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# Analysis to support climate change indicators for local authorities

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## Executive summary

The Kyoto Protocol is now in force, and the UK has agreed a reduction of 12.5% in its greenhouse gas (GHG) emissions<sup>1</sup>. The UK must achieve this reduction and many local authorities (LAs) are keen to contribute. This contribution needs to be planned and managed, and this work programme is part of this strategic planning. In addition, many local authorities recognise the threat of climate change to their own economies and are considering the effects of climate change on their social and economic policy.

On the 5 July 2007 Environment Secretary Hilary Benn stressed the central role Local Authorities have in fighting climate change as he launched the new Defra - Local Government Joint Environmental Prospectus. This practical checklist sets out how local authorities can tackle climate change among other environmental activities.

Local authorities are becoming increasingly involved in climate change and this involvement includes a number of ad-hoc approaches to measuring greenhouse gas emissions and developing carbon assessment and management programmes for their communities. Through good practice in planning, regulating, campaigning and influencing, Local Authorities can make a significant impact on emissions reduction in residences, businesses and for transport in their community. Setting and monitoring the achievement of comparable targets is an important driver in achieving results.

Over the last 2 years Defra have commissioned a programme of work to produce carbon estimates for each LA, to understand the magnitude and spatial variability of carbon emissions in UK LAs. The Local CO<sub>2</sub> emissions estimates are underpinned by data contained within the UK greenhouse gas inventory and using maps of emissions developed by the National Atmospheric Emissions Inventory (NAEI) team who compile the official UK emissions inventory. That study has revealed which sources of carbon within LA boundaries are important, and annual updates to the dataset will reveal which sources are changing in magnitude.

This project, commissioned by Defra, identifies an indicator to monitor progress in Local Authority community emission reductions and an approach for determining annual reports on progress called the Community Climate Change Indicator (CCI).

This report identifies specific metrics that can be used to help LAs focus their efforts to reduce (mitigate) GHG emissions. This work does not consider metrics that LAs could be judged on for their adaptation activities.

This study has identified a set of sources that can be influenced by the actions of LAs and where well-developed methods to provide reliable estimates of carbon emissions already exist. The study recommends excluding direct carbon emissions from installations in the EUETS because these emissions are affected by national policies. However, emissions from power generation and solid and liquid fuel production have been included on an end user basis. In addition, road transport emissions on motorways are also excluded. Although LAs can have some influence over travel choices of people living and working within their boundaries, the traffic on motorways is often involved in longer trips that cross LA boundaries.

We present a revised set of emissions estimates for 2004 based on our recommendations that the Community Climate Change Indicator (CCCI) should be composed of end user emissions from sectors and sources that can be influenced by actions by Local Authorities. Estimates of the uncertainty in the emissions have shown that errors are in the range 1.6 to 5%.

We have identified sources of uncertainty in the current dataset of emissions and have calculated percentage errors for each local authority, ranging from 1.6% to 5%. Most LAs in

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<sup>1</sup> The Kyoto basket of gases is: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride

England have a percentage error of 2.65% or lower. This is because the emissions are dominated by the electricity and gas use in industry and commercial sectors for which the UK estimates and the mapping distributions have low percentage errors. Higher overall percentage errors occur where the dominance of gas supply is lower and a higher proportion of the more uncertain emissions from solid and liquid fuels in the domestic and business/industry sectors, such as in Devon and Cornwall and Northumberland. Higher percentage errors also occur where minor road transport emissions are significant, such as in inner London.

This study has shown that the data available for the construction of the Community Climate Change Indicator are sufficiently robust with relatively low levels of uncertainty.

We recommend that the CCCI is based on emissions calculated on an end user basis. Emissions from power generation and refining are included within the EUETS, but we have re-allocated these emissions to sources included within the CCCI. For example, electricity use in an individual LA has been allocated its share of emissions from the generation of that electricity. Emissions on an end user basis will therefore be larger than emissions by source, and emissions at the locations of all power stations and all refineries on an end user basis will be zero.

### **Improvements to the emissions estimates**

The NAEI work programme includes a goal of continuous improvements of emissions estimates, including the mapped emissions. Work is on-going to improve the Local CO<sub>2</sub> dataset for 2005 and beyond. Further improvements beyond the 2005 dataset have been suggested in this report:

#### **Domestic**

- ▶ Further improvements could be made to the non-gas domestic fuel use distributions: sourcing new data actual consumption of solid and liquid fuels; and making use of the Homes Energy Efficiency Database (HEED) from the Energy Savings Trust.

#### **Industry/business**

- ▶ Emissions from point sources in the 'other industrial consumption' sector could be improved with new data on Part A2 and Part B from the European Pollutant Release and Transfer Register database (E-PRTR) and Climate Change Agreements.
- ▶ Updates are required to the area source distributions for industrial combustion using high-resolution industrial gas consumption data from DTI, improved estimates of energy intensity and updated employment statistics from the Inter-Departmental Business Register (IDBR).

#### **Transport**

- ▶ Further improvements to the road transport emissions modelling are possible if additional traffic count data become available from DfT. Any new data available will be included in the emission mapping each year.
- ▶ A peer review of the road transport modelling methods could also lead to improvements in these estimates.

#### **Other**

- ▶ Uncertainties: Inclusion of additional indicators of the quality of the geographical distributions in the DTI local energy statistics will improve the estimates of uncertainty.
- ▶ End user emissions: the emissions in the indicator can be split into 'direct' emissions (emissions at source) and 'indirect' emissions (those added through the redistribution of energy supply emissions).

### **Estimates of emission savings by Local Authority**

This study has also undertaken a policy review of carbon reduction measures that the government has, or will implement, and a model has been developed to estimate carbon

savings according to each local authority in England. A literature review produced a list of measures to reduce CO<sub>2</sub> emissions in the future (savings of CO<sub>2</sub> in 2010 and 2020). Both national and local measures and the applicability of the measures, using suitable surrogate statistics, have been considered in the model .

The model has been developed to combine the estimates of emissions by LA in 2004 with projected emissions for the UK in 2010 and 2020 (based on the UK's Climate Change Programme (2006)). Projections, including national and local measures and applicability assumptions, have been used to estimate potential reductions in CO<sub>2</sub> emissions for each LA in England. These estimates can provide a starting point for discussions on the setting of targets for emissions reductions to be monitored using the CCCI through the Local Government Performance Framework.

The results show that many LAs in England could expect to achieve between 11% and 13% reduction in emissions compared to 2004 by 2010 and between 19% and 23% compared with 2004 emissions by 2020.

We have also considered how uncertain the estimates of carbon reductions might be. Overall the uncertainty ranges in the savings are estimated at between +/- 2% to +/- 5% for principal measures in 2010 and between +/- 2% to +/- 7% for all measures in 2020.

The modelling undertaken in this work package has been limited by the time available (one month). We have collected a lot of information on measures but this has not been exhaustive. There are still gaps in the dataset of measures, particularly related to transport measures such as restrictions on access (low emission or congestion zones). We have also not included an assessment of the progress made so far by individual local authorities although the model does include qualitative information such as Nottingham declaration signatories and Beacon councils. This could be used in future modelling work to group LAs into leaders, followers and laggards for example, with applicability and efficiency of measures altered for each group.

### **Implementation of the proposed indicator**

Finally, recommendations are made on the possible next steps towards the implementation of this indicator including consultation with Local Authorities; helping LAs set targets; developing common reporting approaches for voluntary reporting and guidance for assessing progress, the effectiveness of measures and integration of better local data (e.g. spatial/transport plans) into assessments of future emissions.

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## Document revision history

Issue	Version	Revision history
1	Draft	▶ Issued to Defra for internal review prior to interim meeting
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3	Final	▶ Issued to Defra for distribution to other Government Departments 6-7-07
4	For publication	▶ Final amendments made for publication by Defra





# 1 Introduction

This introduction outlines

- ▶ The policy context of the work;
- ▶ The aims of the study, and;
- ▶ The structure of this report.

## 1.1 Policy context

Local authorities (LAs) are becoming increasingly involved in climate change and this involvement includes monitoring greenhouse gas emissions against targets or indicators and developing carbon assessment and management programmes. To monitor progress against targets requires a work programme to identify the appropriate targets and develop methods to assess progress against these targets. This project fills an important role to determine which indicators and methods should be used.

This section of the report sets out the policy context around this study, in the form of a short policy review, and introduces key terminology used in the report. The policies are considered in approximate chronological order, after a short section on the UK's Kyoto targets and a description of adaptation and mitigation. The policy review starts at **Section 1.1.6**.

### 1.1.1 Climate change

Climate change is widely recognised as the most serious environmental threat facing our planet (IPCC, 2007). In response, a wide range of activities to reduce greenhouse gas emissions are being undertaken at international, national and local levels. Many measures in the UK climate change programme will apply across the UK, and in addition there are specific initiatives designed to tackle the issues that are most important at a local level. The climate change programme and other relevant initiatives are discussed later in this section.

### 1.1.2 The Kyoto Protocol target and the domestic carbon dioxide goal

The Kyoto Protocol is now in force, and the UK has agreed a reduction of 12.5% in its greenhouse gas (GHG) emissions<sup>2</sup>. The UK must achieve this reduction and many LAs are keen to contribute. This contribution needs to be planned and managed, and this work programme is part of this strategic planning. In addition, many local authorities recognise the threat of climate change to their own economies and are considering the effects of climate change on their social and economic policy. The most recent GHG inventory (2005) indicates that the UK is on target to meet its Kyoto target, and has achieved a reduction of 15% in its greenhouse gas emissions since 1990 (Defra e-Digest of Environmental Statistics, 2007)

The UK has also set itself a more challenging domestic goal to reduce carbon dioxide emissions by 20 per cent below 1990 levels by 2010. The most recent work estimating projected GHG emissions indicates that CO<sub>2</sub> emissions are likely to be 144 MtC in 2010 (DTI 2007).

The terms target and goal are often referred to rather loosely, but the Kyoto reduction is strictly a target as the UK is legally obliged to meet its reduction – agreed as part of a burden sharing agreement with members states of the European Union<sup>3</sup>. The domestic CO<sub>2</sub>

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<sup>2</sup> The Kyoto basket of gases is: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride

<sup>3</sup> The EU-15

reduction is a goal, as the government aspires to achieve this reduction, but it is not legally bound to do so.

### 1.1.3 How can local authorities help UK climate change efforts?

Local authorities have a key role to play to help limit the UK's GHG emissions, and LAs have a dual role in tackling climate change:

- ▶ Firstly in reducing carbon emissions in their own estate and service delivery operations through more efficient energy use, installing renewable energy systems, and improving vehicle efficiency, and,
- ▶ Secondly through playing a leading role in working with communities to reduce carbon emissions in housing, business and local transport through behavioural change<sup>4</sup>.

To understand the magnitude and spatial variability of carbon emissions in UK LAs, Defra have commissioned a programme of work to produce carbon estimates for each LA<sup>5</sup> (King *et al.*, 2006). The study was limited to just carbon because of the technical difficulties in estimating emissions of the full Kyoto basket of six GHGs, and it is underpinned by data contained within the UK greenhouse gas inventory. This study has revealed which sources of carbon within LA boundaries are important, and annual updates to this study will reveal which sources are changing in magnitude.

Whilst the carbon reductions achieved in their own estate can be measured and attributed directly to the efforts of the local council, measuring their impact in local communities is more difficult to attribute directly to LAs. But action by local strategic partnerships led by LAs, should take joint accountability for CO<sub>2</sub> reduction in the community, and this will be critical to the success of these indicators.

LAs can control and limit some sources of GHGs because they are under their direct control (for example emissions from their own estate or vehicle fleet); other sources they have some control over (for example via the planning process) and some sources they have little control over (for example, emissions from Part A regulated processes). A key question now is what metric LAs can use to achieve cost-effective reductions in GHG emissions.

This study has been commissioned by Defra to identify specific metrics that can be used to help LAs focus their efforts to reduce GHG emissions. These activities are mitigation activities, because they aim to avoid the impacts of climate change by addressing the cause or source of the emissions. This work does not consider metrics that LAs could be judged on for their adaptation activities, and it is important to understand the difference between mitigation and adaptation. Both adaptation and mitigation need to be considered because some of the effects of climate change are now certain to occur.

### 1.1.4 Distinction between adaptation and mitigation

People are often confused about the distinction between the terms 'adapting to climate change' and 'mitigating against climate change'. The distinction is important because the two sets of actions are very different. Adaptation is defined by the UK Climate Impact Programme (UKCIP, 2003) as: *The process or outcome of a process that leads to a reduction in harm or risk of harm, or realisation of benefits associated with climate variability and climate change.*

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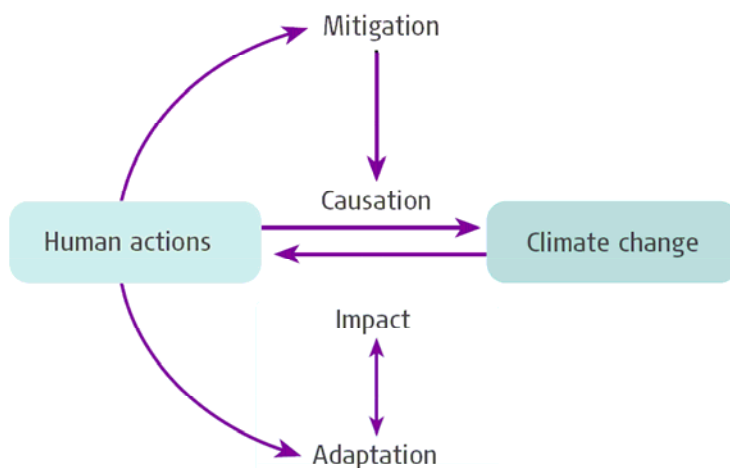
<sup>4</sup> Large businesses participating in the European Union Emissions trading Scheme will be excluded from the indicators examined as part of this work, as LAs have limited influence on their operations.

<sup>5</sup> A project commissioned by Defra and carried out by AEA Energy and Environment to produce a set of experimental statistics of carbon dioxide emissions for local authority (NUTS4) and Government Office Region (NUTS1) areas for the year 2004

The contrast between adaptation and mitigation is summarised in **Figure 1.1**. In essence:

- ▶ *Mitigation* aims to avoid the impacts of climate change by addressing the cause. This is achieved by reducing greenhouse gas emissions or by capturing and storing carbon dioxide from the atmosphere in gaseous or solid form.
- ▶ *Adaptation* aims to address the effects of climate change, such as increased flood or drought risk. It is a response to actual or potential impacts induced by climate change. These impacts may affect human actions directly or they may affect the environment in which we live.

**Figure 1.1** *The difference between adaptation and mitigation (from UKCIP)*



### 1.1.5 Action already being taken at local authority level

Local authorities are well placed to connect with individuals and local groups and help influence them to tackle climate change. LAs are representative local bodies, and they provide a vital role to encourage and enable actions on the ground. A number of LAs, working in partnership with other organisations such as the Energy Saving Trust, have shown that local action can mobilise a shift in individual attitudes and encourage action on climate change (for example, Woking and Nottingham). A number of LAs are also undertaking ambitious carbon reduction projects in their own buildings and operations, working closely with the Carbon Trust and supported through Salix finance<sup>6</sup>. Two examples of Local Authorities working with this finance route are Oxford City Council and Aberdeen.

### 1.1.6 Local authority integration into national climate change policy

There is a rapidly expanding set of legislation, and policies and measures that mention climate change activities that do, or shortly will, affect local authorities. The section below summarises programmes, acts, statements, reviews and consultations that are relevant to this study. It is not designed to be a completely authoritative review, but to cover the main

<sup>6</sup> Salix is an independent, not-for-profit company set up by the Carbon Trust in 2004. It has Government funding of £20 million and is an integral part of the UK Climate Change Programme. The scheme is now working with local government, the NHS and universities and hopes to extend its programme into central government shortly. Salix's role is to help public sector organisations reduce carbon emissions through capital investment in energy efficiency projects. Salix provides interest-free, matched funding, with the fund structured so that the energy savings pay the grant back over time. Salix launched its Local Authority Energy Financing (LAEF) pilot scheme in 2004. The pilot now includes 19 Local Authorities who have completed or commissioned nearly 500 projects with a total value of £3.3 million. The announcement of a further £20 million in funding for 2006/08 has allowed the pilot to be rolled out into a fully fledged Local Authorities programme. LA Phase 1 launched in November 2004 and further phases have subsequently been launched. <http://www.salixfinance.co.uk/laprogramme.html>

government activities that will affect local authorities in the near future. The review concentrates on initiatives in the UK, and is in approximate chronological order.

### **Home Energy Conservation Act (HECA) and energy efficiency**

LAs currently produce annual progress reports on energy efficiency, which outline the actions taken in their communities to improve energy efficiency, as required by the Home Energy Conservation Act (HECA) (1995)<sup>7</sup>. The review of this Act has concluded that this reporting process is ineffective and needs to evolve into an outcome based approach.

### **The Climate Change Programme**

This was a major piece of work commissioned by UK government in 2006<sup>8</sup> and was published on 27<sup>th</sup> March 2006. The Climate Change Programme sets out the government's policies and priorities for action in the UK and internationally and aims to show that the UK can tackle climate change without damaging the UK's economy. The programme set out a number of policies and measures that are specifically aimed at local authorities, and the reductions in GHG emissions predicted by some of these measures have been included in this work. The measures included are explained in **Section 6.2**.

There is a section on the steps that the public sector can take to reduce emissions, and the programme states that the public sector is in a key position to lead on carbon emissions reduction by setting a behavioural and strategic example to the private sector. Setting high standards of energy efficiency and reducing carbon emissions can achieve this, and so the public sector can reduce its own emissions, reduce emissions through selective procurement, and also influence the supply chain for buildings and energy-using appliances.

Within the programme, the Government stated it was committed to a realignment of existing resources away from process - for example the preparation of reports - and towards outcomes - for example carbon savings, delivered in a way most appropriate for the local areas.

### **The Energy Review**

The Government's report on the Energy Review: "The Energy Challenge"<sup>9</sup> was released on 11<sup>th</sup> July 2006 (DTI, 2006a). This work aimed to put the UK in a position to meet the two major long-term challenges in UK energy policy:

- ▶ To tackle climate change by reducing carbon dioxide emissions; and
- ▶ To deliver secure, clean energy at affordable prices, as the UK move to increasing dependence on imported energy

A package of proposals was announced in the Energy Review document to help address these challenges, and work on them is now underway.

The Energy Review stated that "*It is important that local authorities take action to combat climate change, in a cost effective way, taking account of local circumstances and priorities. Our proposals to provide a real incentive for local authorities to take action on climate change will be set out in the Local Government White Paper*".

The Local Government White Paper is discussed later in this section.

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<sup>7</sup> <http://www.defra.gov.uk/environment/energy/heca95/index.htm>

<sup>8</sup> Climate Change The UK Programme 2006. Presented to Parliament by the Secretary of State for the Environment, Food and Rural Affairs by Command of Her Majesty Presented to the Scottish Parliament by the Scottish Ministers: Presented to the Northern Ireland Assembly: Placed with the Welsh Assembly library. March 2006. CM6764. SE/2006/43

<http://www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/ukccp06-all.pdf>

<http://www.official-documents.gov.uk/document/cm67/6764/6764.asp>

<sup>9</sup> The energy challenge: energy review - a report. CM 6887

<http://www.official-documents.gov.uk/document/cm68/6887/6887.asp>

### **Climate Change and Sustainable Energy Act and the Energy Measures Report**

The Climate Change and Sustainable Energy Act 2006<sup>10</sup> (prepared 26<sup>th</sup> June 2006) commits government to producing an 'energy measures report' by August 2007. This report must contain information on measures that local authorities can take in order to:

- ▶ Improve energy efficiency;
- ▶ Increase the levels of microgeneration;
- ▶ Reduce greenhouse gas emissions; and
- ▶ Reduce the number of households living in fuel poverty.

Local authorities will need to 'have regard' to this report when exercising their functions. Whilst the report will focus on emissions reduction and fuel poverty measures, it will also make clear the link with adaptation to climate change.

A joint Defra, DTI and CLG consultation paper was issued on 9 May 2007<sup>11</sup>. This seeks written views from local authorities and others by 1 August 2007 on the approach the Government should take towards the energy measures report.

### **Strong and prosperous communities - The Local Government White Paper and the new performance framework**

The Local Government White Paper, released on 26<sup>th</sup> October 2006,<sup>12</sup> sets out a new performance framework for LAs which the government proposes to introduce in 2008/9. The framework proposes a simplification of the current set of 600-1200 LA indicators to create a set of 200 outcome based indicators. Each LA will agree 35 priority indicators against which targets will be set. The White Paper states that the new performance framework will have an appropriate focus on climate change. This report assesses one of the two proposed climate change mitigation indicators to form part of the set of 200 indicators for LAs.

### **The Stern Review**

The Stern Review<sup>13</sup>, published on 30<sup>th</sup> October 2006, assessed a wide range of evidence on the impacts of climate change and on the economic costs, and used a number of different techniques to assess costs and risks. The authors of the review concluded that the benefits of strong and early action far outweigh the economic costs of not acting.

The review had a global focus, and did not specifically concentrate on the UK LAs.

### **The Climate Change Bill (currently in draft and out for consultation)**

The draft Climate Change Bill<sup>14</sup>, issued on 13<sup>th</sup> March 2007, is designed to set out a new legal framework for the UK achieving, through domestic and international action, at least a 60% reduction in carbon dioxide emissions by 2050, and a 26-32% reduction by 2020, against a 1990 baseline.

The Government will be required to set five-year carbon budgets, placing binding limits on aggregate carbon dioxide emissions. There is provision in the draft Bill for the targets to be amended in the light of significant developments in climate science or in international law or policy.

As is usual practice when introducing new legislation, the bill is accompanied by a regulatory impact assessment. The closing date for responses is 12 June 2007.

<sup>10</sup> Climate Change and Sustainable Energy Act 2006, ISBN 0 10 541906 0

<http://www.opsi.gov.uk/ACTS/acts2006/20060019.htm>

<sup>11</sup> Consultation on Guidance to Local Authorities in England and Wales on Climate Change Mitigation and Fuel Poverty, May 2007.

<http://www.dti.gov.uk/files/file39194.pdf>

<sup>12</sup> Department for Communities and Local Government. Strong and prosperous communities- The Local Government White Paper. Presented to Parliament by The Secretary of State for Communities and Local Government by Command of Her Majesty. October 2006. Cm 6939-I.

<http://www.communities.gov.uk/index.asp?id=1503999>

<http://www.official-documents.gov.uk/document/cm69/6939/6939.asp>

<sup>13</sup> Stern Review on the economics of climate change. ISBN 0-521-70080-9

[http://www.hm-treasury.gov.uk/independent\\_reviews/stern\\_review\\_economics\\_climate\\_change/stern\\_review\\_report.cfm](http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm)

<sup>14</sup> <http://www.defra.gov.uk/corporate/consult/climatechange-bill/>

<http://www.official-documents.gov.uk/document/cm70/7040/7040.asp>

### **The Energy White Paper (2007)**

The government issued an energy white paper on 23<sup>rd</sup> May 2007<sup>15</sup>. This paper was produced by the DTI and updates the energy white paper issued in 2003. The 2007 energy white paper is a companion analysis to The Energy Review (see above) and sets out the framework for action to address energy supply and security, progressively reduce carbon emissions, and manage the risks associated with these activities.

Relevant to this LA indicator study, the white paper provides legally binding carbon targets for the whole UK economy which will need mitigation activity to help deliver them. The key elements of the government programme set out in the paper are:

- ▶ Establish an international framework to tackle climate change;
- ▶ Provide legally binding carbon targets for the whole UK economy, progressively reducing emissions;
- ▶ Make further progress in achieving fully competitive and transparent international markets;
- ▶ Encourage more energy saving through better information, incentives and regulation;
- ▶ Provide more support for low carbon technologies;
- ▶ Ensure the right conditions for investment.

The paper refers to a number of initiatives that will affect LAs, and which are aimed at reducing carbon emissions:

- ▶ *Energy Efficiency Commitment/Carbon Emission Reduction Target*  
The EEC has had a range of social benefits, supporting Local Authority objectives under Decent Homes and the Home Energy Conservation Act.
- ▶ *Work to address fuel poverty*  
The government is currently finalising a new model that will enable each LA to see the baseline fuel poverty level in their area.
- ▶ *Planning Policy Statement (PPS) on climate change – consultation*  
The energy white paper refers to the PPS, and notes that there is also a clear steer to planning professionals and local authority decision makers not to question the national need for renewables and other low carbon technologies, or to question the need for a particular project to be sited at a particular location.
- ▶ *Smarter Travel Choices*  
Traveling to School Initiative - The objective of this initiative is to ensure every school in England has an active travel plan in place by 2010. The funding includes £7.5 million each year to fund a network of 250 local authority based travel advisers to work with schools and help them develop and implement school travel plans.

### **1.1.7 Other policy drivers**

There is a wide range of other policies and initiatives that affect climate change activities at the local authority level. Some of the key drivers are set out below.

#### **The Nottingham Declaration**

The Nottingham Declaration<sup>16</sup> is a voluntary pledge to address the issues of climate change. It represents a high-level, broad statement of commitment that any council can make to its own community. The declaration was originally launched in October 2000 at a conference in Nottingham.

<sup>15</sup> Meeting the Energy Challenge A White Paper on Energy May 2007. Department of Trade and Industry. Presented to Parliament by the Secretary of State for Trade and Industry. By Command of Her Majesty, May 2007. CM 7124.

<http://www.dti.gov.uk/files/file39564.pdf>

<http://www.gnn.gov.uk/environment/fullDetail.asp?ReleaseID=286525&NewsAreaID=2>

<http://www.official-documents.gov.uk/document/cm71/7124/7124.asp>

<sup>16</sup> <http://www.energysavingtrust.org.uk/housingbuildings/localauthorities/NottinghamDeclaration/>

To mark the fifth anniversary of the declaration it was re-launched on 5 December 2005 at the Second National Councils Climate Conference. The new version of the declaration is broadly similar to the original, but better reflects current thinking. The process of revising and re-launching the declaration was undertaken by a steering group that includes all the main national agencies concerned with the different aspects of climate change along with Defra, Improvement and Development Agency for local government (IDeA)<sup>17</sup>, LGA, the Environment Agency, Nottingham City and Nottinghamshire County Councils and ICLEI<sup>18</sup>, the worldwide association of local governments concerned with sustainability.

### **Local Authority Carbon Management Programme**

Through the Local Authority Carbon Management Programme, the Carbon Trust provides councils with technical and change management support and guidance to help them realise carbon emissions savings. The primary focus of the work is to reduce emissions under the control of the local authority such as buildings, vehicle fleets, street lighting and landfill sites.

The programme centres around a 5 step process. This process guides authorities through a systematic analysis of their carbon footprint, the value at stake and the opportunities available to help them manage carbon emissions in a strategic manner.

### **Local Area Agreements**

A Local Area Agreement (LAA) is a three year agreement, presented in local Sustainable Community Strategy<sup>19</sup>, that sets out the priorities for a local area agreed between Central Government, represented by the Government Office (GO), and a local area, represented by the local authority and other key partners through Local Strategic Partnerships (LSPs). The agreements are based upon discussions between local and central government leading to more relevant outcomes for local areas with devolved responsibility to respond and deliver. LAAs aim to align or rationalise funding resources, reduce bureaucracy, and enhance efficiency.

LAA's are identified in the Climate Change Programme (April 2006) as providing a mechanism to achieve specific climate change outcomes. The LAA Guidance and associated Outcomes Framework includes specific outcomes for:

*“Sustainable communities which deliver sustainable development locally through: i) Reducing green house gas emissions and managing impacts of climate change...”*,

as well as a number of air quality related outcomes.

### **Planning Policy Statements**

Planning Policy Statements (PPS) set out the Government's national policies on different aspects of land use planning in England. PPS<sup>20</sup>, released on 31<sup>st</sup> January 2005, sets out the overarching planning policies on the delivery of sustainable development through the planning system. The policies set out in PPS1 will need to be taken into account 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 local planning authorities in the preparation of local development documents. They may also be material to decisions on individual planning applications.

<sup>17</sup> [www.idea.gov.uk/idk/core/page.do?pagelid=1](http://www.idea.gov.uk/idk/core/page.do?pagelid=1)

<sup>18</sup> International clearinghouse on sustainable development and environmental protection policies, programs, and techniques being implemented at the local level

[www.iclei.org](http://www.iclei.org)

<sup>19</sup> Sustainable Community Strategies - Creates a long-term, sustainable vision in an area and sets the agenda for priorities in the local area agreement. See

<http://www.sustainable-development.gov.uk/advice/local/localleadership.htm#mechanisms>

A beginner's guide to sustainable communities can be found at

<http://www.idea-knowledge.gov.uk/idk/core/page.do?pagelid=919821>

<sup>20</sup>

Planning Policy Statement 1: Delivering Sustainable Development. Office of the Deputy Prime Minister (2005). ISBN 0 11 753939 2

[http://www.communities.gov.uk/pub/806/PlanningPolicyStatement1DeliveringSustainableDevelopment\\_id1143806.pdf](http://www.communities.gov.uk/pub/806/PlanningPolicyStatement1DeliveringSustainableDevelopment_id1143806.pdf)



PPS1 states that development plan policies should take account of environmental issues such as:

- ▶ mitigation of the effects of, and adaptation to, climate change through the reduction of greenhouse gas emissions;
- ▶ the use of renewable energy;
- ▶ air quality and pollution;
- ▶ land contamination;
- ▶ the protection of groundwater from contamination;
- ▶ and noise and light pollution;

### **Consultation on PPS1**

CLG has just completed a consultation on climate change supplements to PPS1<sup>21</sup> by setting out how planning should contribute to emission reduction targets. The consultation collected views and comments on a draft Planning Policy Statement (PPS) "Planning and Climate Change". The PPS sets out how "planning, in providing for the new homes, jobs and infrastructure needed by communities, should help shape places with lower carbon emissions and with resilience to the climate change now accepted as inevitable".

The consultation period was the 13<sup>th</sup> December 2006 to 8<sup>th</sup> March 2007.

### **Planning White Paper**

Defra have just issued a planning white paper (issued 21st May 2007)<sup>22</sup>. The White Paper sets out detailed proposals for reform of the planning system, building on government recommendations for improving the speed, responsiveness and efficiency in land use planning, and taking forward proposals for reform of major infrastructure planning.

The white paper proposes reforms on how decisions on nationally significant infrastructure projects are made - including energy, waste, waste-water and transport. It proposes to further streamline the process in the town and country planning system, improve the ability of local authorities to shape their local communities, and ensure that there is a stronger approach to supporting sustainable economic development alongside work to tackle climate change in a way that is integrated with the delivery of other sustainable development objectives. These improvements should make the Town and Country Planning system more efficient and more responsive.

### **Waste Strategy for England**

The Government published Waste Strategy for England 2007 on 24 May 2007<sup>23</sup>. This sets out the government's vision for sustainable waste management. Local authorities are mentioned in this strategy – additional funding for local authorities, including through the private finance initiative, has led to a major increase in kerbside recycling facilities. The strategy notes that local authorities will have to commission or provide convenient recycling services for their residents and commercial customers and advice and information on how to reduce waste. They will also have to work with their communities to plan and invest in new collection and reprocessing facilities.

In April 2007 the Government set performance standards on recycling and composting for all local authorities for the year 2007/08, setting a minimum performance standard of 20% across the country. These are the final set of Best Value Performance Indicators (BVPIs) for

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<sup>21</sup> Consultation - Planning Policy Statement: Planning and Climate Change - Supplement to Planning Policy Statement 1

<http://www.communities.gov.uk/index.asp?id=1505140>

<sup>22</sup> Planning for a Sustainable Future White Paper. Presented to Parliament by The Secretary of State for Communities and Local Government. The Secretary of State for Environment, Food and Rural Affairs, The Secretary of State for Trade and Industry, The Secretary of State for Transport, by Command of Her Majesty. May 2007. Cm 7120.

<http://www.official-documents.gov.uk/document/cm71/7120/7120.asp>

<http://www.communities.gov.uk/index.asp?id=1510503>

<sup>23</sup> Waste Strategy for England 2007. Presented to Parliament by the Secretary of State for Environment, Food and Rural Affairs by Command of Her Majesty. May 2007. Cm 7086.

<http://www.defra.gov.uk/environment/waste/strategy/index.htm>

<http://www.official-documents.gov.uk/document/cm70/7086/7086.asp>

waste. In the new local government framework, there will be a strengthened role for the Local Area Agreements (LAAs). Local authorities are already under a duty to prepare a Sustainable Community Strategy which sets the strategic vision for an area. The Government will now require county and unitary local authorities, in consultation with local partners, to prepare a delivery plan for the strategy – the LAA. The LAA will include a single set of targets for improvement, tailored to local needs and agreed between central government and local partners, such as third sector organisations. In this way, central government will focus on the things that really matter to people everywhere, guaranteeing national minimum standards, but leaving room for local innovation and local priorities.

The strategy notes that in the longer term, the Government is considering developing a greenhouse gas emissions performance indicator for local authority performance on waste. This would reflect total greenhouse gas emissions from a local authority's waste management activity and fit within the new performance framework. Consideration will be given to the development of a methodology for a local authority waste performance greenhouse gas emissions indicator.

### **EU Directive on the Energy Performance of Buildings**

Buildings are major consumers of energy. EC research has indicated that by improving energy efficiency, carbon emissions from buildings could be reduced by 22%. This will help the EU to meet its climate change objectives under the Kyoto Protocol commitments as well as improve the energy performance of new and existing buildings.

The European Commission's Action Plan on Energy Efficiency (2000) indicated the need for specific measures in the building sector. In response, the European Commission (EC) published the proposed Directive on The Energy Performance of Buildings in May 2001.

The European Parliament and Council signed the agreed text of the Directive at Energy Council on 25 November 2002. Upon its publication in the EU Official Journal on 4 January 2003, the Directive became European Law the following day.

The principal objectives of the Directive are<sup>24</sup>:

- ▶ To promote the improvement of the energy performance of buildings within the EU through cost effective measures;
- ▶ To promote the convergence of building standards towards those of Member States which already have ambitious levels.

Measures include:

- ▶ Methodology for calculating the energy performance of buildings;
- ▶ Application of performance standards on new and existing buildings;
- ▶ Certification schemes for all buildings;
- ▶ Regular inspection and assessment of boilers/heating and cooling installations.

The CLG will take the lead for implementing the measures contained within the Directive, as it has responsibility for most of the legislation that will be used to transpose the Directive into law; most measures will be dealt with via the Building Regulations, a major revision of which has been in place since 2005. Local authority buildings will be covered by this Directive

More information is provided on the CLG web site<sup>25</sup>.

### **Energy Performance Commitment**

The Carbon Reduction Commitment (CRC)<sup>26</sup> is a new scheme, announced in the Energy White Paper 2007, which will apply mandatory emissions trading to cut carbon emissions

<sup>24</sup> <http://www.defra.gov.uk/environment/energy/internat/ecbuildings.htm>

<sup>25</sup> <http://www.communities.gov.uk/index.asp?id=1504720>

<sup>26</sup> <http://www.defra.gov.uk/environment/climatechange/uk/business/crc/>

from large commercial and public sector organisations (including supermarkets, hotel chains, government departments, large local authority buildings) by an estimated 1.2 MtC / year by 2020.

The CRC is the new name for the Energy Performance Commitment proposal on which the Government consulted in 2006. The name of the scheme has been changed to prevent any confusion with Energy Performance Certificates.

The EPC would have focussed on emissions from energy use by large organisations – whose electricity use was above 3,000 MWh per year and which are not included in the EU Emissions Trading Scheme and Climate Change Agreements. The CRC will now target emissions from energy use by large organisations whose annual mandatory half hourly metered electricity use is above 6,000MWh – focusing on those emissions outside the Climate Change Agreements (CCAs) and outside the direct emissions covered by the EU Emissions Trading Scheme (EU ETS). In addition, firms with more than 25% of their energy use emissions in Climate Change Agreements would be completely exempt.

The government will publish, in June 2007, a further consultation on the detail of how the proposed CRC can best be implemented. The earliest likely date that the CRC could come into force is January 2010.

### **Beacon Councils**

The Beacon Scheme was set up to disseminate best practice in service delivery across local government. In its broadest sense, this will include climate change activities of mitigation and adaptation. Ten themes are selected for each round of the scheme by government ministers. The themes represent issues which important in the day-to-day lives of the public and reflect key government priorities.

The Communities and Local Government (CLG) take the policy lead but the Beacon Council programme is managed by the IDeA (Improvement and Development Agency) under a service level agreement. While CLG Ministers have final discretion over which authorities are awarded beacon status, they are guided by the advisory panel.

One of the current 10 themes is “*promoting sustainable communities through the planning process*”. An important principle of sustainable communities is minimising carbon emissions through system design, and considering adaptation measures to climate change.

## **1.2 Aims of this study**

The study into local and regional CO<sub>2</sub> emission estimates for 2004 published by Defra last year (King *et al.*, 2006) provided estimates of all CO<sub>2</sub> emissions within each local authority in the UK based on data from the National Atmospheric Emissions Inventory (NAEI) and DTI regional energy statistics.

For this work programme, this dataset has been developed and improved so that it can be used as the basis of an indicator of climate change in the forthcoming Performance Framework for local authorities (CLG, 2006).

Developing the proposed indicators has involved a number of stakeholder discussions between Defra and representatives from LAs, the Local Government Association (LGA) and other relevant partnerships and groups. The two indicators on climate change mitigation have been selected by Defra from a range of other options (including sector specific local measures, average SAP ratings<sup>27</sup>, and assumed CO<sub>2</sub> savings of actions taken by LAs).

The original thinking was that the two indicators below could be used to judge climate change mitigation performance for each local authority:

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<sup>27</sup> Standard Assessment Procedure (SAP) rating - is the Government's standard for home energy rating.

1. Percentage CO<sub>2</sub> reduction in LA estate  
Measurement against this indicator will require each LA to calculate their carbon footprint from analysis of energy/fuel bills and outsourced services. The Carbon Trust currently provides support to LAs to guide them through the process of calculating carbon footprints and to help them develop carbon reduction plans. To date, 98 LAs have gone through this process and a further 35 will be signing up to the programme during 2007/8. Further work is proposed to standardise this carbon footprint methodology for all LAs.
2. Percentage reduction of the per capita CO<sub>2</sub> emission in LA communities  
The Home Energy Conservation Act currently requires each LA to list actions taken in their community and to calculate resulting carbon savings. This process has been criticised by stakeholders as inaccurate, costly and inconsistent. In contrast, the new proposed indicator for the community will rely on centrally produced statistics and reports. The DTI currently collects energy meter readings and fuel sales across the UK and AEA Energy & Environment on behalf of Defra converts this data into carbon emissions for each LA. These data are already captured through an existing process and analysed to produce area by area carbon emissions per capita, and so it is sensible to use this data to report on the proposed climate change indicator for communities. This will reduce the current reporting burden on LAs, allowing them to focus their efforts on actions to reduce CO<sub>2</sub>.

This work is therefore the first phase in the development of the indicator of community CO<sub>2</sub> emissions. Other phases could consider costs and benefits of the measures to reduce emissions and the technical guidance required for Local Authorities to set and meet targets related to the indicator.

**The indicator being assessed will comprise:**

- ▶ Annual reduction in CO<sub>2</sub> emissions across an agreed set of sectors (e.g. housing, transport and business) measured as a percentage reduction of the per capita CO<sub>2</sub> emission from a designated base year.

**More detailed data supporting this indicator will show:**

- ▶ Emissions (CO<sub>2</sub> tonnes per capita) from individual sectors and fuel groups (electricity, gas, solid and liquid fuels).
- ▶ Centrally calculated indicative information on the CO<sub>2</sub> emission reduction potential by Local Authority. This may be used as background information to help Local Authorities set targets for emission reduction.

In addition this work programme has included modelling potential emission reductions by each LA in England. These estimates can provide a starting point for discussions on the setting of targets for emissions reductions to be monitored using the CCCI through the Local Government Performance Framework.

**The aims of the current project are:**

- ▶ To recalculate a modified dataset of 2004 local authority CO<sub>2</sub> emissions estimates with a reduced scope to reflect the emissions that are within the influence of Local Authority actions;
- ▶ To estimate emission reduction potential by LA by modelling the implementation of CO<sub>2</sub> mitigation measures in each LA based on the 2006 UK Climate Change Programme, the 2007 Energy White Paper and sample local measures, and;
- ▶ To provide recommendations on uncertainties, data improvements (and associated costs) and implementation of the LA indicator for reduction of community CO<sub>2</sub> for England.

## 1.3 Quoted accuracy of the emissions in this study

In this report, emissions are quoted to 0.01 ktonne (or better) purely for convenience, to avoid the risk of rounding errors, and for convenience when taking ratios. The number of decimal places used should not be taken as indicative of the accuracy of the estimates.

The totals and percentage changes presented in tables in this reports are calculated from emission estimates held at full precision. The emission estimates quoted in the table are values rounded from estimates held at full precision. The totals and percentages quoted in these tables may therefore differ slightly from the percentages and totals that can be calculated from the emission estimates presented in the tables.

## 1.4 Structure of this report

The report is structured as follows:

- ▶ **Chapter 1** (This chapter) presents the policy context of the work; the aims of the study, and; the structure of this report.
- ▶ **Chapter 2** Outlines the scope of the data in the indicator
- ▶ **Chapter 3** Describes the emissions data for 2004 that are being used as the baseline for this work. Modifications to the 2004 datasets for the purpose of this project are described.
- ▶ **Chapter 4** Summaries the structure of a model to designed to estimate potential reductions in CO<sub>2</sub> emissions for each Local Authority in England; Data needed for the model; and, the output from the model.
- ▶ **Chapter 5** Summarises the literature reviewed to gather information about carbon saving measures that are part of government programmes.
- ▶ **Chapter 6** Lists and classifies the measures we have included in and excluded from the analysis.
- ▶ **Chapter 7** Explains how the applicability of the measures to reduce carbon emissions has been determined; and, the methods and data sets used in the model.
- ▶ **Chapter 8** Presents the results of the modelling of potential emission savings
- ▶ **Chapter 9** Presents the results of the uncertainty analysis in the modelling
- ▶ **Chapter 10** Provides conclusions and recommendations

There are three Appendices that provide additional technical information.

## 2 Scope of emissions included in the indicator

This chapter:

- ▶ States the LA climate change community CO<sub>2</sub> indicator that has been selected for this work and the sources of emissions included in the indicator;
- ▶ Outlines the basis for the calculation of emissions;
- ▶ Explains the base data used in the study; and,
- ▶ Sets out the geographical coverage, the baseline year and the projection years.

### 2.1 The indicator selected and nomenclature

**Section 1.2** sets out the two possible LA carbon mitigation activities indicators which Defra have considered. The indicator that has been selected for this study is the percentage reduction in the per capita CO<sub>2</sub> emission in LA communities.

The next step is to then consider what elements (sources of emissions) this indicator should be composed of, and which should be omitted, and this analysis is presented in the **Section 2.2** immediately below.

From here onwards in this report, the LA climate change community CO<sub>2</sub> indicator is just referred to as the community climate change indicator (CCCI).

### 2.2 Sources of emissions considered - boundaries

There is a wide range of sources of carbon that could be included in an CCCI, but not all the emissions from these sources can be accurately quantified and neither can an LA easily control or influence all the sources. Some emissions of carbon are produced from sources that also give rise to emissions of other pollutants; for example, road traffic will emit carbon and some of the air quality strategy pollutants such as oxides of nitrogen and particulate matter also. Therefore, controlling emissions of carbon from such sources also has the added benefit of reducing emissions of other pollutants, and visa versa.

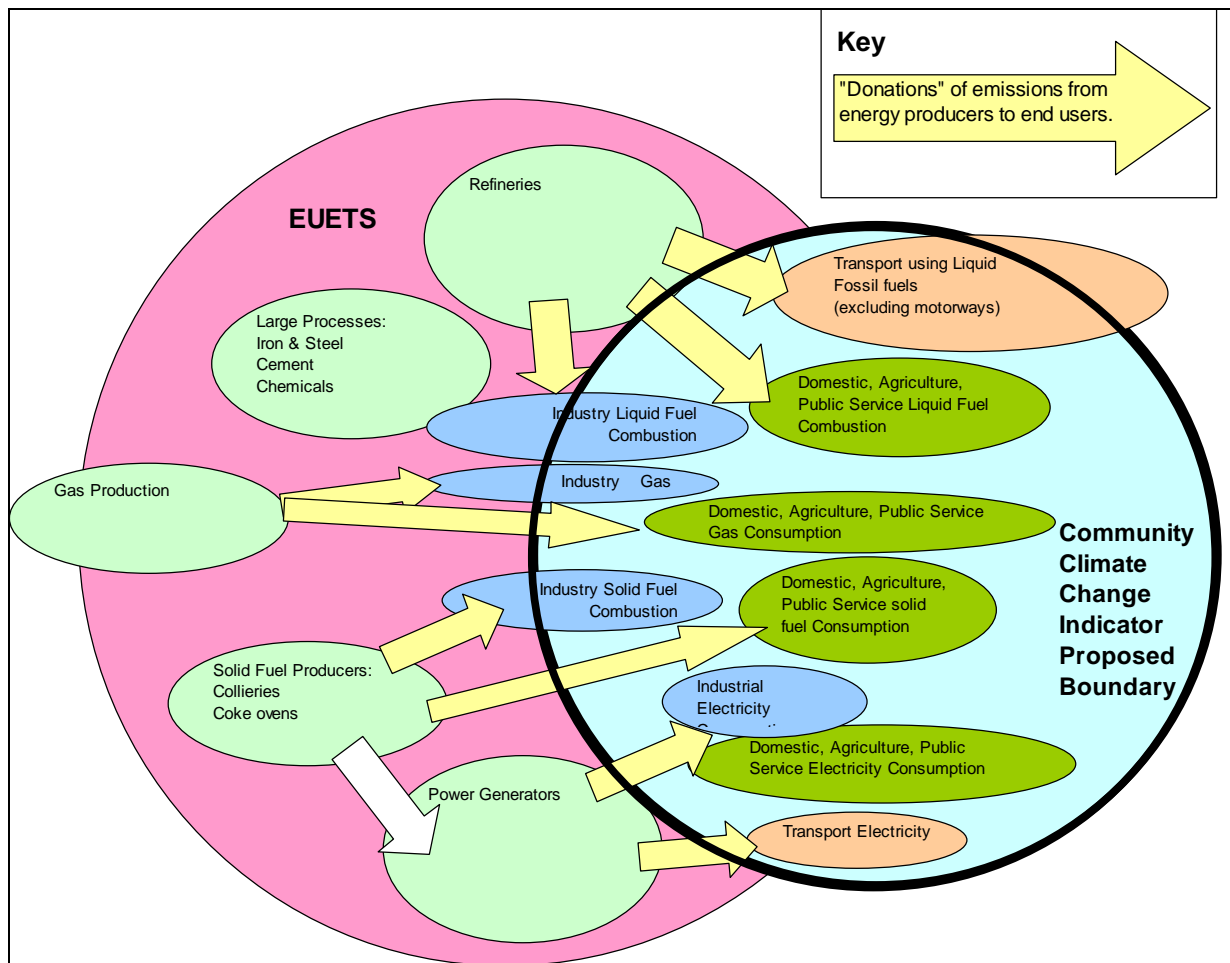
This study has identified a set of sources that can be influenced by the actions of LAs and where well-developed methods to provide reliable estimates of carbon emissions already exist. The study excludes direct carbon emissions from installations in the EUETS<sup>28</sup> because these emissions are affected by national policies. However, emissions from power generation and refining have been included on an end user basis. This is discussed in **Section 2.3.1**. In addition, road transport emissions on motorways are also excluded. Although LAs can have some influence over travel choices of people living and working within their boundaries, the traffic on motorways is often involved in longer trips which cross LA boundaries.

**Figure 2.1** shows the proposed boundary for the emissions included in the CCCI. The figure refers to emissions on an end user basis, and we used this approach to estimating emissions from the sources that comprise the CCCI. End user emissions are discussed in **Section 2.3.1**.

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<sup>28</sup> European Union Emissions Trading Scheme  
<http://www.defra.gov.uk/environment/climatechange/trading/eu/index.htm>

**Figure 2.1** Scope of sources included in the community climate change indicator



## 2.3 Emissions by source and end user

### 2.3.1 Definition of an end user

Emissions by source are simply the direct emissions from an activity, such as the combustion of fuel, for example, during a car journey. Emissions calculated in this way take no account of the emissions that have occurred when the fuel consumed was refined or extracted.

The end user (or final user<sup>29</sup>) calculations allocate emissions from fuel producers to fuel users. The end user calculation therefore allows estimates to be made of emissions for a consumer of fuel, which also include the emissions from producing the fuel the consumer has used. In this study, we use the term end user although there is no difference between a final user and an end user.

<sup>29</sup> A final user is a consumer of fuel for useful energy. A 'fuel producer' is someone who extracts, processes and converts fuels for the end use of final users. Clearly there can be some overlap of these categories but here the fuel uses categories of the UK DTI publication DUKES are used, which enable a distinction to be made in the UK GHG inventory.

The emissions included in the end user categories can be illustrated with an example of two end users – the domestic sector and road transport:

- ▶ Emissions in the **domestic** end user category include:
  1. Direct emissions from domestic premises, for example, from burning gas, coal or oil for space heating, and in addition,
  2. Emissions from power stations generating the electricity used by domestic consumers; emissions from liquid fuel production including refining, storage, flaring and extraction; emissions from coal mines (including emissions due to fuel use in the mining industry itself); and emissions from the extraction, storage and distribution of mains gas.
  
- ▶ Emissions in the **road transport** end user category include:
  1. Direct emissions from motor vehicle exhausts (metals and organic compounds would also be released from brake and tyre wear but these are not relevant in this study), and in addition,
  2. Emissions from liquid fuel production producing motor fuels, including refining, storage, flaring and extraction of oil; and from the distribution and supply of motor fuels.

### 2.3.2 Approach adopted in this work

We recommend that the CCCI is based on emissions calculated on an end user basis; the additional emissions are indicated by the yellow arrows in the **Figure 2.1**.

Emissions from power generation and refining are included within the EUETS, but we have re-allocated these emissions to sources included within the CCCI. For example, electricity use in an individual LA has been allocated its share of emissions from the generation of that electricity. Emissions on an end user basis will therefore be larger than emissions by source, and emissions at the locations of all power stations and all refineries on an end user basis will be zero<sup>30</sup>.

Emissions on an end user basis should help LAs more accurately target efficiency measures. For example, emissions from electricity use in homes, businesses and public services can be influenced by energy efficiency measures championed by LAs for existing and new buildings, and, emissions from transport can also be influenced locally through efficiency and fuel switching measures.

## 2.4 Greenhouse gases included

This study considers only emissions of carbon. Emissions of the other five direct greenhouse gases are not considered because emissions of carbon dominate GHG emissions calculated on a GWP<sup>31</sup> basis, and there is much greater uncertainty in the estimates of emissions from the other gases. The GWP of the direct GHGs is given in **Appendix 1**.

## 2.5 Geographical coverage of the study

This study is restricted to LAs in England only. The local government white paper performance framework produced by the CLG<sup>32</sup> does not cover LAs in Wales and Scotland. These LAs have their own arrangements under devolved government.

<sup>30</sup> Power stations use some electricity themselves, and so they should be allocated emissions from this electricity generated. This minor complication is ignored in the methodology since the quantity of power consumed by power stations is small in relation to the power consumed by other sources.

<sup>31</sup> Global Warming Potential

<sup>32</sup> Communities and Local Government



## **2.6 Base data for the study**

The indicator has been developed for LAs in England only but has been derived from UK based datasets. The study is based on the data developed for local and regional CO<sub>2</sub> emission estimates, for the year 2004, and published by Defra last year (King *et al.*, 2006). This study provided estimates of all CO<sub>2</sub> emissions within each local authority in the UK.

## **2.7 Baseline year for the indicator and projections**

The baseline year for the indicator was 2004 and projections were made for 2010 and 2020.

## 3 Developing the baseline emissions data for the community climate change indicator (CCCI)

This chapter:

- ▶ Explains the methods we have used to develop the baseline emissions data for the CCCI, including adjustments made for EUETS data and motorways;
- ▶ Explains how we have estimated uncertainties in the CCCI;
- ▶ Makes recommendations for improvements to the data underpinning the CCCI;
- ▶ Makes initial recommendations for work that is needed to transform the current CCCI method to one that can be accepted as a national statistic.

### 3.1 Amending the emissions data for 2004

**Section 2.3.2** describes the approach to modifying the emission estimates for 2004 from the local and regional CO<sub>2</sub> emission estimates study (King *et al.*, 2006), and the integration of these data into this work programme. We have recalculated emission estimates for all local authorities by removing the EUETS installations and separating the motorways from the major roads.

**Table 3.1** shows the results of this work at the UK level with overall differences in emissions resulting from these changes. The sectors affected by these changes are highlighted in bold.

The EUETS installations have been identified in the National Atmospheric Emissions Inventory point source database (derived for England and Wales mainly from the Environment Agency pollution inventory), and they have been removed from the LA emission estimates in the relevant sectors.

Motorways have been separated from the A roads by identifying each motorway link in the UK and calculating 1x1 km emissions for just these roads. These motorway emissions were then aggregated to an LA level. Emissions from the A roads emissions were then calculated by difference from the major roads in each LA.

Maps of per capita emissions by local authority from business/industry, domestic and road transport are shown in **Figures 3.1, 3.2 and 3.3** respectively. The full dataset of emissions is included in the spreadsheet accompanying this report.

**Table 3.1** *UK total emissions by sector showing the effects of revisions to CO<sub>2</sub> estimates*  
*Sectors affected by removing the EUETS installations and separating the motorways from the major roads highlighted in **bold***

Emission sector and fuel	Total UK from LA CO <sub>2</sub> 2004 dataset	Revised total UK for proposed LA CO <sub>2</sub> indicator	Percentage of original LA CO <sub>2</sub> 2004 totals
	(ktonnes CO <sub>2</sub> )	(ktonnes CO <sub>2</sub> )	
Industrial, Commercial and Agriculture Electricity	105,567	105567	100%
Industrial, Commercial and Agriculture Gas	57,411	57375	100%
<b>Industrial Gas (Large Users)</b>	<b>6,025</b>	<b>3962</b>	<b>66%</b>
<b>Industry and Commercial Oil</b>	<b>20,078</b>	<b>16829</b>	<b>84%</b>
<b>Industry and Commercial Solid Fuel</b>	<b>15,761</b>	<b>5096</b>	<b>32%</b>
<b>Industry and Commercial Wastes And Biomass</b>	<b>1,806</b>	<b>1513</b>	<b>84%</b>
<b>Industry Process Gases</b>	<b>15,715</b>	<b>6647</b>	<b>42%</b>
<b>Industry Non Fuel</b>	<b>7,408</b>	<b>2063</b>	<b>28%</b>
Industry Off-Road Machinery	7,940	7940	100%
Agriculture Oil	4,565	4565	100%
Agriculture Solid Fuel	21	21	100%
Agriculture Non Fuel	38	38	100%
Railways Diesel	2,771	2771	100%
Domestic Electricity	63,442	63442	100%
Domestic Gas	74,399	74399	100%
Domestic Oil	9,755	9755	100%
Domestic Solid Fuel	5,819	5819	100%
Domestic Home And Garden Machinery	252	252	100%
Domestic Household Products	1,474	1474	100%
<b>Road Transport Petrol (A roads)</b>	<b>52,709</b>	37415	<b>71%</b>
<b>Road Transport Petrol (Motorways)</b>		<b>(15294)</b>	
Road Transport Petrol (Minor roads)	27,556	27556	100%
<b>Road Transport Diesel (A roads)</b>	<b>51,512</b>	<b>31096</b>	<b>60%</b>
<b>Road Transport Diesel (Motorways)</b>		<b>(20416)</b>	
Road Transport Diesel (Minor roads)	18,147	18147	100%
Road Transport Other	548	548	100%
Total	550,718	484,463	88%

**Notes and legend**

Industry
Domestic
Transport

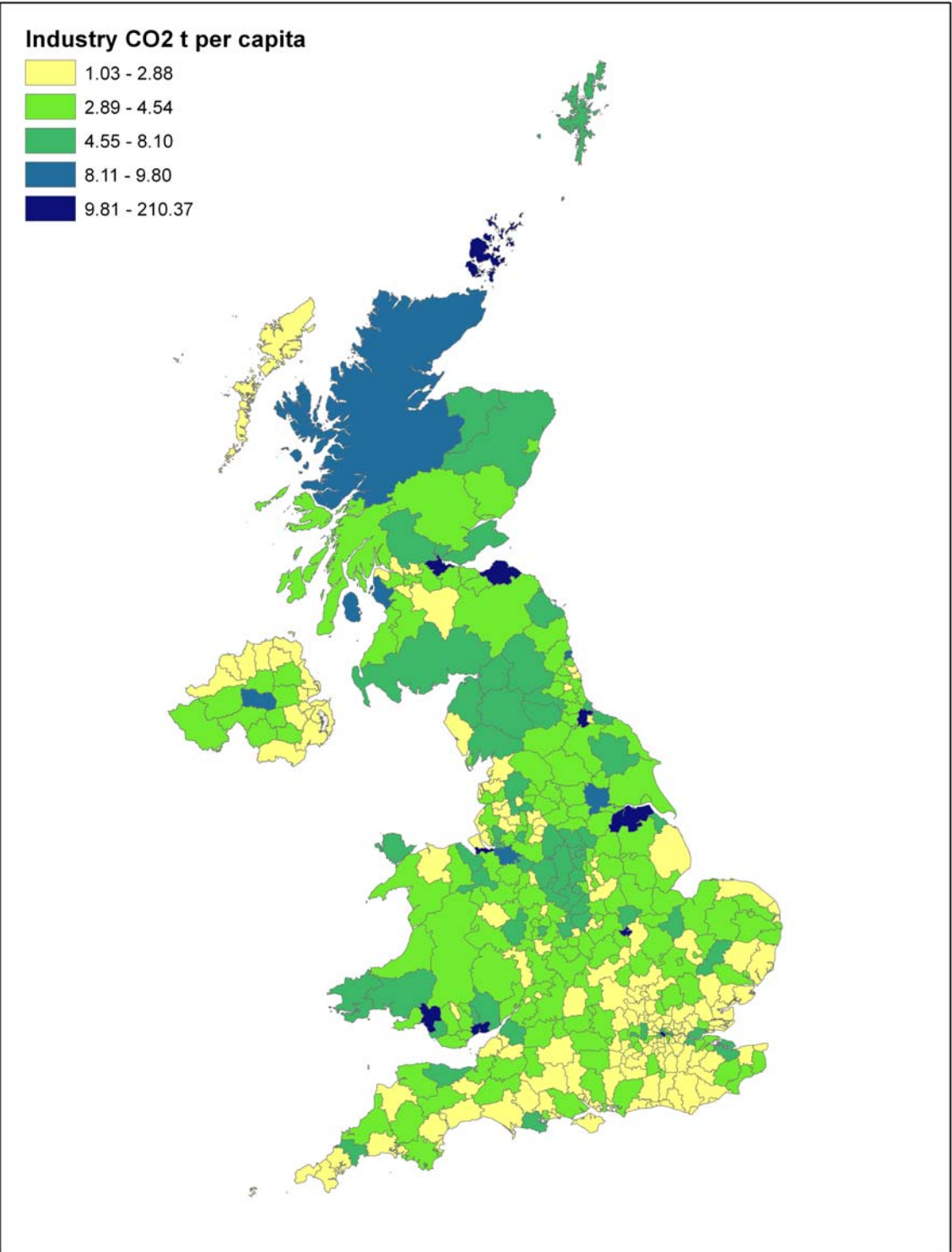
Agriculture non fuel Carbon emissions from the breakdown of pesticide residues

Sectors affected by removing the EUETS installations and separating the motorways from the major roads highlighted in **bold**

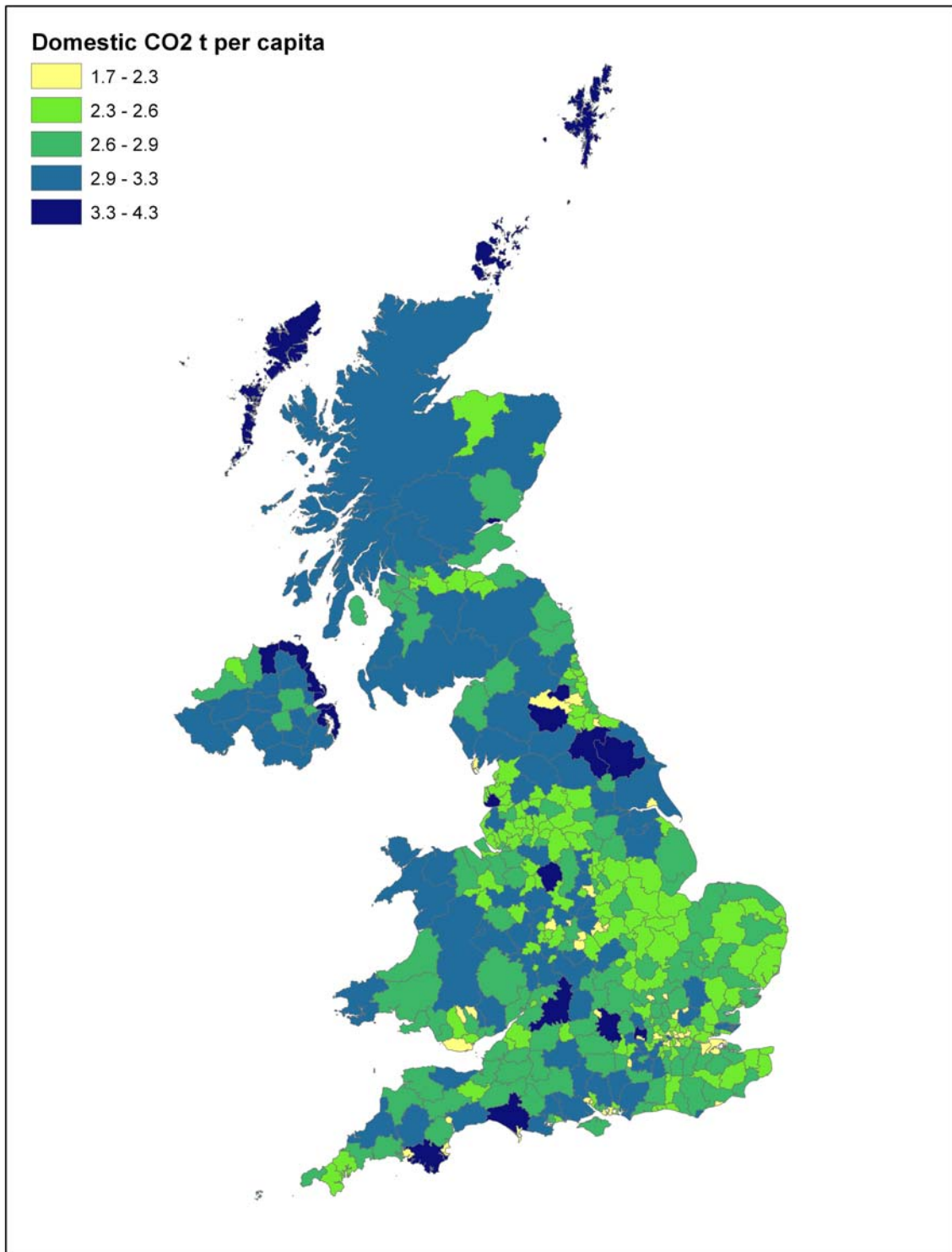
Motorways are not included in the indicator total.

The road transport total presented here is about 8% higher than the published End User CO<sub>2</sub> emission because the Local CO<sub>2</sub> emissions estimates include fuel consumed by all vehicles on the UK roads including those that purchased fuel abroad whereas the UK GHG inventory includes only emissions from fuel sold in the UK.

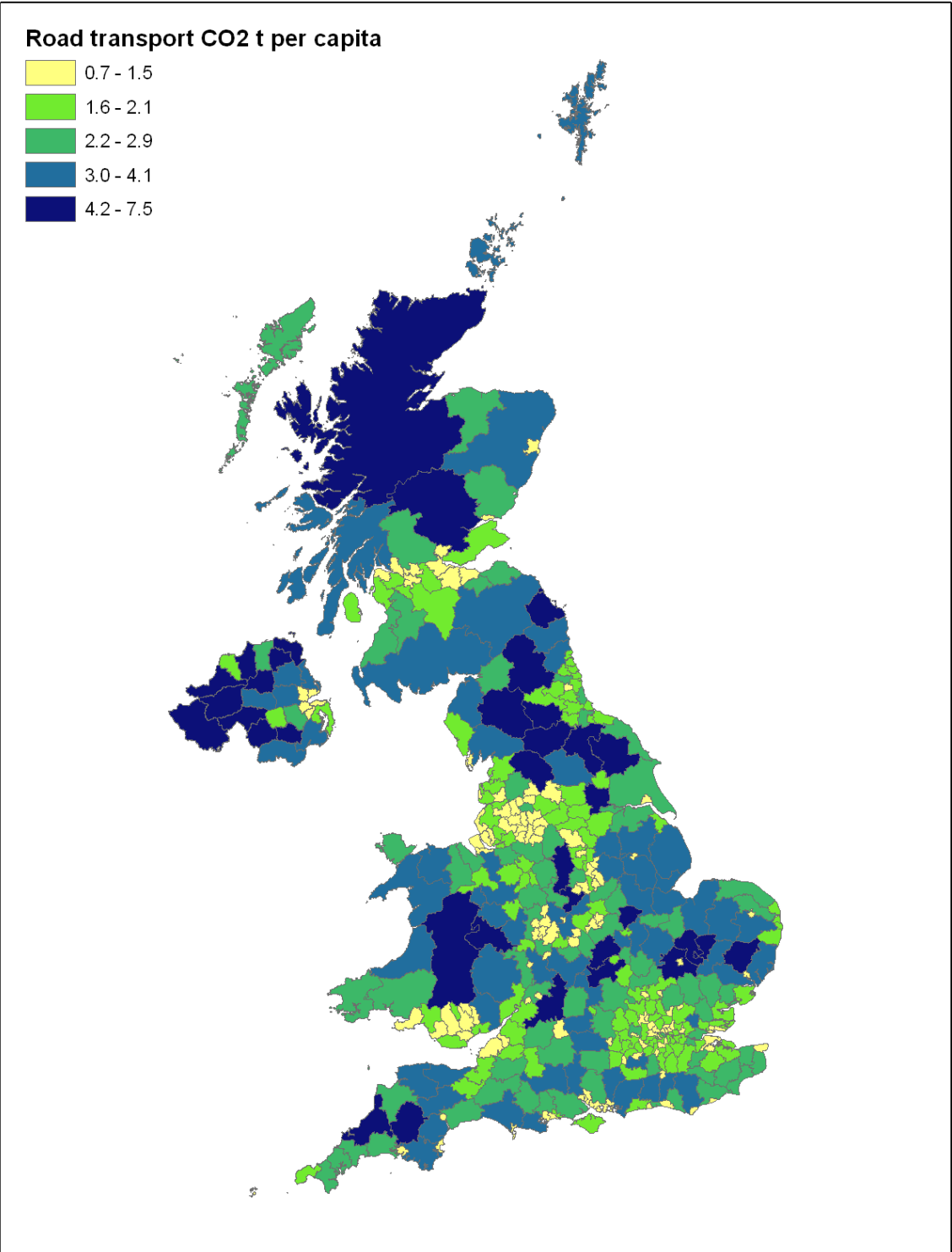
**Figure 3.1** CO<sub>2</sub> emissions from Business and Industry in 2004 (tonnes CO<sub>2</sub> per capita)



**Figure 3.2** CO<sub>2</sub> emissions from Domestic sources in 2004 (tonnes CO<sub>2</sub> per capita)



**Figure 3.3** CO<sub>2</sub> emissions from road transport sources in 2004 (tonnes CO<sub>2</sub> per capita)



## 3.2 Uncertainties in the 2004 LA CO<sub>2</sub> estimates

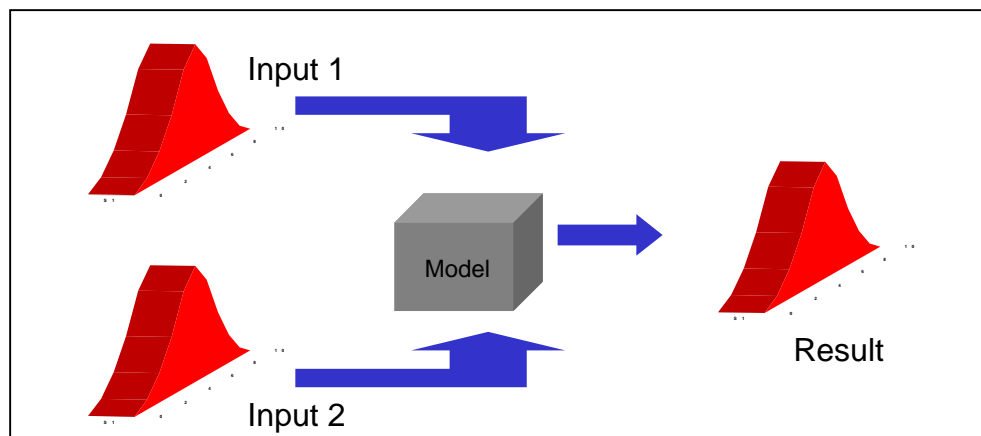
The existence of uncertainty is not a serious problem provided that it can be described, and its effect on the outcome of the analysis quantified. This section describes how uncertainty has been addressed in this analysis.

Overall uncertainties in the emission estimates for each local authority have been assessed by combining three variables. Two of these three variables are sets of uncertainty estimates:

1. Errors in national emissions: estimates of the percentage error margin of the national total sector emissions;
2. Errors in the spatial distribution of emissions: an assessment of the uncertainty in the way that the emissions are distributed between LAs; and,
3. The proportion that each sector contributes to emissions in each Local Authority.

**Figure 3.4** shows how errors from two different distributions can be combined to form a new hybrid distribution.

**Figure 3.4** Combining errors from two or more distributions



Overall uncertainties in the 2004 emissions have been estimated using two different methods for combining component uncertainties. The first is the sum of the squares method for propagating errors through calculations and the second is Monte Carlo simulation using sampling within defined distributions of input values. Each method used the same input data on estimates of component uncertainties as described in the following sections.

Further use of Monte Carlo analysis has been made to assess uncertainties in the estimates of potential CO<sub>2</sub> emissions reductions in 2010 and 2020. This is presented in **Section 9**.

### 3.2.1 Errors in the national sectoral GHG emissions

Estimates of the errors (uncertainty) on the national total GHG emissions, according to IPCC sector<sup>33</sup>, are calculated in the UK's greenhouse gas inventory. This error analysis is published in the UK's National Inventory Report, which is updated annually. To match the baseline year of 2004 used in this work, we have used the error analysis from the 2004 National Inventory Report (Baggott *et al.*, 2006).

The error analysis in the national inventory is calculated using a Monte Carlo simulation, based on assigning probability distribution functions (PDFs) to each emission factor and piece of activity data. Errors in the UK GHG inventory are expressed as  $2s/E$ , where  $E$  is the

<sup>33</sup> The Intergovernmental Panel on Climate Change (IPCC) has devised a reporting nomenclature for greenhouse gases where the gases are reported in six major categories.

central (best) estimate of the emission and  $s$  is one standard deviation of the mean. **Section 3.2.4** provides a summary of the Monte Carlo method.

The emission sectors used for the local CO<sub>2</sub> estimates do not match the sectors reported in the National Inventory Report. Therefore the percentage error values have been combined, via calculation of a weighted average (weighted by emission in each subsector), in order to give national emission percentage error for each of the sectors. These percentage errors are shown in **Table 3.1**.

**Table 3.2** Summary of percent errors in UK National Greenhouse Gas Inventory 2004

LA sector and fuel	Percentage error
Industrial and Commercial Electricity	0.9%
Industrial and Commercial Gas	1.5%
Industry and Commercial Oil	6.0%
Industry Non Fuel	3.6%
Industry Process Gases	4.6%
Industry and Commercial Solid Fuel	4.3%
Industry and Commercial Wastes And Biomass	1.3%
Industrial off road machinery	1.3%
Diesel Railways	2.2%
Agriculture Gas, Oil, solid fuel and off-road	2.0%
Domestic Electricity	0.9%
Domestic Gas	1.6%
Domestic oil and solid fuel	1.6%
Domestic Home and Garden machinery	1.6%
Road Transport Petrol (A roads)	3.0%
Road Transport Petrol (Motorways)	3.0%
Road Transport Petrol (Minor roads)	3.0%
Road Transport Diesel (A roads)	3.0%
Road Transport Diesel (Motorways)	3.0%
Road Transport Minor Roads Diesel	3.0%
Road transport other emissions	3.0%

**Notes and legend**

Industry
Domestic
Transport

The proportions that each sector contributes to the LA emissions are those presented in the 2004 local CO<sub>2</sub> emission estimates. These were calculated through the combination of the various distribution maps for the emission sectors used to calculate the LA emissions.

### 3.2.2 Estimated errors in the national sectoral geographical distributions

The uncertainties in the geographical distributions of emissions for each sector are very difficult to quantify. Experts familiar with the mapping methods, the emissions inventory and emissions by sector have estimated distribution uncertainties using expert judgement based on uncertainty scores (1 to 4) assigned to the emission sector when the 2004 local CO<sub>2</sub> estimates were compiled. As, apart from for electricity, no quantitative estimates of uncertainty for the individual component exist, uncertainties have been estimated using 'Expert Judgment' through a process of 'Expert Elicitation' as described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). **Table 3.3** provides



notes on each sector to help to explain the reasons for the uncertainty scores chosen (from King et al, 2006).

Estimates of uncertainties for sectors and fuels have been ascribed as follows:

- ▶ Score 1: 3% for sectors with low distribution uncertainty (e.g. gas, electricity)
- ▶ Score 2: 5% for sectors with medium levels of distribution uncertainty (e.g. road transport fuel consumption)
- ▶ Score 3: 10% for sectors with higher levels of distribution uncertainty (e.g. residential solid and liquid fuels)
- ▶ Score 4: 30% for sectors with high levels of distribution uncertainty (e.g. Industrial solid and liquid fuels)

**Table 3.3** below shows the uncertainty scores and estimated percentage errors for the emissions sectors.

The estimate for the domestic electricity distribution is derived from quality indicators that accompanied the DTI local electricity consumption dataset (DTI 2006b). This included a measure of the amount of the electricity consumption that was located correctly based on postcodes. 98% of the postcodes across Great Britain could be correctly located to the LAs and therefore we have used 2% as our average error estimate for this whole dataset. Other quality indicators were provided for the gas and electricity datasets but this did not provide enough information in order to be able derive a percentage error in the geographical distribution. It was therefore assumed that these datasets are more uncertain than the domestic electricity data. The geographic distribution of these uncertainties has not been included in this analysis because the data are incomplete. This could be included in the calculations for the 2005 estimates.

Other industrial emissions data (large gas users, wastes and biomass and non-fuel emissions) are considered to have low uncertainty as many of these sources are at known locations.

Higher uncertainties have been estimated for sources where the locations of emissions are not well known. The road transport emissions are a significant source with a higher uncertainty than the other biggest sources (electricity and gas use). The main reason for this is the use of sample data to represent both vehicle movements and emission factors. Average daily flows and average speeds are used on major road links which does not take account of fluctuations in flows and speeds through the day or year. Regionally average flows and speeds are assumed on minor roads because there is not sufficient data to model this more accurately. However, the best available national datasets are used.

Average fleet weighted emission factors are used, derived by the NAEI road transport team based on detailed data on emissions tests and the mix of ages of vehicle types in the fleet. No regional variation in fleet ages is included in the modelling. This could be possible using DVLA data on car registrations but assumptions would be needed regarding the amount influence on local emissions from separately defined local and national average fleet mixes because many cars are used at locations away from their place of registration (particularly company cars, vans and HGVs). Introducing a regional variation in the sizes of engines in the fleet and the petrol / diesel split rather than age would have more influence on the results, partly because newer cars have to meet increasingly tighter standards for air quality pollutants but not CO<sub>2</sub>. However, previous sensitivity analysis has found that variations in fleet composition have little effect on the overall results (Goodwin et al, 2005).

**Table 3.3** Summary of percentage errors in mapping distributions and comments on data quality and uncertainties

Sector	Uncertainty rating	Estimated % error	Comment
Industrial, Commercial and Agriculture Electricity	2	5%	The DTI dataset of electricity consumption has some unallocated consumption.
Industrial, Commercial and Agriculture Gas	2	5%	The quality of the DTI dataset of gas consumption is limited by some poor geo-referencing of meter points to local authorities. Also, the DTI definition of domestic gas consumers includes some small commercial users.
Industrial Gas (Large Users)	1	3%	Reported emissions from EA PI, SEPA, DoE NI
Industry and Commercial Oil	2	5%	A combination of known emissions from PI, SEPA, DoE NI (>60% of UK total) and modelled estimates using fuel and employment distributions
Industry and Commercial Solid Fuel	2	5%	A combination of known emissions from PI, SEPA, DoE NI (>70% of UK total) and modelled estimates using fuel and employment distributions
Industry and Commercial Wastes And Biomass	1	3%	Almost entirely (>90% of UK total) consisting of known emissions from PI, SEPA, DoE NI. The remaining emissions are modelled estimates using fuel and employment distributions
Industry Process Gases	2	5%	A combination of known emissions from PI, SEPA, DoE NI (>60% of UK total) and modelled estimates using fuel and employment distributions
Industry Non Fuel	1	3%	Almost entirely (>90% of UK total) consisting of known emissions from PI, SEPA, DoE NI. The remaining emissions are modelled estimates using fuel and employment distributions
Industry Off-Road Machinery	4	30%	This sector is poorly characterised because little is known about the spatial distributions of these machines.
Agriculture Oil	4	30%	Modelled estimates using fuel and employment distributions for stationary combustion; landuse data used to distribute machinery emissions.
Agriculture Solid Fuel	3	10%	Modelled estimates using fuel and employment distributions
Agriculture Non Fuel	4	30%	Land use maps are used to distribute the application of pesticides.
Railways	4	30%	Using an old dataset of rail movements for GB.
Domestic Electricity		2%	The DTI dataset of electricity consumption has some unallocated consumption.
Domestic Gas	2	5%	The quality of the DTI dataset of gas consumption is limited by some poor geo-referencing of meter points to local authorities. Also, the DTI definition of domestic gas consumers includes some small commercial users.
Domestic Oil	3	10%	Estimates made using complex modelling of household energy demand compared with known gas usage
Domestic Solid Fuel	3	10%	Estimates made using complex modelling of household energy demand compared with known gas usage
Domestic Home And Garden Machinery	3	10%	Based on population distribution
Domestic Household Products	3	10%	Based on population distribution
Road Transport Petrol (A roads & motorways)	2	5%	Activity data are good quality annual average traffic count points. Emissions calculated using complex modelling of fleet mix and average speeds on different roads.
Road Transport Petrol (Minor roads)	3	10%	Activity data are calculated from regional average traffic flows and vehicle splits. Emissions calculated using complex modelling of fleet mix and average speeds on different roads.
Road Transport Diesel (A roads & motorways)	2	5%	Activity data are good quality annual average traffic count points. Emissions calculated using complex modelling of fleet mix and average speeds on different roads.
Road Transport Diesel (Minor roads)	3	5%	Activity data are calculated from regional average traffic flows and vehicle splits. Emissions calculated using complex modelling of fleet mix and average speeds on different roads.
Road Transport Other	4	30%	Locations of LPG use and burning of engine oil are not known and are therefore distributed across all road traffic activity.

### 3.2.3 Combining the uncertainty estimates using Sum of Squares Method

The three variables set out at the start of Section 3.2 have been combined as follows. The percentage emission error in each LA total CO<sub>2</sub> estimate is calculated using the Sum of the squares method using the equation below.

$$\text{Percentage Error for each LA} = \frac{\sqrt{\sum_{\text{sectors}} e^2 (i_1^2 + i_2^2)}}{\sum_{\text{sectors}} e}$$

where:  $e$  is the local emission in the LA for a given sector;

$i_1$  is the UK emission uncertainty error for that sector;

$i_2$  is the mapping emission uncertainty error for that sector.

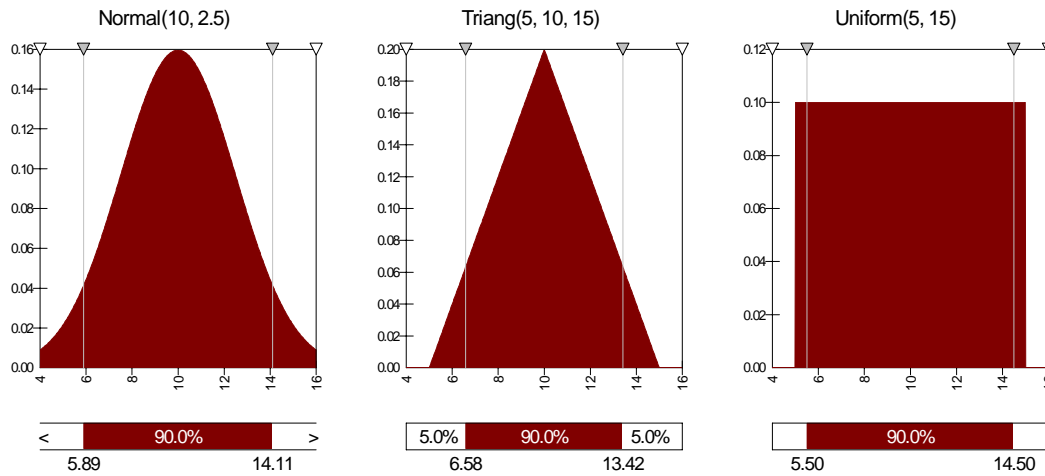
### 3.2.4 Use of Monte Carlo analysis

Monte Carlo analysis has also been used as another way to combine component uncertainties. The method used in this analysis is based on use of the @RISK model. Amongst other features, @RISK enables users to undertake Monte Carlo analysis on model inputs to describe uncertainty in outputs. This in turn requires mathematical definition of the probability distribution of each input variable.

Ranges can often be defined from available data or in relation to existing practice. Whilst it may be relatively easy to describe a range for any parameter it can be more difficult to define the probability distribution of values within that range. In many cases there is a justifiable tendency to assume that results towards the centre of the distribution are more likely than those at the extremes, and that a normal (bell-shaped) distribution is correct (**Figure 3.5**). However, it is wrong to assume more knowledge of a probability distribution than really exists. Where data are limited a simpler distribution, triangular or uniform may be appropriate. Sensitivity of results to different distributions within the input ranges can of course be investigated if necessary.

**Figure 3.5** only includes distributions that are uniform around the best estimate. In some cases other distributions may be appropriate that are skewed to right or left.

**Figure 3.5** Illustrated probability distributions. From left to right: normal, triangular and uniform. x-axis: value: y-axis, probability.



Having defined distributions for each input variable the model is run a given number of times or “iterations” (here, 10,000). For the first iteration, a value is taken at random from the range for each of the input variables. The probability of occurrence of any specific value is determined by the shape of the distribution between the high and low points of the range. These values are then applied to generate the results for the first iteration. Results are stored and the analysis proceeds to the second iteration, and so on. After all iterations have been run @RISK processes the results for each defined output variable to estimate summary statistics (mean, maximum, minimum, etc.), confidence intervals and the shape of distributions. This information can be used in various ways, for example to describe the probability of emission savings being a given size or more.

Based on metrics of energy use (meter readings, vehicle km, etc.) it is possible to quantify emissions of CO<sub>2</sub> using appropriate emission factors. The percentage uncertainty in emission factors for CO<sub>2</sub> is small compared to other air pollutants, as it is closely linked to the carbon content of fuels, which does not vary as much as the content of other pollutant precursors. The sulphur content of coal, for example, may vary by more than an order of magnitude by weight. This is not the case with carbon contents. Ideally, all carbon contained in fuel would be converted to CO<sub>2</sub>, though in practice some is emitted as CO or in volatile organic compounds. However, whilst variation in efficiency of combustion in converting carbon to CO<sub>2</sub> adds to the uncertainty in emission factors, it makes little real difference, and estimated uncertainty in emission factors is small. Mapping uncertainties are higher, however, here estimated as being up to 30% (see **Tables 3.2** and **3.3**).

Monte Carlo analysis is used, sampling within distributions for each variable for 10,000 iterations. The Monte Carlo analysis applies these uncertainties around best estimates with a uniform distribution (in other words, a distribution in which all values from the lowest to the highest are equally likely). This is typically a pessimistic assumption, but is appropriate in the absence of any more detailed information on the likely shape of the probability distributions.

Emission factor and mapping uncertainties for each sector are treated as independent of local authority. This is appropriate for the emission factors, but is again likely to be pessimistic for mapping as errors are likely to cancel one another out for any sector between local authorities. However, there is significant potential for uncertainty in emissions in each local authority to be cancelled out between sectors, limiting the estimated range for each local authority.

### 3.2.5 Results of the uncertainty analysis

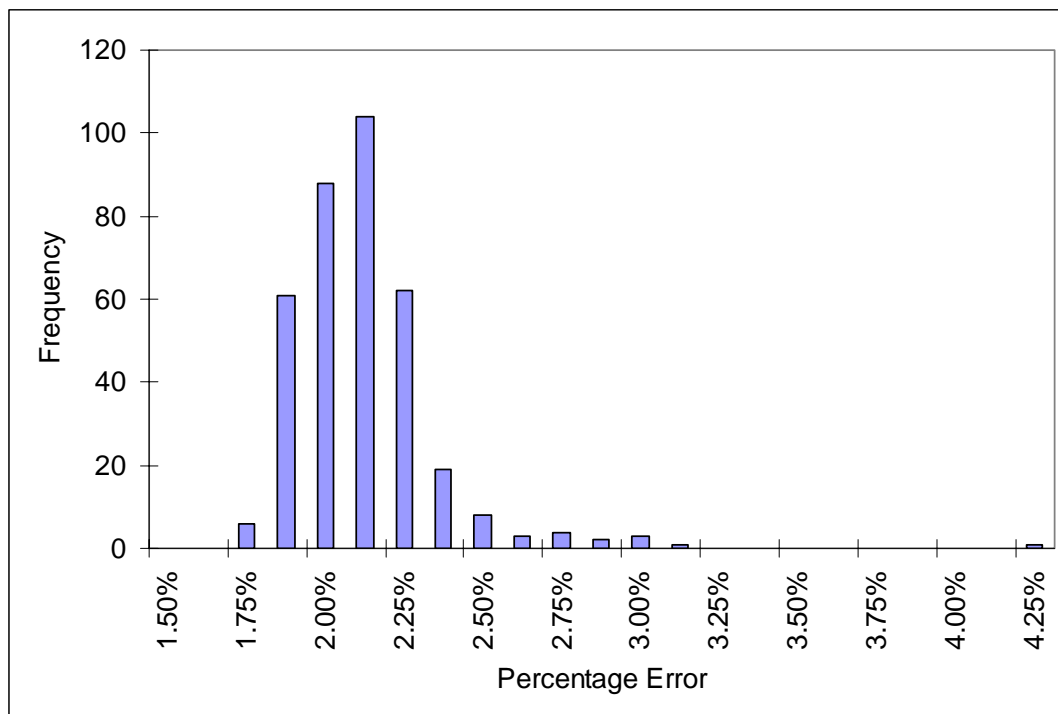
The results of these two different analyses were very similar, with overall estimated error in the total carbon emission estimates for each LA is in the range of 1.6% to 4.1% estimated by the Sum of Squares method and between 1.8% and 4.1% using Monte Carlo analysis. The order of the ranked uncertainties was also very similar with a total of only 5 differences in the highest 40 and lowest 40 results.

**Figure 3.6** and **3.7** shows how the errors calculated from the sum of the squares method vary across England. The percentage error is 2.65 or lower for most LAs. The limited spread around the mean may seem surprising given the size of some of the uncertainties in Tables 3.3, particularly for mapping uncertainties. Two factors are relevant: the smallest uncertainties tend to be for the largest emissions, and uncertainties within individual sectors cancel against uncertainties in other sectors within each local authority area to a significant extent. The latter may have important consequences for setting abatement levels by sector within each local authority without further analysis at a more local level.

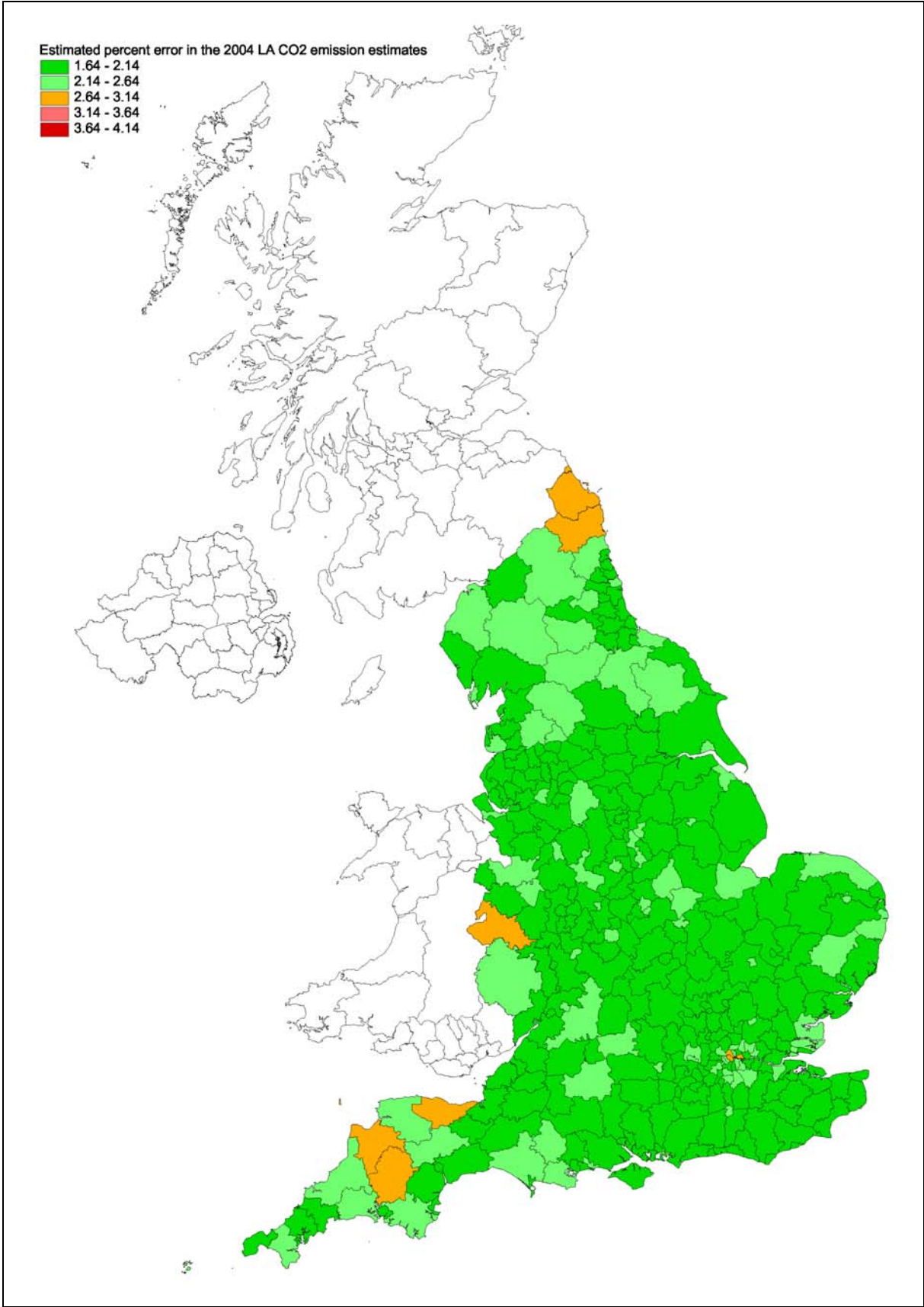
The emissions are dominated by the electricity and gas use in domestic, industry and commercial sectors for which the UK estimates and the mapping distributions have low percentage errors. Higher overall percentage errors occur where the dominance of gas supply is lower so there are more emissions from solid and liquid fuels in the domestic and business/industry sectors, such as in Devon and Cornwall and Northumberland. Higher percentage errors also occur where minor road transport emissions are significant, such as in inner London.

In % terms the smallest estimated spread for any local authority is for Wear Valley in NE England ( $\pm 1.6\%$ ), whilst the largest spread is for the City of London ( $\pm 4.1\%$ ). The City of London is an outlier in this dataset. This LA has emissions that are very dominated by business electricity use (80% of all emissions). The error estimate is therefore close to the 5% mapping uncertainty assigned to this sector.

**Figure 3.6** Variation in percentage error estimated using Sum of Squares Method



**Figure 3.7** Estimated errors in the CO<sub>2</sub> emissions 2004, England



### 3.3 Recommendations for improvements to the emission estimates

Developing this baseline emission data set for the CCCI has revealed some significant uncertainties in the data that underpins it – the data developed for local and regional CO<sub>2</sub> emission estimates, for the year 2004, and published by Defra last year (King *et al.*, 2006). These uncertainties are not because the methods used in the local and regional CO<sub>2</sub> work are flawed or because there are numerical errors, but because there are gaps in the data required for calculating more accurate estimates of emissions at the LA level. In particular, the accuracy of emissions in some sectors could be improved through further data generation and modelling and we recommend this work be done.

Within the National Atmospheric Emissions Inventory (NAEI) programme (run by AEA Energy & Environment on behalf of Defra), there is a targeted development programme to reduce uncertainties in the emission estimates and to extend the application of the emissions data produced. Development work on the NAEI emission maps has been continuing since the compilation of the 2004 CO<sub>2</sub> estimates in autumn 2006. These improvements have included the following work strands:

- ▶ Improvements to the quality of the major road transport modelling – concentrated on further checking of the allocation of the DfT count points to the road network in order to improve the geographical distribution of emissions.
- ▶ Significant improvements have been made to the NAEI point source database including a thorough review of data from the EUETS for 2005 to prevent possible double counting with data for equivalent (but not necessarily exactly the same) sites from the EA Pollution Inventory and equivalent Scottish and Northern Irish databases.

However, further developments are required in order to improve the quality of the emission estimates. These are listed below, by sector, in order of priority. The priority has been defined by the improvement in accuracy to the inventory that would be gained by completing the work.

#### 3.3.1 Recommendations for improvements to the LA CO<sub>2</sub> estimates

##### Domestic

- ▶ Further improvements could be made to the non-gas domestic fuel use distributions. This would require new data to be sourced on actual consumption of solid and liquid fuels from fuel suppliers. The NAEI team could undertake an initial scooping study in specific locations (e.g. rural areas that have a high dependence on these fuels) to determine what type of information might be available from fuel suppliers. This may reveal that enough information is available to enable DTI to commission a wider survey of fuel suppliers.
- ▶ Initial investigations into the Homes Energy Efficiency Database (HEED) from the Energy Savings Trust has identified that it could provide a useful source of data. This should be investigated further. This includes household survey data on fuel usage and if it is a large enough sample could be used to model spatial patterns of different fuels as well as providing an indication of measures applied.

##### Industry/business

- ▶ Improvements are required in the distributions of emissions from point sources in the 'other industrial consumption' sector. These are mostly emissions at industrial plant that are not in the NAEI point source database. Data on Part A2 and Part B installations may become available through the creation of the UK implementation of



the European Pollutant Release and Transfer Register database (E-PRTR). Other data may be available from sites participating in Climate Change Agreements.

- ▶ There is also new modelling required for the residual area source combustion emissions in this sector. This could possibly be done using high resolution industrial gas consumption data from DTI (possibly at 10 km resolution to reduce disclosure issues). This would require improved estimates of energy intensity for different industrial / commercial sectors on an energy use per employee basis. This would use updated data from DTI and /or trade associations, to be combined with updated employment statistics from the Inter-Departmental Business Register (IDBR).

### Transport

- ▶ Further improvements to the road transport emissions modelling are possible if additional traffic count data become available from DfT. Any new data available will be included in the emission mapping each year.
- ▶ A peer review of the road transport modelling methods could also lead to improvements in these estimates.

### Other

- ▶ Uncertainties: Inclusion of additional indicators of the quality of the geographical distributions in the DTI local energy statistics will improve the estimates of uncertainty.
- ▶ End user emissions: the emissions in the indicator can be split into 'direct' emissions (emissions at source) and 'indirect' emissions (those added through the redistribution of energy supply emissions).

## 3.4 Steps towards producing local CO<sub>2</sub> estimates that can be classified as National Statistics

### 3.4.1 Work needed

UK government statisticians currently classify the current data developed for local and regional CO<sub>2</sub> emission estimates (King *et al.*, 2006) as experimental statistics. There needs to be a programme to transform these experimental statistics into national statistics. Obtaining a classification of a national statistic is important as it adds credibility to the indicator, and guarantees that it meets specified standards of quality agreed by the Office for National Statistics. The National Statistics Code of Practice<sup>34</sup> requires compliance on a number of elements incorporated into a compliance plan.

The following steps can be considered as a first draft of this compliance plan:

- ▶ Meet with the government statistician for environmental statistics to determine a compliance plan; our view is that workstrands below would need to be completed.
- ▶ Classification of the DTI local energy consumption input data as National Statistics – electricity and gas use, which account for 58% of the total CO<sub>2</sub> in the indicator (not including emissions from Land Use Land Use Change and Forestry - LULUCF).
- ▶ Improvements to other industrial combustion distributions – updates to employment and fuel use mapping for area sources are needed – contributing up to 7% of overall CO<sub>2</sub> emissions.

<sup>34</sup> The National Statistics Code of Practice sets out the key principles and standards which official statisticians are expected to follow and uphold. It is supported by twelve Protocols which describe how those principles and standards are to be implemented in practice.  
[http://www.statistics.gov.uk/about\\_ns/cop/default.asp](http://www.statistics.gov.uk/about_ns/cop/default.asp)



- ▶ Validation of domestic fuel use modelling for non-gas fuels. This could be further improved using data from EST HEED database and further surveys of solid and liquid fuel distribution companies in areas with high dependence on these fuels.
- ▶ Road transport modelling needs to be peer reviewed and accepted as best estimate of local fuel use – this sector accounts for a further 29% of the total CO<sub>2</sub> in 2004 (not including LULUCF). This may require improvements to the DfT national database of traffic movements.

### **3.4.2 Work programme**

**Appendix 2** sets out our recommended work programme. In most cases we have split each work strand into two parts – a scoping study to see if there is sufficient data to warrant progressing with a more detailed study.

## 4 Analytical approach – the community climate change indicator model

This section summarises the:

- ▶ Structure of a model designed to estimate potential reductions in CO<sub>2</sub> emissions for each Local Authority in England;
- ▶ Data needed for the model; and,
- ▶ Output from the model.

**Sections 5,6 and 7** provide details of the data used in the modelling.

Defra<sup>35</sup> made it clear that an overarching principle of this model should be transparency. This principle was essential to ensure that LAs can easily understand what their efforts will contribute to the overall carbon reduction targets, and how they will be able to monitor the relative successes of their own measures. A transparent modelling approach will maximise the chances of commitment from LAs to carbon reduction targets.

We have developed a spreadsheet model to combine the estimates of emissions by LA in 2004 with:

- ▶ Projected emissions for the UK in 2010 and 2020; and,
- ▶ Estimated reductions in emissions from a variety of different measures.

The model has been designed to estimate potential reductions in CO<sub>2</sub> emissions for each LA in England.

### 4.1 Model input data

The model has been built around the data sets listed in the following sections.

#### 4.1.1 Modified 2004 baseline CO<sub>2</sub> emissions

The method used to derive the modified 2004 baseline CO<sub>2</sub> emissions is explained in **Section 2.7**. Uncertainty analysis to estimate errors in these emissions is included in the model.

#### 4.1.2 Projections of baseline CO<sub>2</sub> emissions 2010 and 2020 “without measures”

We have used baseline projections of CO<sub>2</sub> emissions from the 2007 Energy White paper (EWP) produced by the DTI. The EWP is based on a DTI energy projection called Updated Energy Projection 29 (UEP29). There are several variants of UEP29, and we have selected the central estimate end user emissions variant.

The EWP includes the effects of carbon reduction measures that we needed to assess explicitly – the total emissions in the EWP are presented “with measures” included, for the UK, with no spatial analysis of where these emissions might occur, nor of where we might expect the greatest reductions. These measures, to reduce CO<sub>2</sub> emissions, had been subtracted from the total CO<sub>2</sub> estimates during the EWP analysis. Therefore, we cancelled this effect by adding back CO<sub>2</sub> emissions associated with these measures. The nature of the measures, and their effects in terms of CO<sub>2</sub> saved, were listed in the EWP. This step

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<sup>35</sup> John Mackintosh, Defra statistics

provided a “without measures” baseline and allowed the model to re-allocate the savings associated with each measure spatially, according to LA.

We have spatially distributed these projected emissions according to the 2004 pattern of emissions, with the exception of road transport, where we have estimated future changes in traffic patterns based on the National Road Traffic Forecast model output (DfT 2004).

EU-ETS emissions are not included in the 2004 emission estimates. Therefore an estimate of the percentage of the business and industry emissions that these sites represent has been made using NAEI data (11% for combustion sources and 72% process emissions). This same percentage has been removed from the baseline emissions in 2010 and 2020 to produce an equivalent dataset. This may be an over estimate because of the expected savings in emissions resulting from this scheme.

#### **4.1.3 Literature review to determine projected savings**

We have completed a literature review to produce a list of measures to reduce CO<sub>2</sub> emissions in the future (savings of CO<sub>2</sub> in 2010 and 2020); Chapter 5 lists the literature reviewed, and Chapter 6 summarises the measures distilled from this review.

#### **4.1.4 Generating spatially distributed carbon reductions**

The final step was to apply these measures to the baseline CO<sub>2</sub> emissions on a spatial basis, to generate an estimate of CO<sub>2</sub> savings per LA according to measure.

To achieve this, the emission reductions were allocated using surrogate statistics of applicability constraints such as numbers of households, domestic fuel splits (into solid, gaseous and liquid fuels), traffic modelling area types (sizes of towns/cities) and current industrial emissions. Further details are provided in section 7.

Uncertainty analysis to assess percentage error in the final estimates of emissions reductions was undertaken using Monte Carlo simulation.

## **4.2 Model output**

The model produces estimates of the percentage savings in emissions in each LA in England resulting from the chosen measures. Savings are expressed as a percentage of 2004 emissions and are reported in two ways:

- ▶ principal measures and additional measures included for sensitivity analysis
- ▶ national measures, national measures with influence by Local Authorities and local measures.

Ranges in savings are given based on the results of the Monte Carlo simulation.

## 5 Literature review to gather measures

This work needed a list of climate change mitigation measures that were relevant to LAs, and the effectiveness and costs associated with these measures.

The documents we have reviewed are listed in the section below.

### 5.1 Literature reviewed

**Table 5.1** summarises the literature reviewed. The most important source documents were the 2006 UK Climate Change Programme (2006) including its accompanying Regulatory Impact Assessment and appraisals of individual measures and the DTI Energy White Paper and accompanying reports published in May 2007. We have added other comments as appropriate in the table according.

**Table 5.1** Summary of literature reviewed

Literature	
<b>Main sources</b>	
	UK Climate Change Programme including the Regulatory Impact Assessment and appraisals of individual measures
	Consultation documents related to the EEC3 targets and Illustrative mix of measures
	DTI Energy Review The Energy Challenge 2006
	DTI Energy White Paper (EWP) 2007
	Smarter choices programme report
	Transport measures in the CIVITAS programme
	London LEZ environmental assessment report
	London congestion charging annual reports
	Green Alliance and CSE reports on Local Authority actions
	Literature Draft 'Planning Policy Statement' on climate change
	Merton Rule.org website <sup>36</sup>
<b>Other sources</b>	
	Local Government White Paper 2006
	Nottingham Declaration Online Action Pack

#### Notes

EEC3	Energy Efficiency Commitment phase 3
CIVITAS	City-VITALity-Sustainability ( <a href="http://www.civitas-initiative.org">www.civitas-initiative.org</a> )
LEZ	Low Emission Zone
CSE	Centre for Sustainable Energy

The sources in **Table 5.1** contain information about a mixture of carbon saving measures which operate at national, community and local levels, or on a mixture of levels. **Chapter 6** explains how we classified the measures for the model and extracted the measures that could be affected by LAs.

<sup>36</sup> The Merton Rule is so called because this type of planning policy was first developed by the London Borough of Merton in its Unitary Development Plan (as amended by the Government Inspector and approved in November 2003). The policy stipulates that 'the council will encourage the energy efficient design of buildings and their layout and orientation on site. All new non-residential development above a threshold of 1,000 sqm will be expected to incorporate renewable energy production equipment to provide at least 10% of predicted energy requirements.'

## 6 Measures to reduce CO<sub>2</sub> emissions

This chapter explains

- ▶ The scheme we have used to classify the carbon saving measures relevant to LAs; and,
- ▶ Which measures we have included in and excluded from the analysis.

### 6.1 Classification of carbon saving measures relevant to LAs

Ideally, the model should assess the potential contribution which LAs might be able to make to emissions savings nationally, i.e., what proportion of emissions might LAs be able to influence, and in what sectors do these occur. This approach will help LAs to focus on what they can do themselves, and lessen the possibility that they will be distracted by other national measures.

We have classified the measures into three groups:

1. Purely national measures but still influencing community emissions;
2. National measures but can be improved in performance with influence by LAs; and,
3. Purely local measures implemented by LAs or other organisations.

Also, all of the measures for this analysis have been split into:

1. Principal measures for which we have reasonably robust data (mostly already published in Defra / DTI reports)
2. Additional sensitivity measures (some of which are combined effects of baskets of measures such as softer traffic measures). Measures included for sensitivity analysis are separated because of lack of robust data on savings.

The measures are listed in **Tables 6.1, 6.2 and 6.3**, showing the allocations of the measures to these categories. The modelling results in this report are presented on the basis of both of these classifications.

### 6.2 Measures included in the analysis

**Tables 6.1, 6.2 and 6.3** list the measures applied across Local Authorities to calculate potential reductions in CO<sub>2</sub> in 2010 and 2020. **Appendix 3** provides more detailed commentary about how potential savings might be considered.

Legend for Tables 6.1, 6.2 and 6.3

Business / Industry
Domestic
Transport
Gaps in savings data

### 6.3 Measures not included in the analysis

Some measures have been excluded from this analysis. These are

- ▶ national measures not influencing these emissions: energy sector measures, agriculture and EU-ETS. These are not included because not relevant to the emissions in the indicator;
- ▶ gaps in data: grey rows in the tables of measures indicate where we could not find sufficient data on CO<sub>2</sub> savings but were measures that we felt could make a significant contribution to savings.

**Table 6.1** *Business measures applied across Local Authorities to calculate potential reductions in CO<sub>2</sub> in 2010 and 2020 (MtC)*

Measure name	Measure group (principal, sensitivity, gap)	Targeting of measure (applicability dataset)	Reference	Sector	Category of measure	2010 Low	2010 Central	2010 High	2020 Low	2020 Central	2020 High
Carbon Trust	principal	existing business emissions	UK CCP 2006	Business	National		1.1			1.1	
Building Regulations (re-evaluated)	principal	existing business emissions	EWP 2007 DTI Projections Table D1	Business	National with LA influence		0.5			1.6	
Climate change agreements	principal	existing business emissions	EWP 2007 DTI Projections Table D1	Business	National		2.9			2.9	
Carbon Trust support for investment in energy efficiency in SMEs	principal	existing business emissions	EWP 2007 DTI Projections Table D1	Business	National		0.1			0.1	
Measures to encourage or assist SMEs to take up energy saving opportunities	principal	existing business emissions	EWP 2007 DTI Projections Table D1	Business	National		0.1			0.1	
Energy Performance of Buildings Directive	principal	existing business emissions	EWP 2007 DTI Projections Table D2	Business	National		0		0.2	0.3	0.5
Business Smart Metering	principal	existing business emissions	EWP 2007 (Table 10.1 pg 283)	Business	National		0.1		0.1	0.2	0.2
New measure for achieving carbon savings from large non-energy intensive organisations (Carbon Reduction Commitment, CRC)	principal	existing business emissions	EWP 2007 (Table 10.1 pg 283)	Business	National		0		0.8	0.8	0.8
Products Policy	principal	existing business emissions	EWP 2007 DTI Projections Table D1	Business	National		0.2		0.5	0.9	1.4
Carbon Reduction Commitment	principal	existing business emissions	EWP 2007 DTI Projections Table D2/3	Public Sector	National				0.2	0.2	0.2
Revolving loan fund for the public sector	principal	population	EWP 2007 DTI Projections Table D1	Public Sector	National with LA influence		0.1			0.1	
Activities including CT	principal	population	EWP 2007 DTI Projections Table D1	Public Sector	National with LA influence		0.2			0.2	
Carbon Neutral Government	principal	population	EWP 2007 DTI Projections Table D2/3	Public Sector	National with LA influence		0		0.2	0.2	0.2
Energy Performance of Buildings Directive	principal	population	EWP 2007 DTI Projections Table D2/3	Public Sector	National with LA influence		0		0.2	0.3	0
Products policy	principal	population	EWP 2007 DTI Projections Table D2/3	Public Sector	National with LA influence		0		0.1	0.2	0.5
BEMS/PECT (EMAS)	GAP		<a href="http://www.bems.co.uk/pages/background.html">http://www.bems.co.uk/pages/background.html</a>	Business							

**Table 6.2** Domestic measures applied across Local Authorities to calculate potential reductions in CO<sub>2</sub> in 2010 and 2020 (MtC)

Measure name	Measure group (principal, sensitivity, gap)	Targeting of measure (applicability dataset)	Reference	Sector	Category of measure	2010 Low	2010 Central	2010 High	2020 Low	2020 Central	2020 High
Energy Efficiency Commitment (EEC) (2002-05) (re-evaluated)	principal	split into mix of measures, applied to CWI and exiting households and fuel switching	EWP 2007 DTI Projections Table D1	Domestic	National with LA influence		0.3			0.3	
Energy Efficiency Commitment (EEC) (2005-08) (re-evaluated)	principal	split into mix of measures, applied to CWI and exiting households and fuel switching	EWP 2007 DTI Projections Table D1	Domestic	National with LA influence		0.5			0.5	
Energy Efficiency Commitment (EEC) (2008-11) (re-evaluated = CERT)	principal	split into mix of measures, applied to CWI and exiting households and fuel switching	EWP 2007 DTI Projections Table D1	Domestic	National with LA influence		1.1			1.1	
Supplier Obligations after 2011	principal	split into mix of measures, applied to CWI and exiting households and fuel switching	EWP 2007 DTI Projections Table D2/D3	Domestic	National with LA influence		0		3	3.5	4
Building Regulations (re-evaluated)	principal	projected new households	EWP 2007 DTI Projections Table D1	Domestic	National with LA influence		1.5			3.3	
Zero Carbon Homes	principal	projected new households	EWP 2007 DTI Projections Table D2/D3	Domestic	National with LA influence		0		1.1	1.2	1.2
Energy Performance of Buildings Directive	principal	projected new households	EWP 2007 DTI Projections Table D1/D2/D3	Domestic	National with LA influence		0.2		0.2	0.4	0.6
Package of measures to improve energy efficiency in buildings	principal	2004 households	EWP 2007 DTI Projections Table D1	Domestic	National with LA influence		0.1			0.1	
Warm Front and fuel poverty programmes	principal	2004 households	EWP 2007 DTI Projections Table D1	Domestic	National with LA influence		0.4			0.4	
Energy Efficient Products/Product Policy (additional)	principal	2004 households	EWP 2007 DTI Projections Table D1/D2/D3	Domestic	National		0.6		0.4	0.9	1.3
Better billing	principal	2004 households	EWP 2007 DTI Projections Table D2/D3	Domestic	National		0		0	0.1	0.1
Real time displays and Smart metering	principal	2004 households	EWP 2007 DTI Projections Table D2/D3	Domestic	National		0.1		0	0.1	0.5
Winter fuel payments linked to energy efficiency	sensitivity	2004 households	Synthesis of CC Policy Appraisals Jan 2007	Domestic	National with LA influence		0.1			0.1	
House extension consequential work	sensitivity	2004 households	Synthesis of CC Policy Appraisals Jan 2007	Domestic	National with LA influence		0.1			0.2	
Green roofs	sensitivity	2004 households	Synthesis of CC Policy Appraisals Jan 2007	Domestic	National with LA influence		0			0.2	
Grants to encourage top-up loft insulation under the EEC	sensitivity	2004 households	Synthesis of CC Policy Appraisals Jan 2007	Domestic	National with LA influence		0			0.1	

Analysis to Support Climate Change Indicators for Local Authorities

Measure name	Measure group (principal, sensitivity, gap)	Targeting of measure (applicability dataset)	Reference	Sector	Category of measure	2010 Low	2010 Central	2010 High	2020 Low	2020 Central	2020 High
Raising minimum standards for window replacements	sensitivity	2004 households	Synthesis of CC Policy Appraisals Jan 2007	Domestic	National		0			0.1	
Merton rule implementation	Gap	projected new households	theMertonrule.org plus see CSE 2005 estimate	Domestic /business	National with LA influence		0.0012				
Energy Performace Certificates	Gap		Synthesis of CC Policy Appraisals Jan 2007	Domestic	National						
Tradable Obligations on House Builders	Gap		Synthesis of CC Policy Appraisals Jan 2007	Domestic	National						
Home Information Pack (HIP)	Gap			Domestic	National with LA influence						



**Table 6.3** Road transport measures applied across Local Authorities to calculate potential reductions in CO<sub>2</sub> in 2010 and 2020 (MtC)

Measure name	Measure group (principal, sensitivity, gap)	Targeting of measure (applicability dataset)	Reference	Sector	Category of measure	2010 Low	2010 Central	2010 High	2020 Low	2020 Central	2020 High
Voluntary Agreements package (excluding VA extension beyond 2009)	principal	projected 2010, 2020 road traffic emissions pattern	EWP 2007 DTI Projections Table D1	Transport	National		2.3			3.6	
Future Voluntary Agreements		projected 2010, 2020 road traffic emissions pattern	EWP 2007 DTI Projections Table D2	Transport	National		0.1		1.7	1.7	5.4
Renewable Transport Fuel Obligation (RTFO) (re-evaluated)	principal	projected 2010, 2020 road traffic emissions pattern	EWP 2007 DTI Projections Table D1	Transport	National		1.2			1.6	
Fuel duty escalator	principal	projected 2010, 2020 road traffic emissions pattern	UK CCP 2006	Transport	National		1.9				
extension to sustainable distribution programme	principal	projected 2010, 2020 road traffic emissions pattern	Synthesis of CC Policy Appraisals Jan 2007	Transport	National with LA influence		0.4			0.5	
smarter choices (see expanded measures below)	sensitivity	cities and large towns	Synthesis of CC Policy Appraisals Jan 2007, Defra AND <a href="http://www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/">http://www.dft.gov.uk/pgr/sustainable/smarterchoices/ctwwt/</a>	Transport	Local		0.6			0.8	
Speed limit enforcement	sensitivity		Synthesis of CC Policy Appraisals Jan 2007	Transport	National with LA influence		0.6			0.6	
Restrictive measures on transport use	Gap	cities			Local						
Public Transport Measures	Gap	cities and large towns			Local						
Speed limit changes	Gap		Synthesis of CC Policy Appraisals Jan 2007	Transport	National with LA influence						
Vehicle maintenance (Tyre pressures etc)	Gap			Transport	local						
Driver training (behavioural measures)	Gap			Transport	local						
Municipal fleet clean switch	Gap		<a href="http://www.civitas-initiative.org/docs1/CIVITAS_TRENDESETTER_Final_Policy_Report.pdf">www.civitas-initiative.org/docs1/CIVITAS_TRENDESETTER_Final_Policy_Report.pdf</a>	Transport	local						
measures that can be used to reduce sprawl - SCATTER	Gap		Assessing the Environmental, Social, and Economic Impacts of the Thematic Strategy on the Urban Environment Kollamthodi et al 2005 report to DG Env	Transport	local						

## 7 Applicability constraints for each measure

This chapter explains

- ▶ How the applicability of the measures to reduce carbon emissions has been determined; and,
- ▶ The methods and data sets used in the model.

### 7.1 Determining the applicability of the measures identified

**Chapter 6** summarises the measures to reduce carbon emissions that we have identified as relevant to this work programme. As well as the measures themselves, we need to consider the how applicable the measure is for each LA.

The measures will not be implemented in the same way across the whole of the UK – and the carbon savings will depend on the applicability of the measure in each LA area. For the model, we have tried to estimate the applicability of each measure by choosing a surrogate statistic to represent variations in applicability across the UK. **Tables 6.1, 6.2 and 6.3** (the measures tables) in **Chapter 6** includes a column to identify what dataset has been used to estimate applicability. These datasets are described in **Section 7.2** below.

We have assumed that the savings reported in the UK Climate Change Programme and the Energy White Paper are applicable to the UK as a whole, except in the case of the Energy Efficiency Commitment/Carbon Emission Reduction Target programme which is specific to Great Britain. Therefore the England proportion of the carbon savings has been allocated to English LAs only, based on a share of the UK saving assigned using the same applicability data for other parts of the UK. For example, for new households we have obtained projected household data for NI, Wales and Scotland and calculated an England fraction of the UK total.

### 7.2 Datasets used to determine applicability of measures

The datasets we have used to determine the applicability of the measures selected are listed for each sector below.

#### 7.2.1 Business

##### Existing business emissions

Energy efficiency savings are likely to be in proportion to the amount of energy used, so we have chosen to use the pattern of current emissions to distribute savings in business.

We investigated the use of economic indicators such as GVA (ONS 2003) but the data were not sufficiently up to date nor geographically resolved for our purposes.

A suitable surrogate statistics for savings from improvements to buildings would be projected economic growth, but we were not able to locate a suitable data set for this

## 7.2.2 Public sector

The 2001 census population counts for each LA have been used to distribute savings in public sector emissions. Data on employment in the public sector would have perhaps been a better surrogate statistic, but these data were not available at the LA level. We have verified that regional public sector employment totals (Millard, 2007) follow the same pattern as population totals.

## 7.2.3 Domestic

### Households counts in 2004

CLG data on current households were used to distribute savings in existing housing stock; CLG (2007). We used a separate data set for distributing savings from cavity wall insulation.

### Cavity Wall Insulation (CWI) target dwellings

The applicability of savings in emissions resulting from installing cavity wall insulation were determined from the results a model produced by BRE (BRE, 2005). The model made use of English House Conditions Survey data on houses with cavity construction and those with insulation. Modelling was undertaken to estimate these parameters for the housing stock in each LA based on the EHCS samples in 2002/3 and 2003/4 and national datasets available to BRE of stock, tenure and dwelling profiles. The combination of data on houses with cavities and those already insulated resulted in an index of cavity wall insulation identifying numbers of households in each LA that are not yet insulated.

### Estimated target LAs for fuel switching

We have assumed that savings from fuel switching will be in proportion to the amount of emissions from domestic solid and liquid fuels but that there will be no switching in LAs that have no gas supply. We have used existing 2004 LA CO<sub>2</sub> emission estimates for this dataset.

### New house building

The fractions of new households in each LA of the UK total were used to distribute savings associated with improved energy efficiency of new homes.

Data on projected numbers of households in 2010/11 and 2020/21 were obtained from CLG (2007). Where household numbers are declining we have assumed there are no carbon savings possible from these measures. This results in a conservative assessment of reductions in carbon emissions because some savings will result from refurbishments of existing buildings.

## 7.2.4 Road transport

### CO<sub>2</sub> emissions from traffic growth (from 2004)

National traffic measures have been applied in proportion to estimated traffic emissions in 2010 and 2020. These have been derived from road traffic projections from the National Road Traffic Forecast from DfT most recently updated in 2004 (DfT 2004). The 2004 data set is the most recent set used in the NAEI emission projections. These projections provide amounts of vehicle kms driven in each of 11 types of area across GB,

We have calculated CO<sub>2</sub> emissions associated with these vehicle movements in 2010 and 2020 and then calculated emission growth factors for each area type, shown in table 7.1

**Table 7.1** Estimated Road transport emission growth factors by DfT area type

Area type	Description	Growth factor for CO <sub>2</sub> emissions 2004 to 2010	Growth factor for CO <sub>2</sub> emissions 2004 to 2020
1	Central London	1.11	1.18
2	Inner London	1.14	1.22
3	Outer London	1.14	1.22
4	Inner Conurbations	1.14	1.19
5	Outer Conurbations	1.14	1.21
6	Urban big	1.10	1.16
7	Urban large	1.10	1.15
8	Urban medium	1.11	1.16
9	Urban small	1.09	1.16
10	Rural	1.14	1.24

We have then assigned each LA to an area type based on lists of LAs from DfT and using a map of the area types. Where more than one area type existed in an LA we have applied the lowest growth factor (conservative estimate of traffic growth because the growth rates generally look quite large).

We have assumed a constant CO<sub>2</sub> emission factor (2005). Fuel efficiency improvements are included in the measures.

This is an approximate estimate of the pattern in the future and could be improved significantly with more detailed data on expected traffic growth in LAs (e.g. from Local Transport plans)

The projection for London is assumes emissions increase by 11 to 18% in 2020 but this is contrary to indications that traffic in London is expected to stabilise (DfT *pers comm.* 2007). However there is no data new datasets are available currently.

#### **Traffic in cities and large towns**

We have assumed that the Smarter Choices measures will only be applied in large urban areas (area types 1 to 6). For this measure we have only applied the savings to the relevant LAs in these types of areas. These are listed in **Table 7.2**.

**Table 7.2.** Local Authorities classified as cities and large towns for applying the Smarter Choices measure

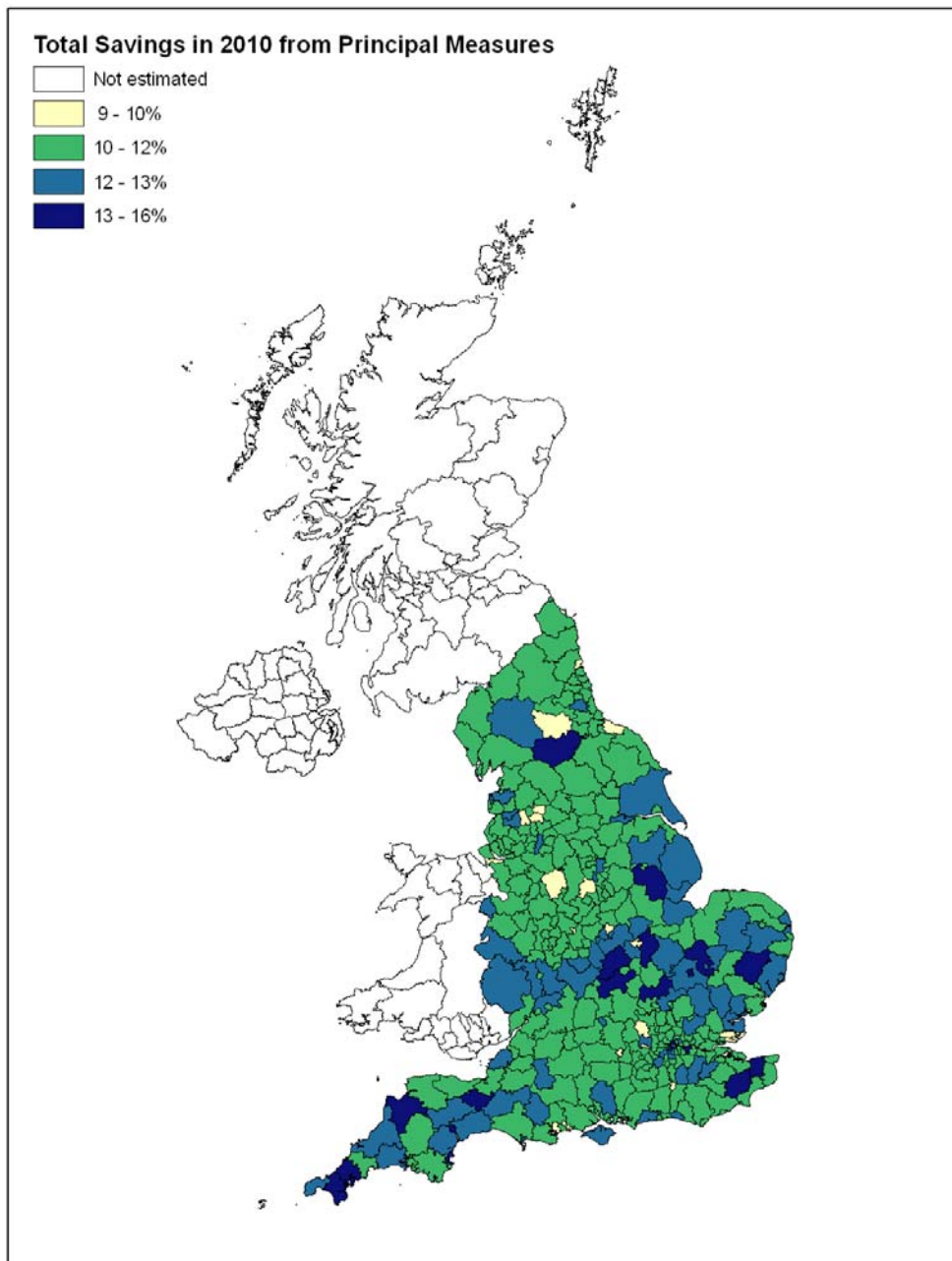
<b>North East</b>	<b>Greater London</b>
Gateshead	Barking and Dagenham
Middlesbrough	Barnet
North Tyneside	Bexley
Redcar and Cleveland	Brent
South Tyneside	Bromley
Stockton-on-Tees	Croydon
Sunderland	Ealing
<b>North West</b>	Enfield
Blackpool	Greenwich
Bolton	Harrow
Bury	Havering
Knowsley	Hillingdon
Oldham	Hounslow
Rochdale	Kingston upon Thames
Salford	Merton
Sefton	Redbridge
St. Helens	Richmond upon Thames
Stockport	Sutton
Tameside	Waltham Forest
Trafford	<b>South East</b>
Warrington	Adur
Wigan	Arun
Wirral	Brighton and Hove
<b>Yorkshire And The Humber</b>	Fareham
Barnsley	Gosport
Calderdale	Havant
Doncaster	Portsmouth
Kingston upon Hull, City of	Southampton
Kirklees	<b>South West</b>
Rotherham	Bournemouth
Wakefield	Bristol, City of
<b>East Midlands</b>	Christchurch
Blaby	Plymouth
Broxtowe	Poole
Erewash	
Leicester	
Nottingham	
Oadby and Wigston	
WEST MIDLANDS	
Coventry	
Dudley	
Newcastle-under-Lyme	
Sandwell	
Solihull	
Stoke-on-Trent	
Walsall	
Wolverhampton	

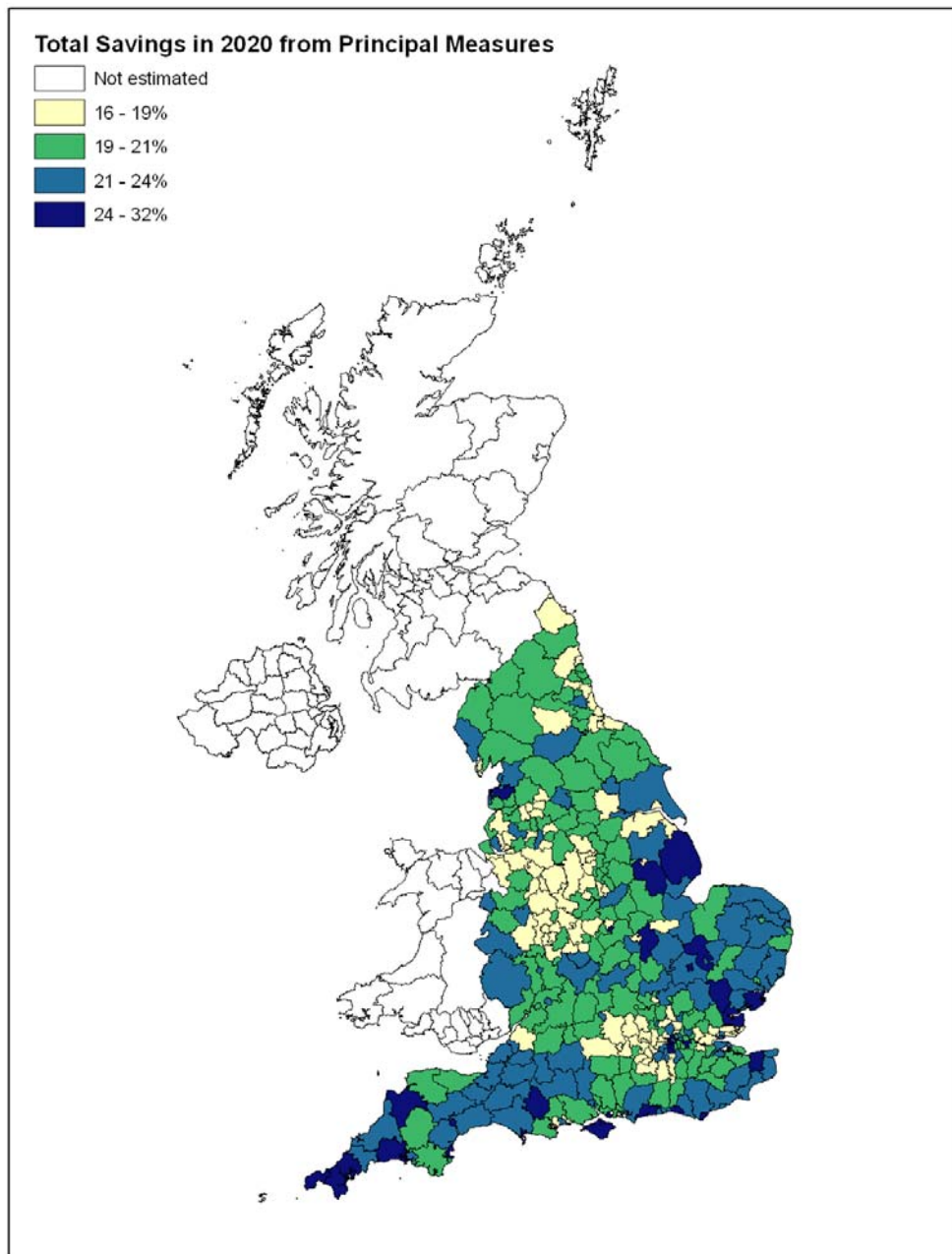
## 8 Estimated CO<sub>2</sub> reductions by LA

### 8.1 Summary of results

Results of the modelling are included in the spreadsheet accompanying this report. A summary of the results is presented in the maps and figures on the following pages. These show estimated percentage savings from the measures compared with 2004 emissions.

**Figure 8.1** *Percentage savings from all principal measures in 2010*



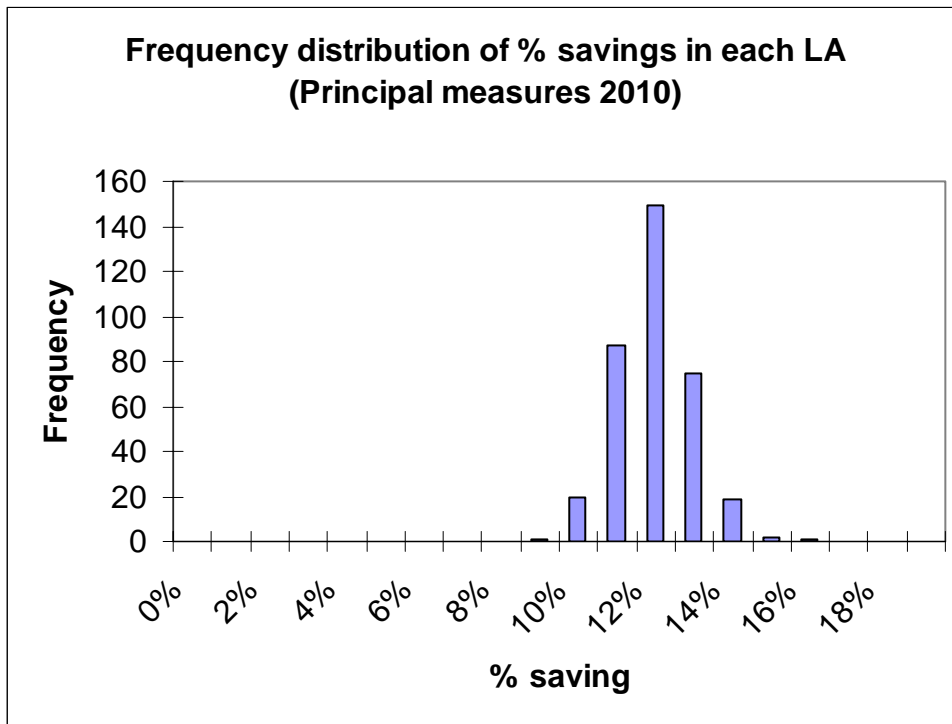
**Figure 8.2** *Percentage savings from all principal measures in 2020*

**Figures 8.3** and **8.4** show the frequency distribution of savings in 2010 and 2020. These show that most LAs in England could expect to achieve 11% to 13% reduction in emissions compared to 2004 by 2010 and about 19% to 23% compared with 2004 emissions by 2020.

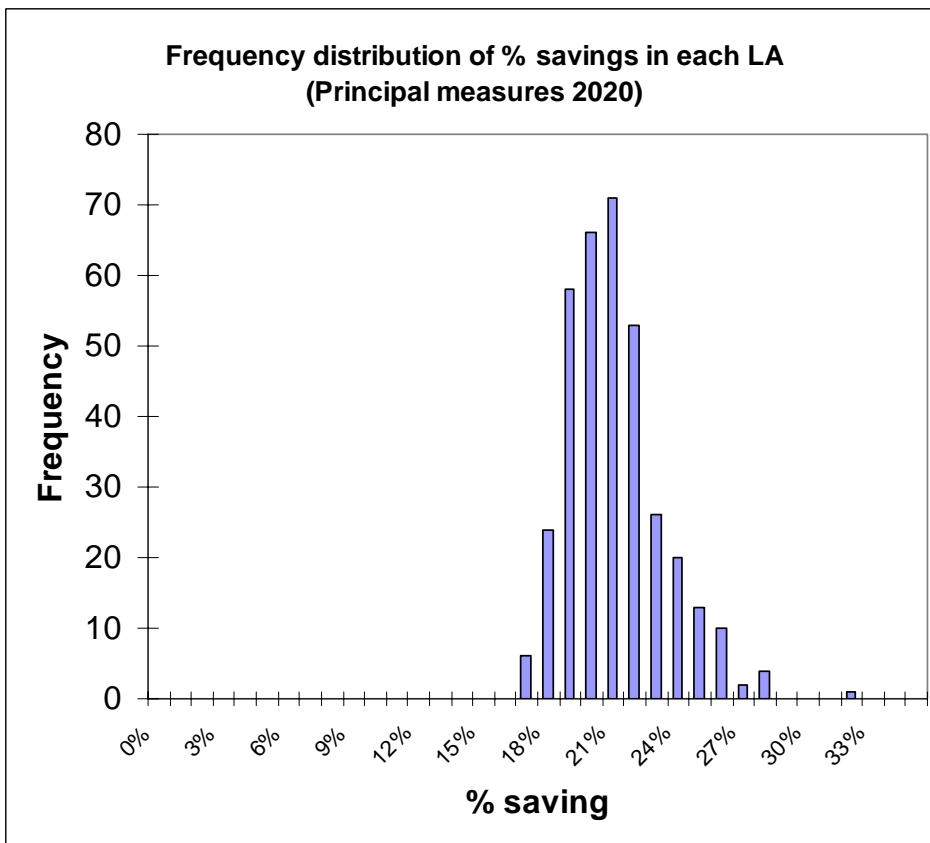
**Figures 8.5** and **8.6** show the contribution of the principal measures and those included for sensitivity analysis to the overall savings in 2010 and 2020 in the Yorkshire and Humberside region.

**Figure 8.7** shows the contribution to total savings (including measures for sensitivity analysis) in the Yorkshire and Humberside region from measures classified as national, national with LA influence and local. The classification of the measures is shown in the tables in **Section 6**. The Yorkshire and Humberside region has been chosen as an example for presentation purposes. Data for all LAs in all the English regions are available in the spreadsheet accompanying this report.

**Figure 8.3** *Frequency distribution of savings from principal measures in 2010*

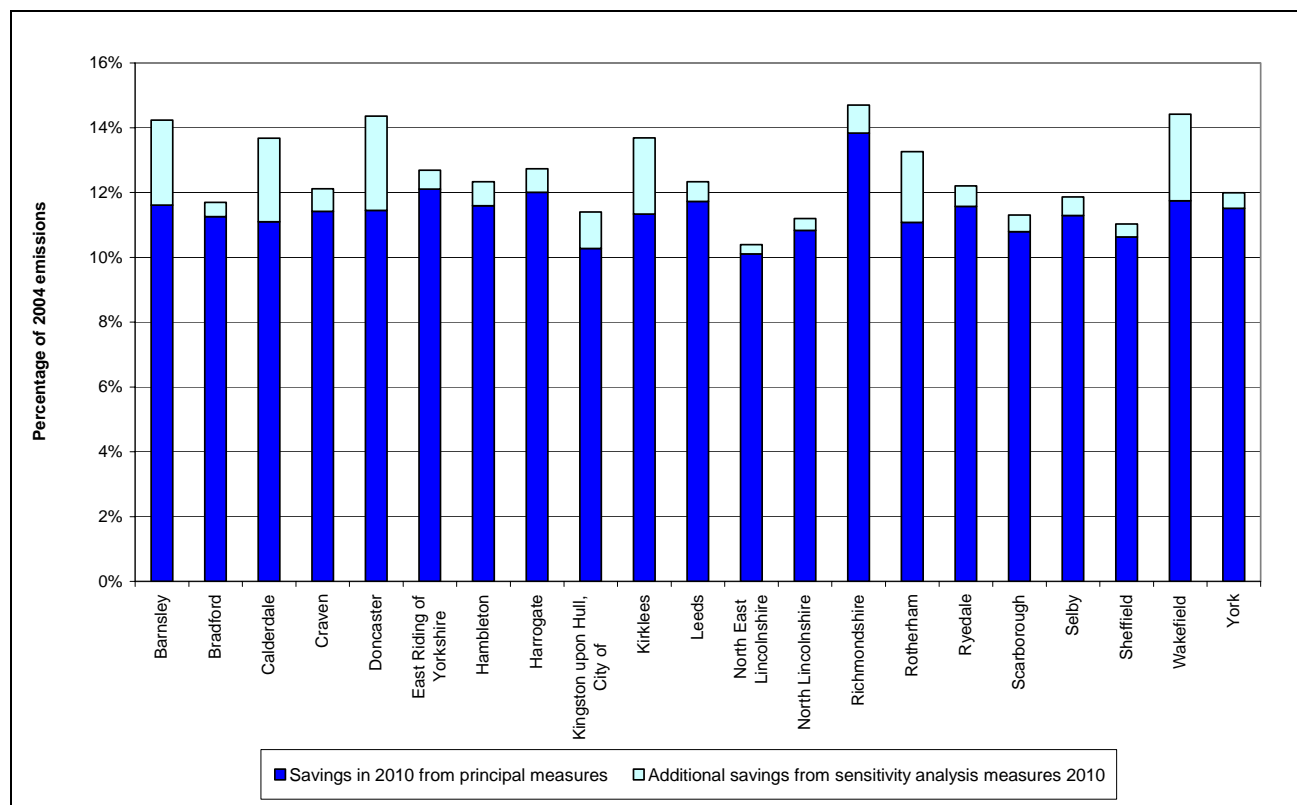


**Figure 8.4** *Frequency distribution of savings from principal measures in 2020*

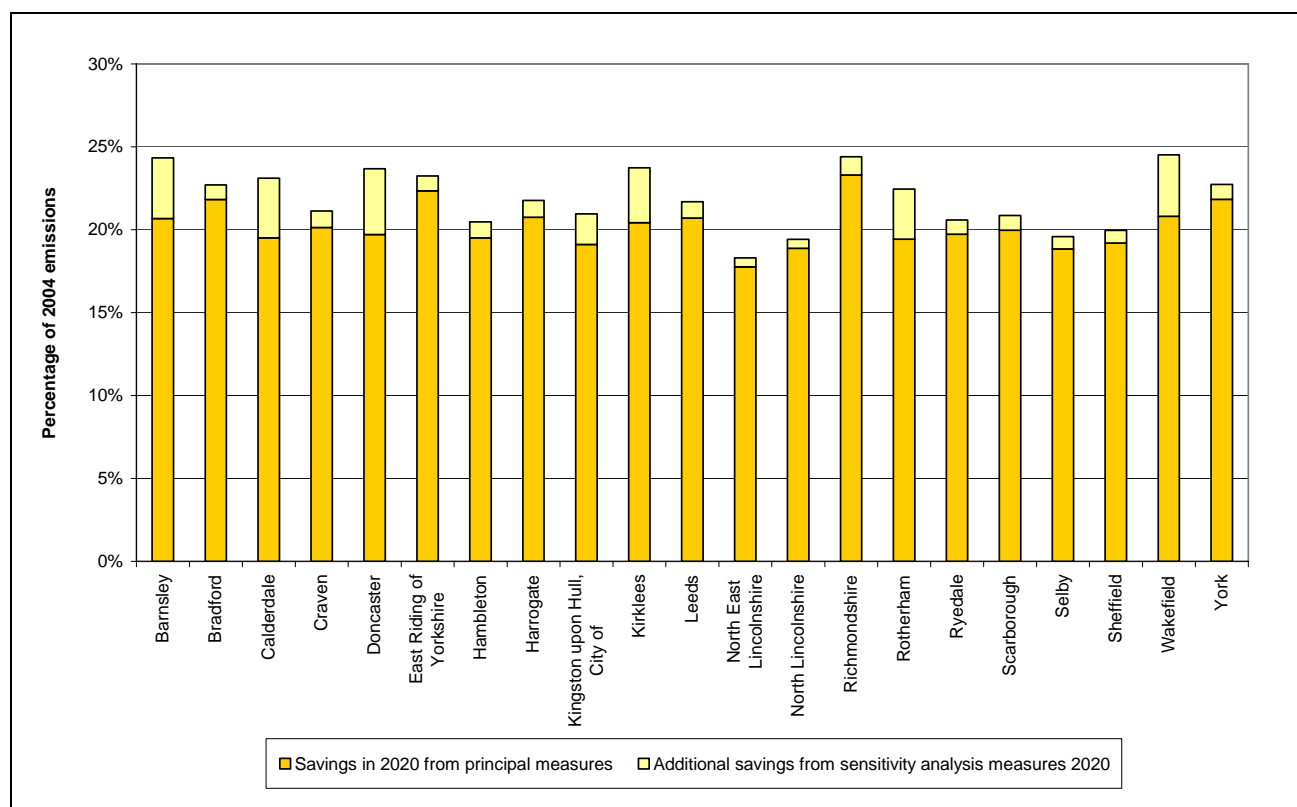




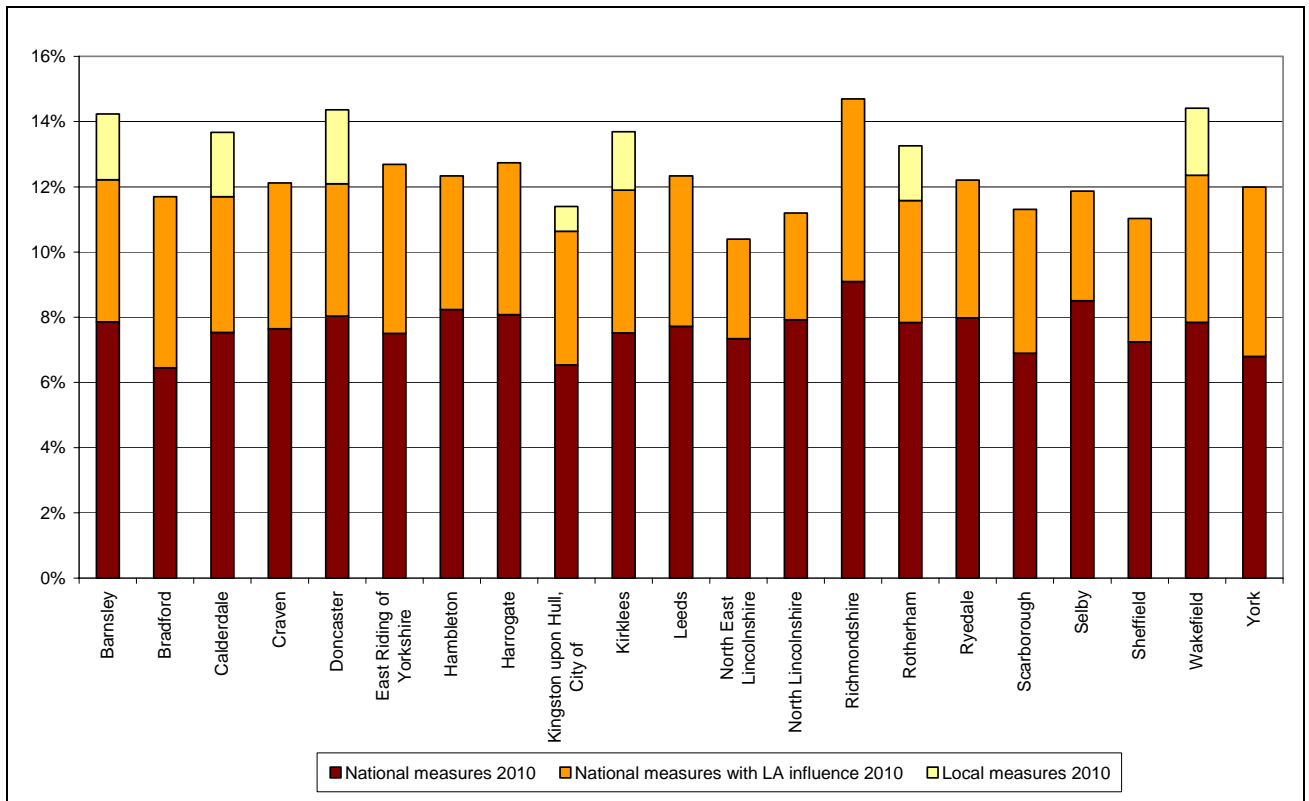
**Figure 8.5** Estimated emissions savings in 2010 in Yorkshire and Humberside



**Figure 8.6** Estimated emissions savings in 2020 in Yorkshire and Humberside



**Figure 8.7** Estimated emissions savings in 2010 split by category of measure (all measures) in Yorkshire and Humberside



Note: 'Local measures' only includes Smarter Choices transport measures.

## 9 Uncertainty in the projected emissions estimates

Uncertainties in the 2004 emissions estimates have been discussed in Section 3.2. This section describes the assessment of uncertainty in the modelling of potential emissions savings by Local Authority. This has been undertaken using the @RISK software using Monte Carlo simulation as described in Section 3.2.4. This required estimates of ranges and distributions of input data i.e. in this case in the savings expected from the various measures. No estimates of errors were made for the applicability datasets as there was not time to investigate this issue.

### 9.1 Defining ranges and distributions for savings from measures

There is relatively little information on the ranges for abatement figures given in the underlying literature. Restriction of the uncertainty analysis to those cases where ranges are available would clearly underestimate uncertainties more generally. Two options are possible:

1. Confine analysis to the use of the best estimates, and not account for uncertainty.
2. Generate artificial ranges for best estimates that have no ranges attached.

It seems preferable to take some account of uncertainty, provided that by doing so uncertainties are not substantially under- or over-estimated. As a first step, consider the ranges given in the existing dataset, and their relation to best estimates (**Table 9.1**).

This information was used to assess the average proportional ranges around the best estimates, which could then be applied to measures for which minimum and maximum estimates were not available. The summary statistics at the bottom of the table show an absolute range of between 0 and a factor 5 around best estimates. Taking all of the ranges into account gives an average minimum to maximum spread of factors of 0.64 and 1.71 around best estimates. However, this includes some false ranges where minimum or maximum estimates are equal to best estimates. Excluding these from the analysis gives a range of factors of 0.51 to 2.25 around best estimates. Given the artificial manner in which these estimates are generated a uniform distribution could be assumed, for which all values within a range have an equal probability of arising in the Monte Carlo sampling process. However, given the asymmetric nature of the range, this would lead to an average estimate 45% higher than the original best estimate. To overcome this problem, alternative shapes for the distribution of the factor for integrating uncertainty in abatement were studied. The following criteria were defined:

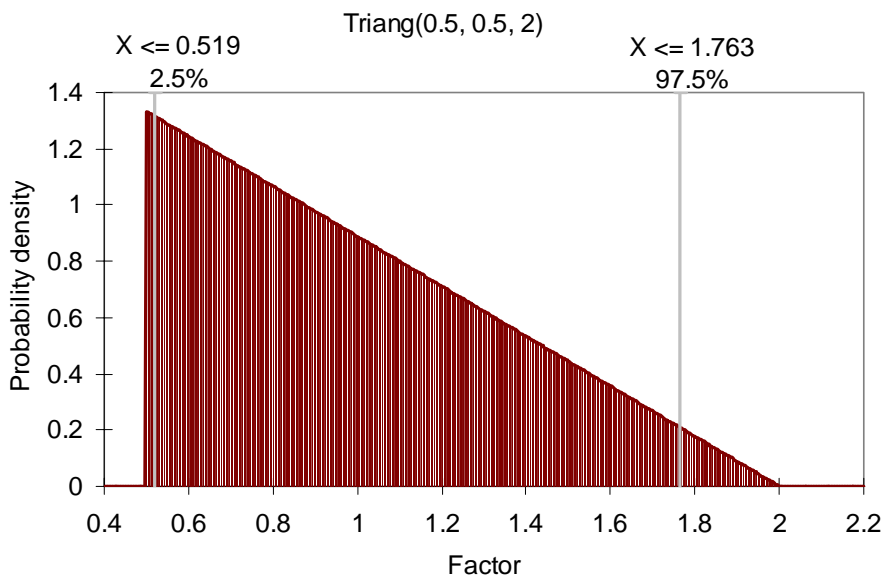
- ▶ Limits should be close to 0.51 and 2.25
- ▶ The mean of the distribution should equal 1 (so that on average, when the best estimate is multiplied by the uncertainty factor, the result will be the best estimate).

The simplest distribution available in the @RISK was a triangular distribution with minimum and most likely estimates both set to 0.5 and the maximum estimate set to 2. The mean of this distribution is 1.0 (**Figure 9.1**).

**Table 9.1** List of measures for which ranges in abatement levels (MtC) in 2020 have been obtained, with ratios of minimum to best estimates and maximum to best estimates.

Measure	Min	Best	Max	Ratio Min/Best	Ratio Max/Best	
Energy Performance of Buildings Directive	0.2	0.3	0.5	0.67	1.67	
Business Smart Metering	0.1	0.2	0.2	0.50	1.00	
New measure for achieving carbon savings from large non-energy intensive organisations (Carbon Reduction Commitment, CRC)	0.8	0.8	0.8	1.00	1.00	
Products Policy	0.5	0.9	1.4	0.56	1.56	
Carbon Reduction Commitment	0.2	0.2	0.2	1.00	1.00	
Carbon Neutral Government	0.2	0.2	0.2	1.00	1.00	
Energy Performance of Buildings Directive	0.2	0.3	0	0.67		
Products policy	0.1	0.2	0.5	0.50	2.50	
Supplier Obligations after 2011	3	3.5	4	0.86	1.14	
Zero Carbon Homes	1.1	1.2	1.2	0.92	1.00	
Energy Performance of Buildings Directive	0.2	0.4	0.6	0.50	1.50	
Energy Efficient Products/Product Policy (additional)	0.4	0.9	1.3	0.44	1.44	
Better billing	0	0.1	0.1	0.00	1.00	
Real time displays and Smart metering	0	0.1	0.5	0.00	5.00	
Future Voluntary Agreements	1.7	1.7	5.4	1.00	3.18	
Mean for all ranges				<b>Mean</b>	0.64	1.71
				<b>Min.</b>	0.00	
				<b>Max.</b>		5.00
Means where min/max figures = best estimates are excluded				<b>Mean</b>	0.51	2.25

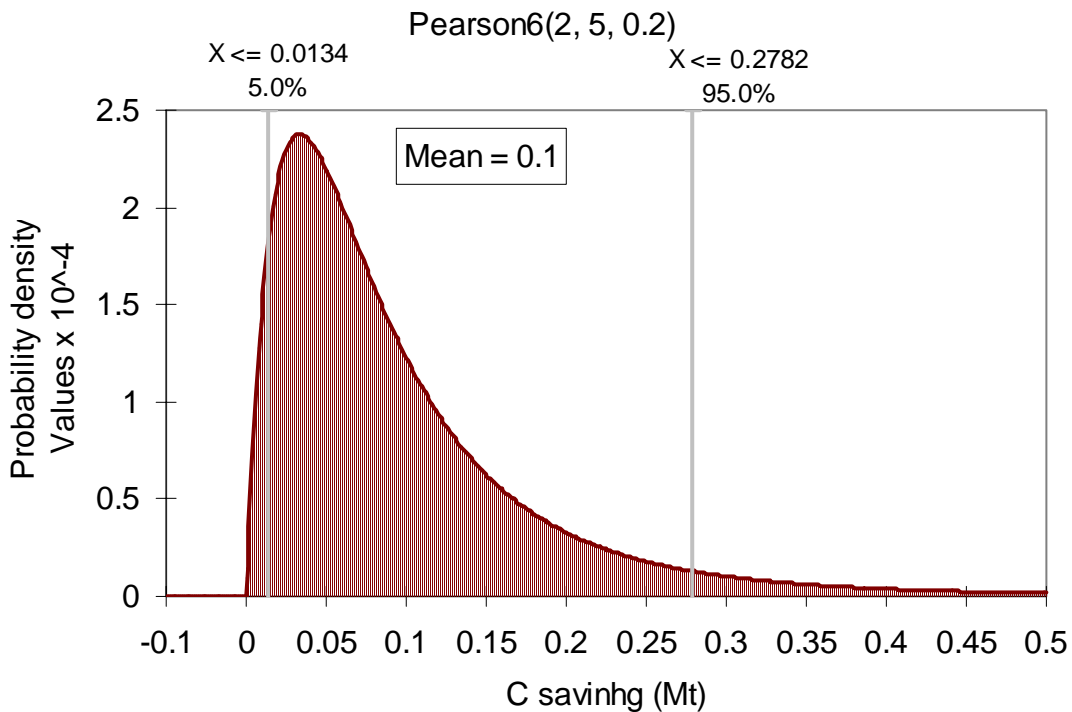
**Figure 9.1** Triangular distribution in uncertainty factors for emissions abatement.



For some measures abatement was expressed as a range without a best estimate. In those cases the range was input with a uniform distribution, the range defining the low and high estimates.

In cases where low, best and high estimates were available different distributions were tested until one was identified that matched the estimates well. For example, the measure ‘Real time displays and smart metering for new houses’ has been identified as having the potential to save between 0 and 0.5 Million tonnes C per year in 2020, with the best estimate skewed strongly left at 0.1 MtC. Applying a triangular distribution as just defined gave a mean estimate of 0.17 MtC, significantly greater than the best estimate. However, a Pearson distribution was identified that fitted the range and gave the best estimate as the mean (Figure 9.2).

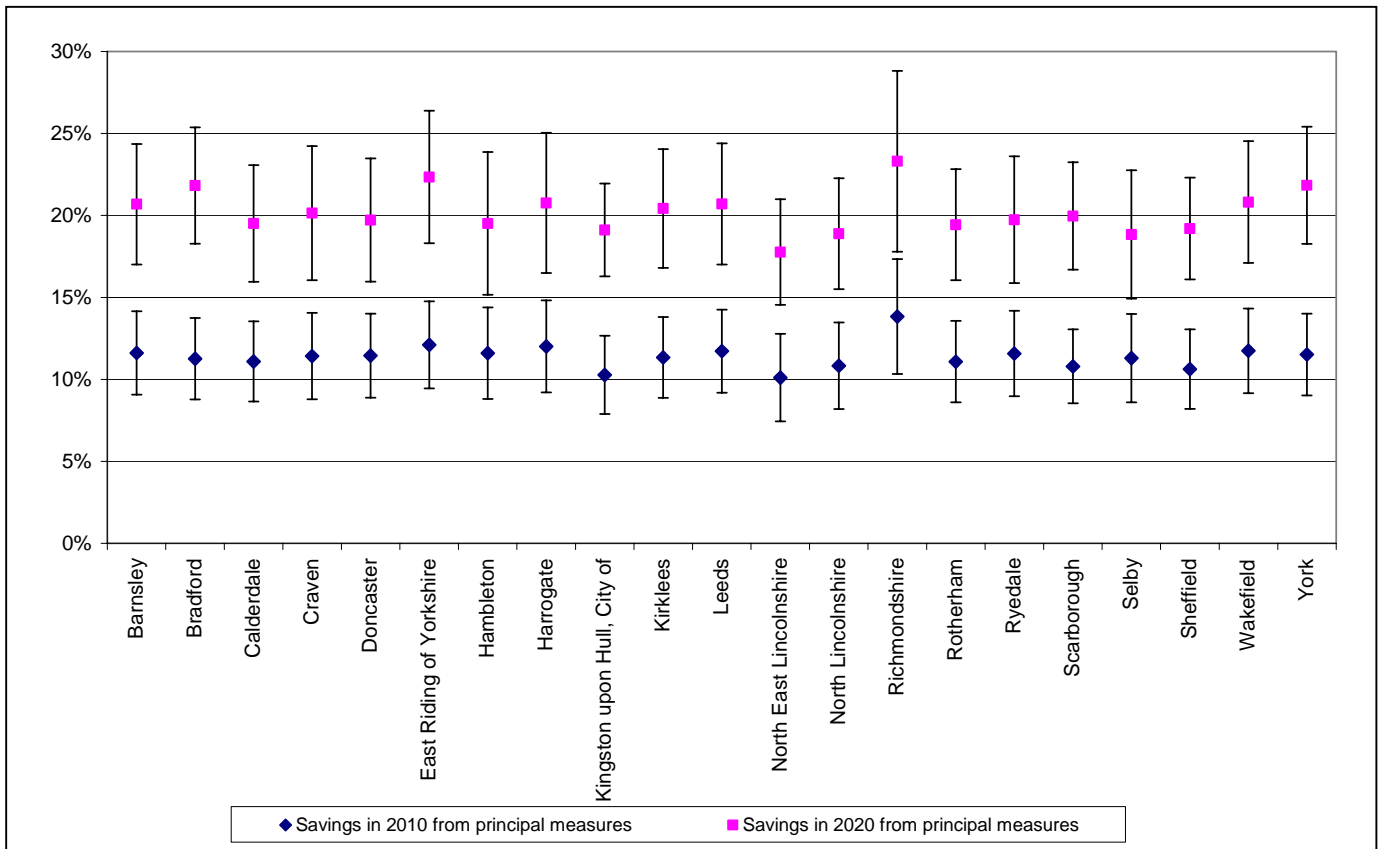
**Figure 9.2** Probability distribution for the measure ‘Real time displays and smart metering for new houses’.



## 9.2 Results of Monte Carlo Simulation

Potential emissions savings have been estimated for each local authority in 2010 and 2020, with and without the additional sensitivity measures. Overall the ranges in the savings are estimated at between +/- 2% to +/- 5% for principal measures in 2010 and between +/- 2% to +/- 7% for all measures in 2020. An example of the results is shown in Figure 9.3 for Yorkshire and Humberside. The error bars represent the calculated 95% confidence interval. Further graphs for other regions are available in the spreadsheet accompanying this report.

**Figure 9.3** Estimated range of CO<sub>2</sub> savings in Local Authorities in Yorkshire and Humberside compared to emissions in 2004 (savings from principal measures only)



## 10 Conclusions and recommendations

This work is the first phase in the development of the community climate change indicator (CCCI). Local Authorities (LAs) have a significant role to play in reducing emissions and leading and inspiring emissions reductions in their communities. LAs are becoming increasingly involved in climate change issues and this involvement includes a willingness to monitor greenhouse gas emissions, set targets and develop carbon reduction management programmes. Effective reduction needs monitoring, review and prioritisation. These activities require a firm basis on which to monitor progress.

Defra has therefore proposed the community climate change indicator, together with a co-ordinated programme to set appropriate targets and assess progress against these, to stimulate action by Local Authorities to reduce CO<sub>2</sub> emissions.

### 10.1 Conclusions

#### 10.1.1 Construction of the indicator

This study has identified a set of sources that can be influenced by the actions of LAs and where well-developed methods to provide reliable estimates of carbon emissions already exist. The study excludes direct carbon emissions from installations in the EUETS because these emissions are affected by national policies. However, emissions from power generation and refining have been included on an end user basis. In addition, road transport emissions on motorways are also excluded. Although LAs can have some influence over travel choices of people living and working within their boundaries, the traffic on motorways is often involved in longer trips which cross LA boundaries.

We have identified sources of uncertainty in the current dataset of emissions and have calculated percentage errors for each local authority, ranging from 1.6% to 5%. Most LAs in England have a percentage error of 2.65% or lower. This is because the emissions are dominated by the electricity and gas use in industry and commercial sectors for which the UK estimates and the mapping distributions have low percentage errors. Higher overall percentage errors occur where the dominance of gas supply is lower so there are more emissions from solid and liquid fuels in the domestic and business/industry sectors, such as in Devon and Cornwall and Northumberland. Higher percentage errors also occur where minor road transport emissions are significant, such as in inner London.

The NAEI work programme includes a programme of continuous improvements of emissions estimates, including the mapped emissions. Therefore work is on-going to improve the Local CO<sub>2</sub> dataset for 2005 and beyond.

#### 10.1.2 Estimates of emission savings by Local Authority

We have developed a spreadsheet model to combine the estimates of emissions by LA in 2004 with projected emissions for the UK in 2010 and 2020 and have estimated reductions in emissions from a variety of different measures. The model has been designed to estimate potential reductions in CO<sub>2</sub> emissions for each LA in England in order to aid the setting of targets for emissions reductions to be monitored by the CCCI.

We have completed a literature review to produce a list of measures to reduce CO<sub>2</sub> emissions in the future (savings of CO<sub>2</sub> in 2010 and 2020). These measures were applied to the baseline CO<sub>2</sub> emissions on a spatial basis, to generate an estimate of CO<sub>2</sub> savings per LA according to measure. To achieve this, the emission reductions were allocated using surrogate statistics of applicability constraints such as numbers of households, domestic fuel

splits (into solid, gaseous and liquid fuels), traffic modelling area types (sizes of towns/cities) and current industrial emissions.

The results show that many LAs in England could expect to achieve between 11% and 13% reduction in emissions compared to 2004 by 2010 and between 19% and 23% compared with 2004 emissions by 2020. Overall the ranges in the savings are estimated at between +/- 2% to +/- 5% for principal measures in 2010 and between +/- 2% to +/- 7% for all measures in 2020.

The modelling undertaken in this work package has been limited by the time available (one month). We have collected a lot of information on measures but this has not been exhaustive. There are still gaps in the dataset of measures, particularly related to transport measures such as restrictions on access (low emission or congestion zones). We have also not included an assessment of the progress made so far by local authorities although the model does include qualitative information such as Nottingham declaration signatories and Beacon councils. This could be used in future modelling work to group LAs into leaders, followers and laggards for example, with applicability and efficiency of measures altered for each group.

## 10.2 Recommendations

This study has shown that the data available for the construction of the Community Climate Change Indicator are sufficiently robust with relatively low levels of uncertainty.

We recommend that the CCCI is based on emissions calculated on an end user basis (Including electricity use and energy used to produce other fuels) for the Local Authority community and excludes emissions from EUETS (Large industrial processes) and Motorways.

### 10.2.1 Improvements to the indicator data

Further improvements beyond the 2005 emissions dataset to reduce the uncertainty of estimates and to incorporate available local data have been suggested in this report:

#### Domestic

- ▶ Further improvements could be made to the non-gas domestic fuel use distributions: sourcing new data actual consumption of solid and liquid fuels; and making use of the Homes Energy Efficiency Database (HEED) from the Energy Savings

#### Industry / business

- ▶ Emissions from point sources in the 'other industrial consumption' sector could be improved with new data on Part A2 and Part B from the European Pollutant Release and Transfer Register database (E-PRTR) and Climate Change Agreements.
- ▶ Updates are required to the area source distributions for industrial combustion using high-resolution industrial gas consumption data from DTI, improved estimates of energy intensity and updated employment statistics from the Inter-Departmental Business Register (IDBR).

#### Transport

- ▶ Further improvements to the road transport emissions modelling are possible if additional traffic count data become available from DfT. Any new data available will be included in the emission mapping each year.
- ▶ A peer review of the road transport modelling methods could also lead to improvements in these estimates.

#### Other

- ▶ Uncertainties: Inclusion of additional indicators of the quality of the geographical distributions in the DTI local energy statistics will improve the estimates of uncertainty.



- ▶ End user emissions: the emissions in the indicator can be split into ‘direct’ emissions (emissions at source) and ‘indirect’ emissions (those added through the redistribution of energy supply emissions).

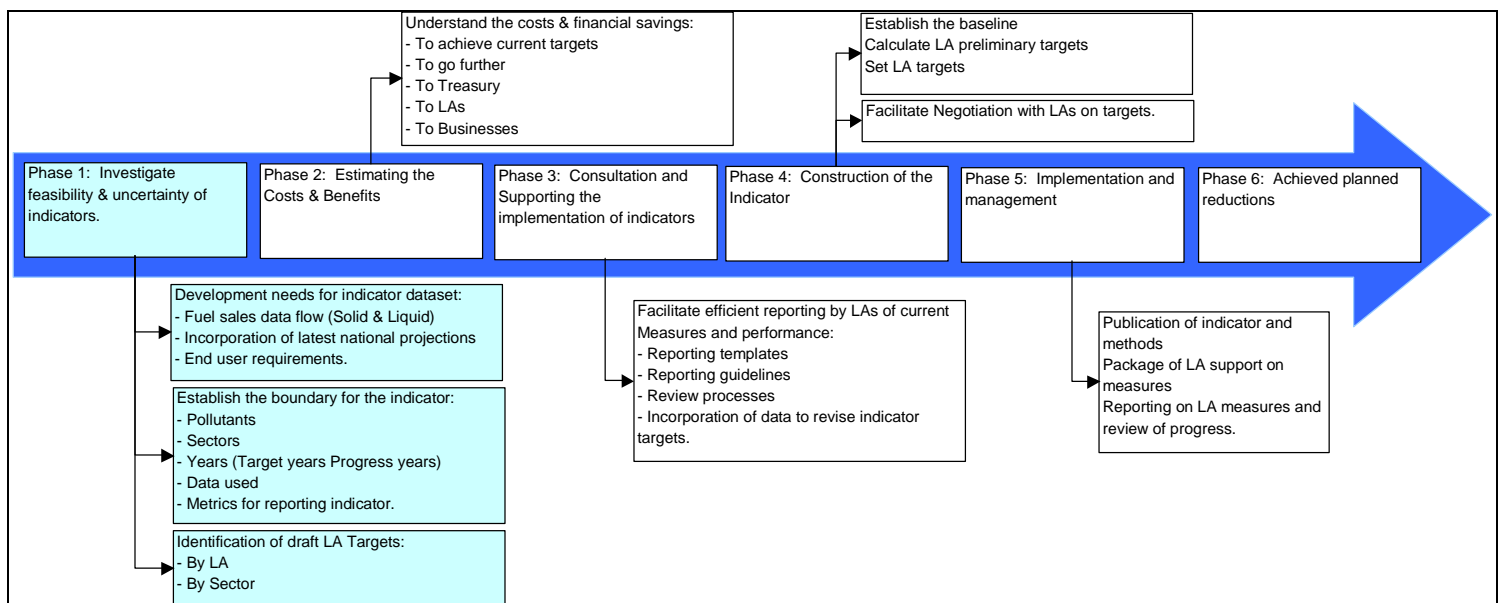
### 10.3 Supporting the implementation of the indicator

The further development of the indicator dataset will need to continue over the course of the next 12 to 18 months. If this indicator is included in the Local Authority Performance Framework, Local Authorities will need to be able to monitor progress for themselves, assess their own future emissions reduction potential and costs and report on actions taken and successes. Defra should consider additional work to establish a system for setting individual Local Authority targets, support for voluntary reporting on measures and performance, guidance for estimating community emissions, incorporation of local data and assessing the costs and effectiveness of measures and activities to reviewing progress against targets.

Figure 10.2 shows the suggested work programme for the implementation of the CCCI. Phase 2 would incorporate researching additional cost of measures data and estimating the likely costs of any proposed emissions reductions. Further details on Phase 3 are provided below.

**Figure 10.1** Suggested work plan for development and implementation of the community CO<sub>2</sub> indicator.

The boxes with a light blue background represent the work in the current project



Phase 3 of this workplan could include the following stages:

- ▶ **Consultation with LAs** on the proposed method of estimating emissions. A series of events for LA representatives could be used to explain the method and get feedback on this. Some LAs that already have their own emissions inventories may suggest that local data should be used instead of nationally derived datasets. This is likely to be the case for a fairly small number of LAs that are active in this field and work could be done with the Beacon Councils.
- ▶ **Reporting templates** may be required if LAs wish to provide supplementary data to support their progress to targets, for example to demonstrate areas where they have put actions in place. Standard reporting templates will ensure that any data submitted

is comparable between local authorities and can be efficiently shared amongst Local Authorities and combined to inform policy..

- ▶ **Guidance** will also be required in order to fully define the community emissions boundaries and to provide information about what data is appropriate to use.
- ▶ **Review of the data** will be necessary to ensure that it is of a sufficient quality to be used in place of the nationally derived emissions for the relevant sectors.

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## Appendix 1

### A1.1 The global warming potential

The direct greenhouse gases have different effectiveness in radiative forcing. The Global Warming Potential (GWP) is a means of providing a simple measure of the relative radiative effects of the emissions of the various gases. The index is defined as the cumulative radiative forcing between the present and a future time horizon caused by a unit mass of gas emitted now, expressed relative to that of CO<sub>2</sub>. It is necessary to define a time horizon because the gases have different lifetimes in the atmosphere. **Table A1.1** shows GWPs defined on a 100-year horizon (IPCC, 1996). These are the GWP values required by FCCC/CP/2002/8, consistent with Decision 2/CP3.

**Table A1.1** *GWP of greenhouse gases on a 100-year horizon used in the UK National Inventory Report*

Gas	GWP
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
HFCs	140-11,700
PFCs	6,500-9,200
SF <sub>6</sub>	23,900

A range of GWP values is shown for HFCs and PFCs because these refer to a number of species, each with its own GWP. By weighting the emission of a gas with its GWP it is possible to estimate the total contribution to global warming of UK greenhouse gas emissions.

GWPs of certain greenhouse gases have been updated in the IPCC Third Assessment Report (IPCC, 2001). However, it has been agreed internationally that these will not apply to the Kyoto targets under the first commitment period. All calculations and inventory submissions throughout this period will be based on the GWPs given in the Second Assessment Report (IPCC, 1996).

## Appendix 2

### A2.1 Work programme to improve and produce the LA CO<sub>2</sub> community indicator estimates

**Table A3.1** Summary of the work to improve and produce the LA CO<sub>2</sub> estimates. (Excludes additional guidance, review and incorporation of additional Local Authority data and dissemination and presentation of the datasets).

Sector	Work strands
<b>Domestic</b>	Improve estimates of domestic fuel use
	<ul style="list-style-type: none"> <li>▶ <i>Scoping study</i> To determine if there is sufficient data to warrant a complete survey – this will build on the limited work already done within the NAEI to improve the quality of the estimates in this sector.</li> </ul>
	<ul style="list-style-type: none"> <li>▶ <i>Complete study</i> This will involve a telephone surveys of fuel domestic fuel suppliers and a review of our internal knowledge gained through Local Authority air quality review and assessment work.</li> </ul>
	<ul style="list-style-type: none"> <li>▶ <i>Statistical modelling using data in EST HEED Database</i> The Homes Energy Efficiency Database (HEED) from the Energy Savings Trust may provide a useful source of data and should be investigated. Statistical modelling to 'gross up' sample data to generate high resolution estimates of households using different fuels</li> </ul>
<b>Industry</b>	Improve estimates of other industrial combustion
	<ul style="list-style-type: none"> <li>▶ <i>Scoping study</i> To determine if there is sufficient data to warrant a complete survey – this will build on the limited work already done within the NAEI to improve the quality of the estimates in this sector.</li> </ul>
	<ul style="list-style-type: none"> <li>▶ <i>Complete study</i> Involving telephone surveys of fuel domestic fuel suppliers and a review of our internal knowledge gained through Local Authority air quality review and assessment work.</li> </ul>
	<ul style="list-style-type: none"> <li>▶ <i>Energy intensity data survey</i> Involving telephone surveys of fuel domestic fuel suppliers and a review of our internal knowledge gained through Local Authority air quality review and assessment work.</li> </ul>
<b>Transport</b>	Road transport modelling
	<ul style="list-style-type: none"> <li>▶ <i>Peer review</i> Peer review of current modelling techniques</li> </ul>
	<ul style="list-style-type: none"> <li>▶ <i>Modelling enhancements</i></li> </ul>
<b>Update mapping</b>	Update mapped emissions
	<ul style="list-style-type: none"> <li>▶ <i>Producing new maps</i> Once we have new source data, emissions maps will need to be updated to incorporate the new datasets</li> </ul>
<b>Compile indicator datasets annually</b>	<ul style="list-style-type: none"> <li>▶ <i>To report annually on the reductions achieved by each LA so it can be assessed by the Audit Commission. Sufficiently detailed to give the information necessary so that LAs can plan their future actions.</i> Production of datasets. Methodology report and helpline to respond to technical questions.</li> </ul>

## Appendix 3

### A3.1 Issues to consider when assessing potential savings

Potential can be looked at in different ways, for example:

1. The **potential of specific government-funded programmes** to directly and indirectly lead to change of technologies, behaviour, etc. and hence emissions, over a set period of time, and for a set amount of money. The direct potential is constrained by the resources made available to programmes and the way that they are implemented. The indirect potential is constrained by the resources and approach taken for dissemination of the results and recommendations of programmes.
2. The **theoretically maximum potential** for emission changes with all technical and non-technical options implemented fully. This will be greater than the potential quantified for government programmes as it is not constrained by economic or social factors. 'Potential' calculated in this way obviously needs to be referenced against scenarios of economic development and energy use.
3. The **social and technical potential** for emission changes over time. This should give an abatement potential better than [1] as it is not constrained by resource, but not as good as [2] as it is constrained by social factors (e.g. behaviour) and by time<sup>37</sup>.

It is therefore important that 'potential' is defined when reference is made to it.

#### Quantifying abatement potentials

Quantifying the abatement potential of a single measure may be straightforward in some cases, for example, concerning the installation of cavity wall insulation. Information exists on the age of buildings and this is a reasonable guide to whether or not buildings will have solid or cavity walls. Information also exists on the extent to which buildings of different ages have been insulated, and on the benefits of this form of insulation.

One of the problems for analysis such as this is that an enormous number of measures can be defined for reducing energy use and hence CO<sub>2</sub> emissions. For example, traffic emissions can be controlled by the following (not intended as a definitive list, but illustrating the breadth of measures that are possible within a single sector):

- Technological improvements...
  - ...to vehicles
  - ...to fuels
- Encouraging public transport use through:
  - Better buses
  - New public transport routes
  - Scheduling new services (e.g. late at night or early in the morning)
  - Better stations and bus stops
  - Better access to public transport information
- Encouraging walking and cycling through:
  - Better lighting
  - More cycle racks, changing facilities

<sup>37</sup> To illustrate reasons for variation in potential over time. New cars with significantly lower emissions than the existing fleet would only gradually enter the market over a period of about 15 years. A widespread programme to install cavity wall insulation would be constrained time-wise by the availability of people to carry out the work, and of course of the finance for doing it.

- More cycle lanes
- Traffic controls
  - Congestion charging
  - Development of low emission zones
  - High occupancy vehicle lanes
  - SCOOT systems
  - Improved signage
  - Speed controls
- Fiscal measures
  - Higher taxes or parking charges for the least efficient vehicles, etc.
  - Subsidies for better fuels
- Other
  - Vehicle maintenance (servicing, tyre pressures, etc.)
  - Driver training

Similarly for the domestic sector:

- Cavity wall insulation
- Loft insulation
- Fuel switching
- Better boilers
- Installation of radiator thermostats
- Improved appliance efficiency
  - Light bulbs
  - White goods
  - Electronic equipment (TVs, computers, etc.)
- Behavioural change
  - Use of temperature controls
  - Switching off appliances, etc. when not in use
- Others

It is not appropriate in this project to include all of these measures (and more!) individually for a number of reasons. The potential for each measure varies between local authorities. Many of the measures are of uncertain effect, and many would have only a small impact anyway. Instead, it seems appropriate to identify the measures likely to have the biggest effect on each sector (public/commercial., domestic, small industry, cars, heavy duty vehicles and possibly others) and to define their emission saving potential. Measures excluded from this list could be brought together into a group and a potential (with associated uncertainty range) assigned to the group as a whole. Analysis could be run with and without the 'other measures' category or categories for each sector to show sensitivity to the inclusion of these measures. To illustrate, it could be appropriate to consider potential for the domestic sector via the following measures and collective groups of measures:

1. Cavity wall insulation
2. Loft insulation
3. Fuel switching
4. Other efficiency measures (light bulbs, white goods, electronic equipment, windows, boilers, radiators through use of thermostats, etc.)
5. Other behavioural measures

The first three of these measures are known to be capable of having a significant impact, and analysis can be supported by detailed information on the current state of the housing stock and energy use/emissions in houses using different fuels and insulated to varying degrees. The fourth measure, covering a diverse range of efficiency measures is also supported by some information, though to a lesser degree than measures 1-3. The final measure is likely to have significant potential, but analysis would be prone to significant uncertainties.



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