbon neutral. Emission factors relative to the 2020 and 2025 (taken as 2026) fleet mix were applied to relevant traffic flows (http://www.naei.org.uk/emissions/index.php).

In addition TEMPRO growth factors were normalised against the DfT actual road traffic growth for the UK as a whole to enable comparable growth (i.e. Actual UK Traffic Growth (2020 to 2006)/TEMPRO UK Traffic Growth (2020 to 2006) as discussed in the Tempro Guidance Note, April 2006 edition (DfT, available at www.tempro.org.uk).

End user emissions were also calculated based on the 2005 fuel based ratios, as discussed in End user (Section 3.3.3).

Emissions are presented separately for each local authority split by fuel type in the spreadsheet, totals are presented in this report.

3.4.9 Rail

Rail is a relatively minor source and as such it has been assumed that the 2020 and 2026 emissions are the same as 2005 in absence of specific rail data, even though passenger numbers are likely to increase.

3.4.10 Aviation

For 2020 and 2026 the DfT projections per airport in terms of the changes in passenger numbers were used to project the emissions to 2020 for the West Midlands (using the DfT central scenario interpolated between 2015 and 2030 (DfT, 2007a)). This methodology does not account for changes in technology/fleet.

Emissions are presented separately for each local authority split by international and domestic and fuel type in the spreadsheet, totals are presented in this report. The underlying data used in the projections are also provided in the spreadsheet.

3.4.11 Other transport

Other transport (Off road) (not road, rail, aviation) is again a relatively minor source and as such has been assumed to be the same as that of 2005.

3.4.12 Waste

For incineration related emissions, emissions were increased in line with UK projections for 2020 and 2026 (constant).

Emissions are presented separately for each local authority in the spreadsheet, totals are presented in this report. The underlying data used in the projections are also provided in the spreadsheet.

3.4.13 Agriculture and nature

Agricultural and natural emissions were based on the 2005 data, however, the UK trend between 2020 and 2005 was applied to account for changes and extrapolated for 2026. This is a relatively simple methodology and reflects the low emissions from this sector.

Emissions are presented separately for each local authority in the spreadsheet, totals are presented in this report. The underlying data used in the projections are also provided in the spreadsheet.

3.5 Summary of methodology

Table 3-3 below summarises the methodology used. The uncertainty column is a qualitative assessment of the margin of error involved in any data analysis. Scientific work is rarely uncertainty free, and the provision of uncertainty estimations is both good practice and allows the reader to appreciate the quality of the presented results. To qualitatively address the uncertainty involved in calculating the 2006 baseline inventory and subsequent projections to 2020 and 2026 the emissions from each source sector have been rated according to the definitions below:

4. High quality estimate based on real emissions or activity data at known locations.

3. Good quality estimate based on mostly real emissions or activity data at known locations and some modelled emissions.

2. Medium quality estimate based on mostly modelled emissions using appropriate surrogate statistics.

1. Low quality estimate based on surrogate statistics that may not be fully appropriate for this sector.

0. Very low quality, which should ideally be recalculated as more data becomes available.

It should be noted that the combustion emissions for the base year have been given a ‘3’ for uncertainty this refers to gas related emissions. Other fuel emissions have been given a ‘2’ (indicated in the bracket). Similarly there are different ratings for gas and other fuel in other years. This is due to the uncertainty surrounding non-gas fuel use data. Gas use activity data is well documented. Similarly, road traffic for the base year is classed as a ‘4’ as the majority of the emissions are associated with major roads, however, minor roads data is not really a ‘4, but only accounts for a small proportion of the road emissions.

Generally, the overall uncertainty for 2006 is around a ‘3’ as it is a reasonable estimate for most source sectors based on actual vehicle kilometres (vkm), fuel use data (2005 factored to 2006), recorded industrial emissions (2005), and land use data. For 2020 and 2026 the overall uncertainty is around 1.

Table 3-3: Methodology Summary

Year	Source	Method	Data sources	Uncertainty	Explanation
2006	LULUCF	Data extracted for each LA in WM	Defra LA CO_2 emissions	3	Land use change emissions taken directly from source.
2020	LULUCF	(WMEI 2005 LULUCF) x (2020 UK LULUCF)/(2005 UK LULUCF)	BERR UEP 30 and WMEI 2005	1	Assumed land use change emissions change in a similar manner to the UK.
2026	LULUCF	(WMEI 2005 LULUCF) x (2026 UK LULUCF)/(2005 UK LULUCF)	BERR UEP 30 and WMEI 2005	1	Assumed land use change emissions change in a similar manner to the UK.
2006	Agriculture	Extracted from the spatial NAEI 2005 x (2006 UK Sector)/(2005 UK Sector)	NAEI and UK GHGI	3	Data extracted from spatial national datasets.
2020	Agriculture	WMEI 2006 Sector	No projection data	1	Assumed constant
2050	Agriculture	WMEI 2006 Sector	No projection data	1	Assumed constant
2006	Waste	Extracted from the spatial NAEI 2005	NAEI and UK GHGI	3	Data extracted from spatial national datasets.
2020	Waste – incineration	WMEI 2006 Sector	No projection data	1	Incineration assumed constant
2026	Waste – incineration	WMEI 2006 Sector	No projection data	1	Incineration assumed constant
2006	Commercial combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2006/UK sector, fuel 2005)	DUKES, NAEI 2005	3 gas (1 other)	Assumes that this sectors fuel use change generally is similar to the same sectors fuel use change in the UK. However, as the emissions are calculated separately for each fuel, this takes account of different fuel mixes and fuel switching to some extent.
2020	Commercial combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2020/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.
2026	Commercial combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2026/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.

2006	Public combustion	(NAEI sector, fuel 2005) x (UK sector, fuel 1990/UK sector, fuel 2005)	DUKES, NAEI 2005	3 gas (1 other)	Assumes that this sectors fuel use change generally is similar to the same sectors fuel use change in the UK. However, as the emissions are calculated separately for each fuel, this takes account of different fuel mixes and fuel switching to some extent.
2020	Public combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2020/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.
2026	Public combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2026/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.
2006	Agricultural combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 1990/UK sector, fuel 2005)	DUKES, NAEI 2005	3 gas (1 other)	Assumes that this sectors fuel use change generally is similar to the same sectors fuel use change in the UK. However, as the emissions are calculated separately for each fuel, this takes account of different fuel mixes and fuel switching to some extent.
2020	Agricultural combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2020/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.
2026	Agricultural combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2026/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.
2006	Residential combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2006/UK sector, fuel 2005) x ((LA households 2006/LA households 2005) / (UK households 2006/UK households 2005))	DUKES, CLG (households) and NAEI 2005	3 gas (2 other)	Assumes that this sectors fuel use change generally is similar to the same sectors fuel use change in the UK. However, as the emissions are calculated separately for each fuel, this takes account of different fuel mixes and fuel switching to some extent. Households (dwellings) is used to give the data a WM bias.

2020	Residential combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2020/UK sector, fuel 2005) x ((LA households 2020/LA households 2005) / (UK households 2020/UK households 2005))	BERR UEP 30, RSS Phase 2 Preferred Option or NLP and CLG (households) and NAEI 2005	2 gas (1 other)	See above.
2026	Residential combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2026/UK sector, fuel 2005) x ((LA households 2026/LA households 2005) / (UK households 2026/UK households 2005))	BERR UEP 30, RSS Phase 2 Preferred Option or NLP and CLG (households) and NAEI 2005	2 gas (1 other)	See above.
2006	Household products	(NAEI sector 2005) x (LA households 2006)/(LA households 2005)	CLG (households) and NAEI 2005	2	Assumes this sector changes in line with households.
2020	Household products	(NAEI sector 2005) x (LA households 2020)/(LA households 2005)	RSS Phase 2 Preferred Option or NLP (households) and NAEI 2005	1	Assumes this sector changes in line with households.
2026	Household products	(NAEI sector 2005) x (LA households 2026)/(LA households 2005)	RSS Phase 2 Preferred Option or NLP (households) and NAEI 2005	1	Assumes this sector changes in line with households.
2006	Road transport	DfT traffic flow data for major roads, DfT vkm for minor roads	DfT via NAEI	4	Refer to section 3.3.4.
2020	Road transport	DfT traffic flow data for major roads 2006, DfT LA based traffic growth (TEMPRO), NAEI fleet projections and MOTTs traffic data	NAEI, TEMPRO, NAEI, MOTTS	2	Refer to section 3.4.8.
2026	Road transport	DfT traffic flow data for major roads 2006, DfT LA based traffic growth (TEMPRO), NAEI fleet projections and MOTTs traffic data	NAEI, TEMPRO, NAEI, MOTTS	2	Refer to section 3.4.8.
2006	Aviation	Extracted per airport from NAEI	NAEI	3	Refer to section 3.3.5.
2020	Aviation	(PAX per airport 2020) x (NAEI 2005)/(PAX per airport 2005)	DfT PAX projections, NAEI	2	Refer to section 3.4.10.
2026	Aviation	(PAX per airport 2026) x (NAEI 2005)/(PAX per airport 2005)	DfT PAX projections, NAEI	2	Refer to section 3.4.10.
2006	Rail	Extracted from NAEI	NAEI	3	Data extracted for WM.
2020	Rail	Minor source, assumed as 2005	NAEI 2005	0	Assume no change.
2026	Rail	Minor source, assumed as 2005	NAEI 2005	0	Assume no change.
2006	Other transport	Extracted from NAEI	NAEI	3	Data extracted for WM.
2020	Other transport	Minor source, assumed as 2005	NAEI 2005	0	Assume no change.
2026	Other transport	Minor source, assumed as 2005	NAEI 2005	0	Assume no change.
2006	Industrial process	(NAEI sector) x (UK sector 2006/UK sector 2005)	DUKES, NAEI	4	Refer to section 3.4.1.
2020	Industrial process	(NAEI sector) x (UK sector 2020/UK sector 2005)	BERR UEP 30 and NAEI 2005	1	Refer to section 3.4.1.
2050	Industrial process	(NAEI sector) x (UK sector 2026/UK sector 2005)	BERR UEP 30 and NAEI 2005	1	Refer to section 3.4.1.

2006	Industrial combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2006/UK sector, fuel 2005)	DUKES and NAEI 2005	3	Assumes that this sectors fuel use change generally is similar to the same sectors fuel use change in the UK. However, as the emissions are calculated separately for each fuel, this takes account of different fuel mixes and fuel switching to some extent.
2020	Industrial combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2020/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.
2026	Industrial combustion per fuel type	(NAEI sector, fuel 2005) x (UK sector, fuel 2026/UK sector, fuel 2005)	BERR UEP 30 and NAEI 2005	2 gas (1 other)	See above.

4 Findings

The emission results are presented by sector and by pollutant in this Section as 'End User' equivalent.

Additional '186' local authority compliant totals (refer to Data sources and methodology, Section 3 for sectors included in 186 equivalent) are included in the spreadsheet.

The results from this study have been compared with the Defra LA CO_2 (King et al, 2008) data for all West Midlands local authorities in 2006 to validate the results and methodology and though based on different datasets and methodologies the results are comparable and therefore it is assumed that the methodology is appropriate for this study, the comparison can be found in Appendix 2.

Trends for CO_2, and a discussion of the results, is included in Emissions results (Section 4.1).

Sub-regional analysis (Section 4.2) discusses the sub-regional differences to the region as a whole. Additional results by local authority and in greater sector detail are available in the spreadsheet and Appendix 3.

It should be noted that the results are primarily driven by UK projections, supplemented where feasible with local statistics and therefore the trends between years tend to be similar to the UK trends.

4.1 Emission results

The total emissions for the 2006 baseline are compared against future emissions in 2020 and 2026 for the following housing scenarios in Table 4-1:

- the CLG derived data (Base);
- the RSS Phase 2 Preferred Option (RSS 2) with 365,600 additional houses compared to 2006;
- NLP scenario 1 (NLP 1) with 417,100 additional houses compared to 2006;
- NLP scenario 2 (NLP 2) with 419,600 additional houses compared to 2006; and
- NLP scenario 3 (NLP3) with 445,600 additional houses compared to 2006.

Tables 4-2 to 4-12 provide a breakdown per scenario for what is actually emitted and the reallocated element of the emissions. As can be seen in Table 4-1, the emissions are projected to decrease from the base year (2006) when projected into the future (2020 and 2026). This is due to the national projections primarily in terms of fuel use and fuel efficiency. The difference between the base case for the future years and the various housing scenarios is small.

Industrial combustion is set to increase in the future due to the BERR projected industrial energy demand and mix (some fuels are more carbon intensive). As the overall energy demand for industry is set to increase this is assumed to drive a corresponding increase in the industrial process emission (non-fuel) seen in future years. There is no change in the different scenarios compared to the base for the same year.

Electricity emissions are set to decrease in the future due to the relative reduction in demand in the BERR projections (driven by, presumably, energy efficiency) and the reduction in emissions from UK power stations due to the assumed BERR fuel mix for UK power stations in the future.

Rail, other transport, waste (incineration) and agricultural non-combustion emissions are relatively small sources and have been assumed to remain static across all years and scenarios.

Road traffic emissions remain fairly constant with some variation which is driven by a number of factors: assumed increased fuel efficiency of road vehicles in future years which reduces the

emissions per vehicle, however, this is offset by the increased number of vehicles using the roads (traffic growth), resulting in an overall increase in emissions in future years. The effect of the increase in vehicle kilometres can be seen in the various scenario results compared to the baseline for each year – this is due to the relative increase in housing in each of the scenarios.

Residential combustion emissions reduce in future years due to the projected BERR domestic energy demand and mix (some fuels are more carbon intensive). The overall energy demand for the residential sector is assumed to decrease because of national carbon saving measures in National Policy. However, some of the decrease is offset by the increasing number of households in the various scenarios, this is more apparent in 2020 than in 2026 due to the greater energy efficiency of new housing post 2020 (new build is assumed linear from 2006 to 2026).

Aviation emissions are based on the Dft airport specific projections as discussed in Projections to 2020 and 2026 (Section 3.4) and it can be seen that there is a jump in emissions projected from 2006 to 2020 and then some slight growth to 2026. There is no change in the different scenarios compared to the base for the same year.

Other combustion emissions reduce in future years due to the projected BERR sector energy demand and mix (some fuels are more carbon intensive). The overall energy demand for these sectors is set to decrease. There is no change in the different scenarios compared to the base for the same year.

Land Use, Land Use Change and Forestry (LULUCF) emissions are based on UK projected LULUCF emissions. There is no change in the different scenarios compared to the base for the same year.

The results from Table 4-1 have also been summarised in Figures 4-1 to 4-4, which depict the trends for total CO_2 for the 'Total with end user' for road transport, residential, other and total emissions.

The required reduction in Figure 4-2 has been estimated by assuming that the West Midlands reduction in emissions from 1990 has been in line with the UK reductions (Jackson et al, 2008) to 2006. Therefore it is the additional reduction required from 2006 to meet the UK targets (assumed in this context to be 26% reduction by 2020 from 1990 and 80% reduction by 2050 from 1990) that has been used. For 2026 it has been assumed that the reduction to 2050 (80%) would apply. Therefore to meet these national targets, emissions in the West Midlands need to decrease by 21% by 2020 and 36% by 2026 compared to the 2006 baseline. Further year on year reductions would then be needed to meet the 2050 80% target. These reductions are shown graphically in Figure 4-2.

As can be seen in Figures 4-1 to 4-4, it is projected that from 2006 there is a drop in total and residential emissions to 2020 and again a drop to 2026, due primarily to assumed National Policy implementation in terms of reducing carbon emissions. However, projected emissions from road transport increase in 2020 and again in 2026 compared to 2006. The main decrease for future year total is seen to come from residential emissions. From Figures 4-1 to 4-4 it can be seen that:

- Road transport is contributing significantly to the total CO_2 emissions in the region, note that this is the case for all sub-regions and local authorities.
- Under the future baseline scenarios the emissions are projected to decease by 4.7MT in 2020 and 6.4MT in 2026, this is driven mainly by the assumed delivery of National Policy.
- With the RSS Phase 2 Preferred Option, total emissions are only projected only decrease by 4.2MT in 2020 and 6.3MT in 2026. This is due to the increase in, and distribution of, housing.
- The projected residential emissions reduce by 5.5MT for both the RSS Phase 2 Preferred Option and the baseline in 2026 compared to 2006.
- Projected road transport emissions increase by 1.7MT for the RSS Phase 2 Preferred Option as oppose to 1.6MT in 2026 for the baseline, compared to 2006.
- **The overall emission reductions from 2006 are smaller for the NLP scenarios (i.e. emissions are higher) compared to both the RSS Phase 2 Preferred Option and baseline, due to higher emissions in both the residential and road transport sectors compared to the other scenarios**.

These projections demonstrate that the West Midlands faces a significant challenge in reaching National CO_2 reduction targets and that it is unlikely that existing national policies will meet these targets.

The RSS Phase 2 Preferred Option and various NLP scenarios do not meet the climate change targets discussed in West Midlands Targets (Section 2.2). Therefore, further significant and concerted policy action is required to meet this challenge, for which the RSS (and forthcoming Regional Strategy) should form a clear focus.

Table 4-1: Total emissions for all scenarios (CO_2 tonnes per year)

Sector	2006	2020 BASE	2020 RSS	2020 NLP1	2020 NLP2	2020 NLP3	2026 BASE	2026 RSS	2026 NLP1	2026 NLP2	2026 NLP3
Industry combustion	3,035,103	3,587,011	3,587,011	3,587,011	3,587,011	3,587,011	3,741,421	3,741,421	3,741,421	3,741,421	3,741,421
Industry combustion EUETS	1,093,525	1,076,554	1,076,554	1,076,554	1,076,554	1,076,554	1,113,903	1,113,903	1,113,903	1,113,903	1,113,903
Industry process	134,223	152,170	152,170	152,170	152,170	152,170	157,666	157,666	157,666	157,666	157,666
Industry process EUETS	981,008	1,128,938	1,128,938	1,128,938	1,128,938	1,128,938	1,190,014	1,190,014	1,190,014	1,190,014	1,190,014
Industry and other electricity	9,443,602	6,842,546	6,842,546	6,842,546	6,842,546	6,842,546	6,339,730	6,339,730	6,339,730	6,339,730	6,339,730
Rail	211,653	211,653	211,653	211,653	211,653	211,653	211,653	211,653	211,653	211,653	211,653
Aviation	566,036	1,346,581	1,346,581	1,346,581	1,346,581	1,346,581	1,463,586	1,463,586	1,463,586	1,463,586	1,463,586
Motorways	6,670,266	7,093,169	7,400,381	7,954,731	7,805,496	8,055,291	7,261,215	7,324,068	7,369,148	7,377,515	7,401,105
Road non motorways	7,929,164	8,684,744	8,908,153	9,228,338	9,166,444	9,318,420	8,981,421	8,978,209	8,986,538	8,986,400	8,990,459
Other transport	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601	1,452,601
Residential	6,694,905	4,463,508	4,446,139	4,519,783	4,519,275	4,555,298	3,445,137	3,447,651	3,525,751	3,524,946	3,562,519
Residential electricity	5,696,950	3,986,662	3,961,507	4,023,236	4,023,281	4,053,238	3,472,581	3,462,673	3,536,502	3,536,557	3,572,386
Agricultural combustion	37,492	44,275	44,275	44,275	44,275	44,275	45,750	45,750	45,750	45,750	45,750
Public sector combustion	888,189	842,397	842,397	842,397	842,397	842,397	805,110	805,110	805,110	805,110	805,110
EU ETS Public sector combustion	155,717	176,289	176,289	176,289	176,289	176,289	170,374	170,374	170,374	170,374	170,374
Commercial combustion	1,037,586	947,387	947,387	947,387	947,387	947,387	901,472	901,472	901,472	901,472	901,472
EU ETS Commercial combustion	2,568	2,194	2,194	2,194	2,194	2,194	2,033	2,033	2,033	2,033	2,033
Waste	308,044	308,044	308,044	308,044	308,044	308,044	308,044	308,044	308,044	308,044	308,044
Agricultural	736	736	736	736	736	736	736	736	736	736	736
LULUCF*	349,883	-336,426	-336,426	-336,426	-336,426	-336,426	-740,137	-740,137	-740,137	-740,137	-740,137
Total with end user	**46,689,251**	**42,011,033**	**42,499,129**	**43,509,037**	**43,297,445**	**43,765,196**	**40,324,309**	**40,376,556**	**40,581,895**	**40,589,373**	**40,690,424**

*Includes sinks as well as sources

Table 4-2: Emissions for 2006 ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	2,928,249	106,854	3,035,103
Industry combustion EUETS	1,077,409	16,116	1,093,525
Industry process	134,223	0	134,223
Industry process EUETS	981,008	0	981,008
Industry and other electricity	0	9,443,602	9,443,602
Rail	191,807	19,845	211,653
Aviation	511,871	54,166	566,036
Motorways	6,032,498	637,768	6,670,266
Road non motorways	7,167,756	761,408	7,929,164
Other transport	1,316,249	136,352	1,452,601
Residential	6,550,310	144,595	6,694,905
Residential electricity	0	5,696,950	5,696,950
Agricultural combustion	36,799	693	37,492
Public sector combustion	870,024	18,165	888,189
EU ETS Public sector combustion	152,871	2,846	155,717
Commercial combustion	1,014,177	23,409	1,037,586
EU ETS Commercial combustion	2,455	113	2,568
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	349,883	0	349,883
Total with end user	**29,626,368**	**17,062,883**	**46,689,251**

*Includes sinks as well as sources

Table 4-3: Emissions for 2020 Base ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,472,923	114,088	3,587,011
Industry combustion EUETS	1,056,982	19,572	1,076,554
Industry process	152,170	0	152,170
Industry process EUETS	1,128,938	0	1,128,938
Industry and other electricity	0	6,842,546	6,842,546
Rail	191,807	19,845	211,653
Aviation	1,217,723	128,859	1,346,581
Motorways	6,414,969	678,200	7,093,169
Road non motorways	7,850,857	833,888	8,684,744
Other transport	1,316,249	136,352	1,452,601
Residential	4,371,314	92,195	4,463,508
Residential electricity	0	3,986,662	3,986,662
Agricultural combustion	43,357	918	44,275
Public sector combustion	826,294	16,103	842,397
EU ETS Public sector combustion	173,610	2,680	176,289
Commercial combustion	927,194	20,193	947,387
EU ETS Commercial combustion	2,106	88	2,194
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-336,426	0	-336,426
Total with end user	**29,118,847**	**12,892,186**	**42,011,033**

*Includes sinks as well as sources

Table 4-4: Emissions for 2020 RSS Phase 2 Preferred Option ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,472,923	114,088	3,587,011
Industry combustion EUETS	1,056,982	19,572	1,076,554
Industry process	152,170	0	152,170
Industry process EUETS	1,128,938	0	1,128,938
Industry and other electricity	0	6,842,546	6,842,546
Rail	191,807	19,845	211,653
Aviation	1,217,723	128,859	1,346,581
Motorways	6,692,772	707,608	7,400,381
Road non motorways	8,052,799	855,355	8,908,153
Other transport	1,316,249	136,352	1,452,601
Residential	4,354,451	91,688	4,446,139
Residential electricity	0	3,961,507	3,961,507
Agricultural combustion	43,357	918	44,275
Public sector combustion	826,294	16,103	842,397
EU ETS Public sector combustion	173,610	2,680	176,289
Commercial combustion	927,194	20,193	947,387
EU ETS Commercial combustion	2,106	88	2,194
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-336,426	0	-336,426
Total with end user	**29,581,730**	**12,917,399**	**42,499,129**

*Includes sinks as well as sources

Table 4-5: Emissions for 2020 NLP 1 ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,472,923	114,088	3,587,011
Industry combustion EUETS	1,056,982	19,572	1,076,554
Industry process	152,170	0	152,170
Industry process EUETS	1,128,938	0	1,128,938
Industry and other electricity	0	6,842,546	6,842,546
Rail	191,807	19,845	211,653
Aviation	1,217,723	128,859	1,346,581
Motorways	7,194,026	760,705	7,954,731
Road non motorways	8,342,241	886,098	9,228,338
Other transport	1,316,249	136,352	1,452,601
Residential	4,426,433	93,350	4,519,783
Residential electricity	0	4,023,236	4,023,236
Agricultural combustion	43,357	918	44,275
Public sector combustion	826,294	16,103	842,397
EU ETS Public sector combustion	173,610	2,680	176,289
Commercial combustion	927,194	20,193	947,387
EU ETS Commercial combustion	2,106	88	2,194
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-336,426	0	-336,426
Total with end user	**30,444,407**	**13,064,630**	**43,509,037**

*Includes sinks as well as sources

Table 4-6: Emissions for 2020 NLP2 ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,472,923	114,088	3,587,011
Industry combustion EUETS	1,056,982	19,572	1,076,554
Industry process	152,170	0	152,170
Industry process EUETS	1,128,938	0	1,128,938
Industry and other electricity	0	6,842,546	6,842,546
Rail	191,807	19,845	211,653
Aviation	1,217,723	128,859	1,346,581
Motorways	7,059,101	746,395	7,805,496
Road non motorways	8,286,283	880,160	9,166,444
Other transport	1,316,249	136,352	1,452,601
Residential	4,426,009	93,266	4,519,275
Residential electricity	0	4,023,281	4,023,281
Agricultural combustion	43,357	918	44,275
Public sector combustion	826,294	16,103	842,397
EU ETS Public sector combustion	173,610	2,680	176,289
Commercial combustion	927,194	20,193	947,387
EU ETS Commercial combustion	2,106	88	2,194
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-336,426	0	-336,426
Total with end user	**30,253,101**	**13,044,344**	**43,297,445**

*Includes sinks as well as sources

Table 4-7: Emissions for 2020 NLP3 ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,472,923	114,088	3,587,011
Industry combustion EUETS	1,056,982	19,572	1,076,554
Industry process	152,170	0	152,170
Industry process EUETS	1,128,938	0	1,128,938
Industry and other electricity	0	6,842,546	6,842,546
Rail	191,807	19,845	211,653
Aviation	1,217,723	128,859	1,346,581
Motorways	7,284,975	770,316	8,055,291
Road non motorways	8,423,667	894,753	9,318,420
Other transport	1,316,249	136,352	1,452,601
Residential	4,461,197	94,101	4,555,298
Residential electricity	0	4,053,238	4,053,238
Agricultural combustion	43,357	918	44,275
Public sector combustion	826,294	16,103	842,397
EU ETS Public sector combustion	173,610	2,680	176,289
Commercial combustion	927,194	20,193	947,387
EU ETS Commercial combustion	2,106	88	2,194
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-336,426	0	-336,426
Total with end user	**30,651,546**	**13,113,650**	**43,765,196**

*Includes sinks as well as sources

Table 4-8: Emissions for 2026 Base ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,625,901	115,520	3,741,421
Industry combustion EUETS	1,093,723	20,180	1,113,903
Industry process	157,666	0	157,666
Industry process EUETS	1,190,014	0	1,190,014
Industry and other electricity	0	6,339,730	6,339,730
Rail	191,807	19,845	211,653
Aviation	1,323,531	140,055	1,463,586
Motorways	6,566,997	694,218	7,261,215
Road non motorways	8,119,079	862,341	8,981,421
Other transport	1,316,249	136,352	1,452,601
Residential	3,376,705	68,432	3,445,137
Residential electricity	0	3,472,581	3,472,581
Agricultural combustion	44,905	845	45,750
Public sector combustion	790,003	15,107	805,110
EU ETS Public sector combustion	167,845	2,529	170,374
Commercial combustion	882,696	18,777	901,472
EU ETS Commercial combustion	1,955	78	2,033
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-740,137	0	-740,137
Total with end user	**28,417,719**	**11,906,590**	**40,324,309**

*Includes sinks as well as sources

Table 4-9: Emissions for 2026 RSS Phase 2 Preferred Option ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,625,901	115,520	3,741,421
Industry combustion EUETS	1,093,723	20,180	1,113,903
Industry process	157,666	0	157,666
Industry process EUETS	1,190,014	0	1,190,014
Industry and other electricity	0	6,339,730	6,339,730
Rail	191,807	19,845	211,653
Aviation	1,323,531	140,055	1,463,586
Motorways	6,623,811	700,257	7,324,068
Road non motorways	8,116,143	862,066	8,978,209
Other transport	1,316,249	136,352	1,452,601
Residential	3,379,401	68,250	3,447,651
Residential electricity	0	3,462,673	3,462,673
Agricultural combustion	44,905	845	45,750
Public sector combustion	790,003	15,107	805,110
EU ETS Public sector combustion	167,845	2,529	170,374
Commercial combustion	882,696	18,777	901,472
EU ETS Commercial combustion	1,955	78	2,033
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-740,137	0	-740,137
Total with end user	**28,474,293**	**11,902,263**	**40,376,556**

*Includes sinks as well as sources

Table 4-10: Emissions for 2026 NLP1 ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,625,901	115,520	3,741,421
Industry combustion EUETS	1,093,723	20,180	1,113,903
Industry process	157,666	0	157,666
Industry process EUETS	1,190,014	0	1,190,014
Industry and other electricity	0	6,339,730	6,339,730
Rail	191,807	19,845	211,653
Aviation	1,323,531	140,055	1,463,586
Motorways	6,664,512	704,636	7,369,148
Road non motorways	8,123,642	862,896	8,986,538
Other transport	1,316,249	136,352	1,452,601
Residential	3,455,799	69,952	3,525,751
Residential electricity	0	3,536,502	3,536,502
Agricultural combustion	44,905	845	45,750
Public sector combustion	790,003	15,107	805,110
EU ETS Public sector combustion	167,845	2,529	170,374
Commercial combustion	882,696	18,777	901,472
EU ETS Commercial combustion	1,955	78	2,033
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-740,137	0	-740,137
Total with end user	**28,598,890**	**11,983,004**	**40,581,895**

*Includes sinks as well as sources

Table 4-11: Emissions for 2026 NLP2 ('r' refers to reallocated to end user) (CO_2 tonnes per year)

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,625,901	115,520	3,741,421
Industry combustion EUETS	1,093,723	20,180	1,113,903
Industry process	157,666	0	157,666
Industry process EUETS	1,190,014	0	1,190,014
Industry and other electricity	0	6,339,730	6,339,730
Rail	191,807	19,845	211,653
Aviation	1,323,531	140,055	1,463,586
Motorways	6,672,105	705,410	7,377,515
Road non motorways	8,123,521	862,879	8,986,400
Other transport	1,316,249	136,352	1,452,601
Residential	3,455,102	69,844	3,524,946
Residential electricity	0	3,536,557	3,536,557
Agricultural combustion	44,905	845	45,750
Public sector combustion	790,003	15,107	805,110
EU ETS Public sector combustion	167,845	2,529	170,374
Commercial combustion	882,696	18,777	901,472
EU ETS Commercial combustion	1,955	78	2,033
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-740,137	0	-740,137
Total with end user	**28,605,665**	**11,983,707**	**40,589,373**

*Includes sinks as well as sources

Table 4-12: Emissions for 2026 NLP3 ('r' refers to reallocated to end user) (CO_2 tonnes per year)~

Sector / Pollutant	CO_2	CO_2r	Total
Industry combustion	3,625,901	115,520	3,741,421
Industry combustion EUETS	1,093,723	20,180	1,113,903
Industry process	157,666	0	157,666
Industry process EUETS	1,190,014	0	1,190,014
Industry and other electricity	0	6,339,730	6,339,730
Rail	191,807	19,845	211,653
Aviation	1,323,531	140,055	1,463,586
Motorways	6,693,411	707,694	7,401,105
Road non motorways	8,127,176	863,283	8,990,459
Other transport	1,316,249	136,352	1,452,601
Residential	3,491,860	70,659	3,562,519
Residential electricity	0	3,572,386	3,572,386
Agricultural combustion	44,905	845	45,750
Public sector combustion	790,003	15,107	805,110
EU ETS Public sector combustion	167,845	2,529	170,374
Commercial combustion	882,696	18,777	901,472
EU ETS Commercial combustion	1,955	78	2,033
Waste	308,044	0	308,044
Agricultural	736	0	736
LULUCF*	-740,137	0	-740,137
Total with end user	**28,667,384**	**12,023,040**	**40,690,424**

*Includes sinks as well as sources

Figure 4-1: CO_2 trends per key sector

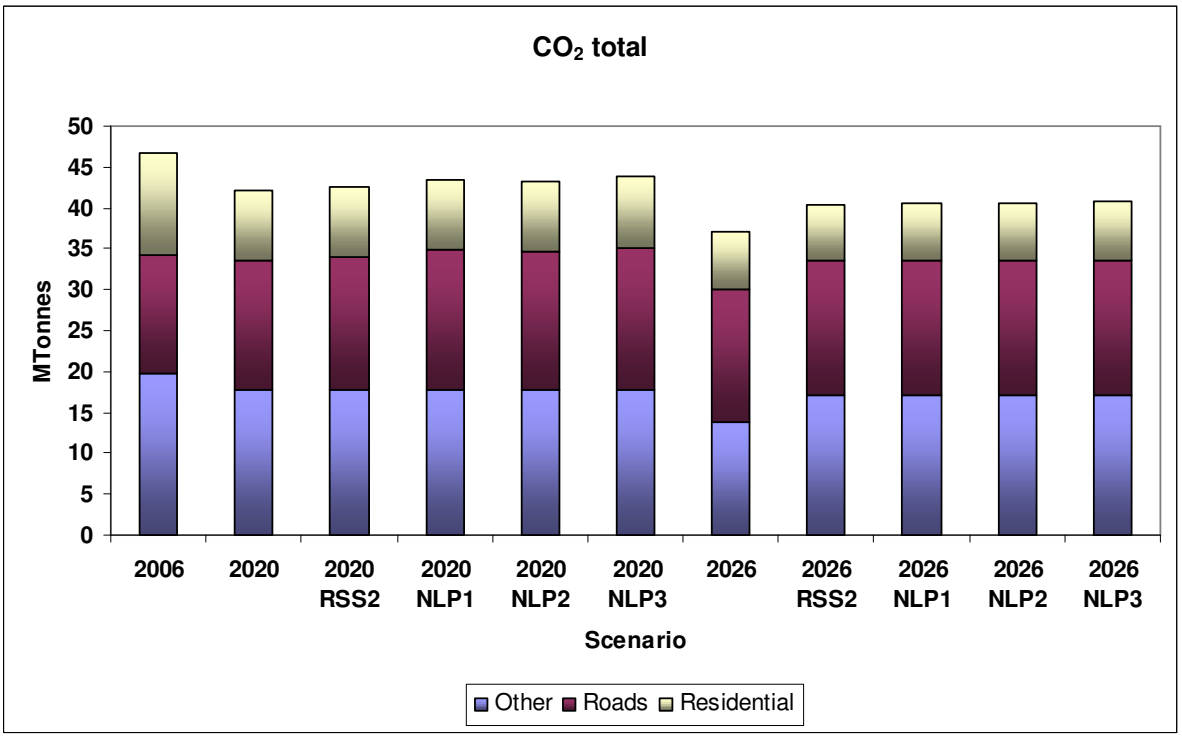


Figure 4-2: CO_2 Total emissions and implied required reduction

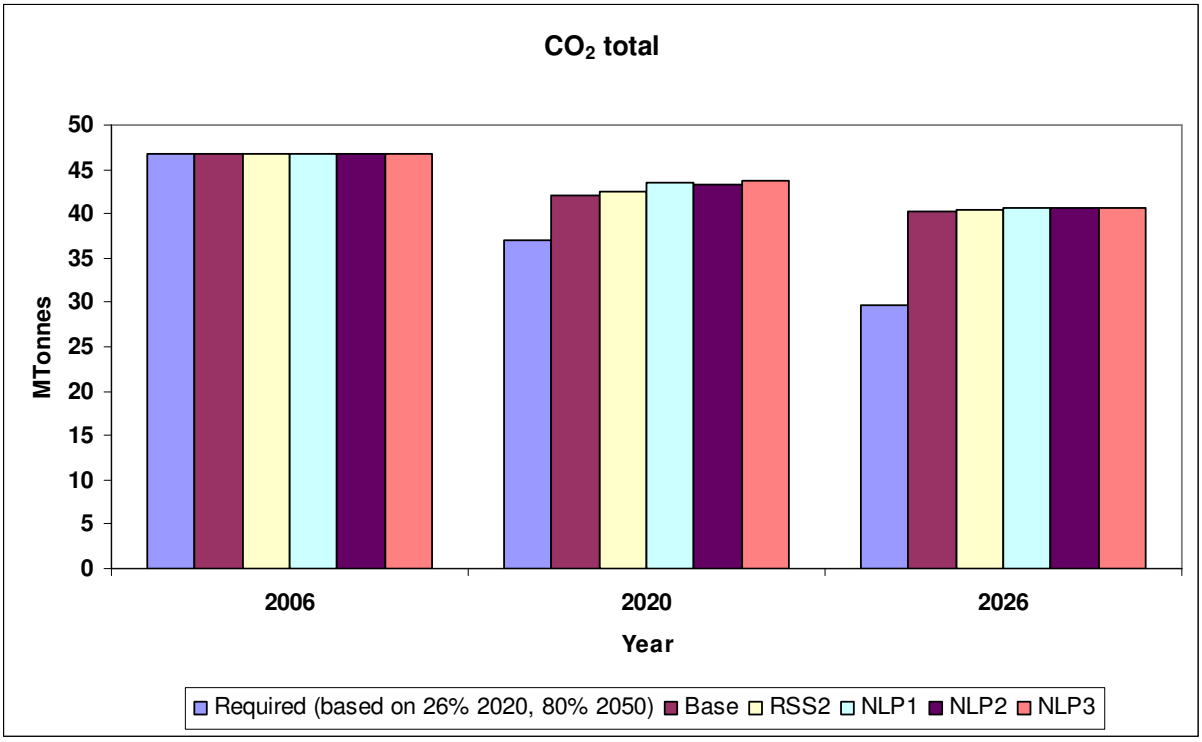


Figure 4-3: CO_2 Residential emissions

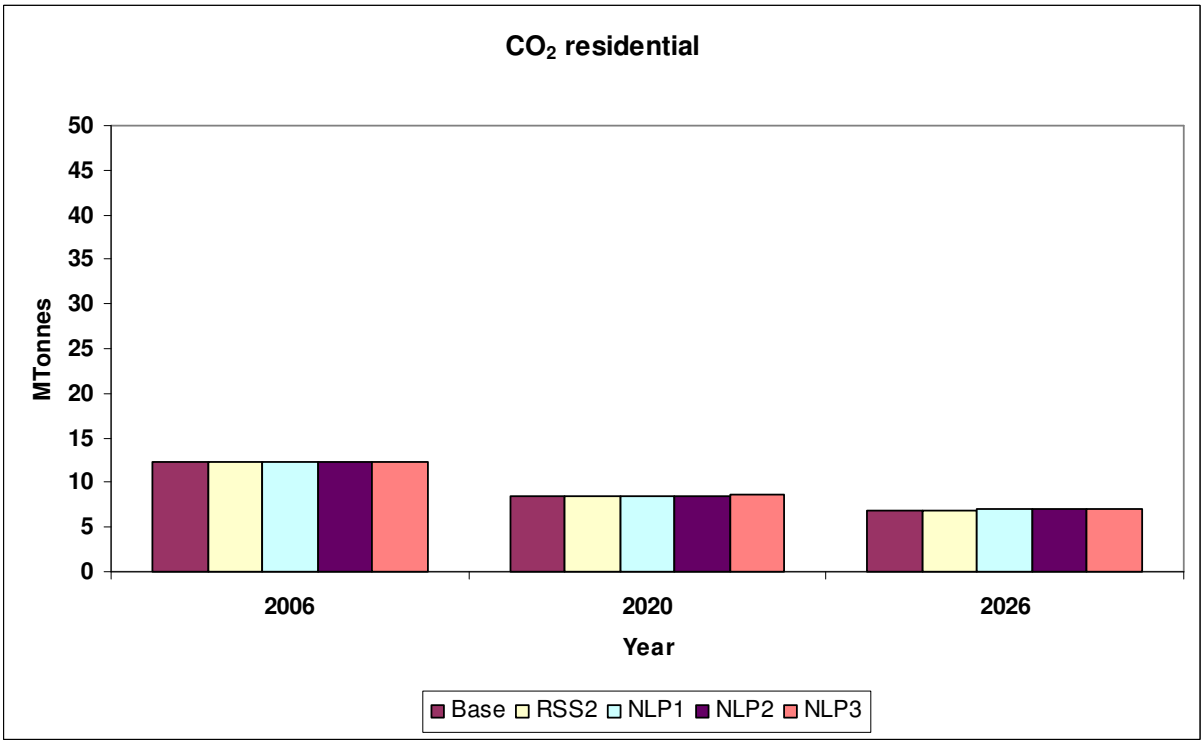
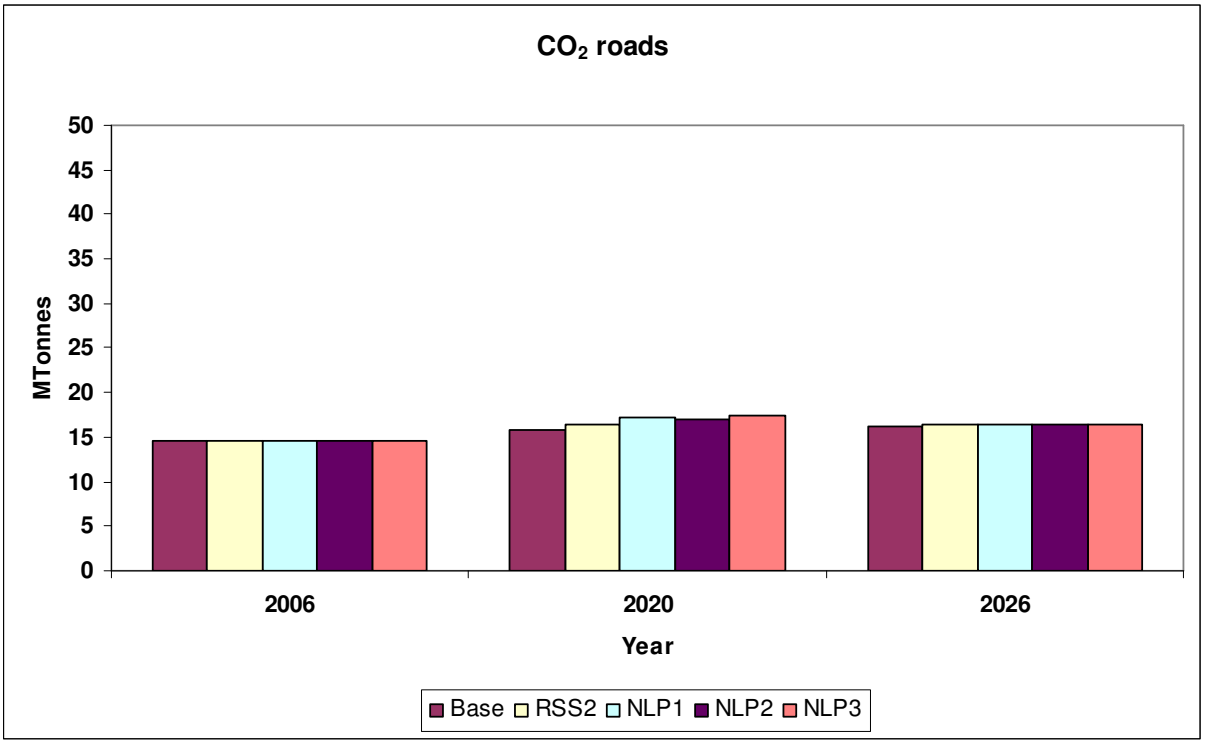


Figure 4-4: CO_2 road emission



4.2 Sub regional analysis

Table 4-13 depicts the main sectors that are affected by the various RSS scenarios in this study for the key sectors: the total emissions; residential emissions; and road traffic emissions by District. The changes in emissions for road transport are driven by the change per household per district data provided by Mott MacDonalds.

Figures 4-5 and 4-6 depict the road transport and residential emissions spatially in 2026. Very little difference is observed between the various housing scenarios in 2026 that can be easily shown visually, with the following exceptions of:

- Dudley which has a decrease in emissions for the RSS Phase 2 Preferred Option (RSS2) and NLP scenarios compared to the base scenario for roads.
- Sandwell which has an increase in emissions for the RSS Phase 2 Preferred Option and NLP scenarios compared to the base scenario for roads.
- Birmingham which has an increase in emissions for the NLP scenarios compared to the base scenario for roads.
- Solihull which has a decrease in emissions for the NLP1 and NLP3 scenarios compared to the base scenario for roads.
- Wolverhampton which has an increase in emissions for the RSS Phase 2 Preferred Option and NLP scenarios compared to the base scenario for residential.
- Birmingham which has a decrease in emissions for the RSS Phase 2 Preferred Option scenario compared to the base scenario for residential.

- Coventry which has an increase in emissions for the RSS Phase 2 Preferred Option and NLP scenarios compared to the base scenario for residential.

The main divergences from the regional emissions trends are listed below.

Those sectors/districts with a smaller decrease in emissions from 2006 than the region (i.e. emissions grow more) for residential and total emissions occur for:

- Coventry all future residential.
- Herefordshire all future residential.
- Solihull all future total.
- Telford and The Wrekin future residential for RSS Phase 2 Preferred Option and NLP scenarios.
- Warwickshire 2020 residential base and NLP scenarios.
- Warwickshire 2026 residential base and NLP scenarios.
- Warwickshire 2020 total NLP1 and NLP3 scenarios.
- Worcestershire 2020 total for NLP3.

Those sectors/districts with a larger decrease in emissions from 2006 than the region (i.e. emissions grow less) for residential and total emissions occur for:

- Dudley 2020 total for NLP3.
- Herefordshire all future total.
- Sandwell 2020 and 2026 residential NLP3.
- Shropshire all future total.
- Solihull 2020 and 2026 residential RSS Phase 2 Preferred Option and NLP2 scenarios.
- Stoke-on-Trent all future residential.
- Walsall 2026 residential base and NLP3 scenarios.
- Walsall 2020 total NLP3.
- Wolverhampton 2020 total all NLP scenarios.
- Wolverhampton 2026 residential base.

Those sectors/districts with a larger increase in emissions from 2006 than the region (i.e. emissions grow more) for road transport emissions occur for:

- Birmingham all 2026 road.

- Wolverhampton, Walsall, Telford and The Wrekin, Sandwell, Herefordshire, Dudley, Coventry all 2026 road.
- Wolverhampton, Walsall, Herefordshire, Dudley, Coventry 2020 road base scenario.
- Stoke-on-Trent, Solihull all future road.
- Worcestershire 2020 road all NLP scenarios.

Those sectors/districts with a smaller increase in emissions from 2006 than the region (i.e. emissions grow less) for road transport emissions occur for:

- Birmingham 2020 road NLP3.
- Warwickshire, Staffordshire, Shropshire all 2026 road.
- Shropshire all 2020 road all NLP scenarios.
- Staffordshire 2020 road base and all NLP scenarios.
- Worcestershire 2026 road base, RSS Phase 2 Preferred Option and NLP2 scenarios.

4.2.1 Impact of urban and rural development

This Section also considers the impacts of rural and urban development patterns in the context of likely transport infrastructure and how the various housing scenarios are likely to affect the regional targets.

The local authorities have been split into Major Urban Areas (MUAs) (WMRA, 2007c) and other areas to assist in this assessment. The West Midlands MUAs are assumed to be the following local authorities: Birmingham; Coventry, Dudley; Sandwell; Walsall; Wolverhampton; Solihull; and Stoke-on-Trent. Though part of Newcastle is classed as an MUA in the RSS (WMRA, 2007c) no separate traffic data was available for the area and therefore it has not been included in the analysis. Additionally, it should be noted that this analysis is based on the traffic data supplied and as the supplied data does not model the non-MUAs in detail the results could be misleading. Further information on the traffic model used to underpin this assessment and its limitations can be found at www.prism-wm.com.

Generally speaking the results (Appendix 3) imply that the emissions per dwelling in general decrease in future years, but this is to be expected even with a rise in actual vehicle kilometres travelled due to increased efficiency, which is assumed due to the turnover of vehicles and the uptake of more efficient vehicles. Additionally, with the exception of Solihull, emissions per dwelling in the MUAs are much lower than in the other local authorities. For Solihull the difference is driven by the high level of motorway traffic in the area. However, when comparing the base case future years with the various RSS and NLP housing scenarios emissions for Birmingham, Sandwell, Solihull increase for all scenarios and Coventry, Stoke-on-Trent and Wolverhampton decrease for all scenarios.

Overall emissions per dwelling decrease for the MUAs for all scenarios compared to the base case, however, emissions increase for the non-MUAs for all scenarios compared to the base case.

The results in general imply that when the emissions are considered on a per dwelling basis where housing developments are based in the MUAs where there is access to public transport, then emissions are likely to decrease (per dwelling only). This would support the RSS Urban Renaisance objective which encourages sustainable development in existing towns and cities. However, due to the actual increase in the number of dwellings this emission per dwelling decrease is eroded when considered in total.

Table 4-13: Emissions for summary sectors per scenario (CO_2 tonnes per year per)

District	Birmingham	Coventry	Dudley	Herefordshire	Sandwell	Shropshire	Solihull	Staffordshire	Stoke-on-Trent	Telford and The Wrekin	Walsall	Warwickshire	Wolverhampton	Worcestershire
2006 Total	7,102,118	2,307,304	1,941,935	1,322,968	1,802,433	3,106,250	2,294,767	7,672,199	1,670,562	1,388,764	1,839,347	6,500,078	1,609,739	6,130,786
2006 Road	1,772,790	520,071	533,750	434,113	686,681	793,837	712,622	2,761,354	280,163	377,156	499,637	2,819,792	327,256	2,080,209
2006 Residential	2,169,880	660,907	673,894	353,524	407,802	904,153	433,717	1,829,542	568,196	377,503	591,437	1,448,578	540,981	1,431,741
2020 Total	6,395,905	2,024,333	1,722,357	1,080,492	1,602,093	2,596,568	2,890,961	6,746,316	1,497,905	1,226,078	1,629,258	5,878,866	1,403,106	5,316,797
2020 Road	1,999,786	591,286	627,820	513,313	776,860	836,268	852,587	2,795,154	343,696	427,958	578,477	2,912,445	384,079	2,138,184
2020 Residential	1,501,001	444,797	445,944	259,925	269,777	638,794	283,808	1,236,277	355,037	263,643	384,858	1,043,092	353,579	969,638
2020 RSS2 Total	6,340,155	2,067,581	1,723,809	1,068,995	1,605,479	2,615,164	2,861,356	6,962,242	1,503,470	1,244,035	1,633,828	6,023,730	1,410,021	5,439,263
2020 RSS2 Road	1,996,590	591,263	623,080	503,470	781,510	858,043	835,514	3,029,575	341,552	427,851	575,924	3,078,563	380,708	2,284,892
2020 RSS2 Residential	1,448,446	488,069	452,136	258,272	268,513	635,615	271,277	1,217,781	362,747	281,708	391,983	1,021,839	363,865	945,396
2020 NLP1 Total	6,361,345	2,067,581	1,723,809	1,071,389	1,605,479	2,621,062	2,986,772	6,962,242	1,503,470	1,244,035	1,633,828	6,375,333	1,410,021	5,942,669
2020 NLP1 Road	1,994,759	591,263	623,080	503,470	781,510	858,043	932,979	3,029,575	341,552	427,851	575,924	3,382,875	380,708	2,759,481
2020 NLP1 Residential	1,471,467	488,069	452,136	260,666	268,513	641,513	299,227	1,217,781	362,747	281,708	391,983	1,069,130	363,865	974,214
2020 NLP 2 Total	6,361,345	2,067,581	1,723,809	1,071,389	1,605,479	2,621,062	2,909,592	6,974,347	1,512,541	1,255,100	1,633,828	6,323,755	1,410,021	5,827,593
2020 NLP 2 Road	1,994,759	591,263	623,080	503,470	781,510	858,043	873,000	3,029,575	341,552	427,525	575,924	3,340,901	380,708	2,650,631
2020 NLP 2 Residential	1,471,467	488,069	452,136	260,666	268,513	641,513	282,027	1,229,886	371,817	293,100	391,983	1,059,526	363,865	967,988
2020 NLP3 Total	6,361,345	2,067,581	1,723,809	1,071,389	1,605,479	2,621,062	2,957,829	6,983,457	1,512,541	1,266,166	1,633,828	6,492,080	1,410,021	6,058,607
2020 NLP3 Road	1,994,759	591,263	623,080	503,470	781,510	858,043	910,487	3,029,575	341,552	427,198	575,924	3,487,811	380,708	2,868,332
2020 NLP3 Residential	1,471,467	488,069	452,136	260,666	268,513	641,513	292,777	1,238,996	371,817	304,492	391,983	1,080,941	363,865	981,301
2026 Total	6,155,405	1,951,593	1,661,018	984,557	1,567,904	2,378,562	2,998,536	6,454,424	1,440,901	1,172,674	1,568,192	5,600,182	1,337,099	5,053,264
2026 Road	2,103,563	628,020	671,490	551,527	819,918	838,035	914,002	2,803,140	369,423	453,902	613,245	2,922,579	408,695	2,145,096
2026 Residential	1,243,438	362,066	363,569	220,803	224,138	525,639	234,014	1,010,025	284,164	207,372	310,872	868,286	285,024	778,308
2026 RSS2 Total	6,107,097	2,007,248	1,666,082	975,316	1,576,485	2,373,607	2,993,282	6,453,993	1,449,522	1,198,079	1,580,023	5,593,662	1,346,831	5,055,328
2026 RSS2 Road	2,111,041	633,243	668,064	543,205	830,878	833,136	921,912	2,810,008	369,417	456,131	615,473	2,937,986	405,721	2,166,062
2026 RSS2 Residential	1,187,653	412,497	372,060	219,883	221,760	525,583	220,851	1,002,726	292,790	230,549	320,475	846,360	297,730	759,407

District	Birmingham	Coventry	Dudley	Herefordshire	Sandwell	Shropshire	Solihull	Staffordshire	Stoke-on-Trent	Telford and The Wrekin	Walsall	Warwickshire	Wolverhampton	Worcestershire
2026 NLP1 Total	6,138,809	2,007,248	1,666,082	978,076	1,576,485	2,380,221	2,987,943	6,453,993	1,449,522	1,198,079	1,580,023	5,674,841	1,346,831	5,143,742
2026 NLP1 Road	2,116,684	633,243	668,064	543,205	830,878	833,136	884,883	2,810,008	369,417	456,131	615,473	2,966,131	405,721	2,222,710
2026 NLP1 Residential	1,213,721	412,497	372,060	222,643	221,760	532,197	252,541	1,002,726	292,790	230,549	320,475	899,393	297,730	791,173
2026 NLP2 Total	6,138,809	2,007,248	1,666,082	978,076	1,576,485	2,380,221	2,991,229	6,467,767	1,459,671	1,212,595	1,580,023	5,660,297	1,346,831	5,124,040
2026 NLP2 Road	2,116,684	633,243	668,064	543,205	830,878	833,136	907,670	2,810,008	369,417	458,449	615,473	2,962,249	405,721	2,209,718
2026 NLP2 Residential	1,213,721	412,497	372,060	222,643	221,760	532,197	233,039	1,016,500	302,939	242,747	320,475	888,731	297,730	784,463
2026 NLP3 Total	6,138,809	2,007,248	1,666,082	978,076	1,576,485	2,380,221	2,989,175	6,478,110	1,459,671	1,227,111	1,580,023	5,697,872	1,346,831	5,164,710
2026 NLP3 Road	2,116,684	633,243	668,064	543,205	830,878	833,136	893,428	2,810,008	369,417	460,766	615,473	2,975,837	405,721	2,235,703
2026 NLP3 Residential	1,213,721	412,497	372,060	222,643	221,760	532,197	245,228	1,026,843	302,939	254,946	320,475	912,719	297,730	799,148

Figure 4-5: Road transport emissions in 2026 (CO_2 Tonnes per year per kilometre)

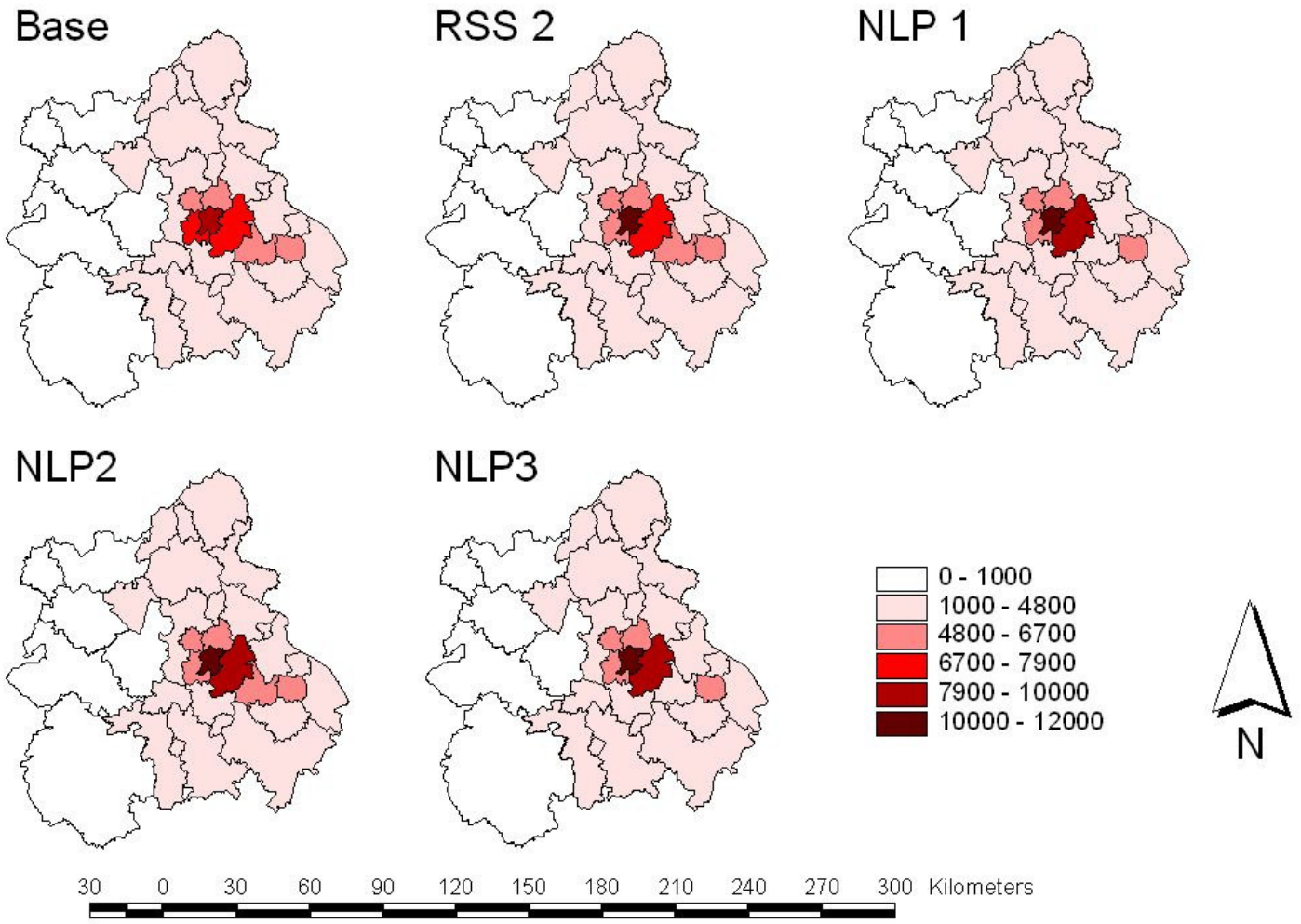
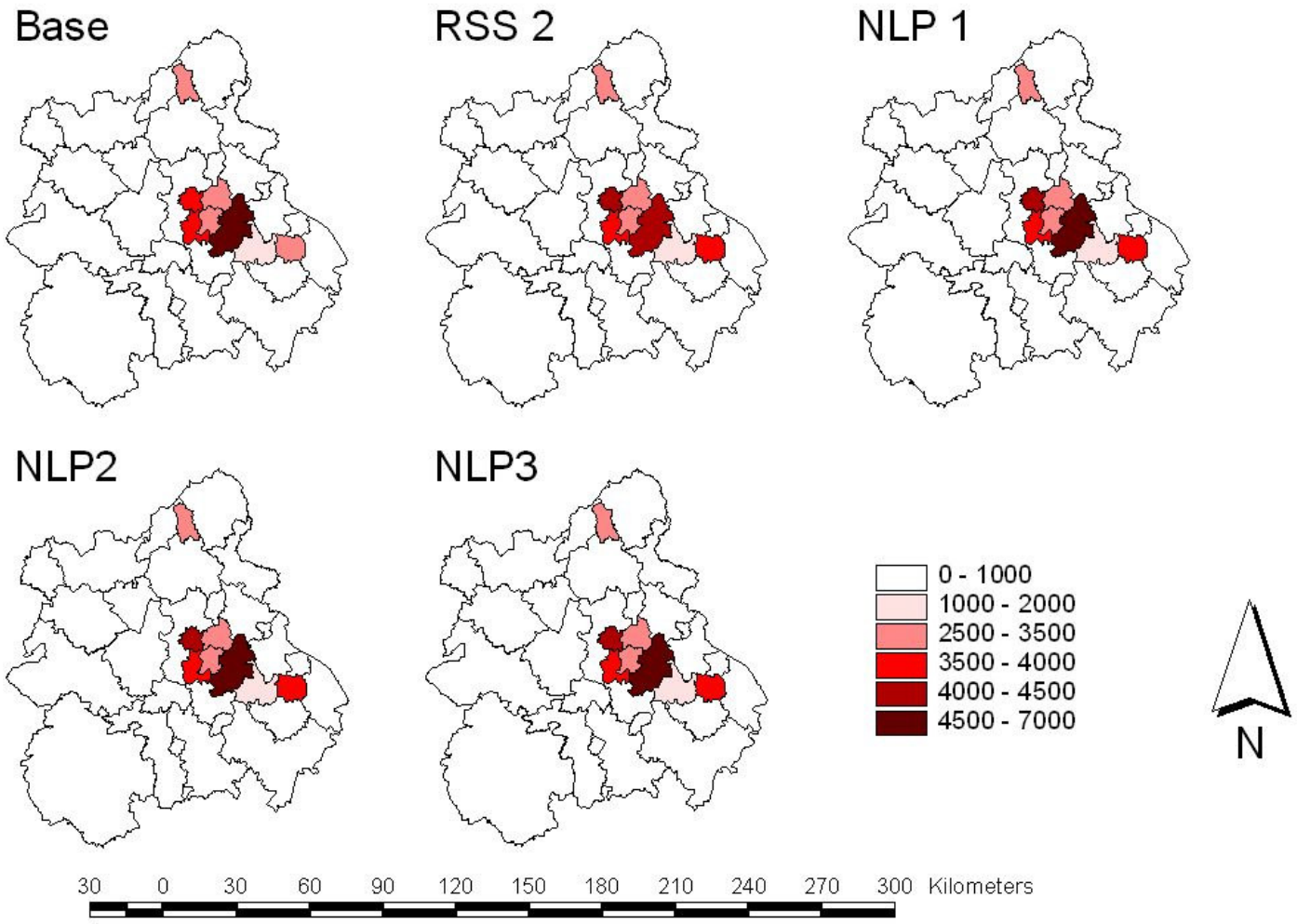


Figure 4-6: Residential emissions in 2026 (CO_2 Tonnes per year per kilometre)



5 Recommendations

5.1 Recommendations

To conclude the various housing scenarios are forecast to have little impact on CO_2 emissions in 2020 and 2026 compared to the baseline emissions for the same year. However, there is reduction in projected emission from the 2006 baseline to all future scenarios primarily due to the assumed implementation of National Policy.

Therefore, a number of recommendations are made in Recommendations (Section 5) that are reproduced below:

- Year on year reductions are necessary to aim to meet existing national targets, and any delay in reductions will result in further reductions being necessary in future year – there is a need to act urgently.
- The RSS is used to drive and encourage the uptake of existing and new national legislation with regard to energy efficiency of all new buildings.
- Where possible the RSS should seek to add planning restrictions to limit non-energy efficient new building.
- The RSS is used to drive and encourage the uptake of existing and new national legislation and initiatives with regard to energy efficiency of all existing buildings.
- Consideration be given in the RSS Phase 3 Revisions as to how the retro-fitting of energy efficiency measures could be encouraged in the existing building stock. For example, through a requirement that major refurbishments submit energy use assessments alongside planning applications.
- Regional and local authorities lead by example with their own stock.
- That new development is encouraged close to existing public transport links and discouraged where there is little public transport provision.
- Progress towards national and regional CO_2 targets is monitored against National Indicators including:

  Greenhouse gas emissions (No. 1).

  CO_2 emissions by end user (No. 2).

  Aviation and shipping emissions (No.3).

  Renewable electricity (No.4).

  Electricity generation (No.5).

  Household energy use (No.28).

  Road transport (No. 29).

  Private vehicles (No.30).

  Road freight (No.31).

  Manufacturing sector (No.32).

  Service sector (No.33).

  Public sector (No.34).

In relation to monitoring progress, it is suggested that:

- A single regional agency (for example the West Midlands Regional Observatory) has responsibility to develop and maintain an inventory of all sources of emissions within the area drawing on the most relevant available national and local data.
- Engage with stakeholders in the local authorities to ensure that the data they compile for their own Climate Change activities is comparable and consistent for the region as a whole. This would assist in data comparability across the sub-regions. It is suggested that each sub region and/or local authority has a champion with responsibility, which could facilitate future emission inventory updates.
- Secure agreements with data suppliers (including Local Authorities) to support data collation on an annual basis.
- Integrate data into the inventory to estimate the resulting CO_2 and make sure that emissions are not omitted or double counted.
- Produce an annual comparison report charting progress and methodological/data changes since previous publications.
- Provide ad-hoc support to the government departments and the public relating to data and trends for the Region.
- Update inventories as and when suitable data are available as part of the monitoring of indicators exercise.
- Review the scope, scale and coverage of the actions in this report on a regular basis.

The following table indicates the types of data that could be collated on an annual basis to indicate progress towards targets, however, further calculations would need to be made to convert this data into CO_2 emissions, it is suggested that fuel specific emission factors are used as detailed on the NAEI website (http://www.naei.org.uk/emissions/index.php). These emission factors give estimates of emissions per unit of fuel use and are used in most UK inventories. The NAEI website also has a link to guidance for compilation of emission estimates. GVA, household and population data by local authority is available online on an annual basis from the Office of National Statistics and CLG.

Table 5-1: Summary of the Monitoring Data Suggestions

Category	Sector	Source	Source	Comment
Residential	Domestic Electricity Use	Annual meter point data from BERR (DTI)	BERR (DTI) web pages http://www.berr.gov.uk/energy/statistics/regional/regional-local-electricity/page36213.html Available for 2003-2006	At LA level
	Domestic Combustion	Annual meter point data from BERR (DTI) for gas	BERR (DTI) web pages http://www.berr.gov.uk/energy/statistics/regional/regional-local-gas/page36200.html Gas available for 2001-2006 http://www.berr.gov.uk/energy/statistics/regional/other/page36195.html Estimated other fuels available for 2003-2005	At LA level. Other domestic fuel use data available from DTI though it is disaggregated national data. Other local data sources could be explored.
Industrial	Point Source Emissions (mainly Part A industrial processes, some Part B processes where data were available)	EA, Local Authorities	EA website http://maps.environment-agency.gov.uk/wiyby/dataSearchController?topic=pollution&lang=_e?lang=_e Local Authority Environmental Health Departments.	At LA level. EA use thresholds so small processes will be difficult to assess. Suggest assess the number of industrial processes each year.
	Industrial Electricity Use	Annual meter point data from BERR (DTI)	BERR (DTI) web pages http://www.berr.gov.uk/energy/statistics/regional/regional-local-electricity/page36213.html Available for 2003-2006	At LA level
	Industrial Combustion	Annual meter point data from BERR (DTI) for gas	BERR (DTI) web pages http://www.berr.gov.uk/energy/statistics/regional/regional-local-gas/page36200.html Gas available for 2001-2006 http://www.berr.gov.uk/energy/statistics/regional/other/page36195.html Estimated other fuels available for 2003-2005	At LA level. Other fuel use data available from DTI though it is disaggregated national data. Other local data sources could be explored.
	Industrial F-Gases	Not relevant to CO_2	Not relevant to CO_2	Not relevant to CO_2
Road Transport	Major Roads (Motorways & A Roads)	DfT or Local Authorities	Most data collated at sub-regional level – contact relevant transport planner in sub-region, then submitted to DfT. http://www.dft-matrix.net Available for 1999-2006	Data collated via surveys at points. This data can be compared with other years to assess traffic growth.
	Other Major Roads (mainly B routes for which data were available)	Local Authorities	Most data collated at sub-regional level – contact relevant transport planner in sub-region	Data collated via surveys at points. This data can be compared with other years to assess traffic growth.

	Minor Roads	DfT or Local Authorities	This data is not specifically collected, estimated from national data.	Suggest sub-regions are consulted on developing their own estimates of minor road vkm.
	Mobile Air Conditioning	Not relevant to CO_2	Not relevant to CO_2	Not relevant to CO_2
Other Sources	Shipping	Number of ships entering ports and size	Port Authorities	Number of ships entering ports and size
	Aviation	Number of airport movements and passengers at each airport	http://www.caa.co.uk/default.aspx?catid=80&pagetype=88&pageid=3&sglid=3	Larger airports submit data to CAA annually.
	Rail	Actual data is difficult to collate	Sub-regional transport planners	Number of rail journeys taken per head of population.
	Off-road	Minor source	Minor source	Suggest that monitoring effort is spent elsewhere.
	Public Sector Combustion (gas)	Annual meter point data from BERR (DTI) for gas	BERR (DTI) web pages	At LA level. Other fuel use data available from DTI though it is disaggregated national data.
	Agricultural Combustion (gas)	Annual meter point data from BERR (DTI) for gas	BERR (DTI) web pages	At LA level. Other fuel use data available from DTI though it is disaggregated national data.
	Waste Treatment & Disposal	LA	LA waste team	Monitor number of landfill sites and amount of waste recycled.
	Agriculture	Minor source	Minor source	Suggest that monitoring effort is spent elsewhere.
	Nature	Minor source	Minor source	Suggest that monitoring effort is spent elsewhere.
	Non-Industrial F-Gases	Not relevant to CO_2	Not relevant to CO_2	Not relevant to CO_2

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Appendices

Appendix 1: Emission inventory data sources

Appendix 2: Comparison of results to validate methodology

Appendix 3: MUA traffic results

Appendix 1

Appendix 1 discusses data sources that in theory could be used for emission inventory compilation, and gives some background to those sources that are discussed in Section 3 of the main report.

National Data Sources

GHG emissions, relevant to the West Midlands region, are currently reported in several national and international datasets:

- **National datasets** include the National Atmospheric Emissions Inventory (NAEI) and the UK Greenhouse Gas Inventory UK (GHGI). The inventories are based on the Digest of United Kingdom Energy Statistics (DUKES), UK wide research into agriculture and waste, installations that report under the EU-ETS, IPPC and DfT road transport data.
- **International datasets** include the *Greenhouse Gas Emission Trends and Projections in Europe 2006 report* produced by the European Environment Agency (EEA). However, due to the wide area covered by the EEA, their reports have limited resolution and are thus unsuitable for use at local level.

The NAEI and UK GHGI are in general based on a combination of both "bottom up" source specific data and the annually released "top down" energy data as presented in the Digest of United Kingdom Energy Statistics (DUKES (BERR, 2007)), such as the fuels consumed by domestic and international aviation, and the use of natural gas. The NAEI and UK GHGI also include other sources of data not relating to energy use.

Some additional BERR fuel use data is available down to the Local Authority level (and in some cases in even greater spatial detail), such as the electricity (2003 to 2006), gas (2001 to 2006), road (2002 to 2005), other fuel (2003 to 2005), road vehicle fuel consumption (2002 to 2005), other fuel use (2003 to 2005) and total energy (2003 to 2005) data. It should be noted that the total energy data includes information on total renewable energy per local authority, including that derived from energy from waste. These data are also used as the basis for many of the NAEI and UK GHG emission estimates and are discussed here for completeness.

The NAEI has been compiled annually since the 1970's, although it has only been spatially disaggregated since the mid 1990's.The UK GHG inventory has been compiled on an annual basis since 1994 and includes emission estimates for the Kyoto basket of gases. For both the Air Quality (NAEI) and the GHG inventories, at the time of compiling the most recent relevant emission estimates available are for 2005. The most recently available spatially disaggregated maps are also for 2005.

UK Greenhouse gas inventory (GHGI)

The Greenhouse Gas Inventory for England, Scotland, Wales and Northern Ireland is an annually updated database compiled by AEA on behalf of Defra and the devolved administrations (Baggot *et al.* 2007). It contains greenhouse gas (GHG) emissions estimates for the constituent countries of the UK for the period 1990 to 2005 and, as such, West Midlands regional emissions are included within the England GHG inventory. The GHGs reported are CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6. Emissions are predominantly calculated using a 'top-down' approach whereby estimated emissions for the UK are distributed using indicators such as population and road vehicle kilometres. The study shows that England accounts for 78.1% of the CO_2e. Although valuable for national trends in GHG levels, the GHG inventory lacks the finer spatial detail and improved data quality made possible by focusing in on smaller areas and using 'bottom-up' methodologies. The UK GHG inventory is the primary mechanism by which the UK's progress towards achieving Kyoto Protocol targets is monitored and was the basis for the calculation of the UK's "Assigned Amount". The "Assigned Amount" is the amount of greenhouse gas emissions that each developed country (in this case the UK) must not exceed under the Kyoto Protocol during the period 2008 to 2012.

As the UK GHG inventory is only disaggregated spatially to country level it is only proposed to use the F-gas element of this inventory for a 2005 baseline on an end user basis (as described in Section 3). This is because there is no further UK spatial disaggregation of F-gases and F-gases are a relatively small contributor to global warming potential (CO_2e). However, the data from the UK GHG inventory has also been used to derive some national sector specific ratios between 1990 and 2005 to enable the calculation of the 1990 data.

NAEI

GHG emissions are also recorded within the NAEI, which is compiled by AEA on behalf of Defra (Air, and Environment Quality Division and the Devolved Administrations) (King *et al.* 2007).

In addition to GHG emissions totals, 1km resolution emission maps for the whole of the UK are routinely produced as part of the NAEI for 25 pollutants including the GHGs CO_2, CH_4 and N_2O. As such, spatial maps for the GHGs CO_2, CH_4 and N_2O are available for the West Midlands region within the NAEI and therefore the NAEI has been used as the main basis of the 2005 base year in this study (as discussed further in Section 3). To summarise, the NAEI includes estimates of CO_2, CH_4, N_2O at 1km x 1km scale, which means it can be considered at the Devolved Administration (DA) level and NUTS4 (Local Authority) level.

- Estimates for the F-gases are only made at the country level, and no work has been completed to date to estimate emissions at a finer scale on a national basis.
- Some major sources of NAEI and UK GHG estimates are calculated on a national basis using bottom up data for major roads (i.e. A roads and motorways); EA regulated industrial sources (including both IPPC and EU-ETS reporting systems); aircraft movement data; and gas (normalised by national fuel consumption statistics) and electricity consumption (via the Defra CO_2 dataset – refer to the following section).
- The remaining sources included in these datasets are generally calculated using a top down approach where emissions are estimated from national datasets and then disaggregated using surrogate statistics. For further information refer to the most recent reports available at http://www.naei.org.uk/reports.php.

Whilst there is detailed data available for some local sources within the national data, additional local data can be used to supplement the national data for some emissions sources, for example “minor roads”; other industrial processes (local authority controlled); local fuel split (to estimate oil and solid fuel use); local inventories (e.g. conducted by councils); and local airport estimates.

It should be noted that for consistency and comparability the inclusion of local emission estimates can be very difficult and could result in, for example, the Birmingham emissions not being comparable to emissions in Coventry because of different methodologies and assumptions used.

Local and Regional CO_2 Emissions Estimates for 2005 for the UK

Over the last few years, BERR has commissioned AEA to research sub-national energy consumption data to enable the preparation of a new series of Regional Energy Statistics that are reported via the periodic BERR Energy Trends publication. Although up until recently these data were still regarded as “experimental” due to the need to model solid and liquid fuel use data from limited raw data, they are nevertheless a useful indicator that can be used to provide an insight into regional energy consumption patterns.

Sub-national energy consumption statistics have become available for gas and electricity use as a result of work conducted by the DTI. The complete energy data sets are used by AEA (on behalf of Defra) to produce a variant of the NAEI – the Defra CO_2 estimates (King *et al.* 2008). This data details local and regional CO_2 emissions estimates for 2005 for the UK (King *et al.* 2008). This differs from the NAEI and UK GHG inventory in two main aspects:

- Firstly, BERR electricity and gas datasets have improved geographical referencing resulting in greater reliability in the energy consumption data, and therefore emissions statistics, than was previously available.

- Secondly, CO_2 emissions associated with power generation, oil refineries and solid fuel production within the local and regional CO_2 inventory are distributed across the users of the energy that they produce (electricity, petrol, diesel, other oil and solid fuels). This provides a more representative picture of "end user" emissions of electricity, solid fuels and refined petroleum fuels such as petrol, diesel and fuel oil.

RESTATS - the Renewable Energy STATisticS Database for the UK

Since 1991, RESTATS has been the source of data on renewable energy statistics used in the annual Digest of UK Energy Statistics (DUKES) and is one of the sources of data to the European Community programmes on renewable energy statistics. The data is available online at http://www.restats.org.uk/ and some data are available on an aggregate regional basis (due to confidentiality), such as in terms of GWh and number of sites. Planning data for possible future renewable energy applications is available by local authority. The results of RESTATS are produced in DUKES and are incorporated into the UK GHG and NAEI and are therefore incorporated into the 2005 base year of this study, but are not available in any spatial detail, with the exception of the total estimates for renewable energy for local authorities via the BERR LA energy use data.

REAP

The Resource Energy Analysis Programme (REAP), The Stockholm Environment Institute tool (http://www.sei.se/reap/download_login.php?region=) is in essence similar to the REEIO model that many regional bodies are familiar with, in that it uses economic information linked to CO_2 emission data. However, the REAP model also uses information from other countries exports and imports and also links these to their reported emissions to build up an economically linked emission picture for the whole world. Due to the differing nature of different countries reported emissions, there will be inconsistencies within the data used. However, the end result is more of a carbon footprint (i.e. emissions associated with the final consumption of goods and services) for each country. This is different to the reported emissions of each country in that it attempts to calculate 'end user' or 'consumption' per capita emissions (i.e. incorporates elements of the travel of food in the food per capita footprint). In the UK this data has been broken down further for 2001 (2003 data not available at the time of writing) and data is available as the carbon footprint per capita per local authority.

Current West Midlands Local Datasets

There are several studies that exist or are currently being undertaken that are relevant to understanding the potential carbon impact of any additional housing development within the West Midlands region. These include:

- Regional Spatial Strategy for the West Midlands, WMRA.
- West Midlands Final RSS Infrastructure Review Report.
- RSS Phase 2 Employment Land Provision, WMRA.
- RSS Phase 2 Housing Background paper, WMRA.
- RSS Phase 2 Towns and City Centres Background Paper, WMRA.
- RSS Phase 2 Infrastructure Implications of the Housing Options, WMRA.
- Stockholm Environment Institute report on Carbon Dioxide Emissions of West Midlands Housing.
- Heat and Energy Mapping Study for the West Midlands, AWM.
- Decentralised Energy Feasibility Study, AWM.
- 'Testing the Preferred Option' Study, HA.
- West Midlands Climate Change Action Plan.
- West Midlands Declaration on Climate Change.
- The West Midlands Economic Strategy, AWM.

Key datasets that are applicable to this study are discussed below and also where relevant in Section 3.

The Highways Agency in the West Midlands report on Testing the Preferred Option data provided by Mott MacDonalds (refer to PRISM below), and used extensively for this study (refer to

Section 3), considered how the WMRSS Phase 2 revision will impact on the West Midlands' Strategic Road Network (SRN), taking into account the likely distributions and sizeable volume of employment land and housing land development in each locality

The Department for Communities and Local Government (CLG) informed the WMRA of the Government Office of the West Midlands' intention of look into the potential of delivering higher housing numbers throughout the West Midlands. Nataniel Lichfield and Partners (NLP) undertook a study to consider the spatial distributions of this increase in housing provision. This data is used extensively in this study and is discussed further in Section 3.

PRISM West Midlands (Policy Responsive Integrated Strategy Model) is a strategic model for the West Midlands to assess detailed travel response to congestion, investment and policy. The model, which covers the West Midlands Metropolitan area, was developed by Mott MacDonald and RAND Europe and is supported by the sub-regions 7 district authorities, the Highways Agency and CENTRO. PRISM is a disaggregate travel demand model that takes the individual traveller as the decision maker, rather than relying on zonal proxies. The data provided by the model is restricted to the metropolitan area of West Midlands, with the regional coverage restricted to key routes only.

RSS Phase 2 Housing Background Paper provides an overview of how the Preferred Option for the Communities for the Future Chapter was developed in reference to housing demand. The report sets out the housing policy background for the region and the other phase two preferred option documents that influence housing policy. The report sets out the projected household change both as a baseline without the preferred option and due to the RSS Phase 2 policy. This data is projected from 2006 to 2026. The report also sets out the annual demolition assumptions for each Local authority over the 2006 to 2026 period. This data has been used extensively in this study, refer to Section 3.

RSS Phase 2 Centres Background Paper provides a source of background information for the regional centres policies in the West Midlands Regional Centres Study. This study then informed the RSS Phase 2 revision. The report contains a review of the network of strategic town and city centres and a comparison of retail and office floor space requirements for strategic towns and city centres. This report assesses the information in terms of the strategic centres and floor space and as such has not been used in this study, refer to Section 3 for discussion on commercial emission estimation.

RSS Phase 2 Infrastructure Implications of the Housing Option report explores the impact of various levels of housing growth on the regions infrastructure.

West Midlands RSS Infrastructure Review Report builds upon the infrastructure implications of the housing option report and assess in detail four main groupings of infrastructure; Utility (water, electricity etc), Impact (environment, land etc), Resource (plant and material etc), and Amenity (facilities etc).

West Midlands Declaration on Climate Change sets out the Regional Assembly's recognition of the impacts of climate change and their commitment to tackling both the causes and effects.

The Stockholm Environment Institute's analysis of Carbon dioxide emissions of West Midlands' Housing for the WMRA looks into different policy option scenarios for minimising carbon emissions from housing developments planned under the RSS Phase 2 revision until the year 2026. Their modelling uses the Resources and Energy Analysis Programme[2] (REAP) by emission estimates by consumption. REAP is used to understand the material flows and carbon dioxide emissions on a range of scales from UK, regional, to local authority level. Their work looks at the potential future housing, building regulations, demolition and energy policies/policy combinations and their relative success levels of mitigating carbon emissions from new housing stock. It was not possible to use data from this analysis as it would have resulted in double counting the emissions reductions and it was unclear as to whether the results were relevant to the more recent RSS Phase 2 preferred option.

The Low Carbon Evidence Base for the West Midlands Regional Economic Strategy study was commissioned by Advantage West Midlands (AWM) to provide a base for the Regional Economic

[2] Stockholm Environment Institute (2007) Carbon Dioxide emissions of West Midlands Housing

Strategy. The study looked into greenhouse gas (GHG) emission inventories at a regional scale and included a comparison of different methodologies used. Additionally it included carbon projections based on economic modelling using the REEIO model.

The Heat and Energy Mapping Study and Decentralised Energy Feasibility Study conducted for AWM includes data on domestic and non-domestic heat and energy use in the West Midlands that will help inform the energy data on which to build regional carbon trajectories forward towards 2026. The evidence collected in this study will compliment the work done by SEI and to help target energy efficiency programmes and decentralised energy schemes in the domestic and non-domestic centres to reduce carbon emissions. The energy demand data provided did not include fuel use splits – it was only split by heating demand and electricity demand and therefore could not be used as no account could be made of fuel splits.

This section discusses the local data that AEA is aware of that are of relevance to this study. Other data may exist, however, due to time limitations, only these sources have been investigated.

Projecting Emissions

National Projections

UK level projections of emissions have been undertaken for a number of reports, such as the UK Climate Change Programme (CCP) (Defra, 2006), which contains detailed projections for the six Kyoto GHGs for a number of years (up to 2020).

The Energy White Paper 2003 (DTI, 2003), the Energy Review 2006 (DTI, 2006) and the Energy White Paper 2007 (DTI, 2007) set out the UK's energy policies and measures and associated GHG savings. In summary, the UK Governments Energy Strategy is to become more energy efficient, develop less carbon intensive energy supplies and secure reliable energy supplies at prices set in competitive markets. The Energy White Paper recognises that climate change and energy security need to be tackled together.

Underpinning the UK's Climate Change Programme (Defra, 2006), and related Energy Papers published by DTI (now BERR), are the UK Updated Energy Projections (UEP). The UEPs are updated on a periodic basis according to the development of Government policy mechanisms. The UK Climate Change Programme (Defra, 2006) and Energy Review (DTI, 2006) are based on UEP 26 released in 2006, whilst the Energy White Paper of 2007 is based on UEP29 ("without Energy White Paper (EWP) measures") and UEP30 ("with EWP measures") released in May 2007 (and recently updated with slight presentational modifications in February 2008, Personal Communication: David Wilson, March 2008). The BERR energy projections run from 1990 to 2020 and include a low, central and high emissions scenarios depending on various criteria such as the mix of fuel used in power stations and fuel prices and the related CO_2 estimates. The BERR model used to generate these energy projections is a top-down macro-economic model that for most sectors does not provide region-specific forecasts. Therefore, it could be argued that in some instances the trends presented for the UK may not be representative of those expected in the West Midlands. However, in many cases the UK trends are the only up to date data available for use. BERR are in the process of working on developments to their energy model, to enable them to develop more detailed region-specific forecasts, but these are unlikely to become available for many months.

Further to this, the BERR energy projections provide a consistent method across all sectors, based on the IAG (Interdepartmental Analyst Group). The energy use and emissions trends within the BERR forecasts are based on comprehensive policy impact appraisal across all fuels, including electricity use by end use sector and taking account of any policy impact overlaps. This is an important point, as the sector-specific impacts of energy efficiency measures will apply across all direct and indirect fuels, and the overall trends in electricity and direct fuel demand from the BERR model take these impacts into account.

Using the BERR model approach ensures that the overlap of policy impacts and the trends in all fuel use, including electricity demand, are represented. Combining several independent policy appraisals may introduce double-counts and hence over-state savings, whilst the combination of standalone

sector-specific policy savings and separate forecasts of electricity demand may introduce inconsistencies.

Analysis to Support Climate Change Indicators for Local Authorities (AEA, 2007) provides information to inform the proposals for new performance indicators on climate change. A revised set of emissions estimates for 2004 were presented in the LA 2004 Defra dataset (King *et al*, 2006), based on AEA's recommendations that the indicators should be composed of end user emissions from sectors and sources that can be influenced by actions by local authorities. The model has been developed to combine the estimates of emissions by local authority in 2004 with projected emissions for the UK in 2010 and 2020 based on UEP 29. However, for UEP29 there are no publicly available projections for non-energy related GHGs, therefore these projections have not been used.

Population and households

Population data is available by local authority. In the context of this study this is from 2004, with projections to the mid 2020's from the ONS. Projections on the growth in the number of dwellings in the RSS occur at a different rate to the population estimates, due to changing domestic dynamics. However, when using any dataset as a driver it is necessary to have a similarly derived UK equivalent to allow the spatial ratio to be calculated. The RSS number of dwellings do not appear to match those on the CLG website (available up to 2026). The UK emission projections take into account government policies in terms of average dwelling increasing energy efficiency and therefore for a given year the relative average emission per person or per household can be calculated for the domestic sector.

Traffic growth

The DfT model TEMPRO provides estimates of traffic growth per local authority for 1991 to 2041. This data has to be adjusted against the current DfT's National Road Traffic Forecasts. The TEMPRO derived factors have been made equivalent on a UK basis to the National Road Traffic Forecasts.

Appendix 2

The results from this study, as presented in the Findings (Section 4) have been compared with the Defra LA CO_2 (King et al, 2008) data for all West Midlands local authorities in 2006 to validate the results and methodology.

The West Midlands data has been taken from Table 4-1 for 2006. To convert to carbon per capita the CO_2 has been multiplied by 12/44 and then divided by 5,366,600 (population) for the relevant sectors.

The road transport and residential sectors include all those sectors listed under road transport and domestic in the LA Defra 2006 dataset (King et al, 2008).

Industry includes all industrial emissions, plus the commercial and public sector combustion emissions, but does not include the energy sector, off road, waste or agricultural emissions.

Agricultural and domestic emissions in the Defra LA CO_2 dataset include some off road emissions, however, for comparison it has been assumed that the majority of these occur under agriculture and therefore agriculture and off road have been added together. LULUCF which includes sinks as well as sources is directly comparable.

Table A2-4: Emissions comparison (Tonnes)

Sector/Pollutant	Defra LA 2006 West Midlands CO_2 T	Defra LA 2006 West Midlands T/capita*	West Midlands 2006 CO_2 T	West Midlands 206 T/capita*
Road Transport	12,793,405	2.38	14,599,430	2.72
Residential	13,139,715	2.45	12,391,854	2.31
Industry	16,968,691	3.16	16,771,521	3.13
Agriculture and off road	1,407,574	0.26	1,490,829	0.28
LULUCF*	349,883	0.07	349,883	0.07
Total LA CO_2	44,898,665	8.37	45,815,170	8.54
Non LA CO_2	-	-	874,081	0.16
Total for dataset	-	-	46,689,251	8.70

*Assumes 5366.6 thousand population in 2006.
*LULUCF includes sinks as well as sources

It can be seen that the LA Defra 2006 dataset (King et al, 2008) and West Midlands dataset compare favourably, though the road transport estimates are higher, due to the data sources, methodology and assumptions used.

The main differences for road transport are in the fleet mix and related emission factors used in the West Midlands dataset, which are based on published emission factors and fleet mix data as discussed in Section 3.3.4 of the main report. However, more up to date fleet mix data and emission factors have been used in the LA Defra 2006 dataset which at the time of this study were unpublished.

There is a small difference for the gas usage as the dataset used to disaggregate the gas emissions in 2005 (on which 2006 is based) is based on the 2004 gas use dataset, rather than the 2006 which has been used in the Defra dataset.

The total and other for the Defra dataset does not contain aviation, whereas the West Midlands dataset does, and the West Midlands dataset is based on a 2005 NAEI dataset which has been projected.

the above differences result in the main differences for the dataset totals.

Therefore, to conclude the emission estimates though based on different datasets and methodologies are comparable and therefore it is assumed that the methodology is appropriate for this study.

Appendix 3

Appendix 3 includes the emission results from road traffic by MUA. The results are discussed in Section 4. Table A3-1: MUA results, emissions of CO_2 2006 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	405,000	641,127	576,339	555,324	1,772,790	1.58	1.42	1.37	4.38
Coventry	126,000	248,555	145,544	125,972	520,071	1.97	1.16	1.00	4.13
Dudley	127,000	146,637	236,934	150,179	533,750	1.15	1.87	1.18	4.20
Sandwell	118,000	137,144	195,565	353,972	686,681	1.16	1.66	3.00	5.82
Solihull	83,000	209,209	76,977	426,436	712,622	2.52	0.93	5.14	8.59
Stoke-on-Trent	104,000	8,433	271,730	0	280,163	0.08	2.61	0.00	2.69
Walsall	103,000	137,163	142,524	219,950	499,637	1.33	1.38	2.14	4.85
Wolverhampton	100,000	144,673	175,386	7,197	327,256	1.45	1.75	0.07	3.27
Non MUAs	1,078,000	1,613,809	2,821,415	4,831,236	9,266,461	1.50	2.62	4.48	8.60
Total	**2,244,000**	**3,286,751**	**4,642,413**	**6,670,266**	**14,599,430**	**1.46**	**2.07**	**2.97**	**6.51**

Table A3-2: MUA results, emissions of CO_2 2020 base (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	456,400	725,486	652,143	622,156	1,999,786	1.59	1.43	1.36	4.38
Coventry	136,200	282,766	165,997	142,523	591,286	2.08	1.22	1.05	4.34
Dudley	137,200	173,125	279,200	175,495	627,820	1.26	2.03	1.28	4.58
Sandwell	130,200	155,406	221,528	399,926	776,860	1.19	1.70	3.07	5.97
Solihull	92,400	250,636	92,216	509,735	852,587	2.71	1.00	5.52	9.23
Stoke-on-Trent	109,600	9,912	333,784	0	343,696	0.09	3.05	0.00	3.14
Walsall	110,400	159,144	165,010	254,323	578,477	1.44	1.49	2.30	5.24
Wolverhampton	106,600	169,874	205,780	8,425	384,079	1.59	1.93	0.08	3.60
Non MUAs	1,233,200	1,661,448	2,981,289	4,980,584	9,623,321	1.35	2.42	4.04	7.80
Total	**2,512,200**	**3,587,798**	**5,096,947**	**7,093,169**	**15,777,913**	**1.43**	**2.03**	**2.82**	**6.28**

Table A3-3: MUA results, emissions of CO_2 2020 RSS Phase 2 Preferred Option (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	440,420	720,101	652,929	623,561	1,996,590	1.64	1.48	1.42	4.53
Coventry	149,450	282,648	166,239	142,376	591,263	1.89	1.11	0.95	3.96
Dudley	139,105	170,051	277,068	175,961	623,080	1.22	1.99	1.26	4.48
Sandwell	129,590	154,685	219,907	406,919	781,510	1.19	1.70	3.14	6.03
Solihull	88,320	251,290	91,669	492,555	835,514	2.85	1.04	5.58	9.46
Stoke-on-Trent	111,980	9,832	331,720	0	341,552	0.09	2.96	0.00	3.05
Walsall	112,444	156,794	163,907	255,223	575,924	1.39	1.46	2.27	5.12
Wolverhampton	109,701	171,208	201,252	8,248	380,708	1.56	1.83	0.08	3.47
Non MUAs	1,218,910	1,762,384	3,124,470	5,295,539	10,182,393	1.45	2.56	4.34	8.35
Total	**2,499,920**	**3,678,992**	**5,229,161**	**7,400,381**	**16,308,534**	**1.47**	**2.09**	**2.96**	**6.52**

Table A3-4: MUA results, emissions of CO_2 2020 NLP1 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	447,420	717,014	653,379	624,366	1,994,759	1.60	1.46	1.40	4.46
Coventry	149,450	282,648	166,239	142,376	591,263	1.89	1.11	0.95	3.96
Dudley	139,105	170,051	277,068	175,961	623,080	1.22	1.99	1.26	4.48
Sandwell	129,590	154,685	219,907	406,919	781,510	1.19	1.70	3.14	6.03
Solihull	97,420	247,559	94,790	590,629	932,979	2.54	0.97	6.06	9.58
Stoke-on-Trent	111,980	9,832	331,720	0	341,552	0.09	2.96	0.00	3.05
Walsall	112,444	156,794	163,907	255,223	575,924	1.39	1.46	2.27	5.12
Wolverhampton	109,701	171,208	201,252	8,248	380,708	1.56	1.83	0.08	3.47
Non MUAs	1,238,860	1,910,665	3,299,621	5,751,010	10,961,295	1.54	2.66	4.64	8.85
Total	**2,535,970**	**3,820,455**	**5,407,883**	**7,954,731**	**17,183,069**	**1.51**	**2.13**	**3.14**	**6.78**

Table A3-5: MUA results, emissions of CO_2 2020 NLP2 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	447,420	717,014	653,379	624,366	1,994,759	1.60	1.46	1.40	4.46
Coventry	149,450	282,648	166,239	142,376	591,263	1.89	1.11	0.95	3.96
Dudley	139,105	170,051	277,068	175,961	623,080	1.22	1.99	1.26	4.48
Sandwell	129,590	154,685	219,907	406,919	781,510	1.19	1.70	3.14	6.03
Solihull	91,820	249,855	92,870	530,276	873,000	2.72	1.01	5.78	9.51
Stoke-on-Trent	114,780	9,832	331,720	0	341,552	0.09	2.89	0.00	2.98
Walsall	112,444	156,794	163,907	255,223	575,924	1.39	1.46	2.27	5.12
Wolverhampton	109,701	171,208	201,252	8,248	380,708	1.56	1.83	0.08	3.47
Non MUAs	1,243,410	1,882,386	3,265,630	5,662,128	10,810,144	1.51	2.63	4.55	8.69
Total	**2,537,720**	**3,794,472**	**5,371,972**	**7,805,496**	**16,971,940**	**1.50**	**2.12**	**3.08**	**6.69**

Table A3-6: MUA results, emissions of CO_2 2020 NLP3 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	447,420	717,014	653,379	624,366	1,994,759	1.60	1.46	1.40	4.46
Coventry	149,450	282,648	166,239	142,376	591,263	1.89	1.11	0.95	3.96
Dudley	139,105	170,051	277,068	175,961	623,080	1.22	1.99	1.26	4.48
Sandwell	129,590	154,685	219,907	406,919	781,510	1.19	1.70	3.14	6.03
Solihull	95,320	248,420	94,070	567,996	910,487	2.61	0.99	5.96	9.55
Stoke-on-Trent	114,780	9,832	331,720	0	341,552	0.09	2.89	0.00	2.98
Walsall	112,444	156,794	163,907	255,223	575,924	1.39	1.46	2.27	5.12
Wolverhampton	109,701	171,208	201,252	8,248	380,708	1.56	1.83	0.08	3.47
Non MUAs	1,258,110	1,951,859	3,348,368	5,874,202	11,174,429	1.55	2.66	4.67	8.88
Total	**2,555,920**	**3,862,510**	**5,455,910**	**8,055,291**	**17,373,711**	**1.51**	**2.13**	**3.15**	**6.80**

Table A3-7: MUA results, emissions of CO_2 2026 base (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	477,000	762,359	685,529	655,675	2,103,563	1.60	1.44	1.37	4.41
Coventry	140,000	300,175	176,246	151,598	628,020	2.14	1.26	1.08	4.49
Dudley	141,000	184,961	298,486	188,044	671,490	1.31	2.12	1.33	4.76
Sandwell	136,000	163,824	233,600	422,495	819,918	1.20	1.72	3.11	6.03
Solihull	96,000	268,384	98,773	546,845	914,002	2.80	1.03	5.70	9.52
Stoke-on-Trent	112,000	10,652	358,772	0	369,423	0.10	3.20	0.00	3.30
Walsall	113,000	168,581	174,873	269,791	613,245	1.49	1.55	2.39	5.43
Wolverhampton	109,000	180,708	219,005	8,982	408,695	1.66	2.01	0.08	3.75
Non MUAs	1,288,000	1,667,544	3,028,950	5,017,785	9,714,279	1.29	2.35	3.90	7.54
Total	**2,612,000**	**3,707,188**	**5,274,233**	**7,261,215**	**16,242,636**	**1.42**	**2.02**	**2.78**	**6.22**

Table A3-8: MUA results, emissions of CO_2 2026 RSS Phase 2 Preferred Option (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	455,600	759,431	691,684	659,926	2,111,041	1.67	1.52	1.45	4.63
Coventry	159,500	303,483	177,356	152,404	633,243	1.90	1.11	0.96	3.97
Dudley	144,293	182,437	297,039	188,588	668,064	1.26	2.06	1.31	4.63
Sandwell	134,557	163,833	232,662	434,383	830,878	1.22	1.73	3.23	6.17
Solihull	90,600	268,898	97,960	555,053	921,912	2.97	1.08	6.13	10.18
Stoke-on-Trent	115,400	10,625	358,793	0	369,417	0.09	3.11	0.00	3.20
Walsall	116,491	166,855	175,471	273,147	615,473	1.43	1.51	2.34	5.28
Wolverhampton	113,859	181,837	215,060	8,824	405,721	1.60	1.89	0.08	3.56
Non MUAs	1,279,300	1,666,063	3,028,722	5,051,743	9,746,528	1.30	2.37	3.95	7.62
Total	**2,609,600**	**3,703,462**	**5,274,747**	**7,324,068**	**16,302,277**	**1.42**	**2.02**	**2.81**	**6.25**

Table A3-9: MUA results, emissions of CO_2 2026 NLP1 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	465,600	757,221	696,329	663,135	2,116,684	1.63	1.50	1.42	4.55
Coventry	159,500	303,483	177,356	152,404	633,243	1.90	1.11	0.96	3.97
Dudley	144,293	182,437	297,039	188,588	668,064	1.26	2.06	1.31	4.63
Sandwell	134,557	163,833	232,662	434,383	830,878	1.22	1.73	3.23	6.17
Solihull	103,600	266,490	101,763	516,630	884,883	2.57	0.98	4.99	8.54
Stoke-on-Trent	115,400	10,625	358,793	0	369,417	0.09	3.11	0.00	3.20
Walsall	116,491	166,855	175,471	273,147	615,473	1.43	1.51	2.34	5.28
Wolverhampton	113,859	181,837	215,060	8,824	405,721	1.60	1.89	0.08	3.56
Non MUAs	1,307,800	1,667,324	3,031,960	5,132,038	9,831,322	1.27	2.32	3.92	7.52
Total	**2,661,100**	**3,700,105**	**5,286,433**	**7,369,148**	**16,355,686**	**1.39**	**1.99**	**2.77**	**6.15**

Table A3-101: MUA results, emissions of CO_2 2026 NLP2 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	465,600	757,221	696,329	663,135	2,116,684	1.63	1.50	1.42	4.55
Coventry	159,500	303,483	177,356	152,404	633,243	1.90	1.11	0.96	3.97
Dudley	144,293	182,437	297,039	188,588	668,064	1.26	2.06	1.31	4.63
Sandwell	134,557	163,833	232,662	434,383	830,878	1.22	1.73	3.23	6.17
Solihull	95,600	267,972	99,423	540,275	907,670	2.80	1.04	5.65	9.49
Stoke-on-Trent	119,400	10,625	358,793	0	369,417	0.09	3.00	0.00	3.09
Walsall	116,491	166,855	175,471	273,147	615,473	1.43	1.51	2.34	5.28
Wolverhampton	113,859	181,837	215,060	8,824	405,721	1.60	1.89	0.08	3.56
Non MUAs	1,314,300	1,667,288	3,032,716	5,116,760	9,816,764	1.27	2.31	3.89	7.47
Total	**2,663,600**	**3,701,551**	**5,284,849**	**7,377,515**	**16,363,915**	**1.39**	**1.98**	**2.77**	**6.14**

Table A3-11: MUA results, emissions of CO_2 2026 NLP3 (T/yr)

MUA	Dwellings	Minor road	Major road	Motorway	Total CO_2	Minor per dwelling	Major per dwelling	Motorway per dwelling	Total per dwelling
Birmingham	465,600	757,221	696,329	663,135	2,116,684	1.63	1.50	1.42	4.55
Coventry	159,500	303,483	177,356	152,404	633,243	1.90	1.11	0.96	3.97
Dudley	144,293	182,437	297,039	188,588	668,064	1.26	2.06	1.31	4.63
Sandwell	134,557	163,833	232,662	434,383	830,878	1.22	1.73	3.23	6.17
Solihull	100,600	267,046	100,886	525,497	893,428	2.65	1.00	5.22	8.88
Stoke-on-Trent	119,400	10,625	358,793	0	369,417	0.09	3.00	0.00	3.09
Walsall	116,491	166,855	175,471	273,147	615,473	1.43	1.51	2.34	5.28
Wolverhampton	113,859	181,837	215,060	8,824	405,721	1.60	1.89	0.08	3.56
Non MUAs	1,335,300	1,667,916	3,035,611	5,155,128	9,858,654	1.25	2.27	3.86	7.38
Total	**2,689,600**	**3,701,253**	**5,289,206**	**7,401,105**	**16,391,564**	**1.38**	**1.97**	**2.75**	**6.09**

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