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An Impact Assessment of the Current Economic Downturn on UK CO2 Emissions

A final report for the Committee on Climate Change

11 August 2009

Revision and Authorisation History

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1.4	11/8/2009	Sudhir Junankar	Final report
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Contents

Executive Summary

- The Committee on Climate Change (CCC) commissioned Cambridge Econometrics (CE) to assess the impact of the current economic downturn on carbon emissions in the UK and to help the CCC in determining the extent to which the emissions reductions in the first budget period (2008-12) could be attributed to the recession rather than policy effort.

- The analysis builds on the reference scenarios, specifically Ref1b, provided to the CCC in September 2008 by CE. The scenarios were undertaken in CE's multisectoral dynamic model of the UK economy MDM-E3. The objective of the analysis was to provide a high-level assessment of the impact on carbon emissions resulting from the current economic downturn, with specific reference to both the EU ETS traded and non-traded sectors.

- The January IMF projections of UK economic growth and manufacturing activity were used, as required by the terms of reference, as the input assumptions to the C1 and C2 scenarios. The IMF projections used project a contraction in UK GDP of 2¾% in 2009 before returning to low growth of ½% in 2010. The IMF has subsequently revised, in April 2009, the projections for both 2009 and 2010 downwards to take account of the impact of the global financial crisis on economic activity.

- Overall, there is a reduction in annual CO2 emissions, on a net carbon account basis, of around 2½-3% each year to 2020 compared to the Ref1b scenario following the impact of the economic recession in 2009.

- There is no impact on the EU ETS traded sector, in terms of CO2 emissions contributing to the net carbon account, as the UK is expected to be a net importer of permits in both the reference and recession scenarios.

- The economic downturn causes a step-change in non-EU ETS traded-sector CO2 emissions in full by 2011, particularly from road transport and the domestic sector. Thereafter the difference in emissions between the C1 scenario and the Ref1b scenario remains virtually unchanged, reflecting the gap in the levels of economic activity (GDP).

1 Introduction

1.1 Background and Objectives

The CCC commissioned CE to undertake an impact assessment of the current economic downturn on UK CO2 emissions

1.1.1 On 1 December 2008 the UK enacted the Climate Change Act committing the UK to an 80% reduction in greenhouse gas (GHG) emissions by 2050. In support of the Climate Change Act, the Committee on Climate Change (CCC) published a report which provided the backdrop to the 2050 target, the interim 2020 target, carbon budgetary periods and various cost estimates of reducing CO2 emissions in the UK. In the 2009 Budget the Chancellor formally set the carbon budgets for the next three five-year budgetary periods, including the legally-binding target of a 34% reduction in greenhouse gases (GHG) by 2020.

1.1.2 However, since the initial analysis, by the CCC, the economic downturn, both globally and in the UK, has worsened considerably. The International Monetary Fund (IMF) April 2009 forecast now projects that the UK economy will contract by 4.1% in 2009 and by a further 0.4% in 2010 (IMF, 2009). In Budget 2009, HM Treasury predicted that the UK economy would contract by 3½% in 2009 but pick up progressively in 2010 and 2011, with annual growth of 1.25% in 2010 and 3.5% in 2011.

1.1.3 Economic activity is a primary driver of greenhouse gas emissions, particularly carbon emissions, through the demand for energy. Given the expected decline in economic activity, the CCC commissioned Cambridge Econometrics (CE) to model the impact of the economic downturn on UK CO2 emissions.

1.1.4 We have modelled two downturn scenarios building on the reference scenarios provided to the CCC in September 2008. The first is an economic downturn scenario based on January 2009 IMF projections. The second scenario builds on the first but with new price assumptions provided by the CCC.

1.2 Structure of the Report

1.2.1 In Chapter 2 of the report we provide an overview of the MDM-E3 model of the UK economy-energy-environment relationships used to undertake this analysis. Chapter 3 outlines the differences in the assumptions between Ref1, Ref1b, Core 1 and Core 2 scenarios. In Chapter 4 we discuss the key results while in Chapter 5 we make some concluding remarks on the findings.

1.2.2 CE also produces twice-yearly forecasts of the economy and the impact on energy demand and carbon emissions. In Appendix A we provide a brief summary outlining the main differences between CE's most recent projections and those provided to the CCC in this report.

2 A Short Description of MDM-E3

2.1 Introduction

2.1.1 The Cambridge Multisectoral Dynamic Model of the UK economy (MDM-E3) is the UK's most detailed integrated energy-environment-economy (E3) model, designed to analyse and forecast changes in economic structure, energy demand and resulting environmental emissions (for more details see CE, 2008a, Annex A).

2.1.2 Energy-environment characteristics are represented by sub-models within MDM-E3 and at present the coverage includes energy demand (primary and final), environmental emissions, the electricity supply industry and domestic energy appliances. The energy-related industries are included within the basic input-output structure and MDM-E3 is a fully-integrated single model allowing extensive economy-energy-environment interaction (see Figure 2.1).

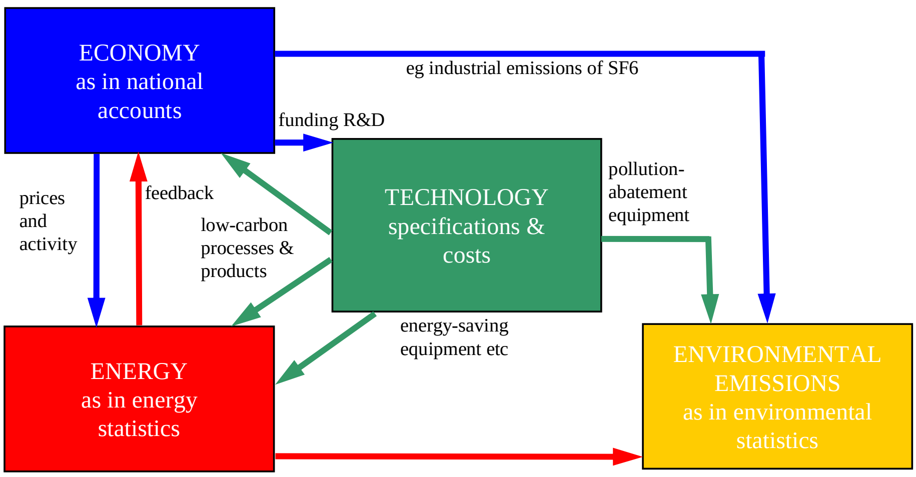
2.1.3 The version of the model used for this project is essentially the same as the one used to produce CE's second energy and emissions forecast published in August 2008 (CE, 2008b).

2.2 The Treatment of the Economy

2.2.1 The principal economic variables in MDM-E3 are:

- the final expenditure macroeconomic aggregates, disaggregated by product, together with their prices
- intermediate demand for products by industries, disaggregated by product and industry, and their prices

FIGURE 2.1: ENGINEERING-ENERGY-ENVIRONMENT-ECONOMY INTERACTIONS IN MDM-E3



Source(s) : Cambridge Econometrics.

- value added, disaggregated by industries, and distinguishing operating surplus and compensation of employees
- employment, disaggregated by industries, and the associated average earnings
- taxes on incomes and production, disaggregated by tax type
- flows of income and spending between institutions and sectors in the economy (households, companies, government, the rest of the world)

2.2.2 Some variables are also disaggregated by government office region and devolved administrations. This applies particularly to value added, employment, wages, household incomes and final and intermediate expenditures. Prices are not typically disaggregated by region, because of data limitations.

2.2.3 MDM-E3 retains an essentially Keynesian demand-led logic for determining final expenditures, output and employment. The principal difference, compared with purely top-down macroeconomic models, is the level of disaggregation and the complete specification of the accounting relationships in supply and use tables required to model output by disaggregated industry.

2.2.4 The parameters of the behavioural relationships in MDM-E3 are estimated econometrically over time, within limits informed by theory, rather than imposed on a priori grounds from theory. The economy is represented as being in a continual state of dynamic adjustment, and the speed of adjustment to changes (in, for example, world conditions or UK policies) is based on empirical evidence. There is therefore no assumption that the economy is in equilibrium in any given year, or that there is any automatic tendency for the economy to return to full employment of resources.

2.3 The Treatment of Energy

2.3.1 MDM-E3 includes detailed treatment of energy demand by ‘fuel user’ (for example, industries, households, transport) and by fuel, measured in energy units. The use of energy in power generation is given its own special treatment. The linkages between the energy submodel and the economy and environment are depicted in Figure 2.2.

2.3.2 Except for power generation, final energy demand by fuel user and fuel is modelled by econometric equations in which the key influences (from the point of view of this study) are the level of activity of the fuel user (for example, the level of output in an industry, or the level of household income) and relative prices (the price of energy relative to the general price level, and the relative prices of the various fuels). A higher level of activity leads to higher energy demand, while higher energy prices discourage energy demand. A change in relative fuel prices induces substitution towards cheaper fuels.

2.3.3 MDM-E3 models the stock of power-generation capacity and the annual generation of power from this stock in response to changes to demand for electricity, fossil fuel prices, carbon prices and incentives to increase the use of renewables. Essentially, new power-generation capacity is built when the expected demand exceeds projected capacity (taking account of the retirement of plant) plus a margin. The choice of technology for the new plant (and in particular the choice of fuel) depends on a comparison of the projected costs of the available alternatives, including the incentives provided by policy (for example, a carbon price or the renewables obligation). The choice of which existing plants supply electricity in a given year (and hence which fuels are used in power generation) is made on the basis of the fuel prices and policy incentives prevailing in that year. The model adjusts each plant's load factor up or down as more or less generation is required.

2.3.4 The policy measures modelled in this study increase the costs of power generation and increase the incentives to build low carbon plants and to take supply from those plants. The costs are passed on to the users of electricity in the price that they pay.

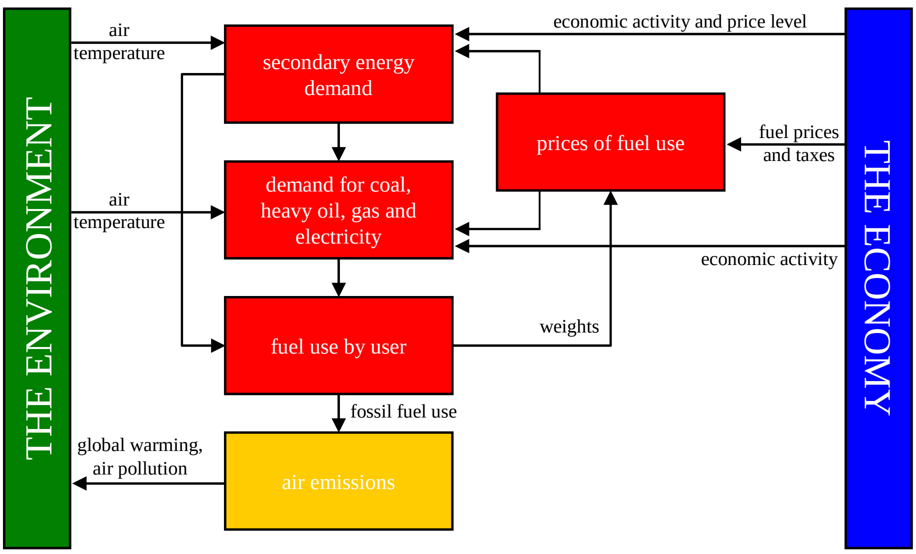
2.3.5 Allowances to emit CO2 under the EU ETS are treated as a financial asset whose price is set by assumption. If allowances are distributed freely (for example, on the grandfather principle), the profits of the firms receiving the allowances are increased. If allowances are auctioned, the revenues accrue to government and may be recycled to firms or households by compensating reductions in taxation or increases in government spending. The price charged by firms covered by the EU ETS is not affected by the decision whether or not to auction allowances.

2.4 The Treatment of Emissions

2.4.1 MDM-E3 covers all the GHG emissions controlled by the Kyoto Protocol, as well as various other air emissions (for example SO2).

2.4.2 For most energy-related air emissions (including CO2), emissions factors for each fuel and fuel user are calculated using the last year of outturn data for emissions (sourced from the NAEI) and energy demand. Unless an end-of-pipe technology is available to curb emissions, as is the case, for example, with flue-gas desulphurisation units, the emissions factors are held constant

FIGURE 2.2: THE ENERGY SUBMODEL IN MDM-E3



Source(s) : Cambridge Econometrics.

for the remainder of the projection period and applied to the level of demand for each fuel and fuel user. Thus, CO_2 emissions from energy use depend on the use of each fossil fuel and its carbon content. This treatment applies to other emissions modelled in MDM-E3 including the other five GHGs.

2.4.3 Non-energy CO_2 emissions are driven by changes in activity for each of the relevant fuel users. Emissions from land use and land use change are not currently covered in MDM-E3.

2.4.4 Non-energy emissions of non-CO_2 GHGs are driven by the demographic assumptions fed into the model ie emissions grow with the population.

3 Assumptions

3.1 Overview

Ref1 and Ref1b are scenarios taken from previous work done for the CCC

3.1.1 The Ref1b run belongs to a family of scenarios that were run as part of a previous study undertaken by CE for the CCC (CE, 2008a). It is a variant of the central reference scenario Ref1 which is described briefly below and differs from the Ref1a run in its treatment of future developments in the UK's generation capacity, specifically, nuclear capacity.

3.1.2 The Ref1b projection was taken as the new baseline for the modelling reported here. Two variants of this scenario were run to examine the effects of the new UK growth assumptions (as a result of the recession) and the further effects of new fossil-fuel price assumptions.

3.2 Assumptions Common to all Ref1 Variants

A number of assumptions were imposed in Ref1

3.2.1 Ref1 was calibrated to reproduce, broadly, the macroeconomic projections outlined in the 2008 Budget report. Variables calibrated include, for example, GDP and manufacturing GVA.

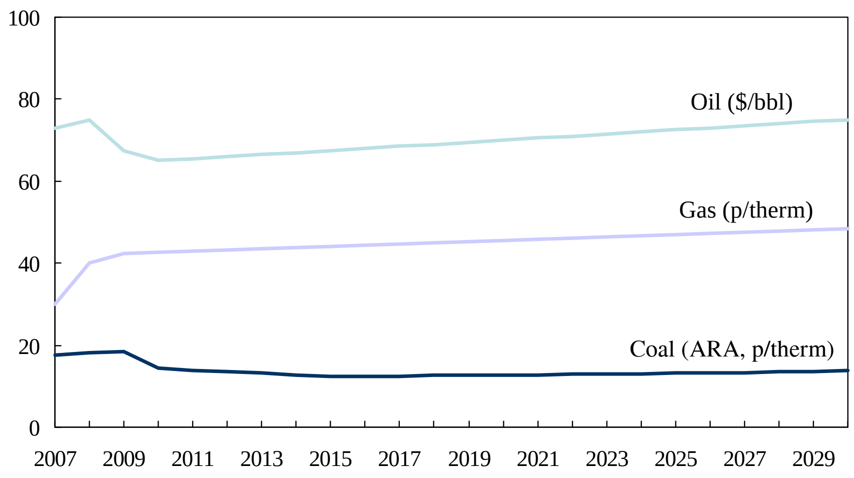
3.2.2 Growth in GDP is around 2½% pa over 2008-2017 (the first two carbon budget periods) slowing to 2¼% pa over 2018-22. Manufacturing GVA is assumed to grow at a lower rate than GDP but, in line with the GDP figures, exhibits progressively slower growth through the projection period.

3.2.3 In Ref1 the CCC's assumptions of future $:£ and €:£ exchange rates were also adopted. The $:£ rate was fixed at 2:1 from 2008 onwards and the €:£ rate at 0.7:1 from 2013 onwards.

BERR's 2008 Central fossil fuel price assumptions were used in Ref1

3.2.4 Ref1 also made use of fossil fuel price assumptions published by BERR

CHART 3.1: CENTRAL FOSSIL FUEL PRICE ASSUMPTIONS



Note(s) : 1. The prices are in 2007 terms, adjusted for general inflation thereafter.
2. It is assumed that 1 tonne of coal is equivalent to 250 therms of energy.

Source(s) : Committee on Climate Change.

(2008), in particular the assumptions from the 'Central' scenario (see Chart 3.1). In these assumptions the real wholesale price of oil rises by more than 3½% in 2008 and then falls by more than 9¾% in 2009. Growth thereafter is positive, but slows over the projection period.

3.2.5 The real, inflation-adjusted price of gas rises over the projection period but at a lower rate than the price of oil. The relative price of coal compared to gas is assumed to fall in real terms.

Additional energy savings were imposed in Ref1

3.2.6 The energy savings expected by the Government from the policies announced in the UK Climate Change Programme Review (Defra, 2006) were applied to Ref1. For consistency, the percentage reductions by fuel user were calculated from the absolute values provided by the CCC and applied to MDM-E3's fuel user categories. The cumulative energy savings added into the baseline are shown in Chart 3.2.

3.2.7 Most of the energy savings are expected to come from households, reducing energy demand in 2020 by 20% when compared to a business-as-usual case. The majority of the savings are expected to come from reduced use of gas. By 2020 the policies are expected to lead to a reduction in energy demand from commerce (primarily the public sector and services) of around 10% and of around 4% from industry.

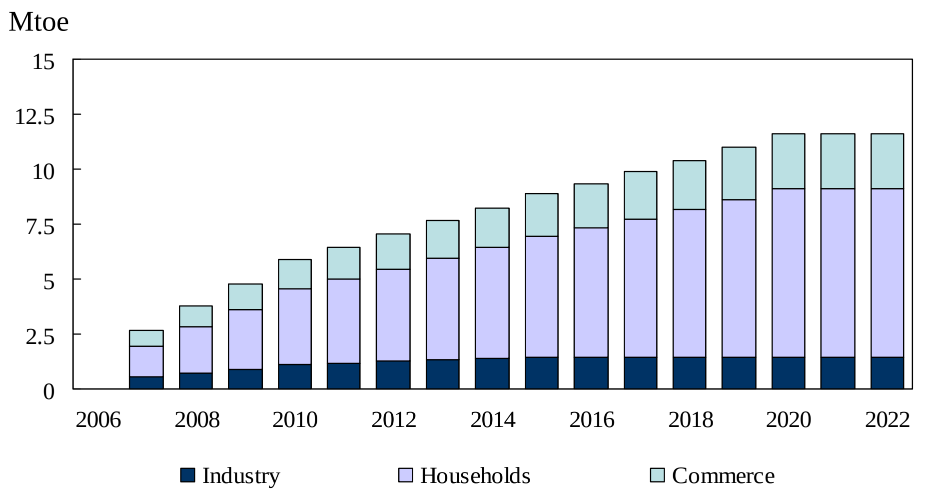
No carbon price was modelled in Ref1 and the CCC provided assumptions regarding power generation

3.2.8 As previously agreed with the CCC, MDM-E3's treatment of the CCL and of fuel duty was left unchanged.

3.2.9 Ref1 assumed no carbon price from the EU ETS.

3.2.10 The CCC's assumptions regarding the power generation capacity were adopted. These included the cost of new build, based on a nominal discount rate of 10% pa. In Ref1 the model was set such that the construction of new nuclear capacity was not an option during the projection period.

CHART 3.2: CENTRAL ASSUMPTIONS OF ENERGY SAVINGS FROM GOVERNMENT BY FUEL USER (CUMULATIVE)



Note(s) : 1. Energy savings in 2006 assumed to be already captured in the 2006 outturn data.
2. Energy savings after 2020 are held at the level assumed for 2020.

Source(s) : Committee on Climate Change and Cambridge Econometrics.

3.3 Ref1b Assumptions

Ref1b differs from Ref1 in the modelling of a carbon price

3.3.1 Ref1b is a variant of Ref1 that assumes a carbon price and the associated emissions caps as a result of the EU ETS. These caps were the same for all subsequent scenarios modelled in this project.

3.3.2 The (real) carbon price is assumed to rise by 5% pa throughout the projection period and the associated caps reflect the assumption that all flights from the UK, (both domestic and international) are regulated by the EU ETS from the beginning of Phase 3 in 2013. The caps are assumed to fall over the remainder of the projection period by 2½-4¼% pa.

3.3.3 In Ref1b, the model is still prevented from building new nuclear capacity. This is the only difference between Ref1a and Ref1b.

3.3.4 In Ref1b the model is allowed to calculate the economic impacts of the carbon price. Thus, differences in the macroeconomic projections between Ref1 and Ref1b can be interpreted as including the economic effects of the EU ETS.

3.3.5 In Ref1b, GDP grows by 1.8% in 2008. To 2014 GDP grows by 2.6-2.7% pa and by around 2¼% pa thereafter. Growth in manufacturing GVA is lower than GDP growth but the profiles are quite similar. The projections of GDP and manufacturing GVA in Ref1b are shown in Chart 3.3.

The traded sector caps are exceeded in Ref1b

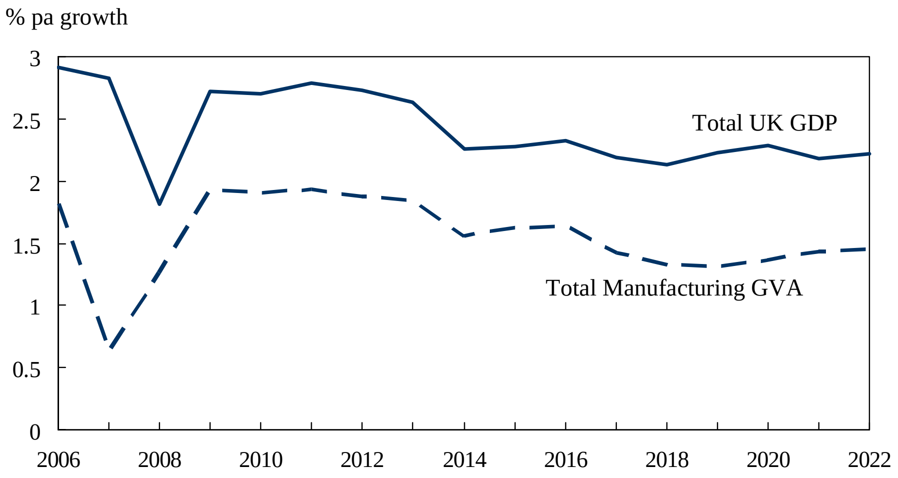
3.3.6 Chart 3.4 shows that traded-sector CO2 emissions in Ref1b exceed the caps proposed in the 2009 Budget (HM Treasury, 2009) in all of the first three carbon-budget periods. By contrast the non-traded caps are easily met in all three periods.

3.4 Core 1 Assumptions

More recent macroeconomic projections were imposed in the Core 1 scenario

3.4.1 The Core 1 (C1) scenario is a variant of Ref1b and takes on a new set of macroeconomic assumptions to simulate the effect of the recession (see Chart

CHART 3.3: BROAD UK MACROECONOMIC ACTIVITY IN REF1B



Note(s) : Per annum growth on market (GDP) and basic price (GVA) bases are shown. Both are chain-volume measures.
Source(s) : ONS, Committee on Climate Change and Cambridge Econometrics.

3.5). These projections come from the IMF's January assumptions for UK growth published at the start of 2009.

3.4.2 GDP growth of ¾% is assumed for 2008, followed by a decline of 2¾% in 2009. Growth of ¼% in 2010 and 1% in 2011 is assumed followed by growth of 2% pa thereafter. Long-run trend growth is thus lower in C1 than it is in Ref1b.

3.4.3 Manufacturing GVA has a similar growth profile to that of GDP though the growth is typically lower. Trend growth from 2012 onwards is 1.4-1.5% pa.

By 2022, the assumed economic growth profile suggests a loss of 13% to GDP in the C1 scenario compared to Ref1b

3.4.4 GDP in 2009 is 6.4% lower in C1 than it is in Ref1b and by 2011 (the year before growth is assumed to return to trend) the difference is around 10%. Slower growth in C1 than in Ref1b leads to a gradual widening of the gap between the projections, to 13% by 2022.

3.4.5 Household income was also calibrated to match the IMF's assumptions. Qualitatively, the differences in households' expenditure between Ref1b and C1 in the short-term are similar to the differences in GDP, albeit more pronounced. Consumption is 9.4% lower in C1 in 2009 than it is in Ref1b. The gap in the longer term fluctuates somewhat, but household expenditure in C1 remains around 14% lower than in Ref1b over the remainder of the projection period.

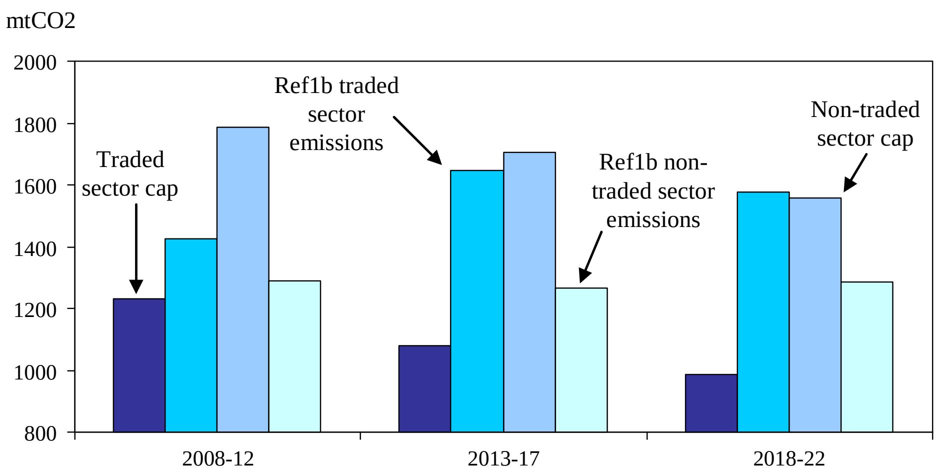
3.4.6 Investment also falls sharply in the recession scenario, by 2.3% in 2009. Steady growth in investment does not resume for some time; until at least 2014. This has implications for the UK's energy-consuming capital stock.

3.5 Core 2 Assumptions

Core 2 is a variant of Core 1, but with updated fossil-fuel and carbon price assumptions

3.5.1 The Core 2 scenario is a variant of Core 1 and takes on a new set of fossil fuel price assumptions and carbon prices.

CHART 3.4: REF1B CO2 EMISSIONS



Note(s) : 1. Includes emissions from non-energy uses.
2. Excludes emissions from land use, land use change and forestry.

Source(s) : NAEI, DEFRA, BERR (DUKES 2007), Committee on Climate Change, HM Treasury and Cambridge Econometrics.

Ref : C82R1bCCC.

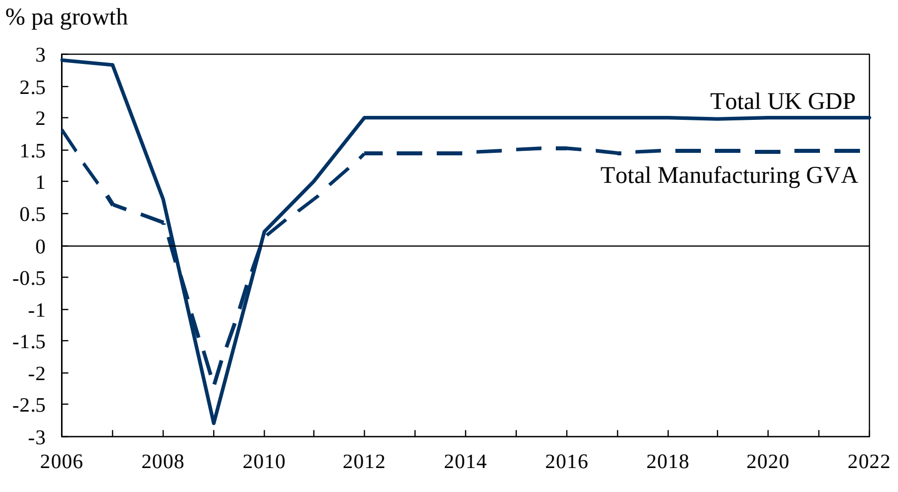
3.5.2 The fossil fuel prices assumed are from the 'Timely Investment, Moderate Demand' scenario which corresponds to what was previously described by DECC as the 'Central' price assumptions (see Chart 3.6).

3.5.3 Under the new set of assumptions, the international crude oil price (in real terms) falls by more than 30% in 2009 (much faster than in the previous set of assumptions) with no change in 2010. The price increases by around 1.4% in 2011 and the growth rate slows over the rest of the projection period.

3.5.4 Gas prices fall by 8.6% in 2009 and rise by 9.4% in 2010. Future assumed price growth is more volatile for this fuel. Like the previous Central set of assumptions, coal becomes relatively cheaper compared to gas.

3.5.5 The evolution of the carbon price was also modified in Core 2 to be consistent with the new fuel-price assumptions. The carbon price in Core 2 is lower in 2008 compared to Core 1 and grows at a slower rate. The emissions caps from the EU ETS were not changed between the scenarios (see Chart 3.7).

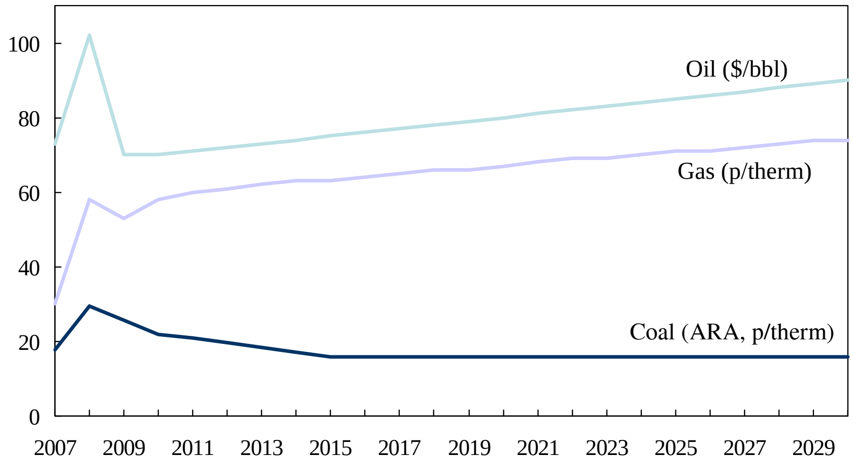
CHART 3.5: CCC ASSUMPTIONS FOR BROAD UK MACROECONOMIC ACTIVITY IN C1



Note(s) : Per annum growth on market (GDP) and basic price (GVA) bases are shown. Both are chain-volume measures.

Source(s) : ONS, Committee on Climate Change and Cambridge Econometrics.

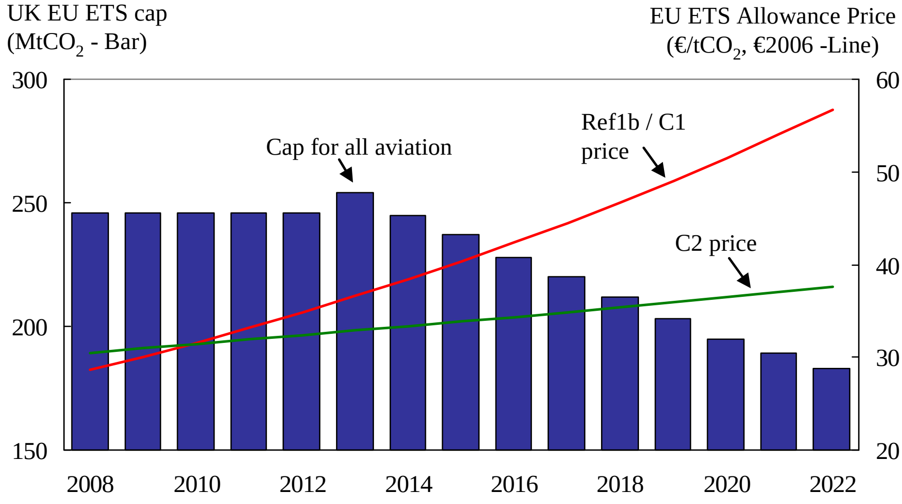
CHART 3.6: FOSSIL FUEL PRICE ASSUMPTIONS FOR C2



Note(s) : 1. The prices are in 2007 terms, adjusted for general inflation thereafter.
2. It is assumed that 1 tonne of coal is equivalent to 250 therms of energy.

Source(s) : Committee on Climate Change.

CHART 3.7: EU ETS CO2 CAP AND PRICE ASSUMPTIONS



Note(s) : Caps shown inclusive of emissions from all aviation including international flight from 2013.

Source(s) : Committee on Climate Change Secretariat.

4 Results

4.1 Overview

4.1.1 This chapter outlines the results of the key C1 recession scenario compared to the Ref1b scenario previously supplied to the CCC. In the second part of this chapter we compare the C1 and C2 scenarios, which are based on differing price assumptions as discussed in Chapter 3.

4.1.2 Unless stated otherwise, CO2 emissions figures are reported on a net carbon account basis.

4.2 The Effect of the Recession on UK CO2 emissions

Total GHG emissions over 2008-12 are 2.5% lower in C1 compared to Ref1b

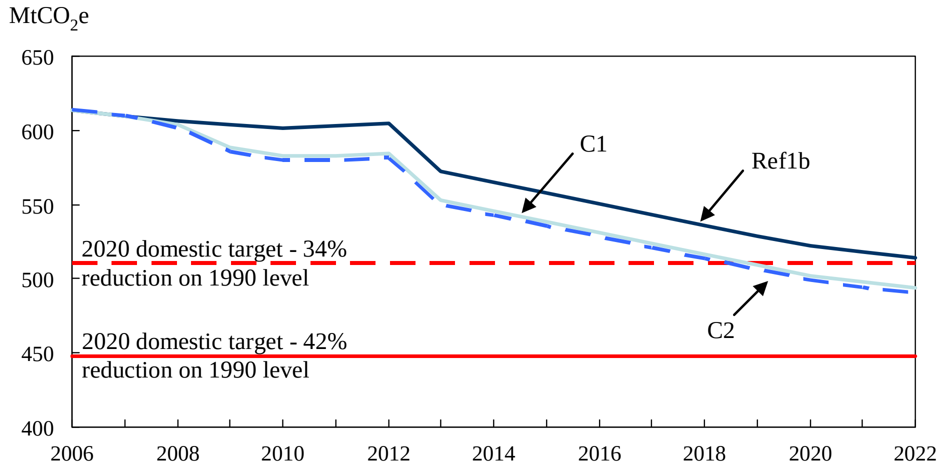
4.2.1 In the first carbon budget period (2008-12), total GHG emissions are 2.5% lower in C1 than in Ref1b. The reductions are driven by reductions in CO2 emissions, which account for more than 95% of the change (see Chart 4.1).

4.2.2 In 2008, emissions of CO2 are 0.5% lower in C1 than in Ref1b. GDP growth in C1 is around 1 pp lower in 2008 than in Ref1b. The largest reductions in final energy demand (and thus emissions) come from road transport and households. This is in line with the reductions in household income and spending modelled, as well as the overall decline in economic activity.

The recession modelled leads change in both the level and growth profile of GDP

4.2.3 The GDP profiles of the three scenarios are shown in Chart 4.2. The paths of GDP in C1 and C2 are not markedly different; throughout the projection period, GDP in C2 is at most ½% lower than in C1. The chart shows GDP growth to be lower in the Core scenarios than in Ref1b. Unsurprisingly, the gap widens most in 2009 owing to the recession (a difference of £83bn in 2003 prices) and in 2011 GDP in C1 is 10.2% (£141bn) lower than in Ref1b. Thereafter, GDP growth in C1 is around 0.2 pp lower than in Ref1b and in

CHART 4.1: PROJECTED UK GHG EMISSIONS



Note(s) : 1. Includes emissions from non-energy uses.
2. Excludes emissions from international travel and land use, land use change and forestry.

Source(s) : NAEI, DEFRA, BERR (DUKES 2007), Committee on Climate Change and Cambridge Econometrics.

Ref : C82R1bCCC, C82ReCCCC, C82ReC2CCC.

2022 the gap is around 13% (£207bn).

4.2.4 A reduction in economy-wide activity leads to a reduction in freight demand that leads to a reduction in the demand for road transport and, in turn, the requirement for fuel. Furthermore, lower economic activity leads to lower household incomes, which causes a reduction in passenger demand for travel. This further reduces the demand for road travel and fuel. Of MDM-E3's fuel users, the estimated (long-run) income elasticity of demand for road transport fuel is relatively high compared to the other fuel users, at 0.4. Consequently, emissions fall strongly as a result of the recession modelled.

4.2.5 A reduction in economic activity impacts on households through the effects on their disposable income. Household expenditure is, other things being equal, reduced, expenditure on energy included, leading to lower emissions. For households the long-run income elasticity of demand for fuel is relatively low at 0.2, indicating that energy is a basic requirement; the impact on energy demand from the recession is thus not nearly as large as the impact on incomes.

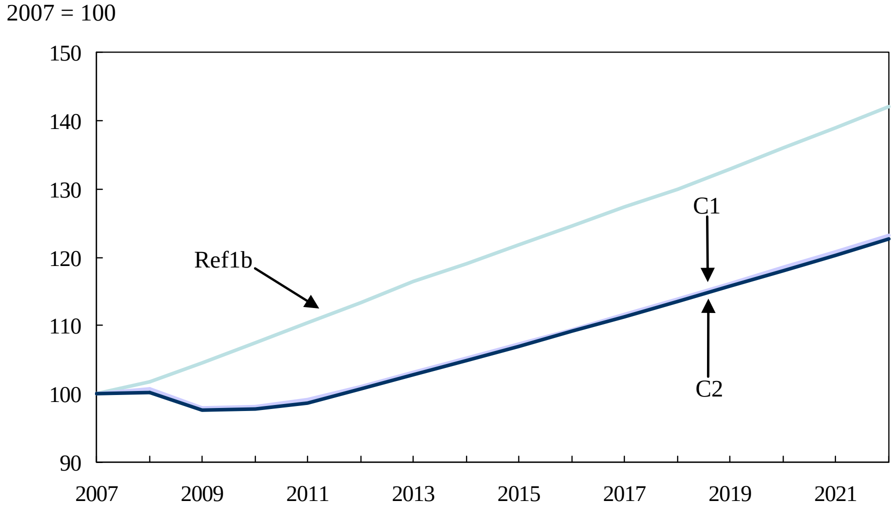
The sharpest fall in emissions comes from the decline in economic activity in 2009

4.2.6 In 2009 GDP in C1 is assumed to fall by 2.8%. Consequently, GHG emissions fall by 2.5% in this year (consistent with a 2.9% reduction in CO2 emissions). This reduction compares to a 0.5% fall in GHG emissions in Ref1b (CO2 emissions fall by 0.7%) and a 2.7% increase in GDP. Once again the largest reductions come from households and road transport.

4.2.7 Emissions from the energy-intensive industries also fall quite strongly in 2009, particularly from the MDM-E3 fuel users Basic Metals and Mineral Products owing to the substantial drop in activity in these sectors (which arises largely from the lower level of output that we have imposed, and is reflected in a 2.2% reduction in manufacturing GVA).

4.2.8 Substantially lower GDP growth in C1 in 2009 compared to Ref1b leads to a marked widening of the gap between the emissions projections in that year.

CHART 4.2: GDP



Note(s) :
Source(s) : ONS, Committee on Climate Change and Cambridge Econometrics.

GHG emissions are 2.5% lower in C1 than in Ref1b and CO2 emissions 2.8% lower.

The recession leads to higher emissions from Other Industry

4.2.9 Energy demand and emissions from the MDM-E3 fuel user Other Industry (ie the non-energy-intensive higher value-added manufacturing sectors) fall at a slower rate in C1 than in Ref1b in the first carbon-budget period.

4.2.10 While it is true that economic activity is lower in C1, MDM-E3's fuel demand equations also account for endogenous technical progress (quality-adjusted investment). The effect of investment on energy demand may be either positive (an industry invests largely in energy-consuming capital) or negative (investment is predominantly in more energy-efficient processes). In the case of Other Industry, the latter effect dominates in the industry's energy demand equations.

4.2.11 Thus, compared to Ref1b, relatively less investment in energy-efficient measures takes place in C1 and, for a given amount of output, manufacturing industries require comparatively more energy. Emissions are higher as a result.

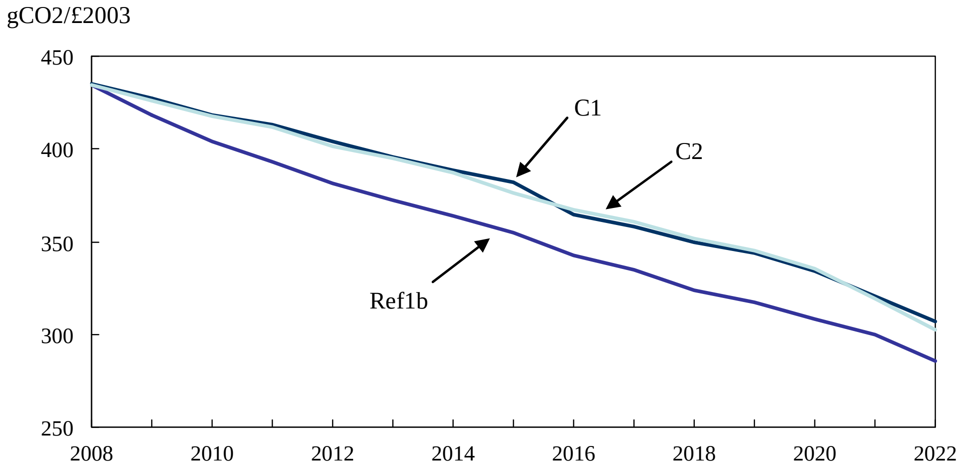
4.2.12 In C1 GHG emissions fall by 1% year-on-year in 2010 compared to a fall of 0.4% in Ref1b (CO2 emissions fall by 1.3% in C1 compared to a fall of 0.6% in Ref1b). GDP grows slightly in 2010 in C1 (less than ¼% compared to growth of 2.7% in Ref1b).

4.2.13 GHG emissions in 2011 scarcely fall in C1; CO2 emissions by 0.2%. This compares to growth in GHG emissions in Ref1b of 0.3% and growth in CO2 emissions of 0.2%.

The longer-term effects of the recession are largely confined to a step change in the emissions profile

4.2.14 The effect of the recession in C1 leads to a sharp fall in emissions during the recessionary period but the presumption of a return to a trend rate of economic growth from 2012 (on the plausible grounds that the recession leads to a once-and-for all loss of output) onwards means that the emissions profiles in C1

CHART 4.3: CARBON INTENSITY



Note(s) : 1. Includes emissions from non-energy uses.
2. Excludes emissions from land use, land use change and forestry.

Source(s) : NAEI, DEFRA, BERR (DUKES 2007), Committee on Climate Change and Cambridge Econometrics.

Ref : C82R1bCCC, C82ReCCCC, C82ReC2CCC.

and Ref1b are quite similar. The recession modelled in C1 leads to a rapid drop in economic activity in 2009 and a slow recovery in the following two years but the longer-term effect is a step change in the path of emissions.

4.2.15 In contrast to the Ref1b projection, scenario C1 suggests that the CCC's recommendation of a legally-binding 34% reduction in GHG emissions by 2020 compared to the 1990 baseline is achievable. In fact, the target is met the year before, in 2019. However, Chart 4.3 shows that the carbon intensity of the economy, in terms of CO2 emitted per unit of GDP, is higher as a result of the recession, because emissions do not fall as quickly as activity during this period. The difference in emissions intensity persists for the remainder of the projection period, compounded somewhat by the fuel mixes in the Core 1 and Core 2 scenarios that favour coal over gas somewhat more than in Ref1b.

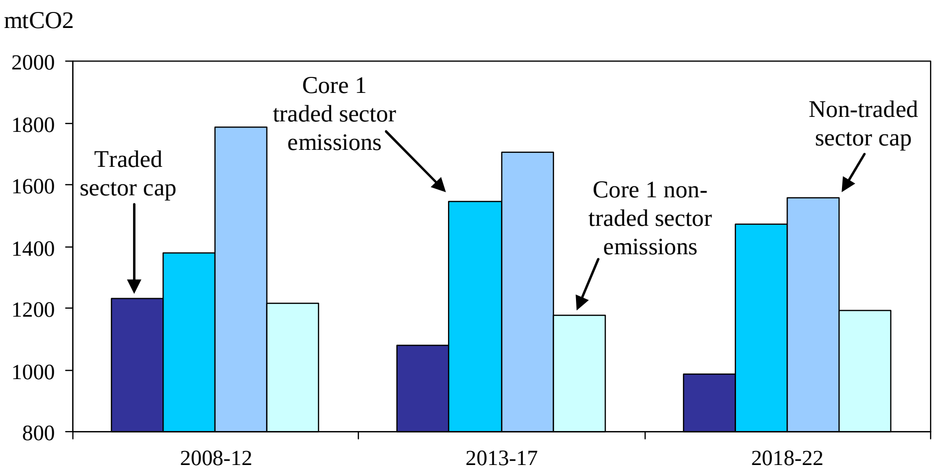
4.2.16 Total GHG emissions in the 2008-12 carbon budgetary period are 2.5% lower in C1 than in Ref1b and total CO2 emissions are 2.9% lower. In 2012 GHG emissions in C1 are 3.3% lower than in Ref1b and CO2 emissions are 3.8% lower. The gap widens during the subsequent two budget periods as a result of the somewhat lower GDP growth projected in C1 (a difference of ¼-¾ pp pa).

In C1 the UK is still projected to exceed its emissions caps

4.2.17 As already mentioned in Section 4.2.13, the principal effect of a recession on UK CO2 emissions, in aggregate, is a change in the long-run level, not the growth of emissions. Following the recession (2010 onwards), as modelled in our study, emissions of CO2, on an IPCC basis, in C1 are around 30 mtCO2 lower than in Ref1b.

4.2.18 Initially, most of these emissions reductions come from the non-traded sector, particularly from households and road transport, where energy demand and the consequent emissions are most closely related to the reduction in economic activity arising from the recession. The UK continues to meet its non-traded emissions caps.

CHART 4.4: CORE 1 CO2 EMISSIONS



Note(s) : 1. Includes emissions from non-energy uses.
2. Excludes emissions from land use, land use change and forestry.

Source(s) : NAEI, DEFRA, BERR (DUKES 2007), Committee on Climate Change, HM Treasury and Cambridge Econometrics.

Ref : C82ReCCCC.

4.2.19 The share of the emissions reductions accounted for by the traded sector increases slightly during the projection period, largely due to emissions reductions from power generation. This reduction can be attributed largely to reductions in final electricity demand (which reduces the amount of electricity power generators need to supply and thus their demand for primary energy). These reductions are still not sufficient for the UK to meets its traded emissions caps (see Chart 4.4).

4.2.20 Net purchases of overseas allowances total 194.5 mtCO2 over 2008-12 in Ref1b. While total CO2 emissions on an IPCC basis are lower in C1, by 118.4 mtCO2, the UK continues to exceed its emissions caps in this period. Net purchases amount to 148.3 mtCO2 over 2008-12, 46.2 mtCO2 lower than those required in Ref1b. In C1 required purchases are 64 mtCO2 lower in the period 2013-17 and 59.9 mtCO2 lower over 2018-22.

4.3 The Sensitivity of the CE Modelling Results to DECC's Updated Fossil Fuel Price Assumptions

Emissions in C2 are slightly lower than in C1

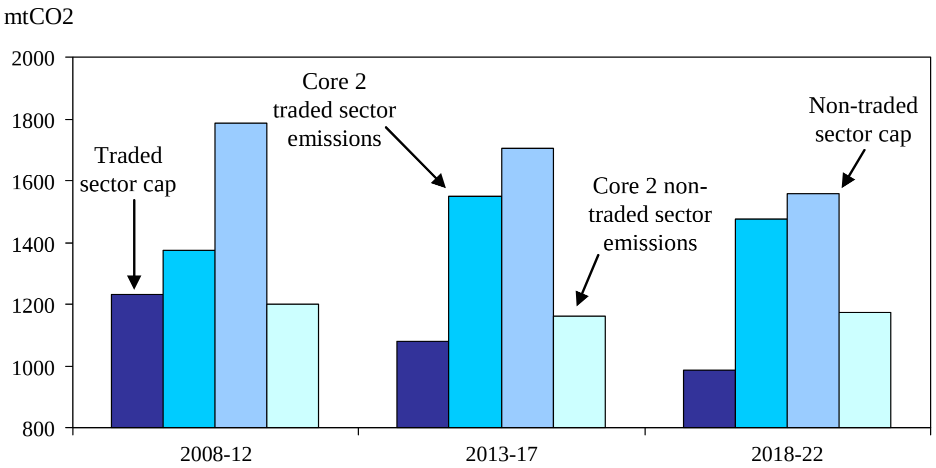
4.3.1 On a net carbon account basis, the new fossil fuel price assumptions, as discussed in Section 3.5, have a small effect on emissions; GHG emissions are 0.3% lower in C2 than in C1 in 2008, falling to 0.9% in 2022. CO2 emissions are 0.4% lower in C2 in 2008 and 1.1% lower in 2022. This is due to the higher (real) price of fossil fuels in the new assumptions.

4.3.2 With the exception of the generation mix, other results from the C2 run are quite similar to those in C1. In C2 the UK still exceeds its traded-sector caps and must continue to purchase allowances from overseas. The non-traded sector caps are still easily met (see Chart 4.5).

The relative price of gas to coal in C2 favours coal for power generation

4.3.3 However, by the IPCC definition[1], emissions after 2016 are actually higher in

CHART 4.5: CORE 2 CO2 EMISSIONS



Note(s) : 1. Includes emissions from non-energy uses.
2. Excludes emissions from land use, land use change and forestry.
Source(s) : NAEI, DEFRA, BERR (DUKES 2007), Committee on Climate Change, HM Treasury and Cambridge Econometrics.
Ref : C82ReC2CCC.

[1] The IPCC basis excludes traded emissions and emissions from international shipping and aviation.

C2 than C1. This is because the relative price of gas to coal in C2 rises above the relative price in C1 (at the start of the projection period, the relative price is cheaper in C2). Coal is a relatively cheaper fuel source in C2 and it is thus more prevalent in C2 than in C1; CO2 emissions are higher. Because the generation mix in C2 places more emphasis on coal, over the period 2016-20, the UK's purchases of overseas allowances are 3-5 mtCO2 higher in C2 than in C1.

5 Concluding Remarks

5.1 Key Messages from the Modelling

5.1.1 The lower economic growth assumed in the C1 scenario lowers carbon emissions throughout the period to 2022.

5.1.2 In the EU ETS traded sector there is no impact on net carbon emissions other than to reduce the permits required to meet the caps. This result is derived because in each of the scenarios modelled in this study the UK is expected to be a net importer of carbon-emissions permits from the EU.

5.1.3 The economic downturn, however, has an impact on the net carbon account through the effects on the non-traded sector. The reduction in economic growth impacts most strongly on road-transport CO2 emissions, but energy use, and consequently CO2 emissions, in the household sector is also reduced.

5.1.4 The CO2 emissions intensity of the UK economy worsens slightly following the reduction in economic activity. This is the result of an overall response coefficient of CO2 emissions to economic activity, derived from our detailed modelling, which is less than one. That is to say that a change of 1% to the level of GDP has an impact of less than 1% on annual CO2 emissions. This shows that while the economic decline will have a positive impact on reducing CO2 emissions it will not improve the structural relationship between economic growth and CO2 emissions.

5.1.5 The reduction in annual CO2 emissions in C1 is the result of a step change following the reduction in economic activity in 2009 and 2010 compared to Ref1b. In the long term the difference between the paths of CO2 emissions is similar to the difference caused by the step change in 2009 and 2010.

5.2 Risks and Uncertainties attached to the Results

5.2.1 The economic assumptions used in the analysis have already been revised by the IMF. As discussed in the introduction the IMF’s April 2009 forecast now projects a 4.1% decline in UK GDP, followed by a decline of 0.4% in 2010. It is likely therefore that CO2 emissions could fall by even more than expected in our projections.

5.2.2 In contrast, HM Treasury, in its Budget 2009 forecast, now predicts that the UK economy will experience a shallower recession in 2009 and a quicker recovery of around 1-1.5% in 2010 and then grow by more than 3% pa in the period 2011-2015. The projections for 2009 and 2010 appear to be optimistic when compared with the IMF forecasts and the latest consensus view of independent economic forecasters, as compiled by HM Treasury in June 2009 is -3.7% in 2009 but is less optimistic, at 0.7%, in 2010. However, if the Treasury’s economic forecasts prove to be correct, then it is likely that emissions could well return to the levels projected in the reference scenario, as economic activity would also revert to the levels assumed in the reference scenarios.

5.2.3 In CE's latest energy-environment forecast published in March 2009, we expected UK GDP to fall by 3½% in 2009 followed by a ½% reduction in 2010. This is associated with a decline of around 6% in CO2 emissions over 2009 and 2010. The assumptions behind the modelling in CE's forecasts are different to those employed in this study and we have described the reasons for the difference between the two projections of CO2 emissions and the underlying assumptions in Appendix A.

6 References

BERR (2008), 'Communication on BERR Fossil Fuel Price Assumptions: Update to present the latest fossil fuel price assumptions following the January 2008 Call for Evidence',
http://www.berr.gov.uk/files/file46071.pdf

Cambridge Econometrics (2008a) 'Projections of UK CO2 emissions and an Assessment of the Economic Impacts of Carbon Budgets',
http://www.theccc.org.uk/reports/supporting-research

Cambridge Econometrics (2008b), 'UK Energy and the Environment August 2008'

Defra (2006) 'Climate Change Programme',
http://www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/ukccp06-all.pdf

HM Treasury (2009), 'Building a low-carbon economy: implementing the Climate Change Act 2008',
http://www.hm-treasury.gov.uk/bud_bud09_carbon.htm

IMF (2009) 'World Economic Outlook',
http://www.imf.org/external/pubs/ft/weo/2009/01/pdf/text.pdf

Appendix A: Comparison with CE's forecast

CE produces twice yearly forecasts of energy demand and associated carbon emissions and greenhouse gas emissions for the UK to 2020. The most recent report was *UK Energy and Environment February 2009.*

In contrast to the work explained in this report, whereby the CORE scenarios were fixed to the economic projections provided by the CCC, the scenario work undertaken in February 2009 is based on the central economic forecast for the UK produced by CE. Further to the central case we have analysed two additional downside scenarios. In the first of these scenarios the economic recession is deep but short-lived with GDP contracting by 4¼% in 2009 before returning to growth in 2010. In the second of these downside scenarios the economic recession is deep and takes a long time to recover, with substantial economic growth returning only in 2012.

The overview of these results was provided in CE's February 2009 UK Energy and Environment service press release[2] which accompanies the main report. As the press release was reported in the media, the CCC asked that we should briefly explain any differences.

Differences may arise in the model results for several reasons:

Model versions

The versions of the model used are slightly different. For consistency with the CE report submitted to the CCC in October 2008 the same model was used for the CORE1 and CORE2 scenario analysis. In CE's own work we had taken an updated model version which included new DUKES energy data published in July 2008 and the latest disaggregated economic data. As new energy data had been added, the econometric coefficients had been re-estimated.

Economic structure

The economic forecast in the CCC analysis is calibrated to broad economic parameters, such as sector level GVA, income, etc. In marked contrast, CE's own analysis is based on a highly disaggregated breakdown of prospective growth across 42 industries in the UK and based upon different regional growth profiles.

Fossil fuel and carbon prices

The underlying fossil fuel and carbon prices differ substantially in the two approaches. In CE's own analysis we continually revise our short term assumptions on the oil price and associated energy and carbon prices. These revisions are based upon the latest data which is continually evolving. However, we do try to maintain consistency with our view of the longer- term energy market fundamentals.

Given these differences it is misleading to compare the results of the two sets of analysis, other than to show that they provide a broad indication of the range of possible CO2 emissions over the period to 2020 that are consistent with the respective underlying economic inputs.

[2] http://www.camecon.com/press_releases/download/UKE3091.pdf