Assessment of Competitiveness Impacts of Carbon Budgets on Electro-intensive Sectors to 2030

FINAL REPORT

24th April 2013

Submitted to:
Committee on Climate Change

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Executive Summary

Introduction

In the Committee on Climate Change's (CCC) Fourth Carbon Budget report (2010) it was concluded that in the absence of an international agreement there will be competitiveness risks in the 2020s, particularly for energy intensive industries. Following that, in its 2011 Renewable Energy Review the CCC highlighted a specific risk that power sector decarbonisation could entail risks for a small number of electricity-intensive UK industries which compete in global markets. In the 2011 Autumn Statement the Government committed to introducing new measures to limit such risks with a compensation package worth £250million for 2013-2015.

This analysis is designed to increase the understanding of the magnitude of potential impacts and of the financial support required in order to mitigate competitiveness risks. It will feed into the CCC's forthcoming report on competitiveness and carbon footprint due later in 2013, which will include a full assessment of the package announced in the 2011 Autumn Statement and competitiveness risks more generally. The analysis will feed into the wider review of the fourth Carbon Budget, to be published in late 2013.

Objectives

The objective of this study is to assess the competitiveness impacts of policies and measures underpinning carbon budgets on key electro-intensive sectors to 2030. The specific objectives are to:

a) Develop projections of electricity price and bill differentials between UK firms and key competitors. This requires an assessment of key 'at risk' sectors and their key competitors. Following this, electricity prices and bills to 2030 are developed for the countries identified.

b) Assess potential competitiveness impacts on electro-intensive sectors to 2030.

c) Explore implications for the design of support packages to mitigate competitiveness impacts.

d) In addition, the project looks at the direct costs of the EU ETS and considers the level of compensation that installations have already received.

Identification of key "at risk" sectors

In this first step, key sectors at risk of competitiveness impacts arising from higher electricity prices to the Fourth Carbon Budget period (taken to be up to 2030) was identified. This was done using available data on electricity cost intensity and trade intensity.

In the second step, key trading partners and competitors for the identified sectors were selected based on 2011 HMRC data and other sector statistics.

Projections of international electricity prices and bills for key 'at risk' sectors to 2030

For the electro-intensive industries identified, projections of electricity prices and bills were made to 2030 in the UK and key trading countries. A number of different scenarios were agreed to allow for uncertainties such as different assumptions on CO_2 prices in the EU ETS and different levels of ambition in climate change policy targets internationally.

Potential competitiveness impacts

The competitiveness impacts will vary between sectors due to differences in the electro-intensity of the sector, the ability of firms to pass on additional costs to consumers, the response by consumers to increases in prices and the trade intensity of the sector.

The sectors being investigated together account for around 1¾% of the UK economy, and there is considerable variation in their underlying characteristics. The largest sector, in terms of output, is rubber and plastics, which is around twice as large as the next biggest sector studied, paper and paper products. Direct electricity costs account for the largest share of material inputs costs for cement (21%) but only account for around 1% of input costs to the refining sector, so changes in electricity prices will therefore have a relatively greater impact on the cost base of cement[1]. However, cement is not as trade exposed as other basic inorganic chemicals which also faces similarly high proportions of input costs coming from electricity (17%).

Two policy environments are considered, with the difference between them that prices outside the EU are higher in the Convergence scenario in the 2020s than in the EU-led action scenario.

Considering just the direct impact of changes in electricity prices, in all scenarios, value-added in all sectors is lower in 2030 than it would have been in the absence of low-carbon policy. This occurs because even when high pass-through rates are assumed, part of the increase in costs has to be absorbed. The relative impact on GVA is highest for sectors with the highest relative electricity costs, namely cement, other basic inorganic chemicals and fertilisers and nitrogenous compounds.

Firms in sectors that are able to pass on more of the electricity cost are relatively better off than in those where pass-through is more difficult. Profits are higher in the former case because domestic demand and trade is relative inelastic. However, for most sectors, in the first instance the impact on gross output and employment is worse if costs are passed on, because there is a demand-side response to higher prices which is not the case where costs are completely absorbed. The negative impact on GVA and gross operating surplus (a proxy for profitability) is less if costs are passed on, despite changes in demand and gross output, than if costs are absorbed. This is intuitive and re-affirms that sectors will not act in a way that is worse for profit than simply absorbing the whole cost. However, as firms absorb cost they may look to restructure the business and shed staff or a plant may become unprofitable and be closed down, leading to job losses.

If electricity prices were to follow the convergence scenario, as opposed to the EU-led scenario, the adverse impact on demand for UK products is reduced. This change in demand is most pronounced in sectors where trade outside of Europe is more prevalent.

Industry also face additional cost pressures from the indirect effect of increased electricity costs has on the cost of other inputs to production. However, the additional competitiveness impact from indirect electricity costs is found to be relatively small for most sectors.

Industry impacts and designing support packages

Industry competitiveness is complex and dependent on a complex interaction of market and production characteristics. The challenge for policymakers seeking to compensate for competitiveness impacts is to isolate the impact of electricity price differentials from all other components determining industrial competitiveness and devise a policy that offers equivalent compensation without distorting the original intentions of the policy.

The impact on firms on higher UK electricity prices (and therefore design of potential support packages), needs to account of losses to UK competitiveness (gross effects), net of losses to international competitors (net effects). It also needs to account for a sector's ability to pass-on costs. An accurate estimate of the impact on sectors or sub-sectors is difficult to estimate as it requires a robust understanding of domestic pass-through rates, international pass-through rates and the policy driven increase in electricity costs to both domestic and international producers. Moreover, it requires an in depth understanding of the economics of the sector. Since policy cost increases (domestically and internationally) and pass-through rates have been estimated as part of this project we provide indications of the impact on sectors' profits (Table 1.1)

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[1] The additional impacts of indirect input cost changes arising from increases in the electricity costs faced by sectors which provide inputs to the sectors assessed were considered as a sensitivity to the core analysis, but did not substantially alter the results

Table 1.1 Indicative levels of sector profit impacts (£2011m) in 2020

Gross operating surplus impact £m	Zero pass through		Low pass through		High pass through	
Sector	Gross	Net	Gross	Net	Gross	Net
Paper/paper prods (SIC 17)	177	144	146	119	115	95
Iron/Steel (SIC 24.1-24.3)	81	63	61	48	22	18
Cement and related (SIC 23.5-23.6)	63	50	45	35	20	16
Of which						
Cement (SIC 23.51)	27	14	19	10	20	16
Lime and plaster (SIC 23.52)	1	1	0	0	0	0
Rubber/plastics (SIC 22)	306	258	193	164	94	82
Glass/glass products (SIC 23.1)	48	37	44	34	31	24
Other basic inorganic chemicals (SIC 20.13)	84	69	67	56	33	29
Fertilisers/nitrogen compounds (SIC 20.15)	32	29	29	27	26	24
Refined petroleum prods (SIC 19.2)	132	123	80	75	35	33
Industrial gases (SIC 20.11)	102	88	79	69	35	32

Within the broad parameters of what state aid can constitute, as identified by the EC, there remain a series of trade-offs than need to be balanced when designing support packages.

Sequencing of eligibility criteria might focus efforts on those sectors believed to be most at risk, but would lengthen the application process for compensation and would still require some prioritisation from policy makers as there are different types of risks to competitiveness across sectors (e.g. delayed investment vs. increased import penetration).

A number of conditions may be attached to compensation e.g. regarding technology deployment or the level of private sector involvement. The challenge will be to ensure that these conditions help target compensation to where it's going to have the largest impact to assist with transitioning to a less energy intensive future but, at the same time, is not overly prescriptive.

There is a significant challenge in identifying future trends in electricity efficiency in the absence of and with compensation. Assumptions need to be made on expected marginal efficiency improvements and the deployment rate of step change technologies, costs of doing so and the incentives created by compensation.

Policymakers will need to decide where to focus compensation in the innovation chain e.g. on further developing nascent step change technologies or supporting the installation of current best available technologies which are already commercially available. Compensation may be directly allocated by the government or by an independent third party.

The duration of compensation will in part depend on the source of revenue for compensation. Compensation may be sourced from general public sector finance or may be linked to a revenue generating policy, such as a market-based program.

A final consideration is the level of support already received by firms in these sectors, many of which have received an over allocation of free allowances in Phase 2 of the EU ETS. However, a careful distinction needs to be drawn between subsidy to a sector and the subsidy to particular firms and/or installations *within* a sector. The electro-intensive firm/installation may or may not be linked to the carbon-intensive production firm/installation freely receiving EU ETS allowances.

Improving the analysis

There is considerable uncertainty in particular around the effective pass through rates for industry. Further empirical work on pass through rates, and the potential asymmetry in effects would be very valuable to refine the analysis.

More simply, this analysis could be considerably improved if installation level, or at least sub-sector level, data on electricity consumption were made available. A particular gap in the evidence in this particular example is data on electricity consumption at a high level of industry disaggregation (e.g. 4-digit SIC level).

1 Introduction and scope

1.1 Introduction

The UK has established a policy framework that aims to achieve a 34% reduction in GHG emissions by 2020 and an 80% cut by 2050 (both on a 1990 baseline). This will require significant abatement in energy intensive industries (EIIs). However, in the absence of a binding global deal to reduce emissions, different countries are pursuing carbon reduction policies at different rates. This can have an impact on the competitiveness of domestic industries.

The 2008 Climate Change Act sets out legally binding long-term framework to cut carbon emissions across the economy by setting a series of 5 year carbon budgets. This is supported by an array of energy and climate change polices including the Renewables Obligation (RO); the Climate Change Levy (CCL); the Assistance for Areas with High Electricity Distribution Costs; the Renewable Heat Incentive (RHI); the Carbon Reduction Commitment (CRC); and the Renewables Feed in Tariff (FiT). On top of that there is the EU Emissions Trading System (EU ETS), which requires its participants to achieve 21% reduction in net GHG emissions by 2020 compared to a 2005 baseline (according to DECC, the EU ETS will cover about 48% of national CO2 emissions from Phase III and is expected to deliver two-thirds of the first three UK carbon budgets under the Climate Change Act 2008).[2]

The Committee on Climate Change (CCC) was set up as part of the 2008 Climate Change Act. The Committee is an independent body tasked with providing advice to government on climate change issues, and particularly the setting of carbon budgets for the UK. The Climate Change Act requires the CCC to take into account:

> *economic circumstances, and in particular the likely impact of the decision on the economy and the competitiveness of particular sectors of the economy.*

In its 2008 report, *Building a low-carbon economy*, the CCC set out analysis showing that competitiveness risks are limited to energy-intensive industries (EIIs) and could be managed through appropriate policy design (e.g. as is proposed in Phase III of the EU ETS). The EIIs[3] employ about 618,000 people across the UK (2% of UK total) and contribute about £49bn gross value added (GVA) (4% of UK total) according to 2008 data from BIS. EIIs also create indirect value and employment further down the product supply chain. Many of them are based in areas of relatively high unemployment. Therefore, it is of economic and strategic importance to ensure that they continue their operations.

Yet, EIIs in the UK are concerned that costs associated with complying with climate and energy policies make them uncompetitive with EIIs located in parts of the world currently without similar constraints, like China and India, for example as expressed by the Confederation of British Industry[4]. ICF conducted a study for Department of Business Innovation and Skills (BIS) to understand the impacts that the energy and climate change policies may have on the UK EIIs[5], focussing on iron and steel, aluminium, cement and chemicals sectors, both in terms of policies directly affecting them, and those indirectly affecting them via electricity and gas prices. Incremental policy costs were developed per policy and per country, expressed per unit electricity (from power sector), and product and GVA produced (from EIIs).

In the CCC's Fourth Carbon Budget report (2010) it was concluded that in the absence of an international agreement, there will be competitiveness risks in the 2020s, particularly for EIIs. This could be addressed either through sectoral agreements or through the imposition of border carbon

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[2] DECC, *EU ETS Phase III (2013 – 2020)*, http://www.decc.gov.uk/en/content/cms/emissions/eu_ets/phase_iii/phase_iii.aspx

[3] using a definition of energy costs comprising 10% or more of a sector's GVA

[4] *'Green policies could end up throwing baby out with bath water'; Report urges tax exemption for energy-intensive firms*, http://www.cospp.com/news/2011/08/1474374163/green-policies-could-end-up-throwing-baby-out-with-bath-water-report-urges-tax-exemption-for-ener.html

[5] ICF (2012) An international comparison of energy and climate change policies impacting energy intensive industries in selected countries. Report for the Department of Business Innovation and Skills.

price levies, with the specific policy instrument to be determined as any competitiveness risks are better understood.

In its 2011 Renewable Energy Review, the CCC highlighted a specific risk that power sector decarbonisation could entail risks for a small number of electricity-intensive UK industries which compete in global markets (e.g. iron and steel, aluminium etc.). These risks were acknowledged in the agreement to legislate the fourth carbon budget, as part of which the Government committed to introduce new measures to limit competitiveness risks for electricity-intensive companies. The Government followed through on this commitment with a package worth £250 million for the period 2013-2015, announced in the 2011 Autumn Statement:

- Up to £100m is compensation for impacts from the Carbon Price Floor pass-through. The Government is currently consulting on eligibility criteria, with a view to making this available from 2013, subject to state aid approval.
- Up to £110 million is compensation for indirect impacts of the EU ETS on electricity prices, in line with European Commission state aid guidelines. EU rules for eligibility were set in 2012 and compensation will be available from 2013.
- A £40 million uplift on relief from the Climate Change Levy (from 65% to 90%) is to be introduced from April 2013.

To support this, in March 2012, BIS and the Department for Energy and Climate Change (DECC) launched a call for evidence, ‘Compensation for the indirect costs of the Carbon Price Floor and EU Emissions Trading Scheme (ETS)’. This asked companies and trade bodies to share information and data on their electricity-intensity, in order to help the government target compensation effectively.

In November 2012, exemptions were announced to offset the additional costs arising under Electricity Market Reform as part of the 2012-13 Energy Bill.

In Spring 2013 the CCC plans to publish a report on competitiveness and carbon footprint, which will include a full assessment of the package announced in the 2011 Autumn Statement and competitiveness risks more generally. The analysis will feed into the wider review of the fourth carbon budget, to be published in late 2013. In this context, the CCC is interested in assessing the competitiveness impacts of carbon budgets on key electro-intensive sectors to 2030. As such, this study will:

- Assess the impact of electricity costs on electricity-intensive industries; and
- Assess options to mitigate such competitiveness impacts.
- Assess the direct costs for energy intensive installations within the EU ETS

1.2 Objectives

The objective of this project is to assess the competitiveness impacts of policies and measures underpinning carbon budgets on key electro-intensive sectors to 2030. The specific objectives are to:

a) Develop projections of electricity price and bill differentials between UK firms and key competitors. This will require an assessment of key ‘at risk’ sectors and their key competitors. Following this, electricity prices and bills to 2030 will be developed for the countries identified;

b) Assess potential competitiveness impacts on electro-intensive sectors to 2030;

c) Explore implications for the design of support packages to mitigate competitiveness impacts.

d) In addition, the project looks at the direct costs of the EU ETS and considers the level of compensation that installations have already received.

1.3 This report

This final report aims to set out the approach taken in the study, results and uncertainties/limitations.

The report is structured as follows:

- Section 2 – Identification of key ‘at risk’ sectors and trading partners;
- Section 3 – Selection of energy and climate change policies in each country;
- Section 3.10 – Projections of electricity prices and bills to 2030;
- Section 4 – Assessment of competitiveness impacts on key sectors to 2030;
- Section 5 – Implications for possible levels of compensation;
- Section 6 – Implications for the design of support packages to mitigate competitiveness impacts.
- Appendix 1: Key trading countries identified
- Appendix 2: Analysis of key policies
- Appendix 3: Carbon price scenarios (provided by the CCC)
- Appendix 4: Incremental impacts on electricity prices of energy and climate change policies
- Appendix 5: Electricity intensity data
- Appendix 6: Sector briefing notes prepared for the committee on climate change
- Appendix 7: Technical specification of the model
- Appendix 8: Modeling results by sector
- Appendix 9: Assessing the free allocation of EU ETS permits

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2 Assessment of key 'at risk' sectors and key competitors

2.1 Introduction

The first task was to identify key sectors at risk of competitiveness impacts arising from higher electricity prices to the fourth carbon budget period (taken to be up to 2030), and their key trading partners. These sectors and trading partners were the focus of our detailed assessment of competitiveness impacts. Our approach to selecting these is set out below.

2.2 Approach

2.2.1 Identification of key 'at risk' sectors

The EU and others[6] have identified two factors affecting competitiveness risk as electricity cost intensity and trade intensity.

Estimated electricity prices and bills for UK industrial sectors up to 2030 were provided by the CCC alongside data on trade intensity. This data was used to calculate electricity cost intensity (£/GVA) and trade intensity (defined as (value of imports + exports)/ (value of domestic production + imports)) of industries in the UK. These metrics were ranked to produce a combined score in order to prioritise sectors.

Following this, the next step was to identify, where data allow, which of the sub industries (within these particular industries) are electro-intensive. This is critical for the chemical and basic metals industries since these industries comprise a wide-array of sub industries whose electricity intensity varies significantly.

Preliminary results of industry selection are shown in Table 2.1

Table 2.1 Preliminary results of industry selection

SIC	Description	Electro Intensive Segments	Trade Intensive Segments
20	Manufacture of chemicals and chemical products	Chlor-Alkali	Although the chlor-alkali industry is not really trade-intensive, its main user is. Chlorine: PVC industry; Alkali: Paper industry
		Industrial Gas (specifically, Oxygen)	Although the industrial gas industry is not really trade-intensive, the downstream industries are, e.g. Iron and steel and Chemicals industries.
		Nitrogenous Fertilizer	Ammonia and urea products
19	Manufacture of coke and refined petroleum products	Coke manufacture	The trade intensive segment of SIC 19 is the refined petroleum products, not coke manufacture

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[6] See for example Carbon Trust (2008); EU ETS impacts on profitability and trade

SIC	Description	Electro Intensive Segments	Trade Intensive Segments
22	Manufacture of rubber and plastic products	Plastic products	Rubber and plastic products
24	Manufacture of basic metals	Aluminium (specifically, Primary Aluminium)	Aluminium
		Iron and Steel (particularly, electric mini-mills[7])	Iron and steel
17	Manufacture of paper and paper products	Paper and paper products	Paper and paper products

The analysis above was supplemented with a review of recent developments of the industries' competitiveness in the UK. For example, the closure of the RioTintoAlcan smelter in Lynemouth significantly reduces UK primary aluminium production and therefore the aluminium sector was not taken forward in the initial phase, but was subsequently added.

Following consultation with the Committee on 16th November 2011 it was agreed that this study would focus on the following EII sectors:

- Manufacture of rubber and plastic products: SIC 22;
- Manufacture of paper and paper products: SIC 17;
- Manufacture of glass and glass products: SIC 23.1;
- Manufacture of cement, lime and plaster, etc.: SIC 23.5-6;
- Manufacture of iron and steel and of ferro-alloys: SIC 24.1-24.3;
- Manufacture of fertilisers and nitrogen compounds: SIC 20.15;
- Manufacture of other inorganic chemicals: SIC 20.13 – for chlor-alkali.[8]

For these sectors a full model analysis and qualitative review was undertaken. The project was subsequently extended to include:

- Manufacture of cement: SIC 23.51;
- Manufacture of Lime and plaster (23.52)
- Refining (19.2)
- Industrial Gases (20.11)
- Ceramics (23.3-23.4)
- Aluminium production (SIC 24.42)

These sectors have been modelled, and the results are reported in Chapter 4.

However, aluminium production was not included in the final analysis because of the fairly recent mothballing of two of the three main aluminium plants in the UK. The remaining Aluminium smelter, Lochabar, sources its electricity from the Lochabar hydroelectric station and is therefore unlikely to be affected by increasing policy costs.

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[7] In a minimill, scrap metal is melted and refined in an electric arc furnace (EAF) to make steel products.

[8] The SIC codes are based on the 2007 UK SIC classification. The sectors have been specified at different levels of classification based on identification of the most electro-intensive segments of sectors.

The ceramics sector was also not included in the final analysis as it was found to have a low electro-intensity (electricity cost is 2.7% of gross output) although a high proportion of UK demand is serviced by imports (39%) and so there could be a small risk of competitiveness loss from increasing material costs.

2.2.2 Identification of key trading partners

Following an identification of key ‘at risk’ sectors, the next step was to identify key trading partners and competitors for this subset of sectors. This was based on an assessment of both:

a. The UK’s current and likely future (based on any recent trade agreements) major trading partners (countries that export and import with the UK) by commodity and industry – 2011 HMRC trade data was the principle data source for this subtask;
b. Countries that were major producers (current and likely future based on understanding of capacity build) regardless of whether they are currently trading with the UK – various data sources were used to compile international industrial capacities including U.S. Geological Survey sector statistics and information from relevant trade associations (such as the World Steel Association).

Results are presented in Appendix 1.

After the most significant trading partners were identified for each industry, the results were combined to produce a final list of eight countries for further analysis:

- Belgium,
- China,
- France,
- Germany,
- The Netherlands,
- Turkey,
- Russia, and
- The US.

For the countries selected for the initial analysis, the share of trade captured by these countries ranged from nearly 50 - 70% and the share of the global market was over half. This sample therefore gives a good representation of current trade in these sectors.

3 Projections of international electricity prices and bills for key 'at risk' sectors to 2030

3.1 Introduction

In this section, we set out our methodology for projecting electricity prices and bills to 2030 for the countries identified in Section 2.2.2. A number of different scenarios were identified:

- Business-as-usual: this incorporates existing and likely future climate change and energy policies that will affect electricity prices
- Carbon price scenarios: these scenarios allow for key uncertainties such as different assumptions on CO_2 prices in the EU ETS and different levels of ambition in climate change policy targets internationally.

3.2 BAU scenario development

3.3 Approach

To develop the electricity price and electricity bill projections of the countries and industries identified, projections are first developed under the BAU case. These are based on climate change measures already implemented or policies that have been announced in the various countries. The data gathering of information on relevant energy and climate change policies in each country was undertaken using multiple sources:

- BIS (2012) report – 'An international comparison of energy and climate change policies impacting energy intensive industries in selected countries'.
- General and multi-national sources:
- ICF's in-house GHG policy tracking system,
- IEA policy database[9],
- IIP Industrial Efficiency Policy Database[10]
- IEA / IRENA Joint Policies and Measures database[11]
- Mure policy database[12],
- Pew Centre on Global Climate Change,
- Emission Reduction Policies and Carbon Prices in Key Economies, by Australian Productivity Commission
- Institute of Industrial Productivity[13]
- Globe International[14].
- European Climate Policy Tracker developed by Ecofys[15]

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[9] http://www.iea.org/textbase/pm/index.html

[10] http://iepd.iipnetwork.org/

[11] http://www.iea.org/policiesandmeasures/renewableenergy/

[12] http://www.isisrome.com/mure/

[13] 'Ten Key Messages for Effective Policy Packages, Sharing best practices in industrial energy efficiency policies', Institute of Industrial Productivity, 2011

[14] National Legislation Studies, available at http://www.globeinternational.info/

[15] http://www.climatepolicytracker.eu/

- Country specialists. Our specialists from China, Russia, Turkey, US and the EU drew on in-house knowledge, access to country-specific information sources and in-country contacts to review and supplement the above information.
- Climate change experts in each country.

3.4 Selection of key policies

Inevitably a large number of policies were identified from the data gathering task. A screening process was undertaken to identify the key policies to be taken forward for the quantitative development of metrics.

Key policies to be taken forward were those which individually were estimated to contribute:

- A medium to large proportion of the total energy and climate change policy costs to EIIs; and
- Those excluded above but may be important to the cumulative effect of policies or may be subject to relatively high uncertainty (noting that further information might be obtained during the development of quantitative metrics).

Appendix 2 presents the selected policies identified during the data gathering task for each country.

3.5 Overview of key policies

There were 5 groups of policies considered: Greenhouse gas policies; energy efficiency; renewable energy; energy taxes and other. These are detailed below.

The **greenhouse gas policies** that have been analysed include:

- the emerging US regulations (GHG Permits / Tailoring Rule requiring Best Available Control Technology (BACT) and New Source Performance Standards (NSPS)),
- the US emissions trading schemes (RGGI and Californian Emission Trading Scheme),
- the pilot Chinese Emissions Trading Schemes, and
- the EU Emissions Trading System (EU ETS).

Those countries of interest to this study that are so far without a mandatory CO2 emission trading scheme are aiming to achieve significant emissions reductions through **energy efficiency policies** including:

Energy Efficiency Targets, e.g. 10,000 Enterprises Programme, Elimination of Backward Technology and Industrial Energy Performance Standards in China; Federal Target Oriented Programme of the Russia Federation and Turkish Energy and Natural Resources Strategic Plan.

For the EU countries, searches were focused on the national implementation of the EU “20-20-20” targets which stipulate 20% energy efficiency improvement by 2020 and the New Energy Efficiency Plan (EEP) from March 2011.

All countries except Russia have **renewable energy** feed-in tariffs or similar policies in place or are planned shortly. In Germany and the Netherlands, [the impact of] feed-in tariffs are substantially reduced for EII sectors. A variety of mechanisms are in place to further support achievement of renewable generation targets including supply / purchase requirements and a range of financial incentives to invest in and operate renewables projects.

China is increasing **energy taxes** as one of its tools to support the achievement of energy intensity reduction targets. Furthermore, in China, a set of punitive prices is available to the authorities when considering action against lack of compliance with energy targets. Energy taxes for EIIs in the EU Member States considered in this study are generally low due to significant re-imbursements.

Some wider **energy policies** for the countries of interest are expected to lead to noticeable electricity price impacts including the Amendment of the Atomic Power Action (nuclear phase out) in Germany and the Law on the New Organisation of Electricity Markets (ending regulated tariffs) in France. Part of the increase in prices expected under the latter policy is being mitigated for EII sectors under a special agreement (EXELTIUM project) whereby the selected EII companies provide capital to support the development of new power generation capacity.

A summary of the key policies selected for each country is shown in the following table, broken down by type of policy. Further detail on these is given in Appendix 2.

Table 3.1 Selection of key policies

Policies	China	Ireland	Russia	Turkey	US	Belgium	France	Germany	Netherlands	UK
GHG - trading	♦	♦			♦[i]	♦	♦	♦	♦	♦
GHG – emission limits					♦[ii]					
GHG – technology requirements					♦[iii]					
Energy efficiency - standards & targets	♦[iv]		♦[v]	♦[vi]						
Energy efficiency - technology requirements	♦[vii]	♦		♦[viii]						
Energy efficiency – end-use							♦[ix]			
Energy efficiency - investment tax incentives			♦[x, xi]		♦[xii]					
Energy efficiency – other financial incentives				♦[xiii]				♦[xiv]		
RE - feed-in tariffs	♦[xv]	♦		♦[xvi]		♦	♦	♦[xvii]	♦	♦
RE - supply requirements					♦[xviii]					♦[xix]
RE - purchase requirements	♦[xx]									
RE - investment tax incentives	♦[xxi]				♦[xxii]					
RE – supply tax incentives					♦[xxiii]					
RE – other financial incentives										
Energy taxes	♦[xxiv]	♦	♦	♦	♦	♦	♦	♦[xxv]	♦	♦[xxvi]
Energy policy							♦[xxvii]	♦[xxviii]		

3.6 Determining policy costs

This section describes the methodologies and data used to derive the estimates of the cost of the energy and climate change policies on electricity prices for the countries in our analysis. This study has sought to obtain the best available information on the costs of the key policies but in many cases cost data is not available and hence estimates have been made. Given the wide range of policies and countries under consideration, it has not been possible within the scope of this study to undertake comprehensive analysis of cost impacts. Instead, indicative cost estimates have been developed, using data that is readily available and using methods that enable a consistent approach to be applied across the different countries.

As such, whilst there is a relatively high level of uncertainty associated with absolute cost estimates of individual policies given the range of simplifying assumptions and limitations of data, the analysis should provide a good indication of the **relative** cost impacts across the target countries and sectors in order to support the comparison of the key energy and climate change policies.

Methodologies

The approach taken to determining policy costs for the selected countries is summarised below. Note that costs are presented in £2011 real prices.

The first choice was to obtain data from impact assessment studies or similar studies that have examined the specific policies in detail. Where such data is not available, the second choice was to develop estimates using the methods in Table 3.2 below.

Table 3.2 Methods for developing cost estimates of policies

GHG – trading

For the EU ETS the methods are as follows:

<u>Indirect costs:</u>

For non-UK MSs: £pa EII = ((EUA $^{\text{* power sector CO2 emissions) / MWh generated) *}}$ MWh consumed by EII.

For Phase III (from 2013-2020) there will be 100% auctioning to the power sector and therefore this approach is considered reasonable within the scope of this study. For Phase II (i.e. 2011 milestone year) this approach is more of a simplification although is still considered reasonable given the inconclusive studies[16] and complex range of factors involved.

For UK: The estimated price and bill impacts of the EU ETS and Carbon Price Floor (CPF) have been provided by the CCC.

Potential compensation to EIIs due to indirect EU ETS costs has not been modelled for any MS as specific policies have not yet been agreed.

Note that the indirect EU ETS costs for 2011 have been subtracted from the current electricity prices (excl. all taxes) from Eurostat to derive a base electricity price for non-UK MSs. For the UK, base electricity price data has been provided by the CCC – see Table 3.4.

Energy efficiency – trading, standards, efficiency upgrade, targets, technology requirements, etc

Indirect costs:

> £pa power sector = tpa CO2 ↓ * £/t CO2 for energy efficiency improvements for coal, gas and other power generation types[17]
>
> £/MWh = £pa power sector / MWh generated
>
> £pa EII = £/MWh * MWh consumed by EII

Direct costs:

> £pa EII = Energy consumption ↓ * £/ unit energy consumption ↓ from fuel and electricity conservation supply curves

Renewable energy targets

Increase in costs to EIIs of feed-in tariffs

Increase in electricity price (in 2015, 2020, 2025, 2030):

£/MWh = ((MWh ↑ RE_{wind} * £/MWh FiT_{wind}) + (MWh ↑ RE_{solar} * £/MWh $\text{FiT}_{\text{solar}}$) + (MWh other

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[16] A range of studies undertaken during phases I and II of the EU ETS provide estimates of the impact of the EU ETS on electricity prices in a range of EU countries. These studies indicate that the level of pass-through under free allocation to the power sector depends on electricity market structure and the price setting generation type, i.e. the marginal plant in the despatch curve. However, these studies vary in their assumptions and results and are inconclusive with regards to the detailed impacts of the EU ETS on electricity prices for large industrial consumers. Studies include: Neuhoff, K., Grubb, M., & Keats, K. (2005). *Impact of the Allowance Allocation on Prices and Efficiency.* Faculty of Economics, University of Cambridge. Cambridge Working Papers in Economics; Newbery, D. (2005). *Emissions Trading and the Impact on Electricity Prices.* Cambridge University; Nind, A. (2005). *Implications of the EU-ETS for the power sector and electricity prices.* ILEX Energy Consulting; Reinaud, J. (2007). *CO2 Allowance and electricity price interaction.* International Energy Agency. OECD; Sijm, J., Bakker, S., Chen, Y., Harmsen, H., & Lise, W. (2005). *CO2 price dynamics: The implications of EU emissions trading for the price of electricity.* ECN. Energy Research Centre of the Netherlands; Sijm, J., Hers, S., Lise, W., & Wetzelaer, B. (2008). *The impact of the EU ETS on electricity prices.* Energy Research Centre of the Netherlands. ECN.

[17] From Report: Australian Greenhouse Gas Office, Integrating Consultancy - Efficiency Standards for Power Generation, January 2000

sources * £/MWh$_{\text{Current}}$)) / MWh total) - £/MWh$_{\text{Current}}$
Increase in costs to EIIs:
£pa EII = £/MWh * MWh consumed by EII

Increase in costs to EIIs of price premia for renewables:
Increase in electricity price (in 2015, 2020, 2025, 2030):
£/MWh = ((MWh ↑ RE$_{\text{total}}$ * £/MWh extra cost of RE)) / MWh total)
Increase in costs to EIIs:
£pa EII = £/MWh * MWh consumed by EII

Energy prices

If related to fuels

£/MWh = % ↑ fuel costs * % fuel in overall generation mix * £/MWh current average

£pa EII = £/MWh * MWh consumed by EII

If related to electricity prices

£pa EII = £/MWh change in electricity price * MWh consumed by EII

Data

The data sources used for developing the cost estimates are shown in the table below.

Table 3.3 Data for developing cost estimates of policies

Type of policy	Specific policies	Reference	Notes
GHG	EU ETS	See previous table	See previous table
	US - RGGI and California ETS	See policy descriptions in Appendix 2 and previous table	See previous table
Energy Efficiency	Energy efficiency – trading, standards, efficiency upgrade, targets. Including: - China – 10,000 Enterprises Programme; - China – Efficiency Upgrade; - Turkey – Ministry of Energy and Natural Resources Strategic Plan - Russia – Federal	Cost effectiveness of energy efficiency measures at power stations from ‘Integrating Consultancy – Efficiency Standards for Power Generation’, Report by Sinclair Knight Merz for Australian Greenhouse Office, 2000	The reference indicates it is significantly more cost effective to apply energy efficiency measures at coal power stations, than gas or oil. As such energy efficiency measures for the power sector are focussed on coal power stations.

Type of policy	Specific policies	Reference	Notes
	Target Oriented Programme of the Russian Federation.		
	CHP Support – Germany	See policy description in Appendix 2 (Policy 2)	
	White Certificates Trading - France	See policy description in Appendix 2 (Policy 1)	
RE	Feed-in Tariff	FiT prices and renewable electricity price premia are quoted in the policy descriptions in Appendix 2.	We have not made assumptions about the evolution of FiT prices beyond currently available information. As such, we have assumed the currently available information applies over the time horizon of this study (e.g. to 2030).
	Investment Tax Credit (ITC) and The Federal Production Tax Credit (PTC) – US	'Federal Policies for Renewable Electricity, Impacts and Interactions', Palmer, Karen, et al, Resources for the Future, January 2011.	The study looked at the impacts of various tax credits included in the American Recovery and Reinvestment Act of 2009. Their analysis combined the tax credits impacts and did not differentiate between the different types of tax credits. We used the combined impacts results for ITC and PTC. The study considered the impacts by region and we used the average for the U.S. as a whole.
Energy Taxes	China - Differential electricity pricing (China Policy 4) Germany – Eco taxes (Germany Policy 4)	See policy descriptions in Appendix 2 and the following table.	As left
	Turkey	See following table	See following table

Type of policy	Specific policies	Reference	Notes
Energy Policy	Energy policy: Amendment of Atomic Power Act - nuclear phase out – Germany	Vereinigung der Bayerischen Wirtshaft, 2011. Ausstieg_aus_der_Kernenergie_bis_2022_Konsequenzen_fuer_Deutschland_und_Bayern[18] EWI, GWS, PROGNOS, 2010. Energieszenarien für ein Energiekonzept der Bundesregierung[19]. Friedrich-Ebert-Stiftung, 2011. Der Einstieg in den Ausstieg Energiepolitische Szenarien für einen Atomausstieg in Deutschland[20].	
	Energy policy: Law on organisation of electricity markets & EXELTIUM – France	See policy descriptions in Appendix 2 (France Policy 4). Source: pps 26 and 41 of foot noted reference[21]	

A summary of the base electricity price data used in the study as well as any taxes on electricity (including energy taxes) is given in the table below.

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[18] http://www.vbw-bayern.de/agv/vbw-Themen-Wirtschaftspolitik-Energie-Publikationen-Ausstieg_aus_der_Kernenergie_bis_2022_Konsequenzen_fuer_Deutschland_und_Bayern--14361,ArticleID__20668.htm

[19] http://www.bmu.de/files/pdfs/allgemein/application/pdf/energieszenarien_2010.pdf

[20] http://library.fes.de/pdf-files/wiso/08339.pdf

[21] http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000023174854&categorieLien=id

Table 3.4 Electricity price data and energy taxes (2011 prices)

Country	Base price[22] (£/MWh)	Energy taxes (£/MWh)	Reference	Notes
China	51.4	9.95 plus other taxes (see notes)	2010 annual communication on the implementation of electricity price and settlement of electricity charges', State Electricity Regulatory Commission[23].	The quoted energy tax is the Differential Electricity Pricing policy (China Policy 4, see Appendix 2). The base price is the price quoted from the reference minus the impact of this policy. Within the base price there are some other taxes including Government Funds (approx 6.5% of electricity price) and the FGD[24] mark-up (approx £1.5/MWh)
Ireland	52.4	0.0	Base price based on Eurostat 2011 data, Band IF 70k MWh < consumption < 150k MWh[25]. 100% exemptions from electricity taxes apply for chemical reduction / in electrolytic processes / in metallurgical processes – for the purposes of this study we have assumed 0 zero taxes for all sectors under consideration[26].	Base price equals Eurostat price (£58.8/MWh) excl all taxes minus indirect EU ETS costs
Russia	32.4	Included in base price	Federal Statistics Service	The base price includes energy taxes.

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[22] The base price was intended to exclude all taxes, climate change policy costs and energy policy costs. However, in some cases it has not been possible within the scope of this study to fully disentangle the different elements that make up the total electricity price. Elements that are included in the base price include current renewable energy costs up to 2011 for all countries except the UK and US and some or all energy taxes for countries outside the EU and Turkey.

[23] Original Chinese document: www.serc.gov.cn/ywdd/201109/W020110928342946677139.doc

[24] Flue gas desulphurisation

[25] The Eurostat data that has been used is that which is most representative of large energy intensive industry, and for which a full data set is available. For this reason, data for Band IG (which represents the largest size category) has not been used. However it is noted that where Eurostat data covers both bands, there is only a small difference in electricity prices between the two bands.

[26] Irish Tax and Customs (2012) ‘Excise Duty Excise Duty – Guide to Electricity Tax’. Available online here: www.revenue.ie/en/tax/excise/leaflets/electricity-tax.pdf

Country	Base price[22] (£/MWh)	Energy taxes (£/MWh)	Reference	Notes
Turkey	46.2	2.2	Source of base price as for Ireland.	Base price equals Eurostat price (£49.5/MWh) excl all taxes minus indirect EU ETS costs
US	31.2	Included in base price	Annual Survey of Manufacturers and Annual Energy Outlook	The base price includes energy taxes.
Belgium	58.6	0.0	Source of base price as for Ireland. 100% exemption to electricity taxes applies to all EIIs[27].	Base price equals Eurostat price (£60.4/MWh) excl all taxes minus indirect EU ETS costs
France	46.1	1.3	Source of base price as for Ireland.	Base price equals Eurostat price (£47.1/MWh) excl all taxes minus indirect EU ETS costs
Germany	58.1	0.1	Source of base price as for Ireland. For details of energy tax see Germany Policy 4, Sec 2.2.11	Base price equals Eurostat price (£62.8/MWh) excl all taxes minus indirect EU ETS costs
Netherlands	55.2	0.0	Source of base price as for Ireland. 100% exemption to electricity taxes applies to all EIIs with consumption exceeding 10 GWh/y.[28]	Base price equals Eurostat price (£54.8/MWh) excl all taxes minus indirect EU ETS costs
UK	59.72	0.0	Data supplied by CCC, as specified in the Terms of Reference.	

Electricity intensity

Alongside the above-mentioned data collected, data on electricity intensity (kWh/ton) were also developed. This data is used in the assessment of potential competitiveness impacts (described in Section 4).

There were two types of data on electricity intensity (kWh/ton) for each industry in each country that were developed: the 2011 values and the projected intensities for 2015, 2020, 2025 and 2030. The methods used to develop them are discussed here:

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[27] Ecofys (2011) ‘Gevolgen van herziening van de Energiebelastingrichtlijn voor Nederland’

[28] Ecofys (2011) ‘Gevolgen van herziening van de Energiebelastingrichtlijn voor Nederland’

- *Electricity Intensities for 2011:* Electricity intensities were developed and estimated using a variety of approaches based on data availability. In general, in developing the intensity values, the following steps were performed:
  - If the kWh/ton is known (from available reports and other data sources) then this value was used. ICF has extensive experience and knowledge in developing detailed data on industrial energy intensities and consumption for the U.S. Thus for U.S. values, ICF relied on this experience and knowledge on data sources. Aside from the U.S. data, there were specific cases when the kWh/ton value was available – for the cement (from the Cement Sustainable Initiative) and chlorine industries (from Eurochlor).
  - If for a specific industry the kWh/ton is not known for one country but is known for another country, then the known value is used where the countries are thought to be comparable. For example, electricity intensity for the chlorine industry in Belgium (which was missing) was derived by using the value for Netherlands.
  - If U.S. intensity data are the only values available, then either:

- If there is information comparing energy (not electricity) intensities of a certain industry between two countries, then estimate the electricity intensity of the non-US-country by applying the comparative ratio of the energy intensities.
- If there is no other information available, use the U.S. data value, as is.
- *Electricity Intensity Projections:* Projections of electricity intensity by industry and country are even more difficult to find. For the projections of electricity intensity, the projections from the International Energy Outlook (IEO) were used. The IEO is an assessment by the U.S. Energy Information Administration (EIA) of the outlook for international energy markets through to the year 2035. The IEO2011 consumption projections[29] (used in this study) are divided into different regions and countries (such as China, Russia, India, etc). The industries represented individually are food, paper, chemicals, refinery, iron and steel, non-ferrous metals, non-metallic minerals, and other manufacturing.

It is noted that the electricity intensity projections for the steel industry remain flat over the projection period. This was done because of the lack of additional information. Although the IEO provided electricity intensity projections for the countries, it did not provide data by type of production process (BOF, EAF).

Appendix 5 provides the electricity efficiency potential for each of the sectors in the countries under consideration.

It is evident that there are critical data issues pertaining to the electricity intensity values for each industry and country. This weakness is primarily due to the lack of available information. Most countries do not have national projections of industrial energy use and intensities. Most countries do not have data on energy use and intensities for their industries. As long as these remain unavailable, analysis like this would have to rely on gross assumptions based on comparative evaluations between industries/countries.

3.7 Development of electricity price metrics

3.8 Indirect policy impacts

This section presents the metrics that have been developed to compare electricity prices across the countries of interest, and the incremental impacts on electricity prices of the different energy and climate change policies.

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[29] The IEO2011 Reference case projection is a business-as-usual trend estimate, given known technology and technological and demographic trends. EIA explores the impacts of alternative assumptions in other scenarios with different macroeconomic growth rates and world oil prices. The IEO2011 cases generally assume that current laws and regulations are maintained throughout the projections.

These are shown in the following figures on the basis of the two different CO_2 price scenarios (as set out in the following section). Appendix 4 provides detailed tables of results.

The different elements in the figures include:

- 'Base' – the estimated base electricity price (i.e. no climate change policy) applicable to the relevant sectors in 2011;
- 'GHG' – the incremental cost of GHG policy measures e.g. EU ETS;
- 'EE' – the incremental costs of Energy Efficiency policy measures e.g. the Chinese 10,000 Enterprises Programme;
- 'RE' – the incremental costs of Renewable Energy policy, in particular the renewable feed-in tariffs and other policies needed to achieve renewable energy production and capacity targets;
- 'ET' – the incremental costs of Energy Taxes;
- 'Other' – the incremental costs of other policies including Energy policy.

Table 3.5 below was provided by the CCC for the study and estimates the impacts of various energy and climate change policies on average electricity prices in the UK.

Table 3.5 Estimated impact of energy and climate change policies on average retail electricity prices in the UK

£/MWh	**2011**	**2020**	**2030**
Estimated average price without policies	59.7	71.0	71.0
Carbon price	4.2	10.7	25.0
Impact of RO (existing)	5.1	10.7	6.3
Impact of FiTs	0.3	2.3	1.8
With CfDs	0.0	12.4	10.2
Impact of Renewables - intermittency	0.0	2.4	3.0
Impact of CCL (full rate)	2.9	2.1	2.1
Total	72.1	111.6	119.5

In their publication, 'Estimated impacts of energy and climate change policies on energy prices and bills', DECC present a range for the costs associated with renewable policies, given that, for example, those industrial consumers that generate electricity on site will not to be subject to some of these costs.[30] For the purposes of the current study autogeneration is taken into account in four of the energy intensive sectors in the UK that have some on site generation according to DUKES 2011 data – steel, paper, chlor-alkali and nitrogen fertilisers. However, for the other countries autogeneration is not considered due to a lack of data. This could be a source of inconsistency in the results insofar as autogeneration is protected from the cost of energy and climate change measure in these countries.

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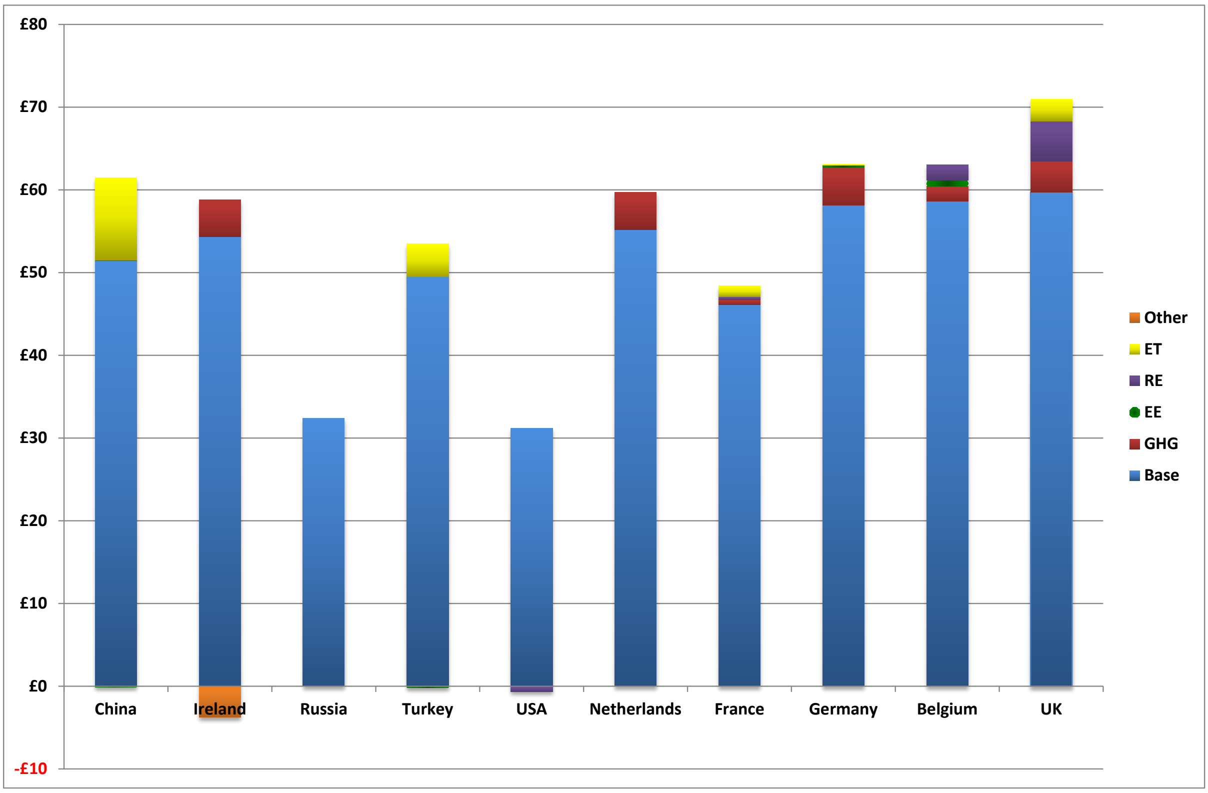
[30] The main driver of the price of electricity from autogeneration is the wholesale fossil fuel price, with a lower impact from the cost of low-carbon policies than for grid electricity. Costs paid via electricity suppliers (i.e. support under the Renewables Obligation and Electricity Market Reform) are not faced by autogeneration. The majority of autogeneration (85%) is exempt from the Climate Change Levy (CCL) as CHP schemes which qualify as Good Quality CHP under the UK's CHP Quality Assurance scheme. Much of the remainder will not face the full CCL cost as they are covered under Climate Change Agreements (CCAs). From April 2013, autogeneration will face the Carbon Price Floor (CPF), with discounts for Good Quality CHP to reflect higher efficiency (i.e. they only pay the CPF on the portion of fuels used to generate electricity).

Table 3.6 **Base electricity price and indicative incremental impacts in 2011 on electricity price of energy and climate change policies (£/MWh, 2011 prices)**



In order to isolate the impact of the policy in the model, base electricity prices remain constant over time across all countries.

Carbon price scenarios

This study considers two different CO_2 price scenarios. These figures have been provided by the CCC (based on DECC's carbon values[31]) for the UK, other EU Member States and non-EU countries (Rest of World, RoW).

Scenario 1 assumes UK-EU-RoW convergence in 2030 (see Table 3.6.). This scenario is consistent with global action to limit global warming to 2°C and a global carbon price by 2030. The EU ETS carbon price is based on DECC central estimates, reflecting EUA futures contracts to 2020, with a move to prices needed to achieve stabilisation goals by 2030. The UK faces a carbon price floor (CPF) which is higher than this up to 2030, but converges with EU ETS prices in 2030. ROW is assumed to lag the EU ETS by 10 years, with a rapid increase to 2030 after this.

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[31] https://www.gov.uk/carbon-valuation

Table 3.7 Carbon prices in 2011£/tCO_2e

£/tCO_2e	UK	EU	RoW
2011	10.0	10.0	0.0
2015	19.0	6.2	0.0
2020	31.0	8.2	0.0
2025	51.7	40.3	30.6
2030	72.3	72.3	72.3

The figures provided for RoW therefore supercede the estimates of regional cap and trade systems in US based on policy impact assessment studies.

Scenario 2 assumes EU-led action. This is a stretching scenario for UK competitiveness impacts as UK and EU carbon prices converge as in Scenario 1 but ROW is on a slower track with no convergence in the forecast period. The EU-ETS price here is consistent with DECC's higher values used for modelling, reflecting higher demand conditions for allowances, consistent with tighter caps, faster growth and low prices of coal relative to gas. The ROW is assumed to introduce a carbon price by 2022, and follow the EU ETS price to 2030. This scenario can be consistent with longer term stabilisation goals, but tests more challenging EU-ROW competitiveness conditions.

This study does not consider a scenario in which the UK moves alone to 2030 as this is not considered realistic.

Using these different scenarios, incremental impacts on electricity prices of climate change policies are shown in the following figures. For this sensitivity the UK costs are unaffected due to the effect of the Carbon Price Floor.

Table 3.8 Indicative incremental impacts in 2011, 2020 and 2030 on electricity price (£/MWh, 2011 prices) of energy and climate change policies – sensitivity under 'Convergence' CO_2 price scenario

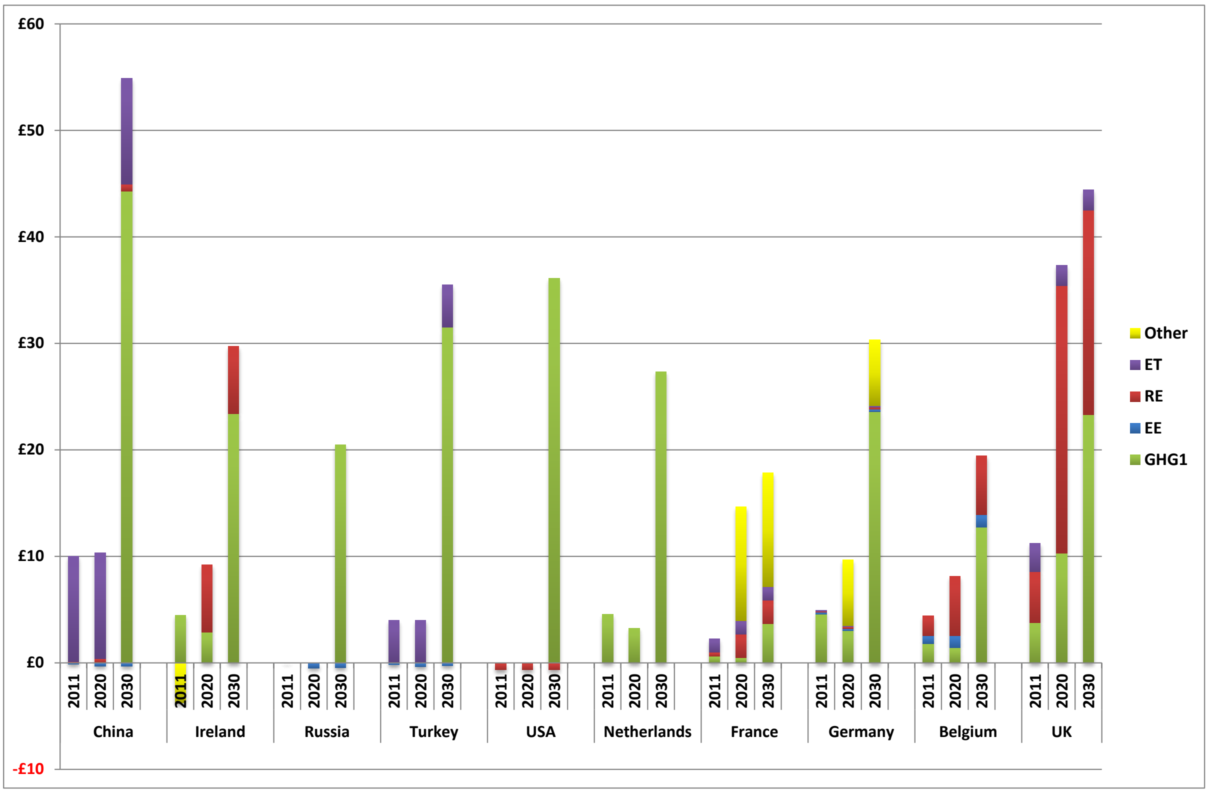
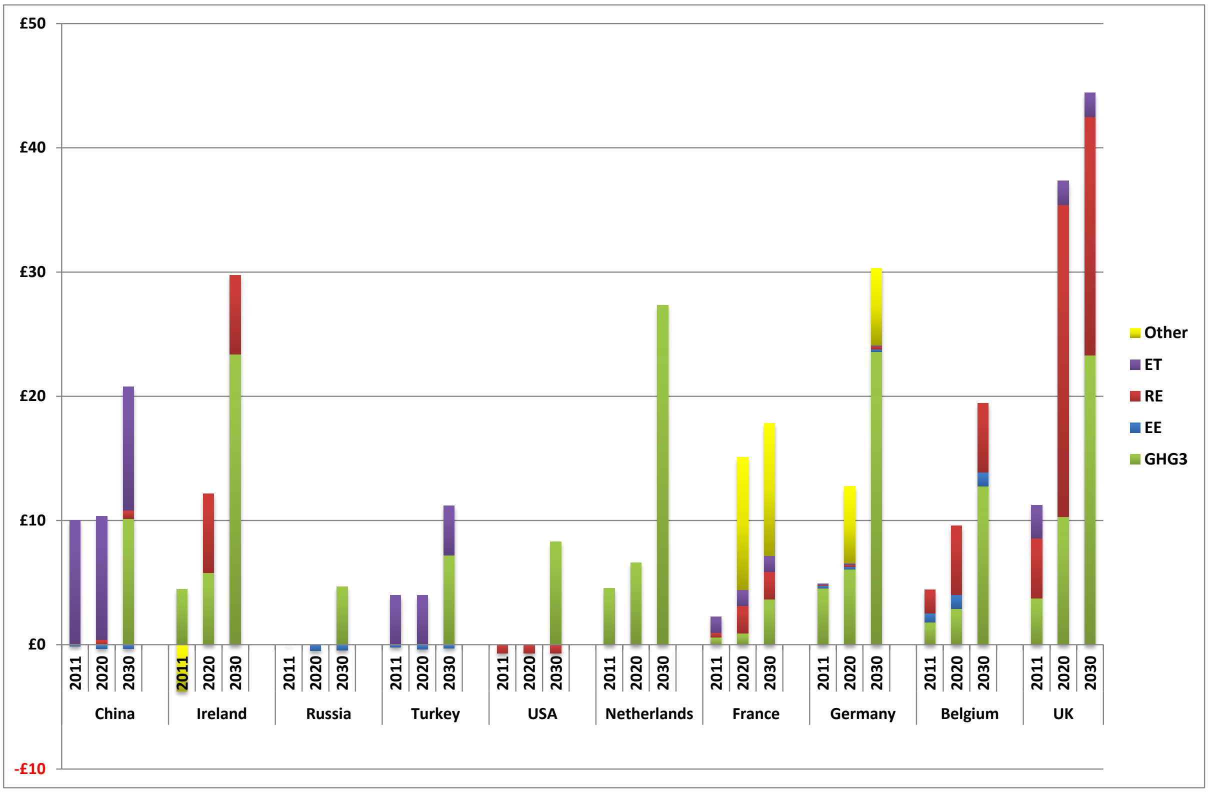


Table 3.9 Indicative incremental impacts in 2011, 2020, 2030 on electricity price (£/MWh, 2011 prices) of energy and climate change policies – sensitivity under 'EU-led action' CO_2 price scenario



3.9 Key observations

The following observations can be made from the development of metrics for indirect policy costs to electro-intensive sectors per unit of electricity:

- The UK has a higher base electricity price for EIIs than the other EU Member States considered in this study.
- Compared to the non-EU countries in this study the UK's base electricity price for electro-intensive sectors is significantly higher than prices in Russia and USA.
- Differences in base electricity prices between countries reflect several factors, including different supply mixes, fuel prices, transmission and distribution costs, non-energy taxes[32], market structures.
- The UK has relatively high incremental policy costs mainly due to renewable energy costs (for example, in Germany, renewable energy costs for EIIs are very low due to the policy to limit added renewable costs to these installations) and also the UK carbon price floor (which is additional to the EU ETS which impacts all EU member states).
- Renewable energy costs are shown to be higher in the EU MSs (particularly in the UK, Ireland, Belgium) compared to outside the EU.
- Russia and the US have the lowest incremental cost impacts on electricity prices as a result of climate change and energy policies. For the US, this is due to the less stringent mandatory energy efficiency and GHG improvement requirements at national level; as well as the focus on tax credits and other incentives to encourage update of energy efficiency and renewable energy (which is estimated to result in savings).
- Energy taxes for EIIs in China (and to a lesser extent Turkey) are particularly significant. However for the EU Member States considered in this study energy taxes are generally low, partly due to the significant reimbursements that are possible.
- Energy efficiency policies in Russia, China and Turkey are shown to result in some savings due to annual fuel cost savings of energy efficiency measures in the power sector outweighing the total annualised investment and operating costs of the energy efficiency measures.
- In Scenario 1 the differentials due to low carbon and energy policies are highest in the 2020s where the differential with the UK ranges from £23-38/MWh. This falls to 2030 as the carbon prices between UK-EU and ROW converge, so that by 2030, the impact of low carbon measures on electricity prices in China is higher than that of the UK, largely due to the carbon intensity of the grid. In the EU-led carbon prices scenario, price differentials between UK and non-ETS countries continue to rise as the carbon price continues to be much lower than in the latter.

3.10 Projections of impacts on bills

The analysis in this study has focussed on the impacts on electricity prices[33], assuming that no direct demand change in response to higher prices. In practice, the response of electro-intensive sectors to energy and climate policies may be to reduce electricity consumption, thus mitigating some of the impact of higher electricity prices. In practice, the scope for existing installations to make significant further reductions in their electricity intensity of production (over those set out in Section 3.6 above) is limited given that economic pressures have been a major driver for minimisation of electricity consumption for many years.

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[32] The base electricity price is intended to exclude taxes although for some non-EU countries the data is not sufficiently transparent to confirm this.

[33] Including any reimbursements - for example, some tax reimbursements are given to electro-intensive sectors if energy efficiency targets are met.

In a comparative analysis of this type, the approach taken in this study - which ignores any impact in reducing energy consumption - being consistent across all countries, is not expected to impact on the conclusions regarding relative competitiveness impacts on electro-intensive sectors.

3.11 Uncertainties and limitations in estimating future electricity bills

This research is designed to increase the CCC’s understanding of the competitiveness impacts of the fourth carbon budget. It represents an attempt to compile information on the impact on electricity prices of climate change and energy policies across a range of countries. The price estimates are subject to some significant uncertainties, as elaborated on below:

- Base electricity prices:
  - It is noted that some energy taxes for non-EU countries may be embedded in the quoted electricity prices as it has not been possible to fully disentangle them.
  - For the purposes of this study it has been assumed that all countries will be affected equally by changes in future fossil fuel prices. In practice this is an oversimplification. For example, in the US, a key issue relates to the impact of domestic shale gas exploration and extraction on future electricity prices. According to the International Energy Outlook[34], U.S. unconventional natural gas production is project to rise from 10.9 trillion cubic feet in 2008 to 19.8 trillion cubic feet in 2035. This is leading to reductions in gas and electricity prices, and is having a positive effect on industrial competitiveness.
- Electricity intensity data:
  - A particular source of uncertainty in this study is electricity intensity (kWh/ton) data. Data on electricity intensity for each industry in each country were needed to estimate electricity consumption and costs. Actual electricity intensity data are not readily available for most industries and most countries. Thus, most of the data needed for the analysis had to be estimated and/or derived using a range of assumptions based on a relatively limited amount of actual data.
- Policy costs:
  - There is clearly uncertainty regarding what actual climate change and energy policies and measures will be implemented in the period up to 2030 in each of the target countries that may have an impact on electricity prices faced by electro-intensive industries. The analysis is based on current knowledge of likely policies and measures, and scenarios of future carbon prices supplied by CCC.
  - There is a relatively high level of uncertainty associated with estimates of costs for the energy sector and electro-intensive sectors of individual policies given the range of available responses to the policies and uncertainties in the costs of these responses. Given the broad scope of policies being considered in this study, various simplifying assumptions have been made. Specific literature sources for data used to estimate costs of policies in different countries are provided in Appendix 2.
  - The analysis in this report focuses on the impact of policies on electricity prices faced by those EIIs that purchase electricity from an energy supplier rather than those that generate their own electricity on-site (apart from the UK – see above). Auto-generators may not be subject to all of the policy costs that are faced by those EIIs that purchase their electricity from an energy supplier, and is also likely to have a different base electricity price to what was assumed in this study.
  - This study has not modelled potential responses of electro-intensive sectors in reducing electricity consumption in the face of higher electricity prices. This is

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[34] International Energy Outlook 2011 (prepared by the U.S. Energy Information Administration). Available online: http://www.eia.gov/forecasts/ieo/pdf/0484(2011).pdf

considered a reasonable simplification given the limited scope of existing installations to make significant reductions in electricity intensity beyond what they have currently achieved.

- Unless there are explicit exemptions/discounts for EIIs, the report assumes that energy suppliers in all countries pass the policy costs they face fully on an equal cost per unit of supply basis to all their customers (i.e. households and businesses, including EIIs). In practise, the degree of cost pass through may not be 100%, especially for more powerful EIIs, and depending on the degree of electricity market reform in some countries over the time horizon of this study (e.g. China).

Whilst the absolute results from this task are subject to a number of assumptions and uncertainties, the data that has been derived on incremental electricity costs as a result of climate and energy policies is considered to be appropriate for the comparative analysis of competitiveness impacts considered in the next task. This is because the approaches for developing the data are, as far as possible, consistent, and therefore uncertainties will tend to become less important in the comparative analysis.

In addition to uncertainties that surround the trajectories for future electricity prices under alternative policies, there are considerable uncertainties regarding the response of firms to the price increases suggested. The quantitative analysis presented in Chapter 4 below considers the sensitivity of outcomes to alternative assumptions for behavioural responses, primarily the extent to which sectors pass on the increase in electricity costs to their consumers. The analysis also considers the additional impacts that might come about from the indirect impact that future electricity costs may have on the cost of other material inputs to production that must be sourced.

4 Assessment of potential competitiveness impacts on key sectors to 2030

4.1 Introduction

This chapter analyses the potential impact of the alternative electricity price scenarios on the 12 sectors of interest[35]. The analysis applies a common framework to each sector. A detailed qualitative review was carried out for the more electro-intensive of the sectors selected, and this has helped inform the quantitative analysis. In particular, these qualitative reviews (presented in Appendix 6) provided evidence to support the selection of particular model parameters.

4.2 The model framework

4.2.1 Overview of the model

The objective of the model is to quantify the impact on a sector of future changes in the electricity prices faced. To do this, the model combines two aspects to estimate an impact on the UK sector and the associated impact on trade relationships. The different aspects of the model can be characterised as follows:

- the impact of changes in UK electricity costs on a UK sectors' cost structure, output prices and volumes
- the impact of changes in international electricity costs on the relative price of imports and in UK export markets and the impact this has on UK output.

Figure 4.1 illustrates the broad model structure.

4.2.2 The impact of changes in UK electricity costs on a UK sectors' cost structure, output prices and output

The key input for each sector is the electricity bill faced in 2011[36]. This analysis focusses on the impact of the electricity cost changes, and a wider consideration of the changing cost of fossil fuel use and process emissions arising from carbon budgets are not considered here. At a sector level the volume of electricity used per unit of output is relatively stable and so using 2011 as a single data point is reasonable for this analysis as it indicates the current position of the sector.

Based on estimates of the impact of policies (and baseline price increases) into future periods, future electricity bills are estimated for each sector. The future electricity bills faced by sectors are the combined result of the increase in electricity prices (as described previously) and assumptions about future electricity efficiency. For efficiency we consider two sensitivities:

- electro-efficiency trends in line with the CCC's fourth carbon budget report[37]
- no improvements in electro-efficiency.

Following an increase in electricity bills, the sector can either absorb 100% of the cost, pass-on 100% of the cost, or somewhere between these. As the model focusses on impacts in 2020 and 2030, the pass-through rates assumed are interpreted as long-term pass-through rates.

Figure 4.1 Overview of the model

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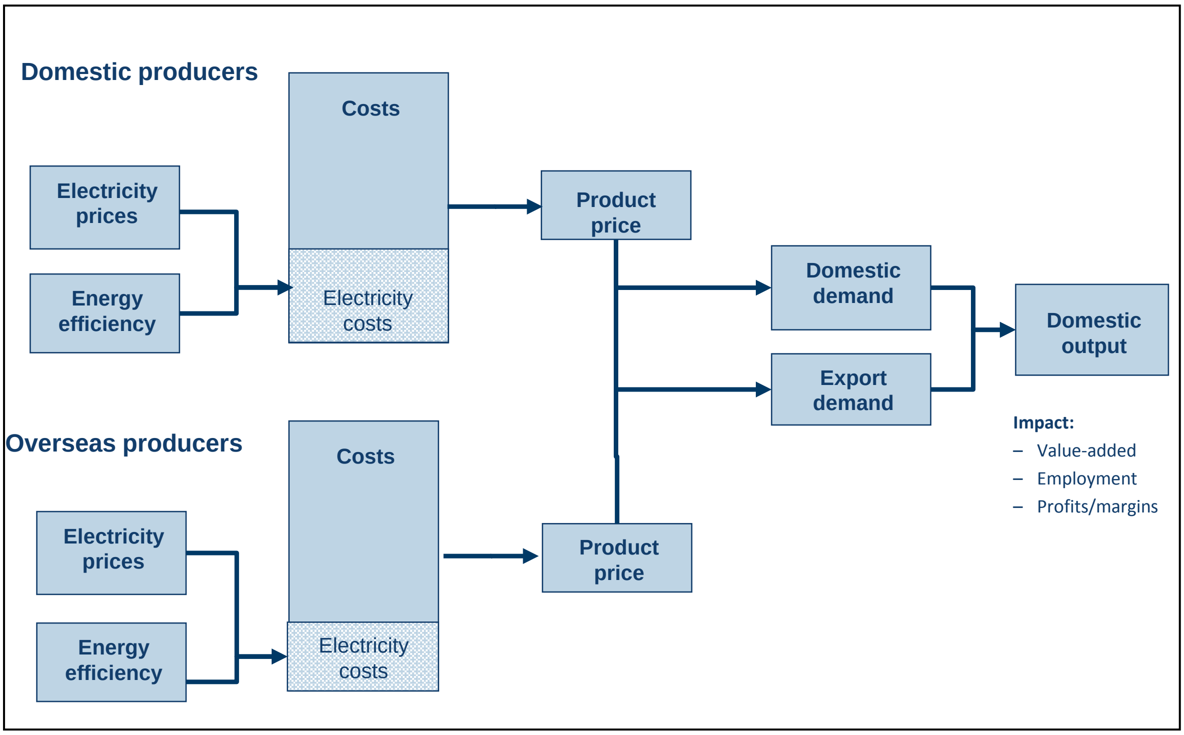
[35] In some cases the sector modelled is broader than the activity of primary interest to the CCC in order for the model to be constructed on robust data.

[36] Including the cost of auto-generation

[37] As provided by the CCC.



the entire additional electricity cost, the model will reflect this in a number of different ways:

2. Output prices remain unchanged, since the cost cannot be passed on, and so there is no change in price competitiveness with other world regions leading to no changes in trade volumes or gross sector output
3. Costs to the sector increase, by the increase in the electricity costs, and so gross value added (which is gross output minus input costs) falls
4. Since gross output is unchanged, we assume that the sector will continue to employ the same number of people and, as a result, the loss to value added will be entirely reflected as a loss to profits

As described above, the model only reflects a ‘first-round’ impact on the sector. In reality a company within a sector might react by reducing its output, or by looking for cost efficiencies elsewhere, perhaps by reducing real wages or making redundancies. A longer term period of lower profits than could be gained elsewhere might lead to a relocation of production. However, if costs are wholly absorbed within a sector, then the impact on gross value added (as reported in the model) is the worst case scenario for the sector, since it would be implausible for a sector to take any action which would result in an impact that was worse than absorbing 100% of the additional cost.

If a sector passes the entire additional electricity cost onto its consumers (in this case usually other companies/sectors), the model will reflect this in a number of different ways:

1. Output prices will change to reflect the increase in the electricity bill relative to the sectors’ gross output. For example, if the electricity bill increases from 5% to 6% of gross sector output, with full cost-pass through industry prices will increase by 1%.
2. An increase in output prices has three effects in the model, each informed by separate demand response parameters (price elasticities of demand)

    a. UK (domestic) demand for the UK product is reduced: (downstream sectors will try to make more efficient use of the product, switch to other products, or will see demand for their own product reduced)

    a. UK (import) demand for imported products will increase as imports are now relatively cheaper

   b. International demand for UK exports will decrease, as UK prices are now less competitive

3. Overall, the fall in demand for UK products translates to a reduction in industry output. In turn, we estimate the impact that this will have on wages/employment, material inputs (including the electricity bill), value added and gross operating surplus (as a proxy for profit).

In reality, the pass-through rate is unlikely to be 0% or 100%. Companies within a sector will look to pass on as much of the cost as possible. Many of the products are not easily traded and have few substitutes and so it seems unlikely that these sectors will absorb the additional cost entirely and it is often assumed that in the long term sectors will pass on all of their costs. However, there are two key factors which suggest that for the sectors examined here, cost pass through might be (considerably) less than one (see Appendix 7 for details):

1. The long-investment cycles for capital can mean that sectors are locked into cost differences that companies simply have to absorb (in the medium to longer term)
2. Many of the sectors assessed are facing increasing international (cost) competition.

4.2.3 The impact of changes in international electricity costs on the relative price of imports and in UK export markets and the impact this has on UK output

A similar but opposite effect is observed in the model if competing producers in other world regions experience increases in electricity costs.

1. Competing regions’ output prices will change to reflect the increase in the electricity bill relative to the sectors’ gross output.
2. An increase in global product/sector prices has three effects in the model, each informed by separate demand response parameters (price elasticities of demand)
   a. UK (import) demand for the global product is reduced: (downstream sectors will try to make more efficient use of the product, switch to other products, or will see demand for their own product reduced)

   b. UK (domestic) demand for domestic products will increase as these are now relatively cheaper than imports

   c. International demand for UK exports will increase, as UK product prices are now more competitive

3. Overall, the increase in demand for UK products translates to an increase in industry output. In turn, we estimate the impact that this will have on wages/employment, material inputs, value added and gross operating surplus (as a proxy for profit).

The model does not identify each import producer country and export market separately but instead considers ‘total imports’ and ‘total exports’. Trends in import prices are taken to be the average of trends in the key competitor countries (as discussed in earlier sections of this report), weighted to account for their relative share of total imports. These are grossed up to reflect total imports and exports in the sectors being considered.

4.2.4 Summary of the key parameters and flows in the model

The key parameters in the model are:

- Pass-through rates (the proportion of costs that are passed on to prices) for UK and competitor producers, and
- Projections of each sectors’ electricity efficiency over time
- Demand responses
  - Own price elasticities for UK domestic demand, exports and imports;
  - Cross-price elasticities for UK domestic demand and UK exports due to changes in competing import prices;

  - Cross-price elasticities for imports to the UK due to changes in UK domestic producer prices.

The impact is identified on a number of key indicators, including: value-added, gross output, employment, gross operating surplus (a close approximation of profits) and profit margin (approximated by gross operating surplus as a share of gross output).

4.2.5 Model limitations

As mentioned, the model is designed to account for the first-round impacts only, and as such is intended to give an indication of the relative magnitude and direction of potential future impacts of international and UK electricity prices.

A limitation of the model is that it represents the impact on trade partners by weighting the impact in different regions according to where imports are sourced. The alternative would be to model each region separately and the interaction between all world producers. However, UK trade data suggests that import shares of the products modelled are fairly stable over time: indicating that there are not large swings toward the marginally cheaper producer, and that import penetration is determined by other factors in addition to prices. As a result, we believe that this treatment is sufficiently robust to inform this analysis.

The results are extremely sensitive to the assumptions on each of the key parameters, and in particular those for pass-through and efficiency in electricity use. To counter this, the following section presents a range of results with differing parameter assumptions.

4.3 Summary of results

The analysis presented below considers the impact of two carbon price scenarios:

- Convergence scenario (Scenario 1), and
- EU-led action scenario (Scenario 2).

Table 4.1 and Table 4.2 summarise the key characteristics of the sectors, and the parameters of the model. Further discussion of model parameters are provided in the separate analysis of results for each sector presented in Sections 4.4-4.13 below.

Table 4.1 Characterising the sectors modelled

Sector	% UK GVA	Elec costs % of gross output	Elec costs % material inputs	Imports % of UK product supply	Exports % of UK product demand
Paper/paper prods (SIC 17)	0.3%	4%	7%	37%	13%
Iron/Steel (SIC 24.1-24.3)	0.1%	2%	3%	38%	35%
Cement and related (SIC 23.5-23.6)	0.1%	2%	3%	5%	3%
Of which					
Cement (SIC 23.51)	<0.1%	14%	21%	18%	7%
Lime and plaster (SIC 23.52)	<0.1%	4%	6%	16%	31%
Rubber/plastics (SIC 22)[38]	0.6%	4%	6%	33%	21%

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[38] An estimate of electricity consumption for the Rubber and Plastics sector was used for the analysis of 11.3TWh. Data now suggests that this estimate was slightly high and the outturn for 2011 electricity consumption for Rubber and Plastics was 10.5TWh. The results in Table 4.3 (and throughout the report) for Rubber and

Sector	% UK GVA	Elec costs % of gross output	Elec costs % material inputs	Imports % of UK product supply	Exports % of UK product demand
Glass/glass products (SIC 23.1)	0.1%	4%	6%	31%	17%
Other basic inorganic chemicals (SIC 20.13)	0.1%	11%	17%	48%	53%
Fertilisers/nitrogen compounds (SIC 20.15)	<0.1%	5%	6%	37%	5%
Refined petroleum prods (SIC 19.2)	0.2%	1%	1%	32%	40%
Industrial gases (SIC 20.11)	0.1%	24.3	51%	38%	29%

Source(s): Cambridge Econometrics. Data for 2011 estimated from ABS 2012, the UK Supply and Use Tables, BIS 2007, DUKES 2012, and ECUK 2012.

Table 4.1 shows there is considerable variation in the underlying economic characteristics of the sectors. Together the sectors directly account for around 1.8% of UK GDP. Of these sectors, direct electricity costs accounts for the largest share of material inputs costs for cement (21%), while they account for just 1% of input costs to the refining sector. Changes in electricity prices will therefore have a relatively greater impact on the cost base of cement. However, cement is not as trade exposed as other basic inorganic chemicals which also faces similarly high proportions of input costs coming from electricity (17%).

Table 4.2 summarises the key parameters for the individual sector models. The model parameters have been taken from quantitative estimates in the literature where available as well as being informed by detailed qualitative assessment of the sectors[39].

Plastics reflect small over-estimates. So, for example the impact on Rubber and Plastics value added in Table 4.3 is likely to be -2.7%, rather than -2.9%. This does not materially impact on the interpretation of the results.

[39] A detailed qualitative assessment was not carried out for refined petroleum products and industrial gases. These sectors were added to the model framework as an extension to the core study.

Table 4.2 Model parameters

Sector	Pass through rate (%)	Domestic demand price elasticity
Paper/paper prods (SIC 17)	20 to 40	-0.50
Iron/Steel (SIC 24.1-24.3)	25 to 75	-0.62
Cement and related (SIC 23.5-23.6)	30 to 75	-0.27
Cement (SIC 23.51)	30 to 75	-0.27
Lime and plaster (SIC 23.52)	30 to 75	-0.27
Rubber/plastics (SIC 22)	40 to 75	-0.41
Glass/glass products (SIC 23.1)	10 to 45	-0.65
Other basic inorganic chemicals (SIC 20.13)	25 to 75	-0.37
Fertilisers/nitrogen compounds (SIC 20.15)	10 to 20	-0.37
Refined petroleum prods (SIC 19.2)	25 to 75	-0.37
Industrial gases (SIC 20.11)	25 to 75	-0.37

There is considerable uncertainty around the effective pass through rates for industry. In light of this the analysis presented below considers the outcomes for what are seen as the upper and lower bounds of a central range of values for pass through rates. The lowest rates of pass through are considered to be in the fertilisers/nitrogen compounds sector (where there is strong competition), where the price elasticity of demand is also considered relatively low (as there are few substitutes). In contrast, operators in the iron and steel sector are viewed as being able to pass on at least 50% of cost increases, but face larger demand elasticity.

The pass-through rates and elasticities were informed from the literature and refined by industry stakeholders and the CCC. They are intended to provide an illustrative range of the likely impacts.

Table 4.3 shows the impact of the policies in 2030 under both the upper and lower values for the range of pass through rates. The results for each sector are presented and discussed in more details in Appendix 8.

Table 4.3 presents the results of the analysis for a series of key indicators:

- Value added: a sectors' value added represents the difference between the costs of inputs to a sector (excl wage costs) and the output (revenue) of the sector. It is akin to wages plus profits. Value added is impacted in these scenarios in one of two ways; either, increasing electricity costs are absorbed by the sector and so value added falls; or, costs are passed on which leads to a reduction in demand, which reduces gross output, which reduces value added.
- Employment: the number of jobs in a sector is expected to fall if gross output falls. We assume that labour productivity remains fixed across the scenarios and so the change in employment reflects a change in gross output (akin to turnover).

- Gross operating surplus is an economic proxy for profit. It is used because data on profit is more volatile as it reflects year-to-year investment cycles, whereas gross operating surplus reflects an underlying profitability for the sector. It is therefore a suitable proxy for profit for this type of analysis. As discussed in Section 4.2 it is assumed that if a sectors costs are absorbed this will directly reduce gross operating surplus, however, in reality firms might look to make redundancies to offset the increased electricity costs.
- Profit margins here are defined as the ratio of gross operating surplus to gross output and as a result reflect the profitability of a sector relative to its output. If a sector was able to pass on all of the additional electricity cost, we might expect the underlying profitability to remain unchanged, even if gross output was reduced, as firms would reduce variable inputs accordingly. However, in reality, firms with a high ratio of fixed costs might see profitability reduced.

Table 4.3 Impact of policy scenarios in 2030

	(EU-UK-RoW Convergence)						(EU-led Action)					
	Value-added	Employment		Gross operating surplus		Profit margin	Value-added	Employment		Gross operating surplus		Profit margin
	%	%	Jobs	£2011m	%	pp	%	%	Jobs	£2011m	%	pp
Low pass through rates												
Paper/paper prods (SIC 17)	-4.9	0.0	50>	-189	-10	-1.6	-5.1	-0.1	-100<	-192	-11	-1.6
Iron/Steel (SIC 24.1-24.3)	-6.9	-0.2	-100<	-110	-41	-1.1	-7.0	-0.3	-100<	-110	-41	-1.1
Cement and related (SIC 23.5-23.6)	-3.3	0.0	-50<	-59	-11	-0.8	-3.3	0.0	-50<	-59	-11	-0.8
Cement (SIC 23.51)	-14.4	-0.2	-50<	-27	-81	-4.5	-14.4	-0.2	-50<	-27	-81	-4.5
Lime and plaster (SIC 23.52)	-5.6	0.0	0	-1	-23	-1.4	-5.6	-0.1	-50<	-1	-23	-1.4
Rubber/plastics (SIC 22)	-2.9	0.1	200>	-235	-7	-1.1	-3.2	-0.2	-250<	-245	-7	-1.1
Glass/glass products (SIC 23.1)	-5.2	-0.1	-50<	-57	-14	-1.7	-5.3	-0.1	-50<	-58	-14	-1.7
Other basic inorganic chemicals (SIC 20.13)	-10.8	-0.7	-50<	-85	-17	-3.6	-10.9	-0.8	-50<	-85	-17	-3.6
Fertilisers/nitrogen compounds (SIC 20.15)	-16.2	0.0	0	-37	-32	-2.1	-16.3	0.0	-50<	-37	-32	-2.1
Refined petroleum prods (SIC 19.2)	-4.0	0.0	0	-107	-7	-0.3	-4.0	0.0	-50<	-108	-7	-0.3

	(EU-UK-RoW Convergence)							(EU-led Action)					
	Value-added	Employment		Gross operating surplus		Profit margin		Value-added	Employment		Gross operating surplus		Profit margin
	%	%	Jobs	£2011m	%	pp		%	%	Jobs	£2011m	%	pp
Industrial gases (SIC 20.11)	-15.7	-0.3	-50<	-99	-25	-7.9		-16.1	-0.6	-50<	-100	-26	-7.9
High pass through rates													
Paper/paper prods (SIC 17)	-3.6	0.1	>50	-141	-8	-1.2		-4.0	-0.3	-200<	-147	-8	-1.2
Iron/Steel (SIC 24.1-24.3)	-2.7	-0.5	-200<	-39	-12	-0.4		-3.0	-0.8	-300<	-40	-12	-0.4
Cement and related (SIC 23.5-23.6)	-1.4	-0.1	-50<	-25	-5	-0.4		-1.5	-0.1	-50<	-26	-5	-0.4
Cement (SIC 23.51)	-6.4	-0.4	-50<	-12	-31	-2.0		-6.5	-0.5	-50<	-12	-31	-2.0
Lime and plaster (SIC 23.52)	-2.5	-0.1	-50<	0	-10	-0.6		-2.5	-0.1	-50<	0	-10	-0.6
Rubber/plastics (SIC 22)	-1.0	0.2	>500	-91	-3	-0.5		-1.6	-0.3	-500<	-111	-3	-0.5
Glass/glass products (SIC 23.1)	-3.8	-0.3	-100<	-40	-10	-1.1		-3.9	-0.5	-150<	-40	-10	-1.1
Other basic inorganic chemicals (SIC 20.13)	-5.6	-2.1	-150<	-39	-8	-1.2		-5.8	-2.4	-150<	-40	-8	-1.2
Fertilisers/nitrogen compounds (SIC 20.15)	-14.4	0.0	0	-33	-29	-1.9		-14.5	-0.1	-50<	-33	-29	-1.9
Refined petroleum prods (SIC 19.2)	-1.6	0.0	0	-44	-3	-0.1		-1.7	-0.1	-50<	-46	-3	-0.1

	(EU-UK-RoW Convergence)							(EU-led Action)					
	Value-added	Employment		Gross operating surplus		Profit margin		Value-added	Employment		Gross operating surplus		Profit margin
	%	%	Jobs	£2011m	%	pp		%	%	Jobs	£2011m	%	pp
Industrial gases (SIC 20.11)	-5.9	-0.7	-50<	-36	-9	-2.7		-7.1	-1.8	-100<	-41	-10	-2.7

Clearly, the indicators are designed not to capture every possible response of a sector, but rather, to give an indication of the likely burden on sectors of increasing electricity costs.

Table 4.3 shows results for two sets of analysis:

1. low pass-through
    a. EU-UK-RoW Convergence scenario
    b. EU-led action scenario
2. high pass-through
    a. EU-UK-RoW Convergence scenario
    b. EU-led action scenario

For both the low and high assumptions for pass-through we assess the relative impacts of the two price scenarios. Electricity prices in the UK are the same in both scenarios. The difference between the scenarios is that electricity prices in the rest of the world are higher in the EU-UK-RoW Convergence scenario (see Chapter 3 for a fuller description).

In all scenarios, value-added in all sectors is lower in 2030 than it would have been in the absence of either policy environment. This occurs because even when high pass-through rates are assumed, part of the increase in costs has to be absorbed. The relative impact on GVA is highest for sectors with the highest relative electricity costs, namely cement, other basic inorganic chemicals and fertilisers and nitrogenous compounds.

Sectors are relatively better off if they are able to pass on more of the electricity cost, since the domestic demand and trade elasticities suggest that the impact on demand for UK products of passing on the costs is limited. Therefore, the impact is lower under higher assumptions for pass through rates. However, these estimates of demand responses may not reflect the full impact if the price impact was so substantial as to create such a marked differential between UK product prices and their international competitors not seen previously. This could be plausible for some of the very electro-intensive sectors discussed here. Anecdotally, however, trade shares are remarkably stable for many of these products, which indicates that price alone is not the determining factor and that there are other factors which affect demand, for example long term contracts, locality, transport costs, customer/supplier relationships and product quality.

However, for most sectors, the impact on gross output and employment is worse if costs are passed on, as a result of larger price increases leading to larger impacts on demand. Overall, however, the relative impact on employment is relatively small (less than ½%). The largest relative employment impact is in basic inorganic chemicals.

If electricity prices were to follow the convergence scenario, as opposed to the EU-led scenario, the adverse impact on demand for UK products is reduced. This change in demand is most pronounced in sectors where trade outside of Europe is more prevalent. Indeed, the paper sector might see a small competitiveness gain as competitor prices increase, leading to very small increases in output and jobs.

Sensitivity to impact of electricity costs on cost of other inputs

The analysis described above considers the effect that increases in a sector's direct electricity bill has on its relative competitiveness. In consultations with industry, views have been expressed that many also face substantial cost pressures because of the indirect effect of increased electricity costs had on the cost of other inputs to production. Table 1.4 shows the sensitivity of the results to this indirect impact of rising electricity prices, based on the EU-led Scenario. The analysis makes a number of simplifying assumptions:

- Suppliers of inputs are assumed to pass on 100% of the increased cost of electricity to their customers
- Producers of these other input goods do not become more efficient in their use of electricity

- Sectors do not become any more efficient in their use of inputs despite their price increasing
- The cost of inputs to production sourced from overseas do not rise.

These assumptions can be considered as representing a ‘pessimistic’ outcome for the indirect effects of increased electricity prices on the cost base of the sectors being considered.

The effect of including these indirect electricity costs does not alter the relative size of the impact by sector. It increases the negative impact on value-added by 2030 by around ½-¾pp with the exception of fertilisers and nitrogen compounds where the additional costs lowers value-added by a further 1-1¼ pp.

Table 4.4 Impact of indirect electricity costs on EU-led scenario in 2030`

	With Indirect Input Cost Effects						No Indirect Input Cost Effects					
	Value-added	Employment		Gross operating surplus		Profit margin	Value-added	Employment		Gross operating surplus		Profit margin
	%	%	Jobs	£2011m	%	pp	%	%	Jobs	£2011m	%	pp
Low pass through rates												
Paper/paper prods (SIC 17)	-5.4	-0.2	-100<	-204	-11	-1.7	-5.1	-0.1	-100<	-192	-11	-1.6
Iron/Steel (SIC 24.1-24.3)	-7.7	-0.3	-150<	-121	-45	-1.2	-7.0	-0.3	-100<	-110	-41	-1.1
Cement and related (SIC 23.5-23.6)	-4.1	-0.1	-50<	-74	-13	-1.1	-3.3	0.0	-50<	-59	-11	-0.8
Cement (SIC 23.51)	-15.2	-0.2	-50<	-28	-85	-4.8	-14.4	-0.2	-50<	-27	-81	-4.5
Lime and plaster (SIC 23.52)	-6.7	-0.1	-50<	-1	-28	-1.6	-5.6	-0.1	-50<	-1	-23	-1.4
Rubber/plastics (SIC 22)	-3.8	-0.2	-500<	-284	-8	-1.3	-3.2	-0.2	-250<	-245	-7	-1.1
Glass/glass products (SIC 23.1)	-6.0	-0.1	-50<	-66	-16	-1.9	-5.3	-0.1	-50<	-58	-14	-1.7
Other basic inorganic chemicals (SIC 20.13)	-11.3	-0.9	-50<	-88	-17	-3.7	-10.9	-0.8	-50<	-85	-17	-3.6
Fertilisers/nitrogen compounds (SIC 20.15)	-18.5	-0.1	-50<	-42	-37	-2.4	-16.3	0.0	-50<	-37	-32	-2.1
Refined petroleum prods (SIC 19.2)	-4.6	-0.1	-50<	-123	-8	-0.3	-4.0	0.0	-50<	-108	-7	-0.3
Industrial gases (SIC 20.11)	-16.3	-0.6	-50<	-102	-26	-8.1	-16.1	-0.6	-50<	-100	-26	-7.9

5 Implications for compensation

5.1 Introduction

The work discussed in earlier chapters has identified the differences in risks to competitiveness for different sectors due to electricity price differentials. Sector-specific characteristics and cost schedules mean that the impact of electricity price differentials will differ. Support packages to mitigate risks to competitiveness will need to account for these differences. It is important to understand the potential trade-offs of design elements in a support package for different sectors, both in the short and long term and also at the industry and macroeconomic level.

The discussion below outlines the issues for consideration when designing support packages, assesses the degree to which the nine sectors of focus may require support, and identifies the trade-offs associated with different design elements in a support package. It then compares the different approaches proposed to compensate for sectors at risk of competitiveness impacts from carbon pricing in Phase III of the EU ETS.

This approach allows for an understanding of how these design elements and trade-offs could be used as the basis for an assessment framework for governments looking to support industries, which are disproportionately impacted by electricity price differentials

5.1.1 Policy context

In the 2011 Autumn Statement, the Chancellor announced that the Government had allocated a £250m package to ensure that the competitiveness of UK-based electro-intensive industries is not compromised during the transition to a low carbon economy given their importance to the UK economy and potential role in the transition (e.g. manufacturing inputs for low carbon technologies)

- Up to £100m is compensation for impacts from the Carbon Price Floor pass-through. The Government is currently consulting on eligibility criteria, with a view to making this available from 2013, subject to state aid approval.
- Up to £110 million is compensation for indirect impacts of the EU ETS on electricity prices, in line with European Commission state aid guidelines. EU rules for eligibility will be set in 2012 and compensation will be available from 2013[40].

Any policies to compensate for the disproportionate impact of carbon pricing policies on electro-intensive industries are likely to require approval by the European Commission (EC) as it falls under the category of State Aid. The EC will consider the necessity of the aid, the minimum amount to realize a particular policy objective, whether distortions to competition are minimized and outweighed by the positive effects the aid will have. The EC has already outlined guidelines on the eligibility of proposals for state aid for addressing high indirect carbon costs from the EU ETS. It has outlined 15 sectors[41], which are eligible to apply for state aid based on the incidence of their indirect emissions costs (baseline years 2005-2011). This list of sectors eligible for state aid is in addition to the 164 sectors identified as being at risk of competitiveness impacts in Phase III of the EU ETS. This larger list of sectors is due to be amended at the end of 2014.

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[40] An additional £40 million uplift on relief from the Climate Change Levy (from 65% to 90%) is to be introduced from April 2013.

[41] The manufacture of plastics is included in this list but eligibility is limited to 6 subsectors.

5.2 Degree of risk and support required – evidence from the modelling

The modelling suggests that under different sensitivities for cost pass-through, given higher electricity prices in the UK to many of its international competitors, electro-intensive industry in the UK will lose cost competitiveness. As a result of lost competitiveness, gross operating surplus (a proxy for profitability) will be reduced.

The loss of gross operating surplus to UK producers is an indication of the potential compensation required to maintain the competitiveness of UK firms. However, it needs to be offset against the increasing (policy driven) electricity costs faced by international competitors.

Table 5.1 provides an indication of the required compensation under different levels of pass through. The gross compensation figure is effectively the amount required to offset the lost profitability of UK firms (the change in gross operating surplus from the modelling), while the net compensation figure is offset against the rising (policy driven) costs of international competitors (by calculating the unit cost increase faced by competitors, mapping to UK output levels and subtracting from the gross compensation calculation). The electricity prices faced by international competitors for this compensation analysis follow the Convergence scenario.

Table 5.1 Indicative levels of compensation (£2011m) in 2020

	Zero pass through		Low pass through		High pass through	
Sector	Gross comp.	Net comp.	Gross comp.	Net comp.	Gross comp.	Net comp.
Paper/paper prods (SIC 17)	177	144	146	119	115	95
Iron/Steel (SIC 24.1-24.3)	81	63	61	48	22	18
Cement and related (SIC 23.5-23.6)	63	50	45	35	20	16
Of which						
Cement (SIC 23.51)	27	14	19	10	20	16
Lime and plaster (SIC 23.52)	1	1	0	0	0	0
Rubber/plastics (SIC 22)	306	258	193	164	94	82
Glass/glass products (SIC 23.1)	48	37	44	34	31	24
Other basic inorganic chemicals (SIC 20.13)	84	69	67	56	33	29
Fertilisers/nitrogen compounds (SIC 20.15)	32	29	29	27	26	24
Refined petroleum prods (SIC 19.2)	132	123	80	75	35	33
Industrial gases (SIC 20.11)	102	88	79	69	35	32

The results clearly show that if costs can be passed on, the compensation should be reflected. Given the difficulty in estimating sectors (or installations) pass-through rates, estimating an equitable level of compensation is complex. Moreover it is equally difficult to estimate the cost faced and then absorbed or passed on by international competitors, which also reduces the compensation required by UK producers to remain competitive.

These figures should be treated as indicative. Only part of a sector, or certain installations, might be eligible for compensation, for example, the entire paper sector (SIC 17) is considered in this analysis but the main impact will be felt in the main paper and pulp manufacturing process (SIC 17.1) and so support mechanisms should be focussed on electro-intensive installations.

The figures also reflect the relative sizes of the sector and should be considered against value added and gross output for the sector for comparison between sectors.

The design of the compensation scheme will be as important as the level of compensation offered, some of the key design issues are explored in the next Chapter. In addition any compensation scheme should account for subsidies already received by the sector such as free allowances, an assessment of the over or under supply of free allowances for six aggregate sectors is provided as in Appendix 9. The results of that analysis suggest that Basic Metals, Paper/paper products and Non-metallic minerals received considerably more allowances for Phase 2 than required, and that due to the weak economic conditions this is likely to persist into Phase 3, albeit at reduced levels. For other sectors the evidence was mixed.

6 Design of support packages

Chapter 5 has identified the degree to which the sectors considered in this study may require support to offset the competitiveness effects of future increases in electricity costs. This chapter explores the issues that need to be considered when designing support packages, including the trade-offs associated with different design elements in a support package. It then compares the different approaches proposed to compensate for sectors at risk of competitiveness impacts from carbon pricing in Phase III of the EU ETS.

6.1 Identifying the need for support packages

Isolating the impact of electricity price differential from other costs

The proportion of electricity cost in overall costs will differ across industries and installations. Relative wages, costs of raw materials and transportation costs are examples of additional cost components, which in part determine relative competitiveness. As indicated by the qualitative assessments, in certain sectors (e.g. raw materials are the largest group of costs for the steel and pulp and paper sectors) these costs can significantly outweigh electricity costs. Production costs need to be placed in context of the industry's market characteristics to determine the impact of increasing electricity costs on competitiveness. This will determine a firm's ability to absorb or pass on these increases and the extent to which electricity prices impact on profitability and long term viability of production.

There are challenges with finding a representative year for the price of different inputs as these will change and will have different impacts depending on the investment schedule and technologies employed by different installations in a sector. Analysing competitiveness impacts at a sufficiently high enough level of sectoral disaggregation over a number of years would help address this challenge of identifying a representative cost schedule but is constrained by data availability and business confidentiality issues. This issue was already faced by DECC/BIS when seeking evidence for the March 2012 consultation on how to target compensation. They reference difficulties in collecting data as companies collate their accounts at different levels, with only some able to provide financial data at a site or process level. In addition, companies also define sites and processes in various ways, using different sector boundaries. Data collection is also costly, as is independent verification.

Identifying relative changes in electricity prices for international competitors

The price of electricity is anticipated to increase in all of the trade partners analysed in section 2 of the report. Any compensation should ideally aim to reduce the electricity price differential for UK industry (that are attributable to policy) so that UK producers are not disadvantaged vis-a-vis international competitors as a result of low carbon policy measures that increase electricity prices. It is unlikely that all installations outside of the UK will face the same electricity price increases across all sectors. Instead, compensation could be based on an average aggregated price increase from the main competitors. It may be possible to identify the most important trade partners and use this to weight the assessment of aggregated electricity price trends outside of the UK but this would likely be different across different sectors and may change over the assessment period (i.e. significant new trade partners may emerge in certain sectors between now and 2030). It is a significant challenge to ensure the right level of compensation is given to UK industry without creating any additional market distortions. This might be why the EC emphasised that it would only authorise compensation that doesn't distort the internal market or lead to overcompensation. The rules allow subsidies of up to 85% of the cost increase faced by the most efficient companies in each sector from 2013 to 2015. This will gradually fall to 75% in 2019-2020.

In the case of the EU ETS, the difficulties with accurately defining electricity price differentials is compounded by the fact that different countries within the EU will have different major trading partners depending on the structure of their economy and their geographical location and historical factors. This may be a reason why the European

Commission has suggested applying for state aid at a member state level to reflect these country-specific circumstances and risks to competitiveness.

Metrics to determine eligibility

There is no single commonly used metric or approach for calculating the degree of risk to industrial competitiveness from electricity price differentials. Instead, proxy variables can be used which capture the majority of the anticipated impact. It can reasonably be assumed that those sectors, which are electricity intensive and trade intensive are most likely to be at risk, as is the basis for compensation currently under the EU ETS. However, there is no consensus on the threshold to determine eligibility and a number of different metrics can be used. In the case of emissions trading schemes, these thresholds differ between policies in different regions.

One simple option to policy makers is to compare sectors and group them in terms of relative risk of competitiveness impacts due to electricity price differentials and then undertake a qualitative assessment of the sector to determine the nature of the risk to competitiveness. If more than one metric is used to determine eligibility, policymakers will also have to consider the relative weighting of different metrics. Qualitative assessments will likely be more costly and time consuming and so may be limited to a small subset of sectors. In Phase III of the EU ETS, qualitative assessments were provided when quantitative data was limited or sensitive.

Policymakers may also choose to include some more general metrics (unrelated to anticipated competitiveness impacts) to determine eligibility or to help prioritise the allocation of state aid including notions of ‘value for money’ or ‘good project management’. This is the case with funds available from some revenue recycling schemes related to carbon pricing (e.g. Australia, Boulder Colorado)

As is the case with EC state aid rules to compensate for indirect costs in the EU ETS, there may be an initial set of broad based criteria for compensation. In the case of the EC, aid can only be given to a predetermined list of 15 sectors and subsectors. Sequencing of eligibility criteria might focus efforts on those sectors believed to be most at risk.

It is also worth noting that the impact of electricity price differentials and associated nature of the risk to competitiveness will differ across industries. For example, there may be impacts along the value chain if a sector provides inputs into downstream sectors (e.g. as is the case for the chemicals and steel industry), it might be that investment is delayed which may only manifest itself as a worsened competitive position in the longer term. If the number of eligible sectors is limited by EC ruling, it might be worthwhile conducting in-depth sector analysis to understand the nature of the risk faced by each industry. This would however, still require policymakers to prioritise addressing these different types of risk if there is only a finite amount of support available (as is the case in the UK).

The impact of support on technology investment decisions

In Section 2, assumptions were made about the expected electricity intensity of production between now and 2030 for different sectors. This requires understanding and assertions on expected marginal efficiency improvements and the deployment rate of step change technologies, which change the profile of electricity consumption in a sector e.g. use of waste hydrogen to produce chlor-alkali using self-generated electricity. Implicitly, it also makes assumptions about the costs of these new production processes. The challenge for policymakers will be to understand if these improvements in electricity efficiency would occur in a sector with a worsening international competitiveness and what additional initiatives might occur if they were offered different types of compensation.

6.2 Design of support packages - Administering compensation

What form does this compensation take?

The Global Subsidies Initiative outlines 4 different categories of compensation, which are based on the WTO’s agreement on Subsidies and Countervailing Measures. These are:

1. Government provides direct transfer of funds or potential direct transfer of funds or liabilities.
2. Revenue is forgone or not collected
3. Government provides goods or services or purchases goods
4. Government provides income or price support.

Each category of compensation leads to different incentives and outcomes for electro-intensive industries. The choice of compensation will often reflect local economic and political factors. For example, as a general rule, North America has favoured targeting funds generated from carbon pricing policies to low carbon related investments (category 1) while Europe has broadly favoured using revenues to provide broader economic support and protection of vulnerable populations in the form of decreased tax rates (category 2) e.g. in Germany, there are reduced rates of eco-tax on fuels used in energy-intensive processes and techniques, mainly in the steel and chemical industries to protect their competitiveness.

Governments may forego tax revenue either directly linked to electricity e.g. in the form of VAT reduction, or by modifying taxes in other areas e.g. labour which has the potential to distort incentives to work.

Government services may also include favourable loans for specific investments e.g. improving the energy efficiency of production. E.g. in Australia the Clean Energy Finance Corporation is able to provide commercial loans, concessional rate loans, loan guarantees and equity investments. Under the Regional Greenhouse Gas Initiative, the Maryland Electric Universal service program purchases electricity on behalf of low-income households and pays power companies directly. This particular example is however likely to reduce the incentive for households to reduce their energy consumption.

Income support is more likely to be given to vulnerable populations than industry to address the impact of any electricity price changes given, as the impact is usually regressive.

The design of the original policy may allow for more innovative forms of compensation and support packages. Under the EU ETS, in addition to the possibility of state aid, under Article 10b of the Directive, compensation can be given in the form of free allowance allocation, a border tariff agreement (BTA) and a binding sectoral agreement. The essential elements of these are:

(i) Free allocation – allocate allowances to cover costs of the scheme to those affected and can be linked to industry benchmarks.
(ii) Border tariff agreement – this would create a level playing field by adjusting for relative carbon costs in traded goods at the border. It can be in the form of an import tax (which effectively extends the carbon market to imports) and an export rebate (which maintains full emission pricing at home)
(iii) Sectoral agreements – these could take a variety of forms (e.g. multilateral/bilateral or product standards) and aim to regulate emissions by sector.

The potential design elements of these additional compensation options are discussed in Table 6.1

Table 6.1 Elements to consider in design of compensation schemes

Principle	Design options to consider	Description	Commentary: EU ETS			
			Benchmark allocation	Binding sectoral agreement	Border tariff adjustments	State Aid
Isolate electricity price differentials from all other cost components*	Operating costs	Comparing electricity costs to raw materials, labour, transportation etc.	For all of these policy options, electricity costs need to be put in context of all other operating, investment and regulatory costs as well as the state of the macroeconomy and downstream demand for products to make the case for support. Given that cost structures can differ significantly within a country depending on the production process and equipment used, there is likely to be wide variation in operating costs at an EU level (particularly with regards to labour) as well as the financial performance of these firms and their respective investment schedules. Corporate taxation will also differ significantly across EU member states as will the structure of the electricity market and fuel mix. These differences are the likely reason why the European Commission decided to allow for the provision of state aid for compensating for indirect carbon costs to be determined on a state-by-state basis.			
	Investment costs	Considering investment schedules, costs of new capital and maintenance				
	Regulatory costs	Aggregate impact of environmental, labour and corporate taxation				
	Macroeconomic context	Sources and rates of downstream demand for products. Both current and future.				
	Reference year/s	Finding a representative year or set of years	For all of these policy options, the EU has chosen to use an average value over a period of time to determine eligibility and the level of support rather than relying from data from a single year. This is intended to smooth out any short-term volatility in cost schedules and demand.			
	Sectoral disaggregation	Electricity use at the sector, subsector, product or process level	Process level benchmarks or agreements may be the most appropriate approach to reflect differences in electricity consumption within the same sector (e.g. EAF/BOF		High data requirements to know the electricity use at the sector level for	Would require high technical understanding of the electricity cost to ensure the right

Principle	Design options to consider	Description	Commentary: EU ETS			
			Benchmark allocation	Binding sectoral agreement	Border tariff adjustments	State Aid
			in steel and mechanical/chemical pulping in paper). Would require high technical understanding of electricity costs in different sectors. In the case of a sectoral agreement, could be industry led (e.g. Cement Sustainability Initiative)		imports from different locations. Higher requirements with more sector disaggregation.	level of financial compensation without distorting the market
	Data sources	May be self-reported by industry, secondary sources, proxy variables.	Self-reported company-level data may contain market sensitive information. This may deter industry led-sectoral approaches, particularly when reporting is highly disaggregated. Would likely need to be a collaborative and iterative process between government and industry, possibly using existing sources to be verified by industry.		Would be difficult to impose reporting requirements on products that are imported.	*See discussion in benchmarking and sectoral agreement boxes.*
Identify relative changes in electricity prices for international competitors.	Trade partner (s)	Identifying most important trade partner(s) across the most number of sectors	Would require a data-intensive and likely complex calculation to benchmark domestic electricity consumption in a sector compared with a weighted benchmark which represents	A globally binding sectoral agreement would negate the need for identifying relative changes in electricity prices.	An adjustment for electricity prices could be made at the border but would be data and labour intensive.	Aid could be provided to compensate for differences in electricity prices but in order to be accurate would likely need to reflect sector specificities in terms of processes and
	Current weighting of trade partners	Weighing changes in electricity prices according current significance of each trading partner				

Principle	Design options to consider	Description	Commentary: EU ETS			
			Benchmark allocation	Binding sectoral agreement	Border tariff adjustments	State Aid
			performance in the rest of the world.			trade partners which would be costly.
	Future weighting of trade partners	Weighing changes in electricity prices according future significance of each trading partner	Future trends in trade patterns are unpredictable but all of these compensation measures should include regular review to ensure the significance of each trade partner and the accuracy of the electricity prices they face.			
	Accounting for uncertainty	Both in domestic and international differences in electricity prices	Similarly, future trends in electricity prices cannot always be accurately identified e.g. the proliferation of unconventional sources of gas.			
Develop common set of metrics to determine sectoral eligibility	Variables to include	A small number of metrics which capture the majority of the potential impact	In the case of Phase III of the EU ETS, the same eligibility criteria were applied as a precursor to adopting one of these three forms of compensation. The thresholds chosen were trade intensity and The cost impact of carbon pricing (both direct and indirect) as a percentage of GVA.			Eligibility for state aid due to indirect carbon cost impact is defined as a trade intensity of over 10 % and indirect carbon costs of at least 5% of GVA.
	Threshold for inclusion	Individual thresholds and interaction of multiple thresholds				
	Qualitative assessment	Supporting assessment to reflect sector-specific characteristics	Qualitative assessments enhance the understanding of industry characteristics and operating conditions of different industries at risk of competitiveness impacts from electricity price differentials but would represent additional costs for governments. They support quantitative assessment but are not a direct substitute given the necessary subjectivity required in comparing sectors qualitatively.			

Principle	**Design options to consider**	**Description**	**Commentary: EU ETS**			
			Benchmark allocation	**Binding sectoral agreement**	**Border tariff adjustments**	**State Aid**
Identify business as usual investment levels	Abatement options	Technology options available to change electricity cost profile	Business as usual investment in abatement technologies would require technical understanding of production processes in each sector as well as a consensus on the costs and feasibility of different abatement options. The investment plans of individual companies within the sector would likely be commercially sensitive information, as would the anticipated profitability of an investment in so far as it relates to business strategies and production levels.			
	Cost of abatement	Costs of different technology options				
	Microeconomic impact	Profitability of technology investment (short term and long term)				
	Macroeconomic impact	Potential for positive or negative spillovers.	Distortions to trade will depend on the coverage and design of the benchmark.	A globally binding sectoral agreement would theoretically prevent any changes to international competitiveness within a sector but there may be a risk of product substitution. A sub-global agreement could lead to trade distortions.	Imposition of border adjustments may lead to retaliation from other countries and/or distortion of trade flows which represents a secondary risk to international competitiveness.	Provision of state aid for this purpose represents forgone public expenditure elsewhere.
	Implications for trade	Changes to international competitiveness				Over or under provision of aid may lead to competitive distortions

Principle	Design options to consider	Description	Commentary: EU ETS			
			Benchmark allocation	Binding sectoral agreement	Border tariff adjustments	State Aid
Identify the most appropriate form of compensation	Sectoral disaggregation	Targeted to specific sectors, subsectors or processes	Benchmarks and sectoral approaches could be designed in a way that targets compensation at a highly disaggregated level.		Border adjustments and state aid arguably more blunt tools and it would be difficult link compensation electro-intensive subsectors or processes.	
	Fiscal implications	Government revenue forgone, direct transfer of funds, provision of goods/services, or income/price support	Benchmarked free allocation in the EU ETS represents foregone auction revenue	If developed as an alternative policy to an ETS would represent foregone revenue	Could represent an increase in border taxation or may deter importers.	The fiscal implications will depend on the design and source of revenue used for state aid
	Distortion of prevailing market conditions	Avoidance of overcompensation	The metrics and thresholds for benchmarks will determine the level of market distortion but the instrument is quite transparent which may facilitate adjustments.	A global sectoral approach has the potential to avoid distorting prevailing market conditions.	Accuracy of compensation at the border is dependent on the accuracy of international electricity prices. Will be challenging and costly to ensure accuracy for complex manufacturing products in particular.	Risky in the case of state aid. Under-compensation is a similar concern.
	Conditions of compensation for	Possibly with respects to reporting, co-financing, type of investment,	*Less relevant for these forms of compensation*.			Of most relevant to state aid. All examples in the

Principle	Design options to consider	Description	Commentary: EU ETS			
			Benchmark allocation	Binding sectoral agreement	Border tariff adjustments	State Aid
	firm.	impact or effectiveness.				description may apply.
	Targeting innovation	Compensation directed to research and development rather than operation	Benchmark may be designed or updated based on emerging/ breakthrough technologies.	Global agreement could include a commitment to invest in innovation	Funds accrued from import tariffs could be used to support innovation	Aid could be made conditional on investment in innovation
Ensure transparent administration and governance of compensation	Governance structure	Outlined in legislation underpinning the compensation policy	Process for development would need to be clearly legislated.	Need to encourage industry collaboration not collusion.	Would need to be compatible with international trade law.	Conditions and eligibility of state aid would need to be clearly legislated.
	Role of third parties	Possibly with respect to distribution, advisory services or co-financing.	May be required for verification around compliance	May require an independent facilitator for consensus building.	Advisory services likely required to understand the impact on trade and taxation.	Co-financing, distribution and compliance roles may be of particular relevance.
	Sub-national and supranational compatibility.	Interaction with different levels of governance	Dependent on the level of global participation.		Compatibility with international law	Compatibility with EU State Aid guidelines
	Duration of compensation	Duration and frequency of amendments to compensation.	For all of these different approaches to compensation, the duration and timeline for amendments and opportunities for stakeholder engagement should be known in advance so the process is inclusive and transparent. All are likely to require			

Principle	Design options to consider	Description	Commentary: EU ETS			
			Benchmark allocation	Binding sectoral agreement	Border tariff adjustments	State Aid
	Communication with industry	Method and frequency of engagement with non-government stakeholders	significant stakeholder engagement to ensure the accuracy and effectiveness of compensation and is likely to be a lengthy process.			

Conditions for compensation

Conditions may be attached to compensation, broadly specifying the way in which it can be used. Attached to this may be reporting requirements to demonstrate compliance. From a theoretical perspective, in the case of electricity cost differentials, compensation may be linked to investment in efficiency measures. Although increasing the efficiency of electricity consumption per tonne of output produced has a direct impact on a company's costs, there may be under investment for a number of reasons including step-change technologies or production processes representing high risk investments, inadequate protection for property rights and misalignment with industry investment schedules or expected payback on investments.

For the sectors analysed in detail for this study candidate technologies might be Combined Heat and Power (particularly in the chlor alkali, plastics and rubber, pulp and paper and steel industries). Some countries already support the use of CHP by reducing the energy tax on electricity generated by CHP (e.g. Estonia). However, the support for CHP can also be finite. In the UK, the technology was previously exempt from the climate change levy via 'levy exemption certificates'. However, the exemption will cease as of 1st April 2013.

Governments also need to consider where in the innovation chain to target compensation. Should it be given for demonstration facilities, for commercialisation or to install best available technologies? This might require a more coordinated policy approach to innovation with other relevant stakeholders e.g. universities, research institutes, investors.

Conditions of aid may be linked to eligibility criteria e.g. in the case of a co-funding requirement from the private sector.

Governance and allocation of compensation

Compensation could be designed and delivered by government or might be allocated to an independent third party for distribution. The role and priorities of a third party can be diverse. For example, it may be required to assume some of the risks in any assets it finances (e.g. in New Hampshire under the RGGI), it may provide more of an advisory role or partnership (e.g. the Carbon Trust in the UK) or it might have more of a role as a regulator to ensure compliance with compensation requirements.

Compensation might be allocated directly based on need at the sector, installation or process level. In the case of the EU ETS, a free allowance allocation was given to 164 sectors but was dependent on emissions performance which was benchmarked at the product level.

Installations which are operating in sectors identified as being at potential risk of competitive distortions due to electricity price differentials (e.g. the list of 15 sectors and subsectors identified by the European Commission who are eligible for State Aid under the EU ETS), could compete for funding based on predetermined assessment criteria (please see case study on Alberta). This would likely lead to a wide array of investments to improve electricity efficiency of production in a number of sectors.

However, this approach might not be appropriate for those sectors most at risk of competitive distortions as installations may need guaranteed compensation to ensure operation in the short term. Alternatively, governments might choose to allocate different sources of compensation to different sectors e.g. in the case of Australia, there is a separate compensation fund for installations working in the food and foundry sectors. These funds may be in addition to low carbon innovation funds which are not linked to carbon pricing policy.

Case Study 1

Alberta's Climate Change and Emissions Management Corporation

Alberta's Climate Change and Emissions Management Corporation (CCEMC) is an interesting example of how compensation is administered to targeted sectors and policy goals which are aligned with the province's climate change strategy (conversion and efficient use of energy, implementation of carbon capture and storage and 'greening' energy production). The CCEMC manages a fund created from revenues from large industrial greenhouse gas emitters (as one way of complying with provincial emissions regulation). The CCEMC, as an independent third party, was established to increase accountability, ensure a close technical working relationship with industry and to include a transparent review process.

Around twice a year, the CCEMC issues calls for 'expressions of interest' from participants for specific projects related to the state's climate change strategy. The fund is used to leverage private investment and anticipates the entire portfolio of projects to be valued at $1bn by the end of 2013. The majority of successful projects usually focus on demonstration and commercialization of low carbon technologies. Applicants retain the intellectual property rights to the technologies developed during their projects but there is a clause that limits the amount of time for commercializing new technologies. After this time, the technology is made publically available in Alberta.

As part of the various compensation packages under the Australian Clean Energy Future legislation, the Clean Technology Investment Program is also a competition for grants. Eligibility is determined by the anticipated reductions in emissions and ability to maintain competitiveness for the applicant. For larger grants applications (exceeding specified thresholds for energy consumption, emissions and project finance), there is the requirement to demonstrate the economy-wide benefits of a particular project to facilitate a longer-term transition to a low carbon economy.

When designing compensation schemes, the level of granularity chosen to identify risks to competitiveness (e.g. process vs. sector level) and the specificities of compensation measures (e.g. conditions or reporting requirements attached) will be key determinants of the costs of administering the compensation scheme.

Carbon pricing policies with compensation measures have also been introduced at the subnational level. In Boulder, Colorado, USA revenues generated from a city-level carbon tax were used to fund energy efficiency initiatives and adoption of renewable technologies in buildings and households. There is an additional challenge of ensuring consistency and complementarity of policies, compensation and targets at the subnational, national and supra-national levels.

Administering compensation at the regional level might allow for a more targeted response to competitiveness impacts e.g. in areas of regional economic decline or coastal regions more exposed to international competition in sectors (as is the likely case for cement given its relatively low value relative to its weight). However, in the case of providing state aid support in EU countries, any regional policies would need to ensure they meet the EC's condition of limiting trade distortions in the internal market.

Duration of compensation

The European Commission specifies that approved state aid should be short term. The challenge will be to ensure short-term competitiveness of disproportionately impacted sectors will be maintained but the incentive to reduce the electricity-intensity of production is still preserved over the long term.

In the case of the UK, the government has allocated a finite amount of money for addressing competitiveness issues in electro-intensive industries for this spending review period (until 2015). This brings some clarity to industry around the longevity of assistance, but the short term nature of the support wouldn't provide the necessary certainty for large scale investment. The duration of compensation will in part depend on the source of revenue for compensation. Compensation may be sourced from general public sector finance or may be linked to a revenue generating policy. E.g. the recommendation that 50% of auction revenues accrued by Members States in the EU ETS should be allocated to carbon reduction purposes. In this instance, the amount of revenue generated is dependent on the level of demand at auction and the associated carbon price. Any shortfall in revenues that have been committed for low carbon technology expenditure would need to come from other sources. This risk could be mitigated by designing the compensation amounts relative to a particular revenue source, but this creates uncertainty (from year to year) on the amount of compensation that firms will receive.

6.3 Conclusions for the design of support packages

Industry competitiveness is complex and dependent on a complex interaction of market and production characteristics. The challenge for policymakers seeking to compensate for competitiveness impacts is to isolate the impact of electricity price differentials from all other components determining industrial competitiveness and devise a policy that offers equivalent compensation. In the case of compensating for the impact of the EU carbon pricing legislation, UK state aid for electro-intensive participants (if permissible by the EC) will have the additional challenge of preserving environmental outcomes and avoiding distortions to the internal market.

The broad parameters of what state aid could constitute have already been partly identified by the EC. The discussion in this section has helped to clarify a number of trade-offs that exist when designing a compensation policy:

- Sequencing of eligibility criteria might focus efforts on those sectors believed to be most at risk. This would lengthen the application process for compensation and would still require some prioritisation from policy makers as there are different types of risks to competitiveness across sectors (e.g. delayed investment vs. increased import penetration).
- Policymakers will have a significant challenge identifying future trends in electricity efficiency in the absence of and with compensation. Assumptions need to be made on expected marginal efficiency improvements and the deployment rate of step change technologies, costs of doing so and the incentives created by compensation.
- A number of conditions may be attached to compensation e.g. regarding technology deployment or the level private sector involvement. The challenge will be to ensure that these conditions help target compensation to where it's going to have the largest impact to assist with transitioning to a less energy intensive future, but is not too prescriptive.
- Policymakers will need to decide where to focus compensation in the innovation chain e.g. on further developing nascent step change technologies or installing current best available technologies which are already commercially available.
- Compensation may be directly allocated by the government or by an independent third party. There are examples where third parties have issued compensation to competing proposals based on predetermined assessment criteria. This would likely lead to a wide variety of abatement initiatives and technologies deployed in different sectors. However, this approach might not be appropriate for those sectors most at risk of competitive

distortions who may need guaranteed compensation to ensure operation in the short term.

- The duration of compensation will in part depend on the source of revenue for compensation. Compensation may be sourced from general public sector finance or may be linked to a revenue generating policy. Any shortfall in revenues from the public policy would need to be made up from general public funds and would need to be designed in a way to give some certainty to investors on the longevity of support.

APPENDIX 1: KEY TRADING COUNTRIES IDENTIFIED

The Table below shows the analysis to identify the key competitor countries for further analysis.

Table A1.1 Analysis of competitors countries

Countries	Iron and steel	Paper	Nitrogenous fertilizer	Chlor alkali/PVC	Rubber and plastics – plastics	Rubber and plastics – rubber	Cement	Glass
Germany	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner
France	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner
Netherlands	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner		
Spain	major UK trade partner		major UK trade partner				major UK trade partner	
Irish Republic		major UK trade partner		major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner	major UK trade partner
Belgium				major UK trade partner	major UK trade partner		major UK trade partner	major UK trade partner
Turkey							possible threat	major UK trade partner
Italy								major UK trade partner
Russia	possible threat		major UK trade partner				possible threat	

Countries	Iron and steel	Paper	Nitrogenous fertilizer	Chlor alkali/PVC	Rubber and plastics – plastics	Rubber and plastics – rubber	Cement	Glass
Sweden		major UK trade partner						
Finland		major UK trade partner						
Lithuania			major UK trade partner					
Egypt			major UK trade partner					
Ukraine			possible threat					
US		major UK trade partner		Major PVC producer		major UK trade partner		major UK trade partner
China	major UK trade partner			Major PVC producer	major UK trade partner	major UK trade partner		major UK trade partner

APPENDIX 2: ANALYSIS OF KEY POLICIES

Introduction

The following information is presented for each country:

- A table showing all the energy and climate change policies identified from the data gathering task. Each table shows for each policy:
  - Status – whether the policy is already in force now (Existing) or whether the policy is not yet in force (New)
  - Type – whether the policy relates to GHG emissions (GHG), energy efficiency (EE), renewable energy (RE), energy tax, etc.; and what type of policy it is, e.g. trading, technology standards, targets, incentives, prices, taxes etc.
  - Enforcement – whether the policy is mandatory or voluntary. Policies that are purely voluntary and impose energy or emission targets / standards on industry have tended to be excluded as it is assumed that companies would only opt in if the benefits outweighed the costs. However, policies that offer financial incentives (i.e. which are also voluntary) have tended to be included if the incentive could be significant.
  - Target sectors – which sector(s) the policy applies to. Electricity and gas sectors are relevant for indirect cost impacts.
  - Cost impacts – this is a qualitative estimate of the relative contribution of the individual policy to the total energy and climate change policy costs for EIIs. Where available, information backing up this estimate is given in the analysis of key policies (shown in next sections).
  - Inclusion status – whether the policy has been taken forward for qualitative analysis and development of quantitative metrics. Details of the approach to screening policies are given in the previous section.
- A description of each of the key policies. Each description includes:
  - Policy name
  - Status – as above, plus details of when it was introduced and when it takes effect
  - Sector coverage – as above
- Aim and key provisions / targets – the main provisions of the policy in terms of targets on GHG emissions, energy efficiency, uptake of renewable energy etc., as well as any key details on how it operates.
- Exemptions available to EIIs – details of any less stringent requirements or exemptions for EIIs
- Who pays for the policy – i.e. industry, government etc.?
- Extent to which objectives have been met – any available information on the effectiveness in practice of the policy
- Estimation of cost impacts – see Section 3 for details of the cost estimation methods that have been applied. Costs are presented in 2011 real prices. Negative figures indicate a cost reduction (when looking at the electricity price) or a saving to the sector (when looking at EIIs).
- Sources of information.

A1.2 China

Table A1.2 Assessment Table – China

Name	Status	Type	Enforcement	Inclusion Status
1. 10,000 Enterprises Programme (formerly 1,000 Programme)	Existing / New	EE targets	Mandatory	Y
2. Efficiency Upgrade for Boilers and Kilns	Existing	EE targets	Mandatory	Y
3. Elimination of Backward Technology	Existing	EE technology	Mandatory	Y
4. Differential Electricity Pricing	Existing	Energy tax	Mandatory	Y
5. Pilot Carbon Trading	New	GHG trading	Mandatory	Y
6. Industrial Energy Performance Standards	Existing	EE targets	Mandatory	Y
7. Renewable Energy Law /Renewable Energy Development Targets	Existing	RE targets	Mandatory	Y[†]
8. Solar Feed-in Tariff	Existing	RE pricing	Mandatory	Y[†]
9. New energy quota system	New	RE targets	Mandatory	Y[†]
10. Wind Power Concession Programme	Existing	RE pricing	Mandatory	Y[†]
11. Preferential Tax Policies for Renewable Energy	Existing	RE incentive	Mandatory	Y[†]
12. Energy Intensity Reduction Target	Existing	EE target	Framework policy	N
13. Expansion of Local Cogeneration (CHP)	Existing	EE target	Mandatory	N
14. Energy Service Companies	Existing	EE incentives	Voluntary	N
15. Carbon Capture and Use Policies	Existing	GHG technology	Voluntary	N
16. Energy and electricity price reform	New	Energy prices	Mandatory	N
17. China Corporate Energy Conservation and GHG Management Programme	Existing	EE & GHG Management	Voluntary	N
18. Demand Side Management (DSM) Implementation Measures	Existing	EE Demand side	Mandatory	N

Policy 1	**10,000 Enterprise Programme (formerly 1,000 Enterprise Programme - Reducing Energy Consumption of the 1000 Largest Industrial Enterprises in China)**
Status	In Force. *Mandatory*
Sector coverage	The Programme requires that energy savings be undertaken by the largest energy intensive enterprises in the iron and steel, non-ferrous metals, coal mining, electric power generation, petroleum and petrochemicals, chemical industry, building / construction materials, textiles, and pulp and paper industries. Enterprises with annual energy consumption of >180,000 tce (tonnes of coal equivalent) (5.3PJ) or above were required to participate in the 1,000 Enterprises Programme. In the 12th Five Year Plan (FYP, 2011 to 2015) this scheme has been expanded to 10,000 enterprises, mostly high energy consuming ones in the power, steel, cement and refining sectors. The 10,000 Enterprises Programme will apply to enterprises with annual energy consumption of >10,000 tce.
Aim and key provisions / targets	The target for the 10,000 Enterprises Programme is a reduction in cumulative energy consumption of 250 Mtce (Million tonnes of coal equivalent) by 2015 relative to 2010 (or 750 to 1125 million tonnes of CO2). Each of the enterprises will follow the general requirements that applied to the original 1,000 enterprises. This will require companies to implement energy audits and benchmarking, establish enterprise energy management system, expand energy manager pilots, carry out energy usage reporting mechanisms, accelerate retrofitting and elevate energy management levels. Local administrators should assess enterprise energy saving targets in those 10,000 enterprises every year and publicly disclose results. For those who did not achieve their annual targets, energy audits will be mandated and rectification should be carried out before a certain deadline. State-Owned Key Enterprises should accept the supervision of local energy departments and spearhead energy reduction efforts within their industry. Further details of the policy will be submitted by the government in late 2011. Note that in this study we have not made any assumptions about potentially more stringent targets after the end of the 12th FYP. It is assumed that measures to comply with the targets under the 12th FYP will stay in place.
Exemptions available to EIIs	No
Who pays for the policy	Power sector and industry pay, although the annualised capital costs of investment in energy efficiency techniques are expected to be outweighed by annual savings in fuel costs.

Policy 1	**10,000 Enterprise Programme (formerly 1,000 Enterprise Programme - Reducing Energy Consumption of the 1000 Largest Industrial Enterprises in China)**
Extent to which objectives met	The 1,000 Enterprise Programme was targeted to achieve 100 Mtce in cumulative energy savings from 2006 - 2010, or approximately 300 - 450 million tons of CO_2. Key points from a recent review of the Top 1,000 Programme are: ▪ Reported savings were 20Mtce in 2006 and 38Mtce in 2007. ▪ In Nov 2009 NDRC announced that the Top 1,000 Programme had reached its target energy savings of 100Mtce. ▪ The enterprises invested over 50 billion RMB ($6.6bn) in technology innovation and implemented over 8,000 energy saving projects in 2007. Corresponding investments in 2008 were reported to be 90 billion RMB ($13.5bn). ▪ Overall it is difficult to assess how much of the reported savings are due to the activities and policies associated with the Top 1000 Programme and how much would have occurred in the absence of the programme. ▪ There is no third party review or verification of the reported results at the enterprise, sector, provincial or national level. ▪ The Programme goal represented only 15% of total required energy savings in the 11th FYP, yet the Top 1,000 enterprises represent the highest energy consumption in the economy.
Other key details	Originally the 1,000 Enterprise Programme covered 1,004 companies, which has decreased to 998 since programme implementation started in 2007. These enterprises comprise 33% of overall nation-wide energy consumption, and approximately 47% of industrial energy consumption.

Estimated cost impacts:									
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100%							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.00						
		2015	-0.24						
		2020	-0.22						
		2025	-0.22						
		2030	-0.23						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		2015	-81.7	-16.8	-45.9	-11.9	-7.1	-5.7	-0.1
		2020	-100.1	-17.1	-41.8	-13.0	-7.7	-5.2	-0.1
		2020	-130.3	-22.3	-54.3	-13.3	-7.9	-6.8	-0.2
		2030	-159.4	-27.3	-66.5	-13.4	-8.0	-8.3	-0.2

Source	EPA Final Report Task I and II 01 2010
	‘Assessment of China’s Energy Saving and Emission Reduction Accomplishments and Opportunities During the 11th Five Year Plan’, Price et al, Energy Policy, Vol 39, Issue 4, April 2011
	12th Five Year emission reduction comprehensive work scenario issued by State Council.

Policy 2	Efficiency Upgrade for Coal-burning Industrial Boilers and Kilns
Status	In Force (announced 2004, effective 2006) Mandatory
Sector coverage	General (boilers & kilns)
Aim and key provisions / targets	China's NDRC announced three measures to reduce the nation's kiln and boiler consumption of coal by 70 million tons: ▪ selection of high-quality coal, lump coal, and sulphur-fixed coal; ▪ renovation of medium-sized and small boilers and kilns with advanced techniques such as circulating fluidised bed (CFB) and pulverised coal firing; ▪ establishment of a scientific management and operation system. Within the 11th Five-Year Plan (FYP) (2006 - 2010), these measures were expected to raise the efficiency coal-burning boilers and kilns by 5 and 2 percentage points, saving 25 million and 10 million tons of coal. In the 12th FYP (2011-2015) measures include implementing key energy reduction projects such as boiler and furnace retrofitting, motor system energy saving, energy system optimisation, and waste heat and waste pressure utilisation. Further measures include implementing technology commercialisation demonstration as well as energy reduction capacity building. By 2015, the operational efficiency of industrial boilers and furnaces should increase by a further 5 and 2 percentage points respectively (compared to 2010) and that of electric motor systems should increase by 2-3 percentage points.
Exemptions available to EIIs	No
Who pays for the policy	Power sector pays, although the annualised capital costs of investment in energy efficiency techniques are expected to be outweighed by annual savings in fuel costs.
Extent to which objectives met	Some information available for 10,000 Enterprises Programme
Other key details	China now uses 500,000 medium-sized and small boilers, with an average capacity of only 2.5 ton per hour, a designed efficiency of 72 to 80 percent and an actual efficiency around 65 percent. 90 percent of them are coal-burning, consuming 350 to 400 million tons each year, of which 70 million tons can be saved.

Estimated cost impacts:

Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100%							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	-0.11						
		2015	-0.10						
		2020	-0.09						
		2025	-0.09						
		2030	-0.09						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	-27.5	-6.9	-23.9	-4.6	-2.7	-3.0	0.0
		2015	-34.0	-7.0	-19.1	-5.0	-2.9	-2.4	0.0
		2020	-41.4	-7.1	-17.3	-5.9	-3.2	-2.1	-0.1
		2020	-54.0	-9.3	-22.5	-5.5	-3.3	-2.8	-0.1
		2030	-66.4	-11.4	-27.7	-5.6	-3.3	-3.5	-0.1

Source	http://www.iea.org/textbase/pm/?mode=cc&id=2516&action=detail http://www.drcnet.com.cn/DRCNET.Channel.Web/ 12th Five Year emission reduction comprehensive work scenario issued by State Council

Policy 3	Elimination of Backward Technology
Status	In Force (2007) / Mandatory
Sector coverage	Power/Cement/Steel/Aluminium/Others
Aim and key provisions / targets	Starting in early 2007, the NDRC issued orders to retire small and inefficient plants in various industrial sub-sectors. As in the 11th FYP period, the target in each industry in the 12th FYP will be to eliminate excess production capacity. Iron, steel, nonferrous metals and building materials are especially singled out. The process is set to change, however, with ‘red’ and ‘black-list’ factories to be selected on efficiency performance as well as on excess capacity grounds. Against this backdrop, continued consolidation of industrial sectors is expected through aggressive rounds of mergers and acquisitions. Steel, for example, is projected to consolidate towards the ten largest companies controlling 60% of production (currently consolidated at 44%). Generators wishing to construct new coal-fired power plants can only do so once smaller and older facilities are fully decommissioned. China’s plan was to close 70GW of outdated thermal power station capacity over the 2006-2010 period. All coal-fired power plants of less than 50MW capacity, and those with capacity between 50 and 100MW that have been in operation for over 20 years were required to close by 2010. Generators with unit coal consumption 10% or more above the provincial average or 15% above the national average are also targeted for closure. In the cement sector, all plants with an annual capacity under 200,000 tonnes were to be closed by the end of 2008, and 250 million tonnes (Mt) of outdated and inefficient capacity to be retired by 2010. In the steel sector, outdated and inefficient pig iron capacity was to be reduced by 100 Mt and steel capacity by 55 Mt, both by 2010. In addition, all blast furnaces below 300 m^3 must be closed by 2010. Steel-making furnaces with less than 20 tonnes capacity and blast furnaces below 100m^3 were to be closed by 2007. NDRC has established reduction quotas at the provincial and regional levels, for which provincial officials are held responsible through agreements signed with the central government. In total, 2,087 companies in 18 industries are involved in the list of retirement of inefficient plants. The industries cover electricity, iron, steel, coke, calcium carbide, iron alloy, aluminium, cement, plate glass, paper, alcohol, monosodium glutamate, citric acid, copper smelting, lead smelting, zinc smelting, tanning, dyeing, chemical fibre and heavy metal polluting industries.
Exemptions available to EIIs	No
Who pays for the policy	Industry itself will be impacted financially by plant closures although compensation can be provided to facilitate and accelerate this process. The compensation is from central government and local government. Central government decide the scope of companies, products etc. to be covered by this policy and based on the stipulation of central government, local governments decide the amount of the award criteria according to the local actual conditions of specific projects. The detailed compensations are different across the different local governments. There are no actual published figures of the amount of compensation paid under this scheme. Given that demand is growing and this policy reduces supply, a key focus of compensation is to incentivise new investment; combine companies together to achieve better economies of scale; establishment of new product lines etc.
Extent to which objectives met	Compared to the overall programme goal in the 11th FYP of 118Mtce net energy savings in final energy, it appears that the programme had saved an estimated 76% of the total goal in the first three years, which was ahead of schedule.

Policy 3	Elimination of Backward Technology
	In the power sector alone, until May 2010, 64 GW of thermal power station capacity has been taken offline. The closure of inefficient plants will continue, with 8GW expected to be phased out during 2011.
Estimated cost impacts	There is no readily available data to quantify the cost impacts of this policy. Qualitatively there will be potentially significant cost impacts in the short and medium term from closure of plants and investing in new plants, although this will be balanced in the long term by the benefits of less energy intensive and more competitive industry and greater economies of scale.
Source	http://www.iea.org/textbase/pm/?mode=cc&id=4306&action=detail The Climate Group, commissioned by HSBC. Delivering Low Carbon Growth – A Guide to China's 12th Five Year Plan 'Assessment of China's Energy Saving and Emission Reduction Accomplishments and Opportunities During the 11th Five Year Plan', Price et al, Energy Policy, Vol 39, Issue 4, April 2011

Policy 4	Differential electricity pricing
Status	In Force (2010) Mandatory
Sector coverage	General
Aim and key provisions / targets	Chinese government is encouraging energy efficiency in industries through differential and punitive electricity pricing. *Differential electricity pricing:* From June 2010, the central government increased the gap of differential electricity prices to the main 8 industries: electrolytic aluminium, ferroalloy, calcium carbide, caustic soda, cement, steel, phosphorus and zinc smelting. To restrain the development of high energy consumption enterprises, the standard defined two types of enterprises: Restricted enterprises and Eliminated enterprises. For restricted enterprises, the differential electricity price is +0.1RMB/kWh (in 2010) [This is the assumed price impact of this policy]; and for eliminated enterprises, the differential electricity price is +0.3RMB/kWh (about 30 to 50% over the standard electricity prices to industries). Furthermore, local governments are allowed to increase electricity price on the high energy consuming enterprises further based on this standard. By the end of 2010 the central government announced 22 industries' standard quotas of energy consumption. *Punitive electricity pricing:* It is mentioned in the 12th Five Year Plan, for enterprises whose unit energy (electricity) consumption are over the national or local standard, they will be punished on electricity pricing. For example, in Zhejiang province, the local government selected 239 enterprises from 44 industries as objects of punitive electricity pricing. For enterprises whose electricity consumption are more than double the standard, the punitive electricity price is increased by 0.3RMB/kWh; those whose electricity consumption is over the standard and within double the standard, the punitive electricity price is increase 0.1RMB/kWh. After that, from June 2010, over 2400 energy consumption enterprises were continually punished. It's considered a strong punishment, because for some industries the cost of electricity is about 30% of the whole product cost.
Exemptions available to EIIs	No
Who pays for the policy	Industry
Extent to which objectives met	This depends on the degree of implementation. The available information gives evidence of implementation.

Estimated cost impacts:									
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	9.95						
		2015	9.95						
		2020	9.95						
		2025	9.95						
		2030	9.95						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	2508.3	627.1	2181.2	416.5	246.7	271.6	4.4
		2015	3398.7	698.8	1909.7	496.0	293.8	237.8	4.9
		2020	4571.5	783.0	1907.3	593.1	351.3	237.5	5.7
		2025	5815.9	996.2	2426.6	593.1	351.3	302.2	7.2
		2030	7032.9	1204.7	2934.3	593.1	351.3	365.4	8.8

Source The Climate Group. China's Clean Revolution II: Opportunities for a low carbon future.

Central Government documentation on differential electricity pricing

Policy 5	Domestic Carbon Trading Programme
Status	Planned (pilot scheme in 2013, national scheme in 2015) / Mandatory
Sector coverage	General (potentially all target industrial sectors)
Aim and key provisions / targets	China will launch carbon trading between now and 2015 as a way to further help China meet its target to improve energy efficiency by 2020. Two targets for 2015 are set in the 12th FYP to prepare for this – to reduce emissions intensity by 17% and energy-intensity by 16%, against 2010 levels[42]. China is currently assessing the relative benefits of sector-specific and economy-wide carbon trading schemes through an examination of the experience of the EU and other regions as well as through domestic pilot carbon trading projects. China started planning for a series of pilot projects in 2011 in high-emission provinces or energy intensive sectors (such as electric power, chemicals and oil). Five cities and two provinces have been selected to potentially be involved in carbon trading. Those chosen will be expected to establish targets and measures to cut carbon intensity. Pilot trading schemes in the cities of Beijing, Chongqing, Shanghai[43], Tianjin and Shenzhen and the provinces of Hubei and Guangdong[44] will be launched by 2013. The purpose of the pilot schemes is to explore the establishment of related systems, set the rules of the game and improve the system mechanism as much as possible, rather than to expand the scope of participations. The schemes would expand to a national level by 2015. Emission targets for each of the regions have not yet been released to the public. There is no clear indication about the situation by 2020 yet, although some key points are as follows: ▪ Chinese Government's commitment of carbon emissions per unit of GDP in 2020 is decreasing 40% to 45% compared to 2005 levels. That implies China has a huge carbon trading opportunity in the market. ▪ In the 11th Five-Year period, China mainly relied on administrative approaches to complete the task of energy saving. For example, to achieve the target that energy consumption per unit GDP reduced 20% by 2010, 1,000 energy intensive enterprises signed up to responsibilities like energy conservation. But the cost-effectiveness of such administrative measures is likely to decrease as smaller installations are covered by the expansion of the 1,000 Enterprises Programme and the no and low cost energy efficiency measures are more likely to have been taken up (i.e. the ‘low hanging fruit’). As such, achieving emission reduction targets whilst minimising costs becomes more of a challenge and raises the interest in market based measures. ▪ China's carbon emissions trading market is undoubtedly still in the exploratory stage. In 2008, China's first three environmental rights trading institutions were set up in Beijing, Tianjin, and Shanghai. In January 2011, the first carbon trading market settled in Shenzhen.
Exemptions available to EIIs	No

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[42] The target for the 11th Five Year Plan (2006 to 2010) was 19%, making an overall 32% reduction from 2006 to 2015.

[43] Shanghai has announced that it will measure emissions and energy use from its large industry in preparation for launching a pilot emissions trading scheme

[44] The province of Guangdong has already developed plans to create a cap and trade scheme between 11 of its cities to meet emission targets.

Who pays for the policy	Industry
Extent to which objectives met	Policy not yet implemented
Estimated cost impacts	Due to the uncertainty regarding the geographic / sectoral scope, the level of the cap, the type of allocation method(s) it is not possible to estimate the costs of this policy at this stage. The main policies currently focused on achievement of the energy intensity targets are described elsewhere in this section. In practice, emissions trading in China is likely to have a low impact initially and is not expected to contribute to much reduction by 2015 as it will be introduced gradually over a number of years. Depending on the geographical scope of the scheme and the stringency of the emissions caps, the scheme could have a medium cost impact by 2020.
Source:	http://in.reuters.com/article/2010/08/12/idINIndia-50793720100812 http://www.pointcarbon.com/polopoly_fs/1.1561908!CMNA20110722.pdf http://www.eenews.net/climatewire/2011/07/19/7 http://www.pointcarbon.com/news/1.1543598 http://www.pointcarbon.com/news/1.1549370; and http://www.eenews.net/climatewire/2011/09/14/4 The Climate Group, commissioned by HSBC. Delivering Low Carbon Growth – A Guide to China's 12th Five Year Plan

Policy 6	**Industrial Energy Performance Standards**
Status	In Force (as of 2007) Mandatory
Sector coverage	Energy intensive industries including: cement, crude steel, caustic soda, copper, ferroalloy, coke, calcium carbide, ceramics, zinc, lead, yellow phosphorus, synthetic ammonia, flat glass, magnesium, copper-alloy, nickel, electrolyzed aluminum, tin, antimony, carbon materials, aluminum alloy and electricity from coal-fired power stations.
Aim and key provisions / targets	Industrial energy performance standards implemented by NDRC set maximum levels of energy consumption per tonne of final product, e.g. x tce per tonne of cement / clinker etc. These apply to existing plants and newly constructed plants, taking into account different types of raw materials, fuels, and capacities. There are 22 standards in all. Aside from the mandatory standards a set of voluntary, more advanced, “reach standards” have been established. Monitoring and evaluation will have three phases: self-evaluation, local supervision, and national-level spot checking. There is some degree of interaction and reinforcement across the different energy efficiency programmes including the 10,000 Enterprises Programme (Policy 1), Efficiency Upgrade for Boilers and Kilns (Policy 2), Elimination of Backward Technology (Policy 3), Differential Electricity Pricing (Policy 4), etc., which all combine to support the achievement of national and sectoral energy efficiency goals.
Exemptions available to EIIs	No
Who pays for the policy	Industry pays in the short-term but may benefit in the long-term.
Extent to which objectives met	Information is not readily available
Estimated cost impacts	The estimated cost impacts of this policy are not readily available. There will clearly be some short and medium term cost impacts although in the long term this policy should lead to reduced costs due to greater energy efficiency and hence improved competitiveness.
Source	http://www.iea.org/textbase/pm/?mode=cc&id=4308&action=detail Price, L., 2010. Information for Development of a Country Factsheet on Industrial Energy Efficiency Policies and Programs in China. Berkeley, CA: Lawrence Berkeley National Laboratory. General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), and the Standardization Administration of China (SAC), 2007. The Norm of Energy Consumption Per Unit of Product of Cement, GB 16780-2007. Beijing: Standard Press of China General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), and the Standardization Administration of China (SAC), 2007. The norm of energy consumption per unit product of major procedure of crude steel manufacturing process, GB 21256-2007. Beijing: Standard Press of China

Policy 7	**Renewable Energy Law**
Status	In force (effective from 2006, revised 2009) Mandatory (penalties apply)

Sector coverage	Power sector
Aim and key provisions / targets	***Renewable Energy Law*** The Renewable Energy Law is a framework policy which lays out the general conditions for renewable energy to become a more important energy source in the People's Republic of China. It was issued in February 2005, took effect on January 1, 2006, and is an important part of the CNCCP. It covers all modern forms of renewable energy, i.e. wind, solar, water, biomass, geothermal and ocean energy. Renewable energy becomes the preferential area for energy development under this law. Furthermore, research and development and the industrial development of renewable energy is listed as the preferential area for hi-tech industrial development in the national programme. Renewable power generation projects will have to obtain an administrative permit to proceed with project development; should there be more than one application for the same project licence, an open tendering process will be held. Project developers that have obtained an administrative permit will be guaranteed a connection to the power and gas grid. All output can be sold at guaranteed prices to the grid company, where prices will be determined by the price authorities of the State Council. Grid operators will be able to recover extra costs associated with this regime through their own selling prices. Energy authorities of local people's governments shall prepare renewable energy development plans specifically for rural areas with specific financial support. Standards for renewable energy technologies will be set by the standardisation authorities of the State Council. In case of breaches of the law by government entities, or grid, gas pipeline or fuel companies, penalties can be imposed by the relevant superior government authority. ***Renewable Energy Development Targets*** According to the Renewable Energy Law, the State Council is responsible for overall implementation and management for the development and utilisation of renewable energy at the national level. It sets mid- and long-term targets for the total volume of renewable energy development, and, on the basis of this, will prepare national plans for the implementation of these targets. In drawing up these targets and plans, it will cooperate with the regional and local people's governments to reflect regional differences in the final plans. The targets include: ***Wind*** ▪ to build 30 large-scale wind farms each with more than 100MW by 2010; ▪ the achieve on-grid wind capacity of 10 GW by 2010; ▪ to increase on-grid wind turbine capacity to 20 GW by 2015 and 30 GW by 2020 ; ***Biomass*** ▪ to achieve biomass and waste fuelled generation of more than 5.5 GW by 2010 ▪ to provide for 24 million cubic metres of biogas utilisation by 2020

	▪ double the 2006 figure of total bioenergy generation by 2010 and increase capacity by up to 14 times by 2020 ***Solar*** ▪ to provide for solar heating to the amount of 30 million square metres by 2020 ▪ 300 MW by 2010 and upgrading the 2020 target of 1.8 GW to 20 GW ***Overall*** ▪ to increase the share of energy from renewable sources in the total primary energy consumption to 10% in 2010 and 15% in 2020 , up from 7.5% in 2005 Under the 12th FYP the renewable capacity targets have been increased to: ***Wind*** ▪ 44GW in 2010, 100GW in 2015 and 200GW in 2020 ▪ Solar ▪ 900MW in 2010, 10GW in 2015 and 50GW in 2020
Exemptions available to EIIs	Information not available
Who pays for the policy	Electricity consumers
Extent to which objectives met	According to officially reported figures, the 2020 overall target for renewable energy has already been achieved – the percentage of installed renewable capacity exceeds 20% of total installed capacity. This is due almost entirely to the prevalence of large hydroelectric power, which the CNCCP states will remain an important measure to promote a less carbon intensive energy mix in China. However, wind capacity is increasing rapidly, with a doubling of installed capacity from 2006-2007, and a tripling from 2007-2008. Experts predict that the target of 30 GW of cumulative installed wind capacity by 2020 will be achieved by 2012, eight years ahead of schedule. Noticing the rapid growth in the wind power industry, the NDRC is increasing its targets as indicated above. However, it is noted that by the end of 2009 one third of wind power capacity was not connected to the central electricity network due to the costs of connection. Work is on-going to improve these connections.

Overall estimated cost impacts of RE policies:									
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100%							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.09						
		2015	0.22						
		2020	0.39						
		2025	0.50						
		2030	0.66						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	22.35	5.59	19.44	3.71	2.20	2.42	0.04
		2015	73.75	15.16	41.44	10.76	6.38	5.16	0.11
		2020	179.68	30.78	74.96	23.31	13.81	9.34	0.22
		2025	293.02	50.19	122.25	29.88	17.70	15.23	0.36
		2030	468.24	80.20	195.36	39.49	23.39	24.33	0.58

Source see page 24 of the following,
http://www.pc.gov.au/__data/assets/pdf_file/0005/109832/04-carbon-prices-chapter2.pdf

www.gov.cn/english/special/115y_index.htm

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Policy 8	**Solar Feed-in Tariff (Specific policy under the Renewable Energy Law)**
Status	In-force (as of 2011) / Mandatory
Sector coverage	Power sector
Aim and key provisions / targets	China’s nationwide solar feed-in tariff went into effect in August 2011. Solar project developers can now sell solar generated electricity at a price of 15 cents per kilowatt-hour. And in some cases, depending on the timing and location of solar projects, the price is slightly higher (up to 18 cents). Up to now, China lacked efficient financial incentives to nurture its solar energy use. In many cases, analysts say, project developers here could barely break even, let alone get a decent investment return. However, with the newly issued feed-in tariff that guarantees a payback time in a matter of seven years and cash yields for nearly another two decades, developers in China are having a greater desire to harness the sun. China hopes that these subsidies will double its current solar capacity by the end of 2011.
Exemptions available to EIIs	No information available
Who pays for the policy	Electricity consumers
Extent to which objectives met	"Although the feed-in tariff is given nationwide, it is only profitable in western China which is rich in sunlight resources," said Lin Boqiang, an energy expert at Xiamen University. "Most of China's future solar projects will be built there as a result, but that region lacks industries and population big enough to consume power that those projects generate. And so, much of the electricity has to be sent thousands of miles away to the power-hungry eastern China." "Thanks to the feed-in tariff, China's solar market may grow very quickly in the next two or three years," Lin said. "But then it will probably get stuck with grid connection just like the case of wind power."
Estimated cost impacts	See Policy 7
Source	http://www.eenews.net/climatewire/2011/09/14/1 and http://www.google.com/search?q=china+solar+feed+in+tariff&sourceid=ie7&rls=com.microsoft:en-us:IE-SearchBox&ie=&oe=.

Policy 9	**New energy quota system (Specific policy under Renewable Energy Law)**
Status	Planned / Mandatory
Sector coverage	Power sector, EII sectors
Aim and key provisions / targets	A quota system, already included in the Renewable Energy Law, is expected to be fully implemented during the 12th FYP period to meet the new-energy target. The quota will be based on regional development and will require energy intensive industries to acquire a certain percentage of electricity from new-energy sources as well as power companies to meet a percentage of generation capacity from 'new energy'. The details of this system have not yet been published. This is thought to be a particularly important policy under the 12 FYP.
Exemptions available to EIIs	No
Who pays for the policy	Electricity consumers
Extent to which objectives met	Not yet implemented
Estimated cost impacts	See Policy 7
Source	The Climate Group, commissioned by HSBC. Delivering Low Carbon Growth – A Guide to China's 12th Five Year Plan

Policy 10	**Wind Power Concession Programme (Specific policy under the Renewable Energy Law)**
Status	In Force (2003) / Mandatory, for applicable projects
Sector coverage	Power sector
Aim and key provisions / targets	Domestic and international companies are invited to bid for relatively large-scale potential projects (100-200MW). Successful bidders are selected according to the price per kWh of wind electricity proposed and the share of domestic components utilised in the wind farm. The wind concession lasts for 25 years and the bid price is guaranteed as a feed-in tariff for the first 30,000 full load hours achieved (for a 100 MW project, this amounts to approximately 3 billion kWh). Depending on the site's wind resource, this could cover about 10-15 years. After 30,000 full load hours, the project owner will receive the average local feed-in-tariff on the power market at that time. Two projects have so far been awarded, one in Rudong, Jiangsu, and one in Huilai, Guangdong. These two projects required 50% domestic content in turbines. The former achieved a price of 0.43 RMB, the latter 0.5 RMB per kWh (USD 0.051 and USD 0.06 respectively). In the course of this project, Vestas is planning to open a blade factory in mainland China. In 2004, the Chinese Government has offered three more concession projects of 100-200MW in size, one in each in Jiangsu, Inner Mongolia, and Jilin. These concession projects will require 70% domestic content and together will result in 650 MW of added capacity. The NDRC expects to award a total of 20 such projects by 2010, contributing to the overall aim to reach 20000MW installed capacity in 2020. The official information indicates feed-in tariff levels divided into four tiers ranging from 0.51 to 0.61 RMB/kWh. Areas with the least abundant wind resources receive the highest tariff and areas with the most abundant resources receive the lowest tariff.
Exemptions available to EIIs	No information available
Who pays for the policy	Electricity consumers
Extent to which objectives met	See above. In the implementation of wind power concession projects in the past few years, China's wind power capacity growth has been equivalent to the total size of the construction of wind power in first 20 years.
Other key details	It is estimated that the % of electricity generation that is wind is 1% (2010) and 8% (2020).
Estimated cost impacts	See Policy 7
Source	http://www.iea.org/textbase/pm/?mode=cc&id=2248&action=detail www.sdpc.gov.cn “Improve the wind power feed-in tariff policy”, National Development and Reform Commission of China, August 2009

Policy 11	**Preferential Tax Policies for Renewable Energy**
Status	In Force (as of 2003, expansion 2007) Mandatory
Sector coverage	Power sector
Aim and key provisions / targets	As of 2003, foreign investment in both biogas and wind energy production also benefits from a reduced income tax rate of 15%, as opposed to 33%. Renewable energy enterprises and bio-energy development projects can also request income tax reduction or exemptions. In addition wind turbines and their main components, as well as photovoltaic modules, benefit from preferential customs duty rates. As of September 2007, the Chinese government was developing a series of preferential tax policies to encourage the development of energy conservation and renewable energy. The new incentives include income tax cuts for the producers and consumers of renewable energy, as well as a reduction of the import tax for "green" equipment.
Exemptions available to EIIs	No information available
Who pays for the policy	Government
Extent to which objectives met	See above
Estimated cost impacts	See Policy 7
Source	http://www.iea.org/textbase/pm/?mode=cc&id=3837&action=detail

This brief section simply introduces some key general EU policies that will be applicable to the individual Member States under review in this study. The focus of the study will be on the national implementation of the policies of most relevance to cost impacts on energy intensive industries.

Legislation	In force / new / proposed	Details of impact on EIIs	Data source
EU energy package target of 20% energy efficiency improvement	in force	See details below	http://ec.europa.eu/clima/policies/package/index_en.htm
Proposal for an energy efficiency directive 22/06/2011 Relevant elements for EIIs: ▪ national energy saving obligation schemes are introduced which will aim at an annual final energy reduction of 1.5%, to be borne by the electricity providers, will overlap with / override existing white certificates ▪ requirements to equip new generation capacity and high-heat-demand industry installations with heat recovery (CHP) units and to ensure their connection to consumers via district heating/cooling networks	proposal	Both elements will affect electricity prices	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52011DC0109:EN:HTML:NOT
New Energy Efficiency Plan (EEP) from March 2011	new	As above, with nearer interim targets	http://ec.europa.eu/energy/efficiency/action_plan/action_plan_en.htm
Directive on the promotion of the use of energy from renewable sources (2009/28/EC)	existing	Increased electricity prices	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32009L0028:EN:NOT
Focus country renewable energy targets	2005	2020 target	
Denmark	17%	30%	
France	10.3%	23%	
Germany	5.8%	18%	
Italy	5.2%	17%	
UK	1.3%	15%	
Proposal for a Revised Energy Taxation Directive -A single minimum rate for CO2 emissions (20 €/t CO2) would be introduced for all sectors not covered by the EU ETS. -Minimum tax rates for energy would be based on the energy content of a fuel (€/GJ) rather than the volume.	Proposed, if approved would enter into force in 2013	May lead to some changes in taxation due to the change in energy content vs. volume. Impact on EIIs expected to be limited due to EU ETS coverage.	http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/11/238
Cogeneration Directive (2004/8/EC)	existing	Limited impact	http://eur-

Legislation	In force / new / proposed	Details of impact on EIIs	Data source
			lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0008:EN:NOT
Energy Services Directive (2006/32/EC)	existing	Limited impact	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0064:en:pdf
Directive 2009/31/EC on the geological storage of carbon dioxide	in force	Minor additional electricity costs due to costs of CCS readiness	http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF
Effort sharing decision	in force	Limited, mainly aimed at sectors outside the EU ETS	

A1.3 Ireland

Table A1.3 Assessment Table – Ireland

Name	Status	Type	Enforcement	Inclusion Status
1. Feed In Tariff for Electricity from Renewable Resources and CHP	Existing	RE prices	Mandatory	Y
2. Large Electricity Users (LEU) Rebate	Existing	Energy	Mandatory	Y

Policy 1	**Feed In Tariff for Electricity from Renewable Resources and CHP**
Status	AER was the feed-in programme that operated from 2001 until 2006 REFIT 1 was first opened in 2007 and closed for applications on 31/12/09. REFIT 2 and 3 are open for new applications from March 2012 for projects built and operational between 1/1/10 and 31/12/15.
Sector coverage	Power Sector
Policy Type	Financial Incentives, Feed-in tariffs
Agency	Department of Communications Energy and Natural Resources
Description	The Renewable Energy Feed in tariff Program (REFIT) encourages RES-E development by providing financial incentive in the form of fixed payments. Licensed suppliers are entitled to receive a fixed payment for every kWh purchased under a PPA with an accredited renewable energy generator. The payments are guaranteed for up to 15 years and adjusted by the increase in CPI (if any). • REFIT 1 covers wind, hydro, biomass landfill gas and other biomass projects (1323MW under the scheme) [3] • REFIT 2 covers wind, small hydro and biomass landfill gas projects (Target: 4000MW new installed capacity) [4] • REFIT 3 covers other biomass technologies (i.e. AD, AD CHP, Biomass CHP and Biomass combustion) (Target: 370 MW new installed capacity) [5]
Exemptions available to EIIs	A LEU rebate applied between 2009 and 2012. The capacity element of the rebate was close in value to the level of the Public Service Obligation elements corresponding to REFIT and AER.
Who pays for the policy	All electricity consumers through the Public Service Obligation, which includes other elements in addition to REFIT and AER. In 2010-2011, the combined contribution to these schemes was 31% of the total raised, increasing to 40% in 2011-2012. For 2010-2011, the following PSO levels were applied to different consumer categories:

	Domestic	Small commercial	Medium and large
	€/customer	€/customer	€/kVA
Oct. 2010-Sept.2011	40.85	142.19	16.55
Oct. 2011-Sept.2012	19.33	57.22	8.58

<table>
<tr><th>Policy 1</th><th colspan="3">Feed In Tariff for Electricity from Renewable Resources and CHP</th></tr>
<tr><td>Policy Cost</td><td colspan="3">REFIT 1- €10 million annually (on the basis of a market price for electricity of 70€/MWh) [6]
REFIT 2 - €196 million annually (on the basis of a market price for electricity of 60€/MWh) [7]
REFIT 3 - €70 million annually (on the basis of a market price for electricity of 60€/MWh) [8]
According to direct communications with Sustainable Energy Ireland, REFIT will either lead to negative costs, if the high fossil fuel price scenarios of the IEA World Energy Outlook are considered, or will be cost-neutral, if the medium fossil fuel price scenarios are considered, due to merit order effects. Due to the fact that the methodology of the current study does not allow for the integration of merit order effects of including renewables in other jurisdictions, a positive cost is included in our calculations.</td></tr>
<tr><td>Extent to which objectives met</td><td colspan="3">1380MW of REFIT renewable generation capacity was supported in the 2012/2013 PSO decision: 55MW of REFIT 2 projects, 2MW of REFIT 3 projects, with the remainder in REFIT 1.</td></tr>
<tr><td rowspan="7">Estimated indirect cost impacts</td><td colspan="3">According to estimates based on electricity market modelling, meeting the targets of the National Renewable Energy Action Plan using a mix of renewables would lead an added cost of €6.7/MWh attributable to REFIT in 2020.[9]
Is there any indication of post 2020 ambition/targets?</td></tr>
<tr><td>Estimated cost pass through to EIIs (%)</td><td colspan="2">100%</td></tr>
<tr><td rowspan="5">Estimated impact on energy prices for EIIs (£/MWh)</td><td>2011</td><td>0.00</td></tr>
<tr><td>2015</td><td>5.11</td></tr>
<tr><td>2020</td><td>7.44</td></tr>
<tr><td>2025</td><td>7.44</td></tr>
<tr><td>2030</td><td>7.44</td></tr>
<tr><td>Sources</td><td colspan="3">(1). National Renewable Energy Action Plan (NEAP) http://www.dcenr.gov.ie/NR/rdonlyres/03DBA6CF-AD04-4ED3-B443-B9F63DF7FC07/0/IrelandNREAPv11Oct2010.pdf , pp. 5-6
(2). First Progress Report (NEAP) http://www.dcenr.gov.ie/NR/rdonlyres/B611ADDD-6937-4340-BCD6-7C85EAE10E8F/0/IrelandfirstreportonNREAPJan2012.pdf, p.2.
(3) REFIT 1
http://www.seai.ie/Renewables/Renewable_Energy_Policy/Policy_Support_Mechanisms/10AERVII_termsandconditionsfinal.pdf
(4) REFIT 2
http://www.dcenr.gov.ie/NR/rdonlyres/500F4F12-089D-470F-B97D-1A6C4CD173A5/0/REFIT2TermsandConditionsMar2012.pdf
(5) REFIT 3
http://www.dcenr.gov.ie/NR/rdonlyres/718E8541-7ADD-4FB2-A471-</td></tr>
</table>

Policy 1	Feed In Tariff for Electricity from Renewable Resources and CHP
	B6081C435625/0/REFIT3BiomassTermsandConditions2012.pdf (6) REFIT 1 (funding) http://www.dcenr.gov.ie/NR/rdonlyres/FBEB2C6E-C1D5-4C66-B1EE-797DF92B81B0/0/CommissionDecision.pdf, http://www.dcenr.gov.ie/NR/rdonlyres/FBEB2C6E-C1D5-4C66-B1EE-797DF92B81B0/0/CommissionDecision.pdf pp.2-3 (7) REFIT 2 (funding) http://ec.europa.eu/competition/state_aid/cases/241165/241165_1364169_98_1.pdf, pp.2-3 (8) REFIT 3 (funding) http://ec.europa.eu/eu_law/state_aids/comp-2011/sa31861-2011n.pdf, pp. 2-3 (9) The Effect of REFIT on Irish Wholesale Electricity Prices Conor Devitt, Laura Malaguzzi Valery, https://www.esri.ie/UserFiles/publications/jacb201162/jacb201162.pdf, p. 365

Policy 2	Large Electricity Users (LEU) Rebate
Status	Ended on 30 September 2012, was in force from 2009
Sector coverage	Industry
Aim and key provisions / targets	A rebate of electricity costs was introduced in 2009 to improve the competitiveness of EIIs. Large Electricity Users, which are defined as users with a connection capacity of 10 kVa, 20 kVa, 38 kVa and 110 kVa have benefitted from the rebate (1). In 2011-2012[45], the total level of the rebate stood at €50 million; compared to the €700 million the LEUs spent on electricity during that period, this constituted a 7.14% reduction in electricity costs for the beneficiaries (1). This was distributed to the LEUs via a fixed lump sum on basis of capacity and a variable rebate per kWh (1). In 2011-2012, the fixed rebate was €4.18/kVa and the variable rebate was €5.46/MWh (2). The rebate was discontinued in 2012 due to budget constraints. This discontinuation is associated with improved competitiveness conditions for LEUs in other terms such as purchasing power etc.
Who pays for the policy	The funding for the rebate came from the general Government budget.
Extent to which objectives met	N/A
Other key details	N/A
Estimated indirect cost impacts	

Estimated cost pass through to EIIs (%)	100	
Estimated impact on energy prices for EIIs (£/MWh)	**2011**	-4.36
	2015	0.00
	2020	0.00
	2025	0.00
	2030	0.00

Source

(1) Personal communication with Leigh Farrelly, Department of Communications, Energy and Natural Resources on 26 and 27 November 2011.
(2) http://www.airtricity.com/knowledge-base/kb-billing/changes-in-passthrough-charges-october-2012/?section=ROICOMM

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[45] October-September

A1.4 Russia

Table A1.4 Assessment Table – Russia

Name	Status	Type	Enforcement	Inclusion Status
1. Federal target-oriented Programme of the Russian Federation “Energy saving and increase of energy efficiency for the period till 2020”	Existing	EE targets	Mandatory	Y
2. Federal law # 261-FZ “On energy conservation improvement of energy efficiency and modifications in certain regulations of the Russian Federation”	Existing	EE incentives	Voluntary	Y
3. Federal Tax Code	Existing	EE incentives	Mandatory	Y
4. Federal law on electric power	Existing	Energy	Mandatory	N
5. Federal law # 69-FZ “On gas supply in the Russian Federation”	Existing	Energy	Mandatory	N
6. Federal law # 81-FZ “On state regulation of coal production and use, on social protection of coal industry employees”	Existing	Energy	Mandatory	N
7. Overall Climate Change Doctrine	Existing	GHG general	Framework	N

Name	Status	Type	Enforcement	Inclusion Status
8. The Integrated Plan of Implementation of the Climate Doctrine of the Russian Federation for the period up to 2020	Existing	GHG general	Framework	N
9. Energy Strategy to 2020	Existing	RE targets	Voluntary	N
10. Information System in sphere of energy saving and increase of energy performance	Existing	EE supporting system	Mandatory	N

Policy 1	**Federal target-oriented Programme of the Russian Federation “Energy saving and increase of energy efficiency for the period till 2020”**
Status	In force (2010) Mandatory
Sector coverage	General (all sectors)
Aim and key provisions / targets	The main goals of the Programme approved by the Decree #2446-p as of 27.12.2010 are: ▪ Imposing mandatory targets for energy savings compared to business as usual performance ▪ Co-financing of the best regional energy efficiency programmes ▪ Guaranteeing to the enterprises of granting credits for projects in the field of energy efficiency increase (in frames of the long-term target agreements) ▪ Creation of the State information system in field of energy efficiency increase (monitoring), training for responsible personnel (executive authorities, budget and commercial organisations, public), awareness raising ▪ Methodological support of energy efficiency. The Russian Energy Agency (REA) is responsible for management of the Programme. The main macroeconomic indicators of the outcomes of the programme are: ▪ software to reduce energy intensity of gross domestic product due to implementation of the Programme is not less than 7.4 per cent for stage I (2011 - 2015) and by 13.5 percent over the life of the Programme (2011 - 2020); ▪ providing an annual saving of primary energy through the implementation of the Programme in an amount not less than 100 million tons of oil equivalent by the end of Phase I (2016) and 195 million tons of oil equivalent by the end of Phase II (to 2021); ▪ providing a total energy savings amounting to 334 million tons of oil equivalent at stage I (2011 - 2015) and 1124 million tons of fuel over the life of the Programme (2011 - 2020). **Target sectors:** ▪ electricity industry ▪ industry ▪ others

	Industry: The implementation of technical measures for energy conservation and energy efficiency in the industry will achieve: ▪ annual savings of primary energy of 34.33 million tons of oil equivalent by the end of Phase I (2016), and 50.75 million tons of oil equivalent by the end of Phase II (to 2021); ▪ total saving of primary energy of 110.35 million tons of oil equivalent at stage I (2011 - 2015) and 333.25 million tons of fuel over the life of the Programme (2011 - 2020). It is not clear how this target is split across different industrial sub-sectors. For the purposes of this study we have assumed that 50% of the target applies to the sectors covered by this study. *Electricity sector:* The implementation activities of the sub programme will provide: ▪ a lower average operating specific fuel consumption of electricity supply from thermal power plants up to 318 g of standard fuel / kWh in 2015 to 300 grams of coal equivalent / kWh in 2020 ▪ reduction of losses in electric networks of up to 8 - 9 percent in 2020 ▪ annual savings of primary energy of 25.32 million tons of oil equivalent by the end of Phase I (2016), and 58.05 million tons of oil equivalent by the end of Phase II (to 2021) and total primary energy savings in the amount of 82.45 million tons of oil equivalent at stage I (2011 - 2015) and 312.81 million tons of fuel over the life of the Programme (2011 - 2020)
Exemptions available to EIIs	No
Who pays for the policy	Power sector and industry pay, although the annualised capital costs of investment in energy efficiency techniques are expected to be outweighed by annual savings in fuel costs.
Extent to which objectives met	Programme is just being implemented.

Estimated cost impacts:									
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.00						
		2015	-0.24						
		2020	-0.48						
		2025	-0.43						
		2030	-0.44						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2015	-13.16	-1.07	-1.72	-0.51	-1.55	-0.45	0.00
		2020	-26.85	-2.02	-3.76	-1.05	-3.22	-0.75	-0.01
		2015	-55.40	-3.29	-3.69	-1.72	-5.25	-1.22	-0.01
		2020	-68.18	-4.04	-3.94	-2.11	-6.46	-1.51	-0.01

Source **Source:** http://minenergo.gov.ru/activity/energoeffektivnost/problem/

Policy 2	**Federal law # 261-FZ "On energy conservation, improvement of energy efficiency and modifications in certain regulations of the Russian Federation"**
Status	In force / Voluntary
Sector coverage	All
Aim and key provisions / targets	Federal law # 261-FZ "On energy conservation, improvement of energy efficiency and modifications in certain regulations of the Russian Federation," contains a range of energy efficiency policies. Specifically related to energy efficiency are various economic instruments to encourage investment in energy efficiency. These include: ▪ An investment tax credit ▪ Accelerated amortisation (depreciation) ▪ Provision of state guarantees to ensure loans for energy efficiency projects. Other measures include: ▪ Information on energy efficiency classification has to be provided for all goods produced within Russia and imported (electrical appliances and computers). ▪ Buildings and constructions must comply with energy efficiency requirements specified by an authorised executive body in accordance with the federal regulation. ▪ By January 1 2011, buildings and constructions that use energy resources were supposed to be equipped with water, natural gas, heat and electricity meters. ▪ Performance measures applied to the evaluation of executive bodies of the Russian Federation shall include energy conservation and energy efficiency measures. ▪ Starting January 1 2010, budget and autonomous organisations that provide services to the state/municipal governments were to receive allotments based on the amount of consumed (in 2009) energy resources (by type) reduced by 15% within a 5-year period with a 3% annual reduction of such amount. ▪ Organisations transmitting energy resources can include expenses on reducing losses of energy resources during transmission in their planned gross revenue accounted for in regulated prices (tariffs) for the transmission of energy resources (within a 5-year period).

	▪ Organisations involved in regulated activities (when prices (tariffs) are regulated) can withhold the savings produced by energy saving measures.
Exemptions available to EIIs	No
Who pays for the policy	Government pays for the economic instruments
Extent to which objectives met	Information not readily available
Estimated cost impacts	Details are not available on the total amount of financial support available under this policy. However, detailed information is available at a project specific level.
Source	In-house knowledge

Policy 3	**Federal Tax Code**
Status	In force / Mandatory
Sector coverage	All
Aim and key provisions / targets	Investment tax credits can be allocated to organisations that carry out R&D or modernise their production in order to increase environmental protection and/or improve energy efficiency of their production. An investment tax credit (for the period from 1 year to 5 years) for income tax, regional and municipal taxes is given on the loan amount, representing 100% of the equipment. The organisation which received an investment tax credit may reduce its payments on the relevant income tax during the term of the agreement on the investment tax credit, but not exceeding 50% the size of the tax payments as defined by the general rules without regard to the availability of contracts for the investment tax credit. Interest on the loan amount amounts to between half and three quarters of the refinancing rate of the Russian Federation.
Exemptions available to EIIs	No
Who pays for the policy	Government pays
Extent to which objectives met	Information not readily available
Estimated cost impacts	Detailed information is available on the tax credit but information is not available on the total amount of funding available to support this programme.
Source	In-house staff knowledge

Policy 4	**Federal law on electric power**
Status	Existing / Mandatory
Sector coverage	Power
Aim and key provisions / targets	State regulation of prices (tariffs). On the wholesale market, the mark-up on the equilibrium wholesale price is regulated by the state if the energy is generated on the equipment that uses renewable energy sources and it depends on target values set within the government policy for improving energy efficiency. Government investment policy: ▪ Aimed at promoting energy conservation, attracting private investments and strengthening state control over investment efficiency in case of natural monopolies. ▪ Creating economic stimuli for introducing new efficient technologies, including small-scale and non-conventional power generation. Note that there is no feed-in tariff system available for renewable energy.
Exemptions available to EIIs	No
Who pays for the policy	Not applicable
Extent to which objectives met	Information not readily available
Estimated cost impacts	Information not readily available.
Source	http://minenergo.gov.ru/activity/energoeffektivnost/problem/

A1.5 Turkey

Table A1.5 Assessment Table – Turkey

Name	Status	Type	Enforcement	Inclusion Status
1. The Republic of Turkey Ministry of Energy and Natural Resources Strategic Plan (2010-2014)	Existing	EE & RE targets	Mandatory	Y
2. National Climate Change Strategy (2010-2020)	Existing	GHG & RE targets	Mandatory	Y
3. Support Scheme for Energy Efficiency in Industry	Existing	EE incentives	Voluntary	Y
4. Electricity Energy Market and Supply Security Strategy Paper	Existing	RE targets	Mandatory	Y
5. Law No. 6094 Amendment to the Renewable Law No. 5346 of 2005	Existing	RE prices	Mandatory	Y
6. Draft Energy Efficiency Strategy Document	New	GHG & EE	Framework	N
7. Energy Efficiency Law – No 5627	Existing	EE	Framework	N
8. Monitoring Energy Efficiency in Sectors	Existing	EE monitoring	Mandatory	N

Name	Status	Type	Enforcement	Inclusion Status
9. Regulation Regarding Power Generation (including micro cogeneration) without Requiring Licensing	Existing	Energy	Voluntary	N

Policy 1	**The Republic of Turkey Ministry of Energy and Natural Resources Strategic Plan (2010-2014)**
Status	In force (May 2010) / Mandatory
Sector coverage	Electricity, Environment, Natural Resources, Renewables
Aim and key provisions / targets	The Ministry of Energy and Natural Resources, within the perspective of the energy and natural resources policy of our country, prepared its Strategic Plan covering the period between 2010 and 2014. Relevant theme and aims are detailed below. ***Increasing the share of the renewable energy resources within the energy supply*** The hydroelectricity plans of 5,000 MW capacity, the construction of which has started, will be completed by 2013. The wind plant installed capacity, which has been 802.8 MW as of 2009 will be increased up to 10,000 MW by the year 2015. The installed capacity for the geothermal plant, which has been 77.2 MW as of 2009, will be increased up to 300 MW until 2015. ***Increasing Energy Efficiency*** The primary energy density is planned to be reduced by 2023 at the rate of 20 percent compared to the amount in 2008. Within framework of the energy efficiency studies in process, 10 percent of reduction in comparison to the year 2008 will be secured by the year 2015. ***Carbon*** After the year 2014, Turkey will aim to slow down the increase of greenhouse gas emissions from the power sector.
Exemptions available to EIIs	No
Who pays for the policy	Unclear if such details have been established yet.

Extent to which objectives met	Not yet implemented.

Estimated cost impacts – Power Sector EE targets:									
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	-0.19						
		2015	-0.38						
		2020	-0.37						
		2025	-0.37						
		2030	-0.37						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	-6.23	-3.29	-1.26	-0.07	-0.01	-0.17	-0.53
		2015	-13.56	-7.19	-2.58	-0.16	-0.02	-0.36	-1.14
		2020	-14.78	-8.38	-2.97	-0.17	-0.02	-0.39	-1.16
		2025	0.00	0.00	-3.26	-0.19	0.00	0.00	0.00
		2030	0.00	0.00	-3.56	-0.20	0.00	0.00	0.00

Source www.enerji.gov.tr

Policy 2	**National Climate Change Strategy (2010-2020)**
Status	In force (May 2010) Mandatory
Sector coverage	Energy and industry sectors
Aim and key provisions / targets	Turkey has developed the National Climate Change Strategy in order to contribute to global efforts to reduce the impacts of climate change, taking into account its own special circumstances and capacity. The Strategy includes a set of objectives to be implemented in the short-term (within one year), the mid-term (undertaken or completed within 1 to 3 years), and long-term (undertaken over a 10 year period). The Strategy will guide the actions to tackle climate change during the period 2010-2020 and will be updated as necessary, in light of emerging national or international developments. Key goals relevant to this study include: **Energy:** **Short Term** ▪ All domestic resources, primarily hydro and wind, will be used at maximum levels, using cleaner production technologies and best available techniques **Medium Term** ▪ Use of low and zero greenhouse gas emission technologies, primarily renewable energy and clean coal technologies, as well as nuclear energy, shall be fostered; R&D activities on clean technologies and energy resources shall be carried out and domestic industries shall be supported in these ventures. ▪ Use of new and alternative fuels in increasing levels shall be supported together with market incentives and penetration strategies for this purpose. ▪ Rehabilitation of existing thermal power plants shall be finalised; and more efficient operation of hydroelectric power plants shall be pursued.

Policy 2	National Climate Change Strategy (2010-2020)
	Long Term ▪ By 2020, energy intensity shall be decreased with reference to 2004 levels. ▪ The share of renewable energy in total electricity generation shall be increased up to 30% by 2023. In this framework, our technical and economic hydro potential will be fully utilised, wind electricity generation capacity will be raised to 20,000 MW and geothermal electricity generation capacity will be raised to 600 MW, Electricity generation from solar energy will be supported. ▪ Greenhouse gas emissions from electricity generation are envisaged to be 7% less than what they would have been in the Reference Scenario by 2020. **Industry:** **Short Term (1 Year)** ▪ Intensive climate change awareness raising activities will be carried out for the industrialists and consumers and handbooks/guidelines will be published. ▪ The process of hiring energy managers in all industrial facilities with annual energy consumption of more than 1,000 TEP shall be finalised and efficient operation of this system shall be ensured. **Medium Term (1-3 Years)** ▪ Voluntary agreements that encourage the implementation of management instruments enabling the monitoring of greenhouse gas emissions, without any capital investment or operating cost, such as energy management systems, greenhouse gas inventory reporting systems and benchmarking systems, as well as incentive mechanisms like climate pioneers programme" will be developed in industry, ▪ All industrial facilities with annual energy consumption of more than

Policy 2	**National Climate Change Strategy (2010-2020)**
	5,000 TEP will conduct annual energy studies. ▪ Heat recovery options in industry, engine speed control systems, and industrial cogeneration systems shall be stimulated and encouraged. ▪ Replacement of resources used in industry with cleaner production resources and use of alternative materials will be encouraged. ▪ Importance will be attached to research and development activities and technology transfer, and industrialists shall be encouraged in this direction. **Long Term (3-10 Years)** ▪ Incentive mechanisms will be introduced to promote cleaner production, climate-friendly and innovative technologies; and effective operation of inspection and enforcement mechanisms will be ensured. ▪ As climate change is among the most important environmental and economic problems affecting the international competitiveness of national industry in the existing international conjuncture, various other measures and policies will be implemented, as appropriate, within the context of the Industry Strategy Paper of Turkey (2010-2013) and the Science and Technology Policies, in close cooperation with the industrial sector. ▪ The determined saving potential shall be realised at maximum levels by the year 2020, through energy efficiency practices in the industry sector.
Exemptions available to EIIs	No
Who pays for the policy	Specific details not available.
Extent to which objectives met	Not yet implemented

Policy 2	**National Climate Change Strategy (2010-2020)**
Estimated cost impacts	See Policy 5 for cost of renewable energy.
Source	www.iklim.cob.gov.tr

Policy 3	Support Scheme for Energy Efficiency in Industry
Status	In Force (2008) Voluntary
Sector coverage	EIIs
Aim and key provisions / targets	In October 2008, By-Laws on Improving Energy Efficiency for the Utilisation of Energy Resources and Energy implementing the provisions of the 2007 Energy Efficiency Law were adopted to support energy efficiency projects and voluntary agreements in industrial establishments. The General Directorate of Electric Power Resources, Survey and Development Administration (EIE) provides investment support for energy efficiency projects with a maximum payback period of five years. The investment support covers 20% of project costs up to a maximum of TRY 500,000. For industrial establishments that have undertaken a voluntary agreement to reduce their energy intensity by 10% on average over a period of 3 years, the EIE will reimburse up to 20% of their energy costs (to a maximum of TRY 100,000) for the 1st year. By the end of 2010, 32 energy efficiency projects had been supported and implementation of 13 projects had been completed. In addition, 22 Voluntary Agreements had been made with industrial establishments aimed at reducing their energy intensity by an average of at least 10% for three years. In order to support SMEs, the Administration for Supporting and Developing Small and Medium Sized Enterprises (KOSGEB) subsidises up to 70% of the costs of energy efficiency training, study and consulting services procured by SMEs. The principles and procedures applicable to this practice have been set out in a regulation dated 18 October 2008, prepared and enforced by the Ministry of Industry and Trade.
Exemptions available to EIIs	No
Who pays for the policy	Government

Extent to which objectives met	Information not readily available
Estimated cost impacts	Information not available on the total amount of financial support being made available. Details are given on the project specific aspects of financial support.
Source	http://www.iea.org/textbase/pm/?mode=cc&action=detail&id=4226

Policy 4	**The Electricity Energy Market and Supply Security Strategy Paper**
Status	In force (May 2009) Mandatory
Sector coverage	Electricity, Natural Resources, Renewables
Aim and key provisions / targets	The Electricity Energy Market and Supply Security Strategy Paper outlines Turkey's long-term targets in the electricity energy sector. It was enforced with the resolution of the Higher Board of Planning in May 2009. The paper set the following goals: ▪ Creation and maintenance of market structure and market activities in a way to ensure supply security ▪ While moving towards the target of creating a sustainable electricity energy market, taking into consideration climate change and environmental impacts in activities in all areas of the industry ▪ Minimising losses during production, transmission, distribution and utilisation of electricity energy; increasing efficiency; reducing electricity energy costs by building a competitive environmentally friendly resource based priorities of energy policy; and using such gains to offer more reasonably priced electricity service to consumers ▪ Encouraging new technologies, ensuring diversity of resources, and maximising use of domestic and renewable resources in order to reduce foreign dependency for energy supply ▪ Increasing the share of domestic contribution in investments to be made in the sector. ▪ The primary target is to ensure that the share of renewable resources in electricity generation is increased up to at least 30% by 2023 (subject to revision based on potential developments in technology, market, and resource potential). ▪ HYDROELECTRIC: ensure by 2023, that all technically and economically available hydroelectric potential is utilised in electricity generation. o Complete 5,000 MW currently under construction or development by 2015

Policy 4	**The Electricity Energy Market and Supply Security Strategy Paper**
	▪ WIND: increase installed wind energy power to 20,000 MW by the year 2023. o 10,000 MW by 2015 ▪ GEOTHERMAL: ensure that the geothermal potential of 600 MW, which is presently established as suitable for electricity energy production, is commissioned by 2023. o 300 MW by 2015 ▪ SOLAR: to generalise the use of solar energy for generating electricity, ensuring maximum utilisation of the country's potential. Technological advances will be closely followed and implemented for the use of solar energy for electricity generation. ▪ OTHER RENEWABLE RESOURCES: Preparation of production plans will take into account possible changes in utilisation potentials of other renewable energy resources based on technological and legislative developments. In case of increases in utilisation of such resources, share of fossil fuels, and particularly of imported resources, will be reduced accordingly.
Exemptions available to EIIs	No
Who pays for the policy	Details not available
Extent to which objectives met	This is a framework strategy document, without specific implementation measures.
Estimated cost impacts	See Policy 5 for cost of renewable energy
Source	www.enerji.gov.tr

Policy 5	Law No. 6094 Amendment to the Renewable Law No. 5346 of 2005
Status	In force (2010) Mandatory
Sector coverage	Electricity, Renewables
Aim and key provisions / targets	On December 29, 2010, Turkey's Parliament approved Law No. 6094 amending the already existing renewable energy law (Law No. 5346). The Law aims to ▪ Expand the utilisation of renewable energy resources for generating electrical energy ▪ Increase the diversification of energy resources ▪ Reduce greenhouse gas emissions The Law included the following renewable energy resources: wind, solar, geothermal, biomass, biogas, wave, current and tidal energy resources **Purchase guarantee:** Legal entities holding retail sales licenses are required to purchase certified renewable energy from renewable plants that come online between 18/5/2005 and 31/12/2015 to satisfy a portion of their energy sales from renewables. The amount required to be purchased from renewables is determined based on the ratio between the retail licensee's total sales in the previous calendar year and the total amount of electricity sold in Turkey in that year by all retailers. The new law determines the long-term prices (feed-in tariffs) for electricity purchases and guarantees a price of ▪ 7.3 U.S. cents per kWh for wind and hydro ▪ 10.5 U.S. cents for geothermal ▪ 13.3 U.S cents for energy from waste products ▪ 13.3 U.S cents for energy from solar energy. These prices are valid for plants that become operational between 13 May 2005, and 31 December 2015. After 31 December 2015, new prices will be defined by the government. It is noted that the Feed in Tariff prices for wind and hydro are below the

Policy 5 **Law No. 6094 Amendment to the Renewable Law No. 5346 of 2005**

modelled average electricity price for Turkey. For the purposes of this study it is assumed that the price of renewable electricity will be at least as high as the average electricity price.

One of the key characteristics of the new law is that there are incentives provided for using domestic/local equipment/technology in renewable generation.

Additional Price Incentives for Use of Domestic Components: The new law provides additional incentives for domestic or local equipment and technology used in renewable generation.

- Energy facilities will generate an additional support of 0.4 cents to 2.4 cents per kWh for a five-year term to companies that started producing energy before the end of 2015.
- Incentives regarding licensing fees, land use, etc. established with Law No. 5346 will continue to be offered.
- The law states that any generator becoming operational before 31 December 2015 that uses mechanical or electromechanical parts manufactured in Turkey will receive the incentives described in the table below in addition to the feed-in tariff for five years.

Type	Additional Tariff Up to (cents/kWh)
Hydro	2.3
Wind	3.7
Geothermal	2.7
Biomass (including landfill)	5.6
Solar	5.7 – 9.2

Licensing Incentives: Renewable generators pay only 1% of the total licensing fee. They are exempt from annual license fees for the first eight years following the facility completion date.

Policy 5	**Law No. 6094 Amendment to the Renewable Law No. 5346 of 2005**
	Land Use Incentives: Renewable generators that are on public land benefit from 85% discount on applicable fees such as rent for the first 10 years. **Transmission Interconnection:** Renewable generators are given priority for system connection.
Exemptions available to EIIs	Information is not available on exemptions available to EIIs
Who pays for the policy	Assumed that electricity consumers would pay the feed-in tariffs, whilst the Government support the incentive aspects. However, on the basis of the information available to this study, Feed in Tariff prices for wind and hydro are below the estimated average electricity price for Turkey. For the purposes of this study it is assumed that the price of renewable electricity will be at least as high as the average electricity price. Therefore the cost of this policy to EII sectors is assumed to be zero, rather than negative.
Extent to which objectives met	Only at very early stages of implementation
Estimated cost impacts:	The cost of this policy to EII sectors is assumed to be zero, rather than negative.

Source	http://www.resmigazete.gov.tr/main.aspx?home=http://www.resmigazete.gov.tr/eskiler/2011/01/20110108-3.htm/20110108.htm&main=http://www.resmigazete.gov.tr/eskiler/2011/01/20110108-3.htm

A1.6 United States

Table A1.6 Assessment Table – US

Name	Status	Type	Enforcement	Inclusion Status
1. Regional Climate Change Initiative (RGGI)	Existing	GHG trading	Mandatory	Y
2. California Climate Solutions Act of 2006 (AB 32) / Emissions Trading Scheme	Existing / New	GHG trading	Mandatory	Y
3. New Source Performance Standards (NSPS)	Existing	GHG Standards.	Mandatory	Y
4. BACT under Tailoring Rule	Existing	GHG Tech.	Mandatory	Y
5. Business Energy Investment Tax Credit (ITC)	Existing	EE & RE incentive	Voluntary	Y
6. Electricity Production Tax Credit (PTC)	Existing	RE Incentive	Voluntary	Y
7. US Renewable Portfolio Standards (RPS)	Existing	RE targets	Mandatory	Y
8. Modified Accelerated Cost-Recovery System (MACRS) + Bonus Depreciation (2008-2012)	Existing	Tax Incentive	Voluntary	N
9. EPA's Mandatory Reporting of Greenhouse Gas Rule	Existing	GHG reporting	Mandatory	N
10. Western Climate Initiative (WCI)	Existing	GHG trading	Framework	N
11. GHG Reduction Goal	Existing	GHG targets	Voluntary	N
12. Other US Industrial Sector Programmes e.g. Save Energy Now,	Existing	EE incentives	Voluntary	N

Name	Status	Type	Enforcement	Inclusion Status
Superior Energy Performance, Industries of the Future				

Policy 1	**Regional Climate Change Initiative (RGGI)**
Status	In force Mandatory (for RGGI), other regional programmes are in the planning phases
Sector coverage	Depends on the programme (RGGI applies only to electric power sector)
Aim and key provisions / targets	Emissions cap-and-trade programme involving Delaware, Connecticut, Maine, New Hampshire, New York, Vermont, Massachusetts, Rhode Island, Maryland, and until the end of 2011, New Jersey. The programme targets emissions from fossil fuel power plants with a capacity of 25MW or higher. There is discussion of making changes to the RGGI system to account for the natural gas boom that has allowed the carbon reduction goals to be met well ahead of time. It has led to an increase of carbon allowances on the RGGI market so that every allowance is at the floor price and 50% of allowances at the most recent auction were not bought. The New Hampshire Senate voted to keep NH in RGGI but with some amendments. The amendments allow the state to withdraw from the programme if another participating state representing at least ten percent of the programme's total electric load withdraws and change fund allocation. Funds obtained through allowance auctions will now go directly to participating utilities for use in their own energy efficiency programmes, rather than continue the existing process whereby auction funds are distributed by the state through clean energy grants. Additionally, votes in state Congresses in Maine and Delaware to pull their respective states from RGGI failed[46]. At present the cost impact of RGGI is low (carbon prices are expected to average around $3/ton over the next several years), but this may change in the future depending on whether coverage is expanded in future years to other sectors besides the power sector and whether the targets are made more stringent. Note that in this study the costs of RGGI per MWh, tonne production and GVA have been expressed in relation to US rather than RGGI state totals, so these impacts represent average country level

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[46] Source: http://www.vnf.com/news-alerts-592.html

	impacts. This is to be consistent with the way other policies in this study have been expressed.
Exemptions available to EIIs	No
Who pays for the policy	Power generators and electricity consumers
Extent to which objectives met	The lack of demand for allowances means that no efforts are being made to further reduce carbon emissions through the programme. Officials will likely announce that the total emissions cap will be reduced faster than planned in order to appropriately match the market[47]. New Jersey's governor Chris Christie (Republican) will remove New Jersey from the RGGI programme by the end of 2011. He says that RGGI is not successfully reducing emissions and therefore is an unnecessary cost to industry[48].
Other key details	The three regional emissions trading systems were actively engaged in discussions about merging their programmes. Currently, momentum on linking the regional initiatives and general support of these regional programmes has stalled. New Jersey announced their planned withdrawal from RGGI starting in 2012 and initiatives to pull other states out of RGGI have been considered in recent state legislative sessions. Also, as of mid-2011, it does not look like the Midwest Greenhouse Gas Reduction Accord (MGGRA) will move forward. Director of the Illinois EPA, Doug Scott, states that it may be possible for the 23 states and handful of Canadian provinces that belong to these three programmes to trade emissions among themselves if Congress does not pass a federal climate bill.

Estimated cost impacts:		
Indirect policy cost	Estimated cost pass through to	100

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[47] http://www.eenews.net/Greenwire/2010/12/03/12

[48] http://www.eenews.net/Greenwire/2011/05/26/2

impacts to EIIs (via electricity prices)	EIIs (%)								
	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.02						
		2015	0.03						
		2020	0.05						
		2025	0.05						
		2030	0.05						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	1.18	1.20	0.18	0.25	0.06	0.20	7.60
		2015	1.97	1.81	0.35	0.40	0.10	0.36	15.24
		2020	3.29	2.65	0.54	0.58	0.16	0.58	20.76
		2025	3.35	2.50	0.55	0.52	0.15	0.62	17.11
		2030	3.21	2.19	0.53	0.42	0.12	0.62	13.57

Source For more information visit: http://www.rggi.org

The following report from February 2011 outlines some of the benefits, in $ amounts, of RGGI, http://www.rggi.org/rggi_benefits.

Economic impact analysis of RGGI can be accessed at:

http://www.edrgroup.com/library/energy-environment/economic-impact-of-regional-greenhouse-gas-initiative.html.

For a map of the three Regional Climate Initiatives, visit here: http://www.grist.org/article/2010-11-09-the-post-election-outlook-for-regional-cap-and-trade

Policy 2	**California Climate Solutions Act of 2006 (AB 32)**
Status	Planned (some programmes in planning phases, cap-and-trade programme to be effective starting in 2013) Mandatory
Sector coverage	General (major economic sectors, including EIIs)
Aim and key provisions / targets	California Climate Solutions Act of 2006 (AB 32) authorises the California Air Resources Board (CARB) to establish a state-wide GHG emissions cap for 2020 based on 1990 emissions, establish mandatory reporting rules for significant sources of GHGs, and adopt a plan indicating how emissions reductions would be achieved. • GHG emissions limit set at 25% reduction by 2020 compared to 1990 levels. • Mandatory GHG emission reporting regulations for the state's 800 largest emitters. • It is expected to apply to large industrial sources at or above 25,000 MTCO2e, electricity generators, and electricity imports in 2012. • The CARB rule development is being coordinated with the Western Climate Initiative (WCI) development. (Source: http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm) • California Air Resources Board officials are discussing what the balance will be between auctioning off allowances and giving out allowances for free in the initial year[49]. • 2012 – 2015: Cap will apply to in-state electricity generators, imported electricity, refineries, and large industrial emission sources. • 2015 and beyond: Cap will be expanded to include fuel distributors, i.e. capturing emissions associated with use of transportation fuels, natural gas, and propane. • 2012: Cap will be set at level of projected emissions from covered entities

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[49] http://www.vnf.com/news-alerts-533.html; http://www.vnf.com/news-alerts-607.html

	• 2013 – 2014: Cap will decrease 2% each year • 2014 – 2020: Cap will decrease 3% each year *Update:* California will delay the official implementation of the cap-and-trade programme by one year, to 2013, to better prepare and implement the market measures and linkages with other entities throughout 2012. The emissions targets will not change as they were set at "business as usual" for 2012 and reductions will not be required until 2013[50]. The first official trades will take place in 15 August 2012 with a floor price of $10.00[51]. Additionally, California has released the updated draft cap-and-trade regulations addressing many controversial areas. Note that in this study the costs of this policy per MWh, tonne production and GVA have been expressed in relation to US rather than California totals, so these impacts represent average country level impacts. This is consistent with the way other policies in this study have been expressed.
Exemptions available to EIIs	Not apparent from available information – to be checked
Who pays for the policy	Power and industry sectors
Extent to which objectives met	Scheme not yet started

Estimated cost impacts:		
Indirect policy cost impacts	Estimated cost pass through to EIIs (%)	100

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[50] http://www.pointcarbon.com/polopoly_fs/1.1555679!CMNA20110701.pdf)

[51] http://www.pointcarbon.com/news/1.1557516

to EIIs (via electricity prices)	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.000						
		2015	0.003						
		2020	0.003						
		2025	0.003						
		2030	0.003						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs / savings to EIIs (£mpa)	2011	0.00	0.00	0.00	0.00	0.00	0.00	0.25
		2015	0.13	0.10	0.10	0.05	0.00	0.02	0.32
		2020	0.15	0.10	0.11	0.05	0.00	0.03	0.29
		2025	0.15	0.10	0.11	0.04	0.00	0.03	0.24
		2030	0.15	0.08	0.11	0.04	0.00	0.03	0.19

Source More information on California policies and programmes under AB32 can be found at: http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm.

Policy 3	**New Source Performance Standards (NSPS)**
Status	Planned (Rules / regulations in 2011/2012; implementation 2013) Mandatory
Sector coverage	Most EIIs
Aim and key provisions / targets	EPA will propose “New Source Performance Standards” (NSPS) for power plants and refineries. The covered entities consist of 40% of the U.S.’s GHG emissions. The NSPS will not put a cap on the amount of emissions, but will be based on efficiency such as requiring a maximum amount of GHG emissions for every megawatt of electricity generated or gallon of fuel refined. A notice of proposed rulemaking (NPRM) for the refinery sectors is expected to be published in the Federal Register in December 2011[52]. Refinery regulations are expected to be finalised by November 2012. For electricity generating units (EGUs), the EPA is expected to release a proposed rule by October 2011. More information on this rulemaking can be accessed at the US EPA website[53]. As a result, a final regulation is not expected to be released until 2012, and actual implementation until 2013 or later.
Exemptions available to EIIs	Not apparent from available information
Who pays for the policy	Power plants and refineries
Extent to which objectives met	Not yet implemented

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[52] http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2060-AQ75

[53] http://yosemite.epa.gov/opei/rulegate.nsf/byRIN/2060-AQ91

Estimated cost impacts	This policy will encourage producers to invest in simple energy efficiency measures and best practices, which are low cost measures.								
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.00						
		2015	0.17						
		2020	0.17						
		2025	0.17						
		2030	0.17						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2015	10.28	9.45	1.81	2.07	0.53	1.90	79.36
		2020	11.42	9.20	1.86	2.01	0.55	2.00	72.09
		2025	11.62	8.68	1.90	1.80	0.51	2.14	59.42
		2030	11.16	7.62	1.86	1.46	0.41	2.15	47.13
Source	(Source: http://www.vnf.com/news-alerts-568.html)								

Policy 4	BACT under Tailoring Rule
Status	Planned (Programme becomes effective in 2011) Mandatory
Sector coverage	Most EIIs
Aim and key provisions / targets	The EPA's "Tailoring Rule" sets thresholds for greenhouse gas (GHG) emissions that define when permits under the New Source Review Prevention of Significant Deterioration (PSD) and title V Operating Permit programmes are required for new and existing industrial facilities. Facilities responsible for nearly 70 percent of the national GHG emissions from stationary sources will be subject to permitting requirements under this rule. This includes the nation's largest GHG emitters—power plants, refineries, and cement production facilities. On 2 January 2011, facilities emitting more than 75,000 tons of CO2e a year and which already have permits for other air pollutants will be required to obtain GHG permits. In July 2011, the regulations will expand to cover all new facilities with GHG emissions of at least 100,000 tons per year and modifications at existing facilities that would increase GHG emissions by at least 75,000 tons per year. Major stationary sources that are either newly constructed or undergoing modifications that will cause a significant increase in emissions must obtain a preconstruction permit that, among other things, requires the installation of "best available control technology" (BACT) for every pollutant "subject to regulation" under the CAA.
Exemptions available to EIIs	Not apparent from available information
Who pays for the policy	Industry
Extent to which objectives met	Not yet implemented

Estimated cost impacts	Since BACT only affects new or modified plants, the cost impact would be minimal. The reason is that the building of new plants and even modifications to existing plant would be uncommon over the next several years due to overcapacities across all industries in the US and bad economic conditions.								
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	0.00						
		2015	0.17						
		2020	0.17						
		2025	0.17						
		2030	0.17						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		2015	10.28	9.45	1.81	2.07	0.53	1.90	79.36
		2020	11.42	9.20	1.86	2.01	0.55	2.00	72.09
		2025	11.62	8.68	1.90	1.80	0.51	2.14	59.42
		2030	11.16	7.62	1.86	1.46	0.41	2.15	47.13

Source http://www.vnf.com/news-alerts-568.html

Other information on the Tailoring Rule can be accessed under the 2010 heading **“**Final GHG Tailoring Rule,” issued in May 2010, see, http://www.epa.gov/nsr/actions.html#2010

The Regulatory Impact Analysis (RIA) which lists estimated costs, number of impacted facilities, etc, can be accessed at: http://www.epa.gov/ttn/ecas/regdata/RIAs/riatailoring.pdf.

Policy 5	Business Energy Investment Tax Credit (ITC)
Status	In force Voluntary
Sector coverage	N/A (applies to certain renewable/energy efficiency technology types)
Aim and key provisions / targets	The federal business energy investment tax credit available under 26 USC § 48 was expanded significantly by the Energy Improvement and Extension Act of 2008 (H.R. 1424)[54], enacted in October 2008. This law extended the duration -- by eight years -- of the existing credits for solar energy, fuel cells and microturbines; increased the credit amount for fuel cells; established new credits for small wind-energy systems, geothermal heat pumps, and combined heat and power (CHP) systems; allowed utilities to use the credits; and allowed taxpayers to take the credit against the alternative minimum tax (AMT), subject to certain limitations. The credit was further expanded by The American Recovery and Reinvestment Act of 2009,[55] enacted in February 2009. In general, credits are available for eligible systems placed in service on or before 31 December 2016: **Solar.** The credit is equal to 30% of expenditures, with no maximum credit. Eligible solar energy property includes equipment that uses solar energy to generate electricity, to heat or cool (or provide hot water for use in) a structure, or to provide solar process heat. Hybrid solar lighting systems, which use solar energy to illuminate the inside of a structure using fibre-optic distributed sunlight, are eligible. Passive solar systems and solar pool-heating systems are not eligible. **Fuel Cells.** The credit is equal to 30% of expenditures, with no maximum credit. However, the credit for fuel cells is capped at $1,500 per 0.5 kilowatt (kW) of capacity. Eligible property includes fuel cells with a minimum capacity of 0.5 kW that have an electricity-only generation efficiency of 30% or higher. (Note that the credit for property placed in service before October 4, 2008, is capped at $500 per 0.5 kW.) **Small Wind Turbines.** The credit is equal to 30% of expenditures, with no maximum credit for small wind turbines placed in service after 31 December 2008. Eligible

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[54] http://thomas.loc.gov/cgi-bin/query/z?c110:H.R.1424.enr

[55] http://thomas.loc.gov/home/h1/Recovery_Bill_Div_B.pdf

Policy 5	Business Energy Investment Tax Credit (ITC)
	small wind property includes wind turbines up to 100 kW in capacity. (In general, the maximum credit is $4,000 for eligible property placed in service after 3 October 2008, and before 1 January 2009. The American Recovery and Reinvestment Act of 2009 removed the $4,000 maximum credit limit for small wind turbines.) **Geothermal Systems.** The credit is equal to 10% of expenditures, with no maximum credit limit stated. Eligible geothermal energy property includes geothermal heat pumps and equipment used to produce, distribute or use energy derived from a geothermal deposit. For electricity produced by geothermal power, equipment qualifies only up to, but not including, the electric transmission stage. For geothermal heat pumps, this credit applies to eligible property placed in service after 3 October 2008. Note that the credit for geothermal property, with the exception of geothermal heat pumps, has no stated expiration date. **Microturbines.** The credit is equal to 10% of expenditures, with no maximum credit limit stated (explicitly). The credit for microturbines is capped at $200 per kW of capacity. Eligible property includes microturbines up to two megawatts (MW) in capacity that have an electricity-only generation efficiency of 26% or higher. **Combined Heat and Power (CHP).** The credit is equal to 10% of expenditures, with no maximum limit stated. Eligible CHP property generally includes systems up to 50 MW in capacity that exceed 60% energy efficiency, subject to certain limitations and reductions for large systems. The efficiency requirement does not apply to CHP systems that use biomass for at least 90% of the system's energy source, but the credit may be reduced for less-efficient systems. This credit applies to eligible property placed in service after 3 October 2008.
Exemptions available to EIIs	No
Who pays for the policy	Government
Extent to which objectives met	Information not readily available

Estimated cost impacts:

Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	-0.34						
		2015	-0.34						
		2020	-0.34						
		2025	-0.34						
		2030	-0.34						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	-19.65	-19.96	-2.93	-4.09	-1.02	-3.29	-126.68
		2015	-20.56	-18.90	-3.62	-4.14	-1.05	-3.79	-158.73
		2020	-22.83	-18.41	-3.73	-4.01	-1.10	-4.01	-144.18
		2025	-23.24	-17.37	-3.80	-3.59	-1.01	-4.29	-118.84
		2030	-22.36	-15.23	-3.71	-2.93	-0.82	-4.30	-94.26

Source Abovementioned legal / policy documents

http://thomas.loc.gov/cgi-bin/query/z?c110:H.R.1424.enr:

http://thomas.loc.gov/home/h1/Recovery_Bill_Div_B.pdf

Policy 6	**Renewable Electricity Production Tax Credit (PTC)**
Status	In force Voluntary
Sector coverage	N/A (applies to certain renewable energy projects)
Aim and key provisions / targets	The federal renewable electricity production tax credit (PTC) is a per-kilowatt-hour tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. Originally enacted in 1992, the PTC has been renewed and expanded numerous times, most recently by H.R. 1424 (Div. B, Sec. 101 & 102) in October 2008 and again by H.R. 1 (Div. B, Section 1101 & 1102) in February 2009. The October 2008 legislation extended the in-service deadlines for all qualifying renewable technologies; expanded the list of qualifying resources to include marine and hydrokinetic resources, such as wave, tidal, current and ocean thermal; and made changes to the definitions of several qualifying resources and facilities. The effective dates of these changes vary. Marine and hydrokinetic energy production is eligible as of the date the legislation was enacted (3 October 2008), as is the incremental energy production associated with expansions of biomass facilities. The February 2009 legislation revised the credit by: (1) extending the in-service deadline for most eligible technologies by three years (two years for marine and hydrokinetic resources); and (2) allowing facilities that qualify for the PTC to opt instead to take the federal business energy investment credit (ITC) or an equivalent cash grant from the U.S. Department of Treasury. The ITC or grant for PTC-eligible technologies is generally equal to 30% of eligible costs.* The tax credit amount is 1.5¢/kWh in 1993 dollars (indexed for inflation) for some technologies and half of that amount for others. The rules governing the PTC vary by resource and facility type. The table below outlines two of the most important characteristics of the tax credit -- in-service deadline and credit amount -- as they apply to different facilities. The table includes changes made by H.R. 1, in February 2009, and the inflation-adjusted

Policy 6	**Renewable Electricity Production Tax Credit (PTC)**

credit amounts are current for the 2011 calendar year.

Resource Type	In-Service Deadline	Credit Amount
Wind	31 December 2012	2.2¢/kWh
Closed-Loop Biomass	31 December 2013	2.2¢/kWh
Open-Loop Biomass	31 December 2013	1.1¢/kWh
Geothermal Energy	31 December 2013	2.2¢/kWh
Landfill Gas	31 December 2013	1.1¢/kWh
Municipal Solid Waste	31 December 2013	1.1¢/kWh
Qualified Hydroelectric	31 December 2013	1.1¢/kWh
Marine and Hydrokinetic (150 kW or larger)**	31 December 2013	1.1¢/kWh

The duration of the credit is generally 10 years after the date the facility is placed in service, but there are two exceptions:

- Open-loop biomass, geothermal, small irrigation hydro, landfill gas and municipal solid waste combustion facilities placed into service after 22 October 2004, and before enactment of the Energy Policy Act of 2005, on 8 August 2005, are only eligible for the credit for a five-year period.
- Open-loop biomass facilities placed in service before 22 October 2004 are eligible for a five-year period beginning 1 January 2005.

Policy 6	**Renewable Electricity Production Tax Credit (PTC)**
	In addition, the tax credit is reduced for projects that receive other federal tax credits, grants, tax-exempt financing, or subsidised energy financing.
Exemptions available to EIIs	No
Who pays for the policy	Government
Extent to which objectives met	Information not readily available

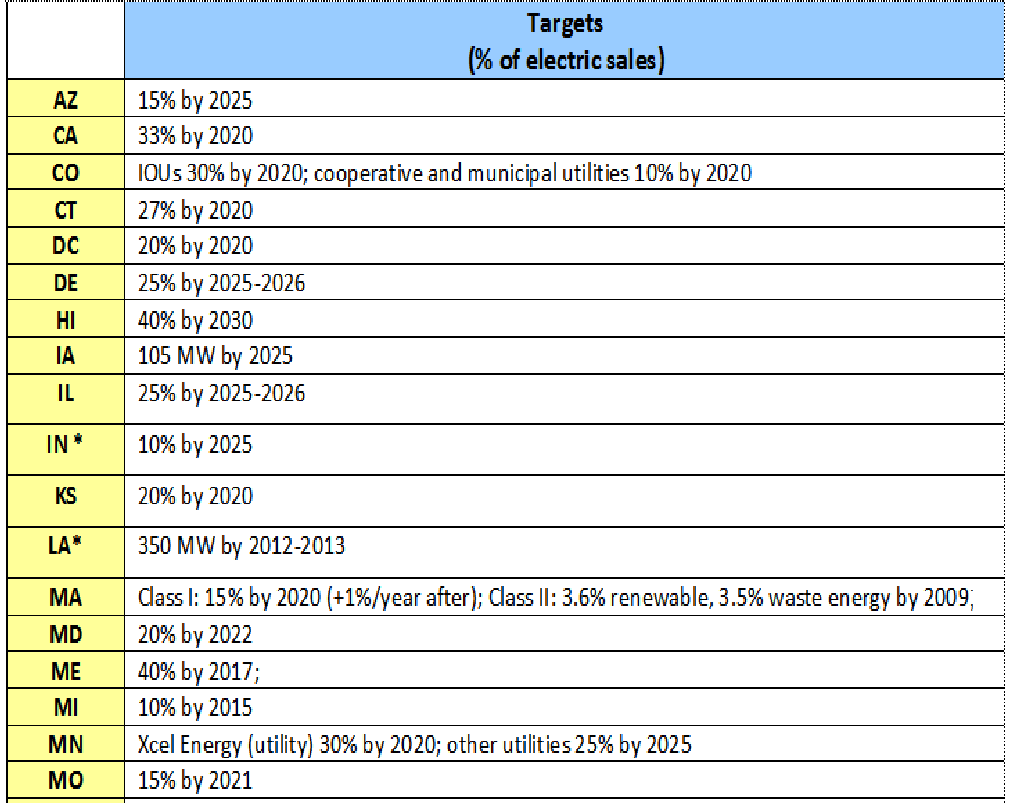
Estimated cost impacts:									
Indirect policy cost impacts to EIIs (via electricity prices)	Estimated cost pass through to EIIs (%)	100							
	Estimated impact on energy prices for EIIs (£/MWh)	2011	-0.34						
		2015	-0.34						
		2020	-0.34						
		2025	-0.34						
		2030	-0.34						
	Sectors		Steel	Paper	Cement	Chlor-alkali	Fertilizer	Glass	Plastics
	Total estimated incremental annualised costs to EIIs (£mpa)	2011	-19.7	-20.0	-2.9	-4.1	-1.0	-3.3	-126.7
		2015	-20.6	-18.9	-3.6	-4.1	-1.1	-3.8	-158.7
		2020	-22.8	-18.4	-3.7	-4.0	-1.1	-4.0	-144.2
		2025	-23.3	-17.4	-3.8	-3.6	-1.0	-4.3	-118.8
		2030	-22.3	-15.2	-3.7	-2.9	-0.8	-4.3	-94.3

Source	Abovementioned legal / policy documents http://thomas.loc.gov/cgi-bin/query/z?c110:H.R.1424.enr:

http://thomas.loc.gov/home/h1/Recovery_Bill_Div_B.pdf

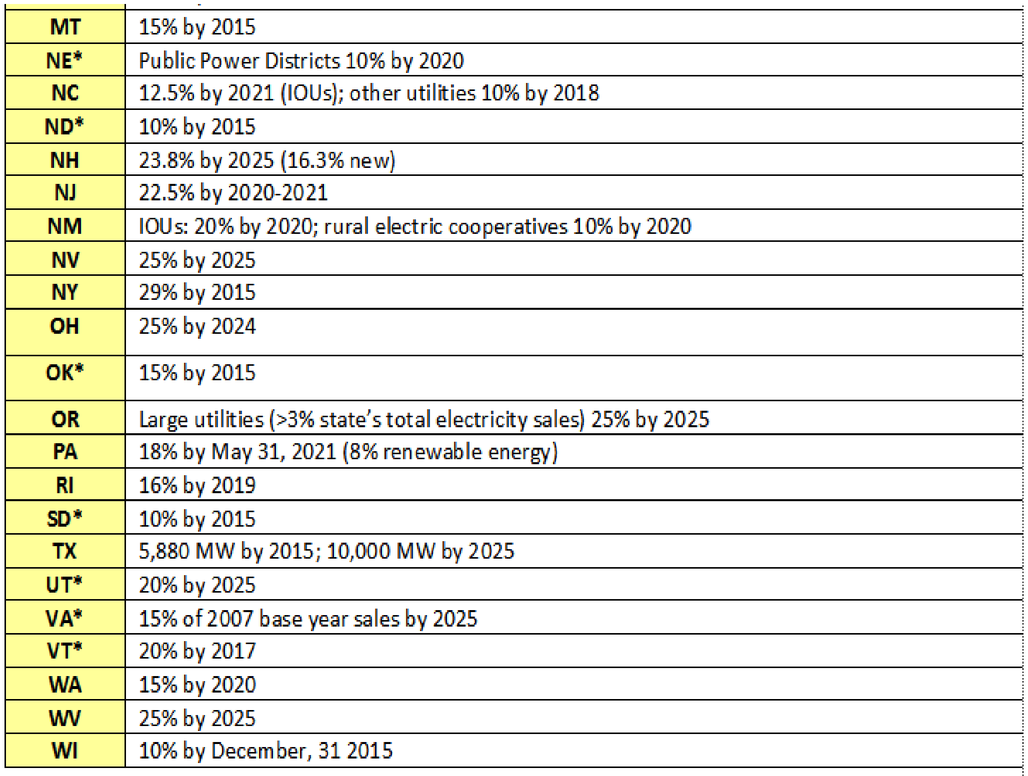
Policy 7	**US Renewable Portfolio Standards (RPS)**
Status	In force Mandatory
Sector coverage	Power
Aim and key provisions / targets	Renewable Portfolio Standard's (RPS) are a policy measure adopted by many states to increase renewable energy generation. A RPS functions by requiring electric utilities and other retail electric providers to supply a specified minimum amount of customer load (typically retail sales) with electricity from certain renewable sources of generation (energy efficiency measures also are sometimes eligible). As of May 2011, RPS requirements have been established in 39 states plus the District of Columbia. Most programmes are mandatory, although some are voluntary standards. Currently, states with RPS requirements mandate that between 4 and 40 percent of electricity be generated from renewable sources by a specified date. A list of states with RPS programmes, and the applicable targets, is located in Table 1 below. **Table 1: State RPS Requirements**

Policy 7	**US Renewable Portfolio Standards (RPS)**



	Targets (% of electric sales)
AZ	15% by 2025
CA	33% by 2020
CO	IOUs 30% by 2020; cooperative and municipal utilities 10% by 2020
CT	27% by 2020
DC	20% by 2020
DE	25% by 2025-2026
HI	40% by 2030
IA	105 MW by 2025
IL	25% by 2025-2026
IN *	10% by 2025
KS	20% by 2020
LA*	350 MW by 2012-2013
MA	Class I: 15% by 2020 (+1%/year after); Class II: 3.6% renewable, 3.5% waste energy by 2009;
MD	20% by 2022
ME	40% by 2017;
MI	10% by 2015
MN	Xcel Energy (utility) 30% by 2020; other utilities 25% by 2025
MO	15% by 2021

Policy 7 **US Renewable Portfolio Standards (RPS)**



MT	15% by 2015
NE*	Public Power Districts 10% by 2020
NC	12.5% by 2021 (IOUs); other utilities 10% by 2018
ND*	10% by 2015
NH	23.8% by 2025 (16.3% new)
NJ	22.5% by 2020-2021
NM	IOUs: 20% by 2020; rural electric cooperatives 10% by 2020
NV	25% by 2025
NY	29% by 2015
OH	25% by 2024
OK*	15% by 2015
OR	Large utilities (>3% state's total electricity sales) 25% by 2025
PA	18% by May 31, 2021 (8% renewable energy)
RI	16% by 2019
SD*	10% by 2015
TX	5,880 MW by 2015; 10,000 MW by 2025
UT*	20% by 2025
VA*	15% of 2007 base year sales by 2025
VT*	20% by 2017
WA	15% by 2020
WV	25% by 2025
WI	10% by December, 31 2015

* States with RPS goals not mandatory requirements.

Renewable Portfolio Standards often function by requiring utilities to submit Renewable Energy Credits (RECs) to fulfil their compliance obligation. Typically, 1 REC = 1 MWh of renewable generation. The impact of a state's RPS on electricity prices is reflected in Renewable Energy Credit (REC) value. REC prices vary based on the stringency of the overall targets, what types of renewables and/or energy efficiency measures qualify, and other factors. Not all states make REC prices publicly available or closely track this information. REC prices are often the highest in North-eastern states. An overview of REC prices is shown in Table 2 below.

Policy 7	**US Renewable Portfolio Standards (RPS)**

Table 2: REC Prices

Year	MA Class 1	MA Class 2 WTE	MA Class 2	MA APS	RI	NH Class 1	NH Class 2	NH Class 3	NH Class 4
2010	$61	$10	$25	$20	$61	$61	$160	$30	$30

Exemptions available to EIIs	Information not readily available
Who pays for the policy	Electricity consumers
Extent to which objectives met	Varies by State
Estimated cost impacts	Since state RPS programmes are very diverse in structure, and there are 40 programmes, we chose not to quantify their cost impacts in this analysis. Additionally, there are already numerous studies available concerning the impact of RPS programmes on electricity prices. The U.S. Department of Energy's Berkeley National Lab looked at the costs of RPS programmes in 2007, and found that "projected rate impacts are generally modest,[56]" and also found the following – "Seventy percent of the state RPS cost studies in our sample project base-case retail electricity rate increases of no greater than one percent in the year that each modelled RPS policy reaches its peak percentage target. In six of those studies, electricity consumers are expected to experience cost

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[56] Ernest Orlando Lawrence Berkeley National Laboratory. "Weighing the Costs and Benefits of State Renewable Portfolio Standards: A Comparative Analysis of State-Level Policy Impact Projections." March 2007. http://eetd.lbl.gov/ea/emp/reports/61580.pdf.

Policy 7	**US Renewable Portfolio Standards (RPS)**
	savings as a result of the state RPS policies being modelled. On the other extreme, nine studies predict rate increases above 1%, and two of these studies predict rate increases of more than 5%. However, the median bill impact across all of the studies in our sample is an increase of only $0.38 per month."
Source	U.S. EPA Combined Heat and Power Partnership (CHPP) & ICF International Evolution Markets: REC Markets – February 2010, Monthly Market Update http://new.evomarkets.com/pdf_documents/February%20REC%20Market%20Update.pdf

A1.7 Belgium

Table A1.7 Assessment Table – Belgium

Name	Status	Type	Enforcement	Inclusion Status
1. Green Electricity Certificate Scheme and Quotas: all regions and the Federal Gov't of Belgium	Existing	RE	Mandatory	Y
2. CHP Certificate Scheme: Flanders	Existing	EE	Framework	Y
3. White Certificates, Flanders Region	Existing	EE	Framework	Y
4. Excise Duty: Electricity and Energy Products	Existing	Energy	Voluntary	Y
5. Climate Fund: Compensation for Increased Electricity Prices	Planned	GHG	N/A	N

Policy 1	**Green Electricity Certificate Scheme and Quotas: all regions and the Federal Gov’t of Belgium**
Status	In force
Sector coverage	Electricity
Aim and key provisions / targets	The Green Electricity Certificate Scheme is a quota scheme aimed at supporting renewable electricity. FIT are in place in Flanders, Brussels and the Walloon. In the latter the Green Certificates cover both renewable electricity and CHP. The Federal Government also operates FITs to support offshore wind generation and solar panels. A quota obligation for green certificates is placed on electricity suppliers. The following quotas apply in Flanders and the Walloon region, where most of the EIIs are based: ▪ Walloon region: in 2011 -13.5%, in 2015 this will rise to 26.7% and in 2020 to 37.9% (2) o The costs of green certificates amounted to €82.07/certificate. ▪ Flanders: 6% in 2011, 16.8% in 2015 and 20.5% in 2020 (1).
Exemptions available to EIIs	Walloon region: In 2011 a nominal quota applied of 13.5% to regular consumers, however, EIIs benefited from the following lower quota levels: ▪ 10.25% for the first 20 GWh/y ▪ 6.75% for consumption between 20-100 GWh/year ▪ 2% for consumption exceeding 100 GWh/year. This led to a 22.4% quota reduction in 2011. From 2013 onwards the exemption rules are expected to change, however the target quota reduction level due to exemption is expected to remain at a similar level – 23%. Flanders: The following discount applies for EIIs with a consumption exceeding 5 GWh/year. 1. For the electricity consumption between 1-20 GWh/y: 40% 2. For the electricity consumption between 20-100 GWh/y: 75% 3. For the electricity consumption between 100-250 GWh: 80% 4. For the electricity consumption exceeding 250 GWh: 98%

<table>
<tr><td>Who pays for the policy</td><td colspan="3">Electricity consumers, see exemptions for EIIs.</td></tr>
<tr><td>Extent to which objectives met</td><td colspan="3">There is a large oversupply of Green Electricity Certificates on the market the Flemish market. This has made the prices fall dramatically towards the legal minimum price (for solar electricity market prices are now below the legal minimum price). Prices have not collapsed yet because most certificate trade agreements are long term contracts and due to 10 year banking provisions and knowledge of rising quotas (2). There is fungibility in the Walloon market and Flemish market, with differing price floors for green certificates operating in the regions and at the federal level, causing arbitrage opportunities and regional cross-subsidy potential.</td></tr>
<tr><td>Other key details</td><td colspan="3">N/A</td></tr>
<tr><td rowspan="6">Estimated indirect cost impacts</td><td>Estimated cost pass through to EIIs (%)</td><td colspan="2">100%</td></tr>
<tr><td rowspan="5">Estimated impact on energy prices for EIIs (£/MWh)</td><td>2011</td><td>1.88</td></tr>
<tr><td>2015</td><td>4.08</td></tr>
<tr><td>2020</td><td>5.55</td></tr>
<tr><td>2025</td><td>5.55</td></tr>
<tr><td>2030</td><td>5.55</td></tr>
<tr><td>Source</td><td colspan="3">(3) Systeem groenestroomcertificaten, 2012
http://www.vreg.be/systeem-groenestroomcertificaten
(4) Marktrapport ’11 VREG, 2012
http://www.vreg.be/sites/default/files/rapporten/marktrapport_2011.pdf</td></tr>
</table>

<table>
<tr><th>Policy 2</th><th>CHP Certificate Scheme: Flanders</th></tr>
<tr><td>Status</td><td>In force</td></tr>
<tr><td>Sector coverage</td><td>Electricity (CHP)</td></tr>
<tr><td>Aim and key provisions / targets</td><td>The Heat Power Certificate Scheme helps Flanders reach its Kyoto Protocol targets of an average yearly reduction of 5.2% in its greenhouse gas emissions (1, 3).
This is a quota system, with energy producers obligated to surrender a set number of CHP certificates per year, which is determined on basis of their annual electricity generation (1). Certificates can be traded, although the open market has been suspended since 2009 due to over-supply of certificates.
The quota level was 4.9% in 2011 and will increase to 10.5% in 2015 and 9.3% in 2020. No quota level projections are available for 2025 and 2030.</td></tr>
<tr><td>Exemptions available to EIIs</td><td>No exemptions apply for EIIs.</td></tr>
<tr><td>Who pays for the policy</td><td>Electricity suppliers. Despite the large oversupply of certificates in the market, prices are not falling significantly, likely because certificates are often being sold as part of long term contracts. However, certificates have already been sold for the legal minimum price of 27 euro (2).</td></tr>
<tr><td>Extent to which objectives met</td><td>Highly effective policy, given the over-supply of certificates.</td></tr>
<tr><td>Other key details</td><td>N/A</td></tr>
<tr><td>Estimated indirect cost impacts</td><td>Costs are given here for both Policy 2 and 3
<table>
<tr><td>Estimated cost pass through to EIIs (%)</td><td colspan="2">100</td></tr>
<tr><td rowspan="3">Estimated impact on energy prices for EIIs (£/MWh)</td><td>2011</td><td>0.73</td></tr>
<tr><td>2015</td><td>1.25</td></tr>
<tr><td>2020</td><td>1.14</td></tr>
</table>
</td></tr>
</table>

		2025	1.14
		2030	1.14
Source	(1) Systeem warmte-krachtcertificaten, 2012 http://www.vreg.be/systeem-warmte-krachtcertificaten-0 (2) Marktrapport ’11 VREG, 2012 http://www.vreg.be/sites/default/files/rapporten/marktrapport_2011.pdf (3) The Flemish Climate Policy Plan 2006 – 2012, 2006. http://www.lne.be/themas/klimaatverandering/vlaams-klimaatbeleidsplan-2006-2012/flemish-climate-policy-plan-2006-2012/070124_english_version_versie_website.pdf		

APPENDIX 3: CARBON PRICE SCENARIOS (PROVIDED BY THE CCC)

Scenario 1: UK-EU-ROW Convergence

£/tCO$_2$e	EUETS	UK		ROW
Real £2011		Overall carbon price including CPF	CPF	
2011	10.0	10.0	0.0	0.0
2012	5.2	5.2	0.0	0.0
2013	5.7	9.2	3.5	0.0
2014	6.0	13.6	7.6	0.0
2015	6.2	19.0	12.8	0.0
2016	6.4	22.6	16.2	0.0
2017	6.8	24.7	17.9	0.0
2018	7.2	26.8	19.6	0.0
2019	7.7	28.9	21.2	0.0
2020	8.2	31.0	22.8	0.0
2021	14.6	35.1	20.5	0.0
2022	21.0	39.3	18.3	5.5
2023	27.4	43.4	16.0	13.9
2024	33.8	47.5	13.7	22.2
2025	40.3	51.7	11.4	30.6
2026	46.7	55.8	9.1	38.9
2027	53.1	59.9	6.9	47.3
2028	59.5	64.1	4.6	55.6
2029	65.9	68.2	2.3	64.0
2030	72.3	72.3	0.0	72.3

Scenario 2: EU-led Action

£/tCO$_2$e	EUETS	UK		ROW
Real £2011		Overall carbon price including CPF	CPF	
2011	10.0	10.0	0.0	0.0
2012	5.2	5.2	0.0	0.0
2013	6.6	9.2	2.5	0.0
2014	8.1	13.6	5.5	0.0
2015	9.5	19.0	9.5	0.0
2016	10.9	22.6	11.7	0.0
2017	12.3	24.7	12.4	0.0
2018	13.7	26.8	13.0	0.0
2019	15.1	28.9	13.7	0.0
2020	16.6	31.0	14.4	0.0
2021	22.1	35.1	13.0	0.0
2022	27.7	39.3	11.5	11.5
2023	33.3	43.4	10.1	11.9
2024	38.9	47.5	8.7	12.3
2025	44.4	51.7	7.2	12.8
2026	50.0	55.8	5.8	13.2
2027	55.6	59.9	4.3	13.7
2028	61.2	64.1	2.9	14.6
2029	66.8	68.2	1.4	15.6
2030	72.3	72.3	0.0	16.6

N.B. The figures in red are actuals.

APPENDIX 4: INCREMENTAL IMPACTS ON ELECTRICITY PRICES OF ENERGY AND CLIMATE CHANGE POLICIES

Table A1.8 Convergence Scenario: Indicative incremental impacts on electricity price (£/MWh) of energy and climate change policies (real, £2011 prices)

Country	GHG trading & standards				Energy efficiency targets				Renewable energy feed-in tariffs & incentives				Energy taxes				Other				Total			
	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030
China	0.0	0.0	18.4	44.3	-0.1	-0.3	-0.3	-0.3	0.1	0.4	0.5	0.7	9.9	9.9	9.9	9.9	0.0	0.0	0.0	0.0	9.9	10.0	28.6	54.6
Ireland	4.5	2.9	13.1	23.4	0.0	0.0	0.0	0.0	0.0	6.4	6.4	6.4	0.0	0.0	0.0	0.0	-3.7	0.0	0.0	0.0	0.7	9.2	19.5	29.7
Russia	0.0	0.0	8.5	20.5	0.0	-0.5	-0.4	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	8.0	20.0
Turkey	0.0	0.0	13.5	31.5	-0.2	-0.4	-0.4	-0.3	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0	0.0	0.0	0.0	0.0	3.8	3.6	17.1	35.2
USA	0.0	0.0	15.3	36.1	0.0	0.0	0.0	0.0	-0.7	-0.7	-0.7	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-0.7	14.6	35.4
Belgium	4.5	3.3	15.4	27.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	3.3	15.4	27.3
France	0.6	0.5	2.0	3.6	0.0	0.0	0.0	0.0	0.4	2.2	2.2	2.2	1.3	1.3	1.3	1.3	0.0	10.7	10.7	10.7	2.3	14.6	16.2	17.8
Germany	4.6	3.0	13.6	23.6	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	6.2	6.2	6.2	4.9	9.7	20.3	30.3
Netherlands	1.8	1.4	6.9	12.7	0.7	1.1	1.1	1.1	1.9	5.6	5.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	8.1	13.5	19.4
UK	3.8	10.3	16.8	23.3	0.0	0.0	0.0	0.0	4.8	25.1	22.1	19.2	2.7	2.0	2.0	2.0	0.0	0.0	0.0	0.0	11.2	37.4	40.9	44.5

Table A1.9 EU-led action Scenario: Indicative incremental impacts on electricity price (£/MWh) of energy and climate change policies (real, £2011 prices)

Country	GHG trading & standards				Energy efficiency targets				Renewable energy feed-in tariffs & incentives				Energy taxes				Other				Total			
	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030	2011	2020	2025	2030
China	0.0	0.0	7.7	10.1	-0.1	-0.3	-0.3	-0.3	0.1	0.4	0.5	0.7	9.9	9.9	9.9	9.9	0.0	0.0	0.0	0.0	9.9	10.0	17.8	20.4
Ireland	4.5	5.8	14.5	23.4	0.0	0.0	0.0	0.0	0.0	6.4	6.4	6.4	0.0	0.0	0.0	0.0	-3.7	0.0	0.0	0.0	0.7	12.2	20.8	29.7
Russia	0.0	0.0	3.5	4.7	0.0	-0.5	-0.4	-0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.5	3.1	4.2
Turkey	0.0	0.0	5.7	7.2	-0.2	-0.4	-0.4	-0.3	0.0	0.0	0.0	0.0	4.0	4.0	4.0	4.0	0.0	0.0	0.0	0.0	3.8	3.6	9.3	10.9
USA	0.0	0.0	6.4	8.3	0.0	0.0	0.0	0.0	-0.7	-0.7	-0.7	-0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.7	-0.7	5.7	7.6
Belgium	4.5	6.6	17.0	27.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	6.6	17.0	27.3
France	0.6	0.9	2.3	3.6	0.0	0.0	0.0	0.0	0.4	2.2	2.2	2.2	1.3	1.3	1.3	1.3	0.0	10.7	10.7	10.7	2.3	15.1	16.4	17.8
Germany	4.6	6.1	15.0	23.6	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.0	6.2	6.2	6.2	4.9	12.7	21.7	30.3
Netherlands	1.8	2.9	7.6	12.7	0.7	1.1	1.1	1.1	1.9	5.6	5.6	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	9.6	14.3	19.4
UK	3.8	10.3	16.8	23.3	0.0	0.0	0.0	0.0	4.8	25.1	22.1	19.2	2.7	2.0	2.0	2.0	0.0	0.0	0.0	0.0	11.2	37.4	40.9	44.5

APPENDIX 5: ELECTRICITY INTENSITY DATA

The electricity intensity data has been used to calculate energy efficiency potential across the sectors in each country.

Table A1.10 Energy efficiency potential across sectors in selected countries (%)

	China	Russia	France	Germany	Belgium	Irish Republic	Netherlands	US	Turkey
Manufacture of paper and paper products	-30.2	-30.2	-33.0	-33.0	-33.0	-33.0	-33.0	-33.0	-33.1
Manufacture of basic iron and steel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manufacture of cement	-51.2	-2.6	-20.1	-4.8	-4.8	-4.8	-4.8	-9.4	-1.2
Manufacture of rubber and plastics	-28.5	-28.5	-20.2	-20.2	-20.2	-20.2	-20.2	-20.2	-20.2
Manufacture of glass	-51.2	-51.2	-7.6	-7.6	-7.6	-7.6	-7.6	-7.6	-4.0
Manufacture of other basic inorganic chemicals (chlor-alkali proxy)	-20.5	-15.8	-24.2	-7.4	-7.4	-7.4	-7.4	-12.3	-4.0
Manufacture of fertilisers and nitrogen compounds	-20.5	-15.8	-24.2	-7.4	-7.4	-7.4	-7.4	-12.4	-4.0

APPENDIX 6: SECTOR BRIEFING NOTES PREPARED FOR THE COMMITTEE ON CLIMATE CHANGE

A1.8 Manufacture of Iron and Steel and of Ferro-alloys

A1.8.1 Summary findings for Manufacture of iron and steel and of ferro-alloys

The Manufacture of Iron and Steel and of Ferro-alloys industry has seen declining output and employment in the UK. The economic downturn has exacerbated this trend but, recent investment in UK steel manufacturing capacity suggests some optimism at least in the short-medium term. Tata steel is restructuring (increased mechanisation and/or concentrating production in a few larger plants) to maintain competitiveness.

The industry produces multiple products for different end uses, combining iron ore with different metals to produce steel alloys with different material properties. There are two main processes for producing steel: using a Basic Oxygen Furnace (BOF)/Blast Furnace (BF) (the most common) and using an Electric Arc Furnace (EAF).

The feedstock and outputs from the sector are increasingly traded. Both imports as a share of total demand and exports as a share of total supply in this sector have increased by 50% between 2000 and 2011. Recently, low shipping and iron ore prices have encouraged a global supply chain. Sahaviriya Steel Industries, owners of a BOF plant in Teeside currently imports iron ore from Brazil, manufactures steel in at the plant and exports it to the Far East for further finishing, before being supplied to Asian markets.

Industry is energy intensive but energy efficiency has been steadily improving. CHP and onsite cogeneration is practiced in eight BOF sites in the UK. Information on EAF auto-generation is not readily available.

Further abatement in the short term is likely to focus on marginal energy efficiency improvements. Step change technologies, including the application of CCS are unlikely to be commercially available for the sector for a few decades.

Key points for modelling:

- Risk of import competition is high
- Risk of competition for exports is high
- Output (in response to investment demand) is pro-cyclical but on a declining trajectory in Europe as economies mature
- Few other products are good substitutes for Iron and Steel in most applications
- Ability to compete on price – price of steel can be volatile, being cyclical. Some niche products more resilient to world markets and can set their own price.
- Different energy profile and abatement options for BF and EAF routes
- Some CHP occurring in the industry
- CCS and step change technologies will become available in the medium term but potential trade-off between emissions and energy management and production costs.
- High costs of energy and raw material inputs
- Volatile prices from input factors other than energy, such as raw materials
- Iron and steel products are not homogenous and quality is an inherent differential between producers. The implication is that the market is not perfectly competitive.
- Increasingly global supply chains. The implication is that non-energy input costs are likely to even out for all producers (depending on transport costs).

A1.8.2 Industry definition

The Manufacture of Iron and Steel and of Ferro-alloys industry is defined by SIC code 24.1. There are around 90 products attributable to the manufacture of iron and steel and of ferro-alloys, which can be broadly grouped into 4 semi-finished standardised product categories:

- hot-rolled flat products
- hot-rolled bars
- concrete reinforcing bars
- wire rod

The sector definition doesn't include the manufacture of tubes, pipes, hollow profiles and related fittings of steel (SIC code 24.2), which are often used for drilling in the oil and gas sector. Similarly, it doesn't include any cold drawing processes (SIC 24.3) which involves putting steel through a press to cut and shape it (without pre-heating) to produce standardised shapes and a bright surface finish on the steel.

However, this disaggregation may not accurately reflect the way businesses are structured as some iron and steel producers in the UK e.g. Tata manufacture steel products that covers all three subsectors.

Our recommendation is to model SIC codes 24.1-3 together, since the energy costs predominantly occur in SIC 24.1 but the trade occurs in 24.2 and 24.3.

A1.8.3 Industry characteristics

The primary output of the iron and steel sector is crude steel. Globally two major technologies are used for the production of crude steel: Blast Furnace (BF)/ Basic Oxygen Furnace (BOF) and Electric Arc Furnace (EAF). These different processes will have their own energy and emissions profiles and different options to reduce energy costs.

Both the amount of steel produced in the UK and the numbers of employees in the industry have declined since 1991. In 2001, the Manufacturers Organisation for UK Manufacturing (EEF) indicated there were 45,100 people employed in the manufacture of steel in the UK with an annual output of 16.5m tonnes of crude steel. In 2011, this figure had fallen to 18,500 and an annual output of 10m tonnes. UK demand has also fallen slightly during this period and the gap has been supplied by rising imports. Despite this fall in output, the UK is the fifth largest steel producer in Europe. Most steel production in the UK uses BOF (75%) with the remainder produced with EAF technology.

In the UK, steel making is concentrated in South Wales, Yorkshire and Humberside and in the West Midlands. Two EAFs producing steel alloys are located in Yorkshire and EAFs making non-alloyed steels are located in Kent and Cardiff. There are three large integrated steel plants in the UK which use the BOF route of steel production. The BOF route requires coking coal and iron ore as inputs. In the UK, these inputs are imported from the USA, Canada, Brazil, Australia and Scandinavia. In the UK, the main steel producer is TATA Steel (formerly Corus), Celsa UK (formerly Allied steel and Wire) followed by Sahariviya Steel Industries and Outokumpu. These 4 companies have a combined market share of 68%. The industry is therefore classified as having a 'medium' level of concentration (the threshold for 'high' being 70%). Tata Steel, accounts for nearly 59% of industry revenue but faces increasing import penetration (30% and rising). The rest of the industry is characterised by many firms operating at small scale, being localised and contributing roughly similar output.

Steel has many uses. Globally, over half of the demand (in terms of weight) for steel is from the construction industry (infrastructure and buildings). Other key demands are from transport equipment (12% of demand), industrial equipment (16%) and metal products (15%). The profile of UK demand for steel is similar to the global picture. The main difference is that there seems to be more production directed to industrial equipment (electrical engineering and mechanical engineering plants), possibly due to a relatively higher product specification for these applications and likely higher value added.

Alloying steel with other metals will give it different material properties. However, broadly speaking, the properties of steel (strength, stiffness, ductility) are fairly similar and there are few substitute materials that would be applicable across all steel product categories. Aluminium is the closest substitute, often used but is produced on a much smaller scale globally (76Mt of aluminium is produced annually compared to 1400Mt steel). Other products such as concrete could be a substitute in the construction industry but would still require additional metal reinforcements (often steel) to ensure the necessary material properties. Similarly wood may sometimes be used as a steel substitute but would require supporting policies to encourage the use of this alternative material. As such, there are few current substitutes for steel across all product categories.

Demand for steel is very pro-cyclical and in recent years demand has fallen globally, largely in response to a contraction in output the transport equipment and construction sectors following the economic downturn. This coupled with a rise in global production capacity (predominantly in Asia) has led to a fall in prices over the same period.

Recently, UK demand for steel (and production) has picked up as UK and global economies stabilised. Tata steel in North-East England and Yorkshire have begun to invest in new capacity and increased production rates. However, it is difficult to determine what are cyclical and underlying trends in the industry as it has been proposed that there is long-term overcapacity in Europe. This uncertainty represents additional risks for financial investors.

Given the current trajectory of per capita steel consumption, population growth and economic development to 2030 will lead to increased global demand for new steel and incentivise more efficient recycling of steel stocks. Allwood et al (2012) projects steel demand in 2050 to be 170% higher than current levels. China will remain the largest consumer of steel over this period but the rate of increase in its steel consumption is predicted to level off by around 2030 as economic growth slows and its economy becomes less resource-intensive. This assessment is supported by recent analysis by Rio Tinto, which anticipates India and South East Asian countries as increasingly important sources of steel demand post 2030.

On the production side, around 70% of global steel production is currently concentrated in China, Russia, South Korea, Japan and the US and the Indian steel industry is expected to expand production in forthcoming years.

A1.8.4 Market characteristics and other considerations

The degree of non-price competition

A large proportion of UK companies operating in the steel manufacturing sector are subsidiaries of global organisations. Although investment in a steel plant represents a large financial commitment over a long period (e.g. the plant at Port Talbot first opened in 1953), owning and operating these plants across different jurisdictions allow these firms to capitalise on short-medium term changes in levels and location of demand and production cost differentials and ensure security of supply of raw materials. This flexibility is particularly important for the steel industry as prices are very procyclical and subject to large changes and supply is very inelastic in the short term (periods of less than a year) because decisions to scale back or cease production at particular facilities are costly and relatively irreversible. The ability of incumbent firms to respond quickly in the short term, coupled with high sunk costs mean there are significant barriers to entry.

Sahaviriya Steel Industries acquired an integrated steel making facility in Teesside, noting its proven track record of producing slabs of steel to different quality grades as one reason for the acquisition. It explicitly references this venture as a way of increasing its global competitiveness, linking it to downstream operations in Thailand to meet growing demand from the Asian market[57].

Tata Steel is the world's 6th largest steel manufacturer and operates two large integrated steel plants in the UK (Scunthorpe and Port Talbot). It also operates numerous downstream facilities including rolling mills, tube mills and processing and distribution centres as well as owning end consumers of steel in the form of Jaguar Land Rover. However, the majority of

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[57] http://www.ssi-steel.co.uk/

steel it produces in the UK is for international consumption, with over 50% of production (including finished products) destined for overseas.

Although the UK operations compete with other sites for capital investment from the parent company, and the UK has relatively higher operating costs than a number of international competitors, integration across the value chain in these companies has likely increased the strategic importance of UK operations.

Additional cost considerations include transport and transaction costs

The European Commission identified close collaboration with downstream consumers on product design and innovation to deliver high quality and high value added products, solutions and services as a key way of maintaining the competitiveness of the European steel sector. This will be increasingly important as steel sectors evolve in developing countries to produce more high value products[58].

Raw materials represent the biggest input costs for the steel industry for both EA and BF production routes. Therefore the price of iron ore represents a significant determinant of a company's costs and relative competitiveness.

Labour costs in the UK steel industry are relatively high compared to other countries. In 2006, wages in the UK steel industry were second highest worldwide after Germany. Employment in the sector in the UK declined by around 85% from 1974-2000. This trend is continuing in response to low levels of demand, which have not returned to pre-recession levels. In the past 2 years, Tata steel UK has cut around 2,500 jobs while there are company plans to expand capital infrastructure, suggesting increased mechanisation and cost savings in the UK industry in response to a recent prolonged downturn in UK and European steel demand.

The trade intensity of the steel sector is high partly because of low and falling transport costs but principally because of the higher value-added per tonne of output compared to a number of other commodities (e.g. cement). A recent study by the Carbon Trust indicated that transport costs are only a very small percentage of overall production costs for facilities operating outside of Europe (around 5% for China and NAFTA region and 2% for CIS region) compared to operating costs (the bulk of which comes from raw materials). In 2012, shipping costs for and iron ore prices fell so low that it became more economical for Chinese consumers to ship ores from Brazil with a higher iron content than to extract iron ore from China. Steel is increasingly traded in the UK. Around 30% of steel demand comes from foreign imports and 30% of UK produced steel is exported. This represents almost a 50% increase in trade levels since 2001.

A1.8.5 Energy-using characteristics and abatement options

Globally, energy represents around a third of total costs for steel manufacturing. Given this high proportion of total costs, there is a strong inherent incentive to improve the energy efficiency of production. The average energy-intensity of steel production globally has been improving steadily since the 1970s but has recently plateaued, suggesting there are only a few opportunities for cost-effective marginal improvements in energy efficiency in the absence of any step change technologies. The IEA estimates that global adoption of current best available technologies (BAT) would yield further energy savings of about 20%.

Electric Arc Furnaces

Recycling scrap steel in electricity arc furnaces (EAF) requires less energy than in blast furnaces (BF) because the energy intensive ore reducing process can be avoided. However scrap steel as a feedstock into the EAF is limited by the availability of sponge iron or scrap steel. Recycling rates are already high, accounting for about 80% of all electric arc furnace metal feedstocks globally. The growth in production using scrap steel is slower than growth in total steel production because of the high proportion of steel stored in capital stock.

The EAF technology uses on average between 400-600 kWh/t of electricity per tonne of steel with the actual figure for any one site greatly influenced by the material composition, power

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[58] http://ec.europa.eu/enterprise/sectors/metals-minerals/files/final_report_steel_en.pdf

input rates and operating practices in the furnace. CHP is not suited to this technology due to highly variable power demand, which means EAF producers pay a higher grid price for electricity.

Blast Oxygen Furnace

Incremental improvements to the energy efficiency of a furnace can be made at the design stage of a BF plant. For example, larger BOF plants will be more energy efficient that smaller ones and the quality of iron ore and coal will also be an important determinant of the energy requirements for producing a tonne of steel. The IEA estimates these factors to result in up to a 20% difference in the energy efficiency of a plant. According to a recent report commissioned by the TUC, UK and EU blast furnaces are operating efficiently and within the constraints of their existing technologies.

Waste heat in the BOF process can be used to generate electricity through use of steam turbines in a process known as cogeneration/combined heat and power (CHP). The type and size of CHP system utilized depends on a variety of site-specific factors including the amount and quality of off-gases from the coke oven, blast furnace, and BOF; the steam requirements of the facility, and the economics of generating power on-site versus purchasing power from the grid. The sector self reported generating 315GWh of CHP in 2011, primarily from waste gases in the blast furnace[59].

Investments in CHP are costly. In 2010, Tata steelworks in Port Talbot, completed a £60m investment for recycling exhaust gases to produce 10% of the plant’s electricity needs. In May 2011, it announced a further £58m investment in a new evaporative cooling system for electricity generation in through a steam turbine and will reduce external power requirements by about 15%.

A number of transformative technologies are in the early stages of development, which would significantly reduce the energy consumption of steel production. An example is the electrolysis of iron ore. However, this technology is currently in the early stages of development. A major project within Europe is the Ultra Low CO2 Steel Making project (ULCOS), which is at the stage of trialling different carbon capture technologies at different plants. According to the TUC, the iron and steel sector is one of the best suited to the early adoption of Carbon Capture and Storage (CCS) technologies which would reduce the emissions associated with production in this sector (estimated to be around 5% of the global total). However, adoption of this technology in the absence of any supporting policies or finance would dramatically increase production costs for those countries and installations that adopt it relative to those who do not.

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[59] Department of Energy and Climate Change (DECC) Digest of the United Kingdom Energy Statistics 2012

A1.9 Manufacture of Cement

A1.9.1 Summary findings for Manufacture of Cement

The Manufacture of Cement sector is small. Only four companies produce cement in the UK directly employing around 3,000 people (c. 0.01% total UK employment), often in rural areas where there are likely to be fewer employment opportunities.

The industry produces three homogenous final products (see definition below), which can be substituted for one another and can in-part be substituted for timber and steel in construction. The cement industry can be characterised as a series of regional oligopolies and as a result costs are typically passed on. The sector has a fairly steady gross operating surplus (a proxy for profit) ratio to gross output of between 8 and 10%.

The product is not heavily traded. Imports have accounted for between 2% and 4% of UK supply in the period 2000-10. In the same period export demand accounted for between 2% and 4% of total UK product demand[60].

The industry is very energy intensive, but is a more modest electricity consumer. Electricity costs are estimated to be less than 5% of production costs (excluding wage costs). Between 90 and 150 kWh of electricity are required for every tonne of output. Over half of the electricity is required for cement grinding and raw material grinding. This could be reduced by pre-crushing the clinker, but this process in itself requires energy as an input.

For the most part, the abatement options are concerned with reducing fossil fuel inputs rather than improving electricity efficiency. CCS is identified as the major breakthrough technology, which would actually require an increase in electricity compared to current levels.

Key points for modelling:

- Import penetration is around 10% (likely to be less for inland markets) but increasing– price elasticities of demand are likely to be low
- Some substitutes in the form of steel and timber – cost price pass-through is likely to be high
- Growth in UK market tied to economic growth (demand for gross fixed capital formation – investment), and will not be as strong as in developing countries.
- The market characteristics suggest that cost-price pass-through will be relatively high and, correspondingly, demand responses to price likely to be low
- Changes in production will have a limited impact on employment given the low employment ratios as an input
- There are abatement/efficiency options but changes in any one fuel input can affect the requirements for other fuel inputs depending on which stage of the production process they are used
- Investment in new capital is required to bring about changes to the energy-using characteristics of the production process, and so changes in the energy use are likely to follow the sectors' investment cycles. Uncertainty over cyclical and longer-term industry trends may deter investment.

A1.9.2 Industry definition

The Manufacture of Cement sector is defined by SIC code 23.51, and includes the production of:

- Cement clinker (PRODCOM code 23511100)
- Portland cement (PRODCOM code 23511210)

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[60] Trade data and gross operating surplus data is taken from ONS SUTs data and is based on SIC codes 23.5-6, as a proxy for the narrower definition of cement 23.51

- Other hydraulic cements (PRODCOM code 23511290)

However, the products/industries represented by this narrow definition are integrated with 23.6 Manufacture of articles of concrete, cement and plaster. Since the electricity costs are likely to be passed on in the first instance from Manufacture of Cement to 23.6 Manufacture of articles of concrete, cement and plaster, the recommendation for the modelling is to assess this more aggregated sector 23.5-6 The Manufacture of cement, lime, plaster and articles of concrete, cement and plaster.

Where possible this sector overview reflects data at the 23.51 level of disaggregation, but in some instances proxy data has been used which reflects the broader sector definition.

A1.9.3 Industry characteristics

The cement industry produces three main types of products (as identified in the Prodcom database detailed database on manufactured products published by Eurostat): clinker, Portland cement and other hydraulic cements. Clinker is an interim output which is then milled with other minerals to produce cement powder. Portland cement is a standardized hydraulic cement (i.e. hardens in water), the proportion of gypsum (required to control the setting time of cement) to clinker is around 5%. For other hydraulic cements a variety of materials can be added in varying proportions, in addition to clinker and gypsum, which affect the performance of the cement. Portland cement is the main type of cement produced in Europe. However, all cement products are fairly homogenous, their application may depend on legislation around material composition in different countries.

There are four companies producing cement in the UK, operating at 14 sites and employing around 3,000 people. Of these Lafarge, Cemex and Hanson cement (part of the HeidelbergCement group) are three of the five largest cement companies operating in Europe. The other company, Tarmac Buxton lime and cement operates a single plant in Tunstead. Tunstead was formerly a wet process cement plant but has been replaced by a new dry process plant on the same site.

Cement is used in building, industrial and infrastructure applications and can in part be substituted for steel and timber[61] in construction. Markets are often regional due to the high transport costs relative to the weight of the product (particularly the case for land based transportation) which often means a low price elasticity of demand, particularly for inland consumers where it starts to become uneconomical to transport cement more than 200-300km (by road).

Demand for cement comes from the construction sector, which is highly pro-cyclical. UK consumption fell by almost 25% between 2008 and 2009 (Figure A1.1) due to the economic downturn and has not yet returned to pre-recession levels. Despite this the ratio between gross operating surplus and gross output remained between 8% and 10%.

Demand for cement is highest in countries undergoing rapid phases of industrialization and development given its importance in creating the infrastructure to support economic growth. In 2009, China and other developing Asian countries accounted for 2/3 of global cement demand. The IEA also suggests that as an economy matures, there is a peak demand for cement. Future demand to 2050 will come from non-OECD countries. Allwood et al. (2012), forecasts that 2050 levels of cement demand could be almost double current levels.

A1.9.4 Market characteristics and other considerations

The degree of non-price competition

Holcim, Lafarge, Cemex, HeidelbergCement and Italcementi are the largest 5 companies operating in Europe, accounting for around 58% of market and 30% of the global market (CemNet, 2008). This supports the assessment that the global cement industry is characterized as a series of regional oligopolies (Ghemawat and Thomas, 2008). Cook (2009) suggests producers compete in a regional market based on extended variable production costs, the transportation cost from their plants to the market and their capacity constraints. There are also high barriers to entry in the market due to high upfront investment costs, which

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[61] Steel is also covered under the EU emissions trading scheme but timber is not.

occur over a long period of time (around 7 years of planning and 35-40 years of operation for new kilns) and low product value to weight ratio which disincentivises transportation over long distances. Given the procyclical nature of cement demand and the high investment costs required to construct cement plants, these multi-national producers are more suited to responding to short-term surplus capacity or capacity constraints across different regions where they operate.

The types of cement these companies produce for the construction sector are largely homogenous and will differ only slightly in terms of their clinker and/or additive content, or how finely the cement has been grinded. This may reflect construction standards or design specifications.

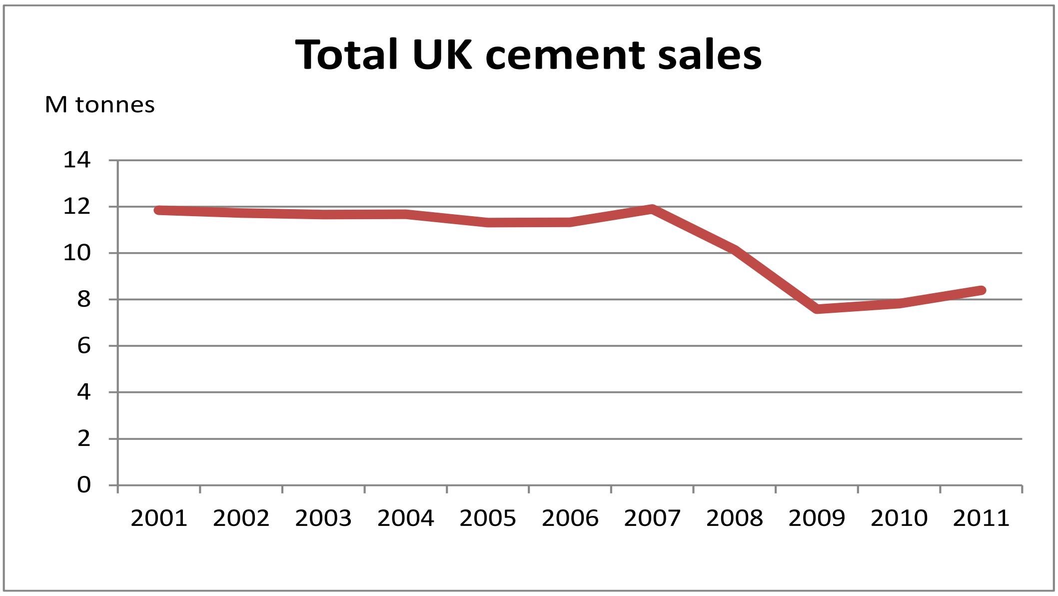
The four cement companies operating in the UK also quarry their materials and produce a wider range of products for the construction sector including aggregates, concrete and plasterboard in different shapes and qualities to meet end user needs. By offering a full range of construction materials, these companies are less vulnerable to short term changes in cement prices, can enjoy economies of scale in the industry and build more of a brand awareness and longer term relationships with downstream customers both nationally and internationally. Hanson also offers specialist services in contracting and civil engineering suggesting further vertical integration across the value chain.

Additional cost considerations include transport and transaction costs

The sector's major non-energy costs are, capital, labour and maintenance costs (30%), raw materials and consumables (28%) and depreciation (11%). The industry is becoming increasingly automated, requiring a limited amount of skilled labour. This reduces the variable costs required in production and may mean that wage differentials across different regions become less important determinants of relative competitiveness (particularly given high barriers to entry to the market).

Transport costs are high relative to the value of cement by weight, particularly for road transportation. This creates regional markets and prices for cement. When cement is transported beyond 300km by road, there is a risk that transportation costs may become higher than cement production costs. Seaborne transportation is cheaper, particularly when exported in bulk over long distances. Markets with access to ports are likely to be more competitive as a result. In the UK, import penetration is around 10% but the number of locations where cement is imported has increased between 2006-2011.

Figure A1.1 Total UK Cement sales



Non-price barriers may also exist for international cement producers. The composition of cement, although relatively homogenous, will differ depending on climatic conditions and the availability of different raw materials. Cement standards exist at the European and national level, specifying the required material composition of cement. Some countries may have a natural advantage in the production of certain cement types.

A1.9.5 Energy-using characteristics and abatement options

On average, energy makes up around 1/3 of cement costs, creating a strong incentive to minimize energy consumption during the production process. Best available technologies in the cement industry produce cement using an energy requirement of around 2.9Gj/tonne, compared to a theoretical minimum energy requirement of 1.8Gj/tonne which assumes no waste energy in the production process. The EU average for cement production is around 3-4Gj/tonne.

According to the Cement Sustainability Initiative (CSI), the thermal energy consumption of dry (fine powder) kiln technologies for clinker production is around 40% lower than that for wet (thick slurry) kiln technologies for clinker production. This represents a significant difference in energy requirements which the CSI notes is a cost advantage to producers. The CSI also indicates that the design of the kiln is the critical determinant of thermal efficiency and energy costs.

The choice of fuel mix during the operation of the kiln will also impact on the energy requirements. The industry is increasingly using alternative fuels such as waste oil, used tires, plastics and solvents. These fuels have lower emissions than traditional fuels and their use also reduces the amount of waste going into landfill or incineration plants. However, the heat and oxygen required by these alternative fuels to ensure complete fuel combustion may be higher than for conventional fuels and more electricity might be required for grinding these alternative fuels prior to burning, the shift from non-thermal energy sources also requires investment in new equipment. Further expansion in the use of alternative fuels may be limited by demand from other industries and regulatory and policy influences which affect the relative profitability of using different fuels.

Currently, in the UK, around 26.5% of fuels used in the cement industry come from waste derived materials. The Mineral Products Association notes the variety of these waste fuels, including solvents, chipped and whole tyres, meat and bone meal, sewage sludge, paper and plastics.

Substituting clinker for other materials would also reduce the CO_2 emissions associated with cement production as clinker production represents the most emissions intensive part of the production process. However, the CSI notes potential trade-offs with energy requirements as using some substitutes such as slag and fly ash generally require more energy for grinding cement finely at a later stage in the production process.

The electrical energy consumed in the cement making process varies between 90-150 kWh per tonne of output. In a dry process, the breakdown of total electricity use through the production process is:

- 38% for cement grinding
- 24% for raw material grinding
- 22% for clinker production including grinding of solid fuels
- 6% for raw material homogenisation
- 5% for raw material extraction and blending, and;
- 5% for conveying, packing and loading.

Grinding therefore represents the biggest source of electricity consumption in the cement production process. The efficiency of grinding can be increased using certain types of pre-crushers to grind clinker into smaller pieces.

Looking ahead to 2030, CCS is identified as a breakthrough technology for reducing the emissions associated with cement production however its application would increase the investment and energy requirements of a cement plant. The IEA estimates that if 20% of cement capacity operated with CCS in 2030 then this would increase the average electricity demand of a cement plant to 115-130 kWh/t of cement and if 40% of production was operating CCS by 2050 then average electricity requirements would rise to 115-145 kWh/t. The CSI offers similar estimates, suggesting the adoption of CCS would increase power consumption by 50-120% at plant level (additional energy required for air separation, stripping, purification, CO2 compression, etc).

A1.10 Manufacture of glass and glass products

A1.10.1 Summary findings for manufacture of glass and glass products

The industry produces large variety of products using different production processes, with product categories differing markedly in terms of their market structure, technologies used, cost structure and downstream applications.

Container glass and flat glass represent the largest product groups in terms of market volume and have larger scale operations and high investment costs. Furnaces will operate continuously and have a long life span, which risks slowing the proliferation of new technologies in the industry.

Melting raw minerals or glass cullet represents the largest source of energy consumption in the production process, as it requires very high temperatures. Heat can be generated through fuel combustion or electricity generation but the latter is relatively expensive and less efficient. Recycling represents a good way of reducing energy requirements in glass production but is limited by the purity of the waste glass collected.

Detailed data on electricity are not available for all glass categories but in the case of flat glass, throughout the entire production process, electricity represents on average around 20% of energy requirements throughout the various production stages (mixing, melting, forming and post-forming)[62].

Extra-EU imports of glass remains low, equalling only 7% of total production in 2011. However, this hides significant variance between different glass products. Import penetration for container glass was only 2% in 2011 while import penetration for glass fibres was close to 60%[63].

A1.10.2 Industry definition

The manufacture of glass and glass products is classified as SIC 23.1. There are five subsectors within this sector, classified as:

- 23.1 Manufacture of flat glass
- 23.12 Shaping and processing of flat glass
- 23.13 Manufacture of hollow glass
- 23.14 Manufacture of glass fibres
- 23.19 Manufacture and processing of other glass, including technical glassware

The PRODCOM database attributes 58 products to these subsectors with the products differing depending on their colour, shape and end use. Broadly speaking, the industry uses the broad categories container, flat, fibre and domestic (including crystal) to group products in the industry.

A1.10.3 Market characteristics and other considerations

New glass is made by melting a number of minerals (predominantly sand, limestone and soda ash) together at very high temperatures (around 1,700 degrees Celsius). Different materials added to this core mixture of materials and the amount of cooling time given to the mixture impacts on the colour and properties of the glass. Glass production was not mechanised until the early 1900s. Prior to this, glass was formed by hand blowing.

Glass can also be recycled and reused without any loss of quality. Recycling first requires the glass to be broken down into small pieces (cullet) before being re-melted in a furnace for re-use in the same way virgin glass would be used.

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[62] http://www1.eere.energy.gov/manufacturing/resources/glass/pdfs/industrial_bandwidth.pdf

[63] http://www.glassallianceeurope.eu/images/cont/panorama-of-the-eu-glass-industries-2011_file.pdf

There is no single substitute material could be introduced across all glass product categories. However, the container and domestic glass sub-sectors could be in part substituted by plastic, carton, steel and aluminium. However these alternatives to glass have different qualities in terms of their material strength, thermal conductivity and longevity and so will not be perfect substitutes.

Container glass

There are two basic methods of container glass production in the UK: Blow and Blow method and the Press and Blow method[64]. Both of these processes place molten glass (gobs) into moulds and manipulate the final container shape using compressed air or plungers.

In 2010, there were 6 container glass manufacturers in the UK. The UK is one of the top five producers in Europe. Along with Germany, France, Spain and Italy, it supplies 70% of container glass manufactured in Europe. Competition also comes from other substitute materials such as aluminium, paper and plastic.

Container glass mainly bottles and jars, accounts for around 60% of all UK glass production. The majority of the container glass produced in the UK is clear rather than coloured. The food and beverage sector represents 95% of downstream demand for European container glass.

Flat glass

Flat glass is made either by the float process or rolling process. The former involves floating molten glass on a large-scale ‘bed’ of molten metal (often tin) to make uniformed, coated and uncoated plates of clear and coloured glass. Globally, 80-90% of all flat glass is manufacturing using the float process. In the rolling process, a stream of molten glass is poured between two water-cooled rollers and can be used to make patterned and wired sheets of glass[65].

Flat glass is the second largest category of glass produced in the UK. Its main downstream customers are in the construction and transport (mainly automotive) sectors. In both sectors, there is demand for flat glass when structures and vehicles are initially constructed and also when retrofitted or repaired (e.g. with double-glazing, to increase the energy efficiency of a building or a replacement window shield in a car). Double-glazing represents a higher value product and requires approximately double the amount of glass compared with single glazing. Demand for glass products in these sectors is very pro-cyclical. China currently represents 50% of global demand for flat glass due to its rapid economic growth rates and expansion in infrastructure. Demand for flat glass is difficult to predict in the longer term. Current trends and policy drivers may offer some insights into new sources of demand by 2030. Firstly, there may be increased demand from retrofitting buildings to improve their energy as this will likely fuel a rise in demand for double-glazing. It is also possible as the power sector decarbonises and Europe meets its 2020 renewable energy targets that demand for solar-control glass and photovoltaic and solar thermal energy panels will increase and the glass required in their construction. Solar panels currently represent only 5% of flat glass demand in the EU market.

In 2010, three multinational companies produced flat glass in the UK: Saint-Gobain, NSG Group and Guardian. There are only 9 glass manufacturers operating in Europe.

Glass fibres

Glass can be made into continuous glass fibre, glass wool via the Crown process[66] or into optical fibres using specialised glass manufacturing techniques. Glass fibres have thousands of different downstream applications across numerous sectors, depending on the production method used. Examples of its use include: building insulation, reinforcing plastics, rubber and cement, creation of optical fibres to transmit images and light round corners (often for use in the medical sector) and for transmission lines in the communications industry.

Domestic glass

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[64] See http://www.britglass.org.uk/sites/all/themes/britishglass/files/form1auto_container_process.pdf for further details on the stages off the blow and blow and press and blow processes.

[65] See http://www.britglass.org.uk/sites/all/themes/britishglass/files/form2float_process.pdf for further explanation of these two processes.

[66] See http://www.britglass.org.uk/sites/all/themes/britishglass/files/form3glass_fibre_manufacture.pdf for further explanation of these two processes.

Domestic glass is usually produced on a smaller scale by more artisanal glass manufacturers producing giftware but it can also be produced by automated processes. This category refers to glass used for indoor decoration (e.g. tableware and kitchenware) and any similar purposes.

The degree of non-price competition

In 2009, there were 963 glass manufacturing enterprises in the UK, employing 27,000 individuals[67].

Different product categories have different market characteristics. According to the IEA[68], average production capacity in a float glass furnace is between 550-1,100 tonnes/day while container glass has an average capacity of 250-250 tonnes/day and specialist glass manufacturers (usually small to medium enterprises) may only produce a few kilograms a week.

Similarly, different product categories have different relationships with downstream sectors and different levels of international trade. For example, EU producers of container glass usually supply the EU market; extra-EU import penetration was only 2.25% in 2011[69]. Production is fairly dispersed across European countries, as production tends to be close to markets. This is because the product has relatively low value relative to its weight and so it is uneconomic to transport it over long distances. This is also likely to be the case for a number of other world regions. Extra-EU exports of container glass similarly represented only around 4% of total production. Many of these downstream customers will then use these containers as packaging for their industries' products for EU and extra EU-consumption (e.g. food or beverage products). Conversely, the EU manufactures 80-90% of global lead crystal products (a 'domestic glass' product), which is highly traded and likely to have stronger brand recognition e.g. Darlington Crystal and Royal Brierly are well-known lead crystal manufacturers headquartered in the UK.

A 2008 study on the competitiveness of the European Glass industry by Ecorys[70] suggests that there should be increased specialisation within the European glass manufacturing industry, which should prioritise production of higher value glass products in all of the glass subsectors. PRODCOM data for 2011 reports main products (by value) from in the UK glass manufacturing sector were multiple-walled insulating units of glass for use in the construction sector (e.g. double glazing), small clear glass bottles and bulk articles of glass fibres. During the past 10 years, a number of facilities producing specialised glass products have closed in the UK including: lighting, cookware, optic fibres and optics. This may indicate increasing specialisation in the UK.

Both the European and UK glass industry place a large importance on the role of innovation in securing market share in high value applications of glass and to maintain industrial competitiveness. The European Alliance of Glass Industries notes the European industry is investing heavily in intensive R&D programmes to develop new ways to use glass, to make available new products, to enhance recyclability and effective recycling, but also to improve the energy efficiency of manufacturing sites. Glass for Europe (the industry body for flat glass manufacturers in Europe) notes particular success in coated glass technologies to improve building insulation, anti-reflective glass to enhance the absorption of sunlight in solar panels and lighter glass to reduce the weight of screens in vehicles make them more fuel efficient as some examples of emerging specialisation. The industry emphasises the role of governments to preserve the incentives to innovate through the use of intellectual property rights.

British Glass, the industry body for the UK glass industry, suggest the UK leads the world in flat glass innovation and this is largely attributed to the high numbers of science and technology graduates, and their relationships with, and proximity to, established glass manufacturers and processors. The Japanese NSG group (representing 17% of global flat

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[67] UK Government Annual Business Survey 2009

[68] IEA (2008), Tracking Emissions, Energy Technology Perspectives

[69] http://www.glassallianceeurope.eu/images/cont/panorama-of-the-eu-glass-industries-2011_file.pdf

[70] Ecorys (2008), Sector Competitiveness Studies - Competitiveness of the Glass Sector, a study for the European Commission.

glass capacity worldwide) has chosen the UK as the location of their research and development headquarters for flat glass. Furthermore, theme of British Glass's 2013 annual conference is innovation in the glass supply chain across all product groups. These examples suggests the industry recognises the importance of both a strong relationships with downstream consumers and ensuring a sufficiently skilled labour force to maintain competitiveness, even as certain production processes in the industry become more automated.

Table A1.11 Flat Glass Capacity share

Company	Country	% World Capacity
NSG Group	Japan	17.0[2]
AGC	Japan	17.0
Saint-Gobain	France	14.0
Guardian	United States	12.0
Others	Various	40.0

Additional cost considerations include transport and transaction costs

Large-scale glass production is a capital-intensive process. Furnaces operate continuously throughout their lifetime and represent a large sunk cost for the industry. The European Commission estimates that a new plant for container glass would cost between €40-50m while a float line for flat glass would cost in the region of around €100m. As producers benefit from economies of scale and will try and maximise capacity utilisation rates.

Furnaces in these glass subsectors are usually only replaced every 15-20 years. Therefore, any changes in furnace technologies in terms of efficiency improvements, risk taking a long time to proliferate throughout the industry.

In terms of operating costs, around 80% of the energy required to heat glass furnaces comes from natural gas so the industry is very susceptible to fluctuations in natural gas prices and those countries with relatively lower prices may enjoy a competitive advantage in glass manufacturing, although other industries may also be competing for natural gas (e.g. as a feedstock in the chemical industry). The industry may also face competition from other industries, which use soda ash and other mineral inputs, which will affect glass manufacturer's cost schedules.

Employment costs in the European glass industry are relatively high compared with international competitors. The number of people employed in the industry in the EU as a whole has been falling since 2000. There has been increasing automation in certain subsectors and consolidation of manufacturing companies as Europe competes with low cost international producers.

The majority of EU flat glass production has historically been traded within the EU. Flat glass is relatively expensive to transport, likely because of its fragility and the need for extra packaging, and so is generally supplied on a local or regional basis. However, there is increasing import penetration in certain glass subsectors (e.g. imports of Chinese flat glass produced using the float method has increased tenfold since 2004 and in particular, it also competes with UK producers for continuous filament fibre glass). Overall, extra-EU imports of glass remains low, equalling only 7% of total production in 2011 across all product categories. However, this hides significant variance between different glass product categories. As discussed earlier, extra-EU import penetration for container glass was only 2% in 2011 while import penetration for glass fibres was close to 60%[71]. There is increasing competition for flat glass from Russia and the Middle East.

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[71] http://www.glassallianceeurope.eu/images/cont/panorama-of-the-eu-glass-industries-2011_file.pdf

Key points for modelling:

- The industry produces a wide variety of products, ranging from container glass to glass fibres.
- There are a large number of glass manufacturing enterprises in the UK. The main products from the UK industry are multiple-walled insulating units of glass for use in the construction sector (e.g. double glazing), small clear glass bottles and bulk articles of glass fibres.
- Internationally, production tends to be fairly closely-located to markets due to the comparatively high transport costs of a relatively heavy product.
- UK leads the world in flat glass innovation.
- Large-scale glass production is a capital-intensive process and plants represent a large sunk cost for the operator.
- Overall, extra-EU imports of glass remains low (less than 10% of total production across the sector as a whole), although there is wide variation by commodity: extra-EU import penetration for container glass was only 2% in 2011 while import penetration for glass fibres was close to 60%.
- The majority of EU flat glass production has historically been traded within the EU, there is increasing import penetration in certain glass subsectors (e.g. imports of Chinese flat glass have increased strongly recently).

A1.10.4 Energy-using characteristics and abatement options

Glass manufacturing is energy intensive. Melting the raw materials or recycled glass is the stage of production that requires the most energy. The mixture is heated in a furnace either via combustion (in oxy-fuel, air-fuel burners) direct electrical heating (Joule heating) or a combination of both (electric boosting) which gives manufacturers flexibility in terms of production rates or fuel use. Electrical heating is costly and relatively inefficient compared to combustion and is not the preferred technology in the industry. Electricity is also used in the glass manufacturing process for operating machinery and for heating, lighting and cooling plants.

The energy requirements differ for different glass product types. In flat glass production, melting represents around 60% of the energy requirements. Energy requirements may be reduced in the float glass method by using industrial gases to increase the efficiency of the process. Throughout the entire production process, electricity represents around 20% of energy requirements throughout the various production stages (mixing, melting, forming and post-forming)[72]. For other product categories, there gaps in data availability on electricity requirements during different stages of production but further processing to increase the added value of products will also increase the energy requirements.

Given the large amount of waste heat associated with the melting stage in the production process, energy efficiency rates can be significantly improved is this waste heat is recovered to generate steam in a waste-heat recovery boiler or to preheat cullet (which lowers the energy requirement to melt it in the furnace), but this will have little impact on the electricity required for production. Although a lot of heat is generated during the glass manufacturing process, a 2007 DECC report identified difficulties with using CHP technologies in the sector. It is challenging to utilise heat in the manufacturing process[73].

Recycling rates are high in the industry because recycling glass requires 25% less energy than producing new product, and often the industry can partly 'self-supply' through melting down rejected production. However, recycling rates will be limited by the maturity and

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[72] http://www1.eere.energy.gov/manufacturing/resources/glass/pdfs/industrial_bandwidth.pdf

[73] For further information, please access http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/emerging_tech/chp/potential-report.pdf

effectiveness of waste collection in a country. Where glass waste is not separated, the cullet may be too mixed to reach necessary purity levels for manufacturing certain glass products.

Key points for modelling:

- Furnaces in these glass subsectors are usually only replaced every 15-20 years. Therefore, any changes in furnace technologies in terms of efficiency improvements, risk taking a long time to proliferate throughout the industry.
- Glass manufacturing is energy intensive. Typically, most (80%) of the energy comes from natural gas. However, the energy requirements differ for different glass product types.
- Little opportunity was seen for the UK industry adopting CHP in the short term due to difficulties with utilising heat in the production process.

A6.2 Manufacture of Rubber and Plastic Products

A6.4.1 Summary findings for manufacture of rubber and plastics

This sector produces a large number of products, of which tyres represents the largest single rubber product category. There are a few well known international tyre brands with manufacturing sites in the UK. Demand for tyres is relatively stable in more mature economies and forecast to grow more in emerging economies as they develop.

General rubber goods manufacturers usually operate at a much smaller scale than tyre manufacturers and produce a smaller range of products targeted to specific consumer groups.

Plastic products are categorised by their shapes and end use. The high number of plastic manufacturers in the UK suggests many producers also operate at small scale. Plastics products have very different material qualities and downstream applications. Different groups of companies within the sector will experience different policy developments and have different ‘watching briefs’.

The price of hydrocarbons (a feedstock) and opportunities from recycling or reuse of products are issues common to both the rubber and plastics sectors.

A6.4.2 Industry definition

The Manufacture of rubber and plastics is defined by SIC code 22. It refers to the shaping of primary forms of rubber (20.17) and plastic (20.16) into more complex intermediate or final shapes to meet downstream requirements.

Rubber products are classified as either

- Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres (22.11)
- Manufacture of other rubber products74 (SIC 22.19)
- Rubber in primary form can be natural, synthetic or a combination of both. Around 60% of global rubber production is now man-made. The British rubber and polyurethane products association (BRPPA) estimates there are around 55,000 varieties of synthetic rubber in existence each with different material properties related to temperature, corrosion resistance, electrical application, resilience and shock absorbance.
- Plastic subsectors are divided into
- Manufacture of plastic plates, sheets, tubes and profiles (SIC 22.21)
- Manufacture of plastic packing goods (SIC 22.22) – this includes sacks, bags, crates, boxes, bottles and flasks
- Manufacture of builders’ ware of plastic (SIC 22.23)
- Manufacture of other plastic products (SIC 22.29)

The material quality of the final product made will depend on the production process and the primary plastic used. There are over 20 different types which are commercially available, each with an individual range of physical and chemical properties. Six plastics - polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyethylene terephthalate and polyurethane account for 80% of plastics demand in Europe. Different material properties

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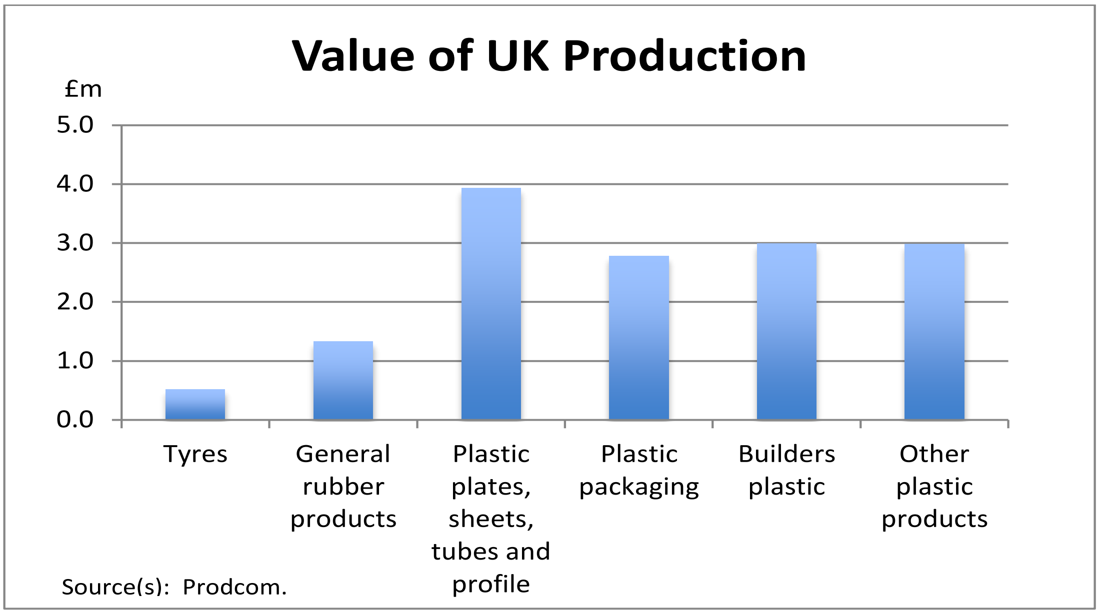
[74] Excluding some items such as footwear and rubber based adhesives.

can be created using additives with specific technical effects such as flame retardants, antioxidants, reinforcing agents and plasticisers.

Figure A1.2 Value of UK production



Source(s): Prodcom.

Figure A1.2 shows the value of UK production in different parts of the rubber and plastic products industry. Tyres represent the highest value single product within the rubber manufacturing industry. Plastic plates, sheets, tubes and profiles represent the highest value subsector within the UK plastics industry.

A6.4.3 Industry characteristics

Rubber

The manufacture of rubber products involves six main stages of production. Firstly the rubber (natural or synthetic) is mixed with additives to give the final product specific material qualities. This mixture is then milled into smaller pieces. The mixture is transferred through an extruder/die to produce specific shapes. Rubber may also be used to coat other materials in a process known as calendaring. The rubber is then vulcanised (cured) to make the final products more durable and less sticky. The rubber product may also undergo grinding to remove rough edges or imperfections from the product or in some cases to form and shape the final product.

Tyres

There are seven main product categories of rubber tyres manufacturing depending on the vehicle. All downstream consumption of tyres is in the transport sector.

In terms of volume, the UK mainly produces car tyres, though manufacturers usually produce all tyre products. Michelin, Cooper tyres, Goodyear Dunlop and Pirelli are international tyre suppliers with manufacturing operations in the UK. In addition to supplying some of the demand for the UK market, these manufacturers export around 15m tyres (motorbikes, cars, vans, trucks and aircrafts) per annum, valued at around £800m.

In terms of imports, Continental, Dunlop and Hancock are also significant suppliers of tyres to the UK market but do not have UK-based manufacturing sites. Of the 300 branded models of car tyres available in the UK, around half are imported from the EU and a quarter from China.

Demand for tyres has been falling in recent years in Western Europe. The economic downturn has also led to a lower replacement rate for vehicles since 2008. In sharp contrast, there is rising demand for tyres across all vehicle categories in emerging economies including China, India and Brazil for both personal and public transportation. As economies develop and populations become more mobile, demand for tyres in these countries is likely to continue to increase strongly.

A second activity in this sub-sector is retreading and rebuilding of tyres. The tread of a tyre wears out quicker than the cushion and casing of the tyre which is not in direct contact with road surfaces. The old, worn out tread can be removed and a new one reattached using either hot or cold moulding techniques. In the UK, the Retread Manufacturers Association has 17 members who retread tyres and twelve members who supply worn tyres to these companies for retreading. It is usually cheaper to purchase car tyres from abroad rather than retread them. However, around half of the truck and bus tyres on the road in the UK have been retreaded and tyre manufacturers often design their tyres with retreading in mind.

General rubber goods are primarily destined for the automobile industry, but are also used in the construction, mechanical and pharmaceutical industries, among others. The British Rubber and Polyurethane Products Association list some examples as plungers in syringes and diaphragms used in medical equipment, anti-vibration and suspension systems in transport, industrial and civil engineering applications, conveyor belting for mining and industrial applications, ducts, seals and hoses used in aerospace and defence industries, expansion joints and protective wraps for corrosion resistance in the offshore and gas industry. Tomkins PLC is the only one of the ten largest global general rubber goods manufacturers that has its headquarters in the UK. It has a number of brands within the company that specialise in providing components in the industrial and automotive sectors and also bath products. The company acquired The Gates Rubber Company (founded in 1911) in 1996, and shortened the brand to ‘Gates Corporation’. This subsidiary, like many others in Tomkins are more diversified than when they were originally established. They manufacture mixed material products used in engineering, many of which contain rubber elements.

Plastics

This group represents the manufacture of new or recycled plastics resins into intermediate or final products. Primary plastics in the form of pellets are softened as they are extruded through a die and then are transformed into their final shape using a moulding technique (e.g. injecting, vacuuming, heating, blowing), whereby the plastic is heated, forced into a mould at high pressure and then cooled. The product may then undergo a final finishing treatment (e.g. components may be wielded together or the plastics may be coated with a different plastic or other material). The variability of the production process and materials is such that a wide variety of products can be made. Manufactured plastics are used in a number of ways including in packaging, construction, electrical items, household items, transportation and medical equipment.

According to the British Plastics Federation, there are around 7,400 companies operating in the plastics industry in the UK with an annual turnover over around £19bn. This high number of producers suggests most companies are operating at a small scale and will likely produce a limited range of moulded products for specific end users e.g. a focus on manufacturing automobile parts or medical equipment. Exports are valued at around £4.1bn and sales account for around 2% of GDP.

A number of materials can be substituted for different end uses of plastic (eg paper-based cartons can be used to replace small plastic bottles). However, not all products have an easily identifiable substitute. Research by Plastics Europe indicate that 16% of the total market of plastic products cannot be realistically replaced by other materials, meaning that in these cases a substitution of plastics is not possible without a significant change in design, function, service rendered or in the process itself, which delivers a certain service.

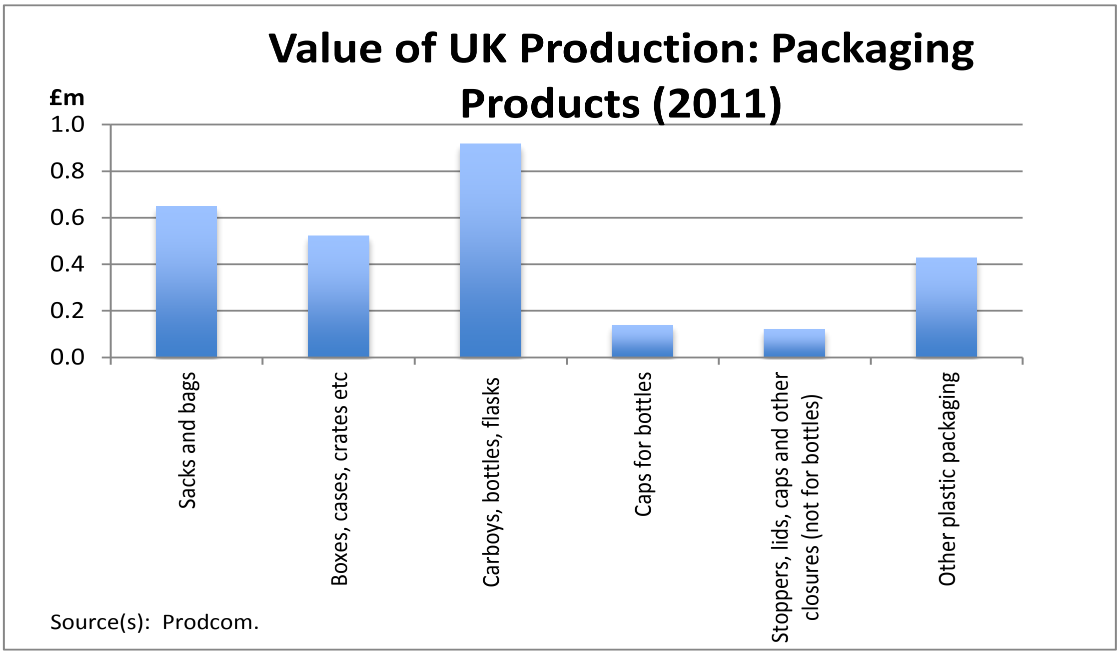
Manufacture of plastic plates, sheets, tubes and profiles (22.21)

Plastic plates, sheets, tubes and profiles are products used by a number of downstream industries including construction, agriculture, automotive and electrical. Because of their wide application, it is difficult to locate data on this specific subgroup because industry analysis is usually grouped by end use. As an example, plastic tubes would be characterized in the construction industry for sewage, drainage and potable water, in extractive sectors for transporting oil and gas, in transportation for rail and land based haulage and in the food and drinks industry for storing liquids.

Manufacture of plastic packing goods (22.22)

According to the British Plastics Federation (BPF), there are around 1,500 companies involved in the UK plastics packaging industry, employing 74,000 workers. Grouping the PRODCOM categories together, the highest valued products in the UK packaging industry in 2011 were carboys, bottles and flasks, sacks and bags and boxes, cases and crates (see Figure A4.2). According to the BPF, around 50% of Europe's food is packaged in plastics. This may indicate that as economies mature and the diets of populations evolve (i.e. through the use of refrigeration, introduction of international supermarkets, proliferation of part-made meals, increased imports of exotic foods), there will be higher global demand for plastic packaging.

Table A1.12 Value of UK production of packaging products



Source(s): Prodcom.

Key points for modelling:

- The value of UK production is dominated by the plastics sector, although tyres represent the largest (in terms of value) single commodity produced. The plastics industry is segmented in two: manufacture of plastic plates, sheets, tubes and profiles for use in e.g. construction, automotives, and manufacture of plastic packaging goods.
- Around 7,400 companies operate in the UK plastics industry, of which 1,500 are involved in plastics packaging, suggesting little market power for producers in the plastics market generally.
- General rubber goods are primarily destined for the automobile industry, but are also used in the construction, mechanical and pharmaceutical industries (eg medical/scientific equipment)

A6.4.4 Market characteristics and other considerations

Rubber tyres

As indicated earlier. The transport sector is the final source of demand for tyres, both for new vehicles and replacement tyres. For many vehicles, tyres are custom designed to meet performance needs, involving months of testing and quality checks between the tyre and vehicle maker before a bulk order is made, suggesting a close relationship with the downstream customer.

The degree of non-price competition

For replacement tyres, manufacturers usually sell to wholesalers and distributors who then sell to smaller outlets. There are approximately 3,000 specialist tyre outlets in the UK. In addition, about 20,000 garages and other outlets also sell new tyres as part of a wider service offering. The industry responds quickly to consumer demand. Delivery is usually within 1 day of ordering. Expectations around the response time of suppliers might change however as Internet sales are expected to increase from their current levels (3% of sales) as consumers seek the cheapest tyre supplier.

General Rubber Goods

According to the BRRPA, there are 543 firms in the general rubber goods industry in the UK with an annual turnover of £1.8bn. According to PRODCOM data there are 34 categories of products produced in this subsector including: thread, cord, tubing, sheets, plates, belts and fabrics. With the exception of larger firms such as Tomkins, the number of firms in the UK would suggest small scale manufacturing of specialised rubber products tailored for end user specifications.

Plastics

There are around 3,000 plastic processers in the UK plastics industry. Using the structure of the BPF as a guide, the industry can be grouped into 19 subcategories which represent different production processes (e.g. rotational moulding and welding and fabrication) plastics (e.g. cellular PVC-U and expanded polystyrene) and products (e.g. windows and sheets and coated fabrics). The BPF suggests these different groups of companies within the sector will experience different policy developments and have different ‘watching briefs’ although a number of issues are likely to be common to the entire industry. A 2006 study for BIS[75] indicated the UK plastics industry was a highly fragmented market with a number of small to medium sized enterprises competing for downstream consumer demand. UK firms were working far less closely with customers and suppliers than German firms, possibly because of an increasing trend of consumers to end long standing relationships with UK based suppliers to lower cost sources from overseas.

Additional cost considerations include transport and transaction costs

The price of hydrocarbon feedstock will influence the price of the production of plastics and rubber in primary forms which in turn will affect the cost schedule for more complex manufacturing of rubber and plastics. In Europe, in 2007, conventional fossil fuel based polymers represented more than 99% of the plastics produced. Those countries enjoying relatively low prices for natural gas and petroleum had lower overall production costs.

Total employment levels and costs in the UK plastics sector fell over 2002-06 though the number of enterprises in the industry rose during this period. This suggests there has been increasing mechanisation or production efficiency in the industry during this period as well as the breakup of Imperial Chemicals Industries into smaller more specialist units. Since 2006, this trend has begun to reverse and opportunities have been identified by a number of industry analysts that there are opportunities to profit from more consolidation within the European plastics manufacturing industry.

The plastics industry recycles a proportion of its production. It has set a target to recycle 50% of packaging plastics by 2020 which is supported by the UK Parliament. Plastic can be recycled up to 6 times, after which it is no longer economically or environmentally viable to recycle. The UK public recycles around 24% of all plastics produced in the UK. Demand for UK recycled plastics is largely driven by government or company targets around the use of recycled plastics. However, transport costs overseas can be a limiting factor. At the start of 2012 shipping costs to the far east (including China) stood at $600 per container but had risen to $1700 by May making shipping lower grade plastics uneconomic.

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[75] Sector Competitiveness Analysis (SCA) of the UK Plastics Processing Industry, Phase 2 report, Strategem, August 2006

In the rubber industry, rising raw material prices are making car tyre retreading, more economically viable. One possible barrier to entry in the UK tyre retreading market is the requirement for individual retreaders to become licensed operators and to comply with EC regulation on tyre approval. If these requirements are more stringent or significantly different to those in countries where tyres are manufactured, this may deter market participation.

Key points for modelling:

- The UK plastics industry is highly fragmented, with strong competition among SMEs in the UK for the domestic market.
- A high proportion of the cost base for plastic manufacturers is accounted for by the hydrocarbon feedstock.
- Transport costs can be factor limiting imports, particularly of low grade items.
- Increased recycling rates will reduce the dependence on virgin hydrocarbon feedstock (and the associated price volatilities). UK recycling rates are lower than in come competitor EU regions.

A6.4.5 Energy-using characteristics and abatement options

Rubber

Online sources exist on improving the efficiency of tyre and rubber goods production through measuring and monitoring each stage of the process and making minor changes to the way that the machinery is operated to optimise the production process, e.g. adjusting temperatures or the speed of motors. The sources identified marginal improvements in the energy efficiency of production rather than any step change technologies.

Increasing the amount of retreading in the tyre industry would reduce the amount of energy required for tyre production. It would also lower material requirements (predominantly oil) required. Retreading rates are currently around 20% of total production in the EU.

There are also opportunities to generate heat from waste in the rubber sector. In 2005, 33% of EU tyres were incinerated, mainly in cement kilns. The industry also uses CHP technology but data on the number of UK plants with CHP facilities was not available. Polimeri Europa UK limited, is an example of a UK based synthetic latex and rubber manufacturer which has installed 50MW capacity of gas-fired CHP.

Plastics

Modern plastics processing machinery is becoming increasingly energy efficient and uses between 20-50% less energy than ten years ago.

According to Plastics Europe, the UK recycles around 20% of all plastics it uses and has an energy recovery rate of around 7% whereby energy is derived from combustion of waste. Non-recyclable plastics usually have a relatively high calorific value compared to other elements in municipal solid waste (MSW). Nine countries in Europe have energy recovery rates of between 55-75%. This may be a result of these countries having the tightest restrictions on landfill, making it a less attractive option for disposing of plastic products once they've been used.

Of all the plastic product groups, packaging has the highest recovery rates for recycling. Scotland introduced the Waste Regulation Act in May 2012 which aims to recycle 70% of all household and business waste by 2025. The UK government has similarly announced plans to recycle 42% of plastics packaging by 2017. These pieces of legislation will likely increase plastic recycling rates in the UK. The UK may explore the option of expanding recovery rates of plastics in MSW, particularly if there is cogeneration on site. This approach would be in accordance with a recommendation from Plastics Europe to use CHP to support local infrastructure.

Reduced Energy Consumption In Plastics Engineering (RECIPE) offers guidance on best production practices in the industry and identifies the determinants of energy requirements at each stage in the plastics production process so site managers are aware of their energy consumption and opportunities to reduce it.

Energy consumption in plastics processing depends upon:

- Type and characteristics of plastics (e.g. different plastics will have different melting temperatures)
- Design, complexity and size of end product.
- Techniques used for moulding.
- The quantity of products produced and frequency of the mould being used. Enjoys economies of scale.

A possible step-change in technology, with implications for the energy demand profile of the industry would be the large-scale use of 3D printing in the plastics industry. This technology could be used to create complex forms which are specific to end user requirements and could thereby reduce waste and the need for storage in the industry. However, it is not clear yet what the energy characteristics of the technology will be compared to existing processes how the electricity consumption would change within the industry nor how this infant technology will evolve in the industry and what that would mean for electricity consumption.

Key points for modelling:

- Energy efficiency trends are quite strong in the sector: the energy efficiency of machinery in the plastics processing has increased by 20%-50% in a decade.
- 3-D printing is a possible step-change in technology, with implications for the industry’s energy demand.

A1.11 Manufacture of paper and paper products

A1.11.1 Summary findings for manufacture of paper and paper products

Demand for pulp and paper has been declining in OECD countries and rising in emerging economies. Drivers of longer term trends in paper consumption are difficult to predict with the introduction of digital media but global demand is still expected to increase.

The number of UK mills and employees has more than halved since the 1990s. This has coincided with increased production capacity in emerging economies such as China.

Paper products are relatively homogenous and so cost schedules play an important role in determining relative competitiveness. Although cost structures can be characterised in aggregate terms, individual plants differ in terms of their product mix, the way they source upstream materials and fuel mix, giving them individual cost schedules.

Increasing competition for inputs from new producers and other sectors of the economy has raised prices in recent years. Wood and pulp represent the highest input costs. The industry self-generates about half of its energy requirements through the use of biomass. In Europe the industry uses biomass to meet around 55% of their energy requirements, making good use of CHP technology. The pulping process can either be mechanical or chemical. The former is around three times as electricity intensive and produces less waste biomass for use in CHP plants.

Recycling rates are high in Europe. In the UK, 100% of newsprint comes from recycled sources, which has a lower energy requirement than virgin paper. Recycling is limited by decreasing material quality over time.

A1.11.2 Industry definition

The manufacture of paper and paper products is classified as SIC code 17. There are 7 seven subsectors within this sector, classified as:

- 17.11 - Manufacture of pulp
- 17.12 - Manufacture of paper and paperboard
- 17.21 - Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
- 17.22 - Manufacture of household and sanitary goods and of toilet requisites.
- 12.23 - Manufacture of paper stationery
- 17. 24 - Manufacture of wallpaper
- 17.29 - Manufacture of other articles of paper and paperboard.

The PRODCOM database identifies 104 products to these sub-sectors which differ depending on the end use, the material composition and whether or not the product has any additional treatments eg paper may be coated, covered in an adhesive and laminated with fabric, plastic or metal. Broadly speaking, paper products differ in terms of colour, brightness, opacity, resistance to light and ageing, moisture content, printability, strength and stiffness.

The most electro-intensive (and indeed energy intensive) part of the sector is focussed in 17.11 Manufacture of pulp and 17.12 Manufacture of paper and paperboard. Businesses in these sectors should be the focus of an assessment of competitiveness. However, the supply chain is integrated and the products produced under 17.11 and 17.12 feed into the rest of the sector. The whole sector (17) has therefore been considered together as part fo the competitiveness assessment in this report.

A1.11.3 Market characteristics and other considerations

Paper is used in a number of downstream sectors. The Confederation of Paper Industries in the UK lists 14 sectors that use paper in their own production processes (rather than for office functions). Uses vary from keeping medical equipment sterile to animal bedding. There is no single substitute for paper, however it can be substituted for certain applications (eg plastic packaging and bags for food or the use of e-readers instead of newspapers or books).

Pulping is the first stage in the paper production process. Virgin pulp comes from cellulose fibres in trees. The fibres are either mechanically pulped (pressed and ground) or chemically pulped (dissolved in a chemical/water solution in a high pressure cooker before washing, sorting and drying). Pulp is then mixed with fillers and additives to create the required properties in paper. This mixture is then poured onto a mesh, whereby excess water is drained and continually squeezed out of the mixture. The largely wet, fibrous mixture is then transferred to a series of hot rollers where any excess water evaporates. This process produces long strips of paper which is rolled up after it has passed through all of the rollers. This roll of paper may undergo further finishing techniques such as coating or cutting the paper into desired sizes.

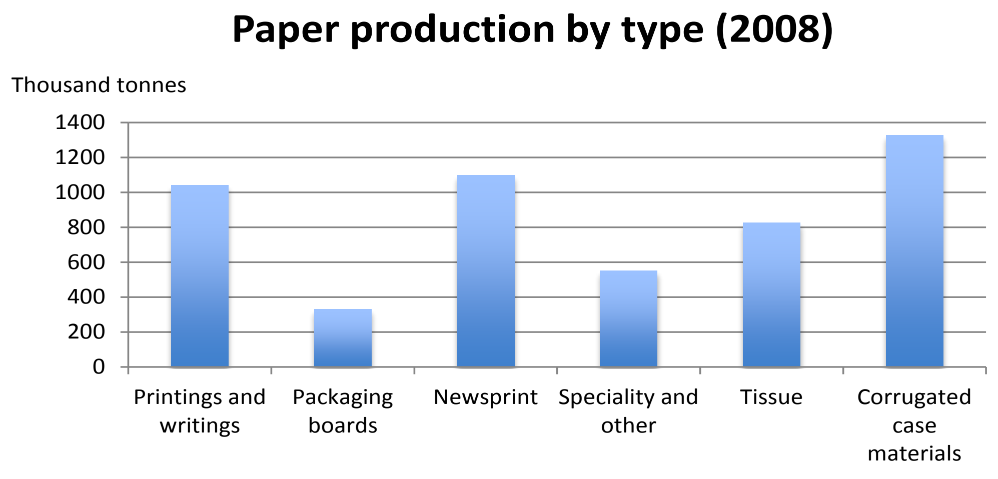
Paper mills can technically operate continuously for 24 hours, 7 day s a week (with the exception of a few hours of maintenance every couple of weeks) for 25-30 years. Best practice in the industry is typically a utilisation rate of about 90%. The initial investment will be in the region of £300-£400m, while a new chemical pulp mill costs in the region of £700m.

Demand for paper is pro-cyclical. Due to the economic downturn, demand for paper fell by around 10% in 2009 compared to 2008 in the main paper producing countries in Europe. These countries are members of the Confederation of European Paper Industries (CEPI). Forecasting longer term paper demand is difficult because of current uncertainties around the use of online reading material and e-readers and other changes in consumer tastes. Since 2000, demand for paper has declined for OECD countries but has increased in many emerging economies including Brazil, India, China and South Africa. It is not clear how this trend will continue as these countries develop and more of the population may have access to digital print. Allwood et al. (2011), surveyed forecasts of future paper demand and identified global paper demand may be up to 2.4 times greater than 2008 levels by 2050. It also suggests that future global demand for paper and paperboard will be strongly influenced by demand in China. In the EU, newsprint and print/graphic paper demand has been falling but this has been somewhat offset by increases in demand for higher grades hygiene and packaging paper.

Figure A1.3 shows the breakdown of paper production by type in the UK in 2008.

Figure A1.3 Paper production in the UK, 2008

The degree of non-price competition



Source(s): The Carbon Trust (2011), Industrial Energy Efficiency Accelerator – Guide to the paper sector.

The UK paper industry is characterised by a few multinational large producers , who make decisions on an international firm-wide basis, and a number of smaller independent mills which tend to produce more specialised, higher value products. . In 1991 27,800 workers were employed by the industry in 103 mills in 1991. In 2011, the UK paper industry employed around 9,400 workers in 52 mills generating 4.4 tonnes of paper (1m for export). Only two of these are integrated mills with pulping facilities which directly inputs into paper production. A number of the mills generate recycled fibre which also feeds directly into paper production in the same location The majority of companies in the UK paper industry only operated a single mill in 2011. SCA (Swedish headquartered), DS Smith Plc (UK headquartered), Kimberley-Clark (US headquartered) and Arjo Wiggins (French headquartered) are the largest paper manufacturers in the UK, operating three or four mills each.

With the exception of 2011, at least one UK paper mill has closed every year since 1997. UK production currently meets around 40% of domestic demand. Although demand for most types of paper has fallen over the last year (with the exception of the tissue sector and coated mechanical sector), the UK Confederation of Paper Industries in its 2011 annual review identified particularly large falls in demand for printing and writing paper and attributes this to the growing and permanent popularity of e-readers. UK exports of this paper group although low in absolute terms, did increase by 9.1% between December 2010 and 2011, offering some reprieve to producers. UK production levels of all paper groups are currently similar to those in the early 1990s. Production levels fell in 2011 in a number of large paper producing countries including Finland, Sweden, Germany, France, USA and Japan. In contrast output in China but the papermaking industry grew by just over 13% in 2011.

Additional cost considerations include transport and transaction costs

According to the CEPI, in 2009, electricity costs represented approximately 7.2% of total production costs for the European paper industry. Electricity is mainly used for driving machinery, controlling systems and lighting. Pulp bought in the market represented 22.3% of costs (Europe is a net importer of pulp and net exporter of paper), wood 16%, chemicals 14.9%, labour 12.4% and fuels 11.3%, other cost categories represent 15.9% of production costs. Another estimate by CPI suggests that in the UK, energy costs represent closer to 20-30% of operational costs and raw material costs are CPI indicates that around two thirds of paper in the UK is now imported. However, it is difficult to make comparisons on the energy efficiency and costs schedules between different mills as the IEA notes no two paper mills are the same. As an example, they differ in terms of product mix, the way they source upstream materials and fuel mix.

Paper products are standardised and fairly homogenous. There is little differentiation between products from different suppliers, making the industry highly competitive in Europe, particularly as production capacity currently exceeds supply. Cost schedules are very important in determining market share in the industry. The European Commission identifies energy prices, availability and suitability of virgin and recyclable materials, access to secondary markets and efficient production processes as main determinants of a company's relative competitiveness in the market.

According to CEPI, transport and logistics currently represent around 10% of costs for European producers. Road is the preferred method of transport in Europe because of its relative speed and reliability over long distances (over 500km) compared with rail or water transportation. There was a temporary fall in road transport costs in 2009 due to the recession, but by 2010 road transportation costs were around 15% above 2008 levels due to declining freight transportation capacity. Long distant transportation may be problematic for some paper product categories e.g. tissue/hygiene products whose softness depends on air content which declines over longer distances. These products tend to be transported over smaller distances.

With the backdrop of the steady decline in the number of mills in the UK, the outlook for investment remains difficult as the industry faces increased costs and competition from overseas producers of homogenised goods. The weak investment by the sector is not confined to the UK: CEPI indicates that in the sector in Europe as a whole has fallen since 2007.

Key points for modelling:

- Applications of paper have possible substitutes (e.g. plastic food packaging, electronic publishing).
- UK production is fairly evenly spread across a number of product categories. The UK sector has a few multinational large producers and a number of smaller independent mills which typically operate a single facility. There are 52 mills in the UK
- Imports to the UK are comparatively high.
- Paper mills represent a large sunk cost by the producer and will be in operation almost continually.
- Demand for some paper products is pro-cyclical.
- Some paper products are standardised and fairly homogenous e.g. newsprint and packaging. There is little differentiation between products from different suppliers, making the industry highly competitive in Europe. Companies operating in some product groups e.g. hygiene, develop stronger branding to differentiate their products.
- The main determinants of a company's relative competitiveness are availability and suitability of recycled paper access to secondary markets (including road transport prices), energy prices, and efficient production processes.

A1.11.4 Energy-using characteristics and abatement options

The amount of electricity required in the production of paper depends on the technology used and the type of final product.

The IEA offers a range of typical electricity requirements for different paper types for EU producers (see Table A1.13).

The two integrated mills in the UK use mechanical pulping. The TUC estimates a total capital investment of £375m is required to convert these mills into chemical pulping mills.

Mechanical pulping requires around three times the amount of electricity needed for chemical pulping but produce higher yields. Unlike chemical pulping, mechanical pulping does not produce black liquor as a by-product that can combusted to produce heat and electricity (thereby making the industry partly self-sufficient in terms of its energy consumption). Chemical pulping mills are expensive to build and will require a local large-scale forest industry to ensure viability. As such, the UK has no chemical pulp mills.

One way of managing electricity consumption in the industry is through recycling. Recycling rates in the UK are already high. On average, recycled pulp represents 70% of the pulp used to make paper in the UK, in newsprint, the paper is made from 100% recycled pulp. Used paper is cut into small pieces and the mixture is heated to create a mixture of cellulose fibres similar to that of virgin pulp. The fibres in recycled pulp are generally shorter which makes the paper lower quality. As a result, paper fibres can only be recycled 4-7 times (depending on the material composition of the pulp) as they decrease in quality and virgin fibres then need to be used. Unrecoverable fibres can be used for energy recovery or as compost.

The recycled pulp is sieved through holes of different shapes and sizes to remove any additives that were applied to for the original paper use. Excess water is removed from the pulp and it undergoes the same production process as virgin pulp to make paper. According to Allwood et al (2011),[76] a tonne of recycled paper requires 18.7-20.7 Gj/tonne while using virgin pulp requires 15.3 -36 Gj/tonne of paper. The IEA offers an estimate of savings potential of up to 10.9Gj/t of recycled paper produced compared with virgin paper.

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[76] Allwood et al. (2011), Sustainable Materials with Both Eyes Open, UIT Cambridge

Table A1.13 Typical electricity requirements for different paper types

Paper type (description)	**Typical electricity requirements (kWh/t)**
Newsprint (paper mainly used for printing newspapers)	500-650
Uncoated mechanical (paper suitable for printing or other graphic purposes where less than 90% of the fibre furnish consists of chemical pulp fibres)	550-800
Uncoated wood-free (paper suitable for printing or other graphic purposes, where at least 90% of the fibre furnish consists of chemical pulp fibres)	500-650
Coated mechanical (all paper suitable for printing or other graphic purposes and coated on one or both sides with minerals e.g. china clay (kaolin), calcium carbonate where less than 90% of the fibre furnish consists of chemical pulp fibres)	550-700
Coated wood-free (all paper suitable for printing or other graphic purposes and coated on one or both sides with minerals e.g. china clay (kaolin), calcium carbonate where at least 90% of the fibre furnish consists of chemical pulp fibres)	650-900
Kraft paper (paperboard made up of a high percentage of unbleached Kraft pulp (chemically pulped using sulphite) mixed in some cases with recycled paper stock. It is used primarily as the outside layer of multi-ply corrugated container-board**)**	850
Tissue and speciality (tissue and other hygienic papers for use in households or commercial and industrial premises.)	500-3000

Source: IEA (2008) Tracking Industrial Energy Efficiency and CO_2 emissions
http://www.iea.org/publications/freepublications/publication/tracking_emissions.pdf

In Europe the industry uses black liquor and other forms of biomass to meet around 55% of their energy requirements, making good use of CHP technology. The IEA asserts that most modern paper mills have their own CHP unit. CHP is particularly well suited to the paper industry as heat is also required directly in the production process to evaporate moisture from pulp and paper during the hot rolling stage. The IEA estimates that CHP technology was used by 40% of the UK pulp and paper industry in 2003, producing around 12.73 Pj/year of electricity. This has increased to 70% in 2012. Future expansion of CHP in the industry may be limited as many manufacturers are small-medium sized enterprises and CHP technology represents a large investment cost. By cross-referencing sources from DECC and from The Carbon Trust, publically reported information suggests 8 of the 49 paper mills in the UK have CHP facilities.

Key points for modelling:

- Electricity costs represented 7.2% of total production costs for the European paper industry although requirements vary greatly on the different paper types being produced.
- Chemical pulping requires around a third the amount of electricity needed by mechanical pulping, and produces a by-product that can in turn be combusted to produce heat and electricity. However the yields are lower and to ensure viability, mills are situated close to large forests. As such, there are no chemical pulping mills in the UK.

- The cost of changing production processes of a plant is substantial.
- Most modern paper mills have their own CHP unit and 40% of the UK pulp and paper had the technology in 2003. Future expansion of CHP in the industry may be limited as many manufacturers are small-medium sized enterprises and CHP technology represents a large investment cost.

A1.12 Manufacture of inorganic chemicals - chlor alkali industry

A1.12.1 Summary findings for chlor-alkali industry

The electrolysis of sodium chlorine produces chlorine, sodium hydroxide and hydrogen in the ‘chlor-alkali’ process. These products have a wide application in a number of downstream sectors. The UK has one large chlor-alkali plant run by INEOS Chlor and a smaller one run by Brenntag.

The largest production capacity is in Asia, with China represents 50% of global chlorine production capacity.

The chlor-alkali process is a very electro-intensive production process, with electricity costs typically accounting for 60-70% of total production costs. Countries with relatively lower electricity prices will therefore have a notable competitive advantage. Electricity requirements will be depend on the technology used during electrolysis. Membrane technology is the most efficient in terms of electricity used per tonne of output.

The industry is increasingly looking to CHP technology to minimise the impact of increasing electricity costs. INEOS Chlor’s UK plant aims to generate 20% of its electricity requirements from CHP by 2013.

A new technology being explored in the industry is the use of waste hydrogen to generate electricity in local fuel cells which could be used to power further chlor-alkali processes in a self-sustaining ‘loop’.

A1.12.2 Industry definition

The manufacture of other inorganic basic chemicals in classified by SIC code 20.13. Within this sector, hundreds of different chemicals are produced through different techniques, which are used for a multitude of purposes either as a final product or as a feedstock into more complex chemical compounds.

This sector study focuses on the chlor-alkali industry. Chlor-alkali is the name given to the process of electrolysis of sodium chloride solution to produce chlorine, sodium hydroxide (caustic soda) and hydrogen in a fixed ratio77. A number of other sodium based products (eg sodium carbonate (soda ash) and sodium chlorate) can also be produced using these initial products. The chlor-alkali process can be applied to potassium chloride to produce potassium hydroxide (caustic potash), used in the chemical industry to make other potassium-based compounds and also used in fertilisers, soaps and detergents.

There is no single specific SIC code that refers specifically to the chlor-alkali process. However, its main products are listed in the PRODCOM database:

- 20.13. 21.11 – Chlorine
- 20.13.25.25 – Sodium hydroxide (caustic soda)
- 20.11.11.50 - Hydrogen

These products undergo further processing and are mixed with other chemicals to form a diverse range of chemical compounds for use in a number of industries.

A1.12.3 Market characteristics and other considerations

The products from the chlor-alkali process as mentioned above are chlorine, sodium hydroxide (caustic soda), sodium, hydrogen, sodium chlorate, sodium carbonate, These products have a huge range of applications in downstream sectors, as shown in Table 6.1.

According to Eurochlor, there are two chlor-alkali plants in the UK: INEOS ChlorVinyls in Runcorn, Cheshire which produces 707,000 tonnes of chlorine per annum (277,000 using

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[77] When these products are discussed individually in this chapter, it is implicit that co-products are also produced.

mercury technology and 430,000 using membrane cell technology) and Brenntag's plant in Thetford which produces just 7000 tonnes using 100% membrane cell technology[78].

In Europe, 70% of chlorine production is concentrated in Germany, Belgium/The Netherlands and France.

Caustic soda and chlorine, although produced in fixed proportions, have different sources of downstream demand and market dynamics. Their prices are co-dependent and in some instances, fluctuations can be large in cases of excess and short supply of either product.

The degree of non-price competition

Most production capacity current exists in Asia. In 2010, China was both the largest producer and consumer of chlorine and caustic soda worldwide. It increased its production capacity by 50% between 2004 and 2008[79].

The industry benefits from economies of scale and the flexibility of high production capabilities to respond to changing consumer demand. Prices will vary depending on extraction costs, supply logistics, proximity to downstream consumers, labour and energy. Energy costs are the most significant cost component in the chlor-alkali industry. The electricity required for electrolysis represents around 60%-70% of the variable production costs for the industry. As such, plants operating in countries with lower electricity costs will likely be relatively more competitive. The price of highly traded bulk commodities tends to converge and so cost differentials become an important determinant of profitability.

In terms of demand, Asia consumes around half of the total volume of caustic soda, soda ash and chlorine produced using the chlor-alkali process.

According to Eurochlor, around 35% of chlorine produced in Europe is used to produce PVC (in Europe) primarily for the construction, automotive, electronic and electrical industries. All of these industries are procyclical, but particularly the first two. Therefore the highest growth rates in PVC demand would be in emerging economies experiencing rapid rates of economic development, large-scale construction of infrastructure and rising disposable income and an increasingly mobile population. INEOS Chlor in the UK is Europe's largest producer of PVC and has a manufacturing site in Durham, 150 miles from its chlor-alkali plant in Cheshire, that operates 24 hours a day throughout the year.

Figure A6.2 shows the structure of demand in Europe for chlorine in 2009, and Figure A6.1 the structure of demand for caustic soda.

Table A1.14 Applications of Chlor-alkali products

Product	Application/Use
Chlorine	Manufacture of solvents, plastics e.g. PVC, cleaning and metal degreasing, textiles, agrochemicals and pharmaceuticals, insecticides, dyestuffs, household cleaning products and chemical weapons
Caustic soda	Manufacture of soap, pulping paper and ceramics, decomposing tissue, industrial cleaning agent,
Hydrogen	Manufacture of ammonia, fuel cell technology, making margarine
Sodium chlorate	Manufacture of domestic bleach, herbicide, provision of emergency oxygen in airplanes.
Soda ash	Softening water, glass manufacturing, developing photographic film, polishing silver and sometimes used in cooking.

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[78] http://www.eurochlor.org/media/63146/2012-annualreview-final.pdf

[79] http://eippcb.jrc.es/reference/BREF/CAK_D1_1211.pdf

Additional cost considerations include transport and transaction costs

There may be non-price barriers for non-UK and non-EU producers in the form of product specifications for imports containing chlorine or caustic soda. An example of this is the introduction of EU-wide restrictions on the use of dichloromethane in paint stripping in 2010. However, measures of this sort are unlikely to increase costs significantly for producers outside of the EU as a number of chemical inputs can be easily replaced or changed in products and large companies operating internationally are likely to be experienced in producing and marketing products to meet different regional end user requirements. EU producers are likely to face similar product requirements in a number of export locations.

There may also be issues with importing chlorine due to the hazardous properties of the chemical and difficulties with storage. This would likely make it expensive to transport over long distances. Imports and exports into Europe currently represent a very small proportion of total chlorine production in Europe (both less than 1%). In 2012, only 6% of all chlorine in the EU was transported outside of pipelines over long distances (4% by rail and 2% by road). Pipelines are usually less than 10km long from the source of production. According to its website, INEOS Chlor's preferred method of transport is by road tankers. The remaining 94% of EU production, which is not transported is used on the same or nearby sites for other chemical processing. Final products containing chlorine e.g. PVC are likely to be more highly traded than the chlor-alkali inputs.

Key points for modelling:

- The industry's products have a huge range of downstream applications.
- The UK has two chlor-alkali plants, with production dominated by INEOS ChlorVinyls site in Runcorn.

Figure A1.4 Use for Caustic soda in Europe

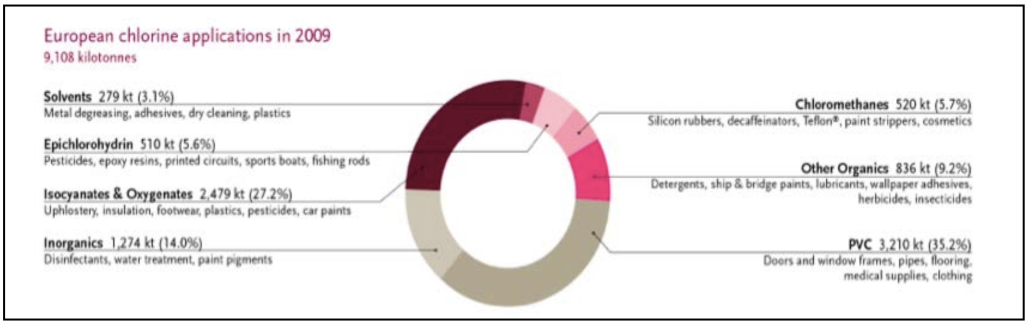
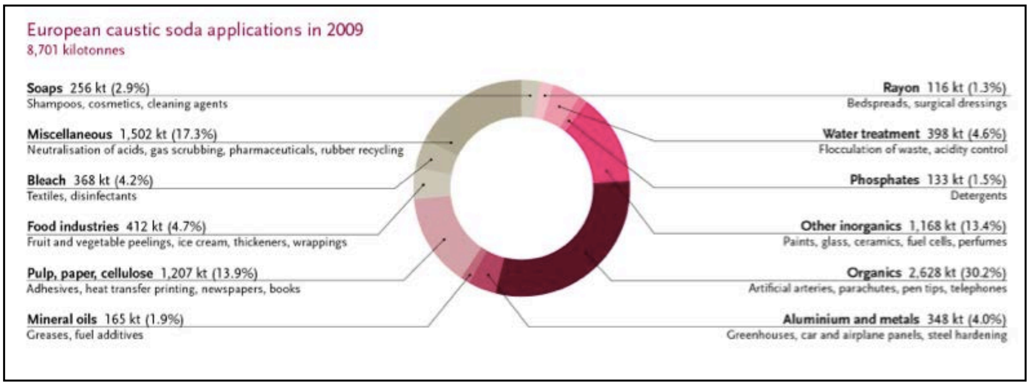


Figure A1.5 Use of Chlorine in Europe



- Energy costs are the most significant cost component in the chlor-alkali industry.
- In Europe, 70% of chlorine production is concentrated in Germany, Belgium/The Netherlands and France. Most global production capacity exists in Asia, with China the largest single consumer and producer.
- 35% of chlorine produced in Europe is used to produce PVC. INEOS Chlor in the UK is Europe's largest producer of PVC.
- Chlorine is expensive to transport due to its hazardous nature and difficulties in storage. The vast majority of chlorine produced in the EU is used in production nearby.

Table A1.15 Electricity requirements for different technologies

KWh/tonne ECU	Mercury process	Diaphragm process (asbestos)	Membrane process
Electrolysis cells	3360	2720	2650
Power and light	200	250	140
Total electricity	3560	2970	2790
Steam consumption	0	610	180
Total	3560	3580	2970

Source(s): EU chlor-alkali BREF 2001.

A1.12.4 Energy-using characteristics and abatement options

The chlor-alkali process requires a large amount of electricity (between 2,100 and 3,300 kWh/ t chlorine for the electrolysis). INEOS Chlor's largest production site in Runcorn, Cheshire, consumes the same amount of electricity as a city the size of Liverpool[80]. According to Eurochlor, around 90% of electricity consumption in a typical plant is from the electrolysis process and the remaining 10% from lighting, operating pump compressors and other equipment.

There are three main production routes used in the global chlor-alkali industry –membrane cell, mercury and diaphragm technologies. Membrane cell technology is the most efficient in terms of power consumption per tonne of output produced, around half of installed production capacity use this technology in Europe. However electricity still represents the largest cost component for producers using this technology. Approximately 30% of chlor-alkali capacity operates with mercury cell technology but there is a voluntary industry agreement to phase out this technology completely by 2020. Eurochlor has expressed concerns that this will require major investments and relatively high electricity prices, as the largest variable cost component in the industry, may incentivise a relocation of industry outside of Europe. In the UK, around 40% of INEOS Chlor's installed generating capacity uses using mercury technology.

A1.12.4 shows the typical electricity requirements of the technologies

The industry has made continual improvements in the energy efficiency of production to reduce costs. As an example, in the UK, INEOS Chlor's energy consumption per tonne of product fell by almost 18% between 1998 and 2008.

Further research is being undertaken in the industry on the impact of changing the parameters of the electrolytic cell (where electrolysis occurs) as this determines the electricity requirement to power the process. One example is the use of oxygen diffusion cathodes instead of hydrogen producing ones as the former requires less electricity and doesn't produce hydrogen

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[80] http://www.ineoschlor.com/efw/energyfromwaste.shtml

as a bi-product. US researchers suggest electricity requirements are reduced by almost a third. In Europe, the Best Available techniques reference (BREF) document is in the process of being updated and will be published in 2013 and give further guidance on industry good practice around electricity consumption which is the principle source of emissions in the industry.

In order to manage some of these energy costs, a number of plants in the UK chemicals industry use CHP. INEOS Chlor plans to generate 20% of its electricity requirements from its Runcore site using CHP by burning waste. The plant will be fully operational in 2013.

A new technology option that is currently being trialled in the industry is using waste hydrogen produced during electrolysis to generate electricity using local fuel cells which can then be used to power further electrolysis. Theoretically, this would mean the industry powers itself through a continual loop of electrolysis and hydrogen production. According to AFC energy, the use of waste hydrogen in fuel cells could generate more than 3,000 MW per annum of generating capacity if applied across the global chlor-alkali industry.

Key points for modelling:

- The chlor-alkali process is energy-intensive.
- Half of all EU chlor-alkali capacity uses the most energy-efficient technology, membrane technology. In the UK, around 40% of INEOS Chlor's installed generating capacity uses using mercury technology.
- INEOS Chlor plans to generate 20% of its electricity requirements from its Runcorn site using CHP, making it less exposed to increases in electricity costs

A1.13 Manufacture of fertilisers and nitrogen compounds

A1.13.1 Summary findings for manufacture of fertilisers and nitrogen compounds

Global demand for fertilisers is predicted to increase steadily to 2030 as populations expand, economies develop, diets change and agricultural productivity gains increasing importance.

The fertiliser industry produces different chemical compounds (all containing either nitrogen, phosphorous or potassium or a combination of the three) to produce different nutrients to be used by the agriculture sector to increase yield quality and quantity.

Ammonia is used in almost all fertiliser production and is produced via the Haber-Bosch process. The most efficient way of producing ammonia is by using natural gas as a primary feedstock (currently used in around 77% of global ammonia production). Natural gas represents between 70-90% of operating costs in an ammonia plant. Those countries with relatively cheap natural gas will have a competitive advantage. Electricity is not a significant input to the process.

Phosphorous and potassium (in the form of potash) are only mined in a few locations, and manufacturing tends to take place close by. This means fertiliser products are highly traded globally. Many commodities used as inputs into fertiliser production are susceptible to price volatility which in turn affects fertiliser prices and short-term profitability of its manufacture. EU import rates are currently around 30%. The UK is one of few countries in Europe that produces potash and is looking to expand production capacity.

The energy and electricity use in the production of fertilisers will differ depending on the product and plant characteristics. Some chemical reactions in the industry will lead to the production of waste energy, which can then be utilized for on-site electricity generation.

Electrolysis can also be used in ammonia production (with hydrogen instead of natural gas as the feedstock) but this is only economically viable in countries with cheap sources of renewable power. The industry is also technically well suited to the introduction of CCS due to the high concentration of waste CO2 produced during the manufacture of ammonia but this would increase production costs significantly for producers choosing to adopt this technology.

A1.13.2 Industry definition

The manufacture of fertiliser and nitrogen compounds is a subset of the chemicals industry. It is classified as SIC 20.15, and there are 30 products listed in this subsector in the PRODCOM database. The value of UK production for some of these product categories are not published (for confidentiality reasons). However, at European level, the products that generate the highest value are

- 20157100 Mineral or chemical fertilisers containing the three fertilising elements nitrogen, phosphorus and potassium (N, P, K)
- 20155100 Potassium chloride - Potash (KCl)
- 20153530 Mixtures of ammonium nitrate (NH_4NO_3) with calcium carbonate ($CaCO_3$)
- 20153300 Ammonium nitrate (NH_4NO_3)
- 20153130 Urea (CH_4N_2O)
- 20151075 Ammonia (NH_3)

The largest categories of UK production (for which data are published) are 20157100 and 20153300).

Some products in the industry are used as inputs in the production of other fertilisers or nitrogen compounds. For example, ammonia is used in the production of ammonium nitrate.

Fertilizers and nitrogen compounds are used to improve soil fertility, crop yields and crop quality. As plants grow, they absorb existing nutrients from the soil, which need to be replaced when plants are harvested to ensure continued soil fertility. The soil type and the plant-specific uptake of nutrients will determine the optimal choice of fertiliser.

Key points for the modelling:

- The UK industry is focused on the production of mineral or chemical fertilisers (containing nitrogen, phosphorus and potassium) and production of ammonium nitrate.

A1.13.3 Market characteristics and other considerations

The six chemical products listed in section 1.2 accounted for around 60% of the value of the EU fertiliser industry in 2011. These products, like most in the sector, are a mixture of both primary nutrients (nitrogen, phosphorus and potassium) and secondary and trace nutrients (e.g. calcium and chlorine). Oxygen (O) and carbon (C) are used by plants for respiration. Plants can only absorb nutrients when they are in ionic form (electronically charged), as is the case with fertilisers, which is why they cannot absorb these chemicals from the atmosphere (78% of air is nitrogen).

Nitrogen occurs naturally in many compounds in soil, water and air but is only usable as a plant nutrient when it is converted into ammonium ions through a process called ‘fixation’. Some fixation occurs naturally, e.g. by bacteria in the soil or by lightning, but nitrogen-based nutrients can be made on an industrial scale by the Haber Bosch process. In this process, nitrogen (from the air) is combined with hydrogen (usually from natural gas) and a catalyst (mainly iron-based) in a number of heated and pressured chambers. The process creates ammonia (NH_3), which can be liquefied, and some waste nitrogen and hydrogen that can be recycled. Ammonia is the source of nearly all manufactured nitrogen fertilisers. For example, ammonia can be combined with carbon dioxide in a production similar process (Bosch-Meiser), to create urea. Ammonia combined with nitric acid to make ammonium nitrate.

Phosphorus is often found in a non-soluble mineral form. However, in the fertiliser industry, phosphorus is made soluble by treating the rock with a mineral acid (e.g. sulphuric or nitric acid and then neutralising the mixture with ammonia).

Potash (soluble source of potassium) can be mined or manufactured through the evaporation of brines. The largest potash deposits are deep underground (around 1km below the surface). Mined potash needs to undergo some basic processing (crushing, grinding, scrubbing and separation) before being used. Potash manufacture involves putting the brine solution in a flotation tank with amine (a derivative of ammonia). The amine reacts with air and floats the potash to the top of the tank to be collected. The potash is rinsed, dried and compacted or crystallised for commercial use.

Demand for nitrogen fertilisers grew by 7% in Europe in 2011 (largely met by imports). In the same year, global demand exceeded supply. However this may change in the medium-term as $90bn of investment in new plant is set to become operational by 2015. The International Fertiliser Industry Association (IFA) anticipates nearly 250 new fertiliser plants will come on stream over the next five years. Asia currently accounts around 40% of ammonia production and is also the largest source of global demand.

Europe is a net importer of fertilisers. Of the 10.9m tonnes of nitrogen fertilisers consumed in Europe in 2010, 3.3m tonnes (30%) were imported, a 37% increase from the previous year. 1.3m tonnes of nitrogen fertilisers were exported from the EU in 2010. The expansion of US shale gas and ethylene capacity is anticipated to also expand ammonia production.

The degree of non-price competition

Global demand for fertilisers and nitrogen compounds has been growing quickly in recent years due to growth in the population, changing, more complex diets (most notably in large emerging economies), increased production of biofuels and higher prices for agricultural commodities. These trends are set to continue to at least 2030. According to the FAO, world population growth is forecasted to reach around 8.3bn by 2030 and will be increasingly well fed with an average of 3,050 kilocalories (kcal) available per person, compared to 2,800 kcal today. The proportion of biofuels in the global fuel mix is likely to increase as fossil fuels become scarcer and governments introduce policies to diversify their fuel mix (e.g. for environmental reasons or to ensure security of supply). Fertiliser Europe anticipates grain used for bio-ethanol to triple from current production levels by 2025. If these projections are to be achieved agricultural land will need to expand or be used more intensively. Both of these scenarios will require increased use of fertilisers. It is worth noting that climate change has the potential to change agricultural practices by 2030 with the forecasted increase in severity and intensity of weather patterns influencing farming decisions to maintain crop yields.

The UK fertilizer market is fairly concentrated, with around 60 firms working in the nitrogen fertiliser industry. In 2012, Growhow accounted for 30% of the market. It is owned by Yara, the world’s largest manufacturer of fertilizers, and CF Industries, the largest manufacturer of nitrogen fertilisers in North America.

Globally, the nitrogen fertiliser market is quite concentrated, possibly because of the large infrastructure requirements and associated benefits associated with economies of scale. Ammonia in particular is costly to produce. There are only 50 ammonia plants operating in Europe.

There are high rates of innovation in the industry to continually improve the performance of fertilisers. Fertilisers are increasingly tailored for specific crop requirements and precision application for different soil types and weather conditions. This trend is likely to continue as populations increase and more changeable weather patterns raise concerns about food security.

Additional cost considerations include transport and transaction costs

Natural gas (CH_4) is the primary feedstock for 77% of global ammonia production, it represents between 70 and 90% of the cost of production[81]. Countries with lower natural gas prices will have a competitive advantage relative to those facing higher feedstock prices. Gas prices around the world are varied and will change as new sources of conventional and unconventional gas are extracted. The increased extraction of shale gas in the US meant that in 2011, the price of gas in the US was around 60-70% lower than the price of gas in Europe. As new sources are discovered in different world regions, the countries which will benefit from relatively low gas prices in 2030 will those that are in the position today. For example, gas, which would have been flared during oil extraction, is being increasingly viewed as a potential feedstock in the production of ammonia[82]. A study on fugitive methane emissions and glass flaring in UK jurisdictions indicated that if captured and utilised, could meet a third of the energy requirements for producing, packaging and transporting all fertilisers used in the UK[83].

Naturally occurring phosphate is only found in a small number of countries, and the only phosphate mine operating in Europe is in Finland[84]. The UK imports 100% of the phosphates used as fertilizers and the agriculture industry has expressed concerns over the security of supply. There is considerable uncertainty surrounding estimates for the amount of global reserves of phosphates. However, new technology has reduced the price of its excavation, enabling access to previously unviable sources, which might offer some short-term reprieve to UK concerns about supply. Aside from mining costs associated with phosphate rock, the price

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[81] IEA (2007) Tracking industrial energy efficiency and CO_2 emissions.

[82] A number of online sources discuss this potential use of gas that would otherwise be flared across all locations where natural gas is produced or there are large amounts of fugitive methane emissions e.g. in the extraction of coal. The UNEP discusses its potential in the Democratic Republic of Congo (http://postconflict.unep.ch/congo/en/content/moanda-gas-flaring) while Reuters suggests potential in North Dakota, USA (http://www.reuters.com/article/2012/09/26/us-column-kemp-usfertiliser-idUSBRE88P0P620120926)

[83] Dawson & Hilton (2011), Fertiliser availability in a resource limited world: nitrogen and phosphorous. Food policy.

[84] Dawson & Hilton (2011), Fertiliser availability in a resource limited world: nitrogen and phosphorous. Food policy.

of phosphate fertilisers is linked to the price of its chemical components, which can be changeable. Historically, sulphur prices (essential in the manufacture of phosphate fertilisers) have been very volatile; the price of sulphur rose by 300% over 2008. Volatility in global commodity markets (particularly in gas prices) can have significant impact on the short-term profitability of fertiliser manufacturers and complicates and investment planning.

Potash is a relatively scarce resource and is only mined and manufactured in a few countries (Russia, Belarus, North America, Israel and Jordan, Western Europe account for 98% of global production[85]). The UK is a net exporter of potash. The mineral is excavated from the Boulby mine in York. Sirius UK, the owner of the mine is looking to expand its production capacity and has begun prospecting in the region and recently discovered the 'world's single thickest potash intersection ever reported'[86].

The above discussion indicates that countries with high levels of naturally occurring deposits of minerals for fertilizers and low natural gas prices will have a competitive advantage in their production. Given this, transport costs will have an increasing influence on fertiliser prices. Fertilisers are heavy and usually transported in bulk across long distances by both sea and land.

Key points for the modelling:

- Globally, a large number of new fertiliser production facilities will come onstream in the next five years.
- Europe is a net importer of fertilisers (c30% of demand)
- Global demand for fertilisers and nitrogen compounds has been growing quickly in recent years and future demand is expected to grow strongly.
- The UK fertilizer market is fairly concentrated. One company, Growhow (part of a global operation) accounted for 30% of the market.
- Nitrogen fertiliser market is quite concentrated globally. Ammonia in particular is costly to produce. There are only 50 ammonia plants operating in Europe
- Countries with high levels of naturally occurring deposits of minerals for fertilizers and low natural gas prices will have a competitive advantage in their production.
- The UK imports all the phosphates used as fertilizers (naturally occurring phosphate is only found in a small number of countries) but is a net exporter of potash, and mining reserves appear secure.

A1.13.4 Energy-using characteristics and abatement options

Approximately 87% of the energy required for making fertiliser products goes into manufacture of ammonia via the Haber-Bosch process, which uses catalysts to extract nitrogen from the air. It requires high temperatures (400-600 degrees) and pressures (20-40MegaPascals) and currently consumes around 1% of global power production[87]. Methane-based production (natural gas) is the most efficient process currently available and is the most widely used fossil fuel globally. Many plants operate close to the theoretical minimum energy requirements in the production process[88]. The IEA estimates the global energy intensity of ammonia production would fall by 20% if all plants used the best available technologies. Even though there have been improvements in energy efficiency of fertiliser production, the annual energy requirement for the industry represents approximately 1.1% of global energy use.

Electricity use in the production of fertilisers will differ depending on the product and plant characteristics. One estimate for the global fertiliser industry in 1995 (so now dated) estimated

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[85] http://eippcb.jrc.es/reference/BREF/lvic_aaf.pdf

[86] http://www.ft.com/cms/s/0/9ed25f12-16bf-11e1-a45d-00144feabdc0.html#axzz2H7ea9S4q

[87] http://www.nature.com/nchem/journal/v4/n11/full/nchem.1476.html

[88] BAT uses 28 Gj/t and the theoretical minimum requires 21Gj/j. Source: IEA (2007) Tracking industrial energy efficiency and CO_2 emissions.

electricity consumption of approximately 0.188 kWh per tonne of ammonia and 20-45 kWh per tonne of ammonium nitrate[89].

In some of the chemical reactions associated with making different fertilisers, there is a net gain in energy. One example is waste heat, which is produced in the conversion of ammonia to nitric acid, which can be used to generate electricity. The TUC[90] indicates that the fertiliser industry uses some of its waste stream for onsite electricity generation (further information on which sites in the UK use this technology was not readily available).

An alternative production route for ammonia, which has a different energy and electricity profile, is to use hydrogen instead of natural gas as a feedstock via electrolysis. In Norway, the Vemork plant operated by Norsk Hydro produces ammonia this way, generating electricity by hydropower. The adoption of this process in other countries depends on the relative prices of renewables and natural gas. The process is generally not economically viable unless there is an abundant source of cheap renewable power. Alternative production processes using alternative catalysts to iron (used in the Haber Bosch process) are being explored.

The IFA has identified CCS as a particularly promising technology for abating greenhouse gas emissions from the production of ammonia. CO_2 is produced in high concentrations as a waste gas during the Haber-Bosch process, making it a relatively cheap abatement option compared to introducing CCS technology in many other industrial sectors. Nevertheless, it would still represent a significant increase in costs for fertilizer producers who adopt it (the cost of capturing all ammonia emissions in the UK in this way is estimated at around £40m)[91].

Key issues for modelling:

- Electricity use in the production of fertilisers will differ greatly depending on the product and plant characteristics. It is required to create the necessary heat and pressure to extract nitrogen from the air.
- Approximately 87% of the energy required for making fertiliser products goes into manufacture of ammonia.
- An alternative production route for ammonia uses hydrogen instead of natural gas as a feedstock via electrolysis, although the process is generally not economically viable unless there is an abundant source of cheap renewable power (e.g. Norway).

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[89] UNEP/UNIDO/IFA (1998), Mineral fertilizer production and the environment.

[90] http://www.tuc.org.uk/tucfiles/52/EIITechnologyInnovation.pdf

[91] http://www.tuc.org.uk/tucfiles/52/EIITechnologyInnovation.pdf

APPENDIX 7: TECHNICAL SPECIFICATION OF THE MODEL

The model is designed to show impacts from a designated 'baseline'.

Demand

Growth in domestic demand:

$$GDD = GP * (OEL + XEL)$$

Growth in domestic demand is equal to change in the industry price (sum of domestic and import prices) (GP) multiplied by the sum of the industry's own price elasticity (OEL) and the cross-price elasticity (XEL).

Growth in UK export demand:

$$GX = GPX * (OELX + XELX)$$

Growth in export demand is equal to change in the export price multiplied by the sum of the industry's own export price elasticity (OELX) and the cross-price elasticity for exports (XELX).

Growth in import demand:

$$GM = \ \ GPM * (OELM + XELM)$$

Growth in import demand is equal to change in the average import price (GPM) multiplied by the sum of the industry's own export price elasticity (OELM) and the cross-price elasticity for exports (XELM).

Prices

Growth in import prices from producer country m:

$$GPMm = GEPm * \left(\frac{ECm}{Ym}\right) * PRm$$

The growth in import prices is growth in electricity prices in country m (GEP) weighted by the share of electricity costs (EC) in the cost of final production (Y) weighted then by the pass through rate (PR). Therefore, if producers can pass on all the increase in costs to the final consumer, then if electricity costs make up 10% of the cost of the product and electricity prices increase by 10%, then the price of output will rise by 1%.

Growth in average import price (facing UK consumers):

$$GPM = \sum_{m} GPm * (\frac{Mm}{M})$$

Growth in average UK import price is the sum of the individual import price increase (GPm), weighted by the relative share of total imports (Mm / M)[92].

Growth in domestic prices

$$GPD = GEC * (\frac{EC}{Y}) * PRD$$

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[92] In practice the model identifies imports from the 5 largest importing countries. The weighted average of changes in these countries is taken as the change in the average UK import price.

Growth in domestic industry price is change in electricity costs (GEC) weighted by the share of electricity costs in total cost of output (EC/Y) weighted by the pass-through rate for the domestic market (PRD).

Growth in export prices

$$GPX = GEC * (\frac{EC}{Y}) * PRX$$

Growth in export industry price is change in electricity costs (GEC) weighted by the share of electricity costs in total cost of output (EC/Y) weighted by the pass-through rate for the export market (PRX).

Other variables

Distributors trading margins:

$$MAG = Y * Rate\_MAG$$

Distributors margins (MAG) is calculated from industry output (Y) using an assumed rate (Rate_MAG)

UK product taxes:

$$YTAX = Y * Rate\_YTax$$

Similarly, UK product taxes (YTax) is calculated from industry output (Y) using an assumed tax rate (Rate_YTax).

Employment:

$$E = \frac{Y}{PROD}$$

Employment: (E) is calculated from industry output (Y) according to a productivity rate (PROD)

Wages and salaries:

$$WS = E * Rate\_WS$$

Similarly, total wages and salaries is calculated from employment (E) according to an average wage rate (Rate_WS)

Accounting identities

Domestic output:

$$Y = DD + X - M$$

Output is the total of domestic demand (DD) and exports (X) less imports (M)

Domestic output at basic prices:

$$Ybp = Ypp - MAG - YTAX$$

Output at basic prices is output at producer prices (Ypp) less distributors margins (MAG) less producer taxes (YTAX)

Value-added:

$$VA = Ypp - MIC$$

Value-added is output at producer prices less (Ypp) material input costs (MIC)

Material input costs:

$$MIC = MICxE + EC$$

Material input costs are material costs excluding electricity costs plus electricity costs

Gross operating surplus:

$$GOS = VA - WS - YTAX$$

Gross Operating Surplus is value-added (VA) les wages and salaries (WS) less product taxes (YTAX)

APPENDIX 8: MODELLING RESULTS BY SECTOR

A1.14 Results for the paper and paper products sector

A1.14.1 Model coverage

The model has been established for the sector as defined by SIC 17. The sector accounts for around 0.3% of value added in the UK, and employs around 58,000 people[93].

A1.14.2 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics:
  - Paper products are used in a large number of industry production processes. Certain applications of paper have possible substitutes (e.g. plastic food packaging, electronic publishing).
  - UK production is fairly evenly spread across a number of product categories. The UK sector has a few multinational large producers and a number of smaller independent mills which typically operate a single facility.
  - Of the 49 UK mills only two integrate mills with pulping facilities.
- Imports to the UK are comparatively high.
- Market characteristics and other considerations:
  - Paper mills represent a large sunk cost by the producer and will be in operation almost continually.
  - Demand for paper products is pro-cyclical.
  - Paper products are standardised and fairly homogenous. There is little differentiation between products from different suppliers, making the industry highly competitive in Europe.
  - The main determinants of a company's relative competitiveness are availability and suitability of forests, access to secondary markets (including road transport prices), energy prices, and efficient production processes.
- Energy using characteristics and abatement options:
  - Electricity costs represented 7.2% of total production costs for the European paper industry although requirements vary greatly on the different paper types being produced.
  - Chemical pulping requires around a third of the amount of electricity needed by mechanical pulping, and produces a by-product that can in turn be combusted to produce heat and electricity.
  - The cost of changing production processes of a plant is substantial.
  - Most modern paper mills have their own CHP unit and 40% of the UK pulp and paper had the technology in 2003. Future expansion of CHP in the industry may be limited as many manufacturers are small-medium sized enterprises and CHP technology represents a large investment cost.

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[93] Full-time equivalent (FTE) jobs.

A1.14.3 Key parameter assumptions

Table A1.16 Key parameters for the paper and paper products sector model

Variable	Value and evidence
Cost pass through rate for domestic producers	**Value:** range 20%- 40% **Evidence**: AEA, CE Delft (2012) study suggests pass through rate between 0% and 38%. An approximate mid-point was used as a lower bound, consistent with IBIS (2012) suggesting medium concentration.
Domestic demand (own) price elasticity	**Value:** -0.5 **Evidence:** Vivid Economics (2006) estimates a demand elasticity of -0.5. CE (2009) estimates a domestic demand price elasticity of -0.5. Consistent with a low pass-through rate.
Export demand (own) price elasticity	**Value:** -0.7 **Evidence:** CE (2009). Although only significant at just over a 10% confidence interval, it seems plausible as a reflection of the sector, where trade substitution occurs.
Import supply (own) price elasticity	**Value:** -0.5 **Evidence:** No quantitative evidence from the literature. Possibly because import prices have moved with domestic prices historically driven by forestry prices and international energy prices. Assume same elasticity as for domestic demand as a whole.
Domestic demand (cross) price elasticity	**Value**: 0.9 **Evidence:** CE (2009). Consistent with market characterization of a fairly homogenous product group with relatively high trade ratios
Export demand (cross) price elasticity	**Value**: 0.0 **Evidence:** **No quantitative estimates from the literature.**
Import supply (cross) price elasticity	**Value**: 0.5 **Evidence**: No quantitative estimates from the literature. Qualitative assessment suggests quite high degree of homogeneity of imports and domestic production.

A1.14.4 The results

A1.14.4 shows the impact of the convergence and EU-action only price scenarios under alternative parameter values.

Table A1.17 Impact of policy scenarios on the paper and paper products sector

Impact compared to Baseline						
	Convergence scenario			EU-led action		
	2020	2025	2030	2020	2025	2030
Low pass through rates						
GVA (%)	-3.9	-4.4	-4.9	-3.9	-4.5	-5.1
Employment (%)	-0.2	-0.1	0.0	-0.2	-0.1	-0.1
Employment (jobs)	-129	-51	24	-110	-82	-78
Gross operating surplus (£2010m)	-146	-167	-189	-145	-168	-192
Gross operating surplus (%)	-8.0	-9.2	-10.4	-8.0	-9.3	-10.6
Profit margin (pp impact)	-1.2	-1.4	-1.6	-1.2	-1.4	-1.6
Profit margin (%, level)	14.4	14.2	14.0	14.4	14.2	14.0
High pass through rates						
GVA (%)	-3.2	-3.4	-3.6	-3.2	-3.5	-4.0
Employment (%)	-0.4	-0.2	0.1	-0.4	-0.3	-0.3
Employment (jobs)	-257	-100	47	-219	-162	-154
Gross operating surplus (£2010m)	-115	-127	-141	-113	-129	-147
Gross operating surplus (%)	-6.3	-7.0	-7.7	-6.2	-7.1	-8.1
Profit margin (pp impact)	-0.9	-1.1	-1.2	-0.9	-1.1	-1.2
Profit margin (%, level)	14.8	14.6	14.5	14.8	14.6	14.5

Table A1.18 Impact on Industry Prices in 2030 – paper and paper products

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.5%	0.5%
Imports	0.3%	0.2%
High pass through		
UK	0.9%	0.9%
Imports	0.6%	0.4%

Costs of UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high-and low pass through environment, so such that by 2030 UK industry prices are 0.9% higher under the high bound pass through rate assumption (40%) and just 0.5% higher under the lower bound view (20%). The equivalent increase in the cost of imports is of a similar scale (0.6%) in the convergence scenario, but the EU-led policy scenario results in import prices just 0.3% higher (under the high pass through rate) in 2030 than in the absence of policy.

There is an adverse effect on value-added and the level of profits in each scenario under both pass through rate assumptions because even under the high pass-through assumption a large amount of the cost must still be absorbed (60%).

In the absence of equivalent policy measures outside of the EU, the policies lower employment in the sector. However, in the case of the convergence scenario where other world regions also face higher electricity prices there is a small positive employment impact in the long term (compared to a no convergence policy scenario) as a consequence of demand switching to domestic production because of the increase in import costs (as determined by the cross-price elasticities). There is still an adverse impact on employment in the short term because (carbon) prices do not converge until the end of the period modelled (2030).

Higher pass through rates support the level of profit (gross operating surplus) and profit margins. Profit margins under the high pass through rate are some 0.4 pp higher than under low profit margins. Under low pass through rates, profit rates fall to 14.0% in 2030 from 15.9% in 2011. The variation in profits occurs only due to the range of pass through rates considered, rather than between the two policy scenarios.

Table A1.19 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, and so there is no change in demand and output (or employment). The impact is seen in value-added, profits and profit margins.

Table A1.19 Impact of zero pass through rates – paper and paper products

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-4.6	-5.4	-6.2
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0	0	0
Gross operating surplus (£2010m)	-177	-207	-237
Gross operating surplus (%)	-9.8	-11.5	-13.1
Profit margin (pp impact)	-1.5	-1.8	-2.0
Profit margin (%, level)	14.1	13.8	13.5

In a world where costs cannot be passed on, the results are the same for both the EU-led and Convergence scenarios and reflect the cost imposition of the increased electricity bill on the sector.

In this case industry value-added falls by 6.2% and profit margins fall to around 13.5%.

A1.15 Results for the iron and steel sector

A1.15.1 Model coverage

The model has been established for the sector as defined by SIC 24.1-24.3, and matches precisely the sector of interest to the CCC. The sector accounts for around 0.1% of UK output and employs around 33,000 people[94].

A1.15.2 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics:
  - Risk of import competition is high;
  - Risk of competition for exports is high;
  - Output (in response to investment demand) is pro-cyclical but on a declining trajectory in Europe as economies mature;
  - Few other products are good substitutes for Iron and Steel in most applications.
- Market characteristics and other considerations:
  - High costs of energy and raw material inputs.
  - Volatile prices from input factors other than energy, such as raw materials;
  - Iron and steel products are not homogenous and quality is an inherent differential between producers. The implication is that the market is not perfectly competitive.
  - Increasingly global supply chains. The implication is that non-energy input costs are likely to even out for all producers (depending on transport costs).
- Energy using characteristics and abatement options:
  - Different energy profile and abatement options for BF and EAF route
  - Some CHP occurring in the industry
  - CCS and step change technologies will become available in the medium term but potential trade-off between emissions and energy management and production costs.

A1.15.3 Key parameter assumptions

Table A1.20 Key parameters for the iron & steel sector model

Variable	Value and evidence	
Cost pass through rate for domestic producers	**Value:**	Range 25%-75%
	Evidence:	AEA, CE Delft study for BIS (2012) suggests pass-through is 110-120%. CE Delft (2010) suggests 100-120%. Over 100% seems implausible. Pass through rates likely to decline in the future as new trading partners with low carbon costs enter the market.
Domestic demand (own) price	**Value:**	-0.62

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[94] Full-time equivalent jobs.

elasticity	**Evidence:** CE (2009) estimates a much larger value of -5.9 but seems inconsistent with 100% pass-through. Vivid Economics (2006) estimates a demand elasticity of -0.62, which seems feasible but doesn't explain trade responses
Export demand (own) price elasticity	**Value** **-**0.62 **Evidence:** No quantitative evidence from literature. Assume price effect in export markets is same as domestic demand.
Import supply (own) price elasticity	**Value:** -0.57 **Evidence**: CE (2009)
Domestic demand (cross) price elasticity	**Value**: 0.2 **Evidence**: CE (2009).
Export demand (cross) price elasticity	**Value**: 0.0 **Evidence**: No evidence**.**
Import supply (cross) price elasticity	**Value:** 0.2 **Evidence:** Value of 0.3 insignificant in CE (2009 study). No other evidence.

A1.15.4 The results

Table A1.21summarises the impact of the two scenarios on the sector under the high and low pass through rate assumptions.

Table A1.21 Impact of policy scenarios on iron & steel Sector

Impact compared to Baseline						
	Convergence scenario			EU-led action		
	2020	2025	2030	2020	2025	2030
Low pass through rates						
GVA (%)	-3.7	-5.2	-6.9	-3.7	-5.2	-7.0
Employment (%)	-0.2	-0.2	-0.2	-0.2	-0.2	-0.3
Employment (jobs)	-58	-61	-59	-56	-69	-89
Gross operating surplus (£2010m)	-61	-84	-110	-61	-84	-110
Gross operating surplus (%)	-18.0	-27.5	-40.9	-18.0	-27.6	-41.0
Profit margin (pp impact)	-0.6	-0.8	-1.1	-0.6	-0.8	-1.1
Profit margin (%, level)	2.7	2.1	1.5	2.7	2.1	1.5
High pass through rates						
GVA (%)	-1.7	-2.2	-2.7	-1.7	-2.3	-3.0
Employment (%)	-0.5	-0.5	-0.5	-0.5	-0.6	-0.8

Employment (jobs)	-175	-180	-172		-168	-205	-261
Gross operating surplus (£2010m)	-22	-30	-39		-22	-30	-40
Gross operating surplus (%)	-6.4	-9.0	-12.2		-6.4	-9.1	-12.5
Profit margin (pp impact)	-0.2	-0.3	-0.4		-0.2	-0.3	-0.4
Profit margin (%, level)	3.1	2.9	2.7		3.1	2.9	2.7

Table A1.22 Impact on industry prices in 2030

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.5%	0.5%
Imports	0.4%	0.2%
High pass through		
UK	1.8%	1.8%
Imports	1.1%	0.5%

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Sector output prices differ between a high-and low pass through environment, such that by 2030 UK industry prices are 1.8% higher under the high bound pass through rate assumption (75%) and just 0.5% higher under the lower bound view (25%) for pass through rates. The equivalent increase in the cost of imports is about two-thirds the increase in UK prices in the convergence scenario (1.1% increase), but the EU-led policy scenario results in import prices just 0.5% higher (under the high pass through rate) in 2030.

Both policy environments result in lower levels of value-added, employment and profits for the Iron and Steel sector in the UK as a result of the higher electricity costs faced. The largest impact is in the EU-action only under the low pass through assumption. In this case value-added in 2030 is 7.0% lower than would otherwise be the case. Profits are estimated to be around 40% lower if cost pass through is low, but only around 12.5% lower if the sector can pass on 75% of the increased electricity cost.

Table A1.23 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.23 Impact of zero pass through rate assumptions – iron & steel

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-4.7	-6.7	-9.1
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0	0	0
Gross operating surplus (£2010m)	-81	-111	-146
Gross operating surplus (%)	-23.8	-38.0	-59.6
Profit margin (pp impact)	-0.8	-1.1	-1.4
Profit margin (%, level)	2.5	1.7	1.0

In this case, by 2030 industry value-added is 9% lower than would otherwise be the case and profit margins will have become almost zero. Given this low rate, if faced with the inability to pass on cost increases, then firms would be forced to close the most inefficient plants.

A1.16 Results for the cement sector

Model coverage

For the cement sector we have modelled three sectors:

- Cement, lime plaster and articles of concrete, etc. (23.5-6)
- Cement (23.51)
- Lime (23.52)

The original project specification was to assess Cement (23.51) and so the qualitative review (see section 4.6.2 below) only discusses Cement (23.51). The models share the same parameters, but are informed with (sub-) sector specific data. The parent sector accounts for around 0.1% of UK value added and it employs around 34,000 people[95]. The sub-sector Cement (23.51) employs around 3,000 people while just 1,000 people are employed in the Lime sector (23.52).

A1.16.1 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics:
  - Risk of import competition has been weak historically, particularly for inland markets, however import supply is increasing from mainland Europe - price elasticities of demand are likely to be medium to low
  - There are few substitutes for most applications of the product which means producers have historically had few barriers in passing on costs, but increased import pressure from Europe might make this more difficult in the future
  - Growth in UK market tied to economic growth (demand for gross fixed capital formation - investment), and will not be as strong as in developing countries
- Market characteristics and other considerations:
  - The market characteristics suggest that cost-price pass-through will be medium to high and, correspondingly, demand responses to price will be medium to low
  - Changes in production will have a limited impact on employment given the low employment ratios as an input
- Energy using characteristics and abatement options:
  - There are abatement/efficiency options but changes in any one fuel input can affect the requirements for other fuel inputs depending on which stage of the production process they are used
  - Investment in new capital is required to bring about changes to the energy-using characteristics of the production process, and so changes in the energy use are likely to follow the sectors' investment cycles which can be long. As a result the sector can find itself ‘locked-in’ to costly technology and processes as a result of substantial changes in energy prices

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[95] Full-time equivalent jobs.

A1.16.2 Key parameter assumptions

Table A1.24 Key parameters for the cement sector models

Variable	Value and evidence
Cost pass through rate for domestic producers	**Value**: Range: 30%-70% **Evidence:** AEA, CE Delft (2012) study suggests pass through rate between 0% and 36%. However, the qualitative evidence suggests there are no product substitutes and trade ratios are low (albeit increasing).
Domestic demand (own) price elasticity	**Value:** -0.27 **Evidence:** Vivid Economics (2006) estimates a demand elasticity of -0.27.
Export demand (own) price elasticity	**Value:** -0.2 **Evidence:** No quantitative estimates from the literature. View taken that export demand will respond as domestic demand.
Import supply (own) price elasticity	**Value**: -0.2 **Evidence:** CE (2009)
Domestic demand (cross) price elasticity	**Value**: 0.2 **Evidence:** CE (2009).
Export demand (cross) price elasticity	**Value**: 0.0 **Evidence:** No evidence.
Import supply (cross) price elasticity	**Value**: 0.2 **Evidence:** Value of 0.3 insignificant in CE (2009 study). No other quantitative estimates in the literature.

A1.16.3 The results

Table A1.25summarises the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.25 Impact of policy scenarios on cement, lime and plaster, and other concrete articles, etc (SIC 23.5-6)

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-2.5	-2.9	-3.3		-2.5	-2.9	-3.3
Employment (%)	-0.1	0.0	0.0		-0.1	0.0	0.0
Employment (jobs)	-23.1	-17.0	-9.9		-21.0	-18.4	-16.5
Gross operating surplus (£2011m)	-44.8	-51.6	-58.7		-44.7	-51.7	-58.8
Gross operating surplus (%)	-8.1	-9.4	-10.7		-8.1	-9.4	-10.7
Profit margin (pp impact)	-0.6	-0.7	-0.8		-0.6	-0.7	-0.8

Impact compared to Baseline						
	Convergence scenario			EU-led action		
	2020	2025	2030	2020	2025	2030
Profit margin (%, level)	7.3	7.2	7.0	7.3	7.2	7.0
High pass through rates						
GVA (%)	-1.2	-1.3	-1.4	-1.2	-1.3	-1.5
Employment (%)	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Employment (jobs)	-53.6	-39.3	-22.9	-48.6	-42.6	-38.2
Gross operating surplus (£2011m)	-19.9	-22.6	-25.4	-19.8	-22.7	-25.7
Gross operating surplus (%)	-3.5	-4.0	-4.6	-3.5	-4.1	-4.6
Profit margin (pp impact)	-0.3	-0.3	-0.4	-0.3	-0.3	-0.4
Profit margin (%, level)	7.8	7.7	7.7	7.8	7.7	7.7

Table A1.26 Impact on industry prices in 2030 - cement, lime and plaster, and other concrete articles, etc. (SIC 23.5-6)

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.5	0.5
Imports	0.3	0.2
High pass through		
UK	1.1	1.1
Imports	0.6	0.5

For the parent sector the cost impact has a modest impact, but this is exaggerated for the Cement (23.51) sector in particular as the most electro-intensive part of the sector. If electricity costs are passed-on to final prices for the overall sector, they are likely to push up UK prices by 1.1% (70% pass-through) or 0.5% under 30% pass through.

The outcome for the two external policy environment scenarios are very similar, indicating that there is currently limited competition for UK producers from countries outside of the EU, although this might increase in the future. The impact does vary according to the extent that producers can pass through costs.

Unsurprisingly, the largest impact is with low pass through rates, under which value-added in 2030 is about 3% lower than would otherwise be the case. Profits are 12% lower and the profit margin has fallen from 8.1% in 2011 to 7.0%. Most of the reduction in profit rates occurs in the short term (before 2020). In contrast, with high pass through rates, profit margins fall to 7.7% in 2030.

Table A1.27 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.27 Impact of zero pass through rate assumption – cement, lime and plaster, and other concrete articles, etc. (SIC 23.5-6)

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-3.5	-4.1	-4.6
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0.0	0.0	0.0
Gross operating surplus (£2011m)	-63.5	-73.4	-83.6
Gross operating surplus (%)	-11.6	-13.5	-15.4
Profit margin (pp impact)	-0.9	-1.1	-1.2
Profit margin (%, level)	6.9	6.8	6.6

In this case, by 2030 industry value-added is 4.6% lower as a result of absorbing the increased electricity costs, but profit levels remain modest (compared to some other sectors assessed), remaining about 6.6% in 2030, although this still represents a fall in profits of around £84m compared to what they might have otherwise been.

Table A1.28 Impact of policy scenarios on cement sector (SIC 23.51)

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-10.3	-12.3	-14.4		-10.3	-12.3	-14.4
Employment (%)	-0.2	-0.2	-0.2		-0.2	-0.2	-0.2
Employment (jobs)	-7.4	-6.5	-5.8		-6.4	-6.3	-6.4
Gross operating surplus (£2011m)	-19.3	-23.0	-26.9		-19.3	-23.0	-26.9
Gross operating surplus (%)	-54.8	-67.3	-80.8		-54.8	-67.3	-80.9
Profit margin (pp impact)	-3.2	-3.9	-4.5		-3.2	-3.9	-4.5
Profit margin (%, level)	2.7	1.9	1.1		2.7	1.9	1.1
High pass through rates							
GVA (%)	-4.8	-5.6	-6.4		-4.8	-5.6	-6.5
Employment (%)	-0.6	-0.5	-0.4		-0.5	-0.5	-0.5
Employment (jobs)	-17.2	-14.5	-12.8		-14.9	-13.9	-14.1
Gross operating surplus (£2011m)	-8.5	-10.1	-11.7		-8.5	-10.1	-11.7
Gross operating surplus (%)	-21.9	-26.3	-30.9		-21.8	-26.3	-31.0
Profit margin (pp impact)	-1.4	-1.7	-2.0		-1.4	-1.7	-2.0

Profit margin (%, level)	5.1	4.8	4.4		5.1	4.8	4.4

The sub-sector Cement (SIC 23.51) is relatively more severely affected than the parent sector because it is the most electro-intensive part of the supply-chain. Under low pass-through assumptions the sector is expected to see reductions in GVA of around 14% compared to a reduction in the parent sector of just 3.3%. Profits margins could fall as low as 1.1% which would clearly lead to plant closures and a substantial shift towards imports.

However, if European and global electricity prices were more similar (ie if carbon prices converged), then the sector would be more able to pass-on costs (as import competitors would be facing similar cost pressures) as a result, the impact on value added could be considerably reduced (6% at 70% pass-through).

Table A1.29 Impact of policy scenarios on the lime sector (SIC 23.52)

Impact compared to Baseline							
	Convergence scenario				**EU-led action**		
	2020	**2025**	**2030**		**2020**	**2025**	**2030**
Low pass through rates							
GVA (%)	-4.1	-4.8	-5.6		-4.1	-4.8	-5.6
Employment (%)	-0.1	0.0	0.0		-0.1	0.0	-0.1
Employment (jobs)	-0.8	-0.4	-0.4		-0.6	-0.4	-0.6
Gross operating surplus (£2011m)	-1	-1	-1		-1	-1	-1
Gross operating surplus (%)	-16.9	-20.1	-23.4		-16.8	-20.1	-23.5
Profit margin (pp impact)	-1.0	-1.2	-1.4		-1.0	-1.2	-1.4
Profit margin (%, level)	4.9	4.7	4.5		4.9	4.7	4.5
High pass through rates							
GVA (%)	-1.9	-2.1	-2.5		-1.9	-2.1	-2.5
Employment (%)	-0.2	-0.1	-0.1		-0.1	-0.1	-0.1
Employment (jobs)	-1.8	-0.8	-0.9		-1.5	-0.8	-1.3
Gross operating surplus (£2011m)	0	0	0		0	0	0
Gross operating surplus (%)	-7.2	-8.4	-9.8		-7.1	-8.4	-9.8
Profit margin (pp impact)	-0.4	-0.5	-0.6		-0.4	-0.5	-0.6
Profit margin (%, level)	5.7	5.6	5.5		5.7	5.6	5.5

The Lime sector is relatively worse affected than its parent sector, but as its electro intensity is lower than Cement, it is less affected than Cement (SIC 23.51). As with Cement, under low pass-through rates, the profitability of the sector could fall to levels that would lead to plant closures and a shift towards import supply.

Historically imports are dominated by European supplies and, based on that, import substitution is likely to be modest as European electricity prices are likely to be similar to UK prices.

A1.17 Results for the rubber and plastics sector

A1.17.1 Model coverage

The model has been established for the sector as defined by SIC 22. The sector accounts for around 0.7% of UK output and employs around 150,000 people[96].

A1.17.2 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics:
  - The value of UK production is dominated by the plastics sector, although tyres represent the largest single commodity produced (in terms of value). The plastics industry is segmented in two: manufacture of plastic plates, sheets, tubes and profiles for use in e.g. construction, automotives, and manufacture of plastic packaging goods.
  - Around 7,400 companies operate in the UK plastics industry, of which 1,500 are involved in plastics packaging, suggesting little market power for producers in the plastics market generally.
  - General rubber goods are primarily destined for the automobile industry, but are also used in the construction, mechanical and pharmaceutical industries (e.g. medical/scientific equipment).
- Market characteristics and other considerations:
  - The UK plastics industry is highly fragmented, with strong competition among SMEs in the UK for the domestic market.
  - A high proportion of the cost base for plastic manufacturers is accounted for by the hydrocarbon feedstock.
  - Transport costs can be a key factor limiting imports, particularly of low grade items.
  - Increased recycling rates will reduce the dependence on virgin hydrocarbon feedstock (and the associated price volatilities). UK recycling rates are lower than in some competitor EU regions.
- Energy using characteristics and abatement options:
  - Energy efficiency trends are quite strong in the sector: the energy efficiency of machinery in the plastics processing has increased by 20%-50% in a decade.
  - 3-D printing is a possible step-change in technology, with implications for the industry's energy demand.

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[96] Full-time equivalent jobs.

A1.17.3 Key parameter assumptions

Table A1.30 Key parameters for the rubber and plastics sector model

Variable	Value and evidence
Cost pass through rate for domestic producers	**Value**: Range: 40%-75% **Evidence**: AEA, CE Delft study for BIS (2012) suggests pass-through for sub-sectors of 100% for PVC and 80% “other rubber”. Some degree of product heterogeneity suggests pass through might be high, but large number of producers suggests it will not be 100%.
Domestic demand (own) price elasticity	**Value**: -0.41 **Evidence:** Literature estimates are statistically insignificant, but value of zero seems implausible, low elasticity assumed.
Export demand (own) price elasticity	**Value**: -0.41 **Evidence**: Assumed elasticity the same as domestic price elasticity.
Import supply (own) price elasticity	**Value**: -0.41 **Evidence**: CE (2010).
Domestic demand (cross) price elasticity	**Value**: 0.53 **Evidence**: CE (2010). Seems plausible given high import supply ratio.
Export demand (cross) price elasticity	**Value**: 0.42 **Evidence**: CE (2010). This seems plausible given the tradable nature of the sector and products.
Import supply (cross) price elasticity	**Value**: 0.1 **Evidence**: CE (2010) estimates are statistically insignificant, but value of zero seems implausible for this sector, low elasticity assumed.

A1.17.4 The results

Table A1.31 summarise the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.31 Impact of policy scenarios on rubber & plastics sector

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-2.6	-2.8	-2.9		-2.6	-2.9	-3.2
Employment (%)	-0.3	-0.1	0.1		-0.2	-0.2	-0.2
Employment (jobs)	-388	-108	199		-344.9	-268.9	-243.9
Gross operating surplus (£2011m)	-193	-214	-235		-192.0	-217.9	-245.2
Gross operating surplus (%)	-5.4	-6.0	-6.6		-5.4	-6.1	-6.9
Profit margin (pp impact)	-0.8	-1.0	-1.1		-0.8	-1.0	-1.1
Profit margin (%, level)	15.4	15.3	15.1		15.4	15.3	15.1
High pass through rates							
GVA (%)	-1.5	-1.3	-1.0		-1.4	-1.5	-1.6
Employment (%)	-0.5	-0.1	0.2		-0.4	-0.3	-0.3
Employment (jobs)	-1000<	-200<	500>		-1000<	-500<	-500<
Gross operating surplus (£2011m)	-94	-93	-91		-92.2	-100.4	-110.9
Gross operating surplus (%)	-2.6	-2.6	-2.5		-2.6	-2.8	-3.1
Profit margin (pp impact)	-0.4	-0.4	-0.5		-0.4	-0.4	-0.5
Profit margin (%, level)	16.1	16.0	15.9		16.1	16.0	15.9

Table A1.32 Impact on industry prices in 2030 – rubber and plastics

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.9%	0.9%
Imports	0.7%	0.3%
High pass through		
UK	1.7%	1.7%
Imports	1.3%	0.6%

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high-and low pass through environment, so such that by 2030 UK industry prices are 1.7% higher under the high bound pass through rate assumption (75%) and just 0.9% higher under the lower bound view (25%) for pass through rates. The equivalent increase in the cost of imports is about the same under as for the UK in the convergence scenario and only a third of the UK increase in the EU-led scenario.

Both policy environments result in lower levels of value-added, gross operating surplus and profit margins than would be the case in the absence of the policies, though the employment effect is positive in the long term (especially in the convergence scenario). The largest impact on value-added is in the EU-action only under the low pass through assumption. In this case value-added in 2030 is 3¼% lower than would otherwise be the case, with profits 7% lower and the profit margins falling slightly from 16½% of gross output in 2011 to around 15% in 2030. In contrast, in the most favourable of the four outcomes shown (convergence scenario under high pass through) value-added in 2030 is only 1% lower than in the absence of policy and profit margins only fall marginally to just below 16%.

Table A1.33reports the outcome under the convergence scenario in the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost of the increase.

Table A1.33 Impact of zero pass through rate assumption – rubber & plastics

Impact compared to baseline (with zero pass through rate)			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-3.9	-4.5	-5.1
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0	0	0
Gross operating surplus (£2011m)	-306	-352	-399
Gross operating surplus (%)	-8.7	-10.0	-11.4
Profit margin (pp impact)	-1.4	-1.6	-1.8
Profit margin (%, level)	14.7	14.5	14.2

In this case, by 2030 industry value-added is 5% lower than would otherwise be the case and profit margins fall to 14%.

The resilience of the sector to increased electricity costs is largely due to the relatively minor role electricity plays in the manufacturing process, with electricity costs only 3-4% of output and 5-6% of material inputs.

A1.18 Results for the glass/glass products sector

A1.18.1 Model coverage

The model has been established for the sector as defined by SIC 23.1. The sector accounts for around 0.1% of UK output and employs around 20,000 people[97].

A.8.5.1 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics:
  - The industry produces a wide variety of products, ranging from container glass to glass fibres. However, the diversity of the sector has diminished over the last decade or so with lighting, optical fibres & optics and large scale tableware subsectors that have either ceased production in the UK or are much less prominent than they once were.
  - There remain a large number of glass manufacturing enterprises in the UK. The main products from the UK industry are multiple-walled insulating units of glass for use in the construction sector (e.g. double glazing), small clear glass bottles and bulk articles of glass fibres.
  - Internationally, production tends to be fairly closely-located to markets due to the comparatively high transport costs of a relatively heavy product.
  - UK leads the world in flat glass innovation.
  - Large-scale glass production is a capital-intensive process and plants represent a large sunk cost for the operator.
- Market characteristics and other considerations:
  - Overall, extra-EU imports of glass remains low (less than 10% of total production across the sector as a whole), although there is wide variation by commodity: extra-EU import penetration for container glass was only 2% in 2011 while import penetration for glass fibres was close to 60%.
  - The majority of EU flat glass production has historically been traded within the EU, there is increasing import penetration in certain glass subsectors (e.g. imports of Chinese flat glass have increased strongly recently). Import competition from Russia and the middle East is expected to intensify following investments in new facilities there.
- Energy using characteristics and abatement options:
  - Furnaces in these glass subsectors are usually only replaced every 15-20 years. Therefore, any changes in furnace technologies in terms of efficiency improvements, risk taking a long time to proliferate throughout the industry.
  - Glass manufacturing is energy intensive. Typically, most (80%) of the energy comes from natural gas. However, the energy requirements differ for different glass product types.
  - Little opportunity was seen for the UK industry adopting CHP in the short term because of technical difficulties in using the heat from the production process.

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[97] Full-time equivalent jobs.

A1.18.2 Key parameter assumptions

Table A1.34 Key parameters for the glass/glass products sector model

Variable	Value and evidence
Cost pass through rate for domestic producers	**Value:** 10%-45% **Evidence**: AEA, CE Delft (2012) study suggests pass through rate between 0% and 60%.
Domestic demand (own) price elasticity	**Value:** -0.65 **Evidence**: CE (2010) estimates a domestic demand price elasticity of -0.65. Consistent with a low pass-through rate.
Export demand (own) price elasticity	**Value:** -0.3 **Evidence**: CE (2009). The value suggests that the export product market is more specialized – less homogenous. This seems plausible and supports the view that UK production is more specialized.
Import supply (own) price elasticity	**Value:** -0.97 **Evidence**: CE (2009). This value implies the import competition is for more homogenous sub-products. This seems plausible and supports the view that UK production is more specialized.
Domestic demand (cross) price elasticity	**Value:** 0.5 **Evidence**: No quantitative estimate in literature, but consider switching from imports occurs when prices increase.
Export demand (cross) price elasticity	**Value:** 0.24 **Evidence**: CE (2010).
Import supply (cross) price elasticity	**Value:** 0.5 **Evidence**: No quantitative estimate in literature, but consider switching from imports occurs when prices increase

A1.18.3 The results

Table A1.35 summarise the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.35 Impact of policy scenarios on glass/glass products sector

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-4.0	-4.6	-5.2		-4.0	-4.6	-5.3
Employment (%)	-0.1	-0.1	-0.1		-0.1	-0.1	-0.1
Employment (jobs)	-50<	-50<	-50<		-50<	-50<	-50<
Gross operating surplus (£2011m)	-44	-51	-57		-44	-51	-58
Gross operating surplus (%)	-10.6	-12.3	-14.1		-10.6	-12.3	-14.1
Profit margin (pp impact)	-1.3	-1.5	-1.7		-1.3	-1.5	-1.7
Profit margin (%, level)	10.8	10.5	10.2		10.8	10.5	10.2
High pass through rates							
GVA (%)	-3.1	-3.4	-3.8		-3.0	-3.5	-3.9
Employment (%)	-0.5	-0.4	-0.3		-0.4	-0.5	-0.5
Employment (jobs)	-150<	-150<	-100<		-150<	-150<	-150<
Gross operating surplus (£2011m)	-31	-35	-40		-31	-35	-40
Gross operating surplus (%)	-7.4	-8.5	-9.6		-7.4	-8.5	-9.7
Profit margin (pp impact)	-0.8	-1.0	-1.1		-0.8	-1.0	-1.1
Profit margin (%, level)	11.3	11.1	10.9		11.3	11.1	10.9

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high-and low pass through environment. Table A1.36 shows the outcome for 2030.

Table A1.36 Impact on industry prices in 2030

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.2%	0.2%
Imports	0.1%	0.1%
High pass through		
UK	0.9%	0.9%
Imports	0.6%	0.4%

The price impact of the convergence scenario is notably greater on UK industry prices than it is for average import prices. In the case of the convergence scenario the differential is about half the import price increase, while in the EU-led action scenario it the impact on UK industry prices is two to three times the impact on import prices.

Both policy environments result in lower levels of value-added, employment and profits than would be the case in the absence of the policies. The largest impact is in the EU-action only under the low pass through assumption (though there is little difference from the impact in the convergence scenario). In this case value-added in 2030 is 4½% lower than would otherwise be the case and employment is ¼% (less than 100 jobs) lower. Profits are 12% lower with the result that the profit margin falls from 12½% in 2011 to 10½%. In contrast, in the most favourable of the four outcomes shown (convergence scenario under high pass through) value-added in 2030 is around 2% lower than in the absence of the policies, with profits around 4½% lower. Profit margins have been maintained at just under 12%.

Table A1.37 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.37 Impact of zero pass through rate assumption – glass/glass products

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-4.3	-5.0	-5.7
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0.0	0.0	0.0
Gross operating surplus (£2011m)	-48	-56	-63
Gross operating surplus (%)	-11.7	-13.6	-15.6
Profit margin (pp impact)	-1.4	-1.6	-1.8
Profit margin (%, level)	10.6	10.3	10.0

In this case, by 2030 industry value-added is 5¾% lower than would otherwise be the case and the level of profits fallen by over 15%. Profit margins remain positive, but fall to 10%.

The impact of higher electricity prices is likely to vary largely within the industry. Some products, such as glass fibre, are increasingly threatened by international imports, and would fare poorly in the EU-action only scenario, while some, particularly the large scale manufacturers with high transport costs, would expect to maintain higher pass through rates and maintain profit margins even if EU electricity prices rose independently of global prices.

A1.19 Results for the other basic inorganic chemicals sector

A1.19.1 Model coverage

The model has been constructed for the sector as defined by SIC 20.13. Within this is the Chlor Alkali production, which is the particular focus of interest for CCC because it is particularly electro-intensive. Data on the detailed Chlor Alkali sector are not considered sufficiently robust for modelling purposes and is proxied by broader industry grouping here. The sector being modelled represents 0.1% of UK output and employs around 5,000 people[98].

A1.19.2 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics
  - The industry's products have a huge range of 'downstream' applications.
  - The UK has two chlor-alkali plants, with production dominated by INEOS ChlorVinyls site in Runcorn.
- Market characteristics and other considerations
  - Energy costs are the most significant cost component in the chlor-alkali industry.
  - In Europe, 70% of chlorine production is concentrated in Germany, Belgium/The Netherlands and France. Most global production capacity exists in Asia, with China the largest single consumer and producer.
  - 35% of chlorine produced in Europe is used to produce PVC. INEOS Chlor in the UK is Europe's largest producer of PVC.
  - Chlorine is expensive to transport due to its hazardous nature and difficulties in storage. The vast majority of chlorine produced in the EU is used in production near to its production.
- Energy using characteristics and abatement options
  - The chlor-alkali process is energy-intensive.
  - Half of all EU chlor-alkali capacity uses the most energy-efficient technology, membrane technology. In the UK, around 40% of INEOS Chlor's installed generating capacity uses using mercury technology.
  - INEOS Chlor plans to generate 20% of its electricity requirements from its Runcorn site using CHP, making it less exposed to increases in electricity costs

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[98] Full-time equivalent jobs.

A1.19.3 Key parameter assumptions

Table A1.38 Key parameters for the other basic inorganic chemical model

Variable	Value and evidence
Cost pass through rate for domestic producers	**Value:** 25%-75% **Evidence**: AEA, CE Delft study for BIS (2012) suggests pass-through is 10% for ‘Other Chems’. Very difficult to rationalize with qualitative evidence, which suggests pass-through will be high given limited number of producers and high transport costs. However, few applications for product, so customers might have equal bargaining power.
Domestic demand (own) price elasticity	**Value:** -0.37 **Evidence**: CE (2010). Low-medium demand response consistent with view that product is quite specialized.
Export demand (own) price elasticity	**Value:** -0.93 **Evidence**: CE (2010) estimate for broader product classification (20.13).
Import supply (own) price elasticity	**Value:** -0.32 **Evidence**: CE (2010). Low-medium demand response consistent with view that product is quite specialized.
Domestic demand (cross) price elasticity	**Value:** 0.2 **Evidence**: No quantitative estimates in the literature.
Export demand (cross) price elasticity	**Value:** 0.0 **Evidence**: No quantitative estimates in the literature. Implies small influence of UK producers in export markets
Import supply (cross) price elasticity	**Value:** 0.2 **Evidence**: No quantitative estimates in the literature.

A1.19.4 The results

Table A1.39 summarise the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.39 Impact of policy scenarios on other basic inorganic chemicals

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-8.7	-9.8	-10.8		-8.7	-9.8	-10.9
Employment (%)	-0.7	-0.7	-0.7		-0.7	-0.8	-0.8
Employment (jobs)	-50<	-50<	-50<		-50<	-50<	-50<
Gross operating surplus (£2011m)	-67	-76	-85		-67	-76	-85
Gross operating surplus (%)	-13.5	-15.2	-16.7		-13.5	-15.2	-16.8

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Profit margin (pp impact)	-2.8	-3.2	-3.6		-2.8	-3.2	-3.6
Profit margin (%, level)	19.0	18.9	18.7		19.0	18.9	18.7
High pass through rates							
GVA (%)	-4.8	-5.2	-5.6		-4.8	-5.3	-5.8
Employment (%)	-2.1	-2.1	-2.1		-2.1	-2.2	-2.4
Employment (jobs)	-150<	-150<	-150<		-150<	-150<	-150<
Gross operating surplus (£2011m)	-33	-36	-39		-33	-37	-40
Gross operating surplus (%)	-6.4	-7.0	-7.6		-6.4	-7.1	-7.8
Profit margin (pp impact)	-1.0	-1.1	-1.2		-1.0	-1.1	-1.2
Profit margin (%, level)	21.6	21.5	21.5		21.6	21.5	21.5

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high-and low pass through environment. Table A8.25 shows the outcome for 2030.

Table A1.40 Impact on industry prices in 2030

Market characteristic	Convergence	EU-led action
Low pass through		
UK	1.4%	1.4%
Imports	0.8%	0.5%
High pass through		
UK	4.2%	4.2%
Imports	2.4%	1.5%

The price impact in each scenario is higher for UK industry prices than it is for average import prices. The differential between UK and import prices widens under high pass through assumptions. In the EU-led action scenario, the price impact for UK producer prices is about three times that for import prices.

Despite the differences in industry prices between the scenarios, there is not that much difference in the impact on value-added for UK producers. This reflects the relative assumptions for own and cross-price elasticities, which mean the effect of own price increases are countered by demand responses to the increase in import prices.

The policy impact on the sector is greater the lower the pass through rate. The largest impact is in the EU-action only under the low pass through assumption, and in this case value-added in 2030 is 11% lower than would be the case in the absence of the policy initiatives, and employment ¾% lower. Profits in 2030 are some 16-17% lower than would otherwise be the case with the profit margin falling from 23% in 2011 to below 19% in 2030. In contrast, under the high pass through rate assumption value-added in 2030 is around 5-6% lower than in the absence of the policies, and profits around 7¾% lower. Profit margins would be maintained above 20%.

Table A1.41 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.41 Impact of zero pass through rate assumption – other basic inorganic chemicals

Impact compared to baseline (with zero pass through rate)			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-10.7	-12.1	-13.4
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0.0	0.0	0.0
Gross operating surplus (£2011m)	-84	-97	-108
Gross operating surplus (%)	-17.2	-19.4	-21.4
Profit margin (pp impact)	-3.7	-4.2	-4.7
Profit margin (%, level)	17.8	17.6	17.4

In this case, by 2030 industry value-added is 13½% lower than would otherwise be the case and the level of profits fallen by 20%. However, profit margins remain positive and high, at more than 15% of gross output.

Chlor Alkali production is likely to be amongst the least affected of subsectors within other basic inorganic chemicals, as a result of the difficulty in storing and transporting it means it has lower trade effects and is likely to have the scope for higher pass through rate. As such, the GVA, employment and profit effects of increased electricity prices are likely to be less pronounced than estimated in the formal modelling.

A1.20 Results for the fertilisers/nitrogen compounds sector

A1.20.1 Model coverage

The model has been constructed for the sector as defined by SIC 20.15, Manufacture of fertilisers and nitrogen compounds. This is broader than just Ammonia production which is the electro-intensive component of the activity and the principle focus of CCC interest. The sector modelled accounts for around 0.1% of UK output and employs around 2,000 people[99].

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[99] Full-time equivalent jobs.

A1.20.2 Key points from the qualitative review

The qualitative review highlighted the following issues for the quantitative analysis:

- Industry characteristics
  - The UK industry is focused on the production of mineral or chemical fertilisers (containing nitrogen, phosphorus and potassium), and production of ammonium nitrate.
- Market characteristics and other considerations
  - Globally, a large number of new fertiliser production facilities will come on-stream in the next five years.
  - Europe is a net importer of fertilisers (c.30% of demand)
  - Global demand for fertilisers and nitrogen compounds has been growing quickly in recent years and future demand is expected to grow strongly.
  - The UK fertilizer market is fairly concentrated. One company, Growhow (part of a global operation) accounts for 30% of the market and an even larger share of UK production.
  - The nitrogen fertiliser market is quite concentrated globally. Ammonia in particular is costly to produce. There are only 50 ammonia plants operating in Europe
  - Countries with high levels of naturally occurring deposits of minerals for fertilizers and low natural gas prices will have a competitive advantage in their production.
  - The UK imports all the phosphates used as fertilizers (Naturally occurring phosphate is only found in a small number of countries) but is a net exporter of potash, and mining reserves appear secure.
- Energy using characteristics and abatement options
  - Electricity use in the production of fertilisers will differ greatly depending on the product and plant characteristics. Approximately 87% of the energy required for making fertiliser products goes into manufacture of ammonia.
  - An alternative production route for ammonia uses hydrogen instead of natural gas as a feedstock via electrolysis, although the process is generally not economically viable unless there is an abundant source of cheap renewable power (e.g. Norway).

A1.20.3 Key parameter assumptions

Table A1.42 Key parameters for the fertilisers/nitrogen compounds sector model

Variable	Value and evidence
Cost pass through rate for domestic producers	**Value:** 10%-20% **Evidence**: AEA, CE Delft study for BIS (2012) suggests pass-through is 16% for Nitrogenous Fertilisers. Difficult to interpret because production of ammonia is concentrated, and there is limited scope for product substitution.
Domestic demand (own) price elasticity	**Value:** -0.37 **Evidence**: CE (2010). Low-medium demand response consistent with view that product is specialized.
Export demand (own) price elasticity	**Value:** -0.93 **Evidence**: CE (2010). Given very low export demand this is very uncertain and has negligible impact.

Variable	Value and evidence
Import supply (own) price elasticity	**Value:** -0.32 **Evidence:** CE (2010). Given very low import penetration this is very uncertain and has negligible impact.
Domestic demand (cross) price elasticity	**Value:** 0.5 **Evidence:** No quantitative estimate from literature.
Export demand (cross) price elasticity	**Value:** 0.0 **Evidence:** No quantitative estimate from literature.
Import supply (cross) price elasticity	**Value:** 0.5 **Evidence:** No quantitative estimate from literature.

A1.20.4 The results

Table A1.43 summarises the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.43 Impact of policy scenarios on fertilisers/ nitrogen chemicals sector

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-13.1	-14.7	-16.2		-13.1	-14.7	-16.3
Employment (%)	-0.1	-0.1	0.0		-0.1	-0.1	0.0
Employment (jobs)	-50<	-50<	50>		-50<	-50<	-50<
Gross operating surplus (£2011m)	-29	-33	-37		-29	-33	-37
Gross operating surplus (%)	-26.5	-29.6	-32.3		-26.5	-29.6	-32.4
Profit margin (pp impact)	-1.6	-1.9	-2.1		-1.6	-1.9	-2.1
Profit margin (%, level)	4.5	4.4	4.4		4.5	4.4	4.4
High pass through rates							
GVA (%)	-11.7	-13.1	-14.4		-11.7	-13.1	-14.5
Employment (%)	-0.2	-0.1	0.0		-0.2	-0.1	-0.1
Employment (jobs)	-50<	-50<	50>		-50<	-50<	-50<
Gross operating surplus (£2011m)	-26	-29	-33		-26	-30	-33
Gross operating surplus (%)	-23.5	-26.2	-28.6		-23.5	-26.2	-28.7
Profit margin (pp impact)	-1.5	-1.7	-1.9		-1.5	-1.7	-1.9
Profit margin (%, level)	4.8	4.7	4.6		4.8	4.7	4.6

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high- and low pass through environment. Table A8.30 shows the outcome for 2030.

Table A1.44 Impact on industry prices in 2030 – fertiliser/nitrogen chemicals

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.3%	0.3%
Imports	0.2%	0.1%
High pass through		
UK	0.5%	0.5%
Imports	0.4%	0.3%

Neither of the two price scenarios has a large impact on the price of UK output or of average imports. The largest increase by 2030 is in the convergence scenario with high-pass through rates, though the impact is no more than ½% increase in prices.

The comparatively small price differences between the two scenarios mean the overall impact is also similar in the two scenarios. The policy impact on the sector is greater the lower the pass through rate. The largest impact is in the EU-action only under the low pass through assumption, and in this case value-added in 2030 is 16½% lower than would otherwise be the case, and profits reduced by around a third. The profit margin is cut from 6.8% in 2011 to just under 4½% in 2030. In contrast, under the high pass through rate assumption value-added in 2030 is around 14-15% lower than in the absence of the policies, and profits 25-30% lower. There is little employment impact from either policy scenario.

Table A1.45 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.45 Impact of zero pass through rate assumption – fertilisers/nitrogen chemicals

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-14.5	-16.4	-18.1
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0.0	0.0	0.0
Gross operating surplus (£2011m)	-32	-37	-41
Gross operating surplus (%)	-29.7	-33.1	-36.1
Profit margin (pp impact)	-1.8	-2.1	-2.3
Profit margin (%, level)	4.3	4.2	4.1

In this case, by 2030 industry value-added is around 18% lower than would otherwise be the case with the level of profits falling by more than a third to around 4% of gross output.

A1.21 Results for the refined petroleum products sector

A1.21.1 Model coverage

The model has been constructed for the sector as defined by SIC 19.2. It accounts for 1¼% of UK gross output (but a much smaller share of value-added) and employs around 9,000 people.

A.8.8.1 Key parameter assumptions

The sector added to the modelling framework as an extension to the core analysis and was not the subject of a detailed qualitative assessment. The assumptions for the key model parameters have been agreed in discussion with the CCC.

Table A1.46 Key parameters for the refined petroleum products sector model

Variable	Value and evidence	
Cost pass through rate for domestic producers	**Value:**	25%-75%
Domestic demand (own) price elasticity	**Value:**	-0.37 (similar to inorganic chemicals sector)
Export demand (own) price elasticity	**Value:**	-0.37
Import supply (own) price elasticity	**Value:**	-0.37
Domestic demand (cross) price elasticity	**Value:**	0.5
Export demand (cross) price elasticity	**Value:**	0.0
Import supply (cross) price elasticity	**Value:**	0.5

A1.21.2 The results

Table A8.33 summarises the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.47 Impact of policy scenarios on refined petroleum products

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-3.0	-3.5	-4.0		-3.0	-3.5	-4.0
Employment (%)	-0.1	0.0	0.0		-0.1	0.0	0.0
Employment (jobs)	-50<	-50<	>50		-50<	-50<	-50<
Gross operating surplus (£2011m)	-80	-94	-107		-80	-94	-108
Gross operating surplus (%)	-4.9	-5.8	-6.6		-4.9	-5.8	-6.6
Profit margin (pp impact)	-0.2	-0.3	-0.3		-0.2	-0.3	-0.3

Impact compared to Baseline							
	Convergence scenario				**EU-led action**		
	2020	**2025**	**2030**		**2020**	**2025**	**2030**
Profit margin (%, level)	4.2	4.2	4.2		4.2	4.2	4.2
High pass through rates							
GVA (%)	-1.3	-1.5	-1.6		-1.3	-1.5	-1.7
Employment (%)	-0.1	-0.1	0.0		-0.1	-0.1	-0.1
Employment (jobs)	-50<	-50<	<50		-50<	-50<	-50<
Gross operating surplus (£2011m)	-35	-40	-44		-35	-40	-46
Gross operating surplus (%)	-2.1	-2.4	-2.7		-2.1	-2.4	-2.8
Profit margin (pp impact)	-0.1	-0.1	-0.1		-0.1	-0.1	-0.1
Profit margin (%, level)	4.4	4.4	4.4		4.4	4.4	4.4

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high- and low pass through environment. Table A8.34 shows the outcome for 2030.

Table A1.48 Impact on industry prices in 2030 – refined petroleum products

Market characteristic	Convergence	EU-led action
Low pass through		
UK	0.3	0.3
Imports	0.2	0.1
High pass through		
UK	0.5	0.5
Imports	0.4	0.2

The price impact of the convergence scenario is similar for both UK producer prices and average import prices. In the EU-led action scenario, the price impact for UK producer prices is about twice that for import prices. In all cases the price increase is relatively small, at just 0.5% of base costs in 2030 under the high pass through rate assumption.

Given the relatively small price impacts, there is very little difference in the impacts across policy scenarios. The policy impact on the sector is greater the lower the pass through rate. The largest impact is in the EU-action only under the low pass through assumption, and in this case value-added in 2030 is 4% lower than would otherwise be the case, and profits (gross operating surplus) some 6½% lower. The profit margin is cut from 5% in 2011 to just over 4% in 2030. In contrast, under the high pass through rate assumption value-added in 2030 is only around 1¾% lower than in the absence of the policies, and profits around 2¾% lower. There is little employment impact from either policy scenario.

Table A8.35 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs to those purchasing the goods. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.49 Impact of zero pass through rate assumption – refined petroleum products

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-4.9	-5.8	-6.7
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0.0	0.0	0.0
Gross operating surplus (£2011m)	-132	-155	-179
Gross operating surplus (%)	-8.2	-9.7	-11.1
Profit margin (pp impact)	-0.4	-0.4	-0.5
Profit margin (%, level)	4.0	4.0	3.9

In this case, by 2030 industry value-added 6¾% lower than would otherwise be the case (not too different from the outcome from low pass through rates) and the level of profits have fallen by 11%. However, the sector can maintain profit margins of around 4%.

A1.22 Results for the manufacture of industrial gases sector

A1.22.1 Model coverage

The model has been constructed for the sector as defined by SIC 20.11. It employs around 5,000 people and accounts for less than 0.1% of UK output.

A1.22.2 Key parameter assumptions

The sector added to the modelling framework as an extension to the core analysis and was not the subject of a detailed qualitative assessment. The assumptions for the key model parameters have been agreed in discussion with the CCC.

Table A1.50 Key parameters for the model of manufacture of industrial gases

Variable	Value and evidence	
Cost pass through rate for domestic producers	**Value:**	25%-75%
Domestic demand (own) price elasticity	**Value:**	-0.37
Export demand (own) price elasticity	**Value:**	-0.93
Import supply (own) price elasticity	**Value:**	-0.32
Domestic demand (cross) price elasticity	**Value:**	0.2
Export demand (cross) price elasticity	**Value:**	0.0
Import supply (cross) price elasticity	**Value:**	0.2

A1.22.3 The results

Table 9-2 summarises the impact of the two scenarios under the upper and lower bound assumptions for the pass through rate.

Table A1.51 Impact of policy scenarios on manufacture of industrial gases

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
Low pass through rates							
GVA (%)	-13.1	-14.5	-15.7		-13.1	-14.6	-16.1
Employment (%)	-0.7	-0.5	-0.3		-0.7	-0.6	-0.6
Employment (jobs)	-50<	-50<	-50<		-50<	-50<	-50<
Gross operating surplus (£2011m)	-79	-90	-99		-79	-90	-100
Gross operating surplus (%)	-21.1	-23.4	-25.4		-21.1	-23.5	-25.8
Profit margin (pp impact)	-6.2	-7.1	-7.9		-6.2	-7.1	-7.9
Profit margin (%, level)	24.1	23.8	23.5		24.1	23.8	23.5

Impact compared to Baseline							
	Convergence scenario				EU-led action		
	2020	2025	2030		2020	2025	2030
High pass through rates							
GVA (%)	-6.3	-6.2	-5.9		-6.2	-6.6	-7.1
Employment (%)	-2.1	-1.4	-0.7		-2.0	-1.8	-1.8
Employment (jobs)	-150<	-100<	-50<		-100<	-100<	-100<
Gross operating surplus (£2011m)	-35	-36	-36		-35	-38	-41
Gross operating surplus (%)	-9.0	-9.1	-9.1		-8.9	-9.5	-10.3
Profit margin (pp impact)	-2.2	-2.4	-2.7		-2.2	-2.5	-2.7
Profit margin (%, level)	29.8	29.7	29.6		29.8	29.7	29.6

Costs faced by UK production are the same in both the convergence and the EU-led action scenarios. Prices differ between a high- and low pass through environment. Table 9-3 shows the outcome for 2030.

Table A1.52 Impact on industry prices in 2030 – manufacture of industrial gases sector

Market characteristic	Convergence	EU-led action
Low pass through		
UK	3.1	3.1
Imports	3.5	1.8
High pass through		
UK	9.2	9.2
Imports	10.6	5.4

The price impact of the convergence scenario varies considerably between the two scenarios. In the convergence scenario the impact on import prices is greater than is the impact on UK industry prices, whereas the reverse is the case in the EU-led action scenario. This reflects the fact that UK imports of industrial gases from outside the EU predominantly come from the US, and that in the convergence scenario the increases in electricity costs are greater in the US than in any other country. In the EU-led action, the increase in UK industry prices is a little under twice the rate in average import prices.

While there is noteable variation in domestic and import prices between the scenarios, this not reflected in greatly different impacts on the UK sector. The outcome is more sensitive to assumptions for the pass through rate than it is to differences in the two price scenarios, in part to relatively low elasticity assumptions and to the sector having a very low rate of import penetration (less than ½% of overall demand). The largest impact on value-added is in the EU-action only under the low pass through assumption, and in this case value-added in 2030 is 16% lower than would otherwise be the case, and profits (gross operating surplus) some 26% lower. The profit margin is cut from 33% in 2011 to around 23% in 2030. In contrast, under the high pass through rate assumption value-added in 2030 is only around 6-7% lower than in the absence of the policies, and profits around 10% lower. The employment impact is greater in the high-pass through assumption, as although firms raise prices to protect their operating surpluses, there is a trade off with lower levels of gross output, and hence employment. Even so, the largest impact is a loss of less than 100 jobs in 2030 compared with the outcome in the absence of these policies.

Table A8.40 reports the outcome under the convergence scenario under the extreme case where the sector is unable to pass through any of the increase in costs to those purchasing the goods. In this case, industry prices do not change, there is no change in demand and output (or employment) and employers bear the entire cost increase.

Table A1.53 Impact of zero pass through rate assumption – manufacture of industrial gases sector

Impact compared to baseline			
	Convergence scenario		
	2020	2025	2030
Zero pass through rate			
GVA (%)	-16.6	-18.7	-20.7
Employment (%)	0.0	0.0	0.0
Employment (jobs)	0.0	0.0	0.0
Gross operating surplus (£2011m)	-102	-116	-130
Gross operating surplus (%)	-27.7	-31.0	-33.9
Profit margin (pp impact)	-8.2	-9.4	-10.5
Profit margin (%, level)	21.4	20.9	20.5

In this case, by 2030 industry value-added is 20% lower than would otherwise be the case. The level of profits is reduced by a third, with the effect that the profit margin falls to 20%. Given the capital-intensive nature of the sector, it may be that such profit rates would be insufficient to maintain funding for new investments.

APPENDIX 9: ASSESSING THE FREE ALLOCATION OF EU ETS PERMITS

A1.23 Introduction

An analysis of compensation for industries facing high electricity costs as a result of environmental policies is presented in Chapter 5. This analysis does not consider any other subsidies already received by these sectors, implicit or otherwise. Since many of the sectors discussed are energy intensive industries, they are also covered by the EU ETS. This Annex provides an assessment of the extent to which sectors have been over or under supplied with free allowances under the EU ETS Directive. The analysis considers six sectors:

- Manufacture of paper and paper products (SIC 17)
- Manufacture of coke and refined petroleum products (SIC 19)
- Manufacture of chemicals and chemical products (SIC 20)
- Manufacture of rubber and plastics (SIC 22)
- Manufacture of other non-metallic mineral products (SIC 23)
- Manufacture of basic metals (SIC 24)

These sector definitions are slightly different to those used for the detailed analysis provided for the electro-intensive sectors in Appendix 8 because of data availability and mapping to the EUTL database. The analysis itself is intended to provide an indication of the over (or under) allocation of EU ETS permits for these broad sectors as a factor for consideration to the levels of support (compensation) that might be provided to electro-intensive sectors.

A1.24 Approach

Two factors need to be considered to assess whether these sectors have been under or over-supplied with EU ETS allowances for Phases 1, 2 and 3:

- the level of free allowances for the EU ETS installations in each sector
- the verified and (for Phase 3) projected emissions for the EU ETS installations each sector

The level of free allowances for each installation for Phase 1 and Phase 2 were taken for the EUTL, which is the Transactions Log for the emissions trading scheme, and subsequently mapped to the sectors of interest. For Phase 3 the allocations were taken from the National Implementation Measures (NIMs)[100] and mapped to the existing installations and then to sectors. For Chemicals and Other non-metallic mineral products, a number of installations became part of the EU ETS in Phase 3. Combined heat and power installations were included and mapped to the relevant sectors. In Phase 3, most CHP sites do not receive any allocation.

For the historical period (2005-2011), emissions for each installation are taken from the EUTL, which records Verified Emissions for each installation[101]. Beyond 2011, projections for emissions were taken from the CCC's latest projection of emissions by sector, by applying the growth rate for the sector to the verified emissions covered by the EU ETS in each sector. The implied assumption is that emissions growth in the part of the sector covered by the EU ETS will be the same as emissions growth in the part of the sector not-covered by the EU ETS. We consider this a conservative assumption, as in reality we would expect carbon emissions to fall faster in installations covered by the ETS.

We also separate the impact of changes in output and efficiency on the emissions projections to provide insight as to whether an over allocation (or projected over allocation) is

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[100] For the paper sector, the data from the NIMs was supplemented with data supplied by the industry.

[101] Data for installations in the paper sector were also supplied by the industry.

the result of a reduction in carbon intensity or a reduction in output. Since a reduction in the carbon intensity of the sectors' installations suggests that investments are being made to reduce carbon emissions has different policy implications to an over allocation that is driven by falling emissions from falling production levels.

Summary of results

Overall, we find that most sectors had an over allocation of permits throughout Phase 2 of the EU ETS (most sectors started the period with an over-allocation, and the economic downturn that has characterised much of the period has contributed to a fall in emissions while levels of free allocations remained unchanged), whereas for Phase 3 the results are more mixed. Table 1 shows the over (- under) allocation of free allowances for the three phases of the EU ETS and the value of the over (-under) allocation in £2011m. The evidence suggests that the Paper, Chemicals, Basic Metals and Non-metallic mineral products sectors have all received substantial over allocations in Phase 2 of the EU ETS.

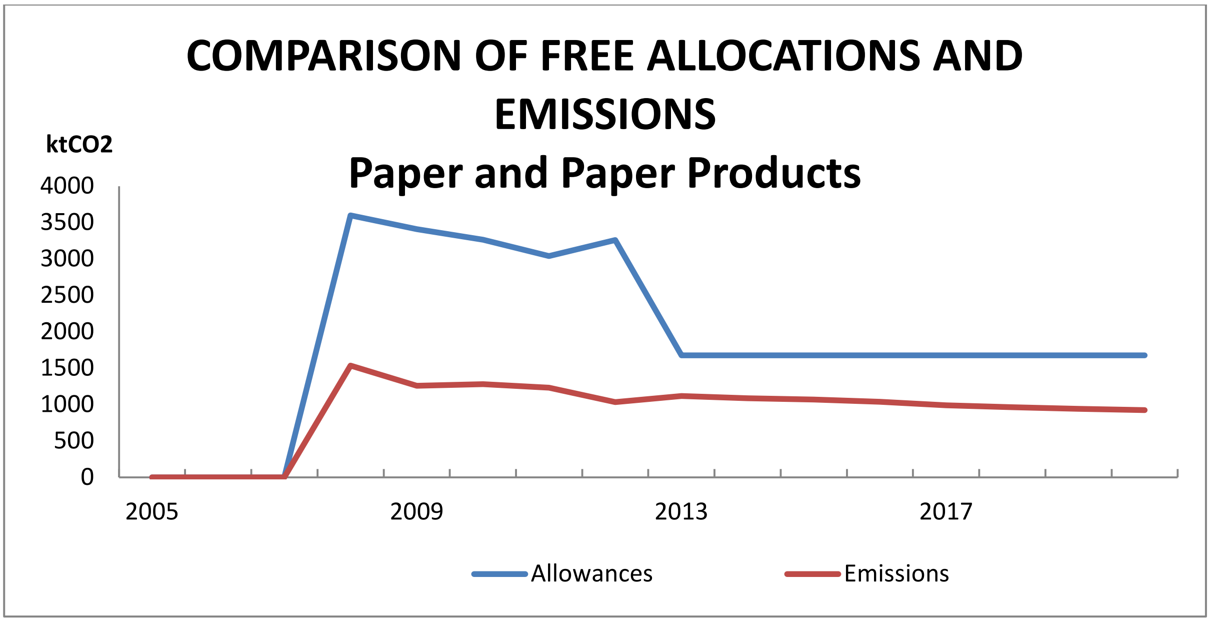
Table A1.54 Over/under allocation of free allowances for the three phases of the EU ETS

	Cumulative surplus allowances ktCO2			Cumulative value of allowances, £2011m		
	2005-07	2008-12	2013-20	2005-07	2008-12	2013-20
Manufacture paper/paper prods (SIC 17)	0	10242	5267	0	119	36
Manufacture coke and refined petroleum products (SIC 19)	-4263	-3612	-32429	-31	-60	-220
Manufacture of chemicals/chemical products (SIC 20)	1987	12943	-1935	17	143	-12
Manufacture of rubber/plastic products (SIC 22)	0	-9	2	0	0	0
Manufacture of other non-metallic mineral products (SIC 23)	-2941	33689	25659	-36	344	180
Manufacture of basic metals (SIC 24)	774	42400	6705	20	443	38

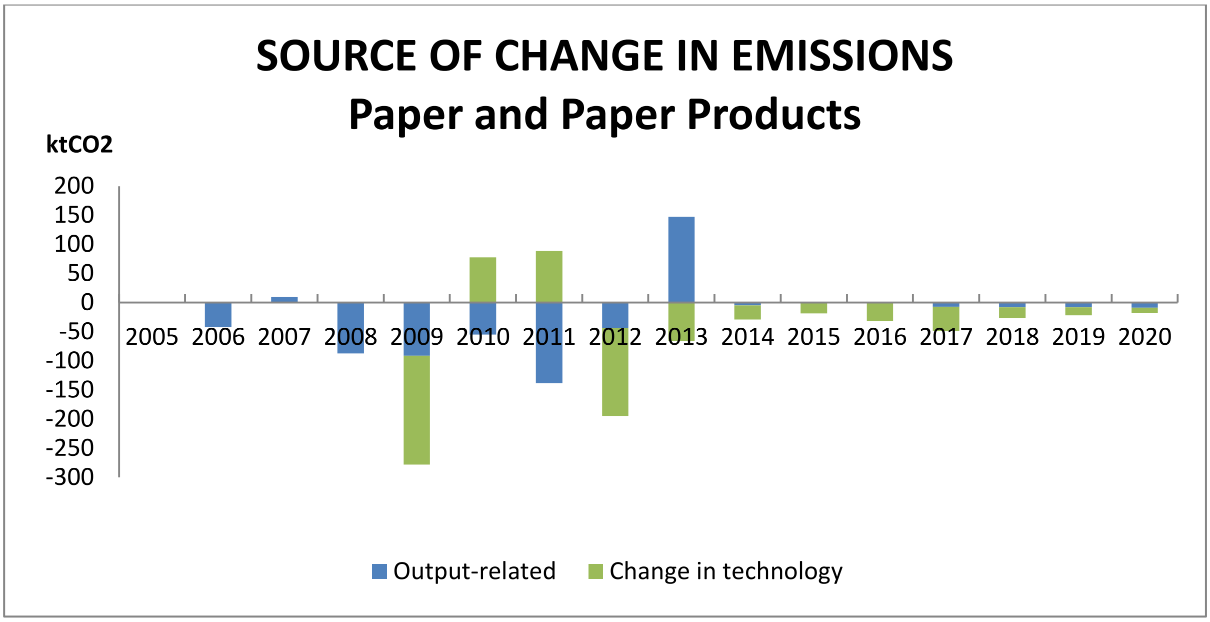
The results for each sector are discussed, in turn, below.

A1.25 Results by sector

A1.25.1 Manufacture of paper and paper products

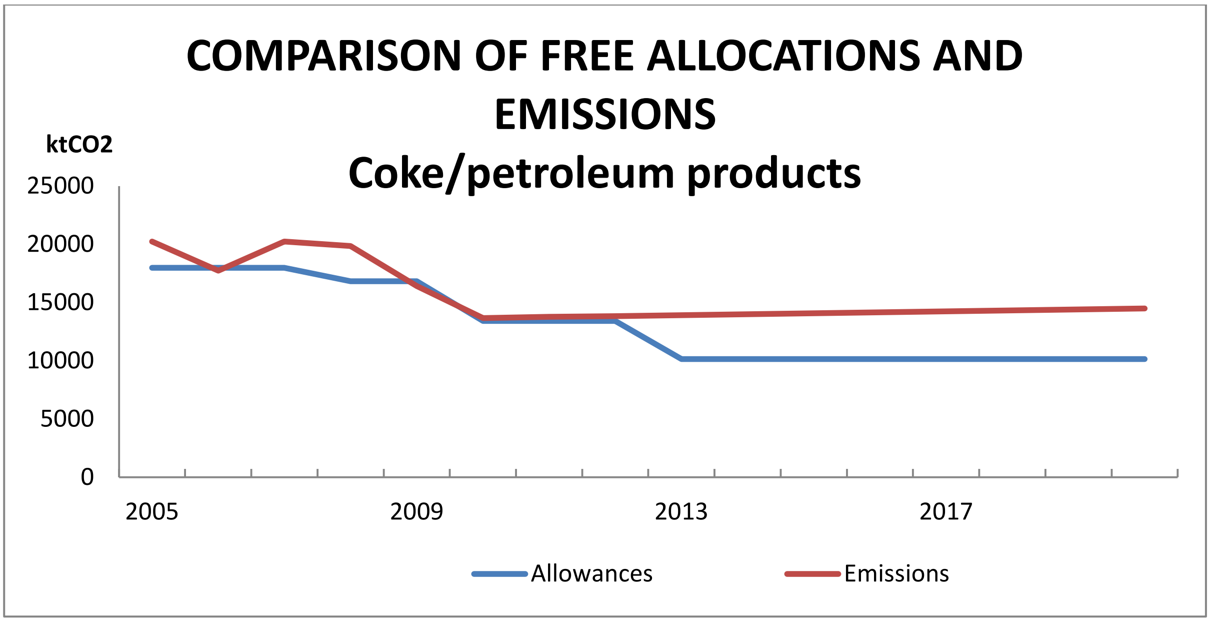


The paper and paper products sector was not included in the first phase of the EU ETS. In the second phase it received a generous allocation of permits. By contrast, in Phase 3, the emissions allocation looks much more closely aligned to the expected projection for emissions, although some over-allocation is expected to persist. This is partly the result of the zero allocation of allowances to 3rd party CHP sites that sell heat to installations in the EU ETS. In this case, the purchasing installation receives an allocation. If the 3rd party CHP site sells heat to installations outside the EU ETS then it will receive an allocation. This has created some uncertainty for future allowances in Phase 3 of the EU ETS especially if installations were to start to fall out of the EU ETS.

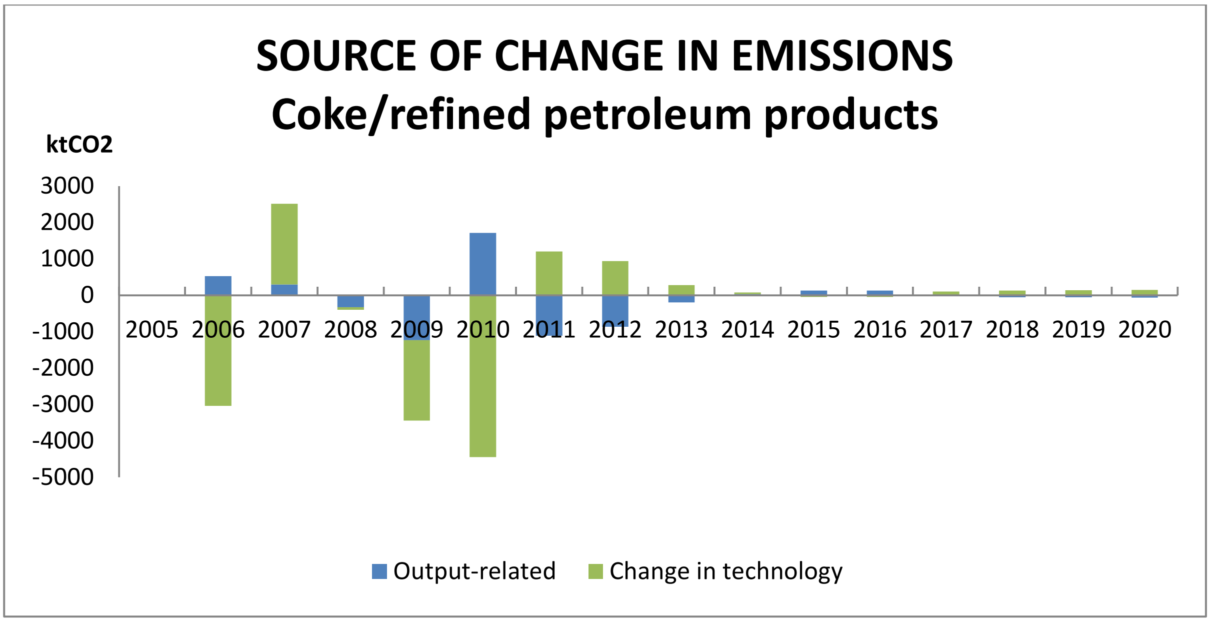


Overall, the CCC's emissions projections suggest a mix of small output changes and carbon efficiency gains over the history and Phase 3. The large peak in 2013 (shown as an output driven effect) reflects the change in the coverage of the ETS to include a number of additional installations in Phase 3. This is a one-off step change and does not affect the results in subsequent years.

A1.25.2 Manufacture of coke and refined petroleum products (SIC 19)

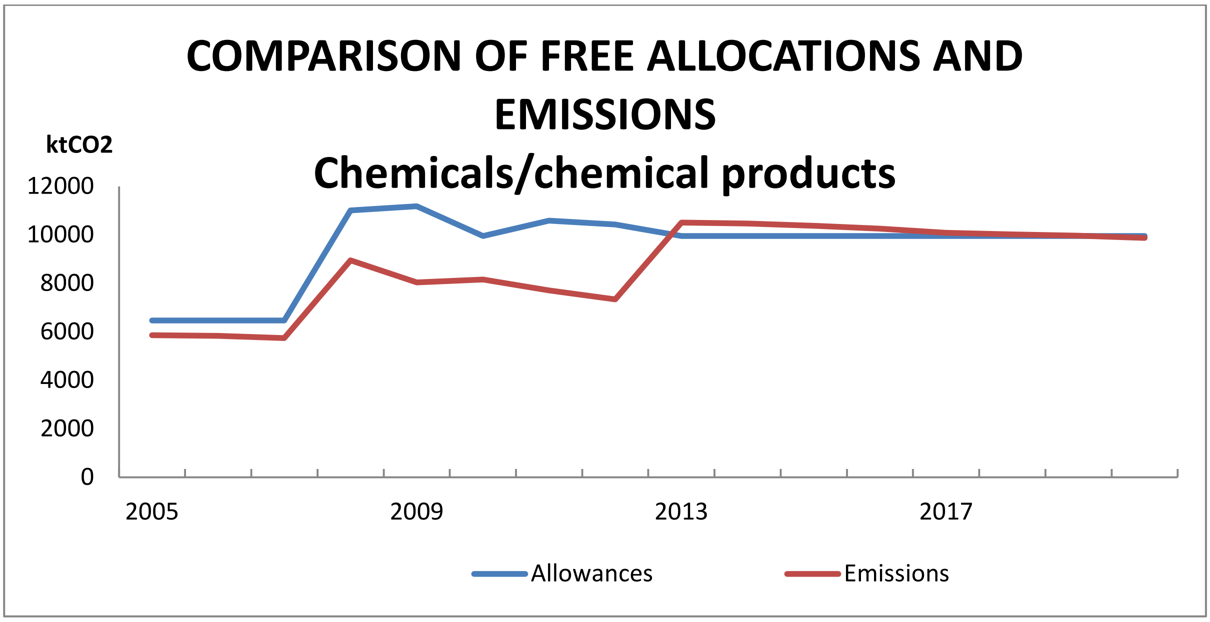


For refining, the reduction in allowances for CHP installations to zero has a substantial impact. Overall the results suggest an under-allocation of permits in Phase 3, following a small over-allocation in Phase 2.

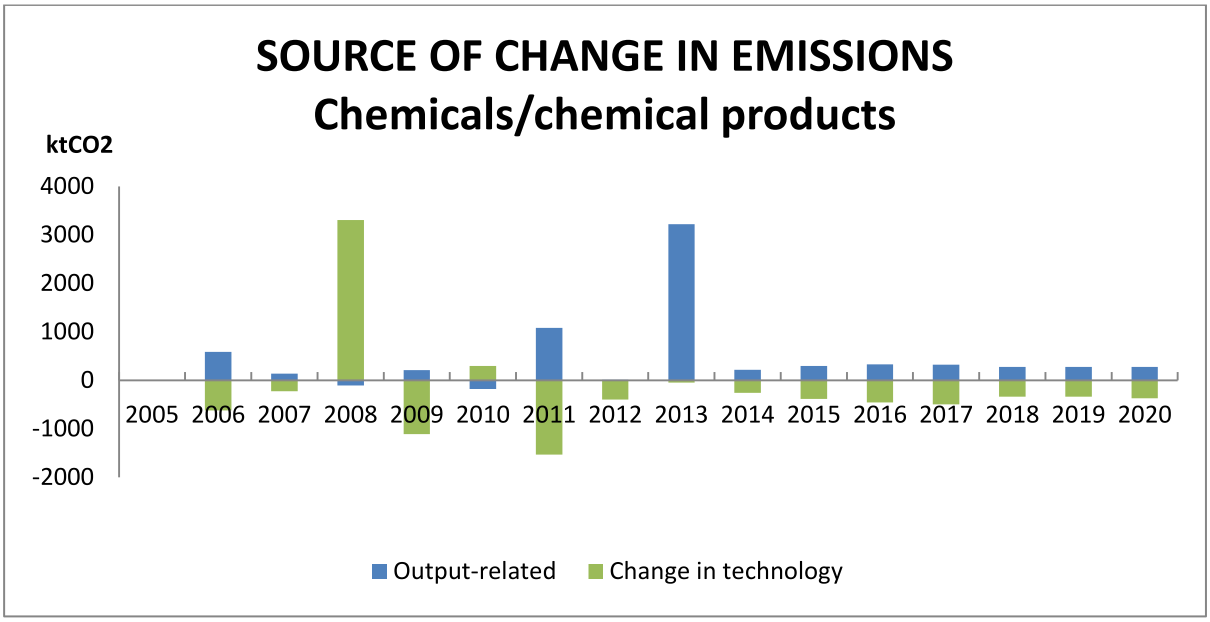


The CCC's emissions projections imply that emissions for this sector will become fairly stable. In Phase 2 the relative impact on output and efficiency were volatile with a collapse in output in 2009, a recovery in 2010, followed by consecutive falls in output. The CCC projections suggest fairly steady output and no improvements in efficiency.

A1.25.3 Manufacture of chemicals and chemical products (SIC 20)

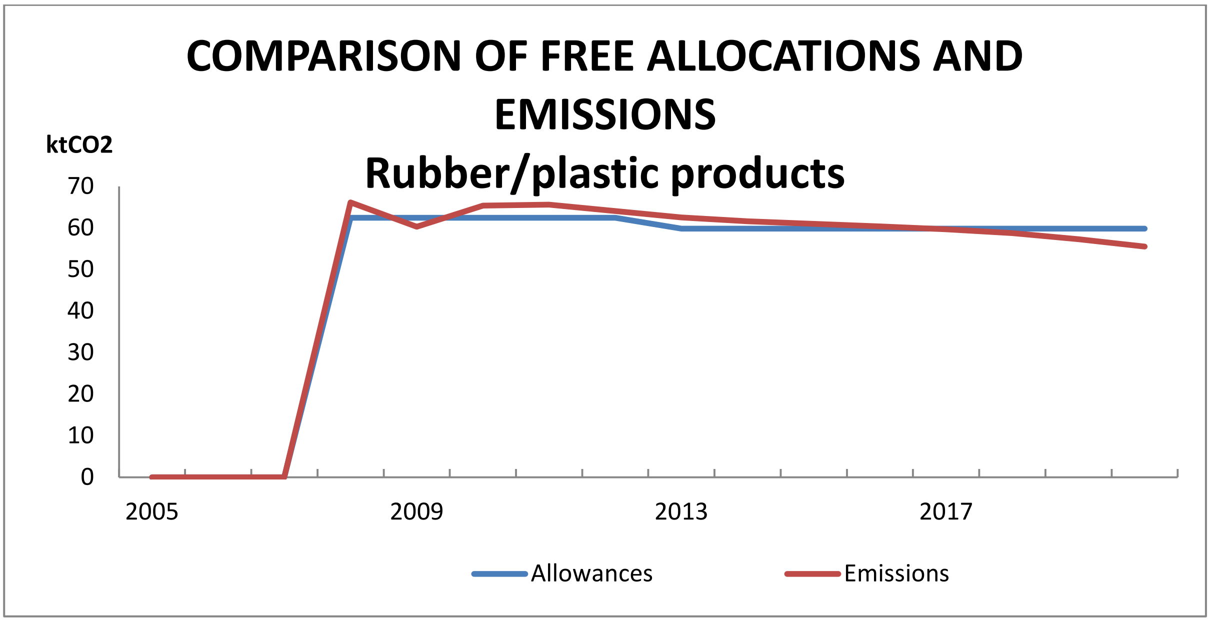


The chemicals and chemical products sector had an over allocation in Phase 1 of the EU ETS. In Phase 2 a number of installations were added as the coverage of the ETS expanded but the allocations more than covered the outturn emissions across the period. In Phase 3, the free allocation remains fairly flat, but this level of allocation now includes more installations in the sector. Overall the allocation for Phase 3 is expected to be broadly in line with the outturn.

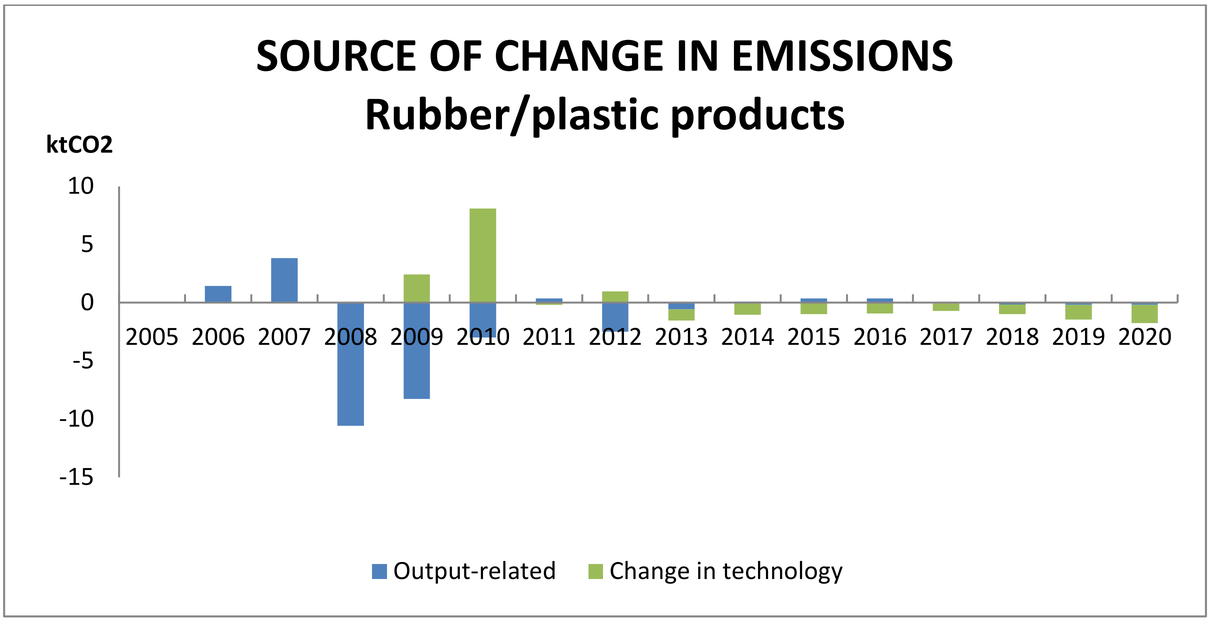


The reduction in emissions over the projection period is expected to come from carbon efficiency improvements i.e. changes in technology. The increase in output-related emissions in 2013 represents the extended coverage of the ETS to include more of the Chemicals sector's installations.

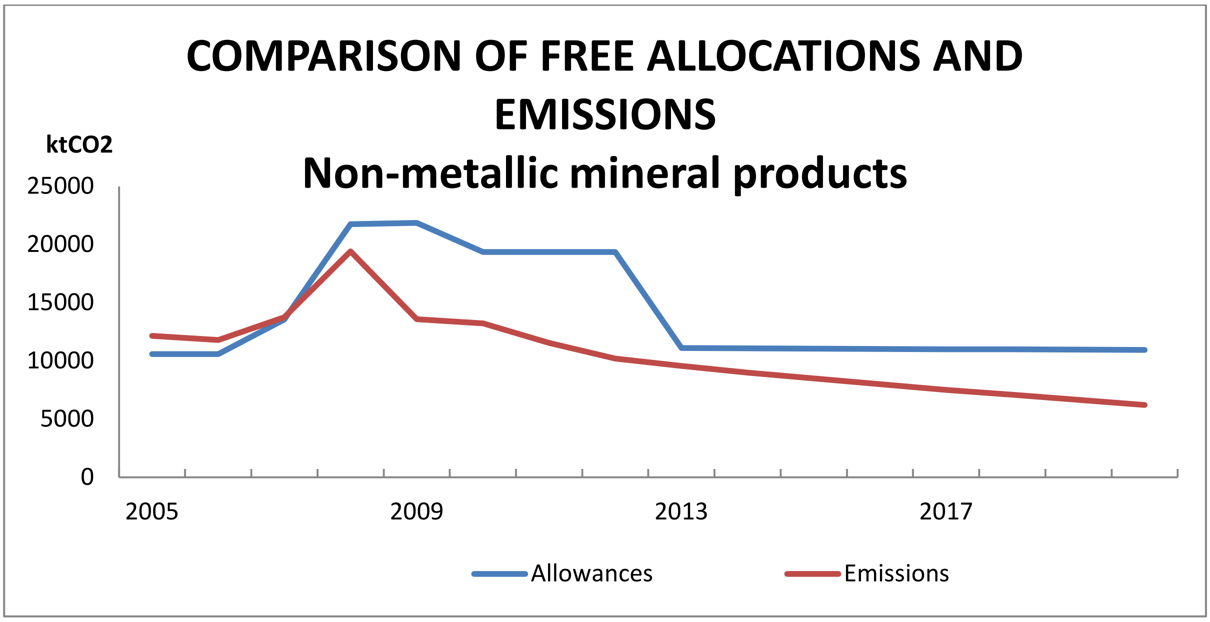
A1.25.4 Manufacture of rubber and plastics (SIC 22)



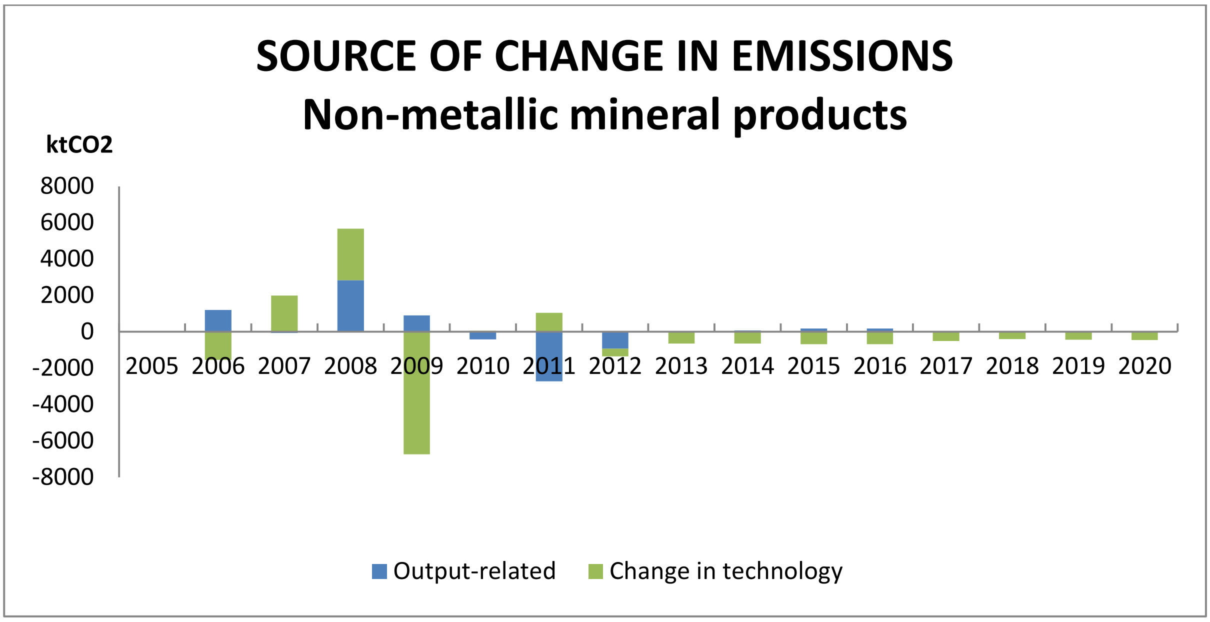
There are only three installations in the Rubber and Plastics sector (SIC 22) that are covered by the EU ETS (two Michelin tyre manufacturing plants and one Pirelli tyre manufacturing plant). The analysis suggests that the free allocations are in line with the historical emissions. If these installations follow the trends projected for the sector as a whole by the CCC, then it could look like a small over-allocation by the end of the period. However, the fall in projected emissions is driven by efficiency improvements rather than falling output (see below).



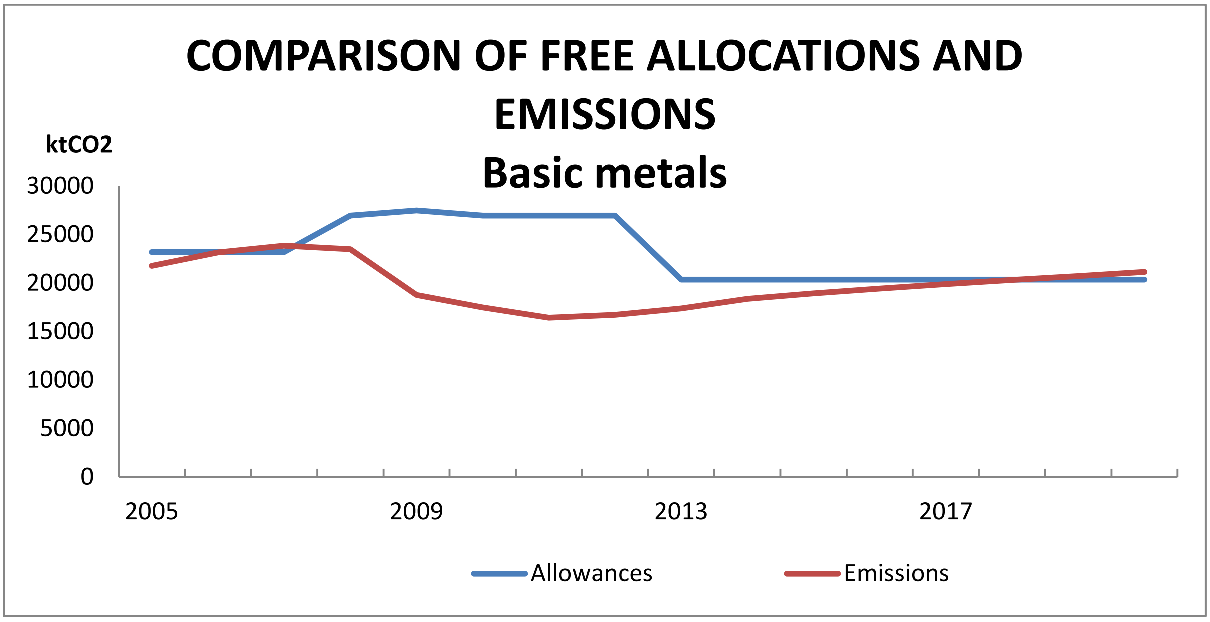
A1.25.5 Manufacture of other non-metallic mineral products (SIC 23)



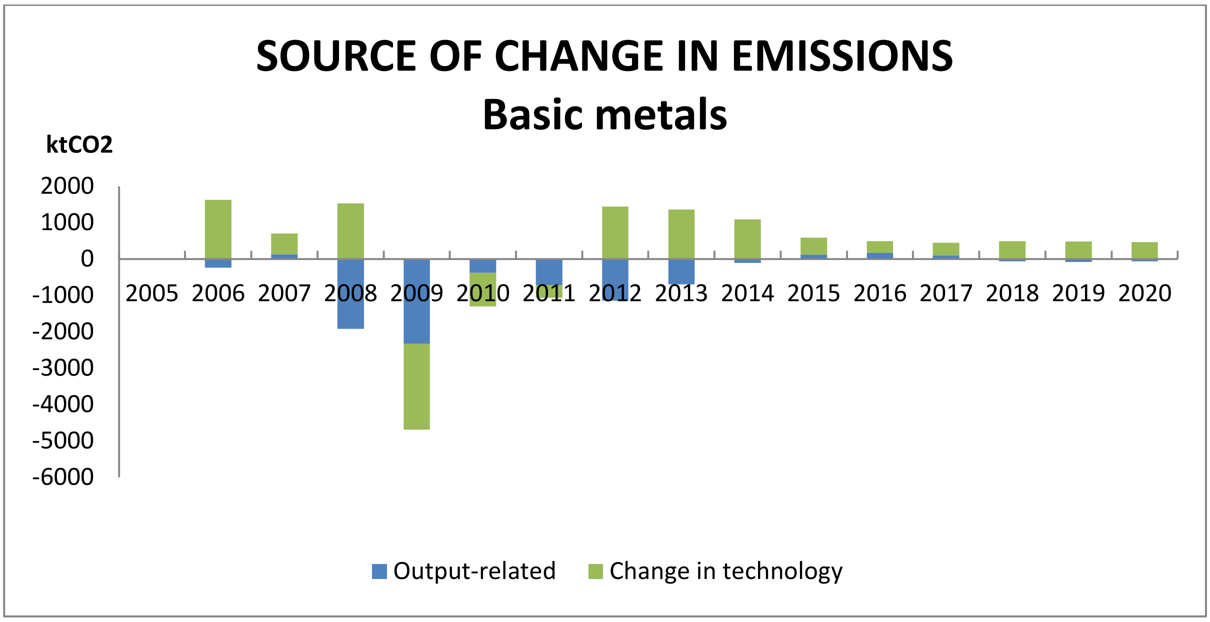
Overall, the evidence suggests that the Non-metallic mineral products sector received an over-allocation of EU ETS allowances in Phase 2. The reduction of allowances in 2013 as a result of the benchmarking process means that the allocation for Phase 3 is more closely aligned with projected emissions, although possibly leading to an over-allocation towards the end of the period if emissions are reduced as projected. The future reduction in emissions is anticipated to come from improving carbon efficiency (see below).



A1.25.6 Manufacture of basic metals (SIC 24)



The basic metals sector received an over-allocation of allowances in Phase 2 as a result of the economic downturn. Although the benchmarking process has led to a reduction in free allowances over Phase 3, the anticipated under-utilisation of capacity and associated falling output means that the free allocations in Phase 3 could exceed outturn emissions but only by a small amount.



A1.26 General conclusions

This analysis suggests that many of the industrial sectors covered by the EU ETS have received an over allocation of allowances in the first two phases of the EU ETS and will continue to do so into Phase 3. In Phase 3 the over-allocation is offset, in part, by the benchmarking process, which reduced the allowances received by each installation in Phase 3, and also the removal of all free allowances for many CHP installations following the legislation on cross-boundary heat. For some sectors (Chemicals and Refining) this could lead to a projected under-allocation of permits in Phase 3.

Since the Phase 3 assessment of over or under allocation of free allowances is based on projections of emissions, it is important to also consider the difference between allocations and projected emissions in 2013 as an indicator of over/under allocation, in addition to considering the period as a whole. For most sectors the allocation in 2013 is either quite close to, or even under, expected emissions. The major exception is non-metallic mineral products, whereby emissions are expected to decline as a result of efficiency.

Another important consideration is whether the over-allocation has been a result of (carbon) efficiency or projected changes in output. This varies across sectors, for Chemicals, Rubber & Plastics, Non-metallic mineral products and Paper there are anticipated improvements in efficiency (for Paper the picture is mixed, year to year, but there are improvements in efficiency combined with reductions in output towards the end of the period), while for Basic Metals, carbon efficiency is projected to worsen slightly to 2020, while for Refining it is expected to be broadly flat.

However, the projections for Phase 3 are subject to a number of assumptions that need to be considered:

- The accuracy of the CCC's emissions projections for 2012-2020: if too high, then there is a bias towards under-allocation (or less over-allocation), if too low then there is a bias towards over-allocation
- The assumption that the installations' emissions will grow (or fall) at the same rate as emissions for the sector as a whole: given that there is an incentive to reduce carbon emissions for EU ETS installations, this is likely to bias the results in favour of under-allocation.

One important consideration is the distinction between sectors and installations. It is not necessarily the case that EU ETS installations are also electro-intensive installations. This distinction matters for the consideration of compensation to electro-intensive industries which should, therefore, be assessed at the level of each individual installation. However, the sector-wide analysis provides some indication of which installations, based on which sector they fall into, are likely to have received an over allocation of permits.

Equally, we assume that projected reductions in output are not closures of installations. A reduction in output has the implication that projected emissions fall, but that the allocations remain in place and are still received in full. In contrast, the closure of an installation would mean that both the emissions for the sector and the allocations received by the sector were reduced if the allocations were not distributed following the installation closure.

Given the over-allocation of EU ETS permits is expected to continue into Phase 3, albeit at a much more reduced level, the value of the over-allocation needs to be considered when determining the level of support offered to electro-intensive sectors.

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[i] State wide emissions trading schemes: Regional Climate Change Initiative (RGGI) and California Emissions Trading Scheme

[ii] New Source Performance Standards (NSPS) for Power Plants and Refineries

[iii] Best Available Control Technology (BACT) under Tailoring Rule

[iv] 10,000 Enterprises Programme, Industrial Energy Performance Standards

[v] Federal Target Oriented Programme of the Russian Federation

[vi] National Climate Change Strategy

[vii] Efficiency upgrade for coal burning industrial boilers and kilns; Elimination of Backward Technology

[viii] Ministry of Energy and Natural Resources Strategic Plan

[ix] White Certificate Trading for End-use Energy Efficiency – requires electricity and gas suppliers to help their customers save energy

[x] Federal law # 261-FZ, Federal Tax Code

[xi] Federal Tax Code

[xii] Business Energy Investment Tax Credit (ITC)

[xiii] Support scheme for energy efficiency in industry

[xiv] CHP support – fixed price paid for electricity from CHP

[xv] Solar Feed-in Tariff, Wind Power Concession Programme

[xvi] Law No 6094 Amendment to the Renewable Law No 5346 of 2005

[xvii] 2009 Amendment of the Renewable Energy Sources Act (EEG)

[xviii] State wide Renewable Portfolio Standards (RPS)

[xix] Renewables Obligation (RO)

[xx] New energy quota system

[xxi] Preferential tax policies for renewable energy

[xxii] Business Energy Investment Tax Credit (ITC)

[xxiii] Renewable Electricity Production Tax Credit (PTC)

[xxiv] Differential electricity pricing

[xxv] Eco Tax changes as part of the Energy Concept of the Federal Government 2011

[xxvi] Climate Change Levy (CCL)

[xxvii] Law on new organisation of electricity markets, EXELTIUM

[xxviii] Amendment of the Atomic Power Act: nuclear phase out