Introduction and key messages

1. Industry emissions trends
2. Opportunities and challenges in reducing industry emissions
3. Managing competitiveness risks

Chapter 4: Progress reducing emissions from industry

Introduction and key messages

Emissions from industry accounted for around a third of UK greenhouse gas emissions in 2012 (around 200 $MtCO_2e$), of which around 80% are CO_2. Industry CO_2 emissions are around 70% direct emissions (of which 92% are from the combustion of fossil fuels and 8% are from chemical processes) and 30% indirect emissions (i.e. electricity-related).

In our 2012 progress report, we reported that industry emissions fell 43% between 1990 and 2011:

- Between 1990 and 2007, CO_2 emissions fell by 15%, primarily due to improvements in energy efficiency and fuel switching (Box 4.1). A further 16% reduction in 2008 and 2009 occurred as a result of the recession, reflecting a fall in output of around 12%.
- In 2010 emissions rose by 2% due to a recovery in output of 4%. In 2011, emissions were 3% lower, despite rising output (of 2%), possibly due to slight improvements in energy efficiency and running plant more efficiently (e.g. iron and steel plant running at higher load factors with better energy performance).
- Non-CO_2 emissions have fallen by around 70% between 1990 and 2011 reflecting the introduction of technologies to abate N_2O emissions in industrial processes and reduced fugitive emissions from the gas distribution network and coal mines.

In this chapter we assess preliminary 2012 data on industry emissions and energy consumption as well as policy milestones.

The key messages of this chapter are:

- Total CO_2 emissions from industry increased by 3% (to 163 $MtCO_2$) in 2012, reflecting increased carbon intensity of the electricity grid (due to switching from gas to coal, set out in Chapter 2).
- Direct emissions increased by 1% in 2012 (to 116 $MtCO_2$), with little evidence that energy efficiency has improved.
- There is unlikely to be adequate progress regarding energy efficiency for direct fuels (i.e. non-electricity), despite higher fossil fuel prices, due to high barriers and weak policy incentives. Without structural reform the EU ETS prices to 2020 will remain low, and Climate Change Agreements do not focus on reducing fossil fuel consumption. In order to improve progress, Government should include the full range of cost-effective abatement options in the industry sector roadmaps currently being developed by DECC and BIS and align financial incentives for low-cost abatement.

- CCS in industry is a key option to meet the 2050 target. Given that industrial CCS projects have not been funded under the current UK CCS competition and a lack of progress internationally, an approach to demonstration and commercialisation compatible with deployment in the 2020s is required.
- In order to ensure that carbon policies do not result in risks to UK competitiveness (e.g. drive existing industry abroad, or stop new industry locating here) it is important to move from high level commitments (e.g. the £250 million compensation package, and exemptions for costs arising under Electricity Market Reform) to a detailed implementing framework.

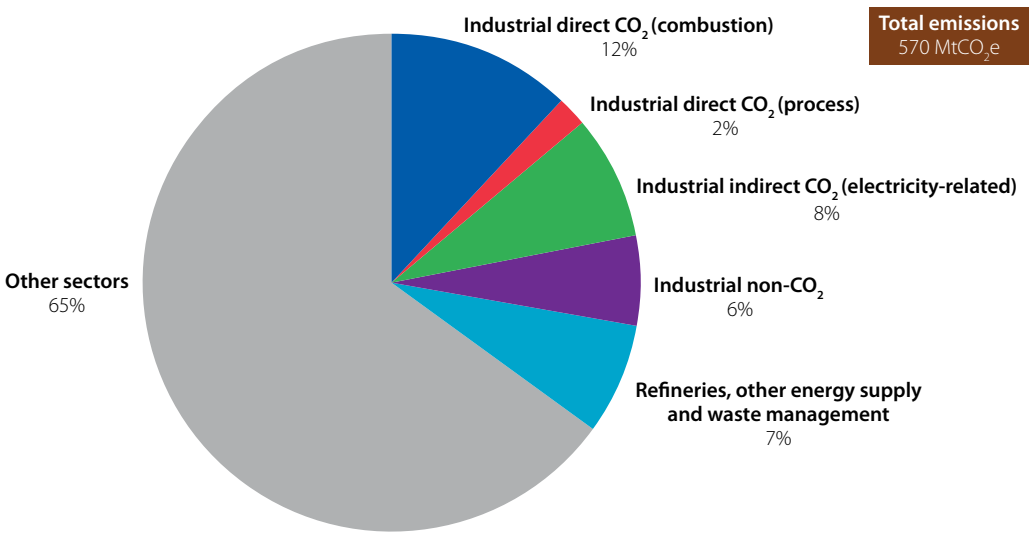
We set out the analysis that underpins these conclusions in three sections.

1. Industry emissions trends
2. Opportunities and challenges in reducing industry emissions
3. Managing competitiveness risks

1. Industry emissions trends

Emissions from industry accounted for around a third of UK greenhouse gas emissions in 2012 (Figure 4.1). Around 80% of industry emissions are CO_2, of which around 70% are direct due to the burning of fossil fuels and chemical processes, and 30% are indirect due to the use of electricity.

Figure 4.1: GHG emissions from industry in the context of total UK emissions (2012)



Source: NAEI (2013)
Notes: 2012 emission estimates are provisional. Emissions from waste are shown here, but are discussed and accounted for in Chapter 7.

Total industry emissions increased by 2% in 2012. Within this overall increase, CO_2 emissions increased by 3% (to 163 $MtCO_2$), and non-CO_2 emissions were flat (36 $MtCO_2$).

Emissions rose despite a fall in output of around 2%. The rise in CO_2 emissions was mainly due to indirect emissions which rose by 7%, reflecting a rise in the carbon intensity of the electricity grid (this is detailed in chapter 2), which more than offset a reduction in electricity consumption of 2%.

Direct emissions increased by 1% in 2012. Although output fell by 2%, consumption of fossil fuels increased by 4% last year. Fuel consumption increases are likely to have been due to a combination of the steel sector reopening plant at Teesside and possibly also a response to low coal prices, and slightly cooler temperatures.

- Production across the manufacturing sector fell by 2%, with greater decreases in some energy-intensive industries (e.g. cement, lime and plaster fell by 15%, linked to continued Eurozone uncertainty and a slump in the construction sector).
- Use of fossil fuels increased by 4% in 2012, and electricity consumption reduced by 2%.
  - Fossil fuel consumption increased in the steel sector due to reopening plant at Teesside (using coal and manufactured fuels).
  - There may have been some switching from electricity to coal in response to relative price changes: the electricity price increased by 4%, the coal price went down by 4% (both in real terms).
  - Gas consumption increased by 4%. This is also possibly a result of colder weather impacting the weather-dependent parts of industry, however, evidence is limited.

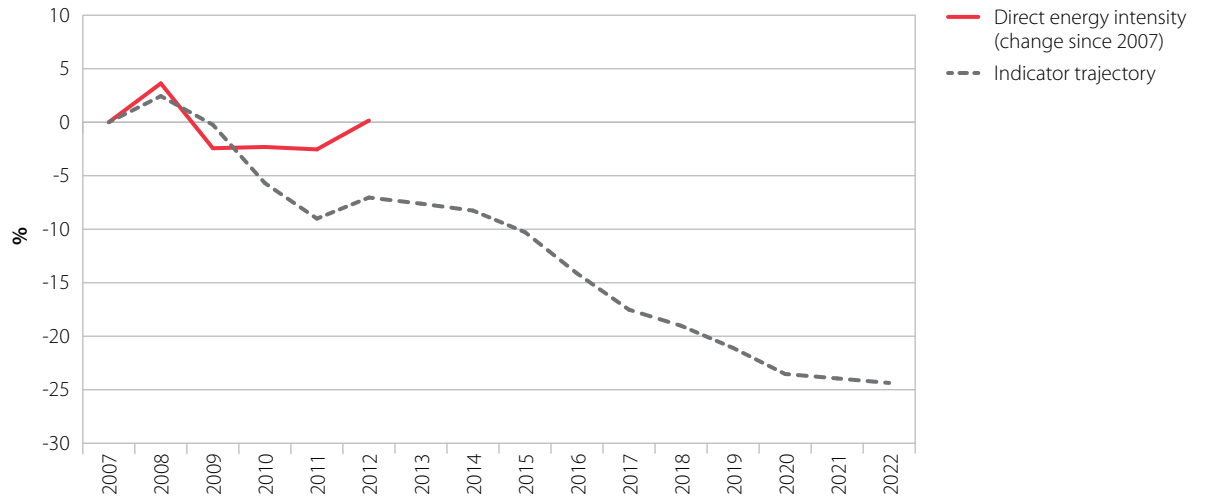
Emissions in 2012 (163 $MtCO_2$) are broadly in line with indicators (160 $MtCO_2$). However, the level we envisaged when we set out our progress indicators in 2009 did not fully account for the recession, and as a result we would have expected emissions to fall below the level of indicators if implementation of abatement measures was on track.

Despite improvements in energy efficiency of around 2% per annum between 1990 and 2007 (as detailed in box 4.1), there is a lack of evidence to substantiate energy efficiency improvement in the first budget period (2007 to 2012).

- Direct energy intensity increased 3% in 2012 due to increases in fossil fuel consumption, despite falling production, and was broadly flat since 2007 (Figure 4.2).
- Falling investment in new plant and equipment[1] may also suggest continued use of older, less efficient plant (investment fell by 1% in 2012, and an average annual fall of 2% in the five years since the recession, compared with average annual increases of 3% in the five years prior to the recession).

1 ONS (2012) National Accounts available at http://www.ons.gov.uk

Figure 4.2: Direct energy-intensity and indicator trajectory (2007-2022)



Source: DECC (2013) *Energy Trends*, March 2013; DECC (2012) DUKES 2012; ONS (2012) *Index of Production*; CCC calculations.
Notes: This chart shows energy-intensity for direct fuels only (i.e. non-electricity).

Box 4.1: Emissions drivers in the industrial sector

CO_2 emissions from UK manufacturing between 1990 and 2012 fell by around 30%.

Falls in industrial emissions could be caused by changes in output (e.g. recession-related emission reductions), fuel switching to lower carbon fuels (e.g. coal to gas), changes in the industrial structure (e.g. energy intensive manufacturing moving abroad) and energy efficiency.

Hammond and Norman (2012) conducted an analysis of emissions drivers in the industrial sector between 1990 and 2007 (i.e. before the current recession), attempting to explain the relative reductions in energy-related industrial emissions.

The primary reasons for the fall in emissions over the period was found to be reductions in energy-intensity (which includes installation of energy efficient technologies and running plant more efficiently), rather than changes in output or industrial restructuring (Table 4.1).

Table 4.1: Emissions drivers in the industrial sector 1990-2007

Driver	Contribution to annual change in energy-related emissions
Production/output	0.46%
Industrial structure (e.g. energy-intensive industry moving abroad)	-0.27%
Energy-intensity improvements (e.g. more efficient equipment, running plant more efficiently)	-1.92%
Fuel switching (e.g. coal to gas or electricity)	0.49%
Emissions factor of the grid	-0.77%
Total (average annual % change in emissions)	-2.01%

Source: Hammond, G. P. and Norman, J. B. (2012) Decomposition analysis of energy-related carbon emissions from UK manufacturing. Energy, 41 (1). pp. 220-227.

Box 4.1: Emissions drivers in the industrial sector

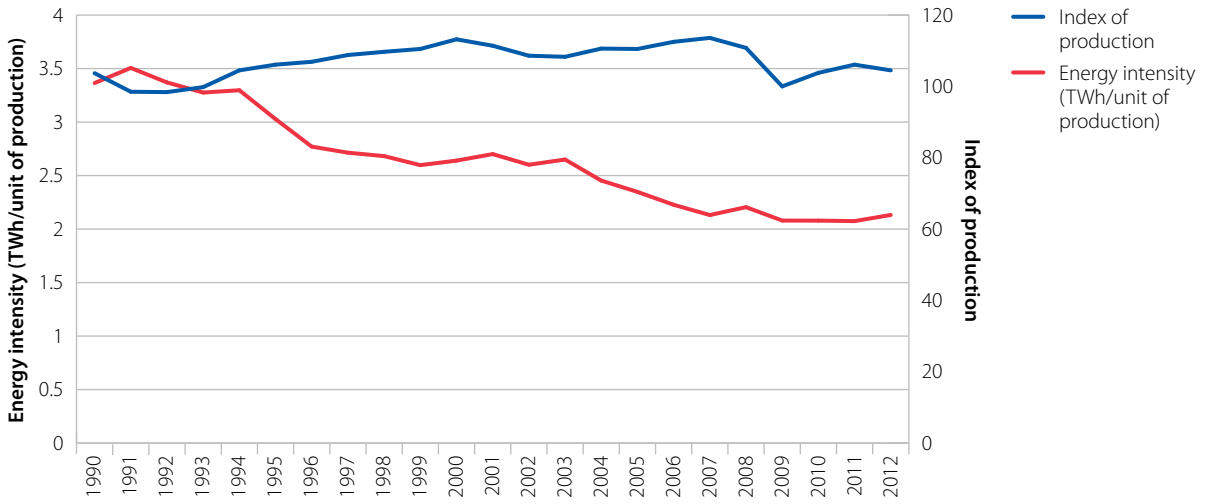
Similar trends are exhibited in other analyses. For example the Department for Trade and Industry (1994, cited in Hammond and Norman, 2012) examined the period prior to 1990, concluding that the main contributor to reductions was falling energy intensity, with structural change having a relatively small impact.

Improvements in energy efficiency are coupled with periods of growth, due to the associated investment in new and often more energy efficient plant and equipment (Jenne and Cattell, 1983 and Greening et al., 1998 cited in Hammond and Norman, 2012).

Trends in output, investment and energy efficiency appear to be consistent with this, although further work is required to establish the extent of these relationships (Figure B4.1).

- In the five years since the start of the recession (2007-2012) there has been depressed industrial production, and investment in new plant and equipment has been below the long term average (2% decrease per year on average 2007-2012, compared with increases of 3% per annum in the five years prior to the recession).
- Energy intensity decreased relatively consistently since 1990, except during recessions, where there is a flattening of the energy intensity trend.

Figure B4.1: Production and energy intensity (1990-2012)



Source: DECC (2013) *Energy Trends*, March 2013; DECC (2012) DUKES 2012; ONS (2012) *Index of Production*; CCC calculations.
Notes: Energy intensity is for directly-combusted fuels only (i.e. non-electricity).

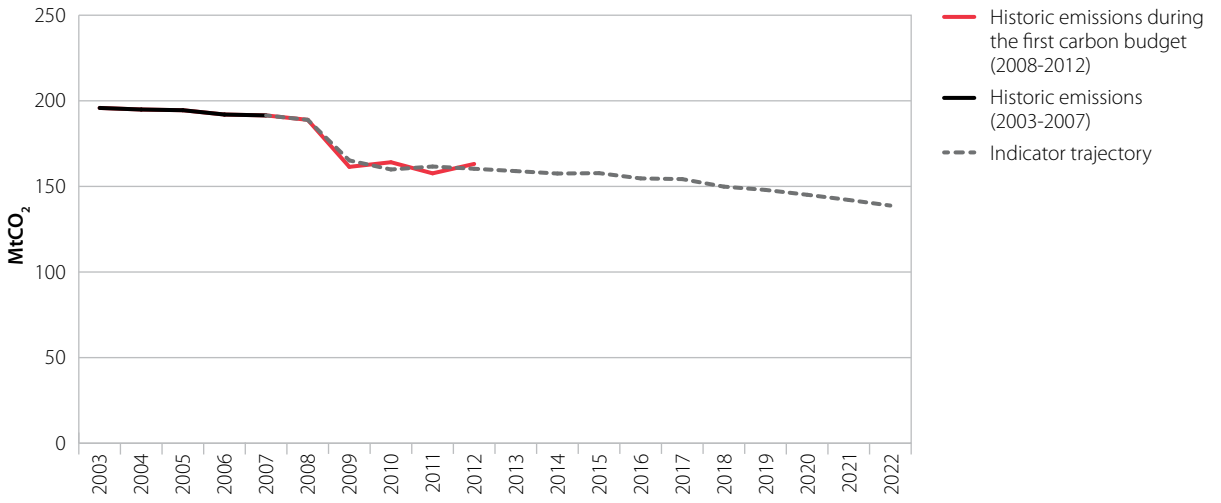
We are improving the level of detail of this assessment (including ways of measuring progress in energy efficiency) as part of our 2014 Progress Report.

Source: Hammond, G. P. and Norman, J. B. (2012) Decomposition analysis of energy-related carbon emissions from UK manufacturing. Energy, 41 (1). pp. 220-227. Available at http://opus.bath.ac.uk/25342/1/Norman_energy_2011.pdf

As a result, industry emissions in 2012 were 3 $MtCO_2$ above the level (160 $MtCO_2$) envisaged when we set out our progress indicators in 2009 (Figure 4.3).

- In 2012, emissions increased due to the rising carbon intensity of power generation. This is a short-term increase resulting from switching from gas to coal in the power sector.
- Direct emissions have not fallen in line with indicators. Given that fossil fuel consumption has not fallen relative to output, this indicates that the pace of energy efficiency improvement will need to increase in order to meet future carbon budgets (e.g. around 15% reduction on current levels is required by the beginning of the fourth carbon budget in 2023).

Figure 4.3: Historic emissions vs indicator trajectory (2003-2022)



Source: NAEI (2013); DECC (2013) *Energy Trends*, March 2013; DECC (2012) DUKES 2012; DECC (2013) *UK Emissions Statistics 2012 Provisional UK figures*; CCC calculations.
Notes: 2012 emission estimates are provisional.

There is an opportunity to reduce emissions further in industry at low cost if barriers can be overcome, as we set out below.

2. Opportunities and challenges in reducing industry emissions

We have previously highlighted scope for reducing emissions in industry in the first four budget periods from around 180 $MtCO_2$ in 2008 to around 120 $MtCO_2$ in 2030[2].

- **Energy efficiency improvement.** The ENUSIM model used by Government suggests scope for reducing industry emissions by around 6 $MtCO_2$ in the period to 2020 through energy efficiency measures.
- **Low-carbon heat and use of bioenergy.** Modelling conducted by NERA suggests the potential to reduce industry emissions by 20 $MtCO_2$ by 2030. This is primarily through use of biomass and biogas, with smaller contributions from heat pumps and CHP.
- **CCS.** CCS could be feasible and cost-effective for deployment in the iron and steel sector and the chemicals industry during the 2020s, and by 2050 could contribute to cost-effective reductions of around 40 $MtCO_2$.
- **Options in energy-intensive industry.** Further cost-effective options for energy-intensive industry include recycling of steel, increased use of clinker substitutes in the cement sector and reduction of flaring in refineries, which taken together provide around 12 $MtCO_2$ abatement by 2030.

2 There are further options for the decarbonisation of industry on the path to 2050 but not embedded in our evidence underpinning the fourth carbon budget. These include extending low-carbon electricity to the production of heat in industry (i.e. as set out in our 2012 International Aviation and Shipping report), and the use of wood in the construction sector as a substitute for energy-intensive materials (detailed in our 2011 Bioenergy Review).

In our 2012 progress report, we noted that it is important to plan for investment in low-carbon measures given long project lead times, and the need to synchronise investment with the refurbishment cycles of the capital stock.

- **Refurbishment cycles.** The abatement measures that we have identified for carbon-intensive industry in the 2020s typically have long lead times. Given the difficulty of retrofitting, and to avoid missing low-carbon investment opportunities, it is important to prepare early for abatement in line with refurbishment cycles. For example, blast furnaces have around 15-20 years between refurbishments, which involve significant disruption (the recent rebuilding of a blast furnace at Port Talbot involved a 130 day construction time). This leads to a risk that these infrequent opportunities for major improvements are missed, and high-carbon infrastructure is locked in.
- **Capital Constraints.** Many of the cost-effective opportunities in energy-intensive industry have substantial upfront requirements for capital. For businesses making investment decisions in a capital constrained environment, low-carbon investments with longer paybacks will struggle to compete with investments in other parts of the supply chain. For example, in consultation with stakeholders from the chemicals sector, it was suggested that high capital cost measures and competition for capital could result in over 50% less abatement in 2030.

In order for firms to plan and finance abatement opportunities, policies will have to be put in place that offer a premium to low-carbon investment, and ensure that this is prioritised in a capital-constrained world. Progress in 2012 in key policy areas was slow:

- **EU ETS.** We previously noted that the price signal from the EU ETS had been weakened from excess allocation of allowances and the recession (surplus allowances in the EU ETS are also covered in Box 4.3). In 2012 this continued, with the carbon price dropping further (from €13/tCO_2 in 2011 to €7/tCO_2 in 2012).
- **Climate Change Agreements (CCAs).** In 2012, the Government announced new simplified CCAs for 2013 to 2023.
  - These reduce the scope of emissions covered by the CCAs to non-EU ETS emissions only (previously they covered both EU ETS and non EU ETS), resulting in around a 60% reduction in emissions covered compared with the previous design. However, energy used across the entire site (i.e. traded and non-traded) will remain eligible for the CCL discount. This implies weakened incentives for reduction of direct emissions in industry[3].
  - However, for indirect emissions, energy efficiency targets have now been announced and, for many sectors, are consistent with or even higher than the level of ambition implied when we published our analysis of carbon budgets in 2008 (e.g. CCAs have agreed a 11% target with the chemicals sector, compared with 2% reduction implied by previous CCC analysis).

3 Indirect emissions are still covered by CCAs however, even though the power sector is within the EU ETS, industry is not required to surrender allowances for their indirect emissions.

- **The Renewable Heat Incentive (RHI).** While the absolute economy-wide level of uptake of renewable heat technologies was on track with our indicators in 2010 and 2011 (Figure 4.4), the rate of increase is unlikely to meet the 12% target of total heat output given current incentives. The RHI commenced in November 2011, and data suggest uptake across the range of technologies is low. Given the limited availability of sustainable biomass, we have identified the use of biomass in large industrial installations as a priority because of the lack of low-carbon alternatives, and recommended that the Government sets out an approach to encourage uptake in this market segment. In May 2013, Government announced increased tariffs (from 1.0 to 2.0 p/kWh) for large biomass in industry. Close monitoring is now required to ensure that this additional incentive improves uptake for large biomass projects. Additionally, uncertainty about RHI funding beyond 2015 needs to be resolved as soon as possible in order to achieve supply chain growth to deliver the increased uptake consistent with meeting carbon budgets.
- **CCS demonstration.** CCS in industry is a key option to meet the 2050 target. Given that industrial CCS projects have not been funded under the current UK CCS competition and that there has been limited progress internationally (Box 4.2), an approach to developing industrial CCS demonstrations compatible with required deployment in the 2020s is required. CCS is also likely to be a key abatement option globally, with significant spillovers from the UK contribution to commercialisation to international action to reduce emissions. The development of CCS infrastructure in the power sector provides an opportunity for co-located industrial plant (e.g. in the chemicals sector) to be included in a CCS commercialisation strategy across both the power and industrial sectors.

Box 4.2: International progress on industrial CCS

The IEA 2012 CCS roadmap forecasts that around half the mitigation potential from CCS could be from industrial applications in 2050. In the UK, the Committee's 2010 advice on the fourth carbon budget report identified CCS applications in industry as feasible and cost-effective from 2030, with potential to abate up to around 40 $MtCO_2$ by 2050.

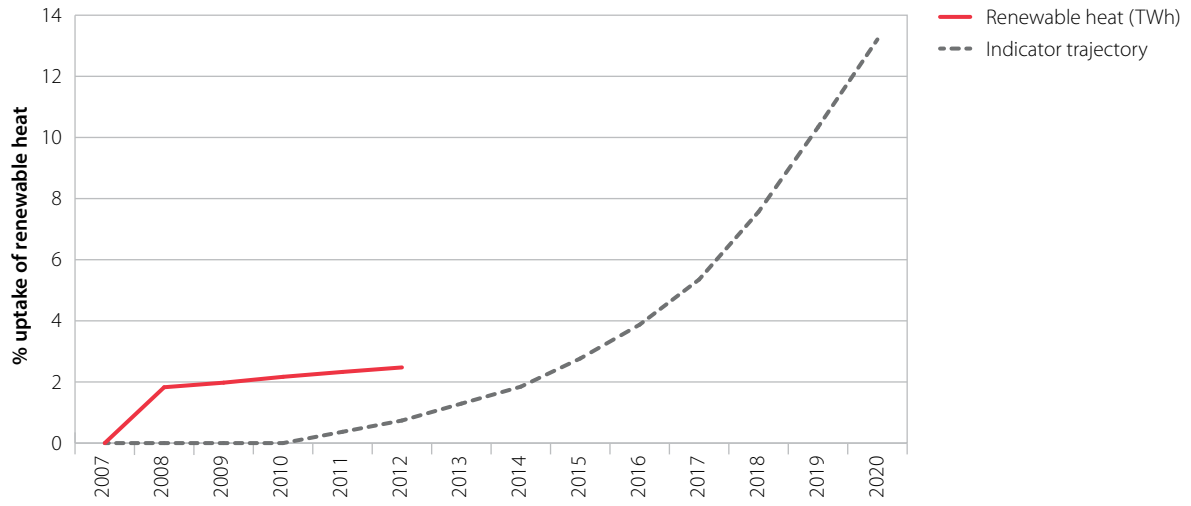
Demonstration of CCS in industry, either in the UK or elsewhere, is crucial to resolving current uncertainties. However, there has been limited progress on industrial CCS at scale:

- Florange steelworks, France was in line for funding under the NER300 fund. However in December 2012 the ArcelorMittal plant withdrew from this round of funding due to technical difficulties.
- Air Liquide hydrogen, Netherlands: 0.5 $MtCO_2$ on a hydrogen plant, with the potential to expand CCS further in the region in future to commence construction in 2014.
- Masdar steelworks, Abu Dhabi: 0.8 $MtCO_2$ on direct reduced iron plants.

Given limited progress on CCS internationally, domestic demonstration of CCS will be important to meet the timetable of 2027-2030, set out in the Carbon Plan to start CCS roll-out in industry.

In the 2013 heat strategy, DECC and BIS committed to developing long-term decarbonisation roadmaps with energy-intensive sectors. This provides an opportunity to set out how gaps in the current policy framework can be filled, and gives more confidence over the implementation of the measures required to meet carbon budgets.

Figure 4.4: Industry renewable heat uptake and trajectory (2007-2020)



Source: DECC (2013) *Energy Trends*, March 2013; DECC (2012) DUKES 2012; BSRIA (2013); CCC calculations.

In the context of the 2014 Progress Report we will develop analysis to input into the development of these roadmaps, including:

- An update on assumptions underpinning fourth carbon budget analysis of abatement options.
- Indicative trajectories showing the opportunities for abatement in key energy-intensive industries consistent with the fourth carbon budget, including technology changes and timelines.
- Competitiveness impacts of rising energy costs (both direct and indirect) and costs of abatement.

It will be necessary to complement roadmaps with long-term financial instruments that align incentives for abatement and overcome barriers to uptake of measures in the industrial sector[4]. Financial support may be most appropriate for projects that have large capital cost requirements and long payback periods but for which the abatement costs are below the expected carbon price. Candidates for this could be those options set out in analysis conducted in 2010 by AEA, underpinning our 2010 fourth carbon budget report (e.g. optimisation of refineries, improved distillation and bio-processing in the chemicals sector). These could potentially be explored by linking opportunities set out in roadmaps to financing under the Green Investment Bank and the Green Deal.

We will explore potential opportunities for financing in more detail as part of our 2014 progress report.

4 CCC (2012) Fourth Progress report. Available at www.theccc.org.uk

3. Managing competitiveness risks

In our 2013 report on competitiveness risks of carbon budgets, we noted that there are potential competitiveness risks for electro-intensive industries that are also subject to international competition and facing higher relative energy costs. These firms could see a squeeze on profits which could potentially drive output and jobs overseas.

The UK Government has recognised these risks and put in place support arrangements:

- In the 2011 Autumn Statement the Government committed £250 million for the period 2013-15 to offset the impact of rising electricity prices for electro-intense industries. Government has consulted on eligibility and design of the scheme, and will announce the final design in late 2013.
- In November 2012, exemptions were announced to offset the additional costs arising under Electricity Market Reform as part of the 2012-13 Energy Bill. Although the value of these exemptions has not currently been specified by Government, we estimated in our 2013 Carbon Footprint and Competitiveness report that they would amount to around £350 million in 2020 if extended to the electro-intensive industries we identified as at-risk[5].
- In the 2013 Budget, further exemptions from the Climate Change Levy were announced to the metallurgical and mineralogical process sectors to be introduced in 2014.

The value of these measures, if continued to 2020, is up to £475 million annually.

We assessed the extent of competitiveness risks to electro–intensive sectors, and found that profit impacts were between £150-400 million in 2020, and therefore manageable under existing policies.

In order to appropriately target support, the Government will have to develop the evidence base on:

- Electricity price increases arising from climate change policy for competitors
- Current and projected future electricity UK consumption, at a detailed level (i.e. Standard Industrial Classification level 4)
- Scope for cost pass-through
- Materiality of electricity price impacts for firm location and investment decisions
- Surplus allowances arising from EU ETS allocations (Box 4.3).

It is important to move from high level commitments to a detailed implementing framework to ensure carbon policies do not drive existing industry abroad, stop new industry from locating here, or make it more difficult for UK firms to compete effectively.

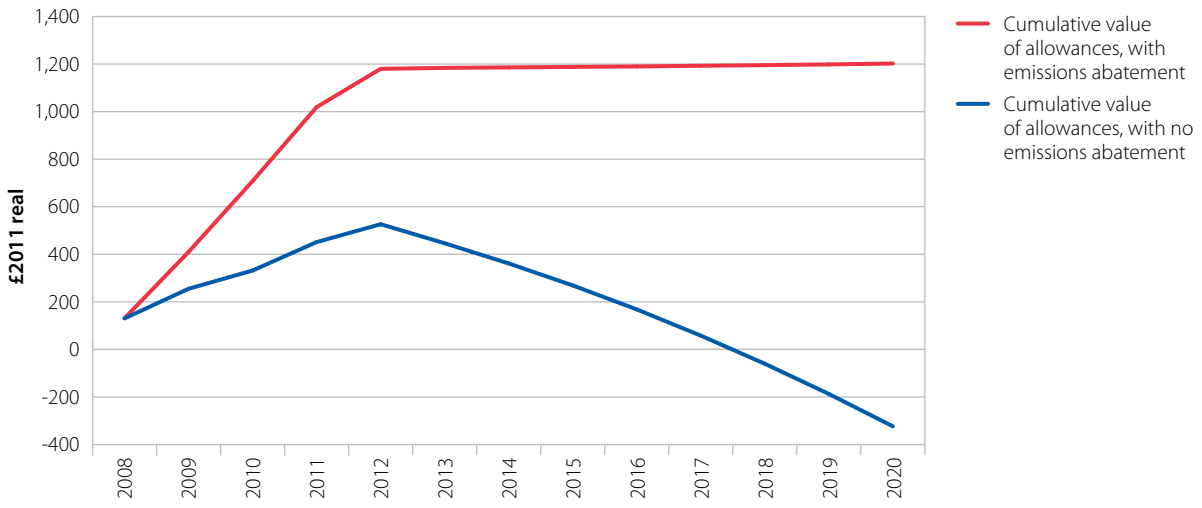
5 These included paper, cement, glass, basic inorganic chemicals, fertilizer and nitrogen, iron and steel, rubber and plastics.

Box 4.3: Surplus EU ETS allocation and weakened carbon price signal

Surplus allocation of allowances in the EU ETS can reduce incentives for reducing emissions by lowering the carbon price. Also, in some sectors, excess allocation may imply windfall profits and this may reduce the incentive to reduce emissions.

Analysis conducted in the context of our 2013 Carbon Footprint and Competitiveness report showed that Energy-intensive industry has surplus allocation by around £530 million in Phase II. Given banking between phases, surplus allowances are expected to continue in Phase III (Figure B4.3).

Figure B4.3: Estimated cumulative value of EU ETS allowances in UK energy-intensive industry (2008-2020)



Source: ICF and Cambridge Econometrics (2013); CCC calculations.
Notes: Based on a carbon price of £6/tCO_2 in 2008, rising to £8/tCO_2 in 2020.

Some specific sectors have substantial surplus in 2020. For example, basic metals (including iron and steel) has surplus allowances of £450 million in 2020. The implication is that some businesses may be more than fully compensated under the current regime.

If it is the case that the same firms requiring support for indirect impacts have received surplus free allowances, the Government could also consider if these should be taken into account in judgements regarding the appropriate level of compensation.

Source: ICF and Cambridge Econometrics (2012).

Key findings

- Total CO_2 emissions from industry **increased by 3% in 2012**. The majority of this increase reflects higher carbon intensity of the electricity grid.
- **There is little evidence that energy efficiency has improved** in 2012 or over the first carbon budget period (2008-2012).
- Given weak incentives for abatement, particularly on direct emissions, **Government should include the full range of cost-effective abatement options in the industry sector roadmaps** currently being developed by DECC and BIS and align financial incentives for low-cost abatement.
- **An approach to demonstration and commercialisation of CCS** compatible with deployment in the 2020s is required.
- To mitigate competitiveness impacts, it is now important to **move from high level commitments to a detailed implementing framework**.

Table 4.1: The Committee's industry indicators

INDUSTRY		Budget 1	Budget 2	Budget 3	2011 trajectory	2011 outturn
Headline indicators						
CO_2 emissions (indicative minimum % change on 2007)	direct	-14%	-9%	-7%	-14%	-15%
	indirect	-12%	-35%	-66%	-12%	-14%
Final energy consumption (indicative minimum % change on 2007)	non-electricity	-19%	-20%	-18%	-19%	-8%
	electricity (autogeneration included)	-16%	-11%	-5%	-16%	-12%
	electricity (centrally produced)	-6%	-19%	-30%	-6%	-11%
Supporting indicators						
Renewable heat						
Buildings and industry renewable heat penetration (% of heat demand)*		1%	5%	12% in 2020	<1%	1.2%**
Industry renewable heat penetration (% of heat demand)		1%	5%	13% in 2020	<1%	2.4%
CCS						
In light of outcome of CCS competition, set out an approach for industrial demonstrations compatible with deployment in the late 2020s			No later than 2013		No project in competition, commercialisation strategy required.	
Energy intensity						
Energy intensity (% change compared with 2007)		-7%	-18%	-24%	0%	
Energy intensity for energy-intensive sectors					-2%**	
Other milestones/drivers/wider monitoring						
Publish industry strategy including detail and milestones for meeting carbon budgets, incentives and mechanisms for overcoming barriers			No later than 2013		DECC/BIS industry roadmaps announced. Will report review of evidence in summer 2013.	

* Reflects incremental penetration of renewable heat above a baseline penetration in 2007 of 1.2%.
** Reported for 2011 (data is not available for 2012).

Key: Headline indicators Implementation indicators Milestones Other drivers