DEPARTMENT OF ENERGY & CLIMATE CHANGE

UPDATED ENERGY AND EMISSIONS PROJECTIONS 2012

October 2012

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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 October 2011[1].

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 2012 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 projections have been updated to take account of new data e.g. revised policy savings estimates, revised DECC fossil fuel and carbon price projections[2], revised Office for Budget Responsibility (OBR) growth projections[3] and revised cost estimates for the power sector[4].

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 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.

For the fourth carbon budget period, the net carbon account is compared with budget of 1,950 $MtCO_2e$ set in the carbon budgets legislation. The level of the fourth carbon budget is subject to review in 2014. If, at that point, our domestic commitments place us on a different emissions trajectory to that of the EU Emissions Trading System, the Government will, as appropriate, revise the budget to align it with the actual EU trajectory. For the

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

[2] 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

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

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

purposes of projecting progress against the 4th carbon budget an illustrative EU ETS cap of 690 $MtCO_2e$ is used which is the assumption used by the CCC in their recommendation for the 4th carbon budget level[5].

The updated projections suggest that the UK will meet its first three legislated carbon budget targets. Projected territorial emissions are higher than those published last year in the first carbon budget period but lower in second, third and fourth periods. This is primarily due to faster projected decarbonisation of the grid. This is due to improvements in the modelling of plant closures, revisions to generation assumptions and to the introduction of Electricity Market Reform (EMR) policies. EMR was not included in the previous projections because the policy was not sufficiently well developed to allow it to be incorporated into the electricity supply model. Emissions in the non-traded sector are slightly higher in the first, third and fourth carbon budget periods. This is because lower projected growth has been off-set by higher population projections, lower policy savings and improvements to modelling.

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 of our projections to uncertainty in assumptions suggest the true future values could be more than 5% higher or lower than the projected values in the long run. However, despite this uncertainty, the analysis suggests that the risk of the UK failing to meet its first three carbon budgets is low. Details of the impact of uncertainty are given in Chapter 5.

[5] http://www.theccc.org.uk/reports/fourth-carbon-budget

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

$MtCO_2e$	October 2011				October 2012			
	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-2012	2013-2017	2018-2022	2023-2027	2008-2012	2013-2017	2018-2022	2023-2027
Traded sector[6]	**1,189**	**1,033**	**849**	**766**	**1,201**	**984**	**678**	**624**
Non-Traded	**1,689**	**1,571**	**1,472**	**1,441**	**1,695**	**1,572**	**1,488**	**1,465**
of which non-CO_2	*446*	*416*	*379*	*354*	*455*	*415*	*374*	*350*
Territorial Emissions	**2,877**	**2,604**	**2,322**	**2,207**	**2,897**	**2,556**	**2,166**	**2,089**
Change in Territorial emissions					19	-48	-156	-118
Traded Sector Cap[7]	1,233	1,078	985	690	1,233	1,078	985	690
EUAs purchased (negative implies sold)[8]	-44	-46	-136	76	-32	-94	-307	-66
Change in Traded /EUA					13	-48	-171	-142
Net Carbon Account	**2,922**	**2,650**	**2,457**	**2,131**	2,928	2,650	2,473	2,155
Carbon Budget	**3,018**	**2,782**	**2,544**	**1,950**	3,018	2,782	2,544	1,950
Shortfall (negative implies emissions under budget)	**-96**	**-132**	**-87**	**181**	-90	-132	-71	205
Change in Non Traded /Net Carbon Account					6	1	16	24

* 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.

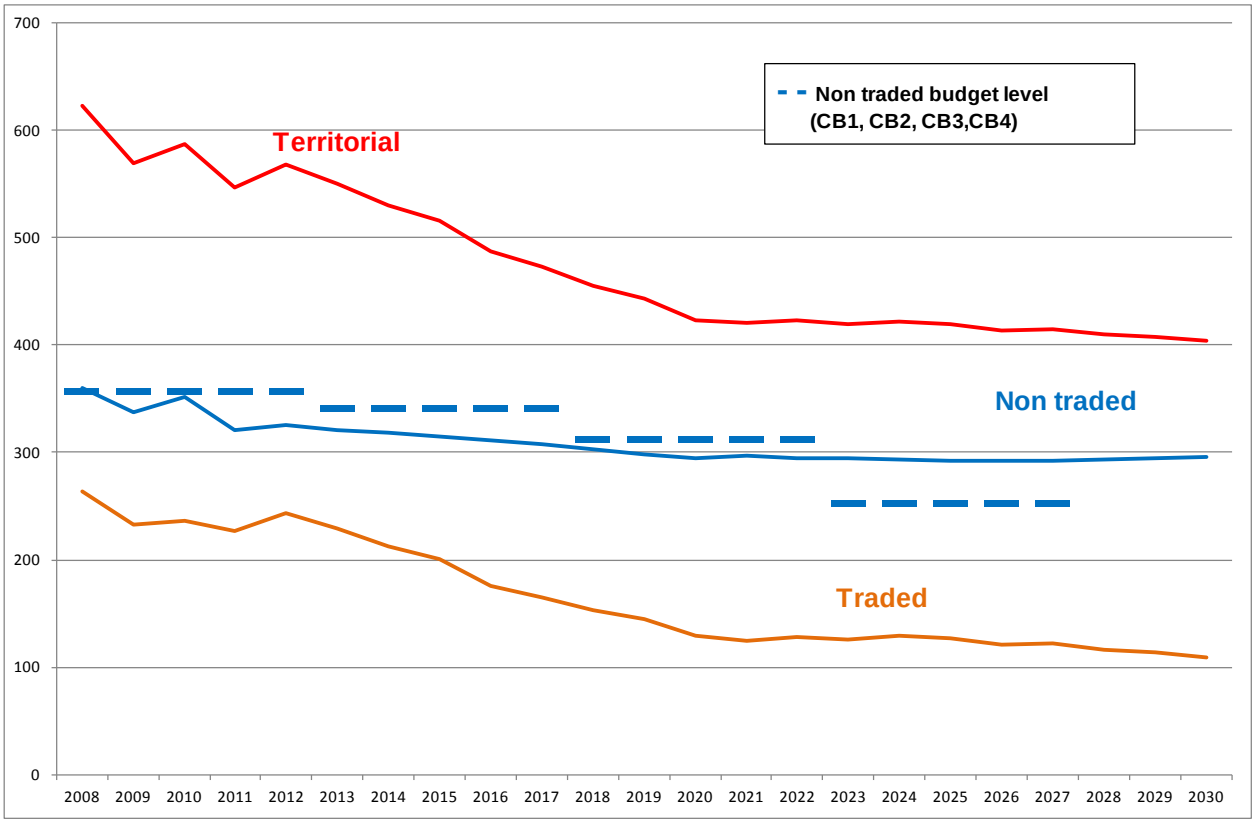
N/A = Not Applicable

[6] This is actual emissions from the traded sector unadjusted for any purchase or sale of EUAs.

[7] The traded sector cap shown here is the estimated UK share of the EU ETS cap recorded in the UK carbon budgets legislation for carbon budgets 1, 2 and 3. For carbon budget 4 an illustrative cap of 690 $MtCO_2e$ is used in line with the level assumed by the CCC in their recommendations for the 4th carbon budget.

[8] 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.

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[9].

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[10]. 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 market based model of producer behaviour. This differs from the model used in previous projections. Under the previous model, the way in which electricity producers meet demand was projected using a model that in effect assumed providers knew what future prices and demand would be and found the least cost method of meeting this demand. Under the new model used to produce these projections, producers are assumed to have limited foresight of future prices and aim to maximise returns on investment. Annex A provides more detail on the differences between the old and new models.

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 2012. 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[11]. 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[12]. The LULUCF projections have not been updated since our last published projections.

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

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

[10] 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

[11] http://www.decc.gov.uk/assets/decc/11/stats/climate-change/5253-nonco2-ghg-emissions-projections-report-spring-2.pdf

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

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 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[13] to account for any carbon units[14] which have been bought 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 remains uncertainty over what the level of the EU ETS traded sector cap will be during the fourth carbon budget period. For the purposes of these projections a 4th carbon budget traded sector cap of 690 $MtCO_2e$ has been assumed for consistency with assumptions in the CCC recommendations for the 4th carbon budget level. The level of the fourth carbon budget is subject to review in 2014 and if at that point our domestic commitments place us on a different emissions trajectory to that of the EU Emissions Trading System the level of the budget will be revised to align it with the actual EU trajectory.

The projections have been updated to take account of new data e.g. revised policy savings estimates, revised DECC fossil fuel[15] and carbon price projections[16], revised OBR growth[17] projections and revised generation cost estimates for the power sector[18]. In addition to updates to assumptions, the model previously used to project electricity generation and capacity was replaced by a new model which aims to project market behaviour of suppliers more realistically. Some minor changes were also made to the demand equations to correct small errors in a number of equations following a data cleaning exercise.

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 October 2011 projections. A detailed list of policies included in these projections is provided in Chapter 4.

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

[14] 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.

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

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

[17] Economic & Fiscal Outlook, Office for Budget Responsibility, March 2012,

http://budgetresponsibility.independent.gov.uk/pubs/March-2012-EFO1.pdf

Fiscal Sustainability Report, Office for Budget Responsibility, July 2012

http://budgetresponsibility.independent.gov.uk/pubs/FSR2012WEB.pdf

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

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 changes. A number of downloadable tables provided in Microsoft Excel format (the Annexes) are listed in Chapter 8.

Chapter 2: Assumptions

The DECC Energy and Emissions Projections Model provides the basis for the carbon dioxide emissions projections in this report 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[19], 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 are published[20] alongside this report.

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.

[19] http://www.decc.gov.uk/assets/decc/11/stats/climate-change/5253-nonco2-ghg-emissions-projections-report-spring-2.pdf

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

[20] Fossil fuel prices projections - Department of Energy and Climate Change: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx

Table 2.1 Fossil fuel price assumptions for central scenario[20]

2012 prices	Crude Oil (Brent) $/bbl	Natural gas NBP p/therm	Coal ARA $/tonne
2011	114.0	57.8	124.6
2012	115.0	61.2	102.0
2015	118.1	76.8	116.7
2020	123.5	71.9	120.0
2025	129.1	71.9	120.0
2030	135.0	71.9	120.0

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

Table 2.2 Crude oil price assumptions for all scenarios[20]

$/bbl, 2012 prices	Low prices	Central prices	High prices
2011	114.0	114.0	114.0
2012	105.0	115.0	125.0
2015	100.4	118.1	134.0
2020	93.1	123.5	150.6
2025	86.3	129.1	169.1
2030	80.0	135.0	190.0

The exchange rates used from 2012 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[21].

Table 2.3 Exchange rate assumptions[21]

Currency	Exchange rate
$/£	1.6037
€/£	1.1525

[21] IAG guidance for policy appraisal - Department of Energy and Climate Change
http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

Economic growth

The growth assumptions for UK GDP, employment and population have been updated since 2011, 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 & Fiscal Outlook[22] published with the Budget in March 2012.

The long-term projections for GDP and Employment growth are from the assumptions in the OBR's Fiscal Sustainability Report[23] from July 2012.

Table 2.4 Exogenous socio-economic growth projections (per cent per annum)

UK Growth Rates % per annum	2011	2012	2013	2014	2015	2016	2020	2025	2030
GDP	0.7[24]	0.1%[25]	2.0%	2.7%	3.0%	3.0%	2.4%	2.5%	2.5%
Population	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	0.6%	0.5%	0.4%
Employment	0.7%	-0.3%	0.3%	0.7%	1.0%	1.0%	0.2%	0.3%	0.3%

The OBR's growth assumptions use the ONS's 2010 based lower migration variant. DECC have adjusted DCLG's 2010 household number projections in line with updated population growth projections.

Table 2.5 DECC derived growth assumptions

UK Growth Rates % per annum	2011	2012	2013	2014	2015	2016	2020	2025	2030
Households	1.0%	1.1%	1.1%	1.1%	1.1%	1.0%	0.9%	0.8%	0,.7%

[22] Economic & Fiscal Outlook, Office for Budget Responsibility, March 2012, http://budgetresponsibility.independent.gov.uk/pubs/March-2012-EFO1.pdf

[23] Fiscal Sustainability Report, Office for Budget Responsibility, July 2012 http://budgetresponsibility.independent.gov.uk/pubs/FSR2012WEB.pdf

[24] For 2011 we used ONS 28 June 2012 estimates.

[25] For 2012 Quarters 1 and 2 we used ONS 28 June 2012 estimates.

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 2.6 shows the price of allowances (the carbon price) projected by DECC. 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[26].

Table 2.6 also shows the effective carbon price assumed for modelling electricity supply which includes carbon price floor (CPF) mechanism. For 2013, 2014 and in part for 2015 we have used the announced Carbon Price support levy rates for 2013/13 and 2014/15 added to the projected EU ETS Carbon Price, after this we use the CPS trajectory announced by the Government in the March 2011 Budget.

Table 2.6 Carbon Prices assumed (£/tonne CO_2)[26]

£/tCO_2, 2012 Prices	2011	2012	2013	2014	2015	2016	2020	2025	2030
Industry & Commerce (EU ETSprice - no carbon price floor)	12.3	5.8	6.0	6.2	6.4	6.7	8.6	10.3	12.3
Electricity Supply Sector (with carbon price floor support)	12.3	5.8	9.6	14.2	19.9	23.6	32.4	54.0	75.6

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

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 (UNFCC) 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 Projections Model.

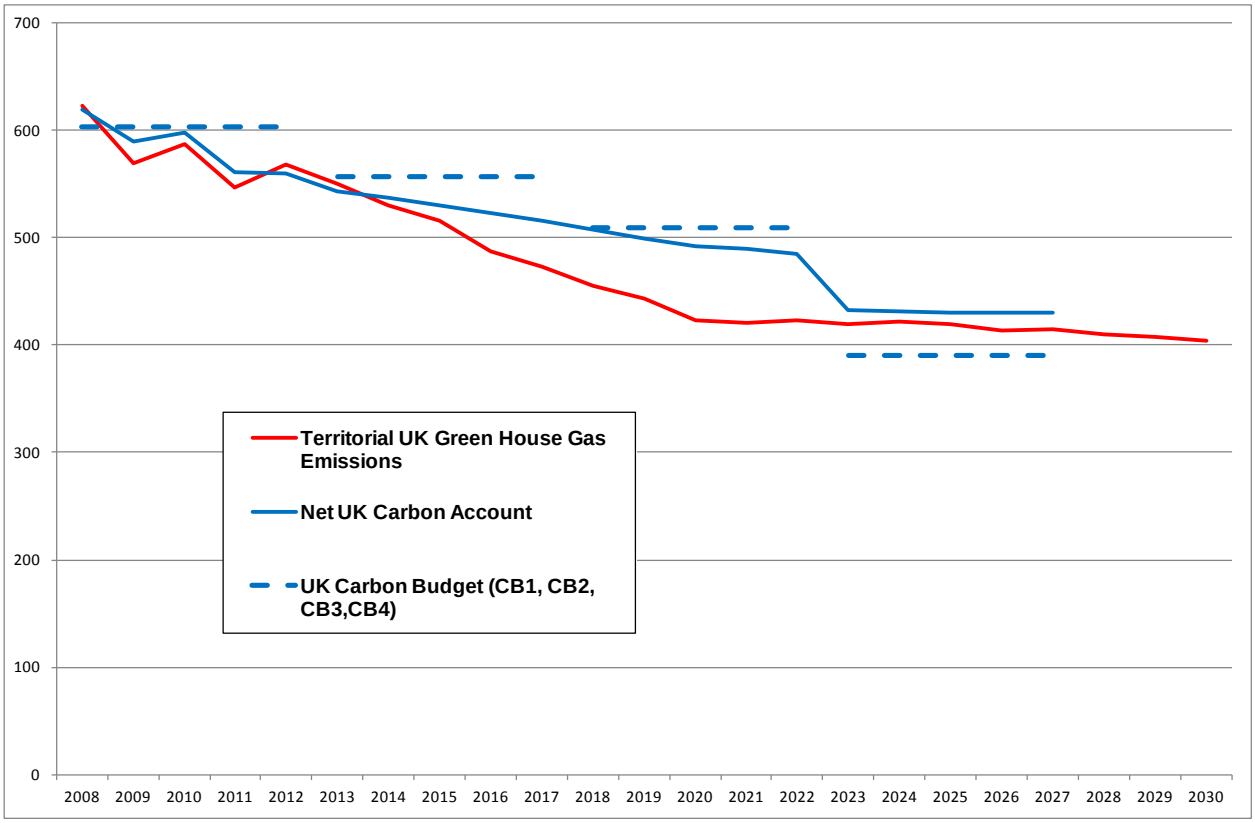
The first section of this chapter contains annual results, presented at five-yearly intervals on an NC basis. The second section of this chapter considers the carbon budgets, which are aggregated over 5 year periods, on a UEP basis. This chapter presents DECC's central emissions projections. Chapter 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[27], and Table 3.1 shows the contributions of UK sectors to the total net emissions.

[27] Note: An EU ETS cap of 690 $MtCO_2e$ has been assumed for the 4th carbon budget.

Figure 3.1 Net UK carbon account and territorial projection: 2008-2030 ($MtCO_2e$)



* Assumes a traded sector cap of 690 $MtCO_2e$ for the 4th carbon budget period

UK Emission projections by sector

Table 3.1 Projected net UK carbon account and UK greenhouse gas emissions broken down by sectors (NC basis[28]). The October 2011 projection for the UK Carbon Account is shown for comparison, all other results relate to the October 2012 projections.

$MtCO_2e$	Central Greenhouse Gas emissions*					
	1990[29]	2010	2015	2020	2025	2030
UK Carbon Account		Net Basis				Territorial basis
October 2011 projection	782	593	531	486	426	418
October 2012 projections	782	598	530	492	431	404
Change since 1990 (Net)		-23%	-32%	-37%	-45%	
UK Greenhouse Gases	**769**	**588**	**516**	**424**	**419**	**404**
Change since 1990 (Territorial)		-23%	-33%	-45%	-45%	-47%
Sectors (NC basis):						
Energy Supply	273	204	164	92	89	71
Business	113	89	85	80	75	74
Industrial Processes	54	11	11	11	11	11
Transport	122	122	111	105	105	104
Residential	81	90	72	69	73	78
Public	13	8	11	11	11	11
Agriculture	63	51	50	45	45	45
Land Use Change	4	-4	-2	-1	0	1
Waste Management	46	17	14	12	11	10
Total	**769**	**588**	**516**	**424**	**419**	**404**

***** 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 107 $MtCO_2$ between 2011 and 2030 due primarily to decarbonisation of the grid with total electricity consumption

[28] 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.

[29] The 1990 GHG estimate is from the 2010 Inventory of 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

rising slightly over the period. Without additional policy effort after 2022 business emissions are projected to fall by 17 $MtCO_2$ and transport emissions by around 15 $MtCO_2$. Residential emissions are projected to rise by around 9 $MtCO_2$. In transport 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[30] 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[31] 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 all carbon budget periods. Uncertainty remains about what the level of the EU ETS cap will be in the fourth carbon budget period. For illustrative purposes a traded sector cap of 690 $MtCO_2e$ has been assumed for the fourth carbon budget period which is consistent with CCC assumptions in their recommendations for the fourth carbon budget level. 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 action beyond existing policies.

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.

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

[31] 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 October 2011.

The updated projections suggest that the UK is likely to comfortably meet its first three carbon budgets. Projected emissions are lower for traded and territorial emissions in the second, third and fourth carbon budget periods than the October 2011 projections. However projected non-traded emissions are slightly higher in carbon budgets 1, 3 and 4. Therefore the margin by which the UK is projected to overachieve against the first three carbon budgets is smaller. There are a large number of factors contributing to the change in projected emissions including changes to savings estimates, updates to data and assumptions and changes to modelling methodology.

Table 3.2 Carbon Budget, October 2011 and October 2012 projections; headline results

$MtCO_2e$	October 2011				October 2012			
	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-2012	2013-2017	2018-2022	2023-2027	2008-2012	2013-2017	2018-2022	2023-2027
Traded sector[32]	**1,189**	**1,033**	**849**	**766**	**1,201**	**984**	**678**	**624**
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Change in Territorial emissions					19	-48	-156	-118
Traded Sector Cap[33]	1,233	1,078	985	690	1,233	1,078	985	690
EUAs purchased (negative implies sold)[34]	-44	-46	-136	76	-32	-94	-307	-66
Change in Traded /EUA					13	-48	-171	-142
Net Carbon Account	**2,922**	**2,650**	**2,457**	**2,131**	2,928	2,650	2,473	2,155
Carbon Budget	**3,018**	**2,782**	**2,544**	**1,950**	3,018	2,782	2,544	1,950
Shortfall (negative implies emissions under budget)	**-96**	**-132**	**-87**	**181**	-90	-132	-71	205
Change in Non Traded /Net Carbon Account					6	1	16	24

[32] This is actual emissions from the traded sector unadjusted for any purchase or sale of EUAs.

[33] The traded sector cap shown here is the estimated UK share of the EU ETS cap recorded in the UK carbon budgets legislation for carbon budgets 1, 2 and 3. For carbon budget 4 an illustrative cap of 690 $MtCO_2e$ is used in line with the level assumed by the CCC in their recommendations for the 4th carbon budget.

[34] 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.

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-2012 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	**1201**	**984**	**678**	**624**
Power stations CO_2	789	603	307	258
Refineries CO_2	77	67	69	76
Services CO_2	9	9	9	9
Industry CO_2	321	296	283	269
Traded Aviation CO_2[35]	2	9	10	11
Non-CO_2 traded Emissions	3	1	1	1
Traded sector cap under EU ETS	**1233**	**1078**	**985**	**690**
EUAs Purchased (negative implies sold)	-32	-94	-307	-66
Non-Traded, sector Emissions	**1695**	**1572**	**1488**	**1465**
Residential CO_2	380	343	330	344
Services CO_2	86	92	77	73
Industry CO_2	147	144	152	152
Transport CO_2	649	593	565	549
Land use and forestry CO_2[36]	-22	-15	-10	-3
Non-Traded non-CO_2 emissions	455	415	374	350
Net UK Carbon Account	**2928**	**2650**	**2473**	**2155**
CARBON BUDGET	**3018**	**2782**	**2544**	**1950**
Shortfall (negative implies emissions under budget)*	**-90**	**-132**	**-71**	**205**

* 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.

[35] 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.

[36] 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.

Changes to emissions projections since October 2011

As outlined above the projected level of total GHG emissions are lower than those previously projected in October 2011. Table 3.4 shows the breakdown of this reduction by sector. The largest reduction is due to lower projected emissions from the power sector, followed by transport and industry. The projected level of emissions from the residential and services sector have increased leading to slightly higher projections for non-traded emissions than October 2011. The underlying reasons for these changes are discussed in this section.

There were a number of drivers leading to lower power sector projections. One of the key changes has been a change in the modelling approach with the power station projections, being produced by a new model. The new model attempts to reflect market behaviour of electricity providers more accurately. One of the improvements to the modelling approach is endogenous modelling of plant closures based on economic viability. Previously plant closures had to be entered manually. This improvement together with faster modelled reactions to price differentials in dispatch decisions, leads to a faster and steeper decline in coal generation in the medium to long term with consequently lower projected emissions. The other main driver is the incorporation of Electricity Market Reform (EMR) policies which leads to greater support for low carbon technologies than assumed under the previous projections. Projected electricity demand is also slightly lower (around 3%) due to lower GDP projections and to a data cleansing exercise undertaken in DECC to identify and remove errors in the demand equations. Details of these methodology changes are included the Appendix to this report.

Industry emissions are lower overall, primarily as a result of lower GDP growth assumptions and lower combined heat and power projections. The latter leads to lower industry emissions but these are offset by higher power sector emissions because a higher proportion of industrial electricity demand has to be met by major power providers.

Residential emissions are higher than projected previously primarily as a result of a higher projected growth rate in the number of households. Services emissions are also higher the previously projected. This is because lower growth is offset by lower projected policy savings in this sector.

Transport emissions are lower in each carbon budget period than previously projected primary due to updates in economic assumptions and model changes to better align with the DfT's National Transport Model.

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

MtCO2e	Carbon Budget 1	Carbon Budget 2	Carbon Budget 3	Carbon Budget 4
	2008-12	2013-17	2018-22	2023-27
Power stations and refineries (CO2 only)	**29**	**-21**	**-142**	**-111**
Generation assumptions and improved modelling	20	-32	-99	-65
Energy Supply Policies (EMR)	0	1	-24	-50
CHP	6	23	18	12
New fossil fuel prices and retail price model	3	-3	-20	4
Economic growth assumptions	-3	-17	-15	-19
Demand/emissions reducing policies	2	9	-9	5
Other updates	0	-2	7	2
Industry (CO2 only)	**-4**	**-22**	**-12**	**-9**
Model development	-8	-8	1	3
CHP	-2	-11	-15	-17
New fossil fuel prices and retail price model	6	14	12	10
Economic growth assumptions	-2	-12	-13	-12
Demand/emissions reducing policies	0	-2	4	7
Other updates	2	-2	-1	-1
Residential (CO2 only)	**-8**	**8**	**10**	**15**
DUKES 2012	-12	0	0	0
Demographic growth assumptions	1	6	10	13
Demand/emissions reducing policies	1	3	5	3
Other updates	1	-2	-4	-0
Services and Agriculture [1] (CO2 only)	**-6**	**8**	**11**	**12**
Model development	-8	-10	-5	-5
DUKES 2012	-5	1	1	1
Demand/emissions reducing policies	8	19	19	20
Other updates	-0	-3	-4	-4
Transport (CO2 only)	**-2**	**-18**	**-18**	**-20**
Model Development	-2	-8	-10	-10
Economic growth assumptions	-1	-10	-11	-11
Other updates	1	-0	4	1
LULUCF (CO2 only)	**-0**	**0**	**-0**	**0**
Total (CO2 only)	**9**	**-46**	**-150**	**-114**
Non-CO2 GHGs	**10**	**-2**	**-5**	**-5**
Total change in territorial emissions	**19**	**-48**	**-156**	**-118**

Comparison with other emissions projections

Cambridge Econometrics (CE) also publish projections of UK energy demand and emissions up to 2025. In their most recent report (UK Energy and Environment, August 2012) CE projected emissions are higher than the DECC estimates given in this report. However in contrast to earlier projections, CE project that the UK will meet the first three carbon budgets, albeit by only a slender margin in periods 1 and 3. CE continue to project that the fourth carbon budget will be missed. 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, or full 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 the 2010 Building Regulations. CE also only include part of the impact of other policies such as the Green Deal, Carbon Emissions Reduction Target, Renewable Transport Fuel Obligation (modelled out to 2015) and Products Policy & Labelling. CE acknowledge that the projected non-traded sector emissions in the fourth carbon budget period is likely to be on the high side due to the omission of some policies from the modelling[37].

- CE project non-CO_2 GHG emissions using a top down approach that relates them to population growth and historical trends in emission 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 appears to be a small disparity between the CE historical CO_2 emissions and the DECC values reported in the updated projections. The difference amounts to around 1% and it is possible that this reflects differences in coverage, as both estimates are reported to be based on the 2010 Greenhouse Gas Inventory. This difference is likely to have an impact on projected values. However the difference in actual emissions is smaller than in previous exercises.

If the CE projections were to be adjusted to include DECC estimates of policy effectiveness the amount by which the UK is projected to miss the fourth carbon budget would be smaller, but an exact estimate is not possible.

[37] It is notable that CE do not include any policies relating to EMR. While this increases territorial emissions relative to the DECC projections it has no direct impact on the UK's projected ability to meet carbon budgets.

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[38] 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 were published last year in the carbon plan[39].

[38] 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.

[39] http://www.decc.gov.uk/en/content/cms/tackling/carbon_plan/carbon_plan.aspx

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

$MtCO_2e$		Non-Traded			
	Carbon Budget	1	2	3	4
	Years	2008-2012	2013-2017	2018-2022	2023-2027
Residential		**34.1**	**79.1**	**107.2**	**108.1**
of which – baseline measures ‡		**32.2**	**52.1**	**60.5**	**52.0**
Building Regulation Part L (2002 & 2005/6)		18.8	30.6	36.1	29.2
Warm Front & Fuel Poverty Measures		-5.6	-5.9	-2.7	0.1
Supplier Obligation (EEC1, EEC2, original CERT)		19.0	27.4	27.0	22.7
of which – measures in the LCTP or later		**1.9**	**27.0**	**46.7**	**56.1**
Real time displays/Smart meters		0.0	1.7	4.8	5.2
EU Products policy (Tranche 1, Legislated)		-1.4	-7.0	-9.8	-8.9
Community Energy Saving Programme		0.1	0.3	0.3	0.2
Supplier Obligation (CERT +20% and CERT extension)		2.7	20.3	19.9	16.0
Building Regulations 2010 Part L		0.4	7.0	14.0	18.8
Zero Carbon Homes		0.0	0.1	2.0	4.7
ECO & Domestic Green Deal		0.0	1.5	3.5	4.9
EU Products policy (Tranche 2, Proposed)		-0.0	1.7	7.0	9.5
Renewable Heat Incentive[40]		0.0	1.3	5.0	5.8
Commercial and Public Services		**12.2**	**22.3**	**44.5**	**46.2**
of which – baseline measures ‡		**11.6**	**11.0**	**9.7**	**7.7**
Carbon Trust Measures		5.0	2.5	0.7	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	0.0
Building Regulations Part L (2002 & 2005/6)		5.1	7.0	7.5	6.1
of which – measures in the LCTP or later		**0.6**	**11.3**	**34.7**	**38.5**
EU Products policy (Tranche 1, Legislated)		-0.1	-0.5	-0.7	-0.6
EU Products policy (Tranche 2, Proposed)		-0.0	0.0	0.4	0.8
Small Business Energy Efficiency Interest-free Loans		0.1	0.1	0.0	0.0
Salix, Public Sector Loans, 10% commitment for Central Govt.		0.1	0.1	0.1	0.1
Business Smart Metering		0.0	1.2	3.6	3.4
Building Regulations 2010 Part L		0.1	1.7	3.5	4.7
Non-Domestic Green Deal		0.0	1.2	4.4	2.2
Carbon Reduction Commitment Energy Efficiency Scheme		0.3	2.6	6.2	8.7
Renewable Heat Incentive		0.1	4.9	17.3	19.3
Industry		**5.2**	**8.6**	**16.2**	**17.0**
of which – baseline measures ‡		**5.0**	**4.4**	**3.5**	**2.6**
Carbon Trust Measures		2.0	1.0	0.3	0.0
UK Emissions Trading Scheme		0.9	0.4	0.1	0.0
Building Regulations Part L (2002 & 2005/6)		2.1	3.0	3.2	2.5
Policies in the Low Carbon Transition Plan and newer		**0.3**	**4.2**	**12.6**	**14.4**
EU Products policy (Tranche 1, Legislated)		-0.0	-0.0	-0.0	-0.0
EU Products policy (Tranche 2, Proposed)		-0.0	-0.0	0.0	0.0
Small Business Energy Efficiency Interest-free Loans		0.1	0.1	0.1	0.0
Climate Change Agreements (2011-18)		0.0	0.0	0.0	0.0
Building Regulations 2010 Part L		0.0	0.6	1.2	1.5

[40] DECC will be monitoring progress of the renewable heat incentive measures, and will review scope for additional ambition later in the decade.

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
Non-Domestic Green Deal	0.0	0.0	0.0	0.0
CRC Energy Efficiency Scheme	0.0	0.2	0.5	0.8
Renewable Heat Incentive	0.1	3.3	10.9	12.1
Transport - measures in the LCTP or later	**1.6**	**23.2**	**56.0**	**82.4**
Car policies: - EU new car mid-term target (130gCO_2/km in 2015); - the EU new car long-term target (95gCO_2/km in 2020); - and complementary measures for cars.	0.3	7.5	28.9	58.4
LGV policies: - the EU new LGV target (147gCO_2/km in 2020).	0.1	1.5	5.7	12.0
HGV policies: - Low rolling resistance types; - and industry-led action to improve efficiencies.	0.2	3.0	6.4	9.7
Transport biofuels (8% by energy in 2020[41])[42]	0.0	5.4	9.8	0.0
Local Sustainable Transport Fund	1.0	5.8	3.2	0.4
Rail electrification	0.0	0.1	1.9	2.0
Agriculture & Waste (non-CO_2) - LCTP or later measures[43]	**-**	**2.1**	**14.9**	**17.0**
Agriculture Action Plan	-	2.1	14.9	17.0
Total	**53.2**	**135.3**	**238.6**	**270.8**
Total – of which baseline measures ‡	**48.8**	**67.4**	**73.7**	**62.3**
Total - measures in the LCTP or later	**4.3**	**67.9**	**164.9**	**208.5**

‡ Baseline measure: a policy introduced in or before the Low Carbon Transition Plan,15 July 2009. Baseline policy measures in Transport and in Agriculture and Waste have not been separately estimated but are included in the baseline projections.

[41]This includes 31TWh renewables contribution to transport energy demand which is consistent with the 10% transport sub-target as set out in the Renewable Energy Directive, including the principle that certain biofuels products count as double towards this target.

[42] Savings from the RFTO (5% by volume) and the EU Voluntary Agreements on new car CO_2 to 2009 are taken into account in these 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 these older measures to be estimated.

[43] 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.

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 in model inputs. 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 to capture the likely variations in some of the key inputs to the projections, in particular, fuel prices, various macro variables, temperature parameters and policy impacts.

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 the demand model to provide a range of simulated fuel and electricity demands. Each simulated demand for electricity is entered into the electricity supply part of the model which is run under a different fuel cost scenario for each demand scenario.

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. 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.

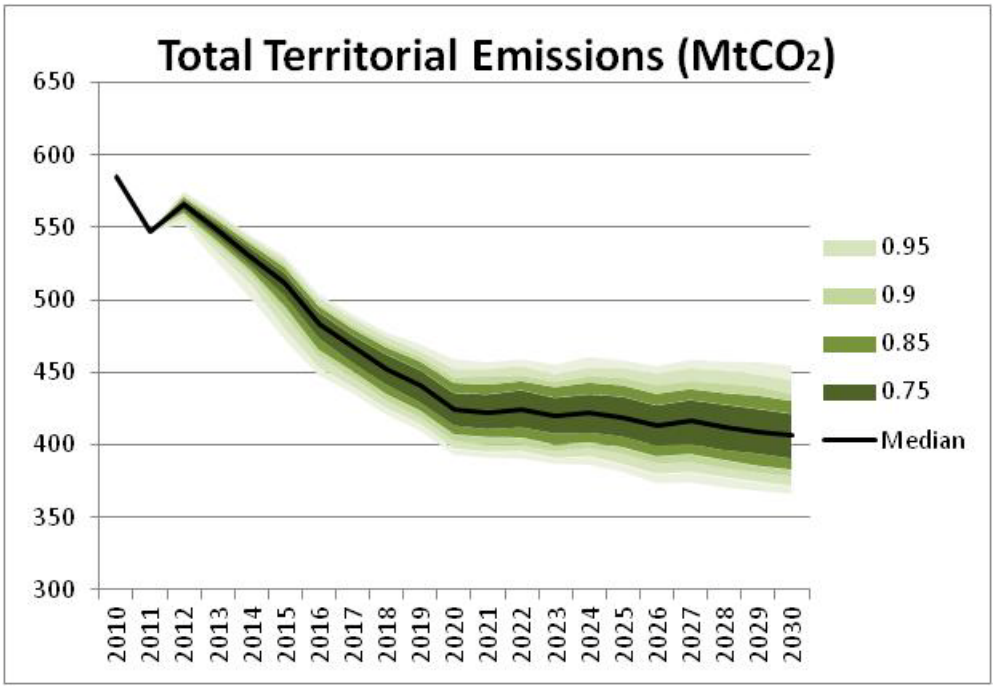
Table 5.1 Uncertainty in net UK Carbon Account and shortfall against budget

$MtCO_2e$		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	2928	2650	2473	2155
	Lower 95% CI	2923	2604	2402	2050
	Upper 95% CI	2933	2683	2533	2246
Carbon Budget		**3,018**	**2,782**	**2,544**	**1,950**
Shortfall (negative implies under budget)	Central	-90	-132	-71	205
	Lower 95% CI	- 95	- 178	- 142	100
	Upper 95% CI	- 85	-99	- 11	296

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	1201	984	678	624
	Lower 95% CI	1188	851	587	549
	Upper 95% CI	1206	1023	777	741
Non-Traded	Central	1695	1572	1488	1465
	Lower 95% CI	1688	1526	1417	1360
	Upper 95% CI	1699	1605	1548	1556
Total	Central	2897	2556	2166	2089
	Lower 95% CI	2880	2396	2022	1915
	Upper 95% CI	2903	2621	2315	2283

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 assuming 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	2,928	2,650	2,473	2,155
	Low growth	2,928	2,646	2,463	2,140
	High growth	2,928	2,655	2,483	2,171
Carbon Budget					
Shortfall (negative implies under budget	Central	-90	-132	-71	205
	Low growth	-90	-136	-81	190
	High growth	-90	-127	-61	221

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	1,201	984	678	624
	Low growth	1,201	978	664	604
	High growth	1,202	990	694	624
Non-Traded	Central	1,695	1,572	1,488	1,465
	Low growth	1,695	1,567	1,478	1,450
	High growth	1,695	1,576	1,498	1,481
Total	Central	2,897	2,556	2,166	2,089
	Low growth	2,896	2,546	2,142	2,054
	High growth	2,897	2,566	2,192	2,105

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. 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	Carbon Budget 4 2023-27
Projected traded sector emissions	1,201	984	678	624
Traded sector carbon budget (UK legislation)	1,233	1,078	985	-
Projected purchase of EU ETS allowances using traded sector carbon budget	-44	-94	-307	-
Latest DECC projections of EU ETS allowances the UK will receive	-	1,066	966	864
Projected purchase of EU ETS allowances using latest projection of UK allocation	-	-82	-288	-240

Chapter 6: Electricity generation

The projections and discussion in this section mainly relates to major power producers (MPPs), including all renewables plants[44]. Most of the discussion also concerns the central case scenario, although the generation mix is sensitive to fossil fuel price assumptions. Full results including those from other fossil fuel price scenarios can be found in annexes D, E, I, J, K and L

Background

Final electricity demand fell in 2011 by over 3% and remains well below pre-recession levels, with falls in each of the main consumer sectors. Demand in 2011 is estimated to have been 7% lower than in 2007, the last full year before the recession started to take effect. Electricity demand in 2011 was lower than in any year since 1998.

Supply from nuclear plants picked up again in 2011 following the fall in 2010 and the average load factor on nuclear stations at around 66%, was higher than in any year since 2006. The load factor remains below the levels seen around the turn of the decade.

The overall available market for fossil fuel sourced generation in 2011 was reduced by falling demand, higher nuclear output and a large increase in renewables generation. Within the fossil fuel sector electricity supply from coal stations was virtually unchanged between 2010 and 2011 – and has remained at around 100TWh a year in the last three years – while supply from gas fired stations fell sharply, from 159TWh to 131TWh. Supply from oil stations remained at very low levels. The fall in gas sourced electricity supply resulted from a combination of the reduced need for fossil sourced supply and a deterioration in the competitiveness of gas against coal. Both of these factors persisted into the first half of 2012 and resulted in a further sharp fall in the amount of electricity supplied by gas stations. Conversely supply from coal stations has increased sharply in the first half of 2012.

The overall result of these developments was a sharp decrease in power station CO_2 emissions in 2011.

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.**

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[45].

[44] Major power producers are as defined in the Digest of UK Energy Statistics, 2012, section 5.66 et seq.

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

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[46] which analysed power station 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 two early stage CCS plants proceed as part of one coal-based and one gas-based project including a small amount of unabated operation. Both plants are assumed to start operation in 2017. 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. Improved modelling of the IED in the new Dynamic Dispatch Model (DDM) used for these projections, suggests that the impact may be greater than assumed in the previous projections leading to earlier closure of unabated coal plants.
- **Electricity Market Reform:** Unlike the projections published in October 2011, these updated projections make assumptions about measures due to be introduced as a result of the Electricity Market Reform (EMR). In particular, while a decarbonisation target has not been set, it is assumed that EMR measures achieve a carbon intensity of generation in 2030 of 100g CO2/kWh. It is assumed that EMR measures are generally deployed to achieve a least cost decarbonisation pathway. However in order to take account of uncertainty in the future costs of alternative technologies, for the purposes of modelling it has been assumed that EMR supports a broader diversity of technologies than would be the case based purely on current central projections for generation costs, demand and fossil fuel prices.
- **Renewables:** The Renewable Energy Strategy including the impact of the Renewables Obligation and measures relating to small scale renewables, delivers a contribution of more than 30% of total electricity supply from renewable sources by 2020. For the period beyond 2020 it is the assumed overall decarbonisation target for EMR policies which drives greater renewables generation.
- **Carbon price floor:** The carbon price faced by electricity providers incorporates the impact of the carbon price floor at levels announced in the March 2012 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.

Modelling Approach

In a change of modelling approach, the power station projections have been produced by a new model called the Dynamic Dispatch Model (DDM). The new model dispatches plant in a traditional cost – minimisation way, but unlike the previous model, projected new

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

builds are dependent on whether plant types are able to achieve pre-determined rates of return. In general the new model is more responsive in the short run to the difference between coal and gas prices and with respect to new build but tends to delay the simulated new build slightly. The new model is also able to model plant closure economics. This feature is an important modelling development and allows simulation of closures across a wide range of economic and other scenarios. See the Appendix on Model Development for further information.

Major Power Producers (MPP)

Electricity demand is projected to decline further to 2017, under the influence of energy saving programmes. Demand then stabilises for a few years before beginning to increase steadily post – 2020. The renewed growth in demand post – 2020 is due mainly to the declining impact of policy – in particular, no new policies designed to further abate emissions are included in the projections. Chapter 4 sets out the policy background.

The generating requirement of the MPPs is determined by the level of overall demand and the level of generation from the non-MPP sector. The level of generation from the non-MPP sector is projected to increase by around 20TWh between 2012 and 2020, which taken together with the trend on total electricity demand, means that required generation from MPPs declines in every year to 2020. Beyond 2020, the requirement on MPPs tracks the overall change in demand, as non-MPP generation is assumed to be constant from 2020 onwards.

The central scenario fossil fuel price assumptions imply a strong competitive environment for coal against gas. The projected annual amount of coal generation over the period 2012 to 2014 exceeds that achieved in any period since 2007, notwithstanding the closure of some coal capacity in the next few years. Thereafter the diminution of coal's competitive position, due in part to the impact of the carbon price support mechanism and in part to falling gas prices, leads to a fall in projected coal generation. Generation from gas- fired plant is projected to fall to historically low levels in 2012, reflecting its adverse competitive position against coal. Gas generation remains at relatively low levels due initially to the fall in demand and then the growth in non- fossil generation. Generation from the early stage CCS plants commences in 2017 and maintains steady output at around 5TWh per year initially. Further growth in capacity from the mid - 2020s produces a generation of 24TWh in 2030. The Renewable Energy Strategy including the impact of the Renewables Obligation and measures relating to small scale renewables, delivers a contribution of more than 30% of total electricity supply from renewable sources by 2020. For the period beyond 2020 it is EMR policies which drive greater renewables generation.

The impact of the increase in renewables generation is to significantly reduce the size of the available market for fossil fuels to 2020. The projected build of new nuclear plants has a similar impact in the period to 2030. The first new nuclear plant is expected to commence generation in 2020 and further new capacity is added to 2030 leading to an overall new build over the period of around 10GW. The exact timescale 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 final structure of the reforms of the electricity market.

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 6.1Projected cumulative new build by plant type for MPPs, 2012 to 2030

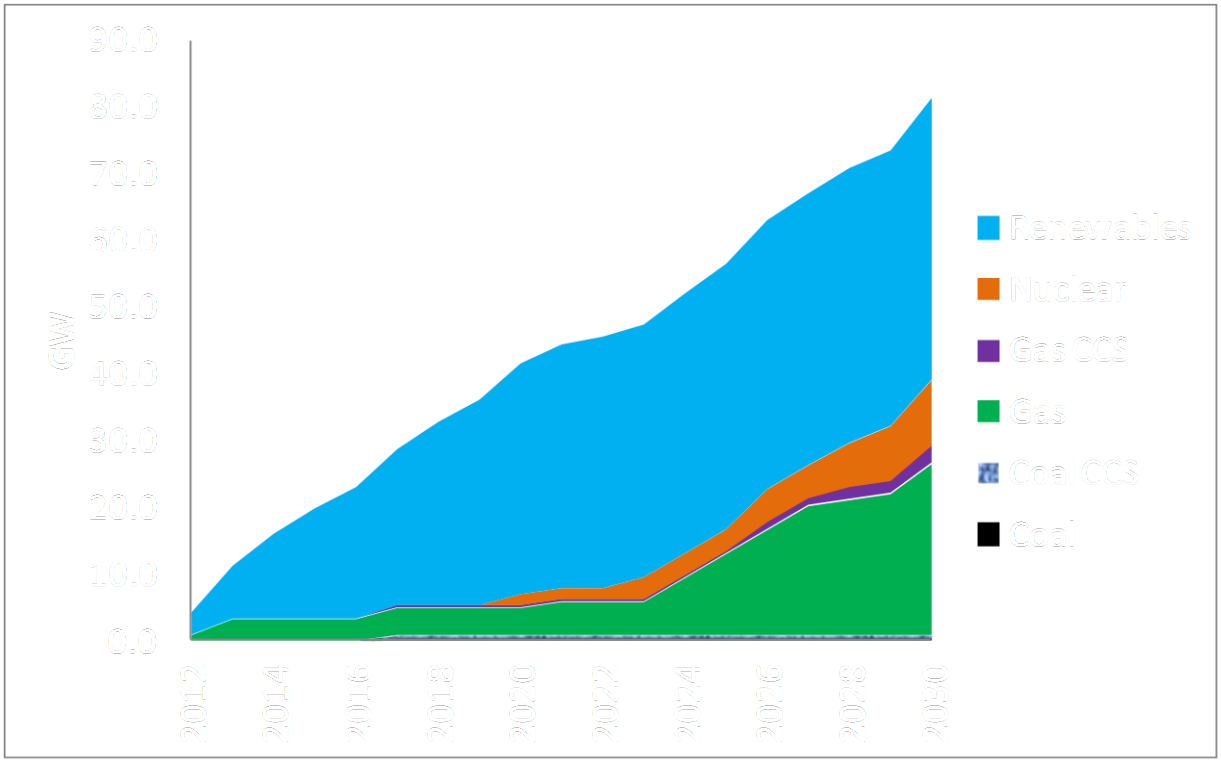
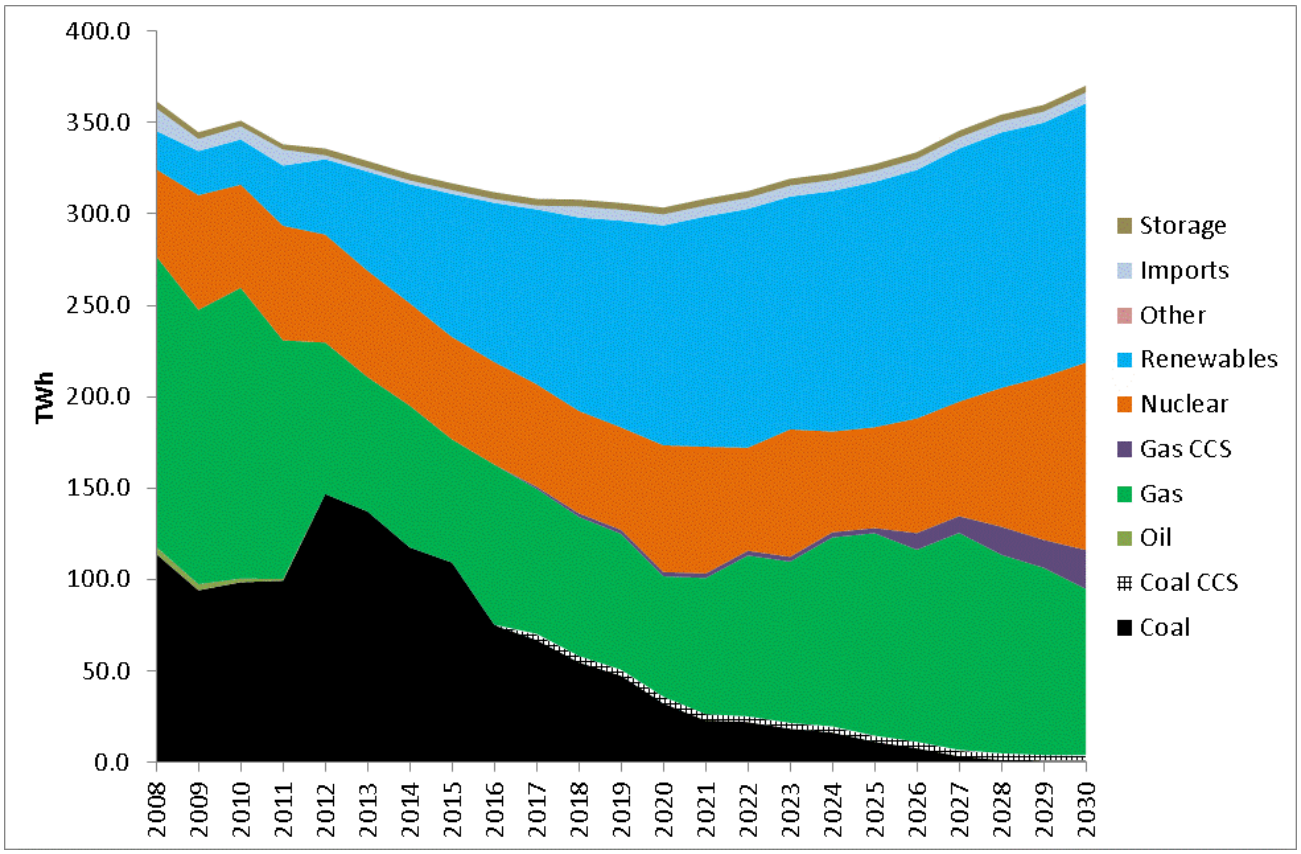


Figure 6.2 shows actual and projected levels of electricity supply by fuel. In summary, the major features of the projection are a large expansion in supply from renewables to 2020 and a significant diminution in supply from coal-fired plants in the longer term.

Figure 6.2 Electricity supplied[47] by fuel for the MPPs, 2008 to 2030



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.

DECC's CHP model has been subject to considerable development during the last year. The model consists of a bottom-up technical and basic economic model, operated on behalf of DECC by AEA Technology and an in-house Monte Carlo model. Whilst the former considers the economic case for individual sites based on their heat and power requirements, the Monte Carlo model has been designed to capture the majority of the costs of CHP, policies that affect development and behavioural aspects of the industrial decision making process. In particular, modelling of the Renewables Obligation, the Renewable Heat Incentive, the EUETS and the Carbon Price Floor have all been improved

[47] 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.

in the latest version of the model. Work on the CHP model continues in order that the contribution that it can make to meeting carbon targets can be fully understood.

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

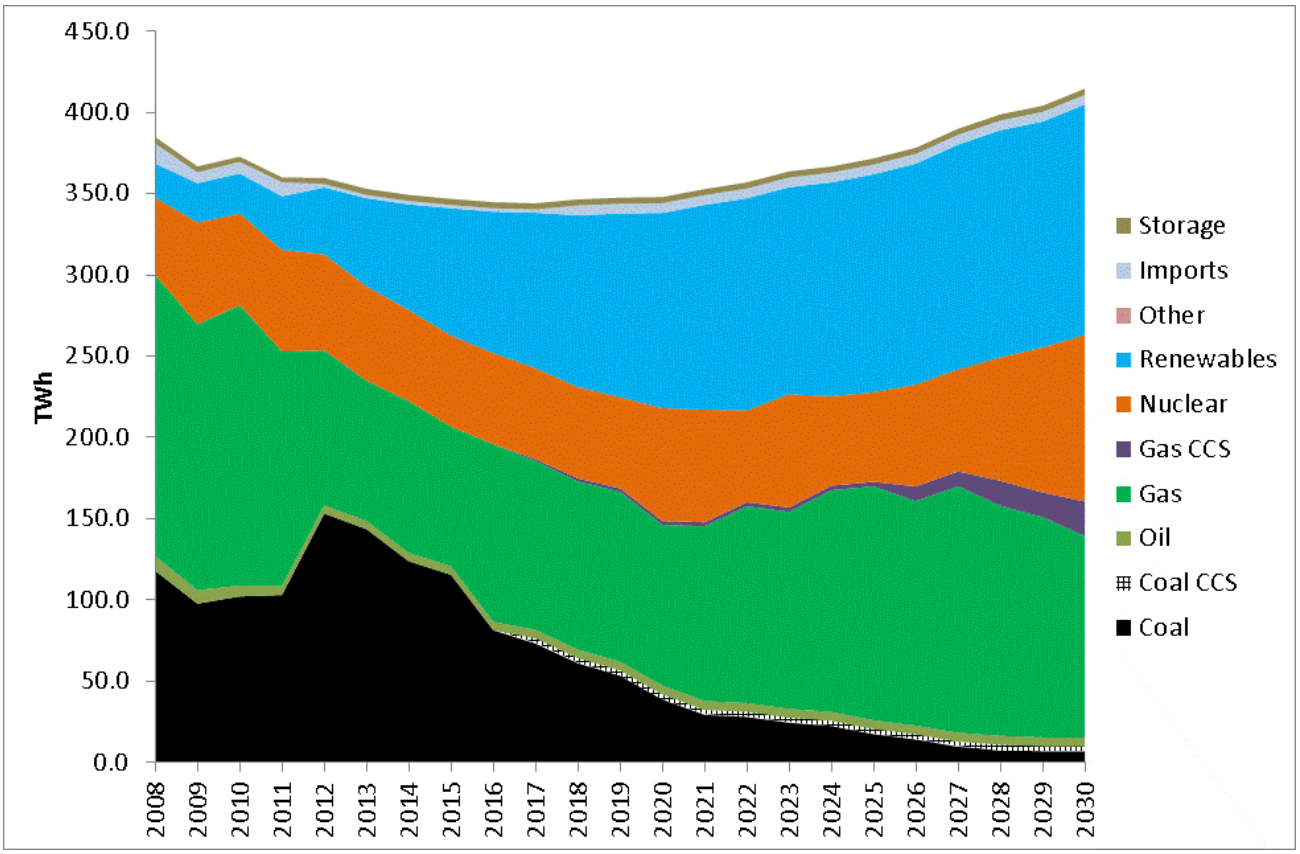
Capacity, GW	2010	2015	2020
October 2011 projection	6.0	8.6	11.3
October 2012 projection	6.1	8.1	8.6

Over the last few years, CHP development has been slow and the latest results suggest that this trend is likely to continue with an evident reduction in the capacity projection for 2020. Much of this is due to the availability of new data that markedly improved our understanding of the heat and power requirements of potential sites. This, taken with the new price projections and improved representation of policies within the model has significantly decreased the modelled potential. Whilst CHP overall is expected to show only modest capacity increases over the next few years, such increases that do occur are mainly from renewable sources, incentivised by the various policies available.

All electricity supply

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

Figure 6.3 Electricity supply[48] by fuel for all generators, 2008 to 2030



[48] 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)[49]

Mtoe	2010	2015	2020	2025	2030
Industry	**28**	**27**	**28**	**27**	**28**
Electricity	9	9	9	9	10
Gas	12	11	10	9	9
Petroleum	5	5	4	4	4
Solid / manufactured fuels	2	2	2	2	2
Renewables	1	1	3	3	3
Domestic	**48**	**39**	**37**	**40**	**43**
Electricity	10	8	8	8	10
Gas	33	28	27	29	31
Petroleum	3	2	1	1	1
Solid / manufactured fuels	1	1	1	1	1
Renewables	1	1	1	1	1
Transport	**55**	**52**	**52**	**52**	**54**
Electricity	0	0	1	1	1
Aviation fuel [2]	12	12	13	15	16
Petroleum (Rail)	1	1	1	1	1
Petroleum (Shipping)	1	2	2	2	2
Petroleum (Road transport)	39	36	34	33	33
Bio-fuel	1	2	3	1	1
Services and Agriculture [1]	**19**	**20**	**19**	**19**	**22**
Electricity	9	9	9	10	11
Gas	8	8	7	6	7
Petroleum	1	2	1	1	1
Solid / manufactured fuels	~	~	~	~	~
Renewables	0	1	2	2	2
Total	**151**	**138**	**136**	**139**	**146**
Electricity	28	26	26	28	32
Gas	54	47	44	45	48
Petroleum [2]	63	58	55	56	57
Solid / manufactured fuels	3	3	2	2	3
Renewables	2	5	9	7	7

~ Less than 0.5 Mtoe

[1] Includes the DUKES Commercial, Public admin, Agriculture and Miscellaneous sectors

[2] Includes International Aviation

Figure 7.1shows 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

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

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.

Figure 7.1 Final energy demand by fuel type

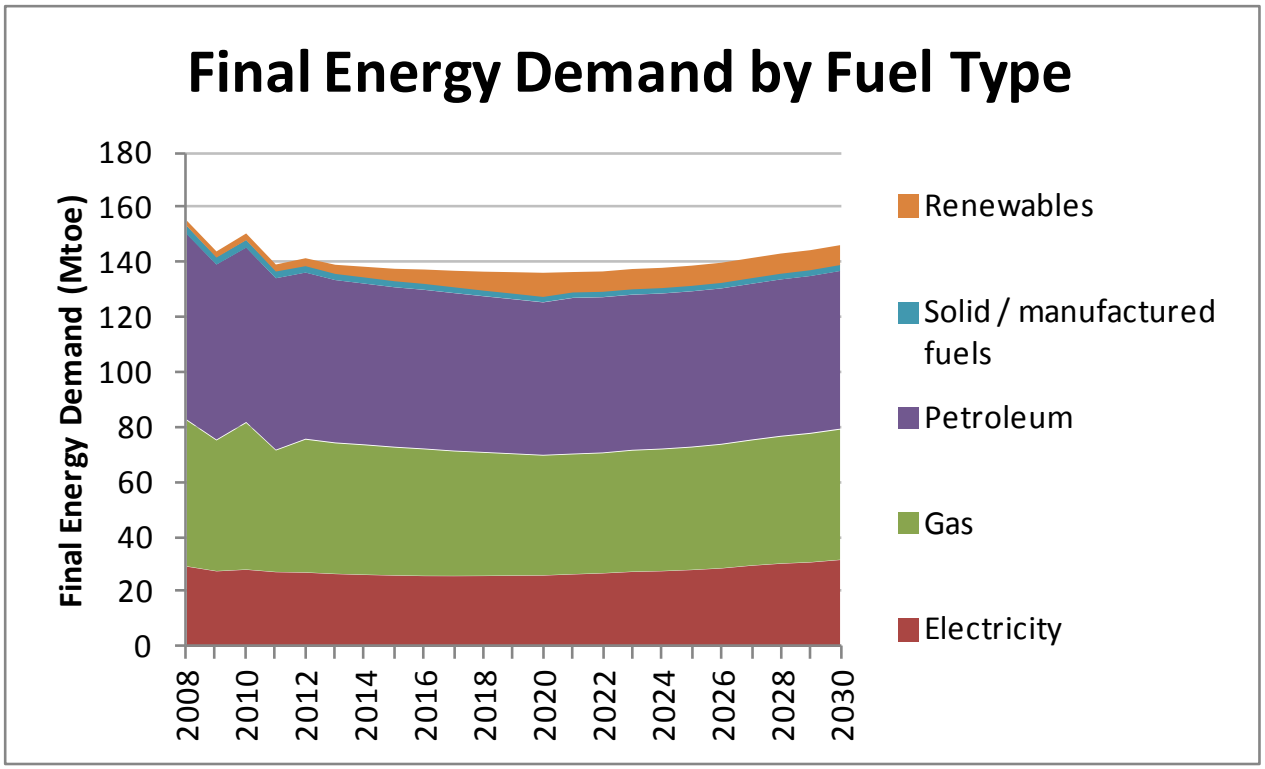
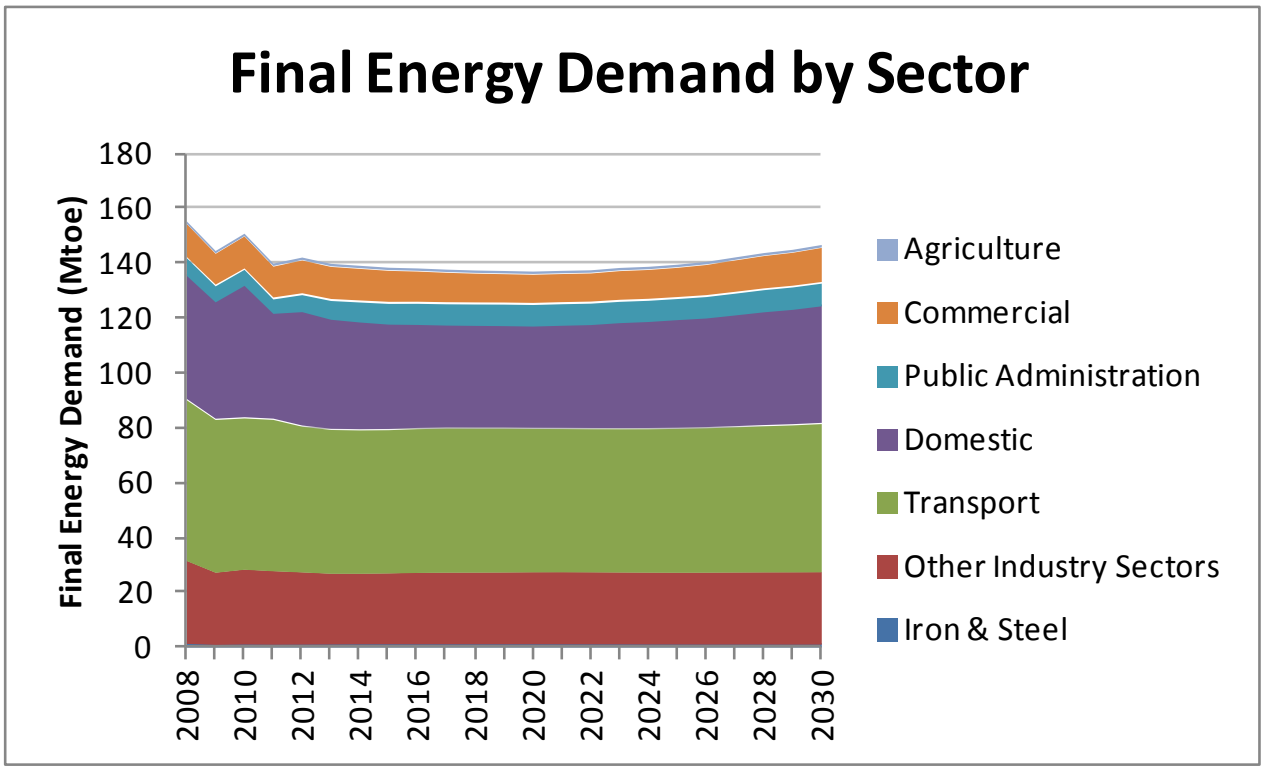


Figure 7.2 Final energy demand by sector[50]



Primary Energy Demand

Primary energy demand has fallen by over 14% since 2005 and is projected to fall further through the next decade or so, before rising in the years leading up to 2030. Over time 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 detailed projections by fuel.

[50] 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.

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: Price and Growth 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: Model Development

Introduction

The following model improvements were incorporated into the Energy and Emissions Projections model (UEP) used by DECC to produce these projections:

- Integration of a new electricity supply model, the "Dynamic Dispatch Model" (DDM) with the existing UEP demand model, replacing the previous UEP electricity supply model.

- Development of a new interface for the demand model and an associated data cleaning exercise to remove unused equations and errors.

- Savings from rail electrification were incorporated into the model. Previously an off-model adjustment had been made to the emissions projections to take account of the impact.

In 2011 DECC carried out a review of the energy demand model. This year the focus was on incorporation of the DDM model and interface. Therefore, apart from corrections to errors, no changes were made to the demand equations. However some model development and testing of equation performance was carried out. This identified a small number of equations that appeared to be systematically under or over-estimating demand. These will be prioritised for re-development over the coming year.

Integration of the Dynamic Dispatch Model for electricity supply

The Dynamic Dispatch model is a model of the behaviour of electricity suppliers commissioned by DECC for the purposes of modelling electricity market reform (EMR) policies. It was completed in 2011 and has previously been used by DECC for internal modelling of EMR policies, using fixed electricity demand scenarios. This year DECC integrated the DDM electricity supply model with the UEP demand model.

The previous UEP electricity supply model was a least cost optimisation model which in effect assumed electricity providers behaved as though they knew future generation costs and demand and found the least cost way of meeting this demand. Some adjustments were made to ensure the model provided projections that were consistent with recently observed real world behaviour. The DDM model attempts to model real world market behaviour of electricity providers more accurately. As in the UEP model, supply from existing plant is dispatched according the least cost way of meeting a given level of demand. However investment decisions on new plant are made on the basis of perceived future returns on investment. Providers are assumed to have limited foresight of future fossil fuel prices and demand and to apply a "hurdle rate" i.e. minimum rate of return which

differs across technologies. This hurdle rate differs between technologies depending on the level of uncertainty or risk associated with future rates of return for that technology. Plant closure decisions are modelled endogenously with plants closing when they are no longer economically viable.

The change of modelling approach leads to slightly higher traded sector emissions in the short run owing to a more immediate reaction to increased competitiveness of coal relative to gas. Without EMR new build decisions for nuclear and renewable plant would be slightly delayed compared with the previous UEP supply model. However the incorporation of EMR into this set of projections largely offsets this impact. In the longer run the lower projected emissions are primarily due to improvements in the modelling of plant closures and associated improvements on modelling of the IED (Industrial Emissions Directive). This leads to substantially lower coal generation in the long run than under the previous projections.

Data cleansing exercise

The UEP demand model database was previously held in a proprietary modelling software package. The software included a system to allow for automatic and ad-hoc adjustments to demand equations. This system led to a number of small errors entering the equations because the default mode was to apply an automatic adjustment. The large number of equations in the model meant that it was not possible to easily identify and remove these errors. To facilitate integration of the DDM and to remove this potential source of error, DECC transferred the demand model equations to an excel interface. During the process of transferring the model it was possible to identify and remove these errors. The largest impacts of these corrections were lower emissions in Industry and Transport. In transport this was due to removal of an automatic adjustment to aviation fuel demand.

An error in implementation of the public sector demand equation for electricity was also identified and corrected. This led to an increase in projected gas demand in that sector because the equation for total energy demand remained unchanged.

Future developments

Demand Equations

During the quality assurance process a number of equations were identified as priorities for development over the coming year following back casting tests and comparison of recent actual and projected trends. Methods are under development for addressing the issues identified but these require further quality assurance and peer review before implementation. The equations that have been identified for review over the coming year are:

- Fuel share equations for industrial sub-sectors
- Public sector total energy demand
- Domestic sector electricity demand
- Non-metallic minerals total energy demand

Combined Heat and Power

Updated projections of the technical potential of Combined Heat and Power (CHP) are provided to DECC by AEA and these are incorporated in the current estimates. Following their inclusion in the CHP model, these projections were subsequently revised by AEA as a result of inconsistencies in assumptions with the DECC model. In particular, revisions to the methodology for carbon price and the CRC were made. These revisions were received too late for incorporation into this year's projections and taken together with improvements to the representation of policies within the model, resulted in a large reduction in potential at 2020.

The actual CHP projections used in these projections are therefore higher than the final projections provided by the earlier AEA and DECC modelling shown in Table A1 below. The result of the various revisions is to reduce capacity at 2015 by 800MW and at 2020 by 2.7GW below the values shown in the table. Revised projections will be incorporated into any subsequent DECC modelling of CHP policies.

Table A1: CHP capacities used in the modelling.

Capacity, GW	2010	2015	2020
Modelled capacities, 2012	6.1	8.9	11.4

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