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UK GREENHOUSE GAS EMISSIONS

ARE WE ON TARGET?

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Audit of UK Greenhouse Gas emissions to 2020: will current Government policies achieve significant reductions?

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Executive Summary

The UK Government has set targets to reduce Greenhouse Gas (GHG) emissions by at least 12.5% by 2012 and 60% by 2050 compared with the baseline emissions of 1990. Compared with other countries these are very ambitious targets and provide international leadership in tackling global warming. It has also set policy aims to achieve significant cuts in GHG emissions by 2020. In the DEFRA Climate Change Review (2006) the policy projection was to achieve a cut in GHGs of ~20% by 2020. In the subsequent DTI Energy Challenge Report (2006) additional policies are estimated to add an extra 19.5-25.3 MtC savings which would achieve a total cut in GHG emissions of ~30% by 2020. This report assesses the UK Government's current policies to reduce carbon emissions and the likelihood of achieving their stated targets and policy aims. First the report provides a historic policy audit to assess whether Government policies have been able to reduce carbon emissions since their introduction. Second the current portfolio of policies will be assessed in terms of whether they will deliver significant reductions in the future. The report focus' on the carbon reduction targets of the UK Government for 2012 and 2020. It reviews the four major sectors of Energy Supply, Business, Domestic and Transport. Minor sectors such as agriculture, forestry and land use changes and the public sector are not dealt with in this report as their contribution is small. In 2004 these sectors contributed less than 3% of the UK total carbon dioxide emissions. The major findings of this report are as follows:

1. UK GHG emission target of a 12.5% cut on the baseline levels required by the Kyoto Protocol by 2012 (~183 MtCe) could be achievable. UK GHG emissions in 2005 were 14.7% below 1990 levels (DEFRA 2007). However, the Government is aware that with continued significant economic growth the UK emissions will start to rise after 2010 and are implementing policies in the Energy Challenge Report (2006) to try to ensure this does not occur.

2. The audit notes that most of the carbon emission reductions to achieve the Kyoto Protocol targets were made in the 1990s with the change in industrial processes, waste management and a switch to natural gas from coal.

3. The major problem faced by Government policies is trying to reduce overall carbon emissions against a background of sustained and significant economic growth. For example there is predicted energy 'gap' of 25 GigaWatts which will be required by the UK in 2020, as well as the predicted huge growth in car usage over the next 13 years.

4. This report has assessed the likely success of each of the government policies and produced a possible range of GHG reductions for 2020 of between 29 to 17 MtCe for the four main sectors. This is significantly lower than predicted by the DEFRA Climate Change Report (2006) and DTI Climate Change Report (2006).

5. With present policies we suggest the Government's implied policy aim of cutting 2020 GHG emission by up to 30% compared with 1990 levels is very optimistic. This audit suggests current policies would achieve a GHG emission reduction of between ~12 and ~17% by 2020.

6. Despite all the complications within each sector reviewed, the over-riding reason for the possible failure of the current government policies to achieve their stated targets is that nearly all of them are voluntary. The DTI Climate Change Report (2006) implied policy aim of upto ~30% GHG reduction could be achieved if current policies were mandatory and new more prescriptive future policies were developed.

7. What this report can not yet assess is the impact of possible changing consumer habits. For example the media group BSkyB went carbon neutral in 2006 and two of the UK's large retailers Marks and Spencer and Tesco have recently announced that they will take their carbon emission seriously and make every effort to reduce them.

8. Government predictions concerning international aviation related to the UK suggest GHG emissions could rise to 14.9 MtC by 2020. This may be an optimistic figure as Bows et al. (2006) report suggests +17.3 MtC at their higher range. Note that GHG from international aviation are not included in our calculation above, National totals, Government and International targets.

	1990 GHG Emissions by Source in MtCe	2020 Government emission projections in MtCe. CCR (2006)	% of UK CO_2 Emissions 2004 End user Source	% of UK GHG Emissions 2004 End user Source	Government projected change in MtCe by 2020 given policies in CCR (2006) and ECR (2006) compared with Audit assessment of these policies - reduction + increase
Domestic Sector	**22.2**	**22.2**	**27%** **16%**	**24%** **14%**	**Government** *End User Change* CCR (2006) ECR (2006) -8.2 MtCe max of –11.3 MtCe **Audit** with current policies only a maximum additional -2 MtC from 2004 levels is likely to be achievable. Could be even less if domestic electrical use increases and building regulations are not followed. ***Audit Range –2.2 to –4.2 MtCe***
Business Sector	**60.7** (NAEI) **57.5** (DEFRA)	**40.4**	**39%** **20%**	**39.3%** **21.6%**	**Government** *End User Change* CCR (2006) ECR (2006) -31.2 MtCe max of –34.7 MtCe **Audit** could rise more if the economy grows more than predicted but could shrink if consumers drive green business. ***Audit Range –30 to -32 MtCe***
National Transport	**34.1**	**40.7**	**28.3%** **23.5%** (figures not including international aviation and shipping)	**25%** **21%** (figures not including international aviation and shipping)	**Government** *End User Change* not including international aviation CCR (2006) ECR (2006) +7.0 MtC minimum rise of +3.8 **Audit** – could rise by more as policies are unlikely to work could be as high as +13 MtCe as car usage will increase significantly and out strip all efficiency gains. ***Audit range +7 to +13 MtCe***
Energy	**74.4**	**51.1**	**N/A** **38%**	**N/A** **34%**	*By Source* **Government** CCR (2006) ECR (2006) -23.3 MtCe max additional saving –14.6 MtCe **Audit** – may not achieve cuts as must find at least an extra 25 GW of energy by 2020 and prevent switch to cheaper coal. Other figures are by End User and thus include the –23.3 MtCe predicted reduction. But future energy gap and economically driven use of coal could reduce this, but some small gains will be made by the new ECR policies. Hence conservative estimation is the CCR (2006) prediction ***Audit range-21.3 to -23.3 MtCe*** End user change 0 to +2 MtCe
	Total 2020 savings	Total MtCe savings in 2020 of above sectors plus 7.4 MtCe saving from agriculture, forestry, land management and Public. **CCR** (2006) = 32.4 (+ 7.4) = **39.8 MtCe** **ECR** (2006) = maximum of 56.8 (+ 7.4) = **64.2 MtCe** **Audit range** (2007) 29.2 to 17.2 MtCe (+ 7.4) = 36.6 to **24.6 MtCe**			

Table ES.1. Executive Summary Table outlining the Government estimated saving and the audit review of these policies
Total UK Emissions are: 152.5 MtC (2004) –just C02, 178.9 MtCe (2004) total GHG
CCR (2006) = DEFRA Climate Change Review (2006) and ECR (2006) = DTI Energy Challenge Report (2006)

ECR (2006) predicted changes have been calculated using the projected reduction from the CCR (2006) and adding the new Government measures to the correct Sector from the data in Table 8.1. page 149 ECR (2006).

Chapter 1: Introduction

1.1 Reducing Emission of Greenhouse Gasses is an Urgent Policy Imperative

The publication of the IPCC 4th Assessment Report (2007) is a stark reminder that global warming is progressing at an alarming rate and that the prospects are that it will be difficult to keep levels of greenhouse gases in the atmosphere at levels that will ensure future climate security.

The Stern Report (2006) makes the case for early action to reduce emission of greenhouse gasses. The expected damages (social costs) from failure to contain climate change within safe limits are expected to exceed the costs of action by a significant factor.

This creates an urgent need for policies that have a commensurate level of final ambition and a time table to match. The reductions required are well beyond the levels in current agreements under the United Nations Framework Convention on Climate Change (UNFCCC) and more will be needed.

1.2 UK Government International Leadership

The UK Government has taken an international lead and was an early participant in the understanding of climate change and in setting ambitious policies. It was a founder of the IPCC and formed and funded the Met Office Hadley Centre (one of the world's leading climate change research centres) as a major part of the international science effort. Following the IPCC's first report, the UK was a major force in the foundation of the UNFCCC following the Rio Earth Summit in 1992. Subsequently, the UK played a major role in the negotiations leading up to agreement on a first measure to limit greenhouse gasses, the Kyoto Protocol. The Kyoto Protocol entered force on the 16th February 2005, setting targets for greenhouse gas reductions and the UK, as a signatory, is committed to a 12.5% cut in GHG emissions compared to 1990 levels.

The Government has also set itself further targets in the form of aims of policy. This is in order to guide the development of measures to deliver the legally binding Kyoto Protocol targets as well as the further reductions that will be required beyond 2012. There are two particular goals covering the medium and long terms. Firstly there is the aim to significantly reduce GHGs by 2020. The 2006 DEFRA Climate Change Report (DEFRA, 2006a) predicts that policies up to early 2006 could reduce 2020 GHG emission by as much as 19.6%. The subsequent DTI Energy Challenge Report (2006) provides additional 'new' policies which they predict could save another 19.5-25.3 MtC which would achieve a cut in GHG of 29% by 2020. The policies discussed in these two reports are designed to provide a significant cut to enable Government to achieve their ambitious aim of a reduction of carbon dioxide by 60% by 2050. We note however that there is continued confusion between Government reports, targets and policies whether the reductions implied are of GHG emissions or just carbon dioxide. As both the Government 2010 and 2050 targets are in terms of carbon dioxide, 20% and 60% respectively. While international agreement such as the Kyoto Protocol are in terms of GHG emissions. However, it should be noted that the UK Government policy aims are ambitious and should be broadly supported. For the purposes of this report, we are focusing on the Kyoto Protocol commitment for 2012 and the implied 2020 policy goals.

1.3 Government route map to the measures needed to deliver the 2020 target

The Government published its projection for delivering the approximate 20% reduction in GHGs in the Climate Change the UK Programme 2006 (DEFRA, 2006a). This report contains an assessment of the current position and of the future measures that will be needed within the different sectors of the economy to ensure that the 20% reduction will be delivered. In addition we have analysed the new policies set out in the DTI The Energy Challenge Report (DTI 2006a) and assessed whether these could make a significant additional cut in GHG emissions by 2020. In both reports, the Government described the progress that had been made since 1990 but noted that higher than expected levels of economic growth and changes in the relative price of fuels had led to increased carbon dioxide emissions in recent years. This, the Government accepts, makes the achievement of the national goals more difficult. The effects of economic growth, in particular, can be seen in the rising demand in the energy and transport sectors. There are, therefore, two challenges for Government: to ensure that the existing policies deliver as intended and to develop new policies that will make further reductions in greenhouse gases in the context of economic growth. It is the aim of this report to assess the performance of current policies and, in the light of what this reveals, to consider whether the additional policies proposed will deliver the Kyoto Commitment and the implied policy goals for 2020.

1.4 Assessing the likelihood of success in delivering the 2012 and 2020 Goals

The methods we have used to explore the likelihood that the policies in place can deliver as planned, follow the methods of policy analysis the Government itself has used. The starting point is the national inventory of greenhouse gases, broken down into major economic sectors. The sectors we have considered are:

- Energy: emissions arising from the conversion of primary energy into secondary energy (electricity) or the production of refined fuels
- Domestic: emissions arising from use of energy in homes
- Business: emissions arising from the use of energy in business premises and industrial plants
- National Transport: emissions arising from the use of road vehicles, trains, inland shipping and national air travel

We have not considered the other major sectors in the Government's published analysis, Agriculture and Public Sector, as they account for less than 3% of all CO_2 emissions in the UK. Moreover all the major changes in these sections according to the Government projections have already occurred since 1990 and little change is expected from 2007 to 2020 (DEFRA 2006a).

There are two ways of apportioning the national emissions of greenhouse gases between sectors: on the basis of the source of the emissions and on the basis of the end user of the emissions. The first of these methods covers the emissions produced directly by each sector, but the second also includes emissions from the secondary energy (electricity) consumed. For the second method, then, the energy sector emissions, which arise only because of demand for secondary energy and refined fuels, are redistributed to the other sectors. On an end user basis, then, there are only three sectors in our analysis: domestic, business and national transport. For each of these major sectors, and for each system of attribution, available figures sho w the annual emissions of each of the major greenhouse gases and also show them as a basket, in terms of their equivalence to CO_2, the main constituent of the basket.

The Government's policy analysis of future measures contains a forward look: emission figures for the different sectors for future years are estimated and accumulated to produce a national total. The forward look has to assimilate information about levels of activity in the different sectors (e.g. changes in demand for energy, industrial output and vehicle miles travelled), and combine it with estimates of the emissions that arise from each unit of activity. To take road transport as an example, information about the expected total distances travelled by the different types of vehicle is combined with information about how fuel efficient these vehicles are likely to be in future.

In a policy that sets out to reduce emissions, growth in activity without commensurate improvement in the emissions performance for each activity unit is a significant problem. In fact, the improvement in efficiency has to more than compensate for growth it also has to deliver the emissions reductions.

The importance of economic growth cannot be overstated and it is essential in assessing the likely performance of the Government's overall strategy to assess the assumptions that are made about growth. How likely is it that the growth figures on which the Government's analysis are based will turn out to be correct and what are the consequences of greater or weaker growth? We have considered these questions in making our assessment by assessing published reports on the topic and by interviewing recognised experts in the field.

The other part of the calculation, estimating the emissions that will arise from each unit of activity in future, depends on

understanding the performance of the different solutions proposed for improving efficiency and the timescales over which they are likely to be adopted. Taking the example of road transport again, this means considering possible future vehicle and fuel technologies available (hybrid power trains, bio-fuels and others) and estimating the rate at which they can come to market and enter service as the different vehicle fleets turn over.

In practice, the measures proposed in the Government's policy analysis are a mixture of measures designed to address the growth part of the calculation and those designed to improve efficiency, by ensuring uptake of new technologies, for example. In arriving at an estimate of future emissions, there are essentially two strands to the process: a future based on extrapolation of current trends and the impacts of current policy (business as usual), which provides a baseline, and a second strand shows the impacts of the range of measures proposed in reducing emissions below this baseline delivering national commitments and goals. An assessment of the Government's policy has to consider both strands to answer the questions: "how realistic is the base line?" and "will the measures proposed deliver the new future that meets commitments and goals?" This is clearly not an exact science, but as assessments of future policies depend on them, they are important and have to be considered in the light of the claims made for them.

One key area of current concern is the rise in emissions from a robustly-growing aviation sector. Emissions arising from international aviation are not included in the basket of greenhouse gases for the Kyoto Protocol and are not included in the national goal. In part this is because of technical problems in allocating the emissions from international activities such as aviation and shipping to individual nations. However, aviation is projected to grow further and, on the basis of international departures from UK airports, would, by 2020, be a significant proportion of the UK total national emission. Government policies, for example on the expansion of airport capacity, will affect the growth in international air travel and the sector cannot be excluded from an analysis of UK policy on climate change in the whole. We have, therefore, considered the impact that the inclusion of this sector would have on national goals for reducing greenhouse gas emissions in this study.

1.5 Policy in Theory and practice: what are the constraints on policy?

Policy making in Government is a complex and highly contested process involving many different constituencies, often with widely divergent interests. Although Government aims for policies based on evidence, the outcome of the process often reveals tensions between different pieces of evidence as well as between different constituencies. For example, although there may be scientific evidence of harm, with significant social costs, from a specific pressure on the environment, this is set in the policy analysis against costs of remedies and benefits that come from the activity responsible for the pressure. Policy makers are aware that road transport is a major source of air pollution with direct impact on people's health but also that people derive benefits from using vehicles on the roads and have a record of resisting costs imposed to reduce emissions.

These tensions are played out at several levels. Within Government, the Departments of State have different interests, environment and industry, for example and the policy development process has to accommodate these through intense negotiations between Departments. There are many different external constituencies, including conservation groups, energy industries, developers of environmental technology, consumers' groups, road users' groups, and these different factions are all actively pressing their interests onto the policy development process, either directly in public or through proxies in official circles.

This policy development process is rather like an immensely complicated, multi-dimensional, tug-of-war and as in a tug-of-war relative strengths determine outcomes. The effect is that the measures finally agreed in environmental policy are usually an uneasy compromise between the scientifically determined scale of response required to deliver an environmental outcome and the level of costs that can be imposed on industry or consumers.

Even when a policy is finally agreed in Whitehall and is implemented there is no guarantee it can be made to stick. The fuel duty escalator, a measure that might have had an environmentally beneficial effect on national fuel use, was abandoned in the face of fuel protests. The Government also now in 2007 seems to be having second thoughts about another environmentally beneficial measure, road pricing.

Whatever good intentions Government may have in setting out policies, then, the effect they have in practice depends on many factors, including compromises in Whitehall and the political mood of the country. The measures set out in the Government's plans for future greenhouse gas emissions have to be considered in this wider context, too.

1.6 How measures are assessed in this report

In this report, we have considered the Government's plans as they are set out, sector by sector. Each chapter provides the overall summary of what our report has found, which can also be found at the beginning of each Sector Chapter and is summarized in ES Table 1. Each sector is reviewed and problems of definition and extracting data for this area are discussed. The performance of Government policies from 1990-2004 to reduce carbon dioxide and GHG emissions is then reviewed. This historic review is essential to provide an understanding as to whether polices have achieved the reduction in carbon emissions that were predicted, as this provides a mechanism to assess future Government predictions of policy in each sector. Current and planned Government and in some cases relevant EU policies are explained and potential

weaknesses are discussed. Each Sector Chapter ends with a summary of the finding and recommendations of how current policies could be improved.

1.7 Definitions

Basket Greenhouse Gases:	Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hyrdoflourocarbons (HFC), perflourocarbons (PFC), sulphur hexafluoride (SF_6).
DEFRA:	Department of Environment, Food and Rural Affairs.
DTI:	Department of Trade and Industry.
GWP:	Global Warming Potential of Greenhouse gases, expressed in relation to carbon dioxide.
$MtCO_2$:	mega-tonnes of carbon dioxide emissions
MtC_e:	mega-tonnes of carbon-equivalent gasses, calculated by dividing carbon dioxide emissions by 3.67 and by multiplying each of the other five greenhouse gases defined in the Kyoto Protocol (methane, nitrous oxides, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) by their global warming potential and dividing by 3.67.
NAEI:	National Atmospheric Emissions Inventory.
NC Format:	National Communication format of reporting emissions to the UN under the Kyoto protocol.
ONS:	Office of National statistics.
UK Business sector:	all emissions bracketed in NC format 'Business' (commercial and industrial activities including: blast furnaces, Iron and Steel combustion plants, cement production, supermarket refridgeration and heating of commercial property), 'Industrial process' (including: cement decarbonising, sinter production and the chemical industry) and 'Waste management' (from an emissions standpoint, primarily landfill) by NAEI.

Chapter 2: Energy Supply Sector

2.1 Summary

- The energy supply sector represented 34% of the total MtCe UK emissions during 2004, and 38% of the total CO_2 emissions.
- Many of the carbon cuts achieved in other sectors may impact on the energy sector by reducing energy demand. Similarly, fewer carbon emissions from the electricity generating sector may feed into carbon savings of end-users.
- Carbon equivalent emissions have fallen 17.5% between 1990-2004, mostly due to a drive towards CCGT gas-fired power generation, with smaller contributions from the Non-Fossil-Fuels Obligation and related programmes.
- The level of decline since 1990 masks an overall rise in emissions since 1999 which coincides with the introduction of the Climate Change Levy (2001), the UK Emissions Trading Scheme (2002) and the Renewables Obligation Order (2002).
- Policies introduced by the present government have tried to drive towards less carbon-intensive electricity generation (Renewables Obligation, various grant schemes, subsidies for biomass heating, support for CHP) and towards the introduction of carbon-abatement technologies (Carbon Abatement Technology scheme, EU Emissions Trading Scheme).
- The 2010 and 2020 targets for each policy must be viewed with a certain degree of scepticism, bearing in mind that they have consistently missed former targets, that they rely on market forces to be truly successful, that they are superimposed on a predicted increase in energy demand over the next two decades, and given the support of traditional industries such as coal and the North Sea Oil and Gas fields, which may be important to help fill the predicted energy ‘gap’ of ~25GW by 2020.
- The expected net import of fossil fuels for energy (particularly electricity) in future may add another element of instability to the system, given the problems which could occur to this supply because of geopolitical considerations. In such an environment, some support for existing domestic fossil fuel industries is understandable, although it should be noted that an increase in the utilisation of the large renewable energy potential in the UK could also help to alleviate some of these concerns.

- **Audit findings are:** – current policies may not achieve cuts predicted (see Table 2.5) as extra 25 GW of energy must be found by 2020, predicted switching to renewables is extremely optimistic and policies at present do not prevent switch to cheaper coal when economically viable. However, as this is a highly contested area we have conservatively suggested that the maximum achievable saving combining policies outline in the DEFRA (2006a) and the DTI (2006a) report would be the original projection by the DEFRA (2006a) report of a reduction of 23.3 MtCe. Concerns regarding the possible failure of the ETS, the renewable obligation and the huge predicted increase energy gain could mean this saving could be reduced by at least 2 MtCe. Providing an audit range of 21.3 to 23.3 MtCe reduction by 2020 compared with a 1990 baseline. However, we would stress that even our lower estimate may be optimistic.

2.2 Overview of the Energy Supply sector

All figures for 'energy supply' follow the definition of the 2006 Climate Change Report as primary electricity generation plus those emissions associated with the production of fuels for consumption in other sectors. Consequently this includes: '..electricity generation (power stations), oil production and refining, gas production and transmission and the production of coal and other solid fuels' (Climate Change the UK Programme 2006, hereafter CCUKP06, DEFRA, 2006a). While Electricity generation is defined as primary generation of electricity within the energy supply sector using fossil fuel or 'renewable-energy' energy sources.

The energy supply sector is distinct in its contribution to UK greenhouse gas emissions because it represents a 'point' source that feeds into other sectors. It includes all activities that generate electricity or fuel for final consumption in other sectors, and so comprises electricity generation, oil production and refining, gas production and transmission and the production of solid fuels such as coal. In 2004, the UK National Atmospheric Emissions Inventory records that the total carbon-equivalent emissions of the basket of six Kyoto gases from the energy supply sector was 61.36 MtC, representing ~34% of the total UK emissions of 178.9 MtC. For carbon dioxide, the energy supply sector is recorded as producing 57.97 MtC in 2004, representing ~38% of the total UK emissions of 152.5 MtC (National Atmospheric Emissions Inventory (NAEI), 2007).[2]

The energy supply sector as a whole in 2005 was dominated by gas (40%), followed by petroleum (33%), coal (17%), nuclear (8%) and renewable sources (2%). However, the vast majority of carbon emissions from the sector as a whole are sourced from electricity generation, which in 2004 accounted for 76.3% of the sector's total carbon equivalent emissions, and 80.3% of the sector's total carbon dioxide emissions. Consequently, a number of government policies have been put in place to tackle two main objectives:

(i) To generate a shift towards less carbon-intensive fuels.

(ii) To encourage the use of carbon–abatement measures which generate a reduction in the amount of carbon emitted from carbon-intensive fuels.

The policies which currently impact on forward-projections of UK carbon emissions relative to the 1990 and 1995 Kyoto greenhouse gas baselines from the energy sector cover a range of timescales, having been introduced both prior to and after 1997. The documents that introduced the various measures include the 2000 UK Climate Change Programme (DEFRA, 2000), the 2003 Energy White Paper (DTI, 2003), the 2006 UK Climate Change Programme (DEFRA, 2006a), and the 2006 DTI Energy Review (DTI, 2006a). However, the official application of these points into UK Government policy occurred in a range of other documents including the 1999 and 2006 Budget Reports, the Renewables Obligation Order (2002), the Finance Bill (2002), the EU large combustion Plants Directive, the Energy Act (2004), the Sustainable Energy Act (2003), and European Union Directive 2003/87/EC.

Most of the measures listed in Table 2.1 refer specifically to electricity generation, since these activities constitute the bulk of emissions from the energy sector and because policies that impact on fuel efficiency are also covered in other sectors such as transport and domestic.

[2] Note that the NAEI data agrees with figures presented in Climate Change: the UK Programme 2006 (DEFRA, 2006a), but disagrees slightly with those in the 2006 DTI Energy Review (DTI, 2006a). This discrepancy is partly due to the inclusion only of power stations and refineries as clearly defined categories in the latter, and some of the 'unacknowledged' NAEI energy supply categories must clearly be included in other sectors' emissions given the similarly of 'total' emissions in both publications. However, a 'total' MtC discrepancy of ~0.5MtC does remain, particularly from 2000 onwards.

Policy	Timescale covered	Target	Carbon effect estimate
Non fossil fuels obligation (NFFO)	1990-2001+	5% renewable electricity by 2003	-4MtC[1] by 2000
Privatisation of energy industry	1990's	-	25% of GHG reductions since 1990 (DEFRA, 2006)
Tighter control of power station planning applications	1998-2000	Control expansion of gas-powered generation	?
UK emissions trading scheme (superseded by the EU ETS from 2007)	2002-2005	-2 MtC by 2005	-1.6 MtC by 2005
Climate Change Levy (including Climate Change Agreements, and Carbon Trust Savings)	2001+	Reduce carbon emissions and encourage use of CHP (10,000 MW by 2010)	-2 MtC by 2020
Renewables Obligation Order	2002-2020+?	6.7% renewable electricity by 2007, 15.4% by 20.15 and 15.4-20% by 2020	-2.5 MtC by 2010; -3.2 - 4 MtC by 2020
Capital Grants Schemes	Variable	To encourage new energy technologies	-0.1 MtC?
Electricity from coal mine methane	2002-2005	Methane from coal mines classified as renewable	?
Increase use of CHP		10,000 MW power by 2010; government departments to source 15% of power by 2010	Included within Climate Change Levy estimate
European Emissions Trading Scheme	Phase 1 (2005-2007); Phase 2 (2008-2011)	-	-8 MtC by 2020
Nuclear new-build	?	?	-0-1.1 MtC
Policies to support oil, gas and coal industries	Variable	Increase investment opportunities; smooth transition to new	?

Table 2.1

2.3 Performance of Policies 1990-2004

Trends in carbon emissions from the energy supply sector and for power stations between 1990 and 2004 are shown in Figure 2.1. During this period, total carbon equivalent emissions fell by 17.5% and carbon dioxide emissions fell by 12%, while total carbon equivalent and carbon dioxide emissions from power stations both fell by 16.5% over the same period. However, this decline took place mostly prior to 1999. Unexpectedly high levels of economic growth since then have led to increases in MtC_e emissions from this sector of 7.5% relative to 1990 levels, equivalent to approximately 5.5 MtC_e. Carbon dioxide emissions also rose by 7 MtC over 1999-2004 (some cuts were achieved in methane emissions) which caused estimates for carbon dioxide emissions from power stations in 2005 to be roughly 9 MtC below recorded values for that year (DEFRA, 2000) (Figure 2.1).[4] These changes took place with a background of increasing energy demand of 1-1.5% p.a. over the last few years (House of Commons Environmental Audit Committee, 2006a).

[3] CCPUK06 (DEFRA, 2006a) estimates that low-carbon fuels including renewables and nuclear energy contributed to ~10% of the total MtCe savings between 1990-2004. However, table 2 (p28) gives a figure of 31mtC_e for this decline, while p26 estimates the decline at 65MtC, giving figures of <3.1MtC and <6.5MtC respectively. *Evaluation of DTI Support for New and Renewable Energy under NFFO and the Supporting Programme (O'Cleirigh and Frontier Economics, 2001)* suggests a figure of ~4MtC based on the amount of displaced coal and oil capacity.

[4] All values calculated from UK National Atmospheric Emissions Indicator figures. Note that the 2006 Climate Change Report indicates a 26% decline in GHG emissions between 1990-2004, which differs from the value of 17.5% quoted here.

It is rather difficult to estimate precise MtC_e savings from the various measures introduced prior to 2004, for the reason that many of them continue to exert an effect towards future targets, or do not have values published relative to targets set out in the various documents published prior to 2004. For these reasons, the approach is taken both here and in the next section on future emissions, of qualitatively evaluating each policy individually and quoting real values where they are available.

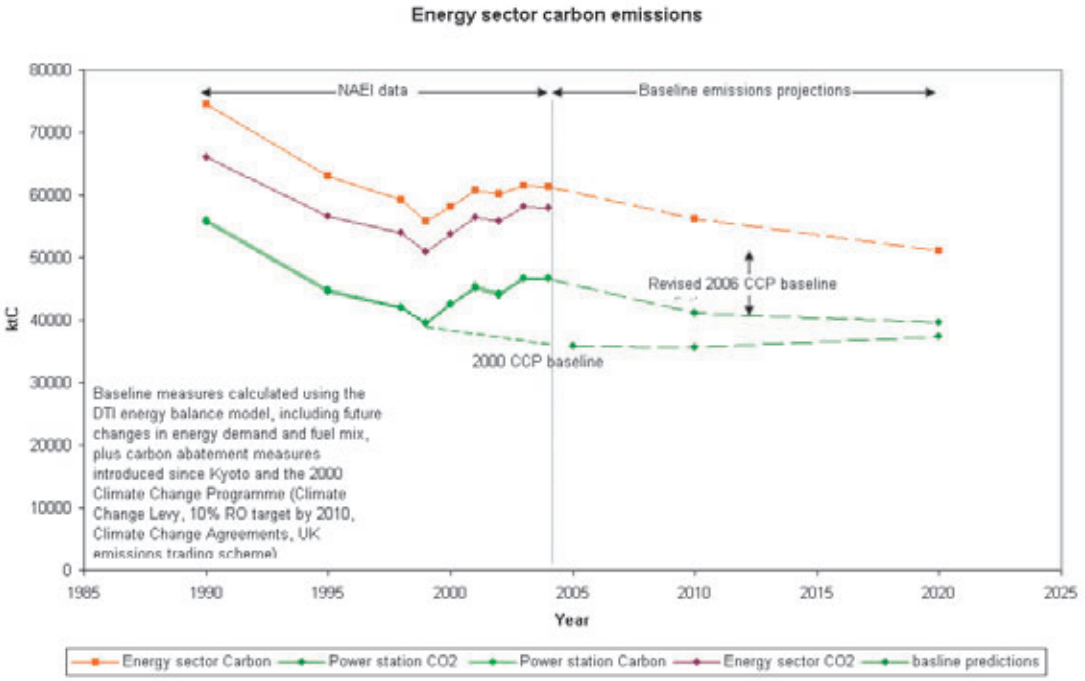

Figure 2.1: Energy sector carbon emissions

2.3.1 De-regulation of the Energy supply industry

Much of the carbon equivalent savings that are recorded after 1990 can be attributed to the move towards more-efficient and cheaper gas-fired Combined Cycle Gas Turbine (CCGT) plants following de-regulation of the industry in the early 1990's. These declines took place because of the higher efficiency of CCGT plants compared to older coal fired stations and because natural gas emits roughly half the amount of carbon per kWh as coal (DEFRA, 2000). The magnitude of this switch has been estimated at about 25% of the total reduction in total UK emissions before 2004, which gives a value of 7.75 MtC_e if UK NAEI data is used (a total of 31MtC reduction), or 16.25 MtC_e if the value of 65 MtC_e quoted in CCUKP06 (DEFRA, 2006a) is used. Following the publication of *Conclusions of the Review of Energy Sources for Power Generation* (DTI, 1998), planning regulations controlling new CCGT power stations were tightened to prevent damage to the UK's long-term energy strategy from an over-reliance on gas. It is likely that this may have reduced the full carbon-saving effect of the switch to gas-fired electricity but the magnitude of this effect is uncertain. The tightened regulations imposed by this measure were relaxed in early 2000. It is useful to quote the 2000 Royal Commission on Environmental Pollution's 22nd Report:

"The UK has reduced carbon emissions from burning fossil fuels. But that has been largely fortuitous."

2.3.2 Non-Fossil Fuels Obligation (1990-) and the Renewables Obligation (2002-)

The NFFO was introduced into England and Wales, along with equivalent policies in N. Ireland and Scotland, as an incentive to boost nuclear power generation. It offered contracts to generators in return for increases in the use of nuclear and renewable energy. Between 1990-2001, the scheme contracted 3271MW of renewable capacity (of which 911MW had become operational by 2001) at a cost of £1.18bn, plus annual running costs of £375,000 (O'Cleirigh and Frontier Economics, 2001). The 2000 Climate Change Report suggested that those projects that were yet to come to fruition under the NFFO and related programmes could raise the proportion of electricity obtained from renewable sources to 5% by 2003.

The Renewables Obligation was announced in the 2000 Climate Change Report and was formally introduced in the Renewables Obligation Order (2002). This requires electricity suppliers to source a certain amount of their electricity from renewable sources each year, in return for Renewables Obligation certificates (ROCs). If suppliers do not meet their targets, they can buy extra ROCs at a price of £32.33/MWh in 2004. A target of 10% renewable electricity was set in the 2000 Climate Change Report, which scaled to a target of 5.5% sourced by 2005. Importantly, not all sources of 'renewable' energy are eligible for ROCs. Those that are eligible are set out in Table 2.2.

Sources qualifying for ROCs	Sources not qualifying for ROCs
Landfill gas	Mixed waste
Sewage gas	Co-fired biomass from 2016
Hydroelectric >20MW	
Hydroelectric <20MW	
Onshore wind	
Offshore wind	
Co-fired biomass (until March 2016)	
Biomass containing <98% organic matter by pyrolysis, gasification, incineration and anaerobic digestion	
Geothermal	
Tidal	
Wave	
Photovoltaics	
Energy crops	

Table 2.2

Figure 2.2, which uses data obtained from the DTI Digest of UK Energy Statistics (DUKES), shows that neither the NFFO or RO targets were met by 2003 or 2005 respectively. By 2003, the contribution of renewables to the UK electricity market remained at 2.2%, and had only reached 4% by 2005. Furthermore, it is noteworthy that these proportions are only calculated from the volume of electricity sold via UK energy providers, which only accounted for 87% of the total amount supplied in 2005 (DUKES, 2006). While the mechanism of the RO is a pragmatic way of driving a change towards lower carbon energy production using market forces, it does not account for a substantial proportion of energy expended outside of the commercial arena. Even when increases in the capacity of renewable energy sources have been proposed, the current planning mechanisms do not seem to be efficient in bringing them into operation. Between 2000 and 2006, UK planning authorities approved 5018 MW of renewable capacity, but only 1605 MW of capacity became operational over the same period (Re-Stats website, 2007). It is possible that recent targets may have been met if the time-lag between planning and fruition were able to be reduced, but again, this is rather difficult to quantify and is the subject of ongoing assessment by the DTI (personnal communication from Steve Dagnall, AEA Technologies, 16/01/07).

2.3.3 UK Emissions Trading Scheme

A UK emissions trading scheme was included in the 2000 Climate Change Report. This scheme was not exclusive to the UK energy supply sector, but also covered other sections of industry. By 2005/06, carbon-equivalent emissions savings from this scheme were 1.6MtC (DEFRA, 2006b), only slightly short of the target of 2MtC outlined by the 2000 Climate Change Report (DEFRA, 2000).

2.3.4 European Union Emissions Trading Scheme

The EU Emissions Trading Scheme was introduced by EU directive 2003/87/EC and came into effect on Januray 1st 2005. The scheme uses market-mechanisms to achieve carbon-emissions savings, by allocating a certain number of tradable

carbon allowances to each installation, each equivalent to 1 $MtCO_2$ and determined based on projected business-as-usual emissions. Installations that exceed their annual allocation can either buy allocations from installations that achieve their required carbon savings or pay a financial penalty. Despite being applied to a range of installations across the energy supply and business sector, the vast majority of emissions savings are expected from power stations, which are less subject to market pressures and therefore are anticipated to be able to apply carbon-abatement measures more effectively.

In 2006, DEFRA published *EU Emission Trading Scheme: 2005 Results for the UK*, which provides a useful test-bed for evaluating the effectiveness of the scheme for its bearing on the reliability of future projections of carbon savings (DEFRA, 2006e). During 2005, 1069 installations were eligible for inclusion in the scheme, of which 715 took part. Of these 715, 37 installations were responsible for 52.6% of MtC_e emissions, each emitting >5 MtC_e/annum. 72% of all emissions came from power stations. By the end of 2005, UK installations had exceeded their combined allocation by 27.1 $MtCO_2$, interestingly because power stations had exceeded their allocation by 36.5 $MtCO_2$, while business installations had achieved a net saving. Failure of power stations to apply carbon-abatement measures in time to achieve their required cuts was estimated to account for 85% of the UK's 'over-emissions' under the EU ETS during 2005, while another 8 $MtCO_2$ could be explained by the increased use of coal-fired electricity generation during winter 2005 due to high gas prices. If energy prices could be predicted more accurately and carbon abatement measures applied more effectively, it is likely that higher savings could have been achieved. A number of eligible installations with existing Climate Change Agreements under the Climate Change Levy (below) were also able to opt out of the scheme.

2.3.5 Climate Change Levy

The Climate Change Levy was introduced by the Government in 2001 as a tax on business users of carbon-intensive energy sources. While specifically applying to the business use of energy, the CCL is included here because of its effect in promoting an expansion in the use of renewable energy sources and 'good-quality' combined heat and power (CHP). The higher energy efficiency of CHP, and its associated energy 'savings' prompted the 2000 Climate Change Programme to set a target of 10,000 MW of CHP to be available by 2010, which was supplemented by the 2006 DTI Energy Review, which set a target for government departments to source 15% of their energy from good quality CHP by 2010. These targets were estimated to achieve a saving of 2 MtC by 2010 by exempting CHP (and renewable energy) from the CCL (DEFRA, 2000). By 2004, HM Treasury estimated the savings from the energy sector under the CCL as 1.46 MtC/annum (HM Treasury, 2006a). However, these savings were estimated as being derived solely from reductions in energy demand relative to the rising baseline predictions. It could be possible that with a sufficiently high rise in baseline energy use, the expected carbon reductions driven by the CCL in the energy sector could simply 'stem' the flow of total MtC_e emissions rather than achieve net cuts.

2.3.6 Grant schemes

There have been a number of capital grants schemes to promote the development of the various technologies required to facilitate a shift towards the use of less carbon-intensive fuels in energy production. These schemes include:

i. £500m Energy Technology Programme (2002-2008), designed to promote offshore wind, biomass, solar photovoltaics and research and development.
ii. £89m New Opportunities Fund, to help develop renewable energy technology (announced in 2000 Climate Change Programme).
iii. £50m Marine Renewables Deployment Fund (2004-), to support wave and tidal electricity schemes.

It is difficult to quantify the effect these schemes may have had on total MtC_e emissions since they were introduced. However, as far as they are concerned with promoting the use of renewable sources of energy, it should be noted that as explained in section 2.3, the 2003 and 2005 targets for expanding the amount of electricity produced by these means were both missed (DTI, 2006a).

2.4 Future targets

Reductions in the carbon-equivalent emissions of greenhouse gasses from the Energy Supply in future depend upon the extent to which carbon-intensive methods of electricity generation are displaced by low-carbon intensive energy sources, and the extent to which new technologies such as Carbon Capture and Storage can be applied to carbon-intensive installations. These changes will take place against a background of a rise in energy demand of ~1.5% p.a., and a gradual de-commissioning of aging nuclear and coal power stations. By 2020, the loss of nuclear capacity is expected to reach 8-9 GW, while the loss from coal-fired stations may reach >19 GW (House of Commons Environmental Audit Committee, 2006a).[5] By 2020, a number of organisations such as the Carbon Trust[6], EDF Energy, and the DTI all expect there to be a UK electricity generation 'gap' of between 20-30 GW (LEK Consulting and the Carbon Trust, 2006).

By 2010, the 2006 UK Climate Change Programme estimates that carbon equivalent emissions from the Energy supply sector will fall from 74.4 MtC_e to 56.2 MtC_e, while CO_2 emissions will fall from 66.1MtC to 53.4 MtC. By 2020, these respective

[5] House of Commons Environmental Audit Committee Keeping the lights on: Nuclear, Renewables and Climate Change. 2006, Ev101.

[6] Policy frameworks for renewables: Analysis on policy frameworks to drive future investment in near and long-term renewable power in the UK. Carbon Trust, 2006.

figures are predicted to have fallen further to 51.1 MtC_e and 49.1 MtC. It is worth noting from figure E1 that the estimates for power station CO_2 emissions are higher than those published six years ago in the 2000 Climate Change Report due to unexpectedly high levels of economic growth after 1999. Such perturbations in economic growth and energy demand have the potential to seriously affect the reliability of future emissions projections, as noted by the Commons Select Committee on Nuclear and Renewable Energy:

"We have serious concerns about the ability of the government to model reliably and in a timely fashion future energy and emissions forecasts (LEK Consulting and the Carbon Trust, 2006)."

Despite these uncertainties in overall projections, the various policies proposed for the energy supply sector can be examined individually to see if it is likely they will achieve their stated goals by 2020.

2.4.1 Policies to decrease the use of carbon-intensive fuels

The energy 'gap' in the electricity generating sector is predicted to be filled by an expansion in the amount of energy produced by natural gas and renewable sources (DTI, 2006a) (Figure 2.2).

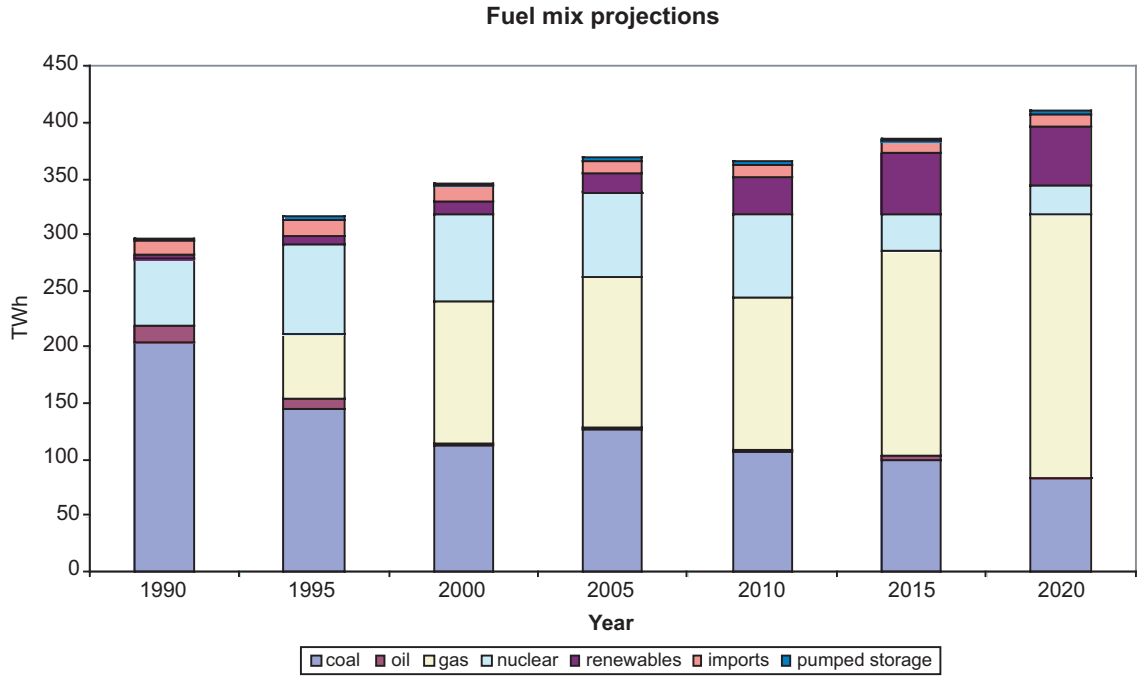

Figure 2.2

The main thrust of the current strategy is to support existing infrastructure as much as possible while helping to facilitate the smooth market-driven transition to low carbon energy sources.

In terms of increasing the capacity and electricity generated by 'low-carbon' source (renewables and nuclear), the main policies are the Renewables Obligation (RO), the various grant programmes designed to make renewable energy sources both technologically and economically feasible, and planning and infrastructure measures to help to deliver the required new generating capacity and to provide the infrastructure necessary to connect this capacity to the National Grid. The RO has set electricity providers targets of 10% by 2010 and 15.4% by 2015. A suggestion to increase the target to 20% by 2020 is qualified by the Energy Review (DTI, 2006a):

"Increases in Obligation levels above 15.4% will not occur at pre-determined stages, as with existing announcements, but will follow a "guaranteed headroom" model, where increases are contingent upon appropriate levels of growth in renewables generation."

This implies that if renewables targets are not met by 2015, very little pressure will be exerted on electricity providers to perform better. This seems a rather counter-intuitive goal for a 'target' to set for itself. The likelihood of the RO actually achieving its 2015 goal is also rather uncertain. Table C3 of the Energy Review indicates that the contribution of renewables to the total amount of electricity produced in the UK will only rise to 13% by 2020 (DTI, 2006a). Similarly, the Carbon Trust estimate that based on existing policy measures, the RO will only produce 10.1% renewable electricity by 2020, and with policy

amendments may still only reach a maximum of 14.9% (LEK Consulting and the Carbon Trust, 2006). The overall carbon reduction target for the RO is 2.5 MtC by 2010, with an additional 0.7-1.5 MtC to be added following policy amendments in the 2006 Energy Review. These amendments include the 'banding' of different sources of renewable energy to favour schemes such as offshore wind, which will not take effect until at least 2009. However, it is unlikely that these carbon reduction targets will be met if the current projections of future energy sources are accurate. Even assuming a linear increasing trend in renewable energy capacity based on recent years (Figure 2.3), which is rather unlikely, the targets will not be met.

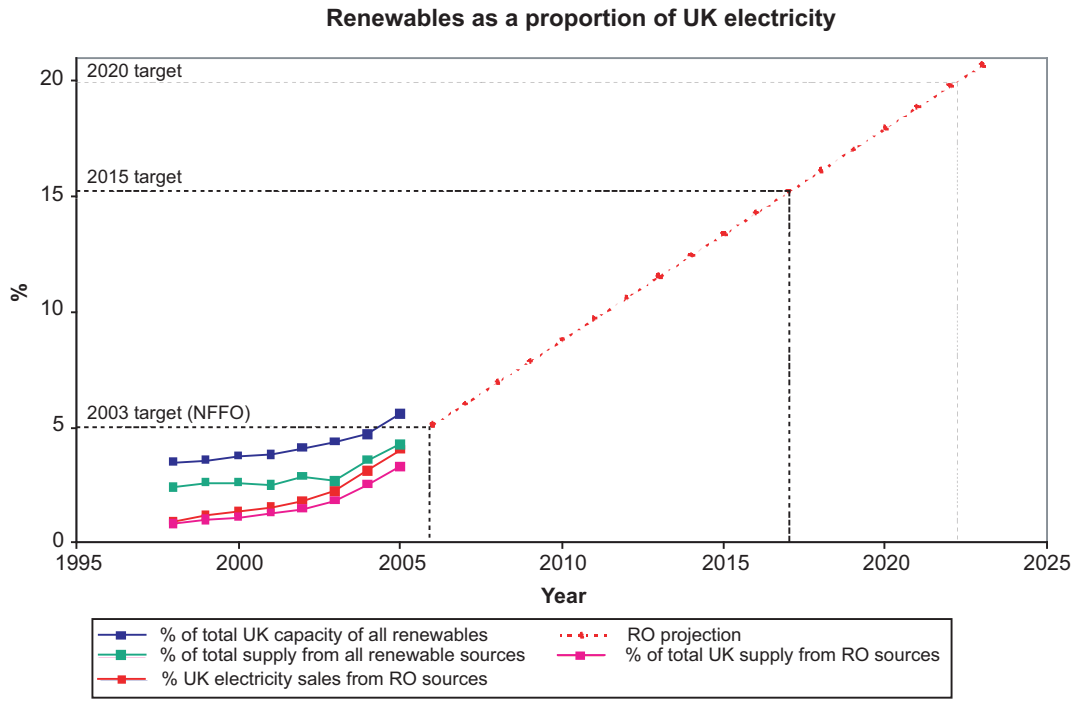

Figure 2.3

Other capital grants schemes have been recently announced in addition to those mentioned in section 3.6. These are a £10-15m pool to subsidise schemes to encourage biomass burning (expected to deliver a saving of 0.1MtC by 2020) and a £50m Carbon Abatement Technology Scheme. Of this fund, £15m has been earmarked to demonstrate hydrogen and fuel cell technology. In late 2004, the government also announced a £560m National Grid expansion scheme to accommodate the planned expansion of renewable generating sources. In terms of amending planning guidelines to ease the process of installing new generating capacity, the government also introduced Regional Approval for Renewable Energy Projects in 2004. This simplified the planning process for wind farms, solar and biomass projects, and encouraged planning authorities to favour renewable projects, but only where the technology was 'viable' (ODPM, 2004). It does not place a requirement for a certain number of schemes to be approved, however. The DTI website also indicates that the RO targets may be assisted by setting regional targets for renewable energy projects (DTI website, accessed 12th January 2007). However, these do not include sites located offshore, and so exclude the expansion of offshore wind farms, which have a huge potential for delivering much of the UK's energy requirements (LEK Consulting and the Carbon Trust, 2006). Bearing in mind that over £1bn was spent during the 1990's on the NFFO, for the result of ~2% expansion of renewable capacity, the likely success of the current schemes is uncertain. The Renewable Energy Foundation describes the point well:

"...the development of the many renewable resources available to the UK... cannot be achieved economically within the regulatory framework that the Government has introduced Renewable Energy Foundation, 2006)."

The 2006 Energy Review (DTI, 2006a) also estimates a possible carbon-emissions saving of 0-1.1 MtC by 2020 as a result of building new nuclear power stations. This saving comes from the fact that nuclear power stations emit very little carbon per unit of energy produced compared to fossil fuels (Table 2.3). However, these may be underestimates.

Energy Source	gC / kWh
Lignite	228
Coal	206
Gas	105
Biomass	8-17
Wind	3-10
Nuclear	3-6

Table 2.3

The House of Commons Environmental Audit Committee (2006a) note estimates as high as 120g/kWh for nuclear power, once the processing and transport of Uranium are accounted for. They also mention the high carbon costs and huge initial investment required to build and commission a new nuclear power installation compared to a modern CCGT plant. When the additional factors of a 12-15 year lead time to plan and build a new nuclear installation is considered, along with the ongoing government commitment to a 'market-driven' energy market (DEFRA, 2000; DEFRA, 2006a; DTI, 2006a), it is unlikely that investors will opt for nuclear rather than for cheaper, existing, more reliable, and less politically sensitive options such as gas. Indeed, uncertainty over the role of nuclear energy in the UK's future energy mix is highlighted by the Government's policy of 'thinking hard about what policy to adopt' as seen exemplified on p124 of the Energy Review (DTI, 2006a). Consequently, a saving of 1.1 MtC by 2020 from nuclear new-build seems very unlikely.

The Government has also introduced a range of policies that could act to counter any net savings from carbon reduction measures in the energy sector. These include changes to the regulatory framework surrounding oil and gas exploitation on the UK continental shelf announced in the 2006 Energy Review (DTI, 2006a), the 2003-2008 Coal Investment Aid programme (DTI, 2006b), which awarded £58.5m to 21 applicants to increase economic coal reserves, and the decision to count coal-mine methane as a renewable electricity source in the 2002 Finance Bill, despite it being derived from 'fossil' carbon. A request was made to the DTI to try and ascertain whether or not future emissions projections include the effect of higher imports of natural gas, particularly via LNG. No response has been received at the time of writing.

2.4.2 Policies to reduce carbon emissions from carbon-intensive sources

The two main policy approaches to tackling the problem of high GHG emissions from the use of carbon-intensive fuels in the energy generation sector include the EU ETS and various funding schemes to develop and promote carbon abatement technologies such as Carbon Capture and Storage (CCS). The expected carbon savings from the EU ETS published by the 2000 Climate Change Programme and the 2003 Energy White Paper fell in the range 3-8 MtC/annum by 2020. The publication of the phase II UK allocation (DEFRA, 2006d) gave a UK total allocation of 246.2 $MtCO_2$ (67.1 MtC), aiming towards the 8 MtC limit, as stated in the 2006 Energy Review. However, the Phase II allocation is actually higher than the total phase I allocation of 236.7 $MtCO_2$ (albeit including 9.5m allowances for installations not included the first time around). Consequently clarification needs to be sought over whether the -8 MtC target is relative to the 1990 Kyoto baseline or to the expected 'business as usual' emissions projections. Looking again at Table C1 of the 2006 Energy Review (DTI, 2006a), it seems that the latter is the case, which means that 8MtC cannot be considered as a total saving relative to 1990 levels by 2020. Furthermore, when the DTI were contacted to discuss whether the projected savings under the EU ETS by 2020 were realistic given that phase II ends in 2012, it was stated that future predictions are 'rather uncertain and depend on a lot of factors.' (personal communication from David Wilson, DTI Energy Strategy and International Unit, not directly quoted, 18/01/07). In summary, given (i) the failure of phase I of the UK allocation of the EU ETS to meet its carbon targets; (ii) the uncertainty of extrapolating the savings predicted after phase II ends in 2012 to 2020; and (iii) the implication that the ETS savings are calculated relative to annual emissions increases rather than to the 1990 baseline; a predicted carbon saving of 8 MtC by 2020 must be considered extremely uncertain.

The other key development in reducing emissions from carbon-intensive energy production is the application of CCS technology, which has the potential to significantly reduce carbon emissions from traditional fossil fuel sources using technology that is reasonably well understood. Captured CO_2 could also be beneficial to the North Sea offshore oil and gas industry by increasing the recovery of remaining reserves by injecting it into existing reservoirs. To date, the government has addressed the potential of CCS by allocating £35m under the Carbon Abatement Technology strategy towards the development of CCS for use in the UK. The 2006 Energy Review also announced a Regulatory Task Force and a North Sea Basin Taskforce to investigate the regulatory measures that would prove beneficial to the introduction of widespread CCS. However, the adoption of this technology may be hindered by its economics. The cost to industry of emitting 'surplus' carbon is currently 4 euros/tonne carbon based on the EUA carbon price under the EU ETS, with a high of 31 euros/tonne in April 2006 (Pointcarbon website, accessed 16/01/07). In comparison, saving a tonne of CO_2 by CCS currently involves a cost of ~30-45 euros, although this will certainly decline in future. This difference creates a market-driven incentive not to widely install CCS technology at present (DTI, 2005). Future developments may however improve this situation, but it nevertheless emphasizes the need for the long term strategic planning of a 'market-driven' energy supply sector to be guided by a strong and unambiguous government policy framework, particularly if emissions reduction targets are to be met.

Measure	Target	Actual
EU ETS phase 1 (2005 - 2007)	135.7MtCO_2 for power stations	172.2MtCO_2 emitted
Non-Fossil Fuels Obligation	5% renewable electricity by 2003	2.2% by 2003
UK ETS	2MtC saving by 2005	1.6MtC saving in 2005/06

Table 2.4

2.5 Conclusions

A summary of the measures which apply to the Energy supply sector is shown in Table 2.4. Only those measures for which emissions reductions could be quantified are shown, with a corresponding indicator of the likelihood of these targets being met, based on past performance of either the same or similar schemes (Table 2.4), and on estimates of whether each scheme (e.g. the RO) is likely to meet its future 'non-carbon' targets. It is important to note that other policy measures, e.g. the planned increase in CHP under the CCL, will have an effect on the energy sector but are quantified in other sector budgets. In addition the various un-quantified measures, such as the Carbon Abatement Technology strategy (DTI, 2005) and the support for the oil and gas industries may have an effect in the future.

The most promising approach to reducing carbon emissions from the Energy Supply sector may be through better long-term support and planning to develop renewable energy sources, particularly offshore wind, whose massive potential is well-documented. The EU ETS could be made to work better if mechanisms were put in place to ensure that installations met their allocation targets. This point is particularly relevant to power stations, which comprise so much of the total phase II allocation (DEFRA, 2006c).

Policy measure	Emissions target	Likelihood of success
RO	-3.2-4MtC by 2020	Unlikely
EU ETS	-8MtC by 2020	Unlikely at present
Nuclear new build	0-1.1MtC by 2020	Very unlikely
Biomass subsidies	0.1MtC by 2020	Probable

Table 2.5

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Chapter 3: Business Sector

3.1 Summary

- The Business sector consists of the NC format categories of: Business, Industrial process and Waste management.
- The Business sector consists of the NC format categories of: Business, Industrial process and Waste management.
- This report focuses on emissions of the 6 basket greenhouse gases (CO_2, CH_4, N_20, HFCs, PFCs and SF_6). CO_2 is discussed on a sole basis only briefly.
- Between 1990 and 2004 the sectors emissions declined by >30% (20 MtCe) based on 1990 levels.
  - Of this 89% is as a result of cuts in CH_4, N_20 and HFCs from Waste management and industrial process.
  - Cuts in MtC emissions from NC Business account to only 4.0% (0.8 MtCe), of the UK business sector's total cuts (1990 – 2004), this sub-sector now accounts for 72.6% (29.6 MtCe) of the UK Business sectors carbon emissions.
- With policies from 2006 taken into account, 2020 emissions (MtCe) are forecast to be 0.3% (1.2 MtCe) greater than 2004 levels. Over this period there is forecast to be significant economic growth (GDP rising to £1.79 trillion – based on DEFRA's assumptions) and expansion of the business sector of the economy, so government policies are, in effect, merely counter balancing the effect of economic growth.
- As environmental protection and economic stimulating policies tend to have different origins any policy which has the intention of stimulating growth would generally be termed as a carbon increasing policy. An analysis of the UK government's economic policy is beyond the scope of this report, and as such will not be considered in detail.
- If the government wishes to cut emissions from the UK Business sector (projections are for an increase from 2004 levels by 2020) then, as there is only limited scope for cuts from waste management (CH_4 from landfill) and very little scope from industrial process, it must cut emissions from NC Business.
- **Audit finds are:** GHG emissions from the business sector have significant dropped since 1990, but could rise significantly if UK economy grows more than predicted but could drop if consumers drive green business. Audit range for potential

end user GHG emissions reductions by 2020 on a 1990 baseline is -30-32 MtCe. This is because we believe the impact of economic growth has systematically been under estimated in the past and will remove much of the gains that could be provided by the additional policies in the DTI (2006a) Report. Neither this report nor the Government, however, can predict the possible positive influence of public consumer movement towards green companies.

3.2 Introduction to sector

The UK Business sector, for the purpose of this report, refers to that section of UK productivity which generates the emissions classified as Business emissions by DEFRA. Under the National Communication format (of reporting progress towards Kyoto targets to the UN) this sector includes the classifications: Business, Industrial process and Waste management. This sector does not include energy supply or agriculture.

The most significant greenhouse gases (GHG) emitted from the sector are CO_2 (from all sub-sectors), CH_4 (primarily from Waste management – landfill in particular) and N_20 (from industrial process); industrial processes also generate the majority of the UK's HFCs, PFCs and SF_6 emissions. Due to the wide range of GHGs emitted from this sector it is felt that the most useful measure of emissions is total emissions of the six basket GHGs in MtC_e (Mega tonnes carbon equivalent), CO_2 emissions shall be discussed only briefly on an individual basis.

3.2.1 Problems encountered auditing this sector

These problems can be separated into four categories: first – data, second – allocation of cuts to policies, third – classifying government policies as carbon increasing, and fourth – independently verifying claimed carbon savings from specific policies.

It was difficult, initially, to find data comparable to that used by DEFRA. ONS Environmental accounts (ONS 2006a) maintain a comprehensive record of UK emissions and the period 1990 – 2004 is available online in great detail (ONS 2006b), however, these are not the figures which DEFRA use. It transpires that ONS calculate emissions on a per capita basis (they subtract emissions for all foreign nationals residing in the UK and add emissions for all UK nationals residing overseas (see ONS, 2006b)), where as DEFRA calculate emissions on a territorial basis. So it is vital to use the correct format of UK emission figures (in this case those compiled by Netcen and NAEI for DEFRA – see below).

Certain policies operate across a number of UK sectors: for instance Building regulations, which affect both domestic and commercial property; and EU Emission Trading Scheme (EU ETS) which covers both the energy supply and business sectors. In these instances it was often difficult to decide on which proportions of the stated carbon cuts to allocate to which sector. Specific instances are discussed in more detail later.

Perhaps most difficult was the subject of government policies which had the effect of increasing carbon. Fundamentally, any policy which has the effect, or intention, of increasing output whilst failing to increase energy efficiency by a greater amount (in terms of total carbon produced or saved) can be described as a carbon increasing policy. As environmental protection and economic stimulating policies tend to have different origins, any policy which has the intention of stimulating growth would generally be termed as a carbon increasing policy. An analysis of the UK Government's economic policy is beyond the scope of this report, and as such will not be considered in detail. However, consideration shall be given to economic growth as a potential source of increased carbon.

The UK Government, normally, details the predicted or planned cuts in carbon emissions from specific policies. However, there are very few circumstances where these claims have been independently verified. Also, as these policies have been in operation for a short period of time there is insufficient data available to perform a suitably robust study into historical policy effectiveness. In consequence government figures, pertaining to carbon savings have been used (though questioned as to their veracity, and whether or not they are unduly optimistic) and it has been difficult (with two notable exceptions to be discussed later) to verify the effectiveness of existing policies.

3.3 Summary of UK Business sector emissions 1990 – 2004.

The following is based on the UK's National Atmospheric Emission Inventory (NAEI – see www.naei.co.uk/reports.php document AEAT/ENV/R/2318 - Baggott *et al*., 2006). This data was used by DEFRA in the document 'Climate Change: The UK Programme 2006' (CCUKP06).

Unless otherwise stated all figures quoted refer to Mega tonnes Carbon Equivalent (MtC_e).

CH_4, N_20, HFC, PFC and SF_6 emissions are converted to CO_2 equivalent by multiplying by their Global Warming Potential (GWP), mass CO_2 is converted to mass C by dividing by 3.67 (a function of the ratio of the atomic mass of C to CO_2 – 12:44). This method is consistent with that used by DEFRA, NAEI and ONS (see Baggott *et al*., 2006; DEFRA 2006a, b; ONS, 2006a, b).

3.3.1 Composition of Business

UK emissions are divided into ten different NC formats: agriculture, business, energy supply, exports, industrial process, land use change, public, residential, transport and waste management. The business sector, as reported by DEFRA, has three sub-components: NC business, NC industrial process and NC waste management. According to NAEI figures, exports produce zero emissions (at least in terms of UN framework reporting protocol).

Figures produced using NAEI data are greater than those presented by DEFRA in CCUKP06.

	1990	**1995**	**2000**	**2004**
NAEI	60.7	53.6	45.1	40.7
DEFRA	57.5	52.5	43.8	38.7
Difference	3.2	1.1	1.3	1.0

Table 3.1: Difference between DEFRA and NAEI total carbon emissions for the UK 1990 - 2004

DEFRA have been contacted in an attempt to reconcile this difference, as of 19/02/07, the UCL Environment Institute has not received an answer. It is possible that the figures obtained from NAEI are a later revision than those used by DEFRA in the production of CCUKP06. All the other sectors listed by DEFRA are reconciled with the NAEI figures, and the omission of any further data from the Business sector would lead to a gross underestimate of reported emissions.
Throughout this report a distinction is drawn between 'UK Business sector' [the business sector of emissions as defined by DEFRA] and 'NC Business' [the business sector of emissions as defined by NC format in NAEI figures].

3.3.2 Analysis of UK Business sector

Figures presented by DEFRA in CCUKP06 show a reduction in business sector's carbon emissions (from the six basket Greenhouse Gases (GHG)) of 32.7% between 1990 and 2004 (57.5 to 38.7 MtC_e), NAEI figures (see table 2) show a reduction of 33.6% (60.7 to 40.7 MtC_e) for the same period.

All further figures quoted refer to NAEI figures, as these contain the sub-component breakdown by source emission.

As MtCE:	**1990**	**1995**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
NC Business	30.4	27.6	29.0	29.3	29.3	29.3	29.4	31.0	29.6
Industrial Process	15.9	13.2	12.7	7.3	6.7	6.0	4.9	5.2	5.1
Waste Management	14.4	12.8	10.6	9.7	9.1	8.0	7.4	6.5	6.1
UK Business sector Total	**60.7**	**53.5**	**52.4**	**46.4**	**45.1**	**43.3**	**41.7**	**42.7**	**40.7**
As percentage of total:									
NC Business	50.0	51.5	55.4	63.2	64.9	67.7	70.5	72.6	72.6
Industrial Process	26.2	24.6	24.3	15.8	14.9	13.8	11.9	12.1	12.4
Waste Management	23.7	23.9	20.3	20.9	20.2	18.5	17.7	15.3	15.0

Table 3.2: UK Business sector carbon emissions with NC format contributions expressed as MtC_e and percentage.

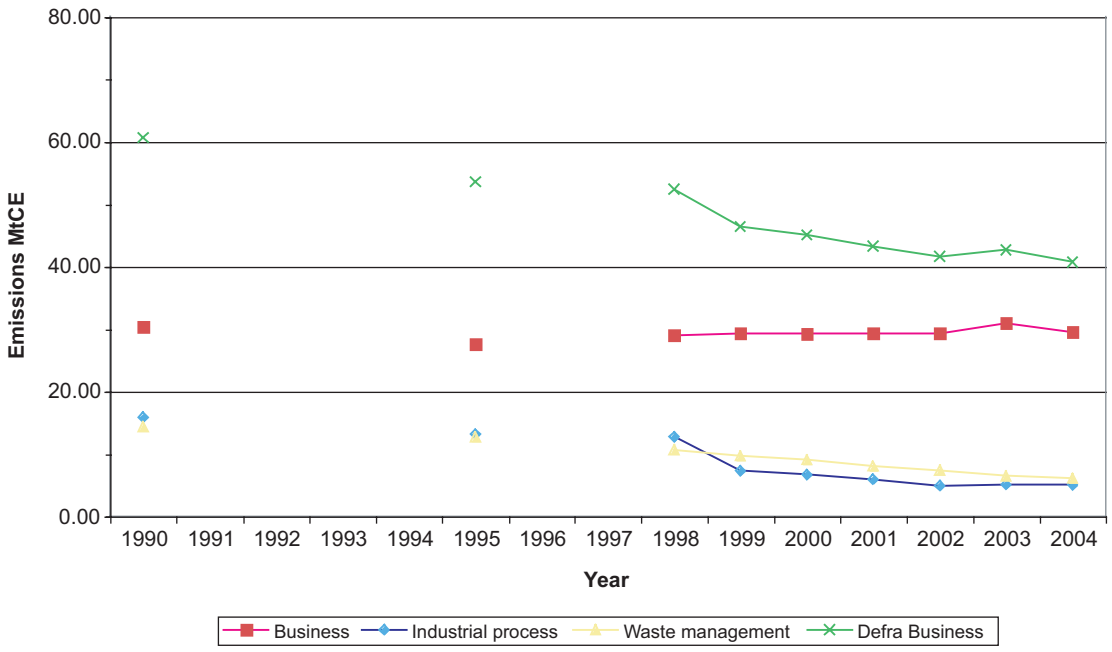

Figure 3.1: Carbon emissions from the UK Business sector 1990 – 2004.

Figure 3.1 shows a decline in emissions of carbon between 1990 and 2004 for the UK Business sector. The greatest decline is in Industrial process and Waste management. NC Business is largely unchanged.

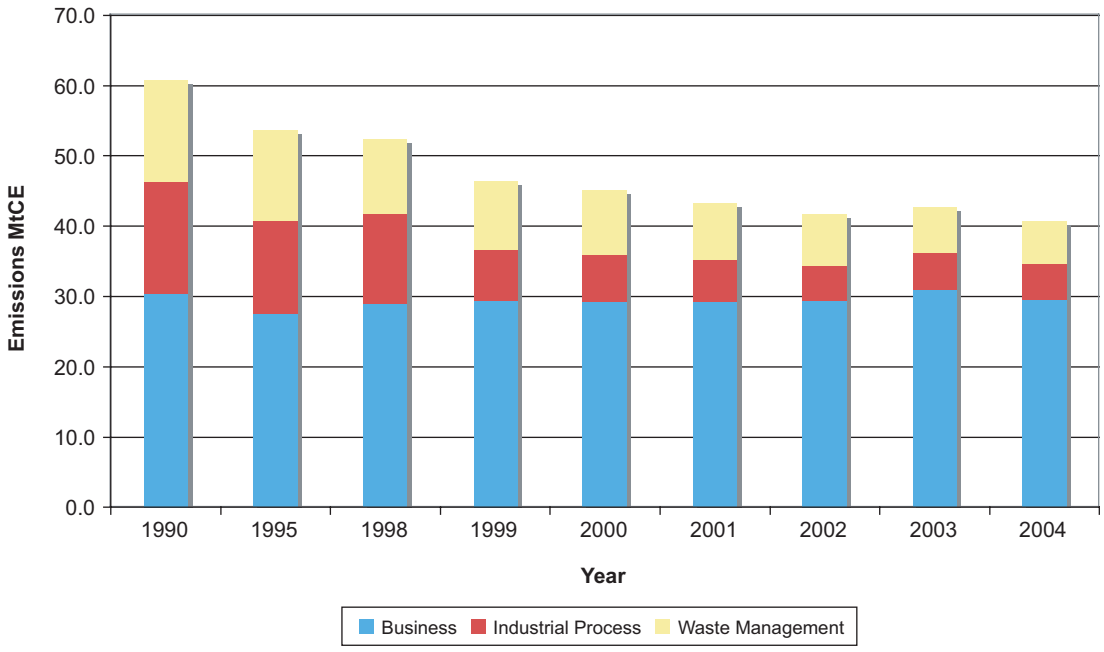

Figure 3.2: UK carbon emissions from UK Business sector sub-components 1990 – 2004.

Figure 3.2 shows, clearly, that the overall reduction in UK Business sector is a result of declines in emissions from Waste management and Industrial process sources. Between 1990 and 2004 NC Business remains stable around the 30 MtC_e level.

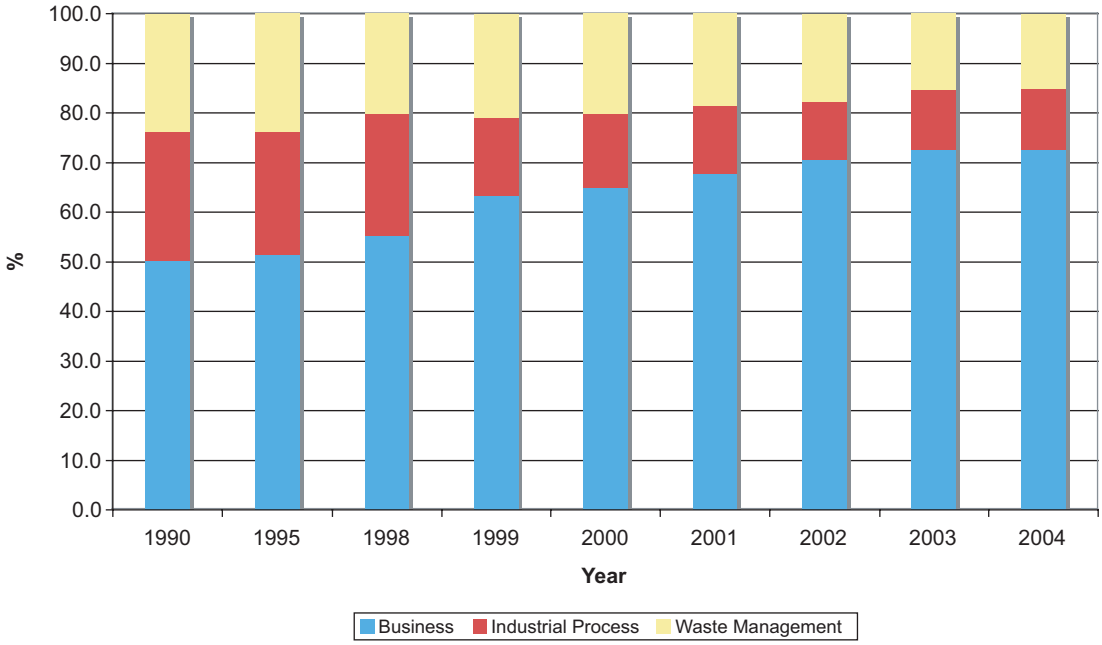

Figure 3.3: Carbon emissions from UK Business sub-components expressed as a percentage of total sector emissions.

Figure 3.3 shows, inline with emissions Mega tonnage, that the proportion of UK Business sector carbon emissions from Waste management and Industrial process drops very significantly. As shown in Table 3.2, in 1990 emissions were 23.7 and 26.2% for Waste management and Industrial process respectively, in 2004 the percentages were 15.0 and 12.4%. Over the same period the proportion of emissions sourced from NC Business rose from 50.0 to 72.6%.

Rate of emission changes (see Figure 3.4) show a steady rate between 1991 and 1998 (based on the three years for which data is available – 1990, 1995 and 1998). Though waste management increases from a 1.9% annual reduction (between 1991 – 1995) to a 5.6% annual reduction between 1995 and 1998. The peak rates are between 1999 and 2002, when reductions for DEFRA Business as a whole pass 10% annual reductions on two occasions. In 2003 and 2004, though Waste management continues to decrease, the reduction in the UK Business as a whole slows, 2003 shows a 2.4% increase in carbon emissions, whereas 2004 shows a reduction of 4.6%. In 2003 Industrial process and NC Business increase their carbon emissions. Table 3.3 summarises these changes.

	1990	1995	1998	1999	2000	2001	2002	2003	2004
NC Business	-	-1.53	1.73	1.08	-0.14	0.07	0.19	5.54	-4.62
Industrial process	-	-2.86	-1.12	-42.29	-8.75	-11.20	-16.92	4.18	-1.88
Waste management	-	-1.87	-5.60	-8.72	-6.13	-12.00	-8.29	-11.40	-6.43
UK Business sector	-	-3.50	-0.72	-11.45	-2.76	-4.05	-3.73	2.39	-4.56

Table 3.3: Percentage change in UK Business sector and sub-components 1990 – 2004 (Note that values recorded in 1995 and 1998 reflect changes over multiple years).

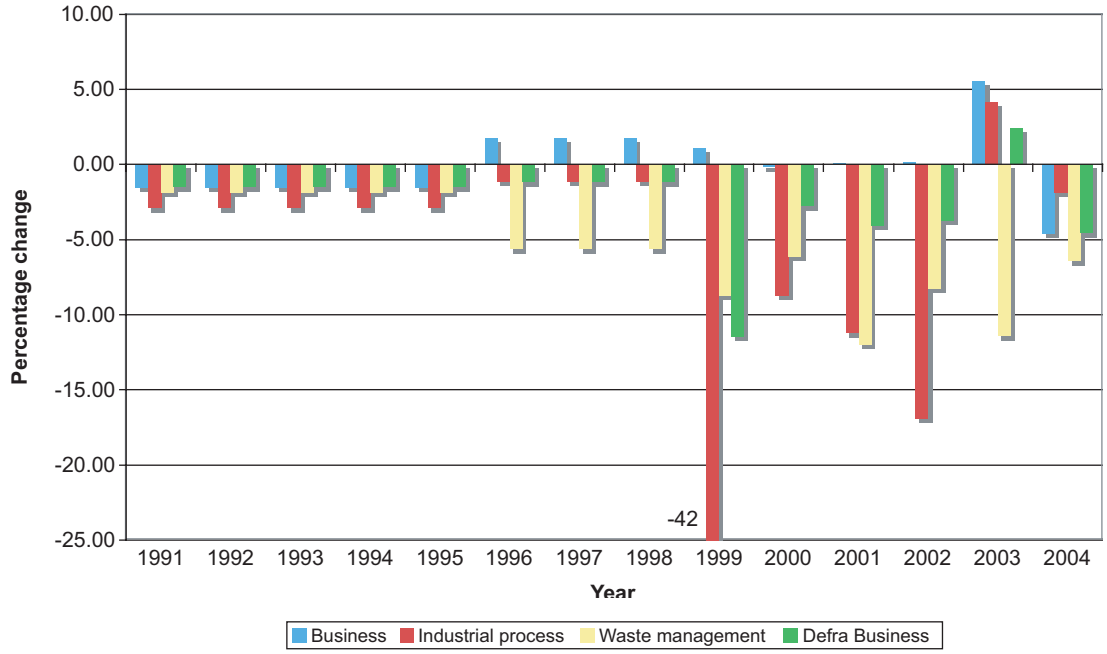

Figure 3.4: Rate of UK Business and sub-components carbon emissions changes 1991 – 2004.

3.3.3 Analysis of NC Business sub-sector

As Figures 3.5 and 3.6 demonstrate this sub-sector is subject to very little change between 1990 and 2004. The dominant carbon sources are Industrial and commercial combustion, Iron and Steel – combustion plant, Auto-generators and industrial off-road machinery.

In terms of proportional changes Industrial combustion reduces slightly, whereas (the NAEI amalgamated category) of Miscellaneous industrial/commercial combustion, and autogenerators increase slightly.

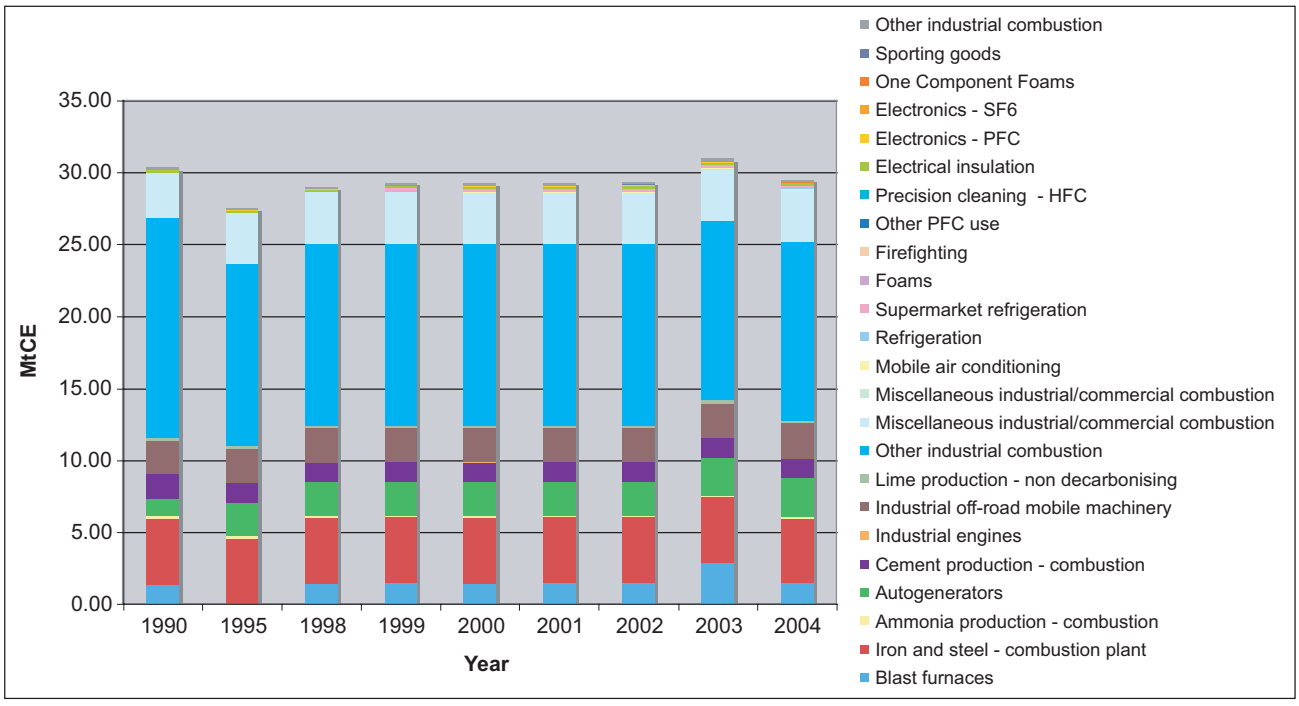

Figure 3.5: NC Business carbon emissions by source 1990 – 2004.

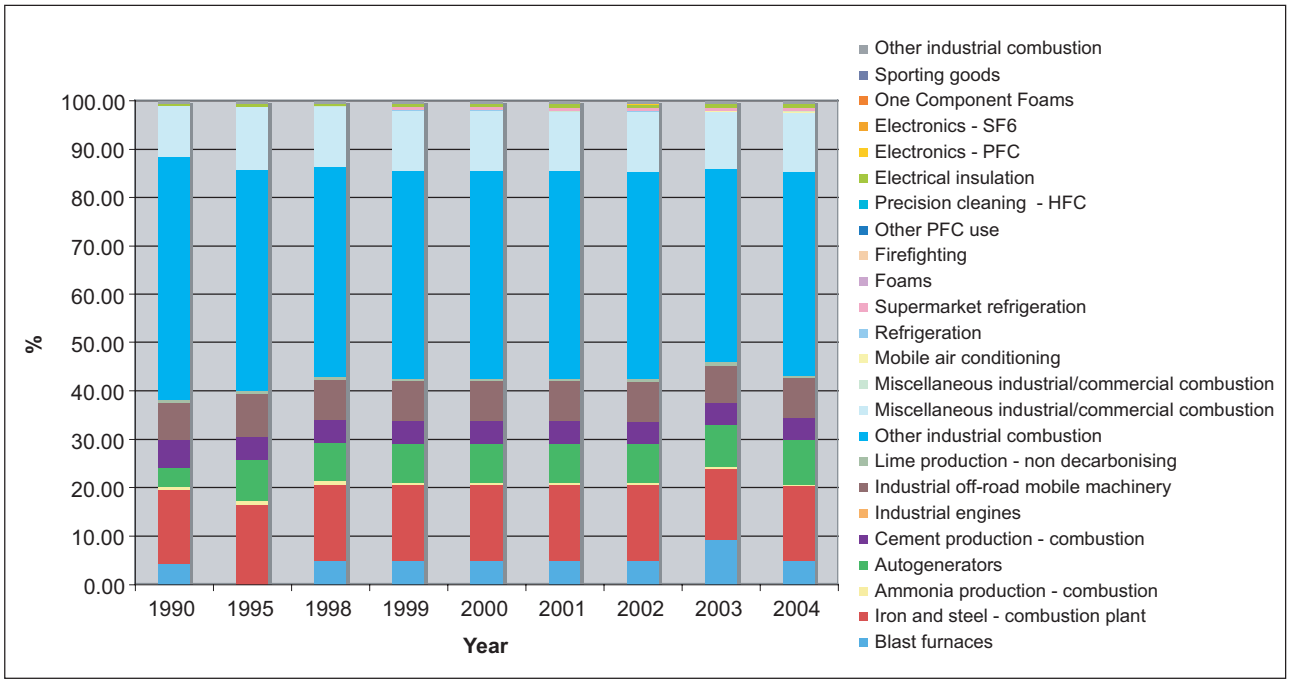

Figure 3.6: NC Business carbon emissions by source expressed as a percentage of sector total.

3.3.4 Analysis of NC Industrial process sub-sector

Figure 3.7 demonstrates a large reduction in carbon emissions from the Industrial process sub-sector. Emissions decline from 15.9 MtC_e in 1990 to 5.1 MtC_e in 2004. The most significant reductions occur in Halocarbon production (3.1 – 0.1 MtC_e) and Adipic Acid production (6.9 – 0.3 MtC_e) over the period.

Changes in the proportions of carbon emissions occur largely due to the reduction in these two components. Whilst carbon (equivalent) emissions from adipic acid production fall from 43.1% of the total in 1990 to 2.45% in 1999, emissions from nitric acid production increase from 7.1% to 18.4%. Between 1990 and 2004 cement decarbonising increases its emissions from 11.4% to 29.4% of the Industrial process total.

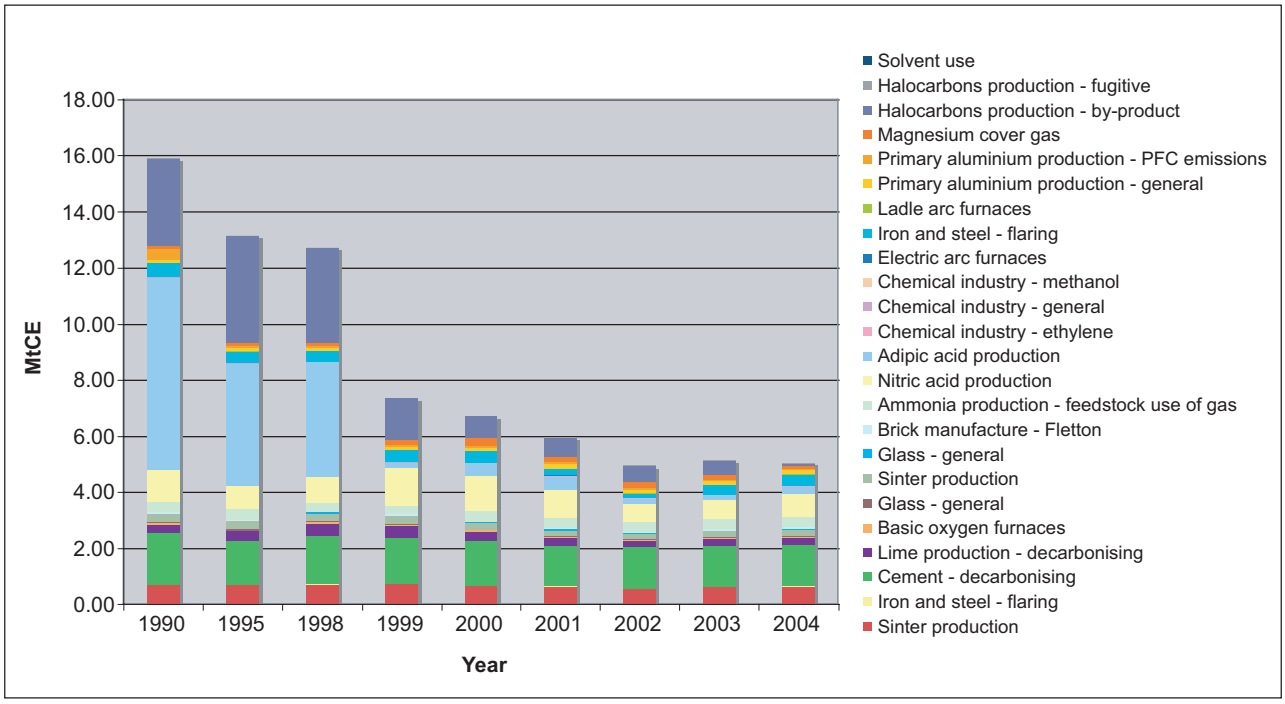

Figure 3.7: NC Industrial process carbon emissions by source 1990 - 2004

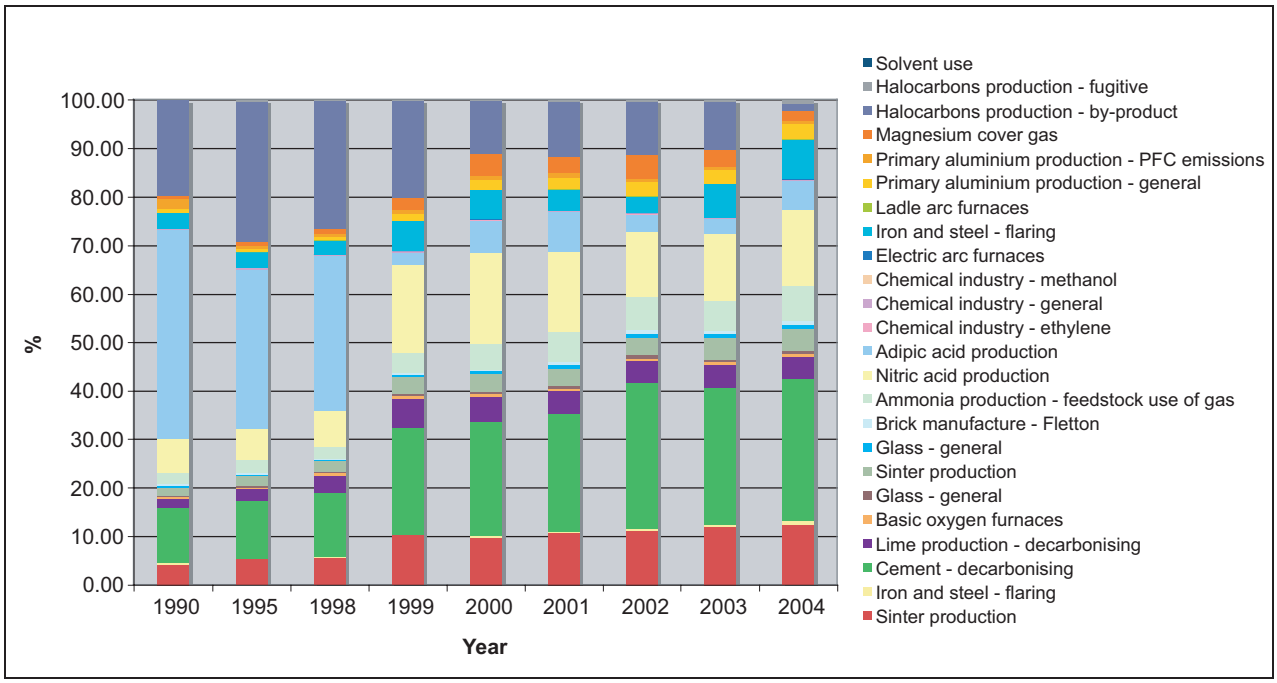

Figure 3.8: NC Industrial process carbon emissions by source expressed as a percentage of sector total.

3.3.5 Analysis of NC Waste management sub-sector

The Waste management sub-sector is dominated by Landfill. Between 1990 and 2004 the carbon (equivalent) emissions for NC Waste management as a whole reduce from 14.4 to 6.1 MtC_e, over the same period carbon equivalent (primarily methane) emissions from Landfill sources are reduced from 13.5 to 5.4 MtC_e.

Proportions remain largely unchanged: there is a slight increase in the proportion of emissions from Sewage sludge decomposition (3.3% in 1990 to 8.9% in 2004), though MtC_e emissions do not change visibly with one decimal.

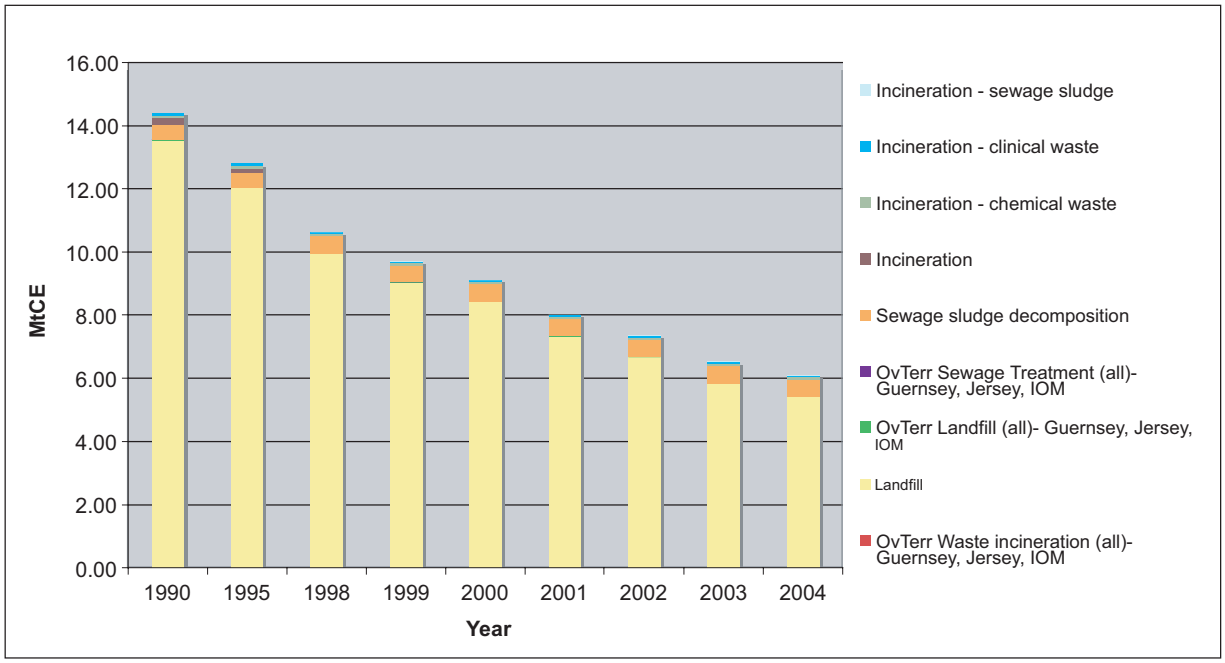

Figure 3.9: NC Waste management carbon emissions by source 1990 – 2004

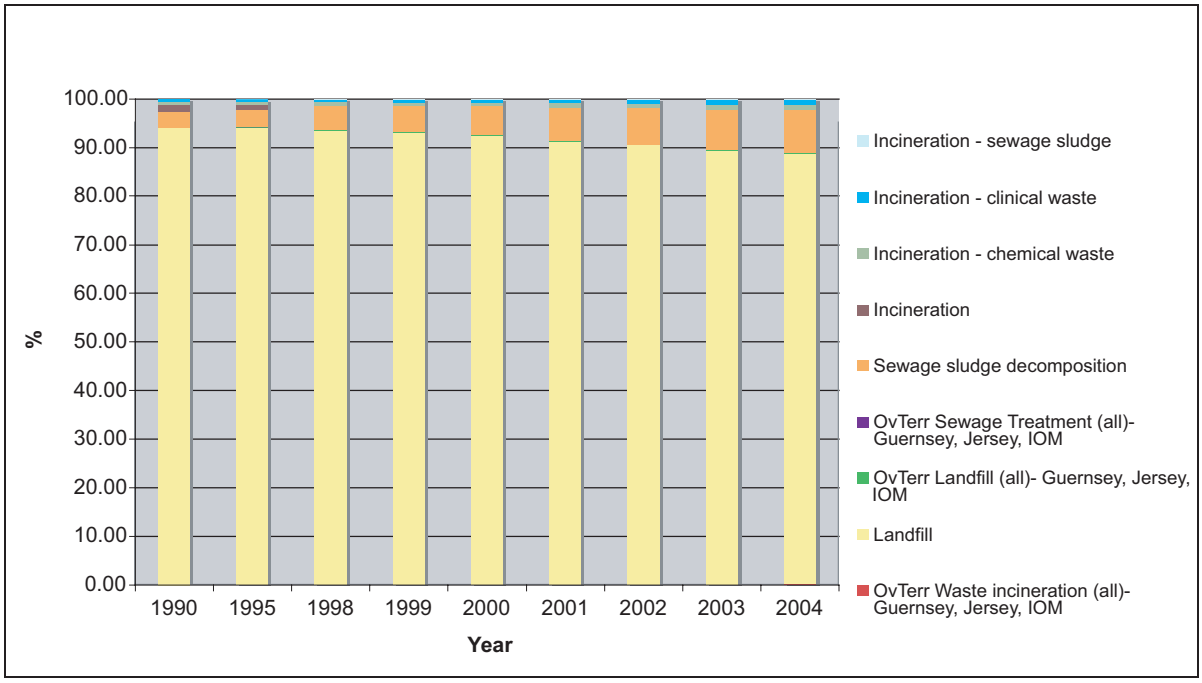

Figure 3.10: NC Waste management carbon emissions by source expressed as a percentage of sector total.

3.3.6 Energy efficiency?

Energy efficiency is discussed in detail by the DTI, who consider industry rather than the NC format categories of Business and Industrial process. As such, this discussion of efficiency does not deal specifically with these NC formats.

According to the DTI (2005) between 1970 and 2004 industrial energy consumption declined by 45%, over the same period output (adjusted for inflation) rose by 49%. Therefore, since 1970 energy consumption per unit output has declined by 63%. The Royal Commission on Environmental Pollution (RCEP, 2000) note that between 1960 and 1998 the UK energy intensity declined from 0.72 W/£ GDP to 0.40 W/£ GDP.

There has been some debate as to the reason behind this change: is it a collapse in energy intensive industries or an overall increase in energy efficiency? RCEP (2000) state that the DTI estimated that 1/12th of the reduction in the UK's overall energy intensity between 1973 and 1995 was due to structural change in the economy.

The industrial sector is heterogeneous in its rates of growth and contraction. Between 1970 and 1996 Iron and Steel output declined, but other energy intensive sectors have grown: e.g. chemicals, where the 2003 output was 108% greater than in 1980 (DTI, 2005). Fuel switching is also believed to have played a significant role.

	1970	**1990**	**1995**	**2000**	**2005**
Coal	12681	4172	2840	1228	1188
Natural Gas	1788	12889	12680	15773	12790
Electricity	6275	8655	8654	9812	10217
Petroleum	28397	8242	7066	5887	7065
Total	**62333**	**38660**	**36276**	**35200**	**33095**
% of total	**1970**	**1990**	**1995**	**2000**	**2005**
Coal	20.3	10.8	7.8	3.5	3.6
Natural Gas	2.9	33.3	35.0	44.8	38.6
Electricity	10.1	22.4	23.9	27.9	30.9
Petroleum	45.6	21.3	19.5	16.7	21.3

(DUKES, 2006)

Table 3.4: Primary energy consumption by fuel type for UK industrial sector, 1970 – 2005. Units – Kt Oil equivalent.

Between 1970 and 2005 the industrial sector's energy sources have changed markedly (see Table 3.4 and DUKES, 2006). In 1970 Coal and Petroleum accounted for 65.9% of the sectors demand, by 2005 this had declined to 24.9%. Conversely, the proportion of energy being supplied by natural gas and electricity has risen from 13% in 1970 to 59.5% in 2005 (DUKES, 2006).

Referring back to the NC format categories between 1990 and 2004 GHG, emissions from Industrial process declined by 68.9%, as measured by emission source. End user emissions, a method where emissions from energy supply are allocated to the end user, saw a decline of 67.9%, 1% less than by source emission. Over this period emissions from energy supply declined by 17.5% (74.4 – 61.4 MtC_e).

This period has also seen a large gain in efficiency per unit output. However, due to economic growth (the UK's real GDP rose by 147% between 1965 and 1998 (RCEP, 2000)) this efficiency has not led to a cut in GHG emissions.

3.4 UK government carbon reducing policies affecting the Business sector

This document covers those policies introduced by the incumbent Labour government elected during 1997. Policies introduced by previous governments will not be discussed here.
Prior to the 2000 Climate Change Programme (DEFRA, 2000), there are few carbon reducing policies, which directly affect the Business sector, implemented by the current government.

The Royal Commission on Environmental Pollution, in their 22nd Report (2000), outline the following measures:

1. VAT on fuel and insulation (Treasury, Customs and Excise).
2. Climate Change Levy (Treasury, Customs and Excise).
3. Building Control (under building regulations).
4. Market Transformation Programme.
5. Energy Efficiency Best Practice Programme (EEBP).
6. Integrated Pollution Prevention and control (IPPC).

1-5 affects all business, 6 affects manufacturing – according to RCEP.

Of these policies discussed only the Climate Change Levy was introduced by the current UK government.

3.4.1 Measures outlined in Climate Change the UK Programme: 2000

Climate Change Levy (CCL), introduced in 2001.
Tax on energy usage for Commerce, industry and services.

Climate change agreements (CCA), introduced 2001.
80% discount from levy for sectors that agree to meet challenging targets for improving energy efficiency or reducing GHG emissions.

DEFRA allocate an annual reduction in emissions of 2.9 MtC by 2010 (DEFRA, 2006a).

Carbon Trust., estabilshed April 2001.
Government funded company encouraging energy efficiency and emissions reduction.

DEFRA allocate an annual reduction in emissions of 1.1 MtC by 2010 (DEFRA, 2006a).

EU emissions trading scheme, established 2003.
Although not a UK government policy, the EU emissions trading scheme has now been incorporated into UK government policy. This scheme covers 1000 UK installations, which are responsible for 50% of the UK's CO_2 emissions.

Reductions in carbon allowances (in the UK) are to be bourne entirely by the electricity supply industry (see DEFRA, 2006a, b). As such they have been allocated to the Energy supply sector rather than to business.

UK emissions trading scheme, introduced April 2002.
A voluntary scheme, with 33 direct participants with annual cumulative green house gas emission reduction targets based on 1998 – 2000 baseline. These participants committed to a reduction of 1.08 MtC by 2006. According to DEFRA actual reductions have reached 1.6 MtC.

DEFRA allocate an annual reduction in emissions of 0.3 MtC by 2010 (DEFRA, 2006a).

Energy Efficiency Loan Scheme. 2002.
From Carbon Trust, a pilot loan scheme for small and medium sized businesses.

Building regulations 2002, 2005.
Tightening part L of the building regulations of England and Wales. Changes covering new boilers and windows (DTI, 2006a).

DEFRA allocate an annual reduction in emissions of 0.4 MtC and 0.2 MtC by 2010 for the 2002 and 2005 updates respectively (DEFRA, 2006a).

3.4.2 Additional measures outlined in Climate Change the UK Programme: 2006

Carbon Trust support for investment in energy efficiency in SMEs
Building on the earlier pilot scheme, loans for small and medium sized companies to invest in energy efficiency.

DEFRA predict an annual reduction in emissions of 0.1 MtC by 2010 (DEFRA, 2006a).

Measures to encourage or assist SMEs to take up energy saving opportunities
These are measures to assist the uptake of the energy efficiency loans.

DEFRA predict an annual reduction in emissions of 0.1 MtC by 2010 (DEFRA, 2006a).

3.4.3 DTI Energy Review: 2006

Focus on large, non-energy intensive users or energy in the commercial and public sectors.
Development of strong new policy instruments to focus on non-energy intensive industry. Measures to increase energy efficiency are not currently being exploited: the objective of this policy is to readdress this.

DEFRA has two policies under consultation: the Energy Performance Commitment (EPC) – a mandatory cap-and-trade proposal covering energy use from organisations with annual consumption >3000 MWh (or bills > £250,000 pa), and Voluntary Benchmarking and Reporting – focusing the attention of participating organisations on their energy use (DEFRA, 2006c).

Cost effectively save 0.5 MtC by 2015 and 1.2 MtC per year by 2020.

Policy	Status	Predicted savings 2010 (MtC)	Predicted savings 2020 (MtC)*	Likelihood of success
Climate change levy	Implemented	3.7	*3.7*	Possible
Climate change agreements	Implemented	2.9	*2.9*	Yes
Carbon trust	Implemented	1.1	*1.1*	Possible
UK Emissions trading scheme	Implemented	0.3	*0.3*	Possible
EU Emissions trading scheme	Implemented	-	-	-
Building regulations 2002	Implemented	0.4	*0.4*	Possible
Building regulations 2005	Implemented	0.2	*0.2*	Possible
Carbon trust support for investment in energy efficiency	Adopted	0.1	0.1	Yes
Measures to assist uptake of energy efficiency measures	Planned	0.1	0.2	Yes
Increase energy efficiency in large non-intensive energy users	Planned	-	1.2	Possible
Total:	**-**	**8.8**	**10.1**	

(*Predictions for 2020 only available for: Measures to assist uptake of energy efficiency measures andncrease energy efficiency in large non-intensive energy users.
With these two exceptions 2020 predictions are duplicates of stated 2010 predictions.)

Table 3.5: Summary of policies and predicted cuts in carbon

3.5 UK Business sector emissions projections and effectiveness of policies

3.5.1 UK Business sector emissions

Figure 3.11 shows projected emissions from the UK Business sector. Projections with pre-2006 policies are taken directly from DEFRA figures (DEFRA, 2006a,b). Projections including 2006 policies are adjusted using figures from both DEFRA and the DTI regarding the likely effectiveness of policies announced in 2006.

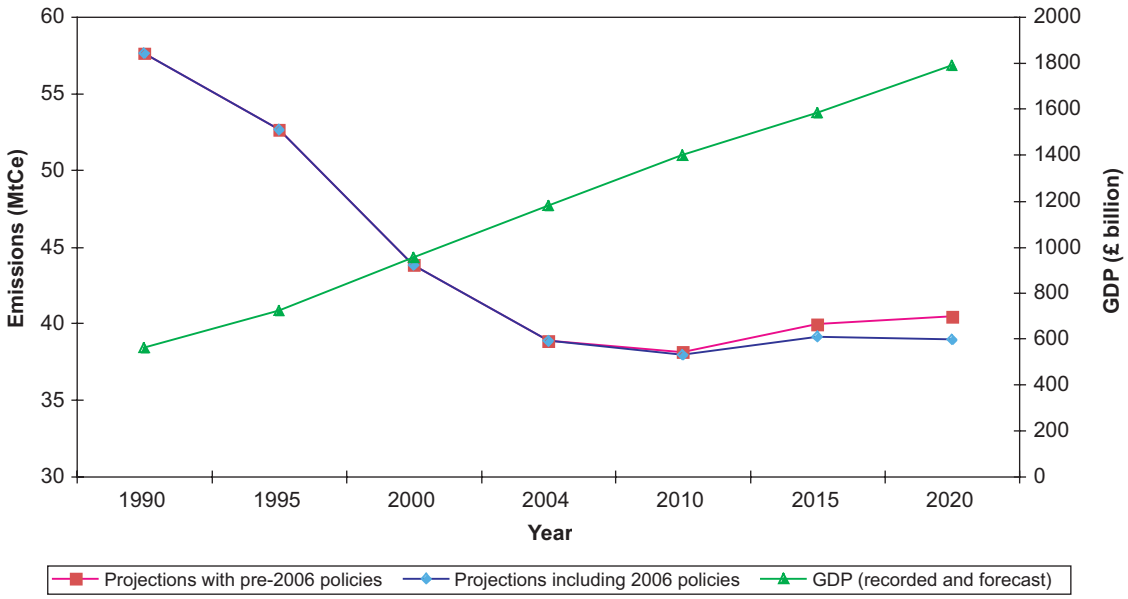

Figure 3.11: Projected carbon emissions from the UK Business sector, 1990 – 2020. Projections are shown with pre-2006 policies and with 2006 policies. (DEFRA, 2006a,b; ONS, 2006b)

These projected emissions are produced using a number of assumptions, perhaps the most pertinent of which is that for economic growth. Growth for 2006 is assumed to be 2.25%, for 2007 and 2008 3%, and for 2009 – 2020 2.5% (see DEFRA, 2006b). A change in this growth rate could lead to a substantial change in resultant emissions. Table 3.5 displays this in numerical form. Baseline projections put the UK business sector emissions in 2020 29.9% below 1990 levels, though 4.1% higher than those recorded in 2004. Taking the 2006 policies into account (and the predicted cuts in carbon emissions attributed to them by DEFRA at face value) 2020 emissions fall to 32.5% below 1990 levels, although are still greater than 2004 emissions, (0.3% higher). 1.2 MtC_e of the 2006 policy-induced-cut is a result of increased energy savings in non-energy-intensive industry. As yet the government does not have any specific measures by which to achieve this cut (DTI, 2006a).

Baseline with pre-2006 policies	1990	1995	2000	2004	2010	2015	2020
NC Business	30.4	29.4	30.3	29.2	28.5	30.4	31.0
Industrial process	15.9	13.2	6.7	5.1	5.4	5.6	5.8
Waste Management	11.3	10	6.8	4.5	4.2	3.9	3.6
Total	**57.6**	**52.6**	**43.8**	**38.8**	**38.1**	**39.9**	**40.4**
% change from previous		-8.7	-16.7	-11.4	-1.8	4.7	1.3
% change from 2004					-1.8		4.1
% change from 1990				-32.6	-33.9		-29.9
With additional policies from 2006							
	1990	**1995**	**2000**	**2004**	**2010**	**2015**	**2020**
NC Business	30.4	29.4	30.3	29.2	28.3	29.6	29.5
Industrial process	15.9	13.2	6.7	5.1	5.4	5.6	5.8
Waste Management	11.3	10	6.8	4.5	4.2	3.9	3.6
Total	**57.6**	**52.6**	**43.8**	**38.8**	**37.9**	**39.1**	**38.9**
% change from previous		-8.7	-16.7	-11.4	-2.3	3.2	-0.5
% change from 2004					-2.3		0.3
% change from 1990				-32.6	-34.2		-32.5

(Projection figures from DEFRA (2006a), additional policies from DEFRA (2006a) and DTI (2006a)).

Table 3.6: Projected carbon emissions from the UK Business sector, 1990 – 2020.
The difference in MtC emissions in 2020 between projections without 2006 policies and with these policies is 1.5 MtC/yr or 3.7%.

3.5.2 Effectiveness of UK government policies in reducing emissions from UK business sector

Using figures from Baggott *et al*. (2006 – see NAEI) the total reduction in GHG emissions from the UK Business sector stands at 20 MtC_e (60.7 in 1990, 40.7 in 2004), 88.5% (or 17.7 MtC_e) can be attributed to three actions. First, the introduction of abatement technology to the production of adipic acid in 1998 (see DEFRA, 2006b), which has lead to a 6.6 MtC_e cut of N_20 (33% of the total MtC_e reduction in the UK Business sector's GHG emissions). Second, a reduction in halocarbon production: from 3.1 MtC_e in 1990, to 0.1 MtC_e in 2004 (15% of the total MtC_e reduction in the UK Business sector's GHG emissions). Finally, a massive reduction in CH_4 emissions from landfill: 13.5 MtC_e in 1990 to 5.4 MtC_e in 2004 (41% of the total MtC_e reduction in the UK Business sector's GHG emissions).

As such the impact of the remainder of the Government's policies has had the potential to influence only the remaining 2.3 MtC_e cut, or 11% of the overall sector's reductions. The Government has only been incumbent since 1997, a fact which should be taken into account when considering total reductions.

Between 1990 and 2004 emissions reported as NC Business fell from 30.4 MtC to 29.6 MtC: a reduction of 0.8 MtC, or 4% of the total UK Business sector's total emissions.

It is also interesting to consider specific emissions of CO_2, which for the UK Business sector as a whole have declined from 34.3 MtC in 1990 to 30.7 MtC in 2004 (DEFRA, 2006b). A reduction of 3.6 MtC, or 11.5% compared to 1990 levels. This compares to a reduction of 20 MtC_e for all GHG emissions, which equates to a cut of 32.9% from 1990 levels. Remaining non-CO_2 emissions amount to 10.0 MtC_e.

3.6 Conclusions

Future UK government policies attempting to reduce the carbon (or carbon equivalent) emission from the UK business sector must focus on the sub-category of NC Business. This sub-sector contributes 72.6% of the carbon equivalent GHG

emissions from the sector. Within this sub-category, the source defined as 'Other industrial combustion' (this includes heating of commercial properties – see Baggott *et al*., 2006) is the primary source.

Economic growth will add pressure to increase emissions as, indeed, is shown by the Government projections: with the sector's emissions forecast to grow between 2004 and 2020.

Policies such as the Climate Change Levy and Climate Change Agreements have potential to produce significant carbon savings. An increase in the rate of the CCL would have the potential to deliver more cuts in emissions (RCEP, 2000), the rate is due to increase inline with inflation from April 2007 (DEFRA, 2006b). The carbon trust also has the potential to deliver greater savings, especially in the commercial sector. The Energy Performance Commitment, currently under consultation at DEFRA, could, if implemented aggressively and extensively with mandatory requirements, also deliver substantial cuts in GHG emissions.

Recent announcements by two large UK retailers (Marks and Spencer and Tesco) show that the commercial sector is taking the carbon issue seriously, at least as a valuable marketing tool (see Guardian, 19/01/07), potential savings in emissions exist from commercial strategy as much as from government policy (which would need to have further mandatory components).

If the UK government directs it's policy in this area in such a way as to increase the commercial sense in combating carbon emissions it will stand a greater chance of success in reducing carbon emissions in the NC Business sub-category, something which, as yet it has failed to do to any great extent.

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Chapter 4: Transport sector

4.1 Summary

- The UK Government is committed to making cuts in carbon emissions of 60% below 1990 levels by 2050. In order to achieve this goal, interim policies to make significant reductions in GHG emissions by 2020 have to be set for the UK to make real progress towards the 2050 target. Despite the declining trend in overall carbon emissions, economic growth and prosperity have seen emissions from the transport sector rise by 9% from 29.9 MtC in 1990 to 32.6 MtC in 2004. The present forecast is for continued economic growth and a potential increase in carbon emissions from this sector of 14% by 2020.

- A combination of this economic growth and the failure of the Voluntary Agreement with European, Japanese and Korean motor manufacturers to deliver expected increases in fuel efficiency, and the assumption that these would be met when projecting future emissions, resulted in the original savings estimates of 6.6 – 8.1 MtC by 2010 being revised down to 5.1 MtC. The failure of the Government to increase vehicle excise duty sufficiently, so that it might act as a proper deterrent to purchasing the highest polluting vehicles, and the cessation of the fuel duty escalator have all contributed to the lower than expected emissions savings. Company car tax reforms are seen as having made a successful contribution to reducing carbon emissions. It is expected that the addition of two new measures, the Renewable Trade Fuel Obligation and an extension of the Voluntary Agreement will provide savings of 6.24 MtC by 2010 rising to 7.02 a decade later.

- New estimates of savings from the Voluntary Agreement in 2006 are more realistic however these are dependent upon the continued arrangement with motor manufacturers, and their ability to successfully reduce new car vehicle emissions. The potential savings from the Renewable Transport Fuel Obligation at a level of 5% by 2010 are also dependent upon meeting required targets. However, incentives exist in the form of a 20 pence/litre reduction in fuel duty, compared to diesel and petrol and a 15 pence/litre buy out price. An increase in the obligation to 10% would realistically require either, the cost effective development of second generation biofuels, or importing large amounts of biofuel (notably palm oil from SE Asia), threatening biodiversity and endangered habitats. Furthermore the release of carbon associated with land-use change, in particular deforestation, may negate any potential savings made in the UK.

- Although not included in the IPCC framework for emissions inventories, international aviation contributes around 20% of the total UK emissions and is expected to increase by 37% from 2010 – 2020. Efforts at reducing emissions are reliant upon fiscal measures such as air passenger duty, which at present does not provide a sufficient deterrent, or attempting

to include aviation emissions in the EU-ETS, which is potentially 6 years away.

- **Audit finds are:** GHG emissions from the transport sector are predict to rise by 2020 on a 1990 baseline, by +6.3 MtC (21%) not including international aviation. This assumes that current Government and EU policies produce a significant 7 MtCe saving. The DTI (2006a) Report suggests that there may be even more savings of up to 10.3 MtCe. A review of all these policies suggest that it is highly unlikely that these policies will be successful so emission from transport could rise by as much as +13 MtCe. Therefore the Audit range is +6 to +13 MtCe.

4.2 Introduction

In 2005 the transport sector (excluding international aviation and shipping) accounted for 35.1 MtC or 22.5% of all UK carbon emissions (by source), 93% of which was emitted on the roads (DTI, 2006c). In contrast to overall UK carbon emissions, those from this sector have increased on the back of economic growth and rising prosperity and the ensuing demand for transport fuel over other types of fuel (Figure 4.1). UKCCP06 (DEFRA, 2006a), states that carbon emissions from road transport totalled 32.6 MtC in 2004 compared with the 1990 baseline of 29.9 MtC in 1990. This represents a 9% increase.

The Government predicts that, despite an increasing trend in fuel efficiency, carbon emissions from the transport sector will continue to grow by a further 8% to the end of the decade and by 14% in 2020.

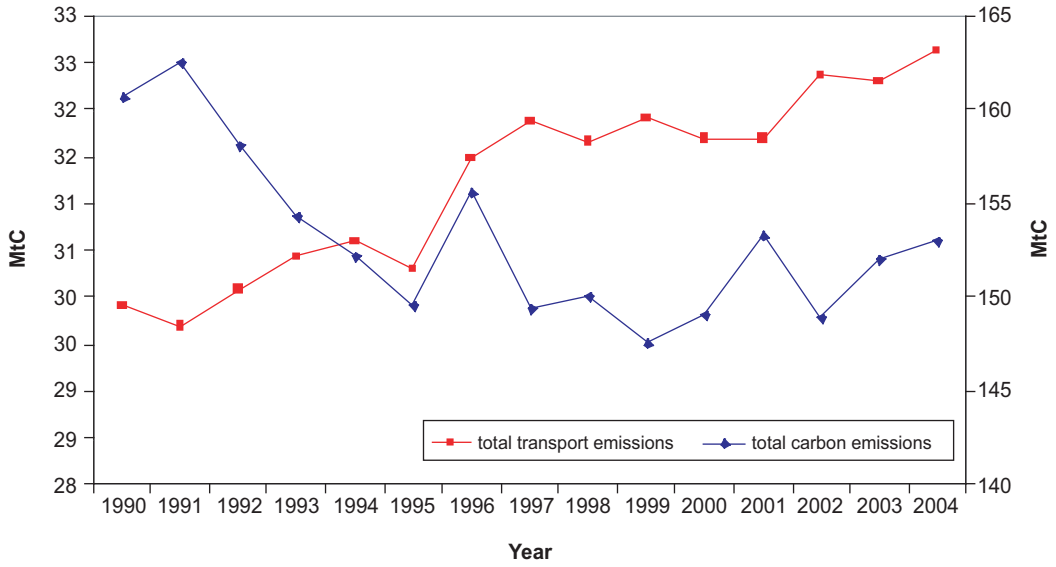

Figure 4.1: Carbon emissions (MtC) from the UK road transport sector and the UK as a whole from 1990 – 2004 (Source: http://www.DEFRA.gov.uk/environment/statistics/globatmos/gagccukmeas.htm).

The breakdown for carbon emissions by source in the entire transport sector is shown in Figure 4.2. International aviation and shipping are not included in any agreements on national emissions inventories due to perceived difficulties in how they may be properly allocated, however as Figure 4.2 shows, when included, international aviation accounts for around 20% of total carbon emissions from this sector.

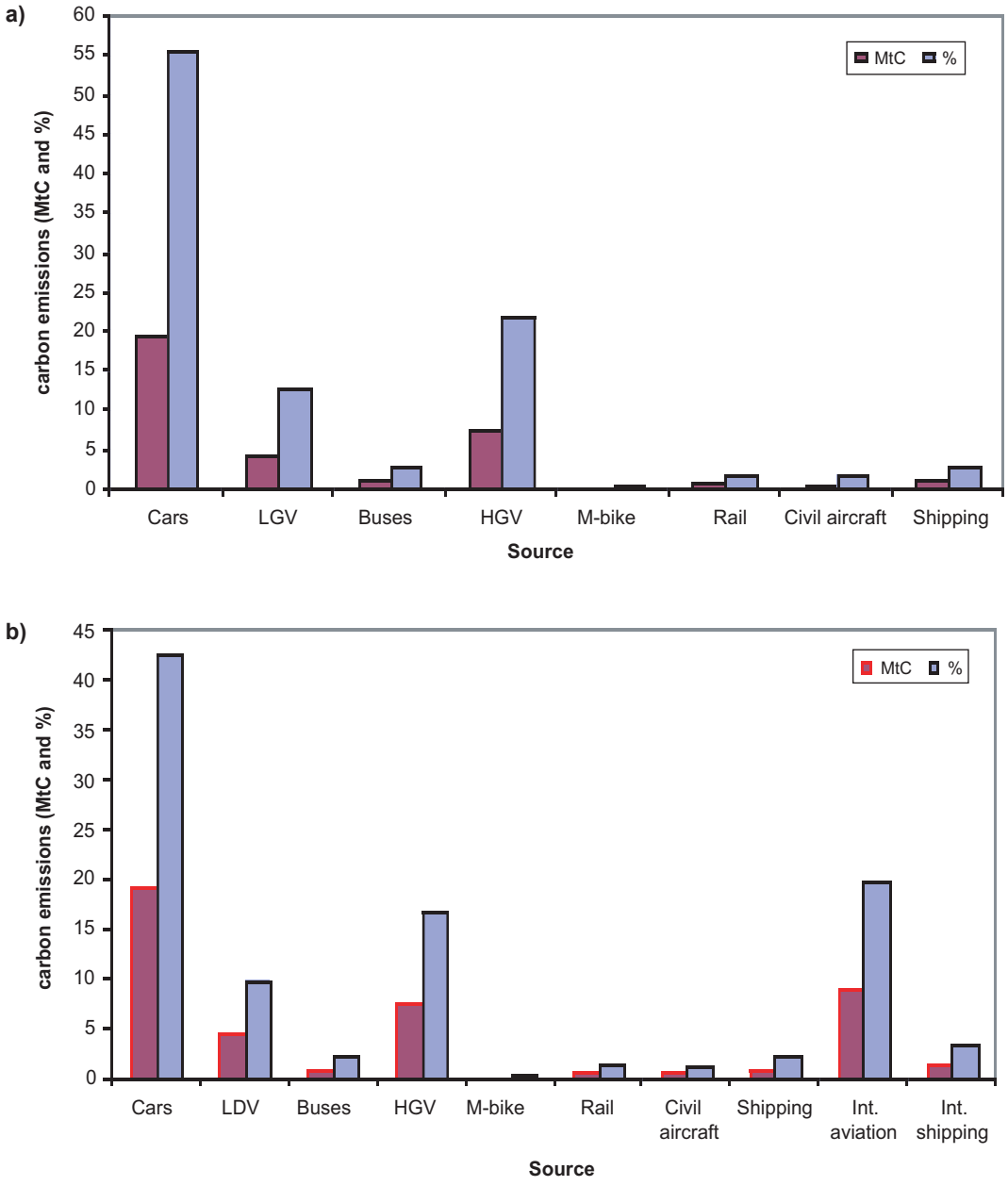

Figure 4.2: Carbon emissions by source category in 2004 (MtC and %), for a) the entire domestic transport sector and b) the transport sector as a whole when international aviation and shipping are included. (DfT 2006a).

4.3 Carbon reductions

The original measures undertaken by the UK Government, and outlined in the UK Climate Change Programme 2000 (DEFRA, 2000, hereafter UKCCP00), originally predicted savings of between 6.7 – 8.2 MtC by 2010. This was based on four policies:

1) The Voluntary Agreement (VA) Package between European, Japanese and Korean Motor Manufacturers; this aims to reduce the average carbon emissions of new cars (< 1 year old), from a baseline of 190 gC/km to 140 gC/km by 2008 for European manufacturers and 2009 for Japanese and Korean producers. UKCCP00 anticipated that the bulk of emissions savings from cars will be as a result of these agreements. This package also includes reforms to company car taxation (CCT) and vehicle excise duty (VED).
2) Transport measures outlined in the Ten Year Plan (DfT, 2000a) aimed at reforming the transport system. These were then built upon in The Future of Transport White Paper (DfT, 2004).
3) Sustainable distribution in Scotland.
4) The fuel duty escalator (now discontinued).

Original measures (2000 – present)	2010 (UKCCP00)	2010 (UKCCP06)	2015	2020
Voluntary Agreement package (VA)	4.0	2.3	3.13	3.58
Wider transport measures	1.6	0.8	0.8	0.8
Sustainable distribution (Scotland)	0.1	0.1	0.1	0.1
Fuel duty Escalator (1993 – 1999)	1 – 2.5	1.9	-	-
Total MtC (original measures UKCCP00)	**6.7 – 8.2**	**5.1**	-	-
Additional measures (UKCCP06)	-	-	-	-
Renewable Transport Fuel Obligation (RTFO)	-	1.0	1.0	1.0
Future VA	-	0.1	0.7	1.5
Total MtC (all measures)	**-**	**6.20**	**5.73**	**6.98**

Table 4.1: Estimated emission savings (MtC) as a result of policies implemented in UKCCP00 (DEFRA, 2000) and UKCCP06 (DEFRA, 2006a). The projected figures for 2015 and 2020 are from the UK Energy and Emissions Projections July 2006 (DTI, 2006d).

However, UKCCP06 revised emission savings down to 5.1 MtC by 2010. Consequently the Government has added potential emissions reductions from two new measures, the Renewable Transport Fuel Obligation (RTFO) and a successor to the present Voluntary Agreement with motor manufacturers (Table 4.1).

As a result of the addition of these two new measures, the latest predictions in UKCCP06 estimate emissions reductions of 6.20 MtC by 2010 (Table 4.1) consequently, even with their inclusion, emissions from road transport are still short of those originally predicted in UKCCP00 (6.7 – 8.2 MtC).

UKCCP00 estimated that carbon emissions form road transport would begin to rise, reaching 34.7 by 2005, by this time however, emissions were around 32.6 MtC (DTI, 2006c), 2.1 MtC lower than the original projections, and would appear to represent some form of success. Despite the overall increasing trend in transport emissions of carbon for the reasons already discussed, the Government does predict that the combination of the original measures and those outlined in UKCCP06 will result in reduced emissions from the estimated savings in UKCCP00 (Figure 4.3).

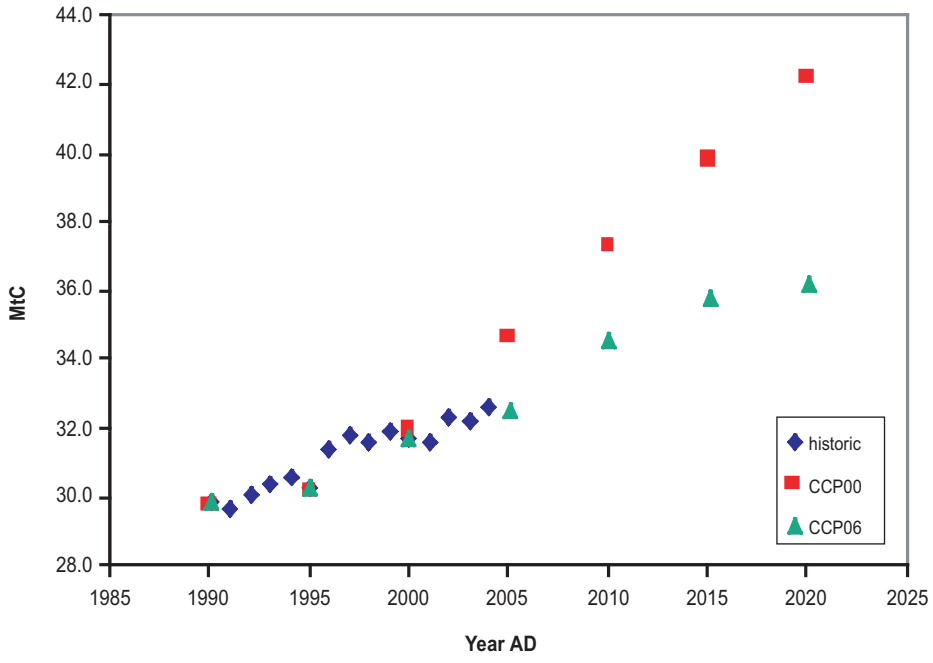

Figure 4.3: Road transport estimated carbon emissions by source, 1990 – 2020 (UKCCP00, UKCCP06) and historic values 1990 – 2004. (http://www.DEFRA.gov.uk/environment/statistics/globatmos/gagccukem.htm).

4.4 Major Policy Measures (UKCCP00/06)

Outlined below are the major policy measures that the Government has implemented or used in attempting to reduce carbon emissions from transport.

4.4.1 The Voluntary Agreement Package

i). Vehicle Emissions
The VA made between the EU and car manufacturers represents the cornerstone of the UK Government's attempts to reduce road transport emissions. However by 2006, the average emissions for new cars had fallen to just 167.2 gC/km, a fall of 1.3% compared with the previous year (Society of Motor Manufacturers and Traders, SMMT, http://www.smmt.co.uk/news/news.cfm?catid=550), while that of the entire UK car fleet in 2004 was 183.8 gC/km. Assuming that the annual average rate in the decline of emissions continues, 2008 is likely to see values of new cars in the UK in the region of 164 gC/km, with the target figure of 140 gC/km being met sometime around 2022, 14 years later than anticipated.

The recorded decline in emissions is not due to the technological prowess of the motor industry, but rather, according to SMMT (2006), the increased dieselisation of the UK car fleet, which in 2006 accounted for 38.3% of the new car market, (SMMT, http://www.smmt.co.uk/news/news.cfm?catid=550), an increase from 16.2% in 1997. The UK, however, lags behind much of Europe where diesels are more widely accepted, and where diesel penetration of the car market in 2005 averaged 50.6% and in some countries accounted for 60-70% of new cars sold (SMMT, 2006), despite the inherent problems of air quality in the form of NOx and particulate emissions. One reason for the slower uptake in the UK market is that fuel duty is the same as that for petrol (48.5p/l). In France and Germany diesel fuel prices may be between 20-40% cheaper than that of petrol thus providing a real incentive for their purchase. The House of Commons Environmental Audit Committee (2006b) found that the lack of incentives for purchasing a diesel needed to be addressed or at the very least explained, as the continued expansion into the UK market of diesel vehicles will be instrumental in reducing carbon emissions.

The original emissions projections from the transport sector in UKCCP00 were based on the assumption that new car average emissions would reach the 140 gC/km target set out in the VA. Their revision down from 4.0 MtC to 2.3 MtC in UKCCP06 assumes that the average carbon emissions from new cars will be 162 gC/km by 2008, with projections past that date being based on annual declines averaging 1.5%. Although this may still prove to be several a little too low, this does provide a much more realistic estimate of savings by 2010.

The assumptions that underpin the 2006 Energy Review (DTI, 2006a) estimate that by 2020 emissions from new vehicles will average 135 gC/km (DfT, 2006d) and that this may provide savings of between 1.84 and 2.05 MtC. However any forward projections beyond 2008 assume that a successor to the VA has been put in place and that the increase in fuel efficiency remains constant.

As this is currently the most effective method the Government has for reducing emissions in this sector, the assumption that it will be extended is probably a safe one, although in what form is difficult to predict. It is possible that this will move from a voluntary agreement to one in which mandatory targets for motor manufacturers are considered, especially in the light of recent announcements by the EU Environment Commissioner (http://news.bbc.co.uk/1/hi/business/6257327.stm?ls). However emission savings made are dependent upon increased fuel efficiency and thus far, the motor manufacturers have failed to meet any of the proposed targets.

ii) Company Car Tax (CCT)
The increased dieselisation of the UK fleet is particularly prominent in the new company car market which accounts for ca. 56% of the UK new car market as a whole (SMMT, 2006). CCT has been based on carbon emissions since April 2002 and is a policy which is actually seen to have produced positive results in the attempts to reduce overall carbon emissions. A report by Her Majesty's Revenue and Customs (HMRC, 2006), concluded that CCT reforms have, on their own, led to a third of the increase in diesel cars seen on the road since 2002. This has resulted in smaller and more efficient vehicles entering the UK company car fleet, where 37% of those purchased in 2005 had emissions < 140 gC/km, twice that of all new cars registered that year (SMMT, 2006). Despite the difficulty in disentangling the savings made by the individual components that make up the VA Package, HMRC (2006) estimate that by 2004, this CCT reform had led to a reduction in the average company car emissions of ca. 15 gC/kg more than would have been otherwise, and will contribute an estimated saving of between 0.35-0.65 MtC by 2010. They further estimate that future savings may result in emissions reductions of between 0.4 – 0.9 MtC by the end of the next decade.

iii) Vehicle Excise Duty (VED)
While the House of Commons Environmental Audit Committee (2006b) found reason to praise the Government over its introduction of the CCT reforms and their contribution to the reduction of carbon emissions, no such praise was forthcoming regarding VED. Reforms in 2001 saw the replacement of a flat rate VED, with a system graduated on carbon emissions. HMRC (2006) estimates that since the introduction of CCT, ca. 400,000 company cars have been replaced by privately owned vehicles which on average emit 5gC/km more than new company cars. As such the VED and its financial incentives are seen as less of a deterrent to purchasing larger and less fuel efficient vehicles than those set out in the CCT.

Budget 2006 did see some reforms, with VED for the lowest emitting vehicles (≤100 gC/km) being reduced to £0, while those in the highest emitting band (>226 gC/km) are charged £210 for petrol and £215 for diesel. The DfTs (2006b) own research suggested that band differentials of £150 were needed to make 55% of consumers switch to a less polluting vehicle, while at just £50, 33% of buyers would consider a more fuel efficient model. However, the current average differential between bands is just £35 for both petrol and diesel, making this policy much less effective in reducing carbon emissions than it might otherwise have been.

4.4.2 The Ten Year Plan

Emissions estimates clearly depend upon the successful prediction of future traffic growth. A recent report by the analysts Steer Davies Gleave (2006) highlights the discrepancies that exist in the Ten Year Plan (DfT, 2000a) and the later Future of Transport White Paper (DfT, 2004). The former envisaged that under baseline conditions, road traffic in England would increase by 22% and emissions by 0.7 MtC, resulting in total emissions of 31.7 MtC (a figure based on the targets of the VA being fully met). The implementation of the policies outlined in the Ten Year Plan were then expected to reduce traffic growth to 17% over the same period and emissions to 29.1 MtC by 2010 (DfT, 2000b), resulting in a saving of 1.6 MtC (Table 4.1). However, in the later White Paper it is assumed that by 2010 traffic growth will have increased by 23 – 29% and emissions by ca. 0.8 MtC consequently reducing the impact of the measures outlined in the Ten Year Plan. It was not, however, assumed that the VA figures would be fully met but that new car average emissions would be 152 gC/km (DfT, 2005), this still proved to be over optimistic. However, while assumptions may be optimistic they may also prove to be too conservative. From 2000 to 2005 road traffic has increased by just 6.9%. Thus, halfway through the 10 year period, the increase in traffic has not been as severe as forecast in both the Ten year Plan and the White Paper. Consequently, this may have helped compensate for any emissions overestimates based on new car average emissions.

The Ten Year Plan and Future of Transport White Paper both have provisions to extend the road network in England as a way of easing congestion, by 1409 lane km in 2010, increasing to 4032 km by 2025. This has been severely criticised (http://www.foe.co.uk/resource/press_releases/department_for_transport_f_01082006.html), and is seen as the Government attempting to build its way out of congestion rather than provide alternative and reliable means of transportation. Original estimates in the Ten Year Plan suggest that this would result in an increase in carbon emissions of just 0.1 MtC p.a. by 2010. This figure was not revised in the White Paper despite the increase in lane km that was announced. Furthermore, Steer Davies Gleave (2006) found that there were no carbon dioxide emissions data for over half of the planned road building schemes.

4.4.3 Fuel Duty Escalator

Implemented by the Conservative Government in 1993, the primary stated objective of this policy was to reduce carbon emissions as a result of above annual inflation increases on the price of fuel. This was abolished by the current Government in 2000. However on the basis that demand for fuel in 2010 will be lower than it would otherwise have been without its implementation, it is still used as an element when calculating the potential reduction in emissions. It is not expected to have any effect past 2010.

4.4.4 Biofuels and the Renewable Transport Fuel Obligation (RTFO)

Financial incentives for the use of biofuels in the UK have been in place since 2002 (current fuel duty is 28 pence/litre) and in 2005 sales of biofuel totalled 118 million litres or 0.24% of all road fuel sold in the UK (DfT, 2006c). As a result of the projected failure of the Government to meet its original targets for 2010 and 2020, UKCCP06, in line with the EU Biofuels Directive (2003) which proposes that 5.75% (by energy contribution) of fuel is comprised of bio products by 2010, introduced the Renewable Transport Fuel Obligation (RTFO).

Current EU laws, however, specify that biofuels may not make up more than 5% by volume (ca. 3-4% by energy), of the fuel blend. UKCCP06 envisages that this will result in a saving of 1.6 MtC. This does not, however, include the carbon life-cycle costs (i.e. the carbon emissions due to land-use change, production methods and transport to the end-user) which must be taken into account. The Low Carbon Vehicle Partnership (LowCVP, 2006) estimates that life-cycle savings of biofuels obtained from wheat may vary from 7 – 77%. In obtaining the estimate of 1.6 MtC, the Government predicts that savings using biofuels, once these costs are taken into consideration, are in the range of 40 – 56%, (DfT, 2005b), and that potential savings of 0.76 – 1.06 MtC may be gained by 2010/11. The higher figure is quoted in UKCCP06, and assumes that the 2010/11 target of 5% will be achieved along with interim levels of 2.5% and 3.75% in 2008-09 and 2009-10 respectively. Financial incentives, in the form of the lower rate of fuel duty and a buy out price (the penalty for those who are unable to supply sufficient biofuel) set at 15 pence/litre will be in place to help ensure that these levels of obligation are met. This potential 1 MtC saving, is, the Government estimates, the equivalent of taking 1 million cars off the road by 2010. The RTFO is due to come into effect on April 1st 2008.

However whether the 5% obligation will be strictly met by 2010 is dependent upon how this figure is calculated. The government has all along stated that it wants biofuels to account for 5% of all transport fuel sales, thus for every 100 litres of fuel sold, 5 litres are to come from biofuels (i.e. 95 litres of fossil fuel and 5 litres of biofuel). This would result in total sales of 5.26%. In contrast, the industry would rather see 5 litres of biofuel being sold for every 100 litres of fossil fuel, resulting in

total biofuel sales of 4.76%. This is further complicated by the fact that the petroleum industry will, in all likelihood, add just under the required amount of biofuel in order to ensure that the blend adheres to the European Fuel Directive and to avoid costly reblending processes.

Frondel and Peters (2007), suggest that for the entire EU to reach the 5.75% target by 2010, without recourse to imports, would require the use of 13% of the total available arable land. The UK may have the potential to meet a 5% obligation by 2010 for bioethanol, produced from the exportable surplus of wheat, however achieving this level of obligation for biodiesel from oil seed rape would require a significant increase in the land-area given over and include the use of set-aside land, if supplies were to be entirely domestic (NFU, 2006) resulting in potentially negative effects on biodiversity.

The Government would like to see an increase in the level of obligation to 10% (DfT, 2006c) after 2010, providing both fuel and vehicle standards allow. It is unrealistic to expect the UK to meet this level of obligation through domestic production alone without having significant effects on overall food production and biodiversity. Consequently, this would require the cost-effective development of second generation biofuels, or the importing of large amounts of biodiesel (derived from palm oil) from other nations, notably Indonesia and Malaysia which are responsible for over 90% of the world's palm oil production (Friends of the Earth, 2004).

In UKCCP06 additional savings estimates for a 10% obligation after 2010 are merely based upon doubling the 5% obligation. In the Energy Review (DTI, 2006a), a saving of 1 MtC is also obtained. However, one of the main assumptions here is that second generation biofuels will be readily available by 2020, and as a result carbon emissions savings are around 65% (DfT, 2006d). If this technology is not available, and biodiesel is being imported from SE Asia, then these figures can be expected to be over optimistic, especially if sufficient attention is not paid to the carbon life-cycle costs associated with the clearing of tropical forests to make way for palm plantations.

The Government states that any increase in the RTFO above 5% is dependent upon robust sustainability preventing the loss of habitats and endangered species, however in Indonesia and Malaysia 48% of all plantations planted have involved some form of forest destruction (Friends of the Earth, 2006). Carbon storage in a hectare of tropical forest may be almost 5 times that in a hectare of palm plantation (Reijenders and Huijbregts, 2006), and it is suggested that where land-use change has occurred, one-off emissions in the range of 200 – 1000 tC/ha may be associated with combustion and rapid decomposition of above ground biomass. This activity may consequently negate emissions savings for many years. Furthermore, in Indonesia and Malaysia ca. 27% of existing and planned plantations are found on peatlands; this is expected to increase along with the heightend demand for palm oil (Hooijer *et al*., 2006). Large amounts of carbon will then be emitted due to both burning and the exposure of peat, leading to its oxidation.

Although difficult to implement, it is hoped that the introduction of a certification scheme with incentives for low carbon fuels will guarantee that production methods (e.g. deforestation) are not having a diverse effect upon endangered habitats and overall emissions savings. These, though, may fall foul of international trade agreements and as a consequence, need to be carefully developed (LowCVP, 2006).

4.4.5 Heavy Goods Vehicles (HGVs)

From 1994 to 2004 carbon emissions from HGVs have risen 20% from 6.3 MtC to 7.6 MtC. The proposed Lorry Road User Charge, due to come in force in 2007/08 but cancelled in 2006, was seen as an opportunity to improve air quality, while also reducing congestion and carbon emissions. This was to be distance-based and apply to all lorry journeys, whether undertaken by UK drivers or those from the continent. While much effort was employed on just how the exchequer would benefit from this policy, no attempt was made to quantify the effects on carbon emissions that this scheme may have had (House of Commons Transport Committee, 2006) and it will now be incorporated into a national road pricing scheme that will not come into operation until 2014.

4.5 International aviation and shipping

The dramatic growth in international aviation, measured by the embarkation and disembarkation of international passengers at UK airports is illustrated in figure 4. UK citizens account for 67% of this movement (Cairns and Newson, 2006), The slight downturn observed in 2001/2 was in response to the September 11th attacks. Forecasts for international travel are routinely undertaken by the aviation industry and these are summarised by Bows *et al*., (2006), estimates for global growth up until 2023, including that of the UK, is around 4 - 5% p.a.

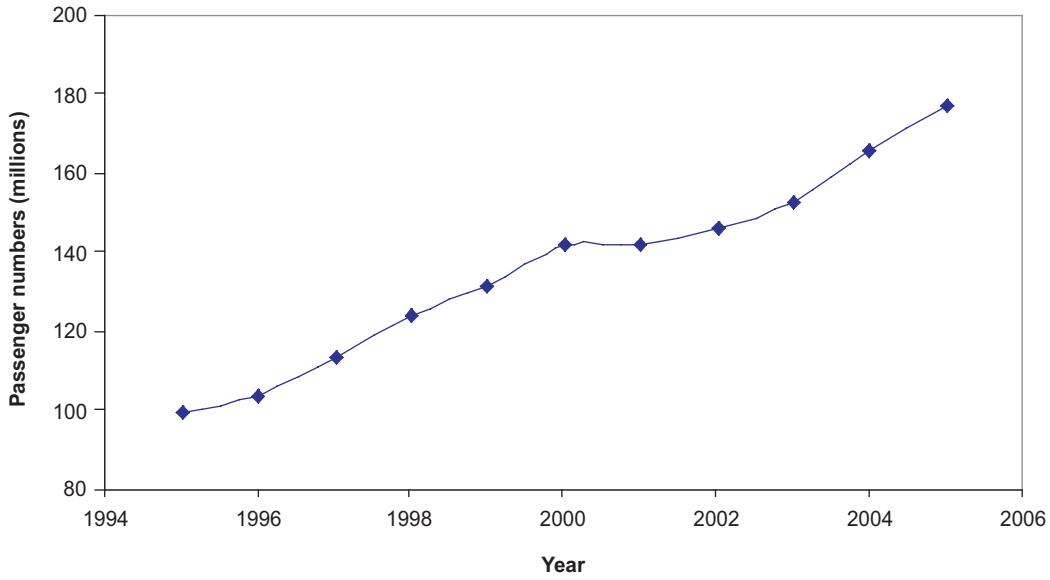

Figure 4.4: Number of international passengers passing through UK airports from 1995 – 2005 (DfT, 2006a).

The Aviation White Paper: The Future of Transport (DfT, 2003), set out to address the challenges faced due to the increasing demand for air travel as a result of both increased prosperity and the growth of the budget airlines. It predicted that, if sufficient capacity is provided, between 400 and 600 million passengers will be passing through the UK's airports by 2030. The later progress report (DfT, 2006e), puts the figure at around 490 million.

As yet, emissions from international aviation are not included in the Kyoto protocol or the more ambitious target set by the UK Government. However those in Figure 4.5 are based on estimates from the refuelling of craft from UK bunkers, whether by UK or non-UK operators. The proposed expansion of UK airports and increased passenger demands will have a serious impact on the quantity of carbon emitted from this source, which in 2004 accounted for 9.12 MtC or 5.5% of total UK emissions (DfT 2006a).

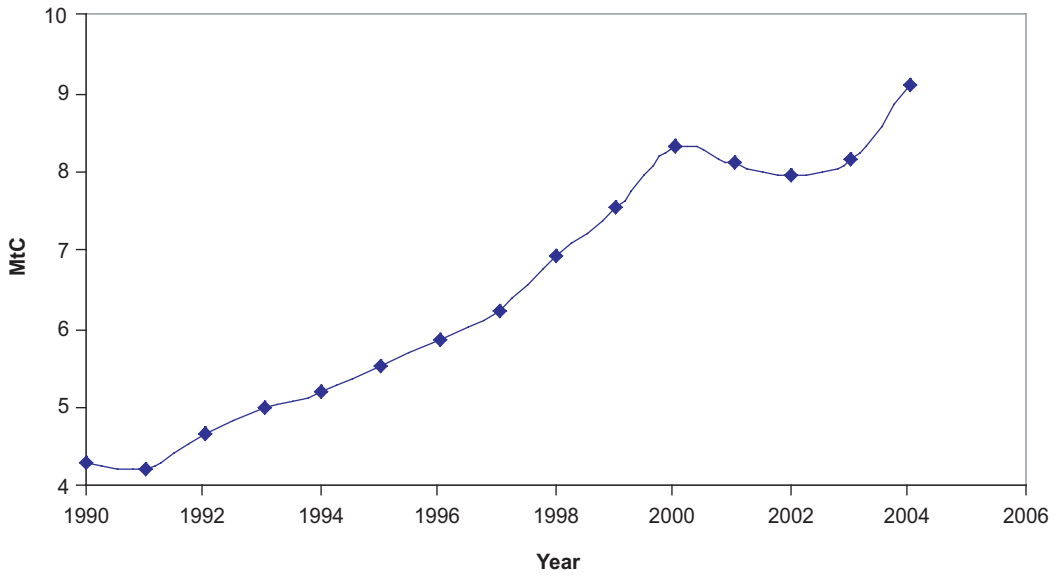

Figure 4.5: Carbon emissions from UK based international aviation bunkers. (http://www.DEFRA.gov.uk/environment/statistics/globatmos/index.htm)

The effect of the increase in passenger numbers is outlined in the Aviation White Paper. The assumptions used in developing these scenarios (Figure 4.6) are criticised by Bows *et al.*, (2006) as being too optimistic, particularly in terms of growth. The model used in estimating the central scenario uses average growth forecasts of 3.3%. This assumption is largely based upon the maturity of the UK market and an expected decline in growth after about 2030. However, despite the perceived maturity of the market, historical growth from 1995 – 2005 averaged 5.4%, including the downturn after the September 11th attacks

(DfT 2006a), if this is excluded from the calculations then the average is almost twice that assumed in the modelling. This is largely down to the increase of international travel on the 'no-frills' budget airlines, the passenger movements on which increased from 5.7 million to 22.4 million from 1998 – 2002 (Cairns and Newson, 2006)

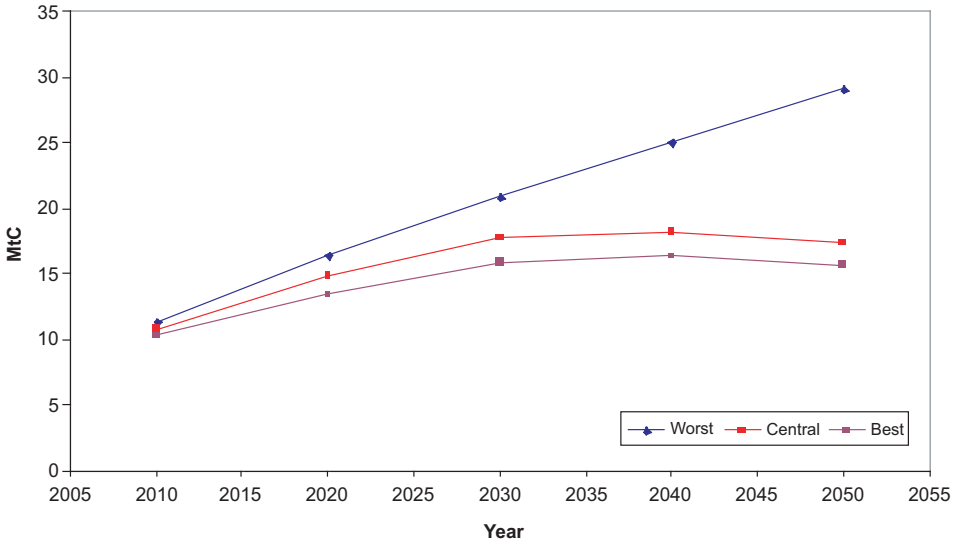

Figure 4.6: UK Government scenarios for the estimated increase in carbon emissions as a result of the anticipated growth of the air industry (http://www.dft.gov.uk/stellent/groups/dft_aviation/documents/page/dft_aviation_031850.pdf)

The emissions predicted by the Government have been called in to question. Bows *et al*. (2006), suggest that the central scenario of 14.9 MtC emissions is too optimistic and that figures of 17.3 are more likely. This is echoed by Owen and Lee (2006), whose 2020 estimate of 13.3 MtC is for scheduled flights only and as such will be an underestimate. Whatever the scenario and the arguments regarding the assumptions, aircraft emissions by 2020 are likely to have grown by between ca. 13.3 and 17.3 MtC and account for between 8.34 and 10.59% of the UK total, at which time UKCCP06 estimates emissions of carbon will be ca. 146 MtC. Furthermore, the central scenario predicts a 37% increase in emissions between 2010 and 2020, compared with a 14% increase by road transport. The worst case emissions scenario of 29.1 MtC by 2050 would account for almost 50% of that permitted by the Kyoto protocol. However under current legislation these emissions will not be included.

As with the road building plans outlined in the Ten Year Plan the Government would appear to be attempting to build its way out of the present congestion at UK airports. The Aviation White Paper specifically sets out a strategic framework for the development of airport capacity over the next 30 years. This policy was severely criticised by the House of Commons Environmental Audit Committee (2003) who stated that the proposed growth in carbon emissions was both 'unsustainable and unacceptable'. They then described the response to their recommendations as poor, stating that the rejection of so much of the report without adequate consideration or explanation failed to address their concerns or those of the Sustainable Development Committee and the Royal Commission on Environmental Pollution.

The only serious plan that the Government would appear to have is for the inclusion of aviation emissions in the EU ETS. The European Commission has recommended that all flights within the EU and international departures should be included in the scheme, however this may take 6 years to become fully operational (Cairns and Newson, 2006).

Fiscal measures that would reduce the amount of air travel are seen as being an effective measure. This has recently come in the way of an increase in the rate of Air Passenger Duty however as with the increased differentials for vehicle excise duty these are not seen as providing an adequate disincentive and would need to be more severe to have a positive effect on emissions.

Like international aviation, emissions from shipping are currently outside the Kyoto Protocol. Globally, international shipping may account for as much as 600 MtC emissions (http://carbonfund.org/site/more/media/255). While the majority of UK registered craft obtained their fuel abroad, emissions from UK bunkers in 2004 totaled 1.6 MtC (http://www.DEFRA.gov.uk/environment/statistics/globatmos/index.htm). Over the past decade freight tonnage at UK ports has increased by about 13% with container traffic up 60% over the same period. The growth of UK ports could have a significant effect on carbon emissions. An extreme example of carbon emissions by international shipping is from Rotterdam in the Netherlands, where in 2003, emissions totalled 43MtC. While this is unlikely to happen on the UK it provides an example of just how carbon emissions may remain unaccounted.

4.6 Conclusions

The failure of the Government to meet the carbon emission goals set for the transport sector are a combination of both the increased economic growth since 2000 and a modelling strategy that has relied too heavily on the Voluntary Agreement between the EU and motor manufacturers who have consistently failed to reach the targets set them.

The failure to increase the fuel duty differential to a sum that would have a significant effect on emissions will prevent the Government from making further emissions savings. The £40 increase for the highest band was a risible attempt at deterring the purchase of the most polluting vehicles. The fuel duty escalator had contributed significant emissions savings while it was operational and its removal will seriously hamper the Government's attempt to meet its 2020 emission targets.

The development of the RTFO has been slow, with the Government already missing its 2005 target. The incentives in place should ensure that the 5% obligation by 2010 is met, although if there is insufficient domestic production, (particularly in the case of biodiesel), the emission savings predicted beyond 2010 will almost surely rely on large imports from environmentally sensitive regions or the development of successful and cost-effective second generation biofuels, which by 2010 is unlikely. If sufficiently robust measures, that do not contravene international trade agreements, are not in place to ensure carbon life-cycle savings any reduction in emissions in the UK may be negated by those from where biofuels are sourced. This will be particularly important when trying to increase the obligation to 10%

Although not included in the Kyoto protocol agreements it is clear that attempts need to be made to address the contribution of international aviation to global carbon emissions. In the UK alone, these are predicted to rise by 37% from 2010 – 2020 and their inclusion in the EU-ETS scheme seems a long way off. It is also clear that, like the vehicle excise duty the Governments attempts at pricing people away from excessive flying will be a failure.

The policies implemented, their estimated emission savings and their chance of success is shown Table 4.2. As can be seen, all the measures have the potential to succeed, however those thought to provide the largest potential savings, the VA and the RTFO are dependent upon external factors and consequently not totally under the Government's control and as a consequence they are just as likely to fail as prove successful. The two measures over which the Government did have control were the fuel duty escalator, which has been abandoned, and vehicle excise duty which the Government did not have the courage to enforce in a way that would provide a sufficient deterrent to the purchase of the highest polluting cars.

	Potential carbon savings (MtC) and likely success						
Measure	**UKCCP00 2010**	**UKCCP06 2010**	**Likely success**	**CCP06 - 2020**	**Likely success**	**Energy Review 2006[5]**	**Likely success (2020)**
Voluntary Agreement (emissions, company car taxation and vehicle excise duty)	4	2.3	✓[1,3]	3.58	?[3]	-	-
Wider transport measures (Ten Year Plan)	1.6	0.8	-	0.84	?	-	-
Fuel Duty Escalator (1993 – 1999)	1.0 – 2.5	1.9	?	-	-	-	-
Sustainable distribution (Scotland)	0.1	0.1	?	0.1	?	-	-
Renewable Trade Fuel Obligation	-	1.0	✓[2]	1.0	✓[4]	0.3 – 1.1	?[4]
Future Voluntary Agreement (emissions levels with motor manufacturers)	-	0.1	✓[3]	1.5	?[3]	1.8 – 2.1[3]	?
Total	**6.7 – 8.2**	**6.24**	**-**	**7.02**	**-**	**-**	**-**

1. Having revised the emissions estimates down based upon new car average emissions of 162 gC/km as opposed to the original figure of 140 gC/km, a 2.3 MtC saving is a much more likely scenario. BUT this does rely upon the VA agreement being extended past 2008 and targets being met if this is not done then these savings are unlikely.

2. The financial incentives/penalties in place make this a realistic target by 2010 if measures are in place to guarantee carbon savings.

3. These estimates rely on the VA being continued past 2008 in some form and the increasing dieselisation of the UK car market. This may not be possible if there are no incentives for consumers to purchase diesels.

4. In UKCCP06 emission savings from the RTFO are unchanged from the 2010 values (1.0 MtC). Attaining this higher level of saving indicated by 2020 in the Energy Review (savings above and beyond those outlined in UKCCP06 due to an assumed increase in the obligation to 10%) will be dependent upon the successful introduction and take-up of second generation biofuels by 2020.

5. In the background analysis to the Energy Review it is very clearly stated that these figures are for purely illustrative terms

Table 4.2: Potential carbon emission savings from measures outlined in UKCCP00/06 (projected figures to 2020 are taken from the July 2006 Updated Energy Programme http://www.dti.gov.uk/files/file31861.pdf) and the 2006 Energy Review).

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Chapter 5: Domestic Sector

5.1 Summary

- Based on the 2000 report projections for targeted 2005 domestic carbon emissions, there was already a recorded gap overshoot of 3.1 MtC by the year 2004 (as documented in the 2006 report; refer to Table 1).
- Reduced rates of VAT on domestic fuel and power (from 8% to 5%) are estimated to increase carbon emissions by 0.2 MtC by 2010
- Increasing energy efficiency is considered the greatest source of emissions savings (i.e. cavity wall insulations) but unrealistic expectations of numbers exist in order to this meet target
- Many policies remain voluntary and do not take into consideration the large proportion of existing housing stock (i.e. the Code for Sustainable Homes)
- 98% of new builds are not able to meet the energy performance certificates required by the 2002 revision of Building Regulations
- Formal accreditation of new building regulations and penalties for non-compliance is needed
- Consumer spending on appliances continues (rebound), with increasing demand in more energy consuming electronics such as televisions (i.e. plasma screens).
- Little knowledge of household standby consumption exists which can be as much as up to 1 MtC a year; equal to around 20% of the target reduction of 4.8 MtC by 2020 for the domestic sector.
- **Audit finds are:** with current policies we suggest that only a cut of 2 MtCe is likely to be achievable in the domestic sector. This could be further reduced if new policies to reduce domestic electrical are not implemented and if voluntary building regulations are not followed. Audit Range 0 to -2 MtCe.

5.2 Introduction to the domestic sector

The Climate Change Programme 2006 (hereafter CCP 2006; DEFRA 2006a) states that domestic carbon emissions, on the basis of end user, in 2004 had fallen to about 2% below the 1990 levels of 42.4 MtC and represented around 27% of total UK carbon dioxide emissions. Through the continuation of measures outlined in the CCP 2000 report (DEFRA, 2000) and the introduction of new policies in the 2006 report, it aims to further reduce this to almost 16% below 1990 levels by 2010 to around 36.5MtC. By 2020 the Government aims to have a total saving of around 4.8 MtC.

The Department for Communities and Local Government (2005) state that in 2005 average domestic use was 1.54 MtC p.a.; and the break down of this proportionate consumption in the house is seen in Figure 5.1.

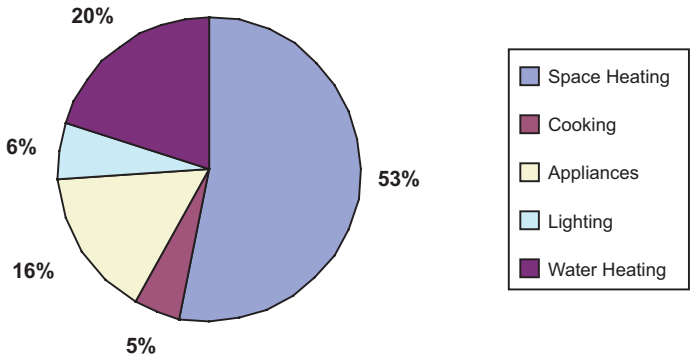

Figure 5.1: Percentage breakdown of average annual domestic energy use (MtC)

Table 5.1: summarises the domestic carbon emissions (source and end user) as documented in the CCP 2000 and 2006 reports, along with the Energy Review (DTI, 2006a). Following the CCP 2000 report, targets for 2010 and 2020 were revised to be more stringent on the basis of the introduction of new policies.

One note however, is the lack of a clear definition distinguishing the difference between domestic and residential sectors; with no clear definition of the two being provided within the report. For example, residential and domestic figures for 2004 (in the CCP 2006 report) show a 0.5 MtC/yr difference (Table 5.1). This is almost equal to the saving the Government wishes to provide from the implementation of the Energy Efficiency Commitment Policy Phase 3 (2008-2011). Clear definitions are therefore needed in order to follow current and projected emissions savings within this sector.

Domestic Net UK Carbon emissions (MtC/yr)	1990	1995	2000	2004	2005	2010	2020
CCP (2000; p. 181) Residential Sector	21.5	21.7	22.2	-	22.3	22.6	23.7
CCP (2000; p. 182)* End User	42.6	40.2	39.7	-	38.6	38.7	40.0
CCP (2006; p. 75) Residential Sector	21.3	21.7	23.3	23.9	-	20.7	21.1
CCP (2006) End User*	42.4	39.1	39.8	41.7	-	36.5	36.0
CCP (2006)	21.7	22.1	23.8	24.4	-	20.8	21.2
Energy Review (2006)	21.0	-	23.2	-	22.3	-	-

*Estimates measured beyond 2010 are less certain; ANNEX E, 2006.

Table 5.1: Summary of domestic and residential carbon emissions for baseline 1990 year towards 2010/2020 targets. '-' specifies where no data is provided.

New proposals set out in the CCP (2006) aim to contribute an additional saving of 1.2 MtC by 2010 in addition to the existing estimated saving of 3.6 MtC from existing measures. A total combined saving of around 4.8 MtC by 2010 is therefore estimated from this sector. The majority of this will be from increased energy efficiency and measures will be discussed within this report.

5.3 Review of previous targets: 1990-2004

Table 5.1 shows that the CCP 2000 targets for the years 2000 and 2005 were not met. The updated CCP 2006 figures demonstrate that, for the residential sector, they were exceeded by 1.1 MtC in 2000 and, while 2005 figures are not provided, by 2004 annual carbon emissions were already 23.9MtC when the CCP 2000 target aimed for a value of 22.3 MtC by 2005 (refer to Table 5.1). Indeed, The House of Commons Environmental Committee (2005) brought to the attention of the Government that the projections from July 2003 identified a gap already of 3% in the Government's achievement of a 20% reduction in carbon dioxide emissions from the 1990 baseline by 2010.

End user (classification giving the most complete account of the relationship between emissions and the production of goods and services) carbon dioxide emissions for the domestic sector were similarly not met according to the figures in Table 5.1. This raises the concern in meeting 2010 and 2020 targets when even more stringent targets have been put forward in the CCP 2006 report (published in March, 2006). This is further exacerbated by considerations taken into account in December's Pre-Budget Report (HM Treasury, 2006b) which stipulates that reduced rates of VAT on domestic fuel and power (from 8% to 5%) is estimated to increase carbon emissions by 0.2 MtC by 2010. It is also interestingly highlighted here that this is not accounted for within the 2006 CCP Report and so may not have been addressed or accounted for.

In looking at improving energy efficiency within the domestic sector it is important to outline the difference between energy efficiency improvements and reductions in energy consumption. In general, overall energy demand has been increasing at over 2% a year, which is greater than past efficiency improvements and so that energy consumption has continued to increase (House of Lords Science and Technology Committee, 2005). On the basis of 2005 residential energy consumption in MtC (refer to Table 5.1; 22.3 MtC) this 2% increase would equate to 0.45 MtC per year. What is more, with increased energy efficiency in homes it is estimated that a direct rebound effect occurs (i.e. increasing energy consumption) in the domestic sector of 30% thereby counteracting total savings (Barker *et al*, 2006).

5.4 Measures adopted to reach domestic sector targets

Measures adopted to reach UK domestic carbon emission targets are two-fold. Initial measures existing from the CCP 2000 report and those introduced in the 2006 report. As stated in 2006, a total saving of 4.8 MtC by 2010/2020 is targeted. Interestingly, when looking at 1990 domestic carbon emissions stated in the same report (at 42.4 MtC; Table 5.1) and the projected 2020 target (36.0 MtC), this equates to a total saving of 6.4 MtC. In other words, the difference in carbon reductions between the 1990 baseline provided and the 2020 target is an actual greater saving than that published of 4.8 MtC. In this case, measures implemented to date to reach this 4.8 MtC are not sufficient to meet the 2020 target that has been set of 36.0 MtC (see Table 5.1).

Main measures which are being adopted are outlined below:

1. Energy Efficiency Commitment (EEC) Phases (1-3)
2. New Building Regulations
3. Appliance efficiency and regulations
4. Fuel Poverty (Warm Front and Decent Homes Initiative)
5. Code for Sustainable Homes
6. Energy Performance of Buildings Directive
7. Billing and Metering

Table 5.2 provides an outline of the expected savings proposed by each of these measures. While CCP 2006 target savings are given for 2010 targets, later revised carbon dioxide emissions figures (from UK energy and emissions projections July 2006, Annex E (DTI, 2006d) which are used to inform the Energy Review (DTI, 2006a)) are also provided. Already discrepancies are evident in the total saving between the papers.

Residential Policies Annex E	**2010 (MtC)**		**2015* (MtC)**	**2020* (MtC)**
	ANNEX E (2006)	CCP (2006; .78)		
EEC1	0.36	0.4	0.36	0.36
EEC2	1.08	0.6	1.24	1.24
EEC3	n/a	0.6	n/a	n/a
HEES/Warm Front 1	0.14	0.4	0.14	0.14
Warm Front 2	0.19		0.21	0.21
Building Regulations 2002	0.64	0.7	0.70	0.70
Building Regulations 2005	0.70	0.8	0.75	0.75
Other, inc. Market Transformation Programme	0.15	0.2	0.17	0.17
Community Energy	0.04		0.04	0.04
Subtotal	**3.3**	**3.6**	**3.61**	**3.61**
Additional Measures announced in CCP (2006)	ANNEX E	From CCP (2006;p.78)		
EEC3	0.5	0.5	0.5	0.5
Energy Performance of Buildings Directive	0.2	0.2	0.2	0.2
Energy Efficiency of buildings	0.1	0.1	0.1	0.1
Billing and metering	0.2	0.2	0.2	0.2
Products Policy	0.2	0.2	0.2	0.2
Subtotal	**1.2**	**1.2**	**1.2**	**1.2**
Total Saving	**4.5**	**4.8**	**4.81**	**4.81**

*Estimates measured beyond 2010 are less certain; (DTI, 2006d)

Table 5.2: Summary of measures and their equivalent savings

Targets state that 3.5 MtC of the 4.8 MtC (~17%) to be saved inorder to meet the 2010 target will be from households in England as set out in the Energy Efficiency Action Plan 2004, in fulfilment of the Sustainable Energy Act 2003. However, between 1996 and 2000 improvement in energy efficiency for existing housing stock was only 4% although a MtC equivalent or baseline for this value is provided to calculate actual savings to date (DEFRA, 2004a).

5.4.1 Energy Efficiency Commitment (EEC)

In 2002, the Government introduced the Energy Efficiency Commitment (EEC) which requires energy suppliers to achieve targets for installing energy efficiency measures in the household sector, particularly among the most vulnerable. This is the principal policy driving efficiency in homes. The mechanism by which this works is by electricity and gas suppliers being required to achieve targets for the promotion of energy efficiency improvements in the domestic sector (DEFRA, 2006a; p. 78). Targets can be fulfilled by suppliers carrying out any combination of approved measures (e.g. installing insulation and promoting low-energy light bulbs) but at least half of energy savings must be from households on income-related benefits/tax credits.

A building's heat loss is normally measured by its "U-value", the wattage lost per square metre for each degree Celsius of temperature difference between the inside and outside. A modern double-glazed window has a U-value of about 2, whereas single-glazed windows have a value more than twice that, emphasising the effect of increasing insuating measures within the domestic sector (Table 5.3; Hamer, 2005).

Poor domestic insulation measures	U-Value Loss (heat loss in $W/m^2/^oC$)
Roof with 50mm thick insulation	0.6
Single glazed window, wooden frame	4.8
Single glazed window, metal frame	5.7
Chimney leaks air at $40m^3$ /hr	-
CW uninsulated, 275mm thick	1.7
Total	**12.8**
Good domestic insulation measures	
Suspended wooden floor	0.7
Double glazed window, wooden frame	2.0
Roof meets regulations	0.2
CWI meets regulations	0.35
Total	**3.25**
Saving	**9.55**

Table 5.3: Summary table showing the effects of proper insulation measures to existing/new housing and U-Value heat loss wasted/saved (adapted from Hamer, 2005).

According to the Stern Review (2006), efficiency is regarded as the biggest single source of emissions savings within the energy sector. The Pre-Budget Report (HM Treasury 2006b) states that the EEC hopes to deliver annual savings of 1.9 MtC p.a. by 2010. However, according to the CCP 2006 report (Table 5.2) this will be a combined saving of 2.1MtC by 2020.

The EEC is broken into 3 phases. The current phase (2005-2008) is estimated to be providing reductions in domestic carbon emissions, combined with Phase 1 (2002-2005) of 1 MtC p.a. Phase 1 (2002-2005) is estimated to have reduced emissions by 0.35 MtC per year by 2010. Phase 2 (2005-2008) is expected to bring in an additional 0.62 MtC annual saving by 2010 (HM Treasury, 2006b). In order to meet 2010 targets of around 2 MtC pa, Phase 3 (2008-2011) will need to save an additional 0.9-1.2 MtC p.a. (HM Treasury, 2006b).

Problems associated with meeting the measures:

- For Phase 2 and more importantly Phase 3, the main emphasis appears to be on increasing the number or cavity wall insulations (CWI) inorder to increase domestic efficiency. The House of Lords Science and Technology Committee Energy Review Report (2005) states that EEC2 cannot be met (target of CWI >600,000/yr) as insulation installations have historically never exceeded 400,000/yr. As EEC measures (i.e. CWI and other insulating measures) remain dependent upon energy suppliers (and domestic needs) it is difficult to quantify the carbon equivalent (MtC) saving estimated by measures and therefore the offset of not meeting such targets. However according to Table 5.2; CWI can save an estimated 1.35 $W/m^2/^\circ C$ – so that a reduction 200,000 short miss of phase 2 and 3 targets of CWI 600,000/yr

would equate to a total U Value of around 270,000 W/m^2/°C.

- As a result of these ambitious targets it is argued that the costs of installations in Phase 3 will be between 2 and 2.5 times greater than those from Phase 2. However, the search costs associated identifying Priority Housing (of which the greatest insulation is aimed at) has not been accounted for.

- The EEC Phase 2 assessment document itself also states that they are still not sure how they are able to calculate the net resource benefit of saving each tonne of carbon from the programme at £300 (*ibid.*).

- Efficiency regulations in place are by no means as stringent as EU counterparts.

- The Climate Change Programme stipulates that due to the short running of EEC2 (one year) it is not able to as yet set a target for Phase 3 (DEFRA 2006a; p. 79) although it later continues to argue that it could deliver about 0.9 to 1.2 MtC per year by 2010.

5.4.2 New Building Regulations

The 2002 Building regulations are thought to deliver reductions of carbon dioxide emissions of 0.7 MtC in the domestic sector by 2010 by steadily driving up the energy standards of new and refurbished buildings (Table 5.1). These Building Regulations are only shared between England and Wales however. Alongside the update to regulations, the new Part L building regulations, which came into force on 6 April 2006, are estimated to increase the energy efficiency of new homes by 40% and reduce fuel bills by the same amount compared to a pre-April 2002 new build (Office of the Deputy Prime Minister [ODPM], 2006). In the UK builders already have to calculate the energy efficiency of new houses, using the government's standard assessment procedure (SAP) an equivalent measurement of future energy bills. Most new houses do very well, with scores of over 80 on a 0 to 120 scale (Hamer, 2005) and since 2001, construction companies have been required to make the scores for their houses available for buyers to see. Unfortunately, many such new houses remain to meet such performance targets and most older (existing) houses have an SAP score of between 40 and 60; only 10 per cent of houses in the UK score more than 60 (*ibid.*).

These new standards (including measures for boilers announced in April 2005) will deliver a saving of 0.98 MtC per year by 2010 (HM Treasury, 2006b). Interestingly the CCP 2006 report argues that these measures will deliver carbon savings of around 0.75 MtC per year by 2010. One further major caveat is that the new Building Regulations do not currently address a significant proportion of the housing stock which exists already. Figures from the 2006 Domestic Energy Fact file (Utley and Shorrock, 2006) show that only 30% of houses in the UK were built after 1970. What is more, of the total housing stock, around 25 million in the UK, only 15,000 (0.6%) are knocked down each year and in order to reach 2050 targets of a 60% reduction in 1990 emissions levels, this rate should be increased fourfold (Monbiot, 2006; p. 71).

The Department for Communities and Local Government (2006a) state that over the last three decades of the twentieth century the number of households increased by 30% while the new level of house building fell by 50%. On the basis of Barker's Review of Housing Supply (2006), latest household projections figures show that households in England will grow by 209,000 per year up to 2026 and to which these new regulations will apply. It has been assumed that there is an 8% growth in household numbers by 2010 for the basis of emissions targets in CCP 2006. The Barker Review (2006; chpt. 2.12) sets a revised number of households at 21.5 million in 2006 in which case this percentage annual growth (of around 200,000 houses per year) is a greater annual growth than that used for the 2010 targets.

Problems associated with meeting the measures:

- With evidence suggesting that few houses are meeting SAPs, there is therefore no formal quantifiable measurement of houses successfully meeting standards and therefore a means of quantifying the reductions in carbon emissions on a basis of these policies. To an end therefore, also the "true" targeted cuts for this policy.

- Last year, when the UK's Building Research Establishment inspected 99 new homes to see how well they complied with building regulations, one-third failed the standards for airtightness (Hamer, 2005).

- With 60% of domestic energy being used as space heating, the British Research Establishment (BRE) highlights that 2/3 of domestic buildings failed to reach the 2005 indicative standard for air permeability.

- Formal accreditation is also needed with penalties for non compliance and local authority on site inspections.

5.4.3 Appliance efficiency and regulation

More energy efficiency products and better labeling is another aim of the Government inorder to reduce domestic carbon emissions. The 2006 Budget Report announced a new initiative, in partnership with major retailers and the Energy Saving Trust, to introduce voluntary schemes in the retail sector to encourage the purchase of more energy efficient alternatives in consumer electronics. The Eco-Design of Energy Using Products (EUP) framework directive aims to provide a formal

mechanism for establishing product standards. However, this scheme does not come into force until 2008 at the earliest. Voluntary agreements are being implemented via the Market Transformation Programme (MTP) which drives sustainable improvements in energy efficiency. The MTP and appliance labelling standards are expected to contribute savings of 0.2 MtC annually by 2010 (Table 5.2; Products Policy).

The House of Lords Science and Technology Second Report on Energy Efficiency (2005) highlight that domestic products account for 17% of domestic energy consumption. Introduced in 1995, The EU Energy Labeling Scheme (A-G) has been responsible for the improvements in standards, setting mandatory labeling for domestic refrigerators, washing machines, tumble dryers, washer dryers, dishwashers, lamps, electric ovens and air conditioners. The Institute of Economic Affairs points out however that since 1995, as energy efficiency increases these standards should have be re-assessed, which has not been conducted. Instead of assigning new values to the existing grades, two new grades, A+ and A++ were introduced which were also widely unadvertised so that most consumers are unaware of their meaning when purchasing new appliances (Mr. Meier of IEA as cited in Energy Efficiency Report 2005).

Energy efficiency standards are not in place as yet for a wider range of IT equipment and TV's. It is also argued that increased energy efficiency may have a rebound effect on consumer spending, so that increased "comfort" is seen in the home. Indeed, in spite of professed public concern about climate change, improved appliance efficiency and information campaigns, domestic electricity consumption rose by 6% in the third quarter of 2005 (*ibid.*). The purchase of smaller consumer electronics such as televisions, DVD players and digital set-top boxes can emit up to 1MtC a year when on standby (HM Treasury, 2006b). While increasing popularity is seen in the larger TV screens, there is also increasing interest in new Plasma screen and LCD screen TVs. A report conducted in May 2006 by the consumer watchdog, Which?, shows that conventional cathode ray tube (CRT) TVs are the most energy efficient, followed by LCD TVs, with Plasma TVs being the least efficient; and these are compared in Table 4 (Which?, 2006).

Status	CRT (32") Energy consumption (W)	LCD (32") Energy consumption (W)	Plasma (37") Energy Consumption (W)*	Plasma (42") Energy consumption (W)
When in use/on	50-100W	100-200W	250	200-300W
When in standby	1-2W	1-4W	-	1-4W

Table 5.4: Summary table of energy consumption of different TV's (Which? Report, 2006)

(NB* Source taken from Vaughan, A, (January, 2007) Online Article "Sky offers journos tips for a 'low carbon 07" on 29/01/2007 from http://thegreenguy.typepad.com/thegreenguy/2007/01/sky_offers_jour.html#more)

In addition to this, a previous Environment Minister Elliot Morley, responding to an MP's question in 2005, revealed that electrical equipment in sleep mode used roughly 7TWh of energy and emitted around 800,000 tonnes of carbon each year (BBC News Website Report; Kniver, 2006).

The number of TVs in the UK is estimated to reach 74 million by 2020, meaning that there will be more televisions than people to watch them (Kinver, 2006). In the UK, measures to combat standby power through the means of product innovation remain voluntary. In 1999 the International Energy Agency (IEA) proposed that all countries harmonise energy policies to reduce standby power use to no more than one watt per device[7]. The proposal contained 3 elements:

- Participating countries would seek to lower standby to below 1 watt in all products by 2010
- Each country would use measures and policies appropriate to its own circumstances
- All countries would adopt the same definition and test procedure

However, the European Code of Conduct has established only voluntary programmes to promote energy-efficient power supplies (necessary to achieve standby levels of one watt or less) and unfortunately to date the only one UK company to sign up has been BSkyB for their set-top box technology; this is beneficial as set-tops consume a high amount of energy on

[7] http://www.iea.org/textbase/subjectqueries/standby.asp

Vaughan, online editor of Newconsumer.com, points out, the onus therefore is on people and consumers to buy such low energy set-tops (and indeed other appliances when they appear on the market) in order to help reduce domestic standby carbon emissions.

Problems associated with meeting the measures:

- Labeling is confusing
- Stricter standards should be set
- Little is known about Standby consumption
- Existing measures put in place are voluntary to date and place pressure on consumer behavioural change
- Standards and labeling are needed for all household technology
- Increasing consumer spending and more energy demanding technologies (e.g. plasmas)

5.4.4 Fuel Poverty (Warm Front and Decent Homes Initiative)

Fuel poverty is caused by a combination of poorly insulated, energy inefficient housing and low incomes (CCP, 2006). A house is classified as being in a state of fuel poverty if in order to maintain a satisfactory heat regime it spends more than 10% of its income on household fuel use. Warm Front is the Government's main tool for tackling fuel poverty in the private sector in England. From the introduction of the Scheme in June 2000 to the end of December 2005, over 1.1 million households received assistance according to the Fuel Poverty 4th Annual Report (DEFRA, 2006d). The scheme was then updated under the CCP report in 2006 where new measures were also set in place, to aim to eradicated fuel poverty by 2016-2018 (2006; p. 88). The Third Annual Progress Report on the UK Fuel Poverty Strategy in 2005 (DEFRA, 2005) stated that there were approximately 2 million households in fuel poverty, down from around 6.5 million in 1996.

The CCP report (2006) argues that the new revised Warm Front Scheme (here Warm Front 2) and other fuel poverty programmes they propose are expected to provide carbon savings of 0.4 MtC by 2010. Interestingly these are not equal to the Warm Front 2010 projections in Annex E which stipulates that Warm Front 1 (previously HEES) would save 0.14 MtC by 2010 and Warm Front (2) 0.19 MtC by 2010 (Table 2).

While advances in tacking fuel poverty have been made, particularly for vulnerable housing, with the advances in fuel cost it is thought that this will be greatly impacted.

Problems associated with meeting the measures:

- Increasing numbers of households needing fuel poverty assistance
- Fuel increases; the total number of vulnerable houses in fuel poverty is thought to increase by around 1 million households from 2003 to 2006. If this is so, the rate at which fuel poverty is tackled will need to increase in order to counteract this increase.

5.4.5 Code for Sustainable Homes

The Code for Sustainable Homes (launched in December 2006) sets voluntary standards above those set by building regulations (Part L) to contribute further to decreasing the environmental impact of housing growth. Consideration by the Government in their 2007 report *"A Green Future: Towards Zero Carbon Development"* to making the Code mandatory is proposed to come into force in April 2008 and until then remains a voluntary adherence. Although this is a mandatory rating against the Code rather than mandatory standards (Prof. Yvonne Rydin, pers. comm.).

The Code will complement the system of Energy Performance Certificates which is being introduced in June 2007 under the Energy Performance of Buildings Directive (EPBD). The EPBD will require that all new homes (and in due course other homes, when they are sold or leased) have an Energy Performance Certificate providing key information about the energy efficiency/carbon performance of the home (The Department for Communities and Local Government, 2006b). These new standards are believed to deliver a saving of 0.98 MtC per year by 2010 according to the HM Treasury (2006b) but it is not clear what other policies (if any) are also included within this target; indeed, the CCP report states that this will be a saving of 0.2 MtC by 2020 (Table 5.2).

The Code will work on a star rating between 1 to 6 where 6 is a "zero carbon home" (i.e. zero net emissions of carbon dioxide from all energy use in the home). The full technical guide on how to comply with the Code of Sustainable Housing is yet to be published however in April 2007. Once again, these measures address new builds. As Rydin (2007) highlights, the Government claims that new house building is the only way to really reach targets for the reductions in energy use in the

domestic sector overall, with it arguing that to make all the cost-effective changes to existing homes would only save 7 MtC per annum, or about 17 per cent of all housing-based emissions.

Problems associated with meeting the measures:

- They remain voluntary until April 2008 (although still in discussion)
- Once again it only applies to new buildings and so does not address a large proportion of the housing stock
- The technical guide is yet to be published

5.4.6 Energy Performance of Buildings Directive

This Directive follows from implements of the EU Energy Performance Directive (EUPD) which came into force from April 2006. The aim of the directive is to set minimum standards on the energy performance of new buildings and the performance of large existing buildings undergoing "major" (greater than 25% of the value of the building or size of the building shell) renovation (European Parliament Report, 2002). From 1 June 2007 anyone buying a home will get a certificate giving clear advice on its energy efficiency and running costs for the first time. The certificate will also give an energy efficiency rating and advice on further improvements that can be made. All properties will have a certificate when they are constructed, sold or let by 2009[8].

In addition to these measures and setting out Energy Performance Certificates for new builds, new sold houses and rented property, regular inspections of boilers and air conditioning systems are also required under the directive. One additional aspect of the Directive for new buildings over 1000m^2 is the requirement to consider 'CHP' combined heat and power which it defines as "the simultaneous conversion of primary fuels into mechanical or electrical and thermal energy, meeting certain quality criteria of energy efficiency" (*ibid.*).

One of the issues with the EUPD is that it is estimated that only ~2% of the UK existing building stock is undergoing construction or refurbishment at any one time and therefore subject to current Building Regulations. Nevertheless, the Government claims that the EUPD can help to save an additional 0.2 MtC by 2010.

Problems associated with meeting the measures:

- Doesn't take into consideration existing smaller houses (<1000m^2) undergoing renovations and therefore a larger percentage of the housing stock doesn't apply
- Certification will come in late for the purpose of full compliance and therefore to meet targets

5.4.7 Billing and Metering

It is argued that better knowledge of energy spending and consumption in the home can help consumers to cut down their domestic energy usage. The Government aims to deliver 0.2 MtC savings in carbon emissions simply through the use of better billing and metering in the UK (DEFRA, 2006a; p. 86). 'Smart Meters' have been shown to reduce energy consumption by 12% in existing studies (Wood and Newborough, 2003).

The Government continues to state that a 5-year programme to install such devices in households in 2007, could lead to a 0.3 MtC saving by 2010, rising to 0.4 MtC by 2020 (DTI, 2006a). According to CCP 2006 report however, billing and metering measures are only estimated to save 0.2 MtC by 2020.

No real action appears to be taking place under this measure; Powergen real-time display trials for energy use are waiting to be published later this year. Similarly, Ofgem's recent review on metering, drawing on international experience, is awaiting publication in May 2007 (*ibid.*). Should a five year programme wish to be conducted this will need to take action soon.

Problems associated with meeting the measures:

- Little action to date exists in order to meet targets

5.5 Conclusions

Conclusions suggest that targets remain ambitious for the domestic sector in its aim to reduce carbon dioxide emissions to 36.0 MtC by 2020, particularly when "gaps" have been seen in meeting earlier targets within the sector. Table 5 acts as a summary of main policies outlined in this document and the potential of their success:

[8] http://www.communities.gov.uk/index.asp?id=1503251

Domestic Policies Introduced to meet carbon emissions targets	2020* (MtC)	Government/Consumer/Industry Mechanism	Likelihood of reaching target
EEC (Phases 1-3)	2.1	Industry and Consumer (no legal compliance)	Possibly
Warm Front and fuel poverty programmes	0.4	Government and Industry	Possibly
Building Regulations 2002/2005	1.45	Industry (no legal compliance)	No
Energy Performance of Buildings Directive (CSH)	0.2 -0.3	Government certification	No
Billing and metering	0.2	Industry and Consumer	No
Products Policy	0.2 – 0.41	Industry and Consumer (behavioural changes)	Possibly
Total Saving	**4.86**		

Table 5.5: Summary of potential to meet 2020 UK domestic carbon emission targets and outline of mechanism behind main policies implemented

While energy efficiency programmes appear to be the main route in addressing carbon emission reductions, it is clear that many obstacles are affecting them. For example, the New Buildings Measures and EUPD have little/no effect upon the large proportion of existing housing stock. Similarly, the effects of the EEC remain to be fully seen and micro-economic effects associated with rebound effects on increasing energy consumption may greatly reduce their performance. Indeed, it would appear that consumer lifestyle and comfort will be a significant issue in combating energy efficiency within the home. With the introduction of many of the outlined measures following the 2006 Climate Change Programme, it remains early days for their full implementation and their ability to contribute to reducing UK domestic carbon emissions for the 2020 target particularly when they remain voluntary.

Appendix I

Summary of 2005 CO_2, CH_4 and N_2O emissions data released by DEFRA 31/01/07.

On the 31st of January 2007 DEFRA published a selection of 2005 GHG emissions data. Data, with source breakdown, was published for CO_2, CH_4 and N_2O emissions. HFC, PFC, SF_6 and the overall UK GHG emissions have been published. All data excludes LUCF removals by sinks.

Summary Tables
Gas summary table

	2004 emissions (MtCe)	2005 emissions (MtCe)	Change (MtCe)	Percentage Change
CO_2	151.7	151.6	-0.1	-0.1%
CH_4	15.4	14.7	-0.7	-5.5%
N_2O	10.5	10.3	-0.2	-1.9%
HFC	8.9	9.2	0.3	3.4%
PFC	0.3	0.4	0.1	33.3%
SF_6	1.1	1.1	-	-
GHG	179.6	178.8	-0.8	-0.4%

Note – Total GHG emissions are greater than the sum of the constituent gases as sinks are not taken into account.

CO_2 summary Table

	2004 emissions (MtCe)	2005 emissions (MtCe)	Change (MtCe)	Percentage Change
Road Transport	32.5	32.7	0.2	0.6%
Energy Industry	56.3	56.8	0.5	0.9%
Other Industry	26.7	26.8	0.1	0.4%
Residential	23.8	22.7	-1.1	-4.6%
Other	12.4	12.6	0.2	1.6%

CH_4 summary Table

	2004 emissions (MtCe)	2005 emissions (MtCe)	Change (MtCe)	Percentage Change
Land Fill	5.9	5.8	-0.1	-1.7%
Agriculture	5.6	5.5	-0.1	-1.8%
Gas Leakage	1.5	1.4	-0.1	-6.7%
Coal Mines	1.5	1.1	-0.4	-26.7%
Other	1.0	0.9	-0.1	-10.0%

N_2O summary table:

	2004 emissions (MtCe)	2005 emissions (MtCe)	Change (MtCe)	Percentage Change
Agriculture	7.0	6.9	-0.1	-1.4%
Industrial Process	0.9	0.7	-0.2	-22.2%
Road Transport	1.3	1.3	-	-
Other	1.3	1.4	0.1	7.7%

Overall emissions:

- Total GHG emissions data are published. GHG emissions totaled 179.6 MtCe for 2004 and 178.8 for 2005. This is a reduction of 0.8 MtCe or 0.4%.
- Combined CO_2, CH_4 and N_2O emissions data for 2004 total 177.5 MtCe, for 2005 they total 176.6 MtCe. This is a reduction of 0.9 MtCe or of 0.5%.
- CO_2 emissions total 151.7 MtCe for 2004 and 151.6 for 2005. This is a reduction of 0.1 MtCe or 0.1%.
- CH_4 emissions total 15.4 MtCe for 2004 and 14.7 for 2005. This is a reduction of 0.8 MtCe or 5.5%.
- N_2O emissions total 10.5 MtCe for 2004 and 10.4 for 2005. This is a reduction of 0.2 MtCe or 1.9%.
- CO_2 emissions have remained stable, there has been a slight decline in N_2O emissions and a significant decline in CH_4 emissions.

CO_2 emissions:

- DEFRA allocates CO_2 emissions to the following sectors: Road Transport, Energy Industry, Other Industry, Residential and Other. The changes from 2004 to 2005 are as follows:
- Road Transport CO_2 emissions total 32.5 MtCe for 2004 and 32.7 for 2005. This is an increase of 0.2 MtCe or 0.6%.
- Energy Industry CO_2 emissions total 56.3 MtCe for 2004 and 56.8 for 2005. This is an increase of 0.5 MtCe or 0.9%.
- Other Industry CO_2 emissions total 26.7 MtCe for 2004 and 26.8 for 2005. This is an increase of 0.1 MtCe or 0.4%.
- Residential CO_2 emissions total 23.8 MtCe for 2004 and 22.7 for 2005. This is a decrease of 1.1 MtCe or 4.6%.
- Other CO_2 emissions total 12.4 MtCe for 2004 and 12.6 for 2005. This is an increase of 0.2 MtCe or 1.6%.

CH_4 emissions:

- DEFRA allocates CH_4 emissions to the following sectors: Landfill, Agriculture, Gas Leakage, Coal Mines and Other. The changes from 2004 to 2005 are as follows:
- Landfill CH_4 emissions total 5.9 MtCe for 2004 and 5.8 for 2005. This is a decrease of 0.1 MtCe or 1.7%.
- Agriculture CH_4 emissions total 5.6 MtCe for 2004 and 5.5 for 2005. This is a decrease of 0.1 MtCe or 1.8%.
- Gas Leakage CH_4 emissions total 1.5 MtCe for 2004 and 1.1 for 2005. This is a decrease of 0.4 MtCe or 6.7%.
- Coal Mine CH_4 emissions total 1.5 MtCe for 2004 and 1.1 for 2005. This is a decrease of 0.4 MtCe or 26.7%.
- Other CH_4 emissions total 1.0 MtCe for 2004 and 0.9 for 2005. This is a decrease of 0.1 MtCe or 10.0%.

N_2O emissions:

- DEFRA allocates N_2O emissions to the following sectors: Agriculture, Industrial Process, Road Transport and Other. The changes from 2004 to 2005 are as follows:
- Agriculture N_2O emissions total 7.0 MtCe for 2004 and 6.9 for 2005. This is a decrease of 0.1 MtCe or 1.4%.
- Industrial Process N_2O emissions total 0.9 MtCe for 2004 and 0.7 for 2005. This is a decrease of 0.2 MtCe or 22.2%.
- Road Transport N_2O emissions total 1.3 MtCe for 2004 and 1.3 for 2005. There is no change in emissions at one decimal place.
- Other N_2O emissions total 1.3 MtCe for 2004 and 1.4 for 2005. This is an increase of 0.1 MtCe or 7.7%.

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