DEPARTMENT OF ENERGY & CLIMATE CHANGE

UPDATED ENERGY AND EMISSIONS PROJECTIONS 2011

URN 11D/871

October 2011

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Executive Summary

The Department of Energy and Climate Change produces regular updated projections of energy demand, supply and greenhouse gas (GHG) emissions. The last full set of projections was published in June 2010[1]. An interim set of projections was published in the fourth Carbon Budget Impact Assessment in May 2011[2].

These projections take account of climate change policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made. The government has in place a clearly defined suite of policies to reduce emissions to meet the first three carbon budgets. Therefore the projections for 2011 to 2022 indicate how we expect to perform against the first three carbon budgets based on a set of analytical assumptions. The projections for the period 2023 onwards represent what we would expect to happen in the absence of any additional policy effort i.e. no new policies or extensions to existing policies. They show that our suite of existing policies will continue to reduce emissions over the fourth carbon budget period, but not by enough to meet the fourth carbon budget level. The difference between the projections for 2023 - 2027 and the fourth carbon budget level therefore indicates the amount of additional policy effort that would be required to meet the budget. The Government will be publishing a report later this year setting out the options for meeting the fourth carbon budget.

The projections have been updated to take account of new data e.g. revised policy savings estimates, revised DECC fossil fuel and carbon price projections[3], revised Office for Budget Responsibility (OBR) growth projections[4] and revised cost estimates for the power sector[5]. In addition to updates to assumptions, a number of improvements have been made to the methodology used to project energy demand following an internal review. The review led to revisions in methodology for projecting industry sub-sectoral growth and to the equations used to project demand in the residential, transport, iron and steel and commercial sectors. Details of the review are given in the Appendix.

Emissions projections are reported on both a net UK carbon account basis and territorial basis. Territorial emissions comprise both emissions covered by the EU Emissions Trading Scheme (EU ETS), (referred to as “traded” emissions) and emissions outside the EU ETS (referred to as “non-traded” emissions). Participants in the EU ETS receive allocations of EU emissions allowances which in total are equal to the UK’s share of the

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[1] http://www.decc.gov.uk/assets/decc/Statistics/Projections/67-updated-emissions-projections-june-2010.pdf

[2] http://www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/Carbon%20budgets/1685-ia-fourth-carbon-budget-level.pdf

[3] Fossil fuel prices:
http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx

Carbon prices:
http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/carbon_values/carbon_values.aspx

[4] http://budgetresponsibility.independent.gov.uk/wordpress/docs/economic_and_fiscal_outlook_23032011.pdf

[5] Generation costs:
http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/gen_costs/gen_costs.aspx

EU ETS cap (referred to as the "traded sector cap"). These participants, may either reduce carbon emissions or purchase allowances to comply with the EU ETS. Under UK carbon accounting procedures, the net UK carbon account is equal to the sum of the traded sector cap and the actual level of non-traded emissions.

It is not possible to predict accurately what the UK's share of the EU ETS cap will be over the fourth carbon budget period. Therefore actual territorial emissions are shown in Table 1 for all carbon budget periods, in addition to the net carbon account for the first, second and third carbon budgets. The shortfall against budget is reported on a net carbon account basis for the first three carbon budgets but on a territorial emissions basis for the fourth carbon budget.

For the fourth carbon budget period, territorial emissions are compared against the budget of 1,950 $MtCO_2e$ set in the carbon budgets legislation. However as set out in the government's proposal for setting the fourth carbon budget[6], the territorial budget is conditional upon a tightening of the EU ETS. The budget will be reviewed in 2014, and if, at that time, our domestic commitments place us on a different emissions trajectory than the EU ETS trajectory agreed by the EU, we will, as appropriate, revise up our budget to align it with the actual EU trajectory.

The updated projections suggest that the UK will meet its first three legislated carbon budget targets. Projected territorial emissions are lower in all three carbon budgets than those published in June 2010. Emissions from both traded and non-traded sectors are projected to be lower than in the June 2010 projections. The main reasons for the change are new cost estimates for power sector generation technologies, revised OBR long-term growth assumptions and changes to the method used to derive industrial sub-sector growth projections.

These projections are subject to several sources of uncertainty including forecast error in demand equations, uncertainty in future policy impacts and uncertainty in projections for economic drivers of demand. Analysis of sensitivity to assumptions and modelling accuracy suggest the true future values could be more than 5% higher or lower than the projected values in the long run. The analysis suggests that the risk of the UK failing to meet its first three carbon budgets is low. Details on the impact of uncertainty are given in Chapter 5.

6 http://www.decc.gov.uk/assets/decc/What%20we%20do/A%20low%20carbon%20UK/Carbon%20budgets/1683-4th-carbon-budget-policy-statement.pdf

Table 1 Emissions projections by carbon budget period ($MtCO_2e$)

$MtCO_2e$	June 2010			October 2011			
	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-2012	2013-2017	2018-2022	2008-2012	2013-2017	2018-2022	2023-2027
Traded sector[7]	**1,200**	**1,128**	**1,003**	**1,189**	**1,033**	**849**	**766**
Non-Traded	**1,756**	**1,642**	**1,512**	**1,689**	**1,571**	**1,472**	**1,441**
of which non-CO_2	*462*	*441*	*409*	*446*	*416*	*379*	*354*
Territorial Emissions	**2,955**	**2,770**	**2,514**	**2,877**	**2,604**	**2,322**	**2,207**
Change in Territorial emissions	N/A	N/A	N/A	-78	-166	-192	N/A
Traded Sector Cap[8]	1,233	1,078	985	1,233	1,078	985	N/A
EUAs purchased (negative implies sold)[9]	-33	50	18	-44	-46	-136	N/A
Change in Traded /EUAs purchased	N/A	N/A	N/A	-11	-96	-154	N/A
Net Carbon Account	**2,989**	**2,720**	**2,497**	**2,922**	**2,650**	**2,457**	N/A
Carbon Budget	**3,018**	**2,782**	**2,544**	**3,018**	**2,782**	**2,544**	**1,950**[10]
Shortfall (negative implies emissions under budget)*	**-29**	**-62**	**-47**	**-96**	**-132**	**-87**	**257**
Change Non Traded /Net Carbon Account	N/A	N/A	N/A	-67	-71	-40	N/A

* Shortfall against budget is reported on a net carbon account basis for carbon budgets 1,2 and 3 but on a territorial emissions basis for carbon budget 4.

It should be noted that figures in this and subsequent tables have been rounded. Totals are calculated from the un-rounded data and therefore may not appear to be the sum of the component parts.

[7] This is actual emissions from the traded sector unadjusted for any purchase or sale of EUAs. It therefore differs from the figures presented in Table 1 of the June 2010 projections as "Traded sector" which was set at the UK's share of the EU ETS cap.

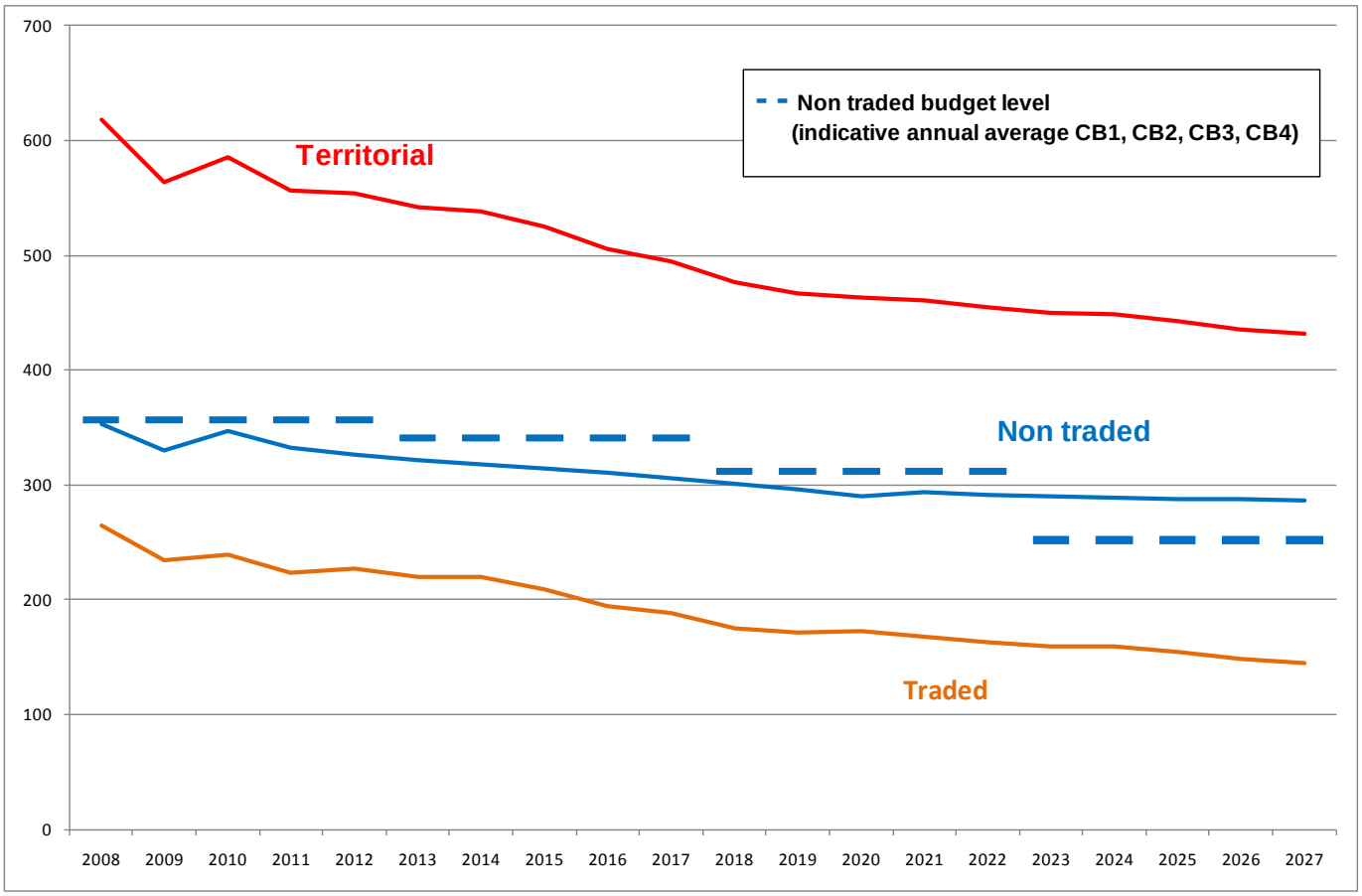
[8] The traded sector cap shown here is the estimated UK share of the EU ETS cap recorded in the UK carbon budgets legislation. This differs slightly from the cap applied in the June 2010 projections which was set at the level of the projected UK EU ETS cap. As a result projected EUAs purchased and the net UK carbon account also differ slightly from those reported in June 2010.

[9] The projected EUA purchases shown here are estimated by subtracting the UK traded cap recorded in the carbon budgets legislation from the projected level of traded emissions. This legislated cap was based on estimates of the UK allocation of EU ETS allowances in each of the first three carbon budget periods. DECC now has more accurate estimates of the actual allocation. DECC's projection of EUA purchases taking account of the latest estimate of the UK's share of EU ETS allowances is given in Chapter 5.

[10] The fourth carbon budget is conditional upon tightening of the EU ETS cap and will be reviewed in 2014

N/A = Not Applicable

Figure 1 Projected UK emissions of greenhouse gases against targets ($MtCO_2e$)



Note: The non-traded budget level for carbon budget 4 has been set at the level recommended by the CCC (1,260 $MtCO_2e$) which assumes an EU ETS traded sector cap of 690 $MtCO_2e$.

Chapter 1: Introduction

The Climate Change Act 2008 introduced a legally binding target to reduce the UK's greenhouse gas (GHG) emissions to at least 80 per cent below 1990 levels by 2050. To drive progress towards this target the Act introduces five-year "carbon budgets". These will define the emissions pathway to the 2050 target by limiting the total GHG emissions allowed in each five year period, beginning in 2008. The first four carbon budgets – for 2008-2012, 2013-2017, 2018-2022, and 2023-2027 – have now been set through secondary legislation[11].

Projections of UK energy demand, supply and carbon dioxide emissions have been published by the UK government on a regular basis, to inform Government energy and environmental analysis, since 2000[12]. CO_2 emissions (apart from those arising from Land Use, Land-Use Change and Forestry), are projected using the DECC Energy and Emissions Model. Within this model demand for energy is projected using a series of equations that relate energy demand to its key drivers such as GDP growth. Demand is adjusted to take account of the policy impacts. The way in which electricity producers meet demand is projected using a model that in effect assumes providers know what future prices and demand will be and find the least cost method of meeting this demand under current policies. The basic methodology remains unchanged since June 2010.

Projections for non-CO_2 emissions and Land Use, Land-Use Change and Forestry (LULUCF) emissions are projected using separate models. Updated non-CO_2 projections were published in September 2011. These have been incorporated into the projections reported here. The methodology and changes in non-CO_2 projections since the last projection are described in the September 2011 publication[13]. CO_2 emissions from LULUCF were estimated by the Centre for Ecology and Hydrology under contract to DECC using a methodology that is consistent with the UK Greenhouse Gas Inventory[14]. Updates to the LULUCF projections have also been incorporated into the projections presented here.

These projections are used to model future levels of the net UK carbon account, and so help government to monitor progress in meeting the carbon budgets. For the fourth carbon budget period the difference between these projections and the carbon budget level show the level of additional policy effort that would be required to meet the budget. The projections take into account the impact of all policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made. The policies that will be put in place to deliver the fourth carbon budget are still under development; more details of these policies will be provided later this year. Therefore the projection for the fourth carbon budget period represents a

[11] See http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/carbon_budgets/carbon_budgets.aspx

[12] Current and previous Energy and Emissions projections are available on the DECC webpage http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx

[13] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/2770-nonco2-ghg-emission-project-autumn2011.pdf

[14] http://www.decc.gov.uk/assets/decc/11/stats/climate-change/2758-mapping-carbon-emissions.pdf

scenario in which there is no extension of existing policies or introduction of new policies after 2022 and will provide the baseline against which the Government will consider further opportunities to reduce emissions over the 2020s.

The first three carbon budgets set a limit on the level of the ***net UK carbon account***. This is calculated by adjusting UK GHG emissions[15] to account for any carbon units[16] which have been bought in from overseas by the Government and others to offset UK emission ('credits') and UK carbon units which have been disposed of (i.e. sold) outside the UK ('debits'). This means that under net carbon accounting procedures non-traded emissions are added to the traded sector cap to give net emissions. The actual level of traded sector emissions therefore has no impact on performance in the first three carbon budgets, it only affects the level of EU ETS allowances purchased or sold. There is currently still considerable uncertainty over what the level of the EU ETS traded sector cap will be in the fourth carbon budget period. Therefore in these projections, performance against the fourth carbon budget is presented on a territorial basis. The level of the fourth carbon budget is subject to revision to ensure it is in line with the UK's share of the EU-ETS cap.

The projections have been updated to take account of new data e.g. revised policy savings estimates, revised DECC fossil fuel[17] and carbon price projections[18], revised OBR growth[19] projections and revised generation cost estimates for the power sector[20]. In addition to updates to assumptions, a number of improvements have been made to the methodology used to project energy demand following an internal review. The review led to revisions in methodology for projecting sectoral growth and to the equations used to project demand in the residential, transport, iron and steel and commercial sectors.

The rest of this document is structured as follows. The key assumptions are set out in Chapter 2. The projections are set out in Chapter 3 and compared with the June 2010 projections. A detailed list of policies included in these projections is provided in Chapter 4. Uncertainty in the projections is considered in Chapter 5. Chapter 6 provides detail on electricity generation. Final and primary demand for energy is presented in Chapter 7. The Appendix provides details of the methodology review undertaken in 2011 and the impact of the consequent changes on emissions projections. A number of downloadable tables provided in Microsoft Excel format (the Annexes) are listed in Chapter 8.

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[15] Allowing for removals from land use, land use change, and forestry.

[16] The term carbon units covers allowances issued under cap and trade schemes such as the EU Emissions Trading System (EUAs), and credits representing emissions reductions in developing countries issued under the Clean Development Mechanism (CERs), as well as other types of units.

[17] Fossil fuel prices - Department of Energy and Climate Change

[18] Carbon values - Department of Energy and Climate Change

[19] http://budgetresponsibility.independent.gov.uk/wordpress/docs/economic_and_fiscal_outlook_23032011.pdf

[20] Generation costs - Department of Energy and Climate Change

Chapter 2: Assumptions

The DECC Energy and Emissions Model provides the basis for the carbon dioxide emissions projections and requires a set of key assumptions including the level of economic growth, international fossil fuel prices, and the number of households in the UK. The assumptions are based on official published UK government projections where these are available.

Projections of non-CO_2 greenhouse gas (GHG) emissions and GHG emissions from the Land Use, Land-Use Change and Forestry sector (LULUCF) are provided by other models[21], based on consistent assumptions, and added to the carbon dioxide projections to provide projections of total UK GHG emissions.

Fossil fuel price assumptions and exchange rates

Assumptions about the level of wholesale fossil fuel prices are produced by DECC based on analysis of the international market and informed by other forecasts published by international organisations.

The latest fossil fuel price assumptions, published[22] alongside this report and reflect both changes over the previous year in global oil markets and a rigorous review. The fossil fuel projections are presented in three different scenarios of future global fuel markets.

The three fossil fuel scenarios are:

- Reflecting low global energy demand (low)
- Reflecting timely investment and moderate demand (central)
- Reflecting high demand and producers' market power (high)

The central energy and emissions projections presented here are based on the central price scenario.

The full range of price assumptions for all fossil fuels is contained in Annex F. Table 2.1 shows the central prices. Table 2.2 shows the crude oil price assumptions for all scenarios to illustrate the range of prices encompassed by these scenarios.

[21] http://www.decc.gov.uk/assets/decc/11/about-us/economics-social-research/2770-nonco2-ghg-emission-project-autumn2011.pdf

http://www.decc.gov.uk/assets/decc/11/stats/climate-change/2758-mapping-carbon-emissions.pdf

[22] Fossil fuel prices - Department of Energy and Climate Change

Table 2.1 Fossil fuel price assumptions for central scenario[22]

2010 prices	Crude oil $/bbl	Natural gas NBP p/therm	Coal ARA £/tonne
2010	81	43	59
2015	113	79	79
2020	118	68	70
2025	123	68	70
2030	128	68	70

National Balancing Point (NBP) and Amsterdam-Rotterdam-Antwerp (ARA), are standard trading locations for gas and coal respectively.

Table 2.2 Crude oil price assumptions for all scenarios[22]

$/bbl, 2010 prices	Low prices	Central prices	High prices
2010	81	81	81
2015	100	113	119
2020	91	118	134
2025	82	123	150
2030	74	128	168

The exchange rates used from 2011 are summarised in Table 2.3. These are the average of the previous calendar year's market rates, and are assumed to remain constant over the projection period. Details of the methodology are given in DECC's IAG Guidance for Policy Appraisal[23].

Table 2.3 Exchange rate assumptions[23]

Currency	Exchange rate
$/£	1.5460
£/€	0.8581

Economic growth

The growth assumptions for UK GDP and employment have been updated since 2010, reflecting new projections, both short and long-term, from the Office of Budget Responsibility (OBR). The short-term growth assumptions are from the OBR's Economic &

[23] IAG guidance for policy appraisal - Department of Energy and Climate Change

Fiscal Outlook[24] published with the Budget in March 2011. The long-term projections for GDP and Employment growth were provided by the OBR to DECC in June 2011.

DECC previously used projections of manufacturing growth provided by HM Treasury and subsequently the OBR to derive the industrial sub-sector growth projections needed by the model. The OBR no longer provides manufacturing growth projections therefore the methodology for deriving industrial sub-sector growth projections has been revised. The revised methodology no longer incorporates an overall manufacturing growth projection, but instead derives individual sub-sector growth projections from the OBR projection of GDP using statistical analysis of historical relationships and trends. Details of the revisions to methodology and their impact on projections are given in the Appendix.

Table 2.4 Economic growth assumptions (per cent)[24]

UK Growth Rates	2010[25]	2011[26]	2012	2013	2014	2015	2020	2025	2030
GDP	1.4	1.3	2.5	2.9	2.9	2.8	2.2	2.1	2.1
Employment	0.2	-0.1	0.1	0.3	0.2	0.3	0.2	0.1	0.1

Carbon price

Participants within the EU Emissions Trading Scheme (EU ETS), including the power generation sector, may either reduce carbon emissions or purchase allowances to comply with the EU ETS. Table 2.5 shows the price of allowances (the carbon price) assumed by DECC, based on a range of fossil fuel price scenarios. These assumptions have been developed for modelling purposes within DECC and should not be considered as DECC "forecasts" of future carbon values. The assumptions underlying these values are explained in the explanatory note published on the same day as these projections[27]. Table 2.5 also shows the effective carbon price assumed for modelling electricity supply which includes the carbon price floor (CPF) mechanism. The levels applied are those announced by the Government in the March 2011 Budget.

[24] http://budgetresponsibility.independent.gov.uk/wordpress/docs/economic_and_fiscal_outlook_23032011.pdf

[25] Updated ONS data

[26] ONS data for Quarter 1 and 2. OBR projection for Q3 and 4.

[27] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/carbon_values/carbon_values.aspx

Table 2.5 Carbon Prices assumed (£/tonne CO_2)[27]

£/tCO_2, 2010 Prices	Industry & Commerce (no carbon price floor)					Electricity Supply Sector (with carbon price floor)				
Fossil Fuel Price Scenario	2010	2015	2020	2025	2030	2010	2015	2020	2025	2030
Low	12.4	13.0	22.2	24.0	25.8	12.4	20.4	30.9	51.5	72.1
Central	12.4	18.3	27.7	29.8	32.1	12.4	20.4	30.9	51.5	72.1
High	12.4	18.3	27.7	29.8	32.1	12.4	20.4	30.9	51.5	72.1

Chapter 3: Emissions projections

This chapter summarises and discusses the GHG emissions projections. Results are presented on two bases, which define the sectors that are used to disaggregate emissions. Regardless of the basis used, the projected value of the net UK carbon account and territorial emissions in a particular year is the same – the basis only affects how this total is split into its components.

The National Communication (NC) basis is defined by the United Nations Framework Convention on Climate Change and used for reporting under this convention. The Updated Emissions Projections (UEP) basis is that used in previous DECC emissions projections and is consistent with the Digest of United Kingdom Energy Statistics (DUKES), an important source of input data for the DECC Energy and Emissions Model.

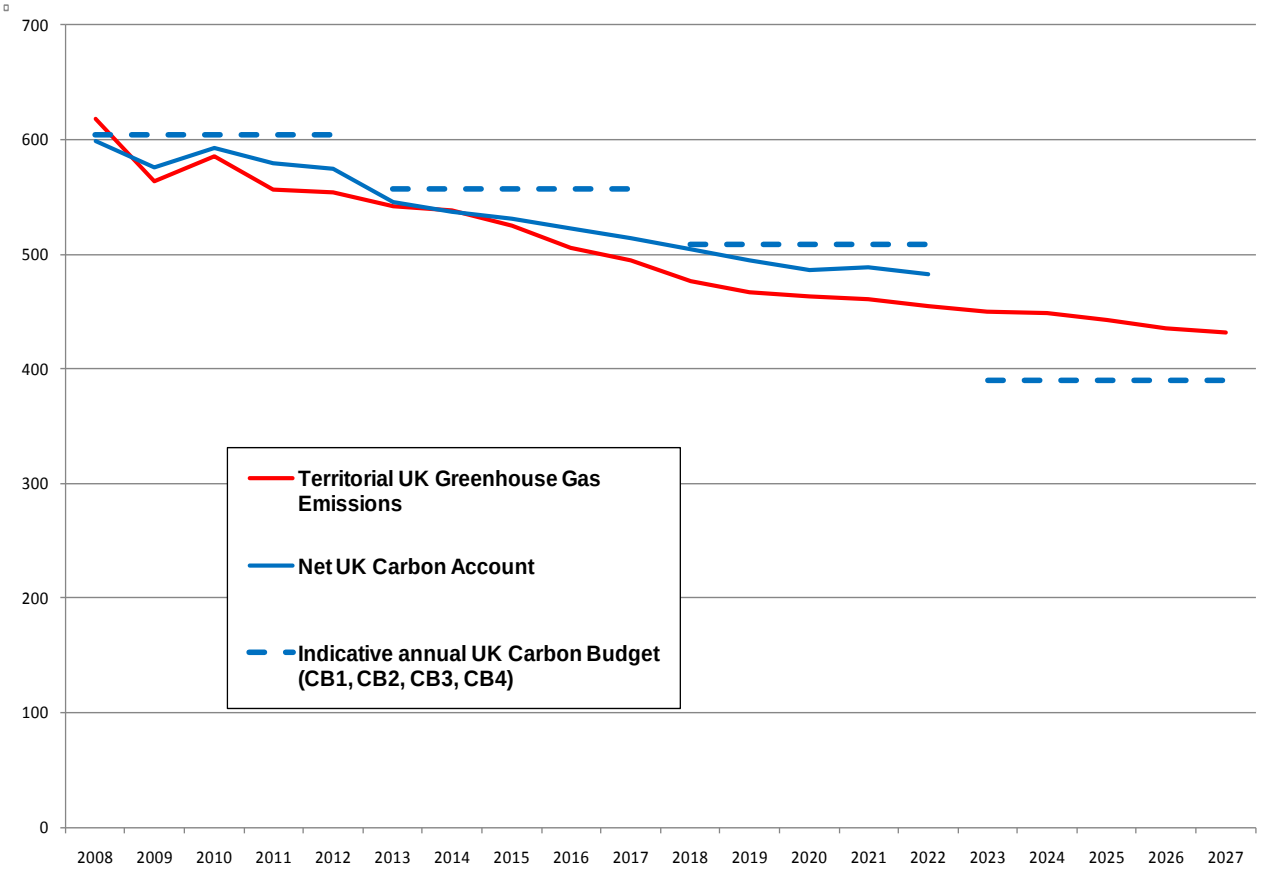
The first section of this chapter contains annual results, presented at five-yearly intervals on an NC basis. The second section of this chapter considers the carbon budgets, which are aggregated over 5 year periods, on a UEP basis. This chapter presents DECC's central emissions projections. Chapter 5 looks at uncertainty in these central projections and sensitivity to economic growth assumptions.

Annual results

Figure 3.1 shows the latest projections of traded and non-traded emissions against carbon budgets[28], and Table 3.1 shows the contributions of UK sectors to the total net emissions.

[28] Note: the fourth carbon budget is likely to still be assessed on a net UK carbon account basis. However due to the considerable uncertainty over what the EU ETS cap will be beyond 2020, only territorial emissions are shown for this period.

Figure 3.1 Net UK carbon account and territorial projection: 2008-2027 ($MtCO_2e$)



UK Emission projections by sector

Table 3.1 Projected net UK carbon account and UK Greenhouse Gas emissions broken down by sectors (NC basis[29]). The June 2010 projection for the UK Carbon Account is shown for comparison, all other results relate to the October 2011 projections.

$MtCO_2e$	Central Greenhouse Gas emissions*					
	1990[30]	2010	2015	2020	2025	2030
UK Carbon Account		Net Basis			Territorial basis	
June 2010 projection	782	597	543	494	483	
October 2011 projections	782	593	531	486	442	418
Change since 1990 (Net)	-	-24%	-32%	-38%		
UK Greenhouse Gases	**782**	**586**	**524**	**463**	**442**	**418**
Change since 1990 (Territorial)	-	-25%	-33%	-41%	-43%	-47%
Sectors (NC basis):	-					
Energy Supply	-	196	166	129	110	85
Business	-	94	91	82	78	76
Industrial Processes	-	12	12	12	12	12
Transport	-	122	115	109	109	107
Residential	-	88	70	66	69	73
Public	-	9	10	8	8	8
Agriculture	-	50	49	46	46	46
Land Use Change	-	-4	-2	-1	0	1
Waste Management	-	18	15	13	12	11
Total	**-**	**586**	**524**	**463**	**442**	**418**

***** It should be noted that figures in this and subsequent tables have been rounded. Totals are calculated from the un-rounded data and therefore may not appear to be the sum of the component parts.

Emissions from energy supply industries are projected to fall by 111$MtCO_2$ between 2010 and 2030 due primarily to decarbonisation of the grid with total electricity consumption rising slightly over the period. Without additional policy effort after 2022 business

[29] In Table 3.1 the United Nations Framework Convention on Climate Change (UNFCCC) National Communication definition of the transport sector is used. This is the sum of road transport and other categories including domestic aviation (between 2008 and 2011), rail, national navigation and military aviation and shipping.

[30] The 1990 GHG estimate is for emissions from UK and UK crown dependencies including LULUCF. This is the same basis as the UEP projections but differs slightly from the definition used for EU reporting and reporting against the Kyoto protocol. See http://www.decc.gov.uk/en/content/cms/statistics/climate_change/gg_emissions/targets/targets.aspx

emissions are projected to fall by 19MtCO_2 and transport and residential emissions are each projected to fall by around 15MtCO_2. The majority of this reduction is due to policy impacts with almost all of the reduction occurring in the first three carbon budget periods. Without additional policy effort there is projected to be little change in transport and business emissions between 2025 and 2030 and a small rise in residential sector emissions.

Progress towards the carbon budgets

The statutory independent Committee on Climate Change (CCC) was established by the Climate Change Act 2008 with the principal aim of advising the Government on setting levels for the five-year carbon budgets, which set a trajectory for UK GHG[31] emission reductions towards the long-term target of at least an 80% reduction in emissions by 2050.

The levels of the first three carbon budgets were set in fiscal Budget 2009[32] at the "interim" level recommended by the CCC prior to global agreement on emissions reductions. The carbon budgets require a reduction in greenhouse gas emissions of 34%, against 1990 levels, by 2020. The fourth carbon budget level was set in June 2011.

The UK emissions projections, including the projection of the carbon dioxide equivalent of the Kyoto basket of non-CO_2 GHGs, provides the basis for assessing progress against meeting the UK carbon budgets. In this section, the emissions are presented on the net UK carbon account basis for the first three carbon budget periods (2008-12, 2013-2017, and 2018-2022) but on a territorial basis for the fourth carbon budget period (2023 to 2027). It is likely that the fourth carbon budget will still be assessed on a net UK carbon account basis as there are no current plans to change the system for UK carbon accounting. However, there is considerable uncertainty about what the level of the EU ETS cap will be in the fourth carbon budget period. Therefore the projections are shown on a territorial basis only for 2023 onwards. The projections for 2023 onwards represent a no additional policy baseline i.e. what we would expect to happen if the government took no further policy action beyond the third carbon budget.

Traded and non-traded sectors

The total UK emissions projections are split into the traded and non-traded sectors. Emissions from installations within the EU ETS are referred to as "traded sector" emissions. Emissions from sectors and installations not participating in the EU ETS are referred to as "non-traded" sector emissions. Under the carbon accounting regulations for UK carbon budgets the net contribution to the net UK carbon account from the traded sector is equal to the UK share of the EU ETS cap.

The traded sector comprises energy industries including power stations, refineries, offshore oil and gas, some combined heat and power (CHP) installations, energy intensive industries and a small number of service sector participants. From 2013 some non-CO_2 emissions (from Nitric Acid plants and PFC emissions from aluminium manufacture) will also be treated as traded. Although international aviation will start to be included in the EU ETS from 2013 it is not included in the current scope of UK Carbon Budget legislation.

[31] In the context of the CCC and the carbon budgets, GHG refers to the Kyoto basket of gases.

[32] http://www.hm-treasury.gov.uk/bud_bud09_carbon.htm

The non-traded sector comprises the residential sector, the transport sectors, part of the industry sector, the majority of commercial and public sectors, LULUCF and non-CO_2 emissions (excluding those gases which are categorised as traded in Phase III).

Table 3.2 summarises the updated projections and compares them to the previous projections published in June 2010.

Table 3.2 Carbon Budget, June 2010 and October 2011 projection headline results

$MtCO_2e$	June 2010			October 2011			
	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-2012	2013-2017	2018-2022	2008-2012	2013-2017	2018-2022	2023-2027
Traded sector[33]	**1,200**	**1,128**	**1,003**	**1,189**	**1,033**	**849**	**766**
Non-Traded	**1,756**	**1,642**	**1,512**	**1,689**	**1,571**	**1,472**	**1,441**
of which non-CO_2	*462*	*441*	*409*	*446*	*416*	*379*	*354*
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Change in Territorial emissions	N/A	N/A	N/A	-78	-166	-192	N/A
Traded Sector Cap[34]	1,233	1,078	985	1,233	1,078	985	N/A
EUAs purchased (negative implies sold)	-33	50	18	-44	-46	-136	N/A
Change in Traded /EUAs purchased	N/A	N/A	N/A	-11	-96	-154	N/A
Net Carbon Account	**2,989**	**2,720**	**2,497**	**2,922**	**2,650**	**2,457**	N/A
Carbon Budget	**3,018**	**2,782**	**2,544**	**3,018**	**2,782**	**2,544**	**1,950**[35]
Shortfall (negative implies emissions under budget)*	**-29**	**-62**	**-47**	**-96**	**-132**	**-87**	**257**
Change Non Traded/Net Carbon Account	N/A	N/A	N/A	-67	-71	-40	N/A

* Shortfall against budget is reported on a net carbon account basis for carbon budgets 1,2 and 3 but on a territorial emissions basis for carbon budget 4.

It should be noted that figures in this and subsequent tables have been rounded. Totals are calculated from the un-rounded data and therefore may not appear to be the sum of the component parts.

N/A = Not Applicable

[33] This is actual emissions from the traded sector unadjusted for any purchase or sale of EUAs. It therefore differs from the figures presented in Table 1 of the June 2010 projections as "Traded sector" which was set at the UK's estimated share of the EU ETS cap.

[34] The traded sector cap shown here is the estimated EU ETS cap recorded in the UK carbon budgets legislation. This differs slightly from the cap applied in the June 2010 projections which was set at the level of the projected UK share of the EU ETS cap. As a result, projected EUAs purchased and the net UK carbon account also differ slightly from those reported in June 2010.

[35] The fourth carbon budget is conditional upon tightening of the EU ETS cap and will be reviewed in 2014

The updated projections suggest that the UK is likely to comfortably meet its first three carbon budgets. Projected emissions are lower for traded, non-traded and territorial emissions in the first three carbon budget periods than the June 2010 projections. Therefore the margin by which the UK is projected to overachieve against the first three carbon budgets is larger. There are a large number of factors contributing to the lower projections including changes to savings estimates, updates to data and assumptions and changes to modelling methodology. The largest impacts arise from changes in power plant assumptions[36], changes to OBR long term growth projections and changes to the method used to project industrial sub-sector growth.

[36] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/gen_costs/gen_costs.aspx

Sector Emissions

Table 3.3 shows the emissions projections from each of the traded and non-traded sectors by budget period.

Table 3.3 Greenhouse gas emissions by sector (DUKES sectors)

$MtCO_2e$	Oct-2011 Projections			
Sector	Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022	Carbon Budget 4 2023-2027
Traded, sector Emissions	**1,189**	**1,033**	**849**	**766**
Power stations CO_2	760	612	436	354
Refineries CO_2	78	79	81	92
Services CO_2	9	9	9	9
Industry CO_2	338	321	309	297
Traded Aviation CO_2[37]	2	11	12	14
Non-CO_2 traded Emissions	2	1	1	1
Traded sector cap under EU ETS	**1,233**	**1,078**	**985**	**-**
EUAs Purchased (negative implies sold)	-44	-46	-136	-
Non-Traded, sector Emissions	**1,689**	**1,571**	**1,472**	**1,441**
Residential CO_2	389	336	320	329
Services CO_2	91	85	61	55
Industry CO_2	135	152	146	141
Transport CO_2	650	598	576	564
Land use and forestry CO_2[38]	-22	-15	-10	-3
Non-Traded non-CO_2 emissions	446	416	379	354
Net UK Carbon Account	**2,922**	**2,650**	**2,457**	**-**
CARBON BUDGET	**3018**	**2782**	**2544**	**1950**[39]
Shortfall (negative implies emissions under budget)*	**-96**	**-132**	**-87**	**257**

* Shortfall against budget is reported on a net carbon account basis for carbon budgets 1,2 and 3 but on a territorial emissions basis for carbon budget 4.

It should be noted that figures in this and subsequent tables have been rounded. Totals are calculated from the un-rounded data and therefore may not appear to be the sum of the component parts.

[37] Domestic aviation will be included in the EU ETS from 2012. Emissions from domestic aviation are included in non-traded transport emissions prior to this.

[38] Land use, land use change and forestry differs from other sectors in that it contains both sources and sinks of GHGs. Sinks remove GHGs from the atmosphere and therefore can give rise to negative figures.

[39] The fourth carbon budget is conditional upon tightening of the EU ETS cap and will be reviewed in 2014

Changes to emissions projections since June 2010

As outlined above the projected level of total GHG emissions are lower than those previously projected in June 2010. Table 3.4 shows the breakdown of this reduction by sector. The largest reduction is due to lower projected emission from the power sector, followed by the transport and services sectors. The projected level of emissions from the residential sector has increased but this is outweighed by reductions in the other sectors. The underlying reasons for these changes are discussed in this section.

There were a number of drivers leading to lower power sector projections. These included changes to generation costs and plant efficiencies as a result of updated research[40], lower GDP growth and revisions to the methodology for projecting industrial sub-sector growth. As described in Chapter 2, DECC has revised its projections of the carbon value for use in modelling downwards in the long run. However, this is largely offset by the introduction of the carbon price floor which has also been incorporated into these projections. The combined impact of these two changes is therefore broadly neutral.

Industry emissions are lower overall, primarily as a result of lower GDP growth assumptions, changes to industrial sub-sector growth projection methodology and higher policy savings. The revisions to the sub-sector growth methodology tend to lead to lower projected growth in most industrial sub-sectors than previously projected. These projections tend to be less optimistic than short term industry forecasts. This is because they are based purely on statistical analysis of past trends and relationships. Industry forecasts are often partly based on expert opinion relating to the sub-sector or economic theory which are not taken into account in the DECC sub-sector projections. Further details on the changes to methodology are provided in Appendix A.

Residential emissions are higher than projected previously primarily as a result of revised demand equations. Expected policy impacts are also slightly lower. The largest change in policy savings relates to Warm Front which is now projected to increase non-traded emissions. The Warm Front Scheme mainly delivers new and replacement gas heating systems to low income and vulnerable households. It is now assumed that, in the absence of the policy, households will mainly heat their dwellings using secondary heating sources (such as plug-in electric heaters). The scheme will therefore reduce electricity usage and increase gas usage which results in an increase in non-traded emissions.

Services emissions are lower than previously projected principally as a result of revisions to the demand equations for the commercial sector following DECC's review of demand methodology.

Transport emissions are lower in each carbon budget period than previously projected. This is as a result of higher oil prices, changes to the demand equation to align with DfT methodology and revisions to methodology in the 2009 UK Greenhouse Gas Inventory. The change in the 2009 UK GHG Inventory was mainly due to better information on the proportion of emissions from shipping that fall within UK waters. Fewer emissions now appear in the national navigation category and more emissions appear in the international bunkers category. The latter is not part of the UK inventory and therefore not included in these projections.

[40] http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/gen_costs/gen_costs.aspx

The impact of the above factors on transport emissions is partially offset in the third carbon budget period as a result of lower policy savings. This is primarily because the road transport biofuels assumption has been reduced from 10% to 8%. This change is made for purely analytical purposes, based on CCC work on sustainability, and does not represent a change in policy. Subject to the outcome of recent consultations Government plans to consult in 2012 on appropriate biofuels trajectories to 2020 to meet its sustainability, renewable energy, and cost-effectiveness objectives, and will decide on trajectories beyond 2020 in due course. Input assumptions for these projections do not predict the outcome of that work and subsequent projections will need to be adjusted to take account of decisions made. Government remains committed to the 15% renewables target and the 10% transport sub-target as set out in the Renewable Energy Directive, including the principle that certain biofuels products count as double towards the transport sub-target.

Table 3.4 Indicative contribution of changes to projections in $MtCO_2e$

$MtCO_2e$	Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022
Power stations and refineries (CO_2 only)	**-9**	**-76**	**-113**
GDP growth projections	-5	-15	-19
New demand equations	21	5	-21
New sub-sector growth projections	-3	-15	-32
Nuclear generation	2	-21	-13
Fossil fuel prices/fuel switching	-7	-26	-49
Plant efficiencies (new plant)	-4	-6	-31
2009 GHG Inventory	-4	-4	-3
Other updates	-9	6	54
Industry (CO_2 only)	**-3**	**5**	**-17**
GDP growth projections	0	-4	-3
New sub-sector growth projections	-3	2	-4
Changes in policy savings	**-6**	**-4**	**-8**
Other updates	6	11	-3
Residential (CO_2 only)	**6**	**10**	**29**
New demand equations	2	20	37
Changes in policy savings	**8**	**6**	**6**
Lower household projections	**-3**	**-11**	**-17**
Other updates	-1	-5	2
Services[41]/Other (CO_2 only)	**-13**	**-17**	**-25**
New commercial demand equation	5	-7	-19
Revised OBR projections	0	-1	-1
New sub-sector growth projections	0	0	0
Changes in policy savings	**-6**	**-4**	**-3**
Other updates	-12	-5	-2
Transport (CO_2 only)	**-31**	**-39**	**-10**
Alignment with DfT demand methodology	-17	-11	1
Changes in policy savings	0	1	22
Higher oil price projections	-2	-15	-14
2009 GHG Inventory	-20	-20	-20
Other updates	8	6	1
LULUCF (CO_2 only)	**-15**	**-19**	**-22**
Non-CO_2 GHGs	**-13**	**-30**	**-35**
Total change in territorial emissions	**-78**	**-166**	**-193**

[41] Includes commercial, public, agriculture and other sub-sectors not included elsewhere

Comparison with other emissions projections

Cambridge Econometrics (CE) also publish projections of UK energy demand and emissions up to 2025. Their most recent report (UK Energy and Environment, August 2011) projects emissions to be higher than the estimates given in this report and suggests we will narrowly miss the first two carbon budgets and the third and fourth by a wider margin. As the CE projections were produced by a different model there will inevitably be some differences in the results. There are 3 key areas that account for the majority of the difference.

- CE only model 'firm' policies which they define as those that will definitely come into force and on which there is sufficient detail to base their modelling. This means that they do not take account of the impacts of a number of major existing or announced policies such as the Renewable Heat Incentive, Feed In Tariffs, Carbon Reduction Commitments and 2010 Building Regulations. They also only include part of the impact of other policies such as the Green Deal, Carbon Emissions Reduction Target, Renewable Transport Fuel Obligation and Products Policy & Labelling.
- CE project non-CO_2 GHG emissions using a top down approach that relates them to population growth and historical trends in emissions coefficients. This approach leads to higher projected emissions than those used in the DECC energy model. The DECC energy model relies on a much more detailed analysis to project these GHG emissions using a number of sector level studies informed by expert opinion. The DECC projections therefore take into account factors affecting future emissions that are not taken into account in the CE projections.
- There is a disparity between the CE historical CO_2 emissions and the verified UK Greenhouse Gas Inventory, largely because theirs were based on the 2008 Inventory. As a result their CO_2 emissions estimates between 2008 and 2012 are cumulatively 45MtCO_2 higher than actual verified emissions. This overestimate in the CE projections will also have an impact on later years estimates. The DECC projections presented in this report have been updated for the 2009 Inventory in which there were substantial revisions to past data. The revision had a substantial impact on DECC projections leading to revised projections being around 35MtCO_2 lower in each carbon budget period following incorporation of the 2009 Inventory.

If the CE projections were to be adjusted to take account our estimates of the above factors, they would suggest that we are on track to meet the first three carbon budgets. Although it is difficult to calculate precisely by how much, we would be likely to comfortably meet the first two carbon budgets and the third by a smaller margin.

The fourth carbon budget period is not comparable between the projections as CE assume a traded sector cap exists and so report on a net carbon account basis. As no traded sector cap has yet been set for the fourth carbon budget period this report only gives figures on a territorial emissions basis.

Chapter 4: Policies included in the projections

These emissions projections include all climate change policies that the government is committed to. The assessment of these policies is undertaken according to DECC-HM Treasury policy appraisal guidelines[42] consistent with the most recent projection baseline, and taking account of existing policies.

Where possible, policies are modelled and incorporated into the DECC Energy and Emissions Model. Other policies enter the model as exogenous demand reduction or in a few cases as off-model adjustments. Recently announced policies are included where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made.

The figures given in the table for the existing measures may differ from those reported in the latest published impact assessment for the individual policies. There are two main reasons for these differences. First policy savings are re-evaluated periodically on the basis of new evidence, improved methodologies or announced changes to the policy. For instance, revisions to UEP baseline projections affect the absolute level of savings expected from certain policies. Secondly, the treatment of policy overlaps used in the UEP projections differs to that used for policy appraisal purposes. In the UEP projections, a number of criteria are used to determine the ordering in which savings are attributed. These include the extent to which the policy is binding (e.g. regulations), when it was announced and how cost-effective the measure is expected to be. This is different to the approach followed for appraisal purposes where the marginal impact of each new policy is assessed after taking account of any policies that have already been announced.

For consistency and to aid comparisons between policies, this chapter contains details of the savings of individual policies in $MtCO_2e$. Therefore it contains the effect of the policy on the output of the model, rather than the inputs used in the modelling process.

Future policies to meet the fourth carbon budget have not been taken into account in these projections. New policies will be incorporated once the details have been agreed. Different options for meeting the fourth carbon budget will be discussed in a report to be published later this year.

[42] The IAG guidance (IAG guidance for policy appraisal - Department of Energy and Climate Change)

supplements the HMT Green Book (http://www.hm-treasury.gov.uk/data_greenbook_index.htm) that provides general guidance on how to conduct appraisal and evaluation of energy use and greenhouse gas emissions.

Table 4.1 Non-traded savings from policy measures included in projections

$MtCO_2e$	Non-Traded			
	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-2012	2013-2017	2018-2022	2023-2027
Residential sector	**31.9**	**79.3**	**108.3**	**107.6**
Building Regulations Part L (2002 & 2005/6) ‡	18.8	30.6	36.1	29.2
Warm Front & Fuel Poverty Measures ‡	-7.9	-6.3	-2.7	0.1
Supplier Obligation (prior to LCTP) ‡	19.0	27.4	27.0	22.7
Supplier Obligation (in LCTP)	2.7	20.3	19.9	16.0
Building Regulations 2010 Part L	0.4	7.4	14.9	19.9
Smart Metering	0.0	1.9	4.8	5.2
EU Products policy (Tranche 1, Legislated)	-1.4	-7.0	-9.8	-8.9
EU Products policy (Tranche 2, Proposed)	-0.1	0.0	2.1	2.5
Community Energy Saving Programme	0.1	0.3	0.3	0.2
Zero Carbon Homes	-	0.1	2.0	4.7
ECO and Domestic Green Deal	-	3.0	9.5	11.4
Renewable Heat Incentive	0.1	1.6	4.1	4.5
Commercial and Public Services	**12.3**	**21.7**	**44.3**	**47.6**
Carbon Trust Measures ‡	4.8	2.0	0.5	0.1
Energy Performance of Buildings Directive ‡	1.5	1.5	1.5	1.5
UK Emissions Trading Scheme ‡	0.1	0.0	0.0	-
Building Regulations Part L (2002 & 2005/6) ‡	5.1	7.0	7.5	6.1
Building Regulations Part L (2010)	0.1	1.7	3.4	4.6
Business Smart Metering	0.0	1.4	3.6	3.4
EU Products policy (Tranche 1, Legislated)	-0.1	-0.6	-0.7	-0.6
EU Products policy (Tranche 2, Proposed)	-0.1	-0.4	-0.7	-0.8
Small Business Energy Efficiency Interest-free Loans	0.1	0.1	0.0	-
Salix, Public Sector Loans, 10% commitment for Central Government	0.3	0.1	0.0	0.0
Non-Domestic Green Deal	-	0.8	3.0	2.9
CRC Energy Efficiency Scheme	0.2	1.8	4.5	6.2
Renewable Heat Incentive	0.3	6.4	21.8	24.3
Industry	**5.9**	**14.2**	**26.4**	**29.0**
Carbon Trust Measures ‡	2.2	0.9	0.3	0.1
UK Emissions Trading Scheme ‡	0.9	0.4	0.1	-
Building Regulations Part L (2002 & 2005/6) ‡	2.1	3.0	3.2	2.5
Building Regulations Part L (2010)	0.0	0.6	1.3	1.6
EU Products policy (Tranche 1, Legislated)	-0.0	-0.0	-0.0	-0.0
EU Products policy (Tranche 2, Proposed)	-0.0	-0.0	-0.1	-0.1
Small Business Energy Efficiency Interest-free Loans	0.1	0.1	0.0	-
Climate Change Agreements (2011-18)	-	-	-	-
Non-Domestic Green Deal	-	0.3	1.2	1.2
CRC Energy Efficiency Scheme	0.1	1.0	2.5	3.5
Renewable Heat Incentive	0.5	7.8	18.0	20.2

Table 4.1 (Continued)

$MtCO_2e$	Non-Traded			
	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-2012	2013-2017	2018-2022	2023-2027
Transport (excluding baseline measures*)	**1.8**	**23.4**	**63.1**	**99.1**
EU new car CO_2 mid-term target - 130g/km CO_2* in 2015	0.4	5.3	13.4	20.5
EU new car CO_2 long-term target -95gCO_2/km in 2020	0.1	1.5	18.2	47.4
Transport biofuel (8% by energy in 2020)	-	5.7	10.5	0.0
EU new van CO_2 regulation – 147gCO_2/km in 2020	0.0	0.6	3.0	7.7
EU complementary measures for cars	0.3	3.4	7.7	10.1
Low rolling resistance tyres for HGVs	0.0	0.5	3.2	3.9
Industry led action to improve HGV efficiencies	0.3	2.2	2.7	5.2
Local Sustainable Transport Fund	0.6	3.7	2.0	0.2
Low carbon buses	0.0	0.2	1.4	3.0
Rail electrification	-	0.1	1.0	1.0
Agriculture & Waste (non-CO_2) (excluding baseline measures†)	**-**	**2.1**	**14.9**	**17.0**
Landfill tax†	N/A	N/A	N/A	N/A
DEFRA waste policy (non-CO_2)†	N/A	N/A	N/A	N/A
Agriculture Action Plan	-	2.1	14.9	17.0
Total (excluding baseline changes)*†	**51.9**	**140.7**	**257.0**	**300.2**

***** Savings from RFTO (5% by volume) and EU Voluntary Agreements on new car CO_2 to 2009 are taken into account in the projections since savings from older measures are included in the baseline for newer measures. However the methodology used to derive the impact of transport measures does not allow policy savings for older measures to be estimated. Therefore they are not reported in this table.

** Estimates of the savings from Transport biofuels are based on achievement of 8% fuel share by 2020. An assumption of 10% was used in the June 2010 projections. This change is for modelling purposes only and does not imply any change policy or in government commitment to renewables.

† Latest projections for Waste emissions do not include an explicit estimate for the impact of Landfill Tax or Waste policy: these have been absorbed into a single baseline projection.

‡ Baseline measure: the policy predates the Low Carbon Transition Plan 2009.

Chapter 5: Uncertainty in the projections

The projections reported here are sensitive to data inputs (e.g. GDP growth, generation costs, policy impacts) and modelling assumptions. The accuracy of the projections is also affected by the extent to which the equations used to forecast future demand accurately predict responses to changes in future prices, growth or other drivers of demand. This chapter contains three sections. The first provides estimates for the overall level of uncertainty in the projections taking account of the combined impact of different sources of uncertainty. The second section focuses on sensitivity to economic growth assumptions. The third considers uncertainty in the projections of EU ETS allowances purchased or sold.

Uncertainty ranges

Projecting emission levels into the 2020s is subject to uncertainty and depends upon modelling correctly the link between economic activity and GHG emissions; modelling and anticipating future drivers, such as temperatures, fuel prices, power station capital costs, economic growth and population; and, accurately forecasting the impact of climate change policy.

In order to take account of some of the sources of this uncertainty in the emissions projections, ranges for emissions levels have been produced based on statistical techniques (Monte Carlo simulation) to capture the likely variations in some of the key inputs to the projections (fuel prices, GDP, temperatures, policy impacts, power station capital costs, non-CO_2 emissions).

Results presented in this section show the impact of capturing this uncertainty. The methodology uses a “Monte Carlo” methodology which allows simulation of fuel demand and hence emissions under a large range of possible values of the drivers, allowing a picture of the uncertainty surrounding emissions projections to emerge. For instance a range within which we would expect the true level of total future policy savings to lie is derived taking account of uncertainties in individual policy savings estimates. At each iteration a particular savings impact estimate is selected at random from the range of possible values. Simulated values for the other drivers are generated in a similar way. These values are fed through to a simplified version of the demand model to provide a range of simulated fuel demands. Each simulated demand for electricity is entered into the electricity supply part of the model which is run under a different capital and fuel cost scenario for each demand scenario. The method also takes some account of modelling uncertainty caused by errors in the demand equation estimates and modelling assumptions but it does not take account of the potential increase in forecast error over time. In addition, uncertainty arising from internal modelling assumptions is not taken into account.

The 95% confidence intervals in Tables 5.1 and 5.2 represent the value of emissions obtained from the lower 2.5% and upper 97.5% percentiles of the simulations respectively. Figure 5.1 shows how the range of uncertainty increases over time. The uncertainty analysis does not fully take account of all sources of uncertainty. In particular the level of

uncertainty resulting from forecast errors in the demand equations will increase the further we project into the future. However, as shown in Table 5.1 the margin of overachievement against targets is large even after allowing for the main sources of uncertainty. This analysis therefore suggests that the likelihood that the UK will fail to meet carbon budget targets in the first three carbon budget periods is low.

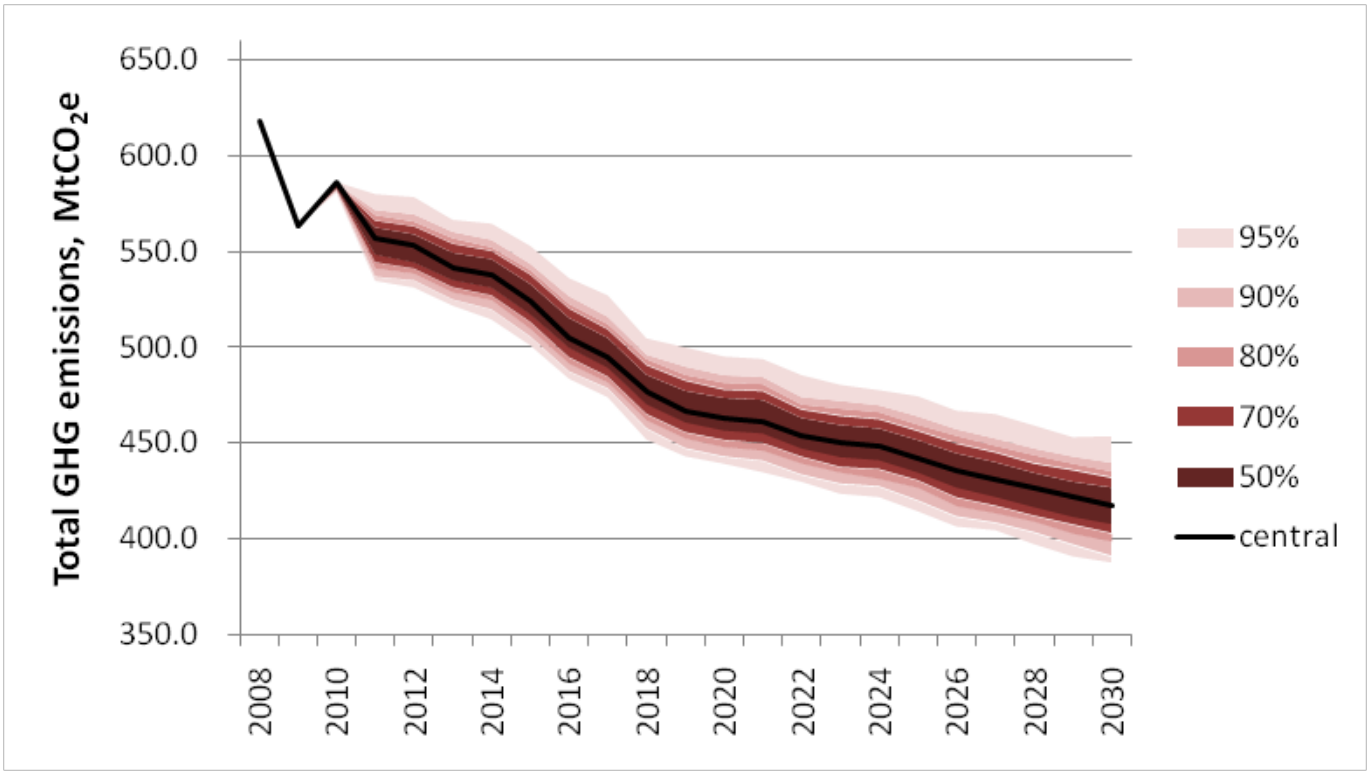
Table 5.1 Uncertainty in net UK Carbon Account and shortfall against budget

$MtCO_2e$		Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022	Carbon Budget 4 2023-2027
Net UK Carbon Account	Central	2,922	2,650	2,457	2,207
	Lower 95% CI	2,894	2,610	2,402	2,111
	Upper 95% CI	2,945	2,709	2,525	2,318
Carbon Budget		3,018	2,782	2,544	1,950
Shortfall (negative implies under budget)	Central	-96	-132	-87	257
	Lower 95% CI	- 124	- 172	- 142	161
	Upper 95% CI	- 73	-73	- 19	368

Table 5.2 Uncertainty in Territorial Emissions

$MtCO_2e$		Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022	Carbon Budget 4 2023-2027
Traded	Central	1,189	1,033	849	766
	Lower 95% CI	1,175	999	803	709
	Upper 95% CI	1,209	1,076	915	829
Non-Traded	Central	1,689	1,571	1,472	1,441
	Lower 95% CI	1,661	1,532	1,417	1,377
	Upper 95% CI	1,712	1,630	1,540	1,510
Total	Central	2,877	2,604	2,322	2,207
	Lower 95% CI	2,843	2,548	2,245	2,111
	Upper 95% CI	2,912	2,692	2,433	2,318

Figure 5.1 Uncertainty in territorial emissions projections



Sensitivity to GDP growth assumptions

One of the main drivers of emissions is the overall rate of economic growth. The uncertainty analysis in the preceding section takes account of uncertainty in economic growth alongside other factors. This section examines the sensitivity of projections to GDP growth assumptions if all other assumptions remain unchanged. Tables 5.3 and 5.4 show how the projections would change if GDP growth were one quarter of a percentage point higher or lower than the central projection in each year. Although economic growth assumptions have a substantial impact on the level of additional policy effort required to meet the fourth carbon budget, the UK would still be projected to meet its first three carbon budgets under a high growth scenario. The revisions to growth projections following the recession therefore increase the margin by which the UK is projected to overachieve against the first three carbon budgets. However even under a higher growth scenario similar to that projected prior to the recession the UK would have been on course to meet the first three carbon budgets.

The projections are also sensitive to sub-sector growth projections as industrial sub-sectors tend to be more energy intensive than the commercial and public sectors. Uncertainty in relative growth rates is not taken into account in Tables 5.3. and 5.4.

Table 5.3: Economic growth sensitivity in net UK Carbon Account and shortfall against budget

$MtCO_2e$		Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022	Carbon Budget 4 2023-2027
Net UK Carbon Account	Central	2,922	2,650	2,457	-
	Low growth	2,921	2,644	2,446	-
	High growth	2,922	2,655	2,469	-
Carbon Budget		3,018	2,782	2,544	1,950
Shortfall (negative implies under budget	Central	-96	-132	-87	257
	Low growth	-97	-138	-98	218
	High growth	-96	-127	-75	301

Table 5.4 Economic growth sensitivity in territorial emissions

$MtCO_2e$		Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022	Carbon Budget 4 2023-2027
Traded	Central	1,189	1,033	849	766
	Low growth	1,189	1,029	836	744
	High growth	1,189	1,038	864	792
Non-Traded	Central	1,689	1,571	1,472	1,441
	Low growth	1,688	1,566	1,461	1,424
	High growth	1,689	1,576	1,484	1,460
Total	Central	2,877	2,604	2,322	2,207
	Low growth	2,877	2,595	2,297	2,168
	High growth	2,878	2,615	2,348	2,251

Uncertainty in projections of EUA purchases and sales

The actual level of EU ETS allowances that will be allocated to UK installations in future Carbon Budget periods is uncertain. This uncertainty has an impact on projections of the net UK carbon account and of purchases and sales of EU ETS allowances. The value of the "traded sector cap" referred to elsewhere in this report is set equal to the forecast allocation of UK EU ETS allowances that was anticipated in the UK Carbon Budgets legislation. This "traded sector cap" is used for the purpose of projecting purchase and sale of UK EU ETS allowances and the UK net carbon account elsewhere in this report.

These values, reported in the legislation, are used because the true values are uncertain and will not be known until after the end of the budget period to which they relate. However, DECC does have internal projections of the actual level of allowances that it expects to be allocated to the UK that are updated on a regular basis. These are used for the purpose of internal monitoring. Projections of UK purchases and sales of EU ETS allowances based on these internal projections are shown in Table 5.5 and compared with the estimates reported elsewhere in this report. This provides an indication of the

sensitivity of projections to uncertainty in the level of EU ETS allowances that will be allocated to the UK.

Table 5.5 EUA purchases and sales

$MtCO_2e$	Carbon Budget 1 2008-2012	Carbon Budget 2 2013-2017	Carbon Budget 3 2018-2022
Projected traded sector emissions	1,189	1,033	849
Traded sector carbon budget (UK legislation)	1,233	1,078	985
Projected purchase of EU ETS allowances using traded sector carbon budget	-44	-46	-136
Latest DECC projections of EU ETS allowances the UK will receive	-	1,066	966
Projected purchase of EU ETS allowances using latest projection of UK allocation	-	-27	-110

Chapter 6: Electricity generation

The projections and discussion in this section relates to major power producers (MPPs), including all renewables plants[43]. The generation mix is sensitive to the fossil fuel price, technology costs and the carbon price. Full results from other fossil fuel price scenarios can be found in annexes D, E, I, J, K and L.

Background

Despite an increase in 2010, electricity demand remains well below pre-recession levels. Demand in 2010 is estimated to have been 4.5% lower than in 2007, the last full year before the recession started to take effect. Notwithstanding the effects of the recession, demand has exhibited a declining trend in recent years and the outturn in 2010 is lower than in any year since 2000 and barring 2009, the outturn in 2010 was lower than any year since 1999.

After a large increase in 2009 nuclear output fell in 2010, reflecting plant outages. Output has picked up again at the end of 2010 and early in 2011. The output from coal and gas stations increased in 2010, reflecting the fall in nuclear output and increase in electricity demand. Output from coal stations has shown an underlying increase recently which seems to reflect movements in coal and gas prices with the differential tending to favour increased coal generation.

The overall result of these developments was an increase in power station CO_2 emissions in 2010.

Assumptions

The power station projections are dependent on a number of specific assumptions. Using different assumptions will lead to different results. **The particular results shown here reflect a set of assumptions on fossil fuel and carbon prices and costs. They do not reflect a desired or preferred outcome for Government. In particular, these results in no way reflect Government's views on the need for different types of electricity generation.**

Plant-specific assumptions used in the modelling have been updated to reflect the results of consultancy work for DECC. Separate studies have dealt with renewable and all other technologies[44]. The key changes to assumptions include both revisions to capital costs, particularly for CCGTs and plant efficiencies, including for new CCGTs.

The power station projections embody a number of other assumptions. The key ones are as follows:

- **Plant-specific assumptions:** These have been updated to reflect the results of recent reports by Parsons Brinkerhoff and ARUP[44] which analysed power station

[43] Major power producers are as defined in the Digest of UK Energy Statistics, 2011, section 5.66 et seq.

[44] Generation costs - Department of Energy and Climate Change

costs, including revisions to both capital costs and plant efficiencies. The projected generation mix is sensitive to relative capital and running cost assumptions.

- **Carbon Capture and Storage (CCS):** It is assumed that four CCS demonstration plants proceed as part of a larger overall increase in new coal-fired capacity, with the first commencing operation in 2014. Commercial CCS technology is assumed to be available by 2025. Any new coal build is then assumed to be fully CCS.
- **Industrial Emissions Directive (IED):** It is unclear how plant operators will decide to operate their plants under the IED. It is assumed that the majority of coal plants remain open under one of the options available under the IED, but that some generating unit closures occur.
- **Electricity Market Reform:** The electricity generation analysis in these projections does not take into consideration the measures due to be introduced as a result of the Electricity Market Reform (EMR). This is because, although the measures in EMR have been tested to ensure they are able to meet a wide range of decarbonisation pathways, the level of the decarbonisation of the electricity sector to be delivered by the EMR has not yet been set. DECC is undertaking analysis using a more detailed model of the electricity sector looking at different decarbonisation scenarios. This will be included in a report due to be published later this year. The projections reported here are based on a model in which producers know what future demand and prices will be (i.e. in effect the model assumes perfect foresight). The more detailed model used for EMR analysis takes account of the impact of uncertainty about future returns on decisions made under current market arrangements. Therefore the results obtained from the latter for the pre-EMR baseline scenario, against which EMR impacts will be assessed, are likely to differ from those reported here.
- **Renewables:** The Renewable Energy Strategy delivers a much higher level of electricity supply from renewable sources by 2020, equivalent to around 30 per cent of total electricity supply. For the period beyond 2020, in order to align with the pre-EMR scenario, it is assumed that renewables continue to receive Renewables Obligation Certificate (ROC) support but without a specific target for the penetration of renewables into the generation market. The build of new renewable capacity is otherwise determined by the cost of adding new capacity, as for other types of plant.
- **Carbon price floor:** The carbon price faced by electricity providers incorporates the impact of the carbon price floor at levels announced in the March 2011 budget.
- **Investor plans**: the projections do not take account of any announcements made by energy companies about planned investment in new plants. However the projections do make allowance for plants whose construction has already begun.

Major Power Producers (MPP)

Overall electricity demand is projected to be lower in 2011 than in 2010. The output of the MPP sector is projected to decline further post–2011, due to the restraining impact of energy efficiency programmes and the projected growth in non-MPP generation. Demand is also restrained to some extent by a projected high level of electricity prices in the long

term. There is much uncertainty as to the underlying shares of generation, but based on the assumptions in these updated projections, the share of coal in generation is expected to increase a little from 2010 levels in the short and medium term. This arises partly because of the increased competitiveness of coal against gas due to the fossil fuel price movements.

The commencement of operations at the CCS demonstration plants, including the unabated component, serves to support coal–fired generation in the second half of the decade, while the share of coal–fired generation accounted for by existing coal stations falls over the same period. Beyond 2020, the impact of economic growth outweighs the impact of the policies and prices on electricity demand, and the requirement for generation from MPPs increases significantly, in contrast to the modest decline in the preceding decade.

The Renewable Energy Strategy (RES) is assumed to lead to a 30% share of renewables in total generation in 2020 and small scale installations brought on by Feed-In Tariffs (FITS) take the total share of renewables to around 31%. Renewables generation continues to rise, but at a slower rate, after 2020.

The impact of the increase in renewables generation is to significantly reduce the size of the available market for fossil fuels. As new coal and gas plants come on stream, the impact falls mainly on existing coal and gas plants, whose load factors fall significantly. Nonetheless, these plants are available as backup for periods when intermittent sources of generation are not operating.

Under central prices, new nuclear is expected to commence in 2022, a year later than in the last projections. This mainly reflects the more attractive economics of new Combined Cycle Gas Turbines (CCGT), which benefits from lower assumed capital costs and higher assumed plant efficiency. However, timescales for the deployment of new nuclear capacity in the UK will be the result of commercial decisions made by private investors and will be affected by the government's proposals for reform of the electricity market which are not taken into account in these projections. Developers have announced plans to build 16GW of new nuclear capacity in the UK, with the first reactor scheduled to become operational in 2018. Projections of future electricity prices and demand, together with the projected need for new generating capacity, are subject to significant uncertainty. Projections of new generating capacity should therefore be viewed as indicative of longer term trends.

Figure 6.1 shows projected cumulative new build by plant type. While there is a contribution from a number of generation technologies, the major expansion in generating capacity over the projection period comes from renewables.

Figure 6.1 Projected cumulative new build by plant type for MPPs, 2011 to 2030

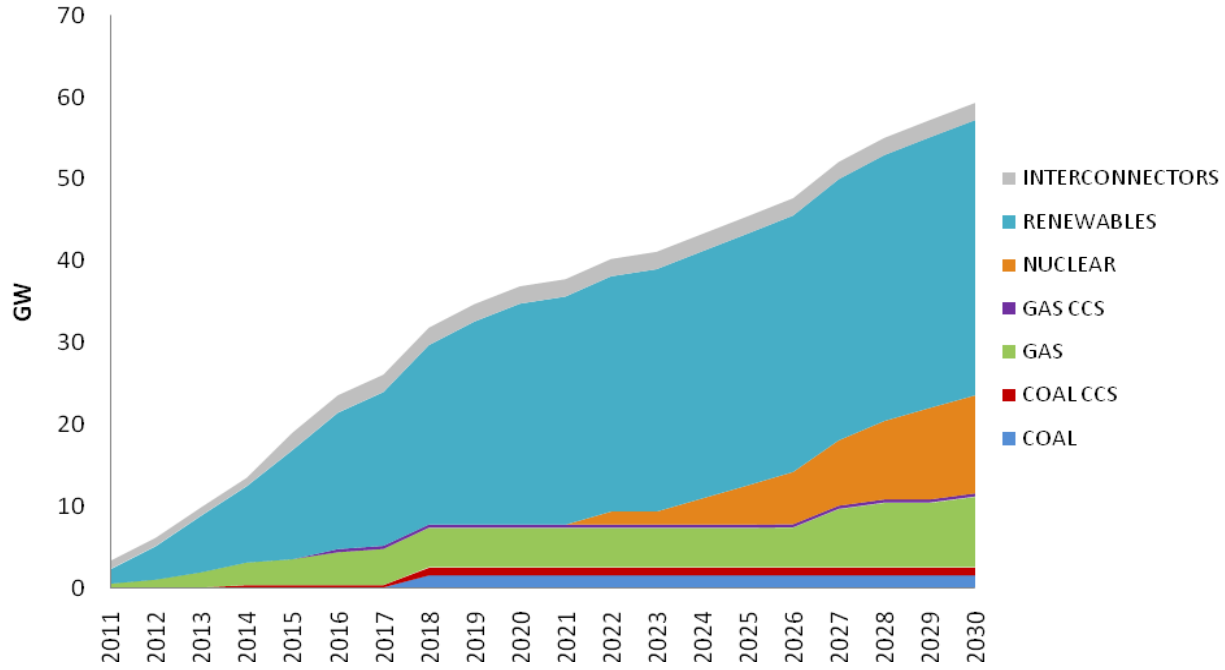
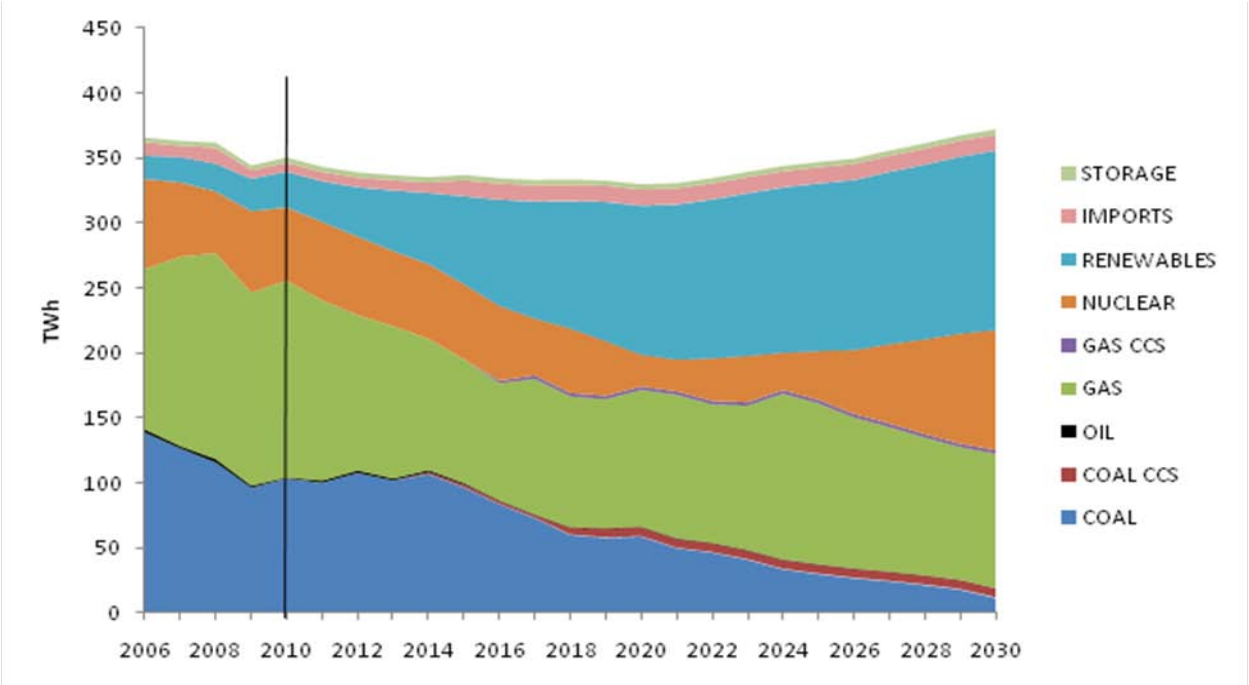


Figure 6.2 shows actual and projected levels of electricity supply by fuel. In summary, the major features of the projection are a large expansion in supply from renewables to 2020 and a significant diminution in supply from coal-fired plants in the longer term.

Figure 6.2 Electricity supplied[45] by fuel for the MPPs, 2006 to 2030



[45] Electricity supply is defined as gross generation less the amount of electricity used on station sites (own use). It therefore corresponds to the term 'Supplied (gross)' used in DUKES Table 5.6.

Combined heat and power capacity

Good quality combined heat and power (CHP) systems offer highly efficient fuel use with low associated emissions per unit of energy output. Whilst providing considerable scope for emissions reduction over the conventional, separate, means of generating electricity and heat (i.e. via power station and boiler), development has been restricted over recent years primarily as a result of unfavourable market price differentials between gas and electricity, uncertainty in heat markets and difficulty in acquiring capital finance .

Projections of CHP capacity were provided by AEA Technology under contract to DECC. The projections are based on a bottom-up model that considers the economic case for individual sites based on their heat and power requirements and incorporate behavioural aspects of the decision making process using a Monte Carlo simulation of industry attitudes towards risk. The current modelling has been updated with the latest available information on the industry.

Revised projections of installed capacity are shown in Table 6.1 and compared with previous projections.

Table 6.1: Updated projection of installed capacity of CHP

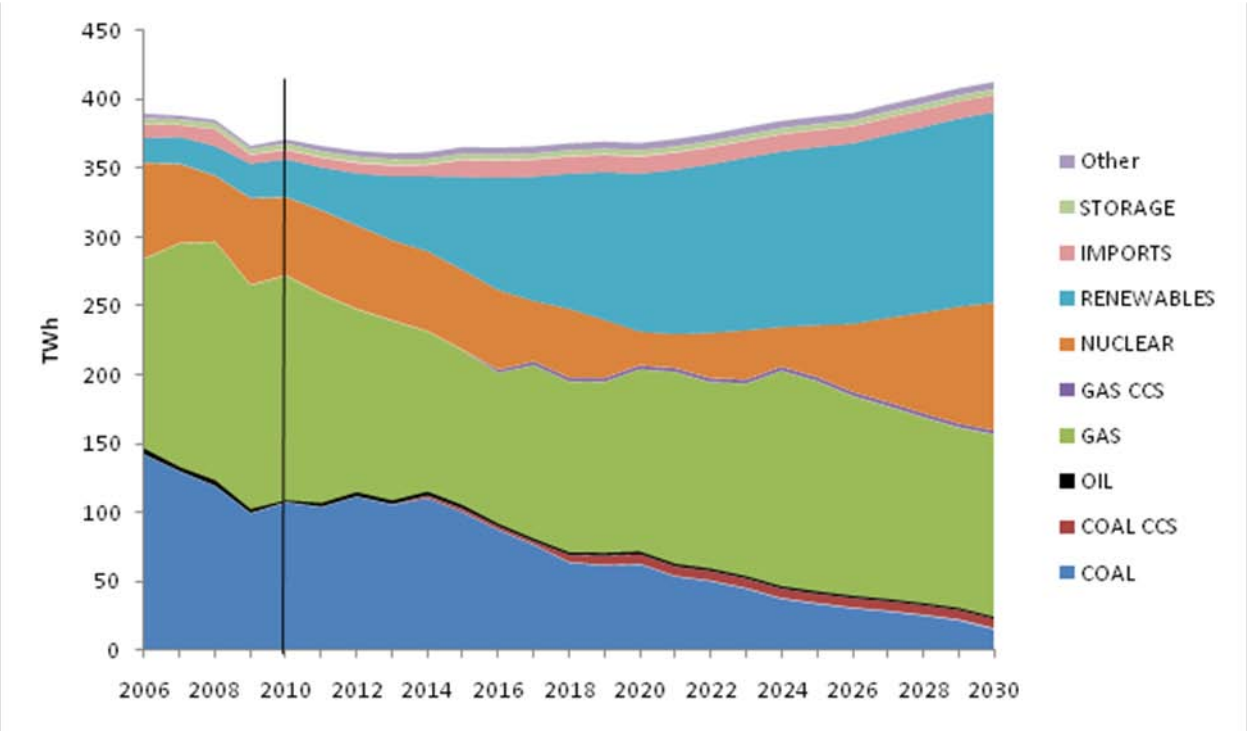
Capacity, GW	2010	2015	2020
June 2010 projection	6.3	9.4	12.7
October 2011 projection	6.0	8.6	11.3

The latest data shows that over the last few years, CHP development has generally remained rather low and whilst there has been a marked increase in the use of renewable fuels in some new installations, this has not been enough to change the trend. This is reflected in the current modelling. There remains, nevertheless, potential for growth in CHP in the UK, particularly in the energy industries sector where the largest capacity potential for CHP will be in the re-gasification of liquefied natural gas imported from abroad. In addition, the progressively increasing penetration of renewable CHP is expected to continue, incentivised by the Renewables Obligation and other policies, such as the Renewable Heat Incentive.

All electricity supply

Figure 6.3 below shows the total electricity demand and generation mix under the central scenario including MPP, CHP and auto-generators.

Figure 6.3 Electricity supply[46] by fuel for all generators, 2010 to 2030



[46] Electricity supply is defined as gross generation less the amount of electricity used on station sites (own use). It therefore corresponds to the term 'Supplied (gross)' used in DUKES Table 5.6.

Chapter 7: Demand for energy

Demand for energy can be considered on a final energy demand or a primary demand basis. Final energy demand is energy used by final consumers (households, businesses etc). Primary energy demand is energy from raw fuels that has not been subjected to any transformation (for example fuel used to produce electricity).

In this chapter projections of final energy demand are presented first. These can be used, together with the results on electricity generation contained in Chapter 6, to calculate projections of primary energy demand.

Final Energy Demand

The results are arranged on the basis of final energy demand by final user and across all sectors and include the estimated impact of the policy measures. Table 7.1 is based on central price assumptions and provides disaggregated demand for each energy source and major sector. Figures, in million tonnes of oil equivalent (Mtoe), are presented on a consistent basis with the Digest of UK Energy Statistics (DUKES) and include all fuel sold within the UK or exported to the Crown Dependencies of Guernsey, Jersey and the Isle of Man.

Table 7.1 Energy demanded by final user (UEP sectors)[47]

Mtoe	2010	2015	2020	2025	2030
Industry	**28**	**29**	**30**	**29**	**29**
Electricity	9	10	10	10	11
Gas	12	11	10	10	10
Petroleum	5	5	4	4	4
Solid / manufactured fuels	2	2	2	1	1
Renewables	0	1	4	4	3
Domestic	**47**	**38**	**36**	**38**	**40**
Electricity	10	8	7	8	9
Gas	33	27	26	27	29
Petroleum	3	1	1	1	1
Solid / manufactured fuels	1	1	1	1	1
Renewables	1	1	1	1	1
Transport	**56**	**57**	**58**	**58**	**60**
Electricity	~	~	~	~	~
Aviation fuel	12	14	16	18	21
Petroleum (Rail)	1	1	1	1	1
Petroleum (Shipping)	1	2	2	2	2
Petroleum (Road transport)	40	37	36	36	35
Bio-fuel	1	2	3	2	2
Other	**19**	**18**	**17**	**17**	**19**
Electricity	9	9	9	10	11
Gas	8	7	5	5	5
Petroleum	1	1	1	1	1
Solid / manufactured fuels	~	~	~	~	~
Renewables	0	1	2	2	2
Total	**150**	**142**	**140**	**143**	**148**
Electricity	28	27	27	29	31
Gas	53	46	41	42	44
Petroleum	64	62	60	62	63
Solid / manufactured fuels	3	3	2	2	2
Renewables	3	4	10	8	8

~ Less than 1 Mtoe

Figure 7.1 shows final energy demand is projected to fall until 2022 and then to increase over the period of the fourth carbon budget. The projected level of final energy demand in 2030 remains below that for 2010. There is a projected increase in final demand for renewable fuels. This is accompanied by a reduction in the final demand for solid / manufactured fuels, petroleum and gas.

Figure 7.2 shows that energy demand from public administration and transport is projected to increase. The domestic and commercial sectors are projected to reduce their final energy demand over the period 2010 to 2030. Further details are available in Annex C.

[47] On an energy supplied basis, excluding non-energy uses, and including fuels used to generate heat sold under contract to third parties.

Figure 7.1 Final energy demand by fuel type

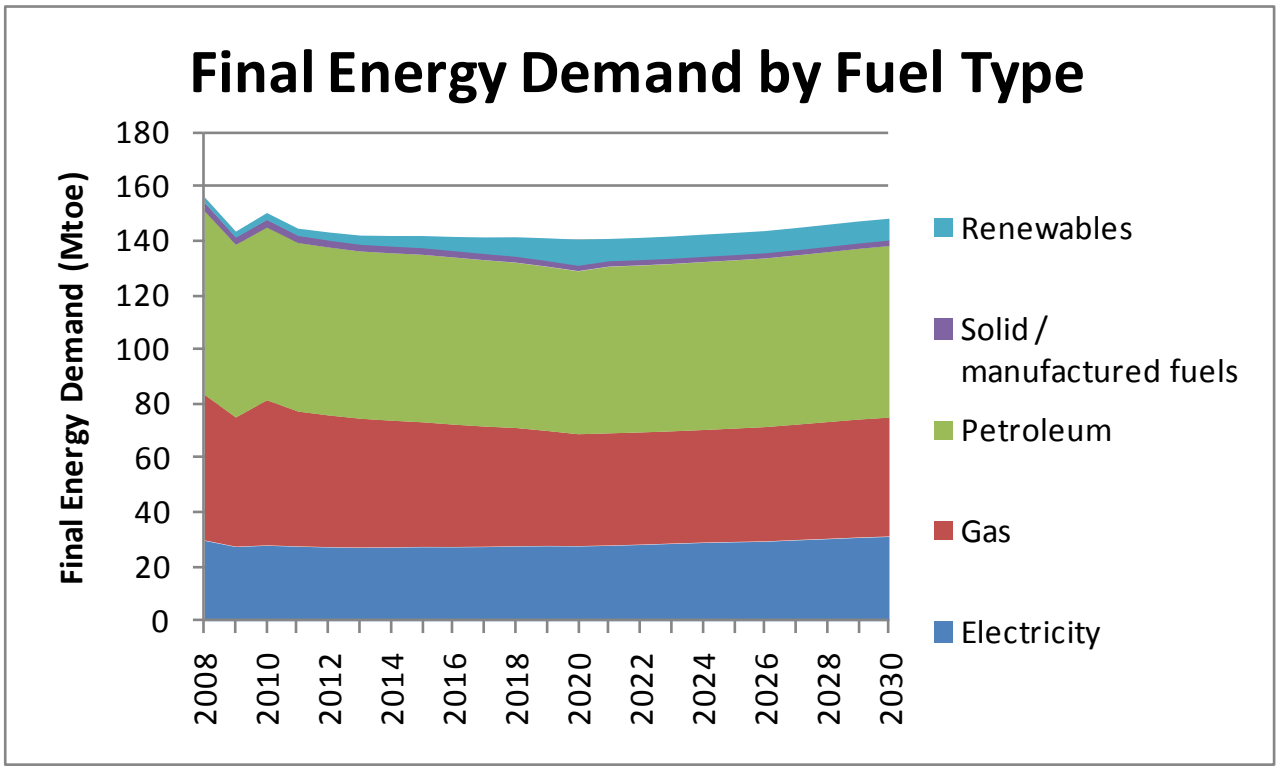
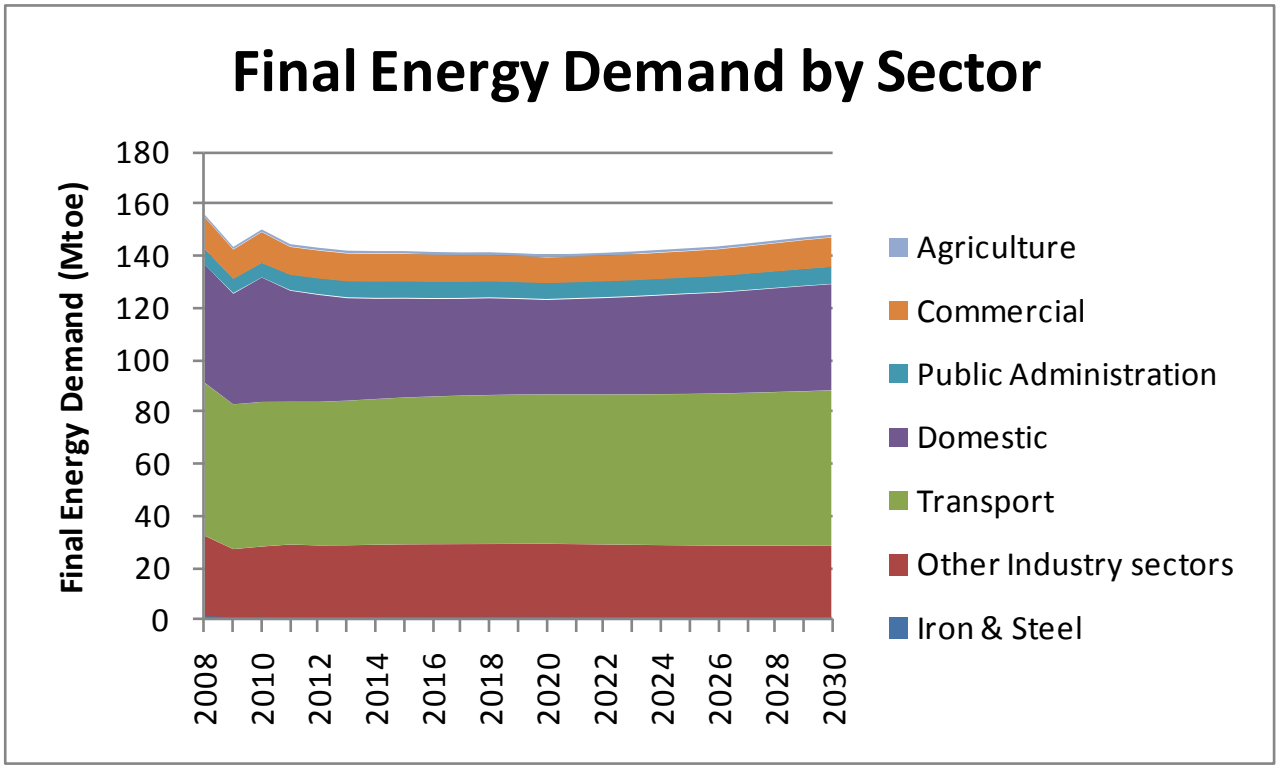


Figure 7.2 Final energy demand by sector[48]

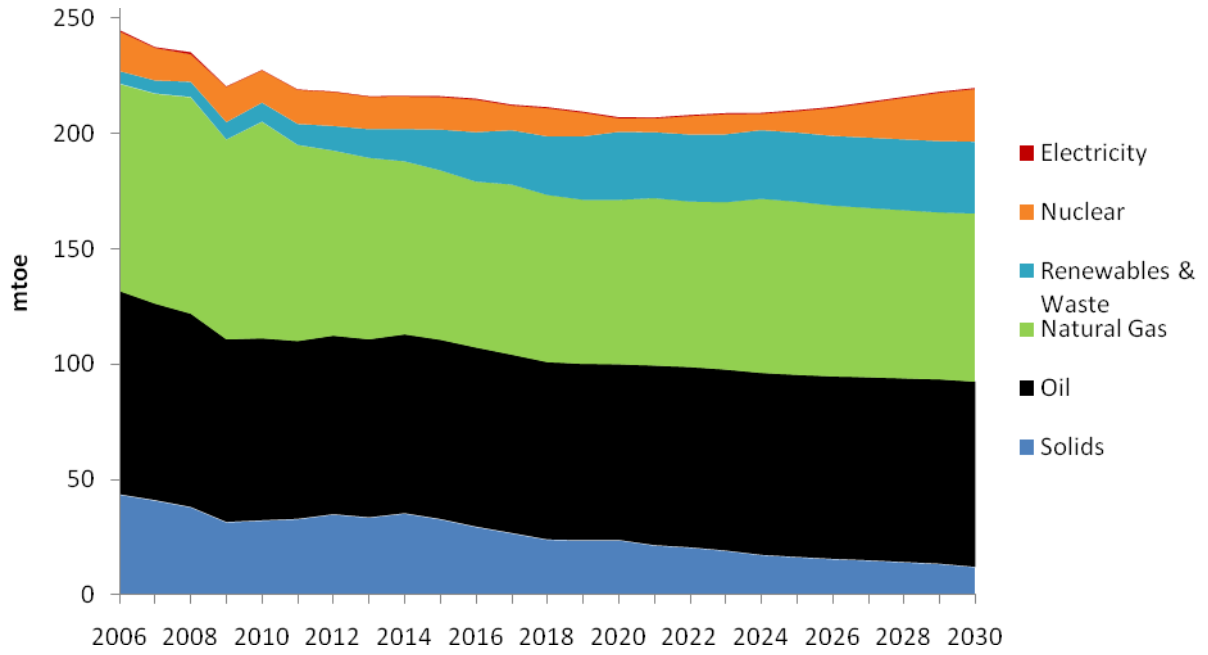


[48] Sectors used here are on the same basis as the Digest of UK Energy Statistics and are not comparable with sectors described for emissions in earlier sections.

Primary Energy Demand

Figure 7.3 shows a reduction in primary energy demand from 2010 to 2030. As with final energy demand there is a projected increase during the fourth carbon budget period. There is a general shift in primary energy demand away from solid fuels and natural gas and towards renewable and nuclear sources. Annex H contains the data supporting Figure 7.3.

Figure 7.3 Projections of primary energy demand[49,50]



[49] In this figure, all renewable energy is included in the category 'renewables & wastes', whereas in DUKES, some renewables are included in other categories, for example, hydro and wind are included with 'primary electricity' in the overall energy balances.

[50] Electricity here refers to net imports of electricity.

Chapter 8: List of supporting tables

The following data tables can be downloaded providing individual year projections for a range of scenarios.

Annex A: Greenhouse gas emissions by source

Annex B: Carbon dioxide emissions by source

Annex C: Final energy demand

Annex D: Major power producers generation by source

Annex E: Total electricity generation by source

Annex F: Fossil fuel, wholesale and retail price assumptions

Annex G: Policy savings included in the projections

Annex H: Primary energy demand

Annex I: Total cumulative new electricity generation capacity

Annex J: Total electricity generation capacity

Annex K: Major power producers cumulative new capacity

Annex L: Major power producers capacity

Appendix: Review of energy demand methodology

Introduction

In 2011 DECC undertook a review of the methodology used to project fuel demand in its emissions projections model. The review consisted of two parts:

- Re-estimation of demand equations for key sectors
- Development of a new methodology for projecting industrial sub-sector growth

Re-estimation of demand equations

Background

Within the emissions projections model, demand for individual fuels is projected using a series of equations for individual sectors and sub-sectors. The equations are derived from econometric[51] analysis of the past relationship between demand and key drivers such as output and price. DECC commissioned Oxford Economics to undertake a review of the demand equations in 2008[52] and this led to re-estimation of the industrial sub-sector demand equations using data up to 2006[53]. The remaining equations remained largely unchanged and were mainly developed from analysis of data up to 2003. The aim of the review was to update the equations and methodology to take account of recent data and allow re-estimation on an annual basis.

The equations were not previously re-estimated using recent data because recent demand has been reduced due to the impact of policies. The model projects forward a before policy baseline demand i.e. a projection of what demand would have been in the absence of climate change policies. Estimated future savings from policies are then deducted. Estimating the equations using data from the period before climate change policies had a substantial impact and ensured that the analysis was not distorted by policy impacts. However, the methodology had the drawback that the latest data were not taken into account and, because trends were likely to change over time, the projections would be less robust. In order to adjust for past policy savings when re-estimating the demand equations, estimates of past policy savings were used to adjust past actual demand.

Priority was given to re-estimation of those equations that had not been redeveloped as part of the Oxford Economics review. Results from re-estimation of individual sector equations are described below. The transport equations were not re-estimated directly but redeveloped to align more closely to DfT's projection methodology. The new equations for the other sectors were developed using data from 1980 to 2009. In order to ensure the

[51] Econometric or regression analysis is a statistical technique that can be used to derive estimates of the influence one or more variables have on the variable of interest e.g. the extent to which demand for fuel decreases as the price increases.

[52] http://www.theccc.org.uk/pdfs/Final_Report_Dec_2008.pdf

[53] http://www.theccc.org.uk/pdfs/Final%20report%20December%202008.pdf

new equations would improve the robustness of future projections, their forecasting performance was tested by estimating the equations on data up to 2003 and comparing projections with actual data. The forecast performance was compared with the projections produced by the old equations which were developed on data up until 2003. The revised equations were found to have better forecasting performance than the previous equations with substantial improvements for the commercial sector and smaller improvements for other sectors.

Residential

The revisions led to a slightly lower projected residential electricity demand and higher gas demand. The increase in gas demand led to residential emissions being around 15% higher than under the previous methodology by the third carbon budget period with the difference increasing over time. The increase was partly due to a statistical revision to residential gas demand outturn data from 2005 onwards.

Commercial

The new projection for the commercial demand for individual fuels is derived from a two stage process, similar to that already used for estimating Industrial sub-sector fuel use. First total energy demand is projected and then a separate equation is used to project the fuel shares for this demand. Both the equation for total demand and the fuel share equation were re-estimated. The revisions led to substantially lower projected commercial gas demand and slightly higher electricity demand. As a result CO_2 emissions are around 30% lower in the services sector than under the previous methodology in the third carbon budget period with the difference increasing over time. The main reason for the change is that the previous method projected on the basis that gas demand would rise in proportion to employment and electricity demand in line with sector Gross Value Added (GVA).

When we reviewed this we found that analysis of past data suggested that commercial demand is more closely related to GVA combined with a long-term trend of declining energy intensity; fuel prices; and, temperatures.

At a fuel shares level there has been a long term secular trend towards a higher share of energy needs being met by electricity, while past growth in the gas share had largely been at the expense of heating oil. The latter substitution has now been largely completed.

Transport

For the transport sector new energy and fuel demand equations were developed for domestic and commercial road transport. These new transport equations were developed in collaboration with DfT to ensure the DECC model results are more closely aligned with the projections from the DfT's National Transport Model. The latter is a sophisticated simulation model that cannot be fully integrated with the DECC model. DfT developed a simplified equation that relates distance travelled to population, fuel prices and economic growth and gives results that are broadly consistent with the National Transport Model. DfT also provided the fuel efficiency series for use in the model with and without policy impacts. Implementation of this revised methodology led to small reductions in projected CO_2 emissions in the first two carbon budgets but slightly higher emissions in carbon budget three with the impacts being less than +/- 5% in all carbon budget periods.

Iron and Steel

Iron and steel demand is projected using a series of equations for the different stages of production. The chemical processes involved in smelting mean that for the most part there is a constant ratio between fuel use and final outputs from the production process. Therefore the revised equations for fuel demand from each individual process are similar to those used previously and relate iron and steel energy demand to output and fuel price. The main change is that the new equations were estimated using DUKES statistics for actual past demand. In the past ISSB (International Steel Statistics Bureau) data was used which meant an adjustment was required to reconcile with DUKES. The change allows DECC to more easily quality assure and reconcile results.

The resulting projections for individual processes give similar results to the previous equations. However during the review, an error was identified in the methodology previously used to aggregate fuel demand from the different processes that led to total emissions from this sector being over-estimated. The improved methodology therefore leads to reductions in emissions in the power sector and industry. As a result emissions from industry are lower than under the previous methodology.

Chemicals and Non-Metallic Minerals

Industrial sub-sector energy demand equations, apart from those for iron and steel, were re-modelled in 2008 by Oxford Economics using data up to 2006.

It was not possible within the timescale of the present review to re-estimate all of these equations. However, the equations for the chemicals and for non-metallic minerals total energy demand were re-estimated using the equations developed by Oxford Economics but incorporating data up to 2009. The changes led to very small increases in energy demand in these sectors.

Revised methodology for projecting industrial sub-sector growth

Introduction

Demand for fuel within the industrial sector is projected on a sub-sector basis. Output is a key driver of demand within these sectors and therefore the methodology requires projections of industrial sub-sector growth. In 2008 DECC commissioned Oxford Economics to provide a set of industrial sub-sector projections for use in future modelling. Prior to this review of the methodology DECC continued to use these projections, adjusted for changes in OBR/HMT growth projections. The method of adjustment assumed that:

- The industrial sector as a whole would grow at the same rate as the manufacturing sector.
- Relative growth rates for the individual industry sub-sectors would remain the same as projected by Oxford Economics in 2008[54].

[54] DECC's predecessor department (BERR) commissioned updated industrial sub-sector growth projections from Oxford Economics in 2008. No report on the projection methodology was commissioned. However, in 2005 DTI commissioned research into growth projections from Oxford Economics. The resulting report outlines OE's general approach to forecasting: http://webarchive.nationalarchives.gov.uk/+/http:/www.berr.gov.uk/files/file26365.pdf

Manufacturing growth projections were taken from HMT published projections and then most recently, from the OBR manufacturing projections published in June 2010. The Oxford Economics projections for industry sub-sectors were then adjusted pro-rata. However the OBR no longer provides manufacturing growth projections and the 2008 Oxford Economics projections were becoming increasingly out of line with trends in relative growth. Therefore a new methodology needed to be developed.

Revised methodology

The revised projections are derived from an econometric analysis of the relationship between individual sub-sector growth and growth in UK GDP, world GDP growth and the effective exchange rate. The projections assume that these past trends and relationships will continue in the future and use OBR projections of UK GDP and IMF projections of world growth to project future growth of each industrial sub-sector. The exchange rate is assumed to remain constant at 0.8581 £/€ during the projection period[55]. The projections are based purely on this econometric analysis and take no account of government policies or expert economic opinion on cyclical impacts or future long term rebalancing of the economy. For this reason they will differ from and tend to be less optimistic than short term industry forecasts.

The revised projections for industrial sector growth compared to those used in the June 2010 projections are shown in Figures A.1 and A.2 below.

Figure A.1 shows how the revised methodology, combined with new and lower OBR projections for long-term GDP growth, has reduced our long-term projection of industrial GVA, after 2018.

Figure A.2 shows how the long term projection is for annual growth to continue at a similar rate on average to that observed in the past.

[55] An alternative model in which industrial sector share of GDP was projected solely on the basis of its own past values (ARIMA model) was also developed but performed less well than the regression based model when used to forecast out of sample in the short run. The resulting long run projection was similar to the regression based model that has been used in these projections.

Figure A.1 October 2011 projections for industry GVA compared to June 2010

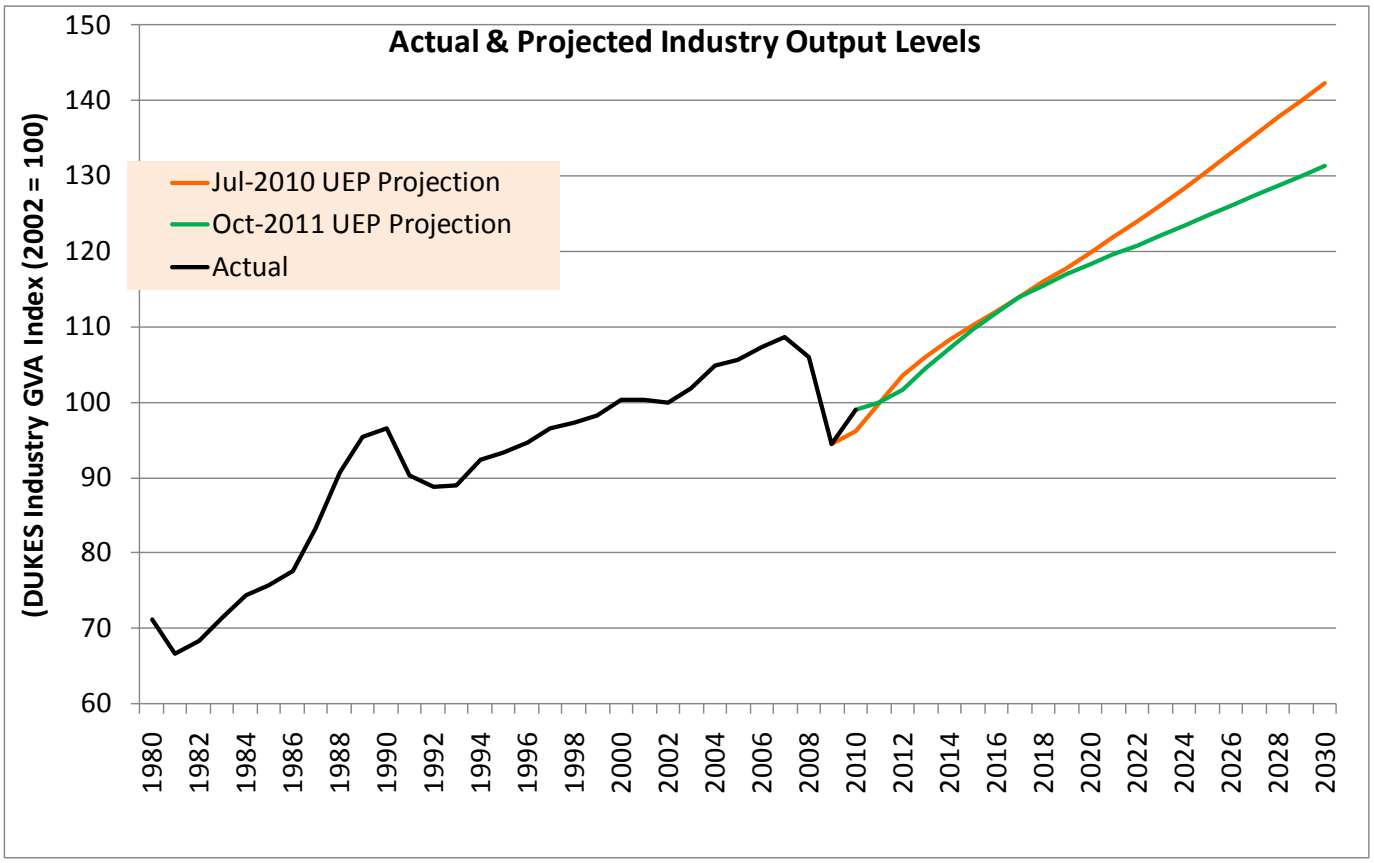
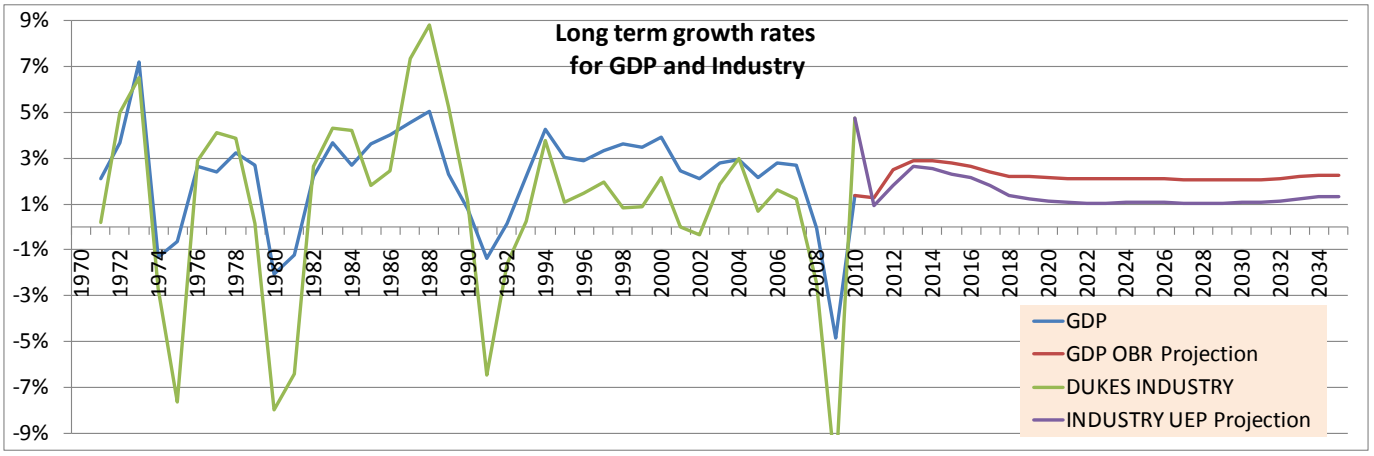


Figure A.2 Long term trends and projections for GDP and Industry growth



Review of DECC emissions model by the Committee on Climate Change

The Committee on Climate Change commissioned Cambridge Econometrics and AEA to carry out an independent review of the DECC Energy and Emissions Model in 2011. This review did not include the revisions that DECC undertook this year as they were happening in parallel. The conclusions reported in the CCC third report on progress against budgets[56] were that DECC's overall approach to emissions projection is sensible but there were a number of areas in which the model could be improved.

The key recommendations and the extent to which they have been addressed by DECC's internal review are described below:

1. *Making greater use of the most recent outturn data in forming projections, including responding to recent forecast errors.*

   The new demand equations and methodology for projecting industrial sub-sector emissions now incorporates the most recent outturn data and will be updated on a regular basis.

2. *More regular updating of key input projections – specifically for industry GVA at the sectoral level.*

   The new methodology for updating industrial sub-sector emissions ensures these can be re-estimated regularly, taking account of the latest actual outturn data.

3. *Increased transparency over the functioning of the model, the input assumptions and the drivers behind changes in the published projections.*

   The external input assumptions are published in annual updates to the projections and a full set of assumptions are published in annexes to the report. In this report we have included illustrative estimates of the impact of key changes to drivers and assumptions. We have made some improvements to our modelling to enable us to track the impact of updates and methodology changes more easily. However the large number of changes to inputs between projections means that it is not possible to provide precise estimates of every change.

   We accept that documentation on the demand equations used in the model has not been readily accessible in the past. In future DECC intends to maintain a technical report that fully documents the equations used to project demand and industrial sub-sector growth. We anticipate that the report relating to the projections presented here will be available by January 2012. This will be available on request from emissionsprojections@decc.gsi.gov.uk.

4. *In the longer term there may be scope to re-estimate the key relationships in the model and build in more bottom-up components (e.g. to better explain improvements in energy efficiency).*

   The Department is currently considering developing more detailed bottom-up models for domestic and non-domestic buildings emissions. However at this stage it is not clear that more detailed bottom-up modelling would be appropriate for all sectors. Whilst the department recognises that bottom-up modelling allows more flexible

[56] http://hmccc.s3.amazonaws.com/Progress%202011/CCC%20Progress%20Report_Interactive_2.pdf

modelling of policy impacts, this approach does not necessarily lead to more robust national emissions projections. Therefore the Department needs to carefully consider the areas in which extra investment in more detailed modelling is appropriate.

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URN 11D/871