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Climate change policies and the UK business sector: overview, impacts and suggestions for reform

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Contents

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Acronyms

APD: Air Passenger Duty
CCA: Climate Change Agreement
CCGT: Combined Cycle Gas Turbine
CCL: Climate Change Levy
CCT: Company Car Tax
CERT: Carbon Emission Reduction Target
CESP: Community Energy Saving Programme
CHP: Combined Heat and Power
CPF: Carbon Price Floor
CPSR: Carbon Price Support Rate
CRC: Carbon Reduction Commitment Energy Efficiency Scheme
ECA: Enhanced Capital Allowance
ECO: Energy Company Obligation
EEA: European Environment Agency
EII: Energy Intensive Industry
EMR: Electricity Market Reform
EPS: Emissions Performance Standard
EUA: European Union Allowance
EU ETS: European Union Emissions Trading System
FIT CfD: Feed-in Tariff with Contracts for Difference
FIT: Feed-in Tariff
HM Government: Her Majesty's Government
HMRC: Her Majesty's Revenue & Customs
HMT: Her Majesty's Treasury
IEA: International Energy Agency
LPG: Liquefied Petroleum Gas
NFFO: Non-Fossil Fuel Obligation
RHI: Renewable Heat Incentive
RO: Renewables Obligation
ROC: Renewables Obligation Certificate
RTFO: Renewable Transport Fuel Obligation
VED: Vehicle Excise Duty
VOC: Volatile Organic Compound
WHD: Warm House Discount

Executive Summary

UK businesses are subject to a complex framework of energy and climate change policies. Policies vary substantially in terms of their design, the number and types of businesses they affect, the implicit carbon tax they levy on energy used, and their financial costs (in the case of taxes) or revenues (if subsidies). Overlapping polices reduce the overall efficiency of the policy framework and mean that some businesses pay more than once for the carbon dioxide they emit. Developing an understanding of how policies are applied and reported against also creates a significant administrative burden for businesses.

The objective of this policy paper is to provide an overview of the main energy and climate change policies and their impacts on business in the UK, and to offer some proposals to introduce a simpler and more effective policy framework.

The UK policy landscape

A number of policies impose a direct cost on the amount of energy that businesses consume, in particular the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme, the Climate Change Levy (CCL), Climate Change Agreements (CCAs), the European Union Emissions Trading System (EU ETS) and the Carbon Price Floor (CPF). There are also policies that are levied at the point of power generation ('upstream'), but whose costs are passed-through to 'downstream' energy users in the form of higher electricity prices. These include the EU ETS (for power generators), CPF and policies that support the deployment of renewable electricity, notably the Renewables Obligation (RO), soon to be replaced by the Feed-in Tariff with Contracts for Difference (FIT CfD), and the small-scale Feed-in-Tariff (FIT).

Other policies provide financial support to some businesses which invest in low-carbon and energy efficiency technologies, without directly affecting electricity costs. These include the Renewable Heat Incentive (RHI) and the Green Deal. Subsidies are also provided for the research, development and deployment of low-carbon technologies. Beyond the scope of this paper are a number of other policies that tackle climate change indirectly and also have an impact on business costs and behaviour. These include transport and waste levies, building standards and product policies.

The layering of these policies has led to inconsistencies and overlaps. Many businesses pay a form of carbon price several times over, depending on which policies they are subject to. As a result, effective carbon prices vary significantly, both across businesses and across fuels. Notably, electricity is currently more heavily charged than energy from fossil fuels with higher carbon contents, suggesting that policies do not send the right signals about emissions reductions to energy users. This can lead to inefficient allocation of abatement activity across sectors, distorting relative prices and making it harder or more expensive to achieve policy objectives, such as improving energy efficiency and reducing emissions.

Given these inconsistencies, there is considerable scope to improve the effectiveness of energy and climate change policies. Affected businesses themselves criticise the lack of a clearer and more coherent policy landscape.

Proposals for reform

In this paper, we propose a simplification that would see the three key downstream policies – namely the CRC, CCAs and CCL – merged into a single tax instrument. At least initially, the new instrument would broadly retain the design of the CCL. However, it would be levied on all energy use without exemption, and would provide a single, consistent carbon price across all businesses and fuels. In the longer term, consideration should be given to replacing the CCL-style energy tax (what we refer to here as CCL+) with a single carbon pricing policy that imposes a uniform carbon tax on coal, gas and liquefied petroleum gas (LPG) further upstream – that is, at the point of import or production.

There is a strong case for removing the CRC because it overlaps with other existing policies (particularly the CCL), it is poorly designed, and it imposes high administrative costs. The removal of the CCAs deserves more explanation, as businesses generally consider that the scheme provides a visible and effective incentive for low-carbon investment. However, the available evidence suggests that the CCL has been more effective than the CCAs in reducing emissions, and without any significant impact on output or jobs. This suggests that CCAs are not justified on the grounds of competitiveness – the main reason for its introduction – and that extending the CCL to all businesses could induce more energy savings at little or no cost in terms of competitiveness.

To ensure a uniform carbon price, the proposed tax on coal, gas and LPG would be levied in proportion to their carbon content. The tax rate for electricity use would have to be lower to account for the fact that electricity already bears the implicit carbon price imposed at the point of generation, via the EU ETS, the CPF, the RO, and the FITs, the costs of which are passed on to electricity users. And as these upstream costs are expected to rise in the coming years, electricity may eventually be exempt from any tax on energy use.

We do not make any firm recommendations on what would constitute an appropriate carbon price. This is a sensitive issue and concerns about business competitiveness must be weighed up against the appropriate contribution of industry to achieving the UK's carbon targets. In principle, there is an argument for aligning the carbon price for businesses along a single value for both the EU ETS traded and non-traded sectors, consistent with the overall UK carbon budget. This would result in a significant increase in the carbon price charged on gas, coal and LPG.

Since this reform could result in higher tax rates for many businesses, it would also imply increased fiscal revenues for the Government. However, there is a case for recycling back to businesses the revenues that would be regarded as a surplus when compared with the current situation. In particular, some revenue would need to be earmarked for compensating businesses whose international competitiveness is likely to be impacted. Compensation options could include lump-sum payments or reductions in business taxes. Using carbon tax revenues to finance measures like the FITs or the RO would remove them from energy bills, thus reducing costs, although this raises questions about the wider distributional impacts of these policies.

1 Introduction

The Climate Change Act[1] commits the UK to reducing its greenhouse gas emissions by 80 per cent by 2050, relative to 1990 levels. This will require deep cuts in emissions during the 2020s. Large emissions reductions are expected from the power sector, as well as in other industrial sectors, as fossil fuels are gradually replaced by low-carbon energy sources. The Committee on Climate Change (CCC, 2010b), in its 'medium abatement scenario', envisages an annual emissions reduction by 2030 of about 91 per cent below 2008 levels in the power sector, 56 per cent in buildings, 43 per cent in surface transport, 28 per cent in industry (including refineries and other energy supply) and 19 per cent in agriculture, with further reductions expected between 2030 and 2050.

In order to curb domestic emissions, a number of policies have been introduced in the UK since the late 1980s. Most policies work by putting an implicit or explicit price on carbon emissions or by providing subsidies to encourage energy efficiency and investment in low-carbon energy sources. Several of these policies affect the UK business sector, in particular by raising the price of fossil fuels and electricity.

Today the landscape of energy and climate change policies is complex. Existing policies attempt to take into account multiple market failures and, as a result, some overlap between policies has been unavoidable. Nevertheless, there are instances where this complexity has jeopardised policy effectiveness, because of some flaws in the initial (or revised) design of these policy instruments, or because of unexpected interactions between them, or simply due to changed economic circumstances.

To ensure that energy and climate change policies have their intended effect at the least cost for business and society, one needs to understand how they work as a coherent policy 'package', and identify and remove any unnecessary overlaps.

This paper aims to contribute to such an assessment by presenting an analysis of the main energy and climate change policies that currently affect the business sector in the UK. In particular, the paper focuses on the issue of carbon pricing, and particularly on how it is currently applied inconsistently in terms of policies, sectors and fuels, and how a more coherent and effective carbon price signal is needed for businesses. The impact of these policies on households is discussed in a companion paper by the Institute for Fiscal Studies (Advani, Johnson, Leicester, & Stoye, 2013).

This paper does not intend to provide an exhaustive assessment of the policies under analysis, which would take into account other elements beside the explicit or implicit carbon price, such as transaction costs, accountability, enforceability and public acceptability (on policy assessment and design, see for example OECD, 2007; Gunningham & Grabosky, 1998; Sullivan, 2005; etc.). But by focussing on carbon pricing, we aim to outline some of the inconsistencies within the current policy landscape in relation to the UK statutory emission reduction targets, and we suggest how existing policies could be simplified and improved.

[1] See: http://www.legislation.gov.uk/ukpga/2008/27/contents

Chapter 2 describes how the main energy and climate change policies affect different industrial sectors in the UK. Chapter 3 investigates how these policies overlap and discusses the inconsistency in carbon price created by these policies. Chapter 4 presents the results of a firm-level analysis on the impact of three key carbon pricing policies, namely the European Union Emissions Trading System, the Climate Change Levy and Climate Change Agreements, on output, employment and innovation. Chapter 5 investigates the potential implications of a policy simplification that aligns energy taxes around a single carbon price. Finally, Chapter 6 presents the paper's key findings and recommendations.

2 Policy landscape

The business sector is responsible for almost 40 per cent of UK carbon dioxide emissions (see Box 2.1). In order to improve energy efficiency and reduce emissions across the economy, a number of energy and climate change policies have been implemented since the 1980s. These have resulted in what is today a complex system of market-based instruments and regulatory measures.

The main policies currently affecting businesses are outlined in Section 2.1. The businesses affected and their perceptions of the current policy regime are discussed in Section 2.2. The key issues are briefly summarised in Section 2.3.

Box 2.1 UK carbon dioxide emissions by sector

The latest available estimates by the Department of Energy and Climate Change (DECC, 2013a) indicate that, in 2012, greenhouse gas emissions in the UK were around 570 million tonnes of carbon-dioxide-equivalent. Carbon dioxide accounted for almost 85 per cent of these emissions, i.e. 480 million tonnes.

Business activities (including industrial and commercial activities, as well as the public sector) accounted for almost 40 per cent of total carbon dioxide emissions, or around 160 million tonnes. About half of these emissions were associated with electricity use, while the rest were generated by the direct use of fossil fuels. Emissions from the business sector have significantly decreased during the past two decades. In 2012, they were almost 30 per cent less than in 1990. This was mostly due to a reduction in emissions from industrial combustion; further reductions have been recorded since 2008 following the economic recession. In the past two years, however, emissions have started to rise. In 2012 carbon dioxide levels were around 5 per cent higher than in the previous year (DECC, 2013a).

Details of emissions by sector are shown in Figure 2.1. Estimates by 'source' distinguish between emissions generated by the power sector for the production of electricity, and those emitted by other sectors via direct use of fossil fuels (for example, for heating, industrial processes, etc.). Estimates by 'end-user' reallocate emissions generated by power stations to actual electricity users.

Figure 2.1 Emissions by sector, 2012 (provisional data)

Note: The 'Business' category in the chart includes the following categories from the original data source: Business, Industrial Processes, Public Sector

Source: DECC (2013a)

2.1 Policy overview

UK businesses are affected by several energy and climate change policies. Most of them are designed to be 'market-friendly', using price signals to encourage cost-effective behavioural changes (Bowen & Rydge, 2011). They rely on prices set in tradable quota markets (such as prices of tradable emission permits in the European Union Emissions Trading System and of Renewables Obligation Certificates under the current regime for promoting renewable energy in the production of electricity), direct price-based instruments (usually policies setting an implicit or explicit price on carbon dioxide) and, often, a mix of these approaches. There are also regulations mandating specific actions, such as labelling requirements for energy efficiency or reporting standards for greenhouse gas emissions, although these fall outside the scope of this study.

Current UK energy and climate change policies aim to fulfil a number of objectives. These include reducing greenhouse gas emissions, stimulating innovation and uptake of low-carbon technologies, and tackling other externalities (for example, traffic congestion).

The main policies to tackle greenhouse gas emissions are the Carbon Reduction Commitment Energy Efficiency Scheme (CRC), the Climate Change Levy (CCL), the Climate Change Agreements (CCAs), the European Union Emissions Trading System (EU ETS) and the Carbon Price Floor (CPF). They do so by explicitly or implicitly setting a price on the carbon content of energy.

Policies such as the Renewables Obligation (RO), the Feed-in-Tariffs (FITs), the Renewable Heat Incentive (RHI), and the Green Deal aim primarily to support the uptake of low-carbon energy sources and to promote the development of an energy system that is able to accommodate them. From 2014, new measures will be introduced as part of the Electricity Market Reform (EMR), namely the new the Feed-in Tariff with Contracts for Difference (FIT CfD), which will gradually replace the RO; the Capacity Mechanism; and Emissions

Performance Standards (EPSs). Subsidies for research and development are also available to support low-carbon technologies.

Other measures have been introduced to tackle externalities other than climate change, but can nonetheless have a significant impact on greenhouse gas emissions. For example, taxes applied to the transport sector, such as Fuel Duty, the Vehicle Excise Duty (VED), the Air Passenger Duty (APD), the Renewable Transport Fuel Obligation (RTFO) and the Company Car Tax (CCT), all have the effect of decreasing carbon emissions, whilst also reducing congestion, traffic accidents and noise. Taxes on waste, especially the Landfill Tax, contribute to curbing greenhouse gas emissions by reducing the amount of methane emitted from landfill waste. Subsidies and tax breaks for particular business equipment can also spur investment in low-carbon and/or energy efficiency technology, for example through the Enhanced Capital Allowance (ECA).

A brief description of these policies, in chronological order of their introduction, is shown in Box 2.2. A more detailed analysis can be found in a companion paper by the Institute for Fiscal Studies, the Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, 2013). Additional policies, not included in
Box 2.2, can also help to reduce emissions, such as product policies affecting the efficiency of energy-using and energy-related products, the Aggregate Levy on the extraction of rock, sand and gravel, and Energy Performance of Buildings Regulations.

Box 2.2 Chronology of the introduction of energy and climate change policies and other related instruments affecting the UK business sector

1993: Duty on hydrocarbon oils (or Fuel Duty) and escalator. A set of taxes on hydrocarbon oils (for example, petrol, diesel, biodiesel) were first introduced in 1909. In 1993, the Government introduced an annual Fuel Price Escalator, initially at 3 per cent above the rate of inflation, which increased to 6 per cent after 1997. The escalator was abolished in 2000, although rates have been adjusted since.

1994: Air Passenger Duty (APD). An excise duty on passengers being carried from a UK airport on a chargeable aircraft. From 2013, there are 12 different rates of duty, ranging from £13 to £376 per passenger, depending on the distance to the final destination, the class of travel and the type of aircraft used.

1996: Landfill Tax. The tax applies to municipal solid waste going to landfill. In 2012, the standard rate for 'active' waste (substances that either decay or contaminate land, including household waste) increased from £56 to £64 per tonne, while a reduced rate of £2.68 applies to 'inert' waste (for example, bricks, concrete, etc.).

2001: Vehicle Excise Duty (VED). An annual duty on road vehicles. This measure dates back to 1896, but for cars registered on or after March 2001, the rate of VED is based in fuel type and carbon dioxide emissions. It is intended to encourage the purchase of more efficient cars and the early scrapping of less efficient vehicles.

2001: Climate Change Levy (CCL). A tax on the use of energy in industry, commerce and the public sector. The full rates from 1 April 2012 are £5.09/MWh for electricity, £1.77/MWh for gas, £11.37/tonne for LPG and £13.87/tonne for coal.

2001: Climate Change Agreements (CCAs). CCAs allow eligible energy-intensive businesses to receive a discount on the Climate Change Levy (CCL) in return for meeting targets for energy efficiency or carbon saving. From mid-2013, the discount is 65 per cent for gas and 90 per cent for electricity.

2001: Enhanced Capital Allowance (ECA). A scheme providing businesses with tax relief for investments in qualifying plant and machinery (for example, boilers and motors), including energy efficiency and low-carbon technologies. Businesses can write off the capital cost of new plant or machinery against their taxable profits.

2002: Company Car Tax (CCT). An employees' benefit-in-kind taxation, reformed in 2002 to take into account

the environmental impact of company cars. Employees are liable to pay income tax on the taxable value of a company car they receive as a benefit. The taxable value ranges between 15 per cent and 35 per cent of a car's price, depending on its carbon dioxide emissions. Discounts are granted to cars running on lower emission fuels.

2002: Renewables Obligation (RO). The RO incentivises large-scale renewable electricity generation by requiring electricity suppliers to source a specified proportion of their electricity from renewable energy generators, in exchange for Renewables Obligation Certificates (ROCs). The programme will gradually be replaced by Feed in Tariffs with Contracts for Difference (FIT CfDs) from 2014, and will be completely phased out in 2017.

2005: European Union Emissions Trading System (EU ETS). A cap and trade system applying to direct emissions from energy-intensive facilities. A Europe-wide cap is set on the emissions of specific greenhouse gas emissions (mainly carbon dioxide) and converted into tradable emission allowances (EUAs). These are provided to participants via a mixture of free allocation and auctioning. The trading of EUAs determines the market price for carbon.

2008: Renewable Transport Fuel Obligation (RTFO). The RTFO scheme requires suppliers of road transport fuel to ensure that a minimum proportion of it comes from sustainable, renewable sources (e.g. biofuels), or that a substitute amount of money is paid.

2010: Carbon Reduction Commitment Energy Efficiency Scheme (CRC). A carbon levy imposed on electricity and gas, targeting emissions from large public and private sector organisations which are not already covered by the EU ETS or the CCA. Between 2010 and 2014 the tax rate has been £12/tCO_2.

2010: Feed-in-Tariffs (FITs). FITs are designed to incentivise small-scale, low-carbon electricity generation. FIT Generators that register with the scheme receive two types of payment: a generation tariff paid for every unit of electricity they generate and use on site, and a (higher) export tariff which is applied to surplus electricity which is exported to the grid.

2011: Renewable Heat Incentive (RHI). A tariff paid to eligible companies and bodies in the commercial, public and industrial sectors which take up renewable heat generating technologies.[2] Payments vary by technology and scale and are paid quarterly over a 20-year period. From 2014, RHIs will also apply to households.

2011: Warm House Discount (WHD). The WHD aims to reduce the incidence of fuel poverty by requiring energy suppliers to offer electricity bill rebates to low-income and vulnerable households.

2013: Energy Company Obligation (ECO). The scheme replaces the Carbon Emissions Reduction Target (CERT) and the Community Energy Saving Programme (CESP). It requires large energy companies to support domestic energy efficiency for poor and vulnerable households, households in deprived areas, 'hard-to-treat' properties, and expensive measures not covered by the Green Deal.

2013: Carbon Price Floor (CPF). The CPF sets a 'floor' to the EU ETS carbon price, i.e. a minimum carbon price which should be paid by UK power generators participating in the EU ETS. The floor price is set at £16/tCO_2 in 2013, increasing to £30/tCO_2 in 2020 and £70/tCO_2 in 2030. If the EU ETS carbon price is expected to be below this target, carbon price support rates (CPSRs) for the CCL and Fuel Duty are imposed on fossil fuels used for electricity generation. These are set to bridge the gap between the price of EUAs (estimated on two-year-ahead future traded prices) and the CPF, and are announced two years in advance. The CPSRs for 2013-14 and 2014-15 are, respectively, £4.94/tCO_2 and £7.28 /tCO_2.

2013: Green Deal. A special form of loan which enables organisations (including private companies, local authorities, charities and trade associations) to offer consumers (households and businesses) energy efficiency improvements at no upfront cost, and to recoup payments through a charge in instalments on energy bills.

2014: Feed-in Tariffs with Contracts for Difference (FIT CfDs). A long-term contract between electricity generators and a government-owned counterparty to supply electricity at a fixed 'strike price'. If the wholesale market price is below the strike price, the generator receives the difference from the contract counterparty; if the market price is above it, it is the generator who pays the difference (two-way FIT CfDs). Between 2014 and 2017, generators can choose between ROs or CfDs. From 2017, only CfDs only apply.

2014: Capacity Mechanism. A policy to reward the provision of capacity. The estimated amount of capacity needed to ensure security of supply is contracted through a competitive central auction. Successful providers

[2] Thresholds apply to some technologies: for example, no more than 200 kWh generated from solar thermal and biogas combustion.

enter into capacity agreements, committing them to provide electricity when needed in the delivery year(s) in return for a steady capacity payment, or face penalties.

2014: Emissions Performance Standard (EPS). An annual limit on the total amount of carbon dioxide per unit of installed capacity that new fossil fuel power stations are allowed to emit. The EPS will initially be set at 450g CO_2/kWh for all new fossil fuel plants, except carbon capture and storage (CCS) demonstration plants. The level of the EPS on the date of consent for a new plant will apply for the economic life of the installation.

Energy and climate change policies affect businesses in different ways. First, several of them represent a direct cost charged on the amount of energy that firms consume. Notably, companies which are covered by the CRC, CCL, or CCAs pay a tax on every unit of electricity and fuel they consume.

In 2012-13, the fiscal revenues associated with the CCL, and the reduced CCL rates granted by the CCA, were around £600 million (HMRC, 2013b), while the CRC revenues were around £700 million (HMT, 2013). Those participating in the EU ETS (the 'traded sectors') pay the price of European Union Allowances (EUAs) which they need to hold for every tonne of carbon they emit. The price of EUAs is determined by trading and so varies over time. Between January and June 2013 it was, on average, €4.13/tCO_2 (£3.50/tCO_2).[3] Although businesses can be granted a specified number of free EUAs, on the basis of their historical emissions, from 2013 there will be an increasing shift away from free allocations towards auctioning. In 2013, more than 40 per cent of EUAs are expected to be auctioned, and we estimate that this will be worth around £300 million to the UK Government.[4]

Some policies are a direct cost imposed on the power sector only. We refer to these as 'upstream' policies, as they are levied at the point of power generation (upstream) rather that at point of use (downstream).[5] Energy suppliers recoup the costs of these policies by charging consumers (businesses and households) more on their bills[6] (see, for example, Sijm *et al.*, 2006 on the issue of cost pass-through). These policies include the RO, FITs, the EU ETS and CPF (see Box 2.2 for a description of these policies) - through the Carbon Price Support Rate (CPSR).

The CPF imposes a tax on power generators through the CPSR, which is effectively a special rate of the CCL and Fuel Duty. This tax is paid when the price of EUAs in the EU ETS is below

[3] This is the average clearing price for carbon permits in UK auctions held between 16 January and 19 June 2013 (https://www.theice.com/marketdata/reports/ReportCenter.shtml#report/148). It was converted using the average exchange rate between January and June 2013, which was £1 = €1.18.

[4] This is lower than current Government estimates. The Office for Budget Responsibility (OBR, 2013) forecasts that revenues from UK auctions of EUAs will be £700 million in 2013-14. The discrepancy is most likely due to the recent drop in price of EUAs.

[5] In other contexts 'upstream' often refers to fuel production, while power supply is 'mid-stream' and energy consumption 'downstream'. For simplicity, in this paper we consider 'upstream' both fuel production and energy supply.

[6] In cases of perfect competition and with perfectly elastic supply, the pass-through rate of taxes to final consumers would be equivalent to 100 per cent. In reality this is unlikely to be the case. For instance, Sijm *et al.* (2006) estimate that the EU ETS pass-through rates for Germany and the Netherlands vary between 60 and 100 per cent of carbon dioxide costs. For simplicity, in this and the companion paper by the Institute for Fiscal Studies, the Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, 2013), we assume the impact of upstream policies on final prices for electricity users is fully passed through, and determined by the carbon intensity of power generated by combined cycle gas turbines (CCGTs), as the marginal generating plant.

the minimum level set by the CPF. In 2013-14 the CPSR is estimated to generate fiscal revenues of around £740 million (HMT, 2011).

The RO and FITs are both a cost (for the power sector, and indirectly for all energy users), and a subsidy for those who adopt renewable energy technologies. Overall, the RO was worth around £2 billion in 2011-12 (Ofgem, 2013). DECC (2011) estimated this has increased the electricity bill of an average medium-sized business by about 10 per cent in 2013, (adding £8/MWh to the average electricity unit cost of around £81/MWh in the absence of policies). The FIT scheme cost around £500 million in 2012-13 (Grover, 2013) and added around 2.5 per cent to the electricity bill of medium-sized businesses in 2013, i.e. £2/MWh (DECC, 2011).

Other policies that provide financial support to low-carbon and energy efficiency technologies have their budgets covered by general government funding rather than via higher electricity costs. An important policy of this type is the RHI. This measure has a total allocated budget of £800 million between 2011 and 2015 - although take-up so far has been relatively low (Ofgem, 2012b). Expenditures in 2012-13 were estimated to be around £40 million (Ofgem, 2012c).

The sizes of subsidies provided for research, development and deployment for low-carbon technologies are outlined in Box 2.3.

Box 2.3 Support for research, development and deployment for low-carbon technologies

While it may be technically possible to achieve emissions reductions using current technologies, this is likely to become increasingly costly as cheaper options are exhausted and more fundamental structural changes, such as the electrification of the transport sector, are required (Bowen & Rydge, 2011). Although carbon price signals already provide an incentive to adopt low-carbon technologies, further incentives may be justified to support research, development and deployment in these areas, as innovation and learning can bring down their costs.

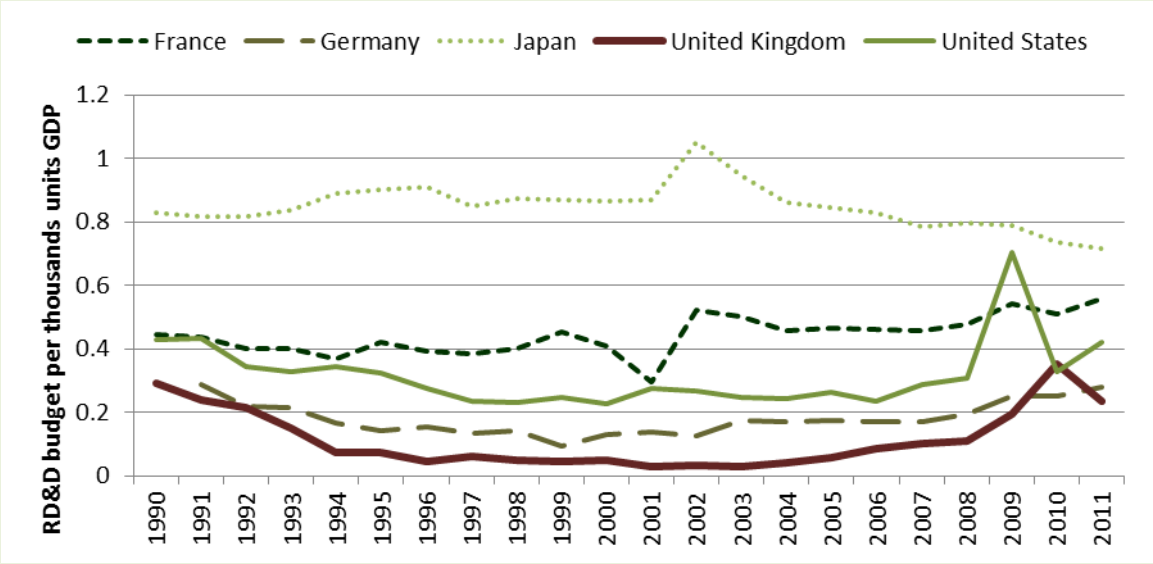
Figure 2.2 shows trends in Government support for research and development for low-carbon energy during the past two decades in the UK and other OECD countries. Spending on research and development for low-carbon energy has experienced a slow decline since the 1990s in the UK, both in total and as a percentage of GDP. This has largely been caused by a general reduction of research and development expenditure by the nuclear industry worldwide. The UK, through most of the 1990s and 2000s, lagged far behind other major OECD countries in terms of research and development investment on low-carbon energy.

More recently there has been a resurgence in public spending on research and development in the UK and other OECD countries, due to increased spending on renewable energy and energy efficiency, reflecting climate change and energy security objectives. In the UK, investment in research and development for low-carbon energy technologies has increased significantly since 2004, reaching up to £475 million in 2010 (in 2012 values) (IEA, 2013).

Despite this increase, an assessment by the Committee on Climate Change (CCC, 2010a) of the compatibility of the UK's research and innovation spending with its climate change objectives concluded that Government funding was at its minimum acceptable level and that increases are necessary in some areas.

Furthermore, from 2010, spending on research and development for low-carbon energy has declined as a result of the economic crisis. In 2012 research and development spending was estimated to be around £250 million in the UK (IEA, 2013).

Figure 2.2 Government research, development and deployment budgets for low-carbon energy, per thousand units of GDP



Note: Low-carbon energy includes: energy efficiency, renewables, nuclear, hydrogen and fuel cells, other power and storage technologies, and other technology or research. Data for Germany start in 1991.

Source: IEA (2013)

2.2 Sectors affected

Table 2.1 gives an overview of which energy and climate change policies affect different (broad) economic sectors. In practice other characteristics affect which firms are affected besides the sector they belong to, such as their size and energy consumption. Furthermore, several policies apply at the level of installation rather than firm, i.e. apply to smaller individual units within a business. As a result, different parts of the same business can be subject to different policies; for example, some of its installations could be subject to the CCL and others to CCAs. The reality is therefore much more complex than Table 2.1 might suggest. Nevertheless, even an aggregated picture like the one presented in Table 2.1 highlights the large number of policy regimes to which businesses can be subject.

The analysis is based on the 'two digit' sectors defined in the 2007 UK Standard Industrial Classification (SIC). These were further grouped into seven macro-categories: Primary; Construction; Energy; Manufacture; Transport; Public Services; and Other Services. We also identify, within each category, those sectors or sub-sectors that have a different policy regime compared with other businesses within that group, in particular those that are eligible for CCAs or participate in the EU ETS.

Policy impacts are distinguished between direct or indirect costs, or subsidies. We consider that policies create a direct cost for businesses when they need to pay a given fee imposed by the policy. Indirect costs are associated with upstream policies, the costs of which are passed-through to electricity users.

Table 2.1 Applicability of energy and climate change policies to different sectors

SIC code (2007)	Sector	CRC	CCL	CCA	EU ETS	CPF	RO/FIT CfD	FIT	RHI	FD	LT	VED
01-09	PRIMARY	D	D		I	I	I	I/S	S	D	D	D
Except:												
01 07 08	01.2 Perennial crops; 01.46 Pigs; 01.47 Poultry 07.1 Mining of iron ores 08.1 Quarrying stone, sand & clay			D	I	I	I	I/S	S	D	D	D
06	Extraction of oil and gas				I	I	I	I	S		D	D
41-43	CONSTRUCTION	D	D		I	I	I	I		D	D	D
Except:												
43	43.3 Building completion/finishing			D	I	I	I	I		D	D	D
35	ENERGY				D	D	D	D			D	D
10-32	MANUFACTURE	D	D		I	I	I	I/S	S	D	D	D
Except:												
17 20 23 24	Paper Chemicals Non-metallic mineral products Basic metals			D	D	I	I	I/S	S	D	D	D
19	Refineries				D	I	I	I	S		D	D
10 11 13 15 16 18 22 25 26 28 29	10.1 Meat; 10.5 Dairy; 10.7 Bakery 11.01 Distilleries; 11.05 Beer; 11.06 Malt Manufacture of textiles Leather 16.21 Wood panels 18.1 Printing Rubber and plastic products 25.92 Light metal packaging 26.11 Semiconductors 28.25 Cold storage Motor vehicles			D	I	I	I	I/S	S	D	D	D
49-51	TRANSPORT	D	D		I	I	I	I		D	D	D
Except:												
51	Air transport			D	D	I	I	I		D	D	D
84,85,91	PUBLIC SERVICES	D	D		I	I	I	I	S	D	D	D
33-99	OTHER SERVICES	D	D		I	I	I	I/S	S	D	D	D
Except:												
47 96	47.1 Non-specialised retail stores 96.01 Laundries			D	I	I	I	I/S	S	D	D	D

Note: D= direct effect; I= indirect effect; S= subsidy. Empty cells = mostly no/limited effect

Source: This study

The system is complex. For example, while the CCL applies to all business sectors, small energy users are exempt.[7] And reduced CCL rates are offered to energy-intensive industries (EII) which sign up to CCAs. The EU ETS targets only activities that involve the use of large amounts of energy and generate large amounts of greenhouse gases, and, within these activities, only large installations are regulated. The CRC applies to large public and private sector organisations not already covered by CCAs and the EU ETS. Other policies, such as the LT or FD, apply to all sectors. And, as noted above, the costs of policies which apply solely to the energy sector are generally passed on to all businesses (and other energy users) through higher electricity prices (see e.g. Sijm *et al.*, 2006), and therefore indirectly affect all sectors. Additional details about the sectoral coverage of policies are provided in Table 2.2.

Table 2.2 Eligibility criteria by policy, 2013

Policy	Sector	Eligibility
CCL	All sectors, unless covered by CCA	All non-domestic energy users except small activities e.g. businesses consuming below 1,000 kWh/month of electricity (12 MWh/year) and 4,397 kWh/month of gas (53 MWh/year).
CCA	EII and other manufacturers	Sectors with energy intensity of at least 10 per cent (ratio of energy cost to value of production), OR, energy intensity of at least per cent AND import penetration of at least 50 per cent.
CRC	All sectors unless covered by ETS or CCA	At least 1 half-hourly electricity meter settled on the half-hourly market and electricity consumption above 6,000 MWh/year.
EU ETS	Energy and EII	Sector specific thresholds (e.g. power plants above 35 MW); emissions should be above 25,000 t CO_2/year.
CPF	Energy	Fossil fuel-based electricity generators, their suppliers and electricity utilities.
RO	Energy	Renewable electricity installations above 5 MW.
FIT	All sectors	Renewable electricity installations below 5 MW.
RHI	All sectors	All firms except those with solar thermal above 200 kWh and biogas combustion above 200kWh.
CERT/CESP	Energy	Energy suppliers with more than 50,000 domestic customers and electricity generators that produce at least 10TWh/year.
CERT	Energy	Energy suppliers with more than 250,000 domestic customers.
ECO	Energy	Energy suppliers with more than 250,000 domestic customers, supplying more than 400 GWh of electricity or 2,000 GWh of gas.
WHD	Energy	Energy suppliers with more than 250,000 domestic customers.
Green Deal	All sectors	No eligibility criteria.
FD	All sectors	No eligibility criteria.
VED	All sectors	No eligibility criteria.
LT	All sectors	No eligibility criteria.
FIT CfD	Energy	Renewable electricity installations above 5 MW, CCS and nuclear power plants.
Capacity Mechanism	Energy	All power plants except those covered by FIT CfD.
EPS	Energy	New fossil fuel power stations without CCS and with capacity at or over 50 MW.

[7] For instance those consuming less than 1,000 kWh/month of electricity (0.012 MWh/year) and 4,397 kWh/month of gas (0. 053 MWh/year) are exempt from the CCL. The small quantity limits applicable to each fuel are defined in Notice CCL1/3 (HMRC, 2012).

Smart meters	All sectors	Energy suppliers with more than 250,000 domestic customers are required to install the meters. The beneficiaries are small to medium-sized non-domestic users (annual gas consumption below 732 MWh; electricity profile classes 3 and 4).

Businesses have to carefully assess which policies they are subject to or they risk being penalised for failure to comply. A lot of work is sometimes required to demonstrate compliance with policies because the process of measuring and verifying emissions can be cumbersome and time-consuming. This has been particularly true for the CRC. A survey of CRC participants revealed that the administrative costs have so far been higher than intended. Costs incurred by an average business in the first four years of the scheme (i.e. its Phase 1) were about £62,000 - an average of £15,500 per year. Extrapolations indicate that these added an additional £0.59 (5 per cent) to the cost of each tonne of carbon in Phase 1 (KPMG, 2012). Costs were also incurred by businesses not regulated by the scheme, but who had to prove their non-eligibility. No estimate is available, but for some businesses even these costs may have been significant (see an example in Box 2.4).

Where a number of policies affect a business, there can be unintended interactions between the policies which reduce their overall effectiveness. These interactions can also lead to increased costs for the business, both because they increase the administrative burden, and also because they can mean that a business pays for some of its carbon emissions more than once. This is further discussed in Section 3.1.

Businesses' perceptions of energy and climate change policies vary depending on which and how many policies apply to them, their energy intensity, size and ability to transfer policy costs to customers, and their exposure to the international competitive market. A survey by the Confederation of British Industry (CBI, 2012) reveals some interesting insights, some of which were supported during interviews carried out with businesses in the course of this study (see Box 2.5):

- The CRC is among the most criticised policies, and is considered as a drag on, rather than a driver of, clean investment. Key concerns are its lack of a clear purpose; frequent, unexpected changes to its design; and its high administrative burden.
- The CCL is seen as simple to manage - it is typically just a line within an energy bill. However, the carbon price signal it provides can get 'lost' in bills and so it can be less visible to decision-makers within companies, and therefore acts as less of a driver for investment and behavioural changes.
- CCAs are considered to have a stronger visibility than the CCL, but at the expense of higher administrative costs.
- The LT and VED are generally considered effective at unlocking business investment. They are valued for having a clear purpose and for working well alongside other policies, for being designed in line with the way industries operate, and for being implemented effectively, particularly the LT escalator.

Interviews with 800 manufacturers in six European countries, including the UK, have highlighted some of the weaknesses of the EU ETS (Martin, Muûls, & Wagner, 2011). In particular, it emerged that most businesses within the EU ETS do not trade in the allowance (EUA) market. Of the businesses interviewed, 30 per cent do not consider EUAs as a

financial opportunity, but rather see the emission cap implicit in their EUA allocation as something they merely need to comply with. A regression analysis also revealed that businesses that are eligible for free allowances conduct significantly less product innovation than firms which are required to purchase them through auctioning, suggesting that the generous allocation of free EUAs hampers innovation.

Some additional insights based on a number of interviews carried out in the course of this study are summarised in Box 2.4.

Box 2.4 Business insights about energy and climate change policies

To ground our economic analysis in evidence, we spoke to several businesses and a business association about the current policy landscape and how it affects their investment decisions. The relative narrowness of the sample of businesses interviewed means that the evidence is not comprehensive, but it does provide some useful first-hand insights into business perceptions of energy and climate change policies.

An energy supplier*:* The EU ETS had a positive influence on the company's low-carbon investment when it was first introduced, but a major shortcoming has been the system's failure to provide a durable, sustainable and consistent price. By 'consistent', the company means that "*the ETS price should avoid boom and bust cycles and provide greater stability to low-carbon investments by continually reflecting the carbon price required to deliver the overall decarbonisation target – not that it should be the same price throughout*". The CPF is considered a welcome introduction as it gives more certainty about the carbon price. It is anticipated that CfDs and broader electricity market reform implemented as a result of the passage of the new Energy Bill will boost low-carbon investment. However, in parallel, reform of the EU ETS is considered necessary to provide a consistent price signal and to enable the carbon market to respond to future unforeseen economic circumstances. Overall, the business believes that the UK Government has been learning from experience and improving energy and climate change policies over recent years. It also believes that domestic policies would be more effective if they tackled carbon dioxide emissions at source, rather than at the point of energy use, as some of them do currently.

An electrical goods manufacturer: Half of the emissions from this business are covered by CCAs. This business believes that the system of targets and tax discounts provided by the CCAs is a useful incentive, as it effectively allows them to make a double saving on energy bills – first through a discount on the CCL, and again through energy efficiency savings. Senior management can easily 'buy in' to this type of incentive and therefore support the energy efficiency investment needed for compliance. The tax relief offered under the Enhanced Capital Allowance has also had a positive effect on low-carbon investment for this business. The CRC does not apply to the business, but significant resources were initially invested in order to demonstrate its non-eligibility. The Green Deal is not considered very cost-effective, given its relatively high interest rate compared with the interest rates that the business can secure through conventional bank loans.

A large building material manufacturer: Policy complexity is an important issue for this business. As a large and complex business, with a number of large and small sites across the country, it is subject to number of different climate policies which overlap and interact. Among these, the business feels that the administrative costs of complying with the CRC are particularly high. While the CCAs provide a good incentive for energy efficiency investment, the prolonged negotiations over the targets set in the agreements have led to relatively high administrative costs. The CCL, in contrast, has low administrative costs, but its impact on investment decisions has so far been relatively low, as it is seen as part of the operating costs of the business rather than a real lever for investment. Policy uncertainty, including uncertainty around the future price of carbon in the EU ETS, is perceived as a 'drag' on low-carbon investment. Constancy, on the other hand, can make policies much more effective. In this regard, the LT is considered by the business to be a positive example, as its purpose and design have remained clear and consistent over time and between governments.

A large retailer*:* About 40 per cent of the emissions generated by this retailer are covered by CCAs while the remainder are subject to the full rates of the CCL. A large proportion of its emissions are also subject to the CRC. It is considered to create the biggest financial and administrative burden of all the energy and climate change policies the business is affected by. The indirect policy costs, passed on through electricity prices, are also perceived as significant, particularly those associated with the RO. At the same time, the retailer reports that the RO and FIT scheme have been a positive incentive for investment in renewable energy sources. The CCL and CCAs are reported to have had a moderate influence on investments and behaviour, although their impact was stronger in their early years, while now they are mostly seen as a pure cost. The CRC is regarded as the least effective measure. Overall, the business notes that overlaps and inconsistencies between policies mean it pays for its carbon emissions several times over. Subsidies for renewables are considered to be disproportionately high and not always appropriately targeted. Policy uncertainty is regarded as a substantial issue. Reducing the uncertainty of policy costs (for example, of the RO) is considered to be important in order to keep future energy prices from rising too steeply and unpredictably.

A large investment and retail bank: This business, like many others in the sector, has relatively low energy consumption and is therefore not eligible for CCAs, but is subject to the CRC. The bank's experience with the CRC was initially positive, as the possibility to rank highly in the league table acted as a significant incentive for improving energy efficiency. However, subsequent changes to the measure, in particular the abolition of the league table and of its revenue-recycling element, reduced its effectiveness and damaged the CRC's credibility within the firm, particularly amongst senior management. The policy is now perceived as a pure cost, rather than a driver for change. The policies supporting the low-carbon sector are creating opportunities for the financial services sector to develop new products and services to finance investment. For example, as the Green Deal applies relatively high interest rates, the bank has seized the opportunity to offer cheaper loans to its clients for low-carbon equipment. Policy uncertainty is perceived by the bank as a significant risk to its investment arm.

A university*:* Universities are not eligible for CCAs. They are commonly subject to the full rates of the CCL, as well as the CRC. For this university, the financial cost of the CCL and the CRC are similar, but the administrative costs associated with the CRC are substantially larger. The CRC was initially considered to be a good idea, as it helped raise awareness of energy use and emissions. However, following and adapting to changes in the scheme has been time-consuming, and compilation of the data required for reporting has proven complex. This has caused a general loss of interest in the measure from the high-level management, and the CRC is now considered as a cost rather than a driver for low-carbon investment. Nevertheless, despite frustrations and shortcomings, the university acknowledges that the reporting required by the CRC has proven useful for increasing awareness of energy use and improving the management of energy bills. The FiT scheme has been a strong driver for the university's investment decisions, although its financial benefits are now relatively small. The CCL, on the other hand, is 'hidden' in the energy bills and does not require any mandatory reporting. It therefore has not provided a strong message to the top management about the need for low-carbon investment. The university feels that a single carbon price, clearly linked to kWh or carbon units and associated with regular reporting, would be a useful policy improvement.

2.3 Summary of findings

UK businesses are affected by several energy and climate change policies. Some of them represent a direct cost charged for the amount of energy that firms consume, particularly the CRC Energy Efficiency Scheme (CRC), the Climate Change Levy (CCL), Climate Change Agreements (CCAs) and the European Union Emissions Trading System (EU ETS).

There are also policies levied at the point of power generation ('upstream'), but their costs are passed-through to 'downstream' energy users through higher electricity prices. These include the EU ETS itself (when it applies to power generators) as well as the Carbon Price Floor (CPF) and instruments supporting renewable electricity, like the Renewables

Obligation (RO; soon to be replaced by the Feed-in Tariff with Contracts for Difference) and the small scale Feed-in Tariffs (FITs).

Other policies provide financial support to businesses which invest in low-carbon and energy efficiency technologies, without affecting electricity costs. These include the Renewable Heat Incentive (RHI) and the Green Deal. Subsidies are also provided for research, development and deployment of low-carbon technologies.

These policies vary substantially in their design, the number and type of businesses they affect, the implicit carbon tax they levy on energy used, and the overall costs they impose on businesses (or revenues, in the case of subsidies).

The next chapter provides an overview of the characteristics of the main energy and climate change policies analysed for this paper.

3 Policy overlaps and uneven carbon prices

A number of energy and climate change policies have been introduced in the UK in the past two decades. The different policies have sometimes created unexpected and/or undesirable interactions, which reduce policy effectiveness and transparency. The result has been a complex policy landscape, in which businesses (or installations within businesses) can be subject to several different policies and, as a result, can sometimes be charged for carbon dioxide emissions several times over.

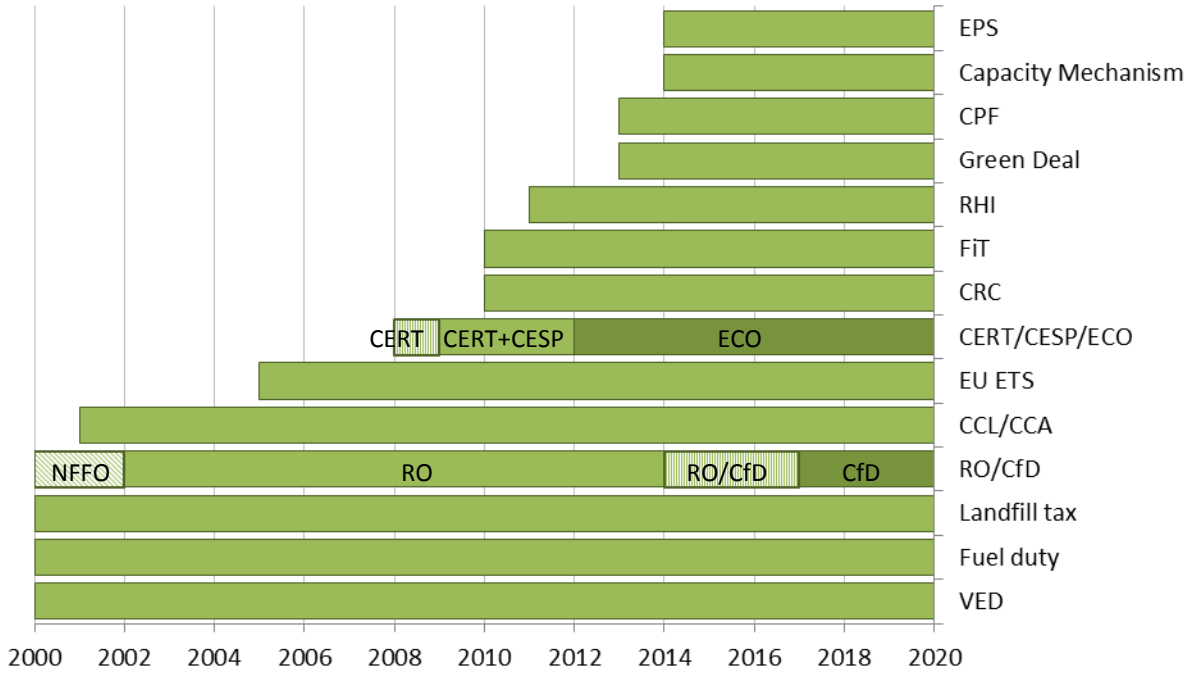
Section 3.1 describes how and to what extent policies currently overlap, while Section 3.2 explores in more detail the issue of uneven carbon pricing resulting from policy interaction. A short summary of the findings is provided in Section 3.3.

3.1 Policy overlaps

The number of environmental policies has increased in the UK since the mid-1990s. In particular, over the past decade, a range of new energy and climate change policies, from pure tax instruments such as the CCL and the CRC, to policies supporting renewables and energy efficiency, including the RO and FITs.

Some policies have evolved over time, with subtle changes to their design and aim (and sometimes their name) made at each stage of their evolution. In 2013, for example, the Energy Company Obligation (ECO) replaced the earlier Carbon Emission Reduction Target (CERT) and Community Energy Saving Programme (CESP), introduced in 2008 and 2009 respectively. The 1989 Non-Fossil Fuel Obligation (NFFO) was replaced in 2001 by the RO. The latter will work jointly with the new CfDs between 2014 and 2017, and will be fully replaced by them afterwards.

Figure 3.1 Main environmental and climate change policies and other related measures, 2000-2020



Source: Authors

With the implementation of such a wide range of policies, some undesirable overlaps have been created between them.
Figure 3.2 shows the interactions between the main energy and climate change policies that affect business.

Climate Change Levy (CCL). This is the most widespread policy. The Department for Environment, Food and Rural Affairs (DEFRA) estimated in 2008 that the CCL applied to approximately 900,000 organisations that were together responsible for 187 million tonnes of carbon dioxide emissions, while small businesses that did not pay the CCL were responsible for about 4 million tonnes of carbon dioxide (see House of Commons Environmental Audit Committee, 2010).

Climate Change Agreements (CCAs). Our analysis (see Chapter 4) suggests that, in 2013, around 7,300 installations had CCAs in place. These are often smaller units of larger businesses.[8] We estimate that around 2,800 businesses have CCAs for one or more of their installations.[9] No recent estimate is available of emissions associated with companies that have CCAs, but earlier analysis by DEFRA (2007) suggested they were of the order of 90 million tonnes of carbon dioxide.

[8] In this paper we use the term 'firm' and 'business' interchangeably, and refer to the UK Data Centre definition of 'enterprise', i.e. 'the smallest combination of legal units that is an organisational unit producing goods or services, which benefits from a certain degree of autonomy in decision-making, especially for the allocation of its current resources. An enterprise carries out one or more activities at one or more locations. An enterprise may be a sole legal unit.'
[9] This is likely to be an underestimate, as data is fully available for only 6,260 installations.

CRC Energy Efficiency Scheme (CRC). The number of businesses that participated in the CRC in 2012 was about 2,100.[10] We estimate that their combined emissions in the same year were around 53 million tonnes of carbon dioxide.[11] These businesses are typically also subject to the CCL. In some cases there may be an overlap between the CRC and CCAs, as installations holding a CCA may still be subject to the CRC if their CCA covers less than 25 per cent of their total emissions (although from 2014 even these installations will be completely exempt from the CRC). The overlap between the CRC and the CCA, however, is limited (DEFRA, 2007).

European Union Emissions Trading System (EU ETS). Around 1,200 installations in the UK participated in the EU ETS in 2013 (excluding airlines).[12] According to our analysis, these were managed by around 600 businesses (see Chapter 4.2). According to Government estimates, EU ETS installations were responsible for about 230 million tonnes of carbon dioxide emissions in 2012 (Her Majesty's Government, 2013). Businesses participating in the EU ETS either fall under the CCL regime, or are granted rebated rates under the CCAs, if they are energy-intensive industries. We estimate that about 400 installations (150 businesses) are subject to both the EU ETS and CCAs in 2013. Analysis by DEFRA estimates that emissions from businesses falling under both regimes were around 40 million tonnes of carbon dioxide in 2007 (DEFRA, 2007). A few businesses regulated by the EU ETS fall outside both the CCL and the CCA. These are mostly offshore installations and refineries. In 2008, DEFRA estimated there were around 70 of such organisations, responsible for about 37 million tonnes of carbon dioxide (see House of Commons Environmental Audit Committee, 2010).

Carbon Price Floor (CPF). We estimate that about 172 power generation installations (managed by about 80 businesses[13]) participated in the EU ETS in the UK in 2013. Assuming their number has not substantially changed in the past year, these would also be now subject to the Carbon Price Support Rates (CPSR) under the CPF. Their emissions were equivalent to around 157 million tonnes of carbon dioxide in 2012 (Her Majesty's Government, 2013). Power generators are not subject to either the CCL or the CCA.

Electricity cost pass-through. All firms, with the exception of the upstream sectors (such as oil and gas extraction and refineries), are also indirectly affected by the policies that apply to the power sector. Policies for which costs are typically passed through (at least in the short run) include the EU ETS, the CPF (through the CPSR), FITs, the RO and, as from 2014, the measures associated with the UK electricity market reform, in particular the FIT CfD, replacing the RO and the Capacity Mechanism.

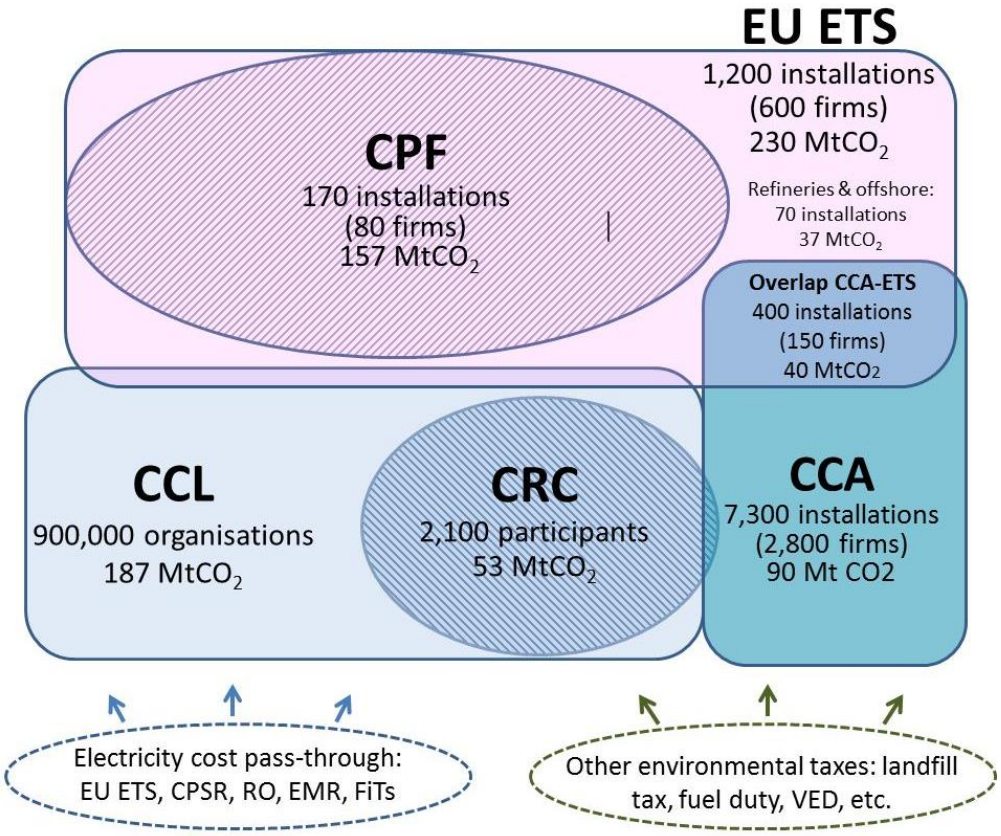
[10] The number refers to organisations that reported electricity use under the CRC. The information was provided by the UK Environment Agency under the provisions of the Environmental Information Regulations 2004 (EIR).

[11] Assuming their fuel consumption in 2012 was: 6,880 tonnes of coal; 84,963 GWh of electricity; 49,276 GWh of gas; and 27,549,417 litres of LPG. This information was provided by the UK Environment Agency under the provisions of the Environmental Information Regulations 2004 (EIR). Units were converted into carbon dioxide using the conversion factors described in Appendix 2 [available online].

[12] Airlines accounted for around 300 installations, managed by 180 firms.

[13] These are part of 31 company groups, including the 6 UK large energy suppliers – these own around 123 of the 172 installations i.e. around 70 per cent of the total.

Figure 3.2 Overlap between UK energy and climate change policies



Note: Emissions may not add up to the totals as they were calculated by different sources and refer to different periods

Sources: Participant numbers: data for CRC provided by the UK Environmental Agency under the provisions of the Environmental Information Regulations 2004 (EIR); data for CPF, EU ETS, CCAs and overlap CCA-ETS based on our calculations; data for CCL, no-CCL and refineries & offshore based on House of Commons Environmental Audit Committee (2010). Emissions: data for CCAs based on DEFRA (2007); data for CRC based on our calculations building on data provided by the UK Environmental Agency (as above); ETS and CPF data based on (Her Majesty's Government, 2013) ; data for CCL, no-CCL and refineries & offshore based on House of Commons Environmental Audit Committee (2010).

The overlap of policies that target the same source of emissions (such as electricity use) causes firms to pay a form of carbon price several times over (see also Chapter 3.2 on carbon pricing). Some firms outside the EU ETS, for example, pay for their carbon emissions first through higher payments for electricity due to upstream policy costs passed through by energy suppliers; second, through the CCL, if they are not eligible to the reduced rates of under the CCA; and, third, through the CRC (Bowen & Rydge, 2011).

Energy-intensive industries outside the EU ETS also face these three layers of policy costs but, as they are often covered by a CCA, would have to pay only 35 per cent of the CCL rate (10 per cent for electricity), although they need to meet specific energy efficiency targets.

Businesses covered by the EU ETS, on the other hand, will not be subject to the CRC and, depending on their characteristics, may benefit from the reduced tax rates granted by the

CCA regime. Very small businesses may only be subject to the costs passed through by energy suppliers, but not to other direct carbon prices.

There are also issues arising from how upstream policies interact with the EU ETS. The RO, for instance, requires electricity suppliers to buy a specific and annually increasing percentage of electricity from renewable sources. In doing so, it restricts the flexibility and efficiency of the EU ETS (DEFRA, 2007). The RO, together with the CPF, reduces UK emissions in the traded sector, effectively making more European Union Emissions Allowances (EUAs) available in other countries (since the cap is fixed), which can depress the their price within the market.

While not the object of this study, it is important to acknowledge that other environmental measures overlap with UK energy and climate change policies, and can affect businesses' costs and energy performance. DEFRA (2007), for instance, notes that Combined Heat and Power (CHP) policies (like the RHI and the exemption of CHP technologies from the CCL) provide additional incentives for the adoption of low-carbon and renewable technologies, but can create market distortions by reducing the cost of these technologies. The Large Combustion Plant Directive targets emissions other than carbon, but can lead to greenhouse gas emission reductions as co-benefits. The Integrated Pollution Prevention and Control (IPPC) regulations also set requirements and incentives which can be inconsistent with carbon reduction objectives. For example, the reduction of emissions of volatile organic compounds (VOC) required by the VOC Solvents Directive, under the IPPC, requires energy intensive techniques and may therefore be inconsistent with CCA, CCL or EU ETS targets.

Overall, the extent to which firms are subject to these overlaps depends on which policies apply to them. This varies by sector and is dependent on the characteristics of the business. This issue is discussed in more detail in Section 2.2. Some overlaps may be unavoidable, for example when different policies target different market externalities, like emissions reductions and research and development failures. Others, however, are less justifiable and can create an unnecessary burden on businesses, as well as reducing policy effectiveness.

Overall, the complexity of the current policy regime is a concern for most businesses. According to a survey by the Confederation of British Industry (CBI, 2012), businesses perceive there to be a confusing number of energy and climate change policies with multiple overlaps. There is also a perception that the policy framework has been designed in an *ad hoc* manner, without proper regard for how different policies work together and interact. The majority of the businesses surveyed believe there is considerable scope to improve the effectiveness of UK energy and climate change policies. Similar views were reflected in the interviews carried out for this study (see Box 2.4)

3.2 Uneven carbon prices

Several UK energy and climate change policies put a price on carbon, either explicitly or implicitly. It is explicit when a price is charged directly on each tonne of carbon dioxide emitted. It is implicit when a measure is levied on the volume of fuels consumed (for example, per tonne of coal) rather than on their carbon emissions. In such case the carbon

price embedded in these measures needs to be calculated, based on the carbon content of the fuel (e.g. the amount of carbon emitted by burning a tonne of coal) to estimate the price charged on each unit of carbon emitted.

The carbon price in the EU ETS, the CPSR applied under the CPF and the CRC, for instance, are explicitly levied on the carbon dioxide content of fuels. The CCL and the discounted CCL rates granted under CCAd, instead, are levied on units of energy used, such as kWh (for gas and electricity), GJ (coal), kg (coal, LPG) or litres (gas oil, fuel oil and other fossil fuels used for transportation). Policies that support renewable energy sources, the costs of which are borne by energy suppliers, such as the RO and FITs, increase electricity costs and result in an implicit carbon tax for electricity users.

An overview of the variety of tax rates associated with some of the key UK energy policies is shown in Table 3.1.

Table 3.1 Tax rates of selected energy and climate change policies, 2013 (£)

Fuel	CCL		CCA		CRC		CPSR		EU ETS	
Electricity	0.524	p/kWh	0.052	p/kWh	12	£/tCO_2	-		-	
Natural gas	0.182	p/kWh	0.064	p/kWh	12	£/tCO_2	0.091	p/kWh	3.5	£/tCO_2
LPG	1.172	p/kg	0.410	p/kg	-		1.460	p/kg	3.5	£/tCO_2
Coal	1.429	p/kg	0.500	p/kg	-		44.264	p/GJ	3.5	£/tCO_2

Note: The EU ETS carbon price is based on the average clearing price for carbon permits in UK auctions held between 16th January and 19th June 2013.[14] This was €4.13 per tonne of carbon dioxide. This is converted at an exchange rate of £1 = €1.18 taken as an approximate average of rates observed in 2013 to mid-June 2013.[15]

Source: CCL and CCA based on HMRC (2013a); CRC based on Environment Agency (2013); CPSR based on HMT (2011); EU ETS based on ICE (2013)

Since tax rates are expressed in diverse units of measurements, it is necessary to make certain assumptions about the carbon content of fossil fuels and electricity in order to calculate the implicit carbon price. This raises the issue of whether 'marginal' or 'average' conversion factors should be used to make this calculation; that is, whether we are interested in the carbon content of the last (marginal) unit of energy consumed or the average carbon content of all units consumed.

Average and marginal carbon content are identical in the case of fossil fuels, but differ for electricity. For electricity, the average carbon content reflects the mix of all sources used for generating electricity (which includes fossil fuels, renewables and nuclear), while the marginal carbon content depends on whether coal- or gas-fired generation plants are used to generate an *additional* unit when demand increases, and the technical specification of the plant. We have assumed in this paper that combined cycle gas turbines (CCGTs) are the marginal power plants[16]. Details of the method used can be found in Appendix 2 [available

[14] See: https://www.theice.com/marketdata/reports/ReportCenter.shtml#report/148
[15] See: http://fx-rate.net/GBP/EUR/
[16] Note that, in the case of the CRC, the policy fixes a price of £12/tCO_2 for imputed emissions from gas and electricity use. The policy specifies conversion factors from gas and electricity use in MWh to assumed carbon emissions which then form the basis of the tax. We use these policy-specific conversion factors to convert the

online] and Appendix B in a companion paper by the Institute for Fiscal Studies, Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, 2013).

In an ideal world, the carbon price levied on electricity should constantly change, reflecting the carbon content of the fuels (gas, coal, wind turbines etc.) used for electricity generation at a given moment. Hence, in principle, an energy user should pay a higher carbon tax per kilowatt-hour (kWh) when the electricity he or she is using is produced by sources with a high carbon content (such as coal), and virtually no carbon tariff when produced by renewables. In this ideal scenario, one would adopt 'marginal' conversion factors when converting a 'per kwh' energy tax into a carbon price (and the other way around).

In reality electricity taxes are usually set at a fixed cost per kWh, disregarding what the carbon content of electricity is at different times of a day. What matters in this case is the 'average' carbon content of electricity, based on the total emissions associated with power generation over a certain period, for example in a year.

This paper adopts marginal conversion factors, on the grounds that we are primarily interested in the price signal associated with additional consumption at the margin. This is a matter of choice, and the main consideration is how to apply the same rate consistently across all the policies under consideration. We use the marginal conversion rates provided by DEFRA and DECC (2012).

Once the carbon price of each policy is compared on an equal basis (£/tonnes of carbon dioxide), it becomes apparent that there is a large variation between the current rates across policies and fuels, as shown in Table 3.2. In particular, there is a large disparity between the carbon price charged on electricity and that on other fuels.

Table 3.2 Marginal carbon tax rates across policy instruments and fuels (£/tCO2), 2013-14 (in 2013 values)

	CCL	CCA	CRC	EU ETS	CPSR	RO/CfD	FIT
Electricity	13.37	1.34	16.56	3.5	4.92	22.08	5.27
Gas	9.85	3.45	11.92	-	-	-	-
LPG	4	1.4	-	-	-	-	-
Coal	6.68	2.34	-	-	-	-	-

Source: Based on Advani et al. (2013)

We also estimate what carbon prices will be in 2020, based on the expected evolution of the policies under analysis (for more details see Appendix B in a companion paper with the Institute for Fiscal Studies, Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, 2013).

CRC tax rate to a per-MWh basis, and then use the conversion factors described in (Advani *et al.*, 2013) to re-express the CRC as a carbon tax. We do this rather than just take the £12/tCO_2 figure directly because the CRC conversion factor for electricity is based on grid average emissions whereas we are interested in the marginal tax. See Appendix B in (Advani *et al.*, 2013) for further details.

Future policies will see large increases in the carbon prices applied to electricity, largely from the rise in the CPF (and its associated CPSR) and the introduction of the Feed-in Tariff with Contracts for Difference (FIT CfD), replacing the Renewable Obligation (RO) as the main support for renewable generation. It should be noted that the CRC rate will reach £16t/CO_2 in nominal terms (£12/t CO_2), but the effective carbon tax it will impose on electricity will have fallen in line with grid-average emissions (see Advani, Bassi, et al., 2013). The carbon tax rates for 2020 are shown in Table 3.3.

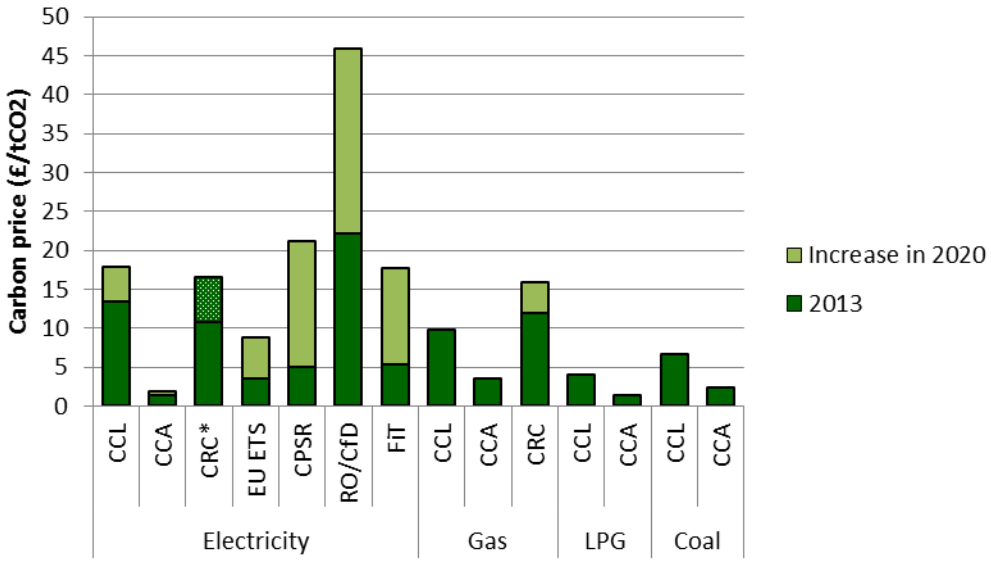
Table 3.3 Marginal carbon tax rates across policy instruments and fuels (£/tCO2), 2020 (in 2013 values)

	CCL	CCA	CRC	EU ETS	CPSR	RO/CfD	FIT
Electricity	17.90	1.79	10.73	8.82	21.18	45.83	17.63
Gas	9.85	3.45	15.89				
LPG	4.00	1.40					
Coal	6.68	2.34					

Source: Based on Advani et al. (2013)

A comparison between the 2013 and 2020 implicit carbon prices is shown in Figure 3.3.

Figure 3.3 Marginal rates of carbon taxation (£/tCO2), 2013/14 and 2020



Note: CRC*: By 2020 the CRC rate for both electricity and gas will have risen to £16/tCO_2. However, the effective carbon tax imposed on electricity will effectively be lower (£10.73//tCO_2, as opposed to £16.56/tCO_2 in 2013), as grid-average emissions will have fallen. See Appendix B in Advani *et al.*, (2013) for details of the methodology and assumptions used.

Source: Based on Advani et al. (2013)

The overlaps between energy and climate change policies, noted in Section 3.1, also mean that the carbon prices embedded in each policy overlap. The effective carbon price therefore tends to vary significantly from business to business (see Figure 3.4).
All businesses are generally subject to the indirect costs of the EU ETS, CPSR, RO and FITs, which are passed on by energy suppliers through higher electricity costs. Variations in the carbon price between businesses therefore usually depend on the extent to which each of the CCL, CCA or CRC apply.

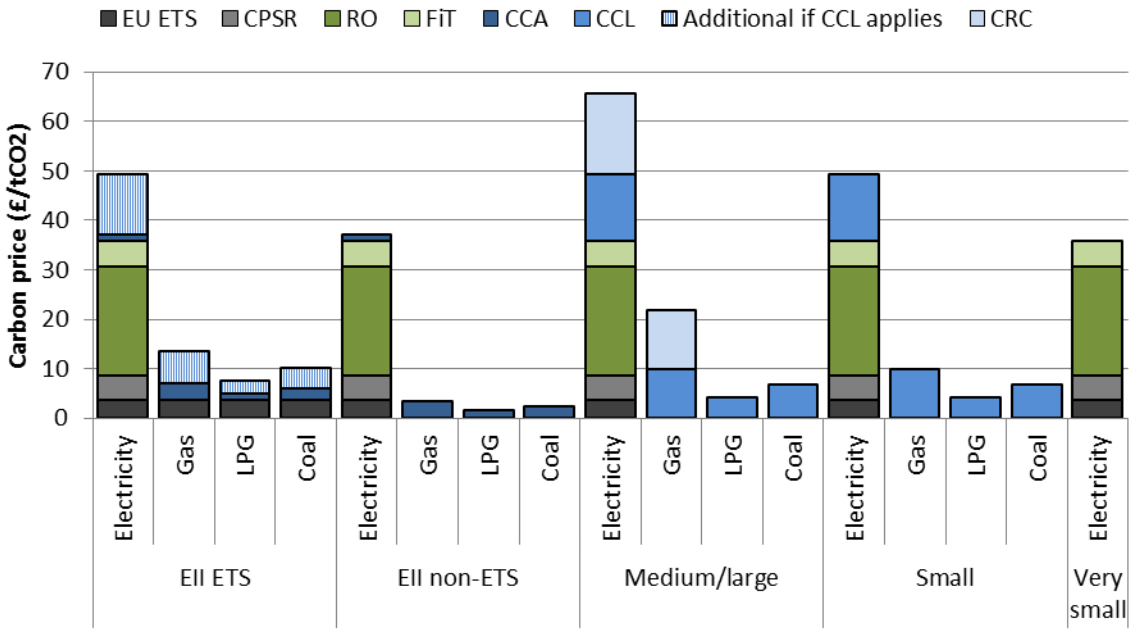
To describe how carbon prices vary across different businesses, we have grouped them into five broad sectors:

- Large energy-intensive industries (EII), ETS: they participate in the EU ETS directly, and are either subject to the full rate of the CCL or are eligible for discounted CCL rates under the CCAs. They generally are not subject to the CRC.
- Large energy-intensive industries (EII), non-ETS: they do not participate in the EU ETS directly. They are eligible for CCAs. They generally are not subject to the CRC.
- Medium/large businesses: they are subject to the CCL and are large enough to be subject to the CRC.
- Small businesses: they are subject to the CCL, but not the CRC.
- Very small: they are not subject to the CCL.

We find that energy-intensive industries generally pay the lowest carbon price for carbon emissions. Most medium-large firms (except the most energy intensive ones) pay the highest price, as they can be exposed to both the full rate of the CCL and the CRC.

Once the implicit or explicit carbon prices embedded in these policies are aggregated to take account of their overlaps, the discrepancy between the carbon price charged on electricity and that levied on fossil fuels becomes even more striking (see Figure 3.4). In 2013-2014, carbon prices for electricity range from £37.11/tCO_2 to £65.70/tCO_2, while gas carbon prices range between £3.45/tCO_2 and £21.77/tCO_2, coal from £2.34/tCO_2 to £6.68/tCO_2, and LPG from £1.40/tCO_2 to £4.00/tCO_2. This suggests that the current policy regime is providing a perverse incentive for businesses to prefer high carbon content fuels over electricity. This could serve to discourage further electrification of the energy system, potentially making the decarbonisation objectives set in the UK's carbon budgets (CCC, 2010b) more difficult to achieve.

Figure 3.4 Uneven carbon prices across sectors and fuels (2013)



Source: Authors' calculations

Uneven prices across business sectors in some cases can be justified by the need to meet other social or economic objectives. For example, in the absence of a global carbon price, there is a risk that businesses subject to relatively high carbon prices can be at a competitive disadvantage compared with companies located in countries that do not apply equivalent policies, especially when the goods or services they produce can be easily traded across borders. This may induce companies to close down or relocate to countries that apply less stringent climate policies, effectively reducing employment opportunities and economic input generated in the UK. As a result, emissions from these businesses could simply move to other countries, a phenomenon known as carbon leakage. The implications for competitiveness of relatively high carbon prices, like those embedded in the CCL, as opposed to discounted carbon prices granted by the CCAs, are discussed in the next Chapter.

The Organisation for Economic Co-operation and Development notes that, generally, any exemption from an energy tax represents a distortion that affects the level of emissions in the exempted sectors (OECD, 2013). Differentiated carbon pricing may, therefore, not be the most efficient tool to address these economic or social issues, and other routes should be explored to address secondary impacts, such as competitiveness, without affecting the carbon price signal (see for example section 7.2.3 on carbon leakage in a companion paper by the Institute for Fiscal Studies, Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, 2013).

3.3 Summary of findings

Several energy and climate change policies overlap, leading to a relatively complex policy regime which differs across business sectors and between individual firms within a sector, and even between units of the same business. Some overlaps may be unavoidable, for example when more than one policy is required to tackle different market externalities, such as greenhouse gases and research and development failures. Others, however, are less justifiable and can create an unnecessary burden for businesses, whilst also reducing the effectiveness of the individual policies.

As a result of policy overlaps, some businesses pay for their emissions several times over, depending on which policies apply to them. Generally, all businesses that use electricity are equally subject to the same implicit carbon price passed on by power generators, which is related to the EU ETS, the CPF, the RO and the FITs. Fossil fuels, such as gas and coal, are not subject to these indirect policy costs, and are therefore are charged a relatively lower carbon price. The main disparity between carbon prices levied on different businesses depends on to which each of the CCL, the CCAs and the CRC apply to them.

Carbon prices in the UK are therefore uneven, both across sectors and fuels. In particular, current carbon prices reveal high disparities between electricity and other fuels, and between high and low energy-intensity companies.

Table 3.4 provides an overview of the main characteristics of the key energy and climate change policies analysed in this paper, including elements discussed here and in Chapter 2.

Table 3.4 Implicit rates of carbon taxation across main energy and climate change related policies

Policy	Type of instrument	Type of business affected	Number of businesses affected	Implicit carbon price[c] (in 2013)	Costs/ revenues
CCL	Tax on energy use	Businesses of any sector (except very small energy users)	~900,000 participants (in 2008)[b]	Electricity: £ 13.4 /tCO_2 Gas: £ 9.9 /tCO_2 LPG: £ 4 /tCO_2 Coal: £ 6.7 /tCO_2	~£600 million (in 2012/2013)[h]
CCAs	Tax on energy use (discounted CCL rates) + energy targets	Energy intensive industries (54 sectors in 2011)[a]	~2,800 firms (in 2013)[c]	Electricity: £ 1.3 /tCO_2 Gas: £3.5 /tCO_2 LPG: £ 1.4 /tCO_2 Coal: £2.3 /tCO_2	
CRC	Tax on carbon	Medium/large companies consuming more than 6,000 MWh/year.	~2,100 participants (in 2012)[d]	Electricity: £16.6 /tCO_2 Gas: £11.9 /tCO_2	~£700 million (in 2012/2013)[h]
EU ETS	Cap and trade system	Selected energy intensive industries (thresholds apply)	~ 600 firms (in 2013)[c]	Fossil fuels: £ 3.5 /tCO_2 Electricity (pass through): £ 3.5 /tCO_2	~£300 million (in 2013)[c]

CPF	Tax on fossil fuels used to generate electricity	Power generators	~ 80 firms (in 2013) [c]	Electricity (pass through): £ 4.9 /tCO_2	~£740 million (in 2013)[i]
RO	Subsidy to large renewables installations	Energy suppliers and renewable electricity generators	~ 2,300 participants (in 2012)[e]	Electricity (pass through): £ 22.1 /tCO_2	~2,000 million (in 2011/12)[e]
FITs	Subsidy to small renewables installations	Energy suppliers and businesses of any sector (and households) applying for funding	~ 11,000 participants (in 2013)[f]	Electricity (pass through): £ 5.3 /tCO_2	£150 million (in 2011/12)[j]
Green Deal	Loan on energy efficiency devices	Businesses of any sector (and households) applying for funding	n/d	n/a (loan)	n/d
RHI	Subsidy to renewable heat	Businesses of any sector (and households) applying for funding	~ 1,500 participants (in 2013)[g]	n/a (funded through general taxation)	~ £40 million (in 2012/13)[k]

Notes: Participants can be smaller units within firms; n/a = not applicable; n/d = no data available

Sources: a. AEA (2011); b. House of Commons Environmental Audit Committee (2010); c. Authors' estimates; d. Estimate based on data provided by the Environment Agency under the provisions of the Environmental Information Regulations 2004 (EIR); e. Ofgem (2013b); f. Ofgem (2013a); g. DECC (2013c); h. HMT (2013); i. HMT (2011); j. Ofgem (2012a); k. Ofgem (2012c)

4 The impact of climate change policies on competitiveness and innovation

The impact of energy and climate change policies on business competitiveness and innovation is a key issue for policy-makers. Poorly designed policies have the potential to put businesses in trade-exposed sectors at an economic disadvantage compared with international competitors located in countries that do not apply similar policies. But, if designed well, policies that price carbon can not only drive emissions reductions, but also promote low-carbon innovation.

We focus on two major 'downstream' climate change policies which have been in place for long enough to have a relevant series of data: the CCL and CCA package and the EU ETS. Insufficient data is available for a similar analysis of the CRC, as this was introduced only in 2010 and has undergone several changes.

Since the introduction of these policies, only two studies have used plant-level or firm-level data to analyse their impact on carbon emissions, competitiveness and innovation. Martin *et al.* (2011) estimated the impact of the CCA and CCL on energy efficiency, employment and production. Calel (2013) analysed the impact of the EU ETS on carbon dioxide intensity, patenting activity and research and development expenditures. We extend and update

these previous findings on competitiveness and innovation by analysing a new set of firm-level data up to 2010.

The combination of new and past results makes it possible to provide the first comprehensive analysis of the impact of the main climate change policies on carbon emissions, competitiveness and innovation in the UK. The key findings for the CCL and CCA are presented in Section 4.1, while Section 4.2 discusses the EU ETS. Section 4.3 provides a summary of the main findings. Appendix 1 [available online] outlines the method used for our assessment.

4.1 The CCA and the CCL

Research by Martin *et al.* (2011) compared 697 facilities which had CCAs in place with 3,851 facilities that paid the full rate of the CCL, to analyse the impact of joining a CCA (relative to paying the standard rate of the CCL) on energy intensity, turnover and employment. The period covered by the analysis was 1999 to 2004 (i.e. two years before and four years after the signing of the agreements). It is important to keep in mind that the analysis only considered the effect of the CCL *in comparison* with the CCA i.e. the effect it had in addition to any effect the (less stringent) CCA targets may have had on business behaviour.

In order to construct a counterfactual scenario of how the businesses subject to CCAs would have behaved had they been subject to the full CCL rate, each CCA firm was compared with a similar business that had decided not to sign a CCA (and hence was subject to the full rate of the CCL) but otherwise shared similar characteristics – such as turnover, number of employees and assets – and operated in the same economic sector.[17]

The authors found evidence that the CCL caused plants to decrease their energy intensity by about 20 per cent more than plants subject to a CCA. Plants in the most energy-intensive sectors appeared to have reduced their emissions the most. No difference in emissions was found for plants with low energy intensity. Analysis of fuel choices at the plant-level suggested that the improved energy intensity was mainly driven by a reduction in electricity use of about 22 per cent. If we translate this into actual emission reductions, businesses subject to the CCL reduced their emissions between 8 and 22 per cent more than businesses with CCAs in place between 2001 and 2004.

The CCL package was a unilateral policy initiative adopted in the UK, but not in the rest of the European Union (although other domestic measures may apply in some other Member States). Hence, a concern is that the CCL may have had a detrimental effect on the international competitiveness of UK industry. In particular, businesses might respond to the CCL by closing down plants altogether or by re-locating to countries with less stringent environmental legislation in place, resulting in UK greenhouse gas emissions simply being moved abroad. This concern was one of the motivations for offering the CCAs as an alternative mechanism.

[17] Defined at SIC 3-digit level

Can we find empirical evidence that the CCAs have protected companies from the adverse competitiveness effects of the CCL? Martin *et al.* (2011) found no statistically significant impact from paying the full rate of the CCL on employment, gross output, or the likelihood that a firm would exit the market, relative to comparable firms that signed a CCA. It appears, therefore, that the CCL did not cause firms to shed jobs or lose revenue relative to firms having CCAs. It is important to emphasise that Martin *et al.* (2011) compared firms exposed to the full CCL or to the reduced CCA rate that operated in the same economic sectors and therefore faced the same international competition. Businesses that joined a CCA would therefore have been expected to perform better than firms paying the full rate of the tax.

One of the limitations of the analysis by Martin *et al.* (2011) is that the data only covered the years 1999 to 2004. In order to investigate whether their results still hold for the more recent period, we gathered financial information for a large sample of 3 million UK-based companies for the period 1997-2010. Among these, we identified 2,834 companies operating facilities with a CCA.[18]

We found that the companies with a CCA and those subject to the full CCL, which were statistically similar during the period 1997-2000, remained statistically similar during the period 2001-2010 in terms of turnover or employment. Therefore, based on a larger sample and more recent data, we are able to confirm the conclusion of Martin *et al.* (2011) that the CCL does not seem to have had any detrimental effect on the competitiveness of regulated companies compared with firms that were granted a discounted tax rate via a CCA.

To understand whether the businesses subject to the CCL are innovating more than businesses subject to CCAs, or vice versa, we also looked at the patent records of similar businesses that are subject to the different policies. The data show that the businesses are innovating at the same rate, so the CCL does not seem to provide additional incentives to develop new low-carbon technologies compared with CCAs. This suggests that businesses subject to the CCL, which have been shown to reduce their energy intensity, did so by adopting existing technologies from external suppliers.

The tax discount granted to plants subject to a CCA has been justified as a means of preventing energy-intensive firms from losing competitiveness in international product markets due to the unilateral implementation of the tax and the lack of international harmonisation of environmental legislation. However, the evidence so far suggests that the CCL had no discernible impact on employment, output or plant exit compared with similar exempted businesses subject to CCAs which, importantly, operate in the same economic sectors and hence face the same international competition. However, the CCL did induce large improvements in energy efficiency. A preliminary estimate presented by Martin *et al.* (2011) showed that, had the CCL been applied to all plants without rebates, it would have decreased aggregate energy expenditures in manufacturing by at least 5 per cent and aggregate electricity consumption by at least 12 per cent, without jeopardising profits or employment. We conclude from this analysis that there is evidence to support the case for a revision of the CCL and CCA policy package.

[18] Note that poultry meat rearing and processing facilities are not included in the analysis, but account for about 800 facilities having CCAs.

4.2 The EU ETS

Around 600 UK businesses in energy-intensive sectors are regulated through the EU ETS. A natural consequence of the implementation of the EU ETS is that firms in the scheme face higher carbon prices than their competitors outside the European Union who are not subject to comparable regulation. This has led to worries about a possible loss of competitiveness for regulated businesses, generally thought of as a loss of output and employment. Output might decline because businesses reallocate resources in order to comply with the EU ETS and also because of industry relocation to places outside the European Union Member States.

In order to investigate the potential competitiveness effect of the EU ETS on UK-based businesses, we identified 616 companies that together operate 1200 EU ETS-regulated plants in the UK. The FAME database, which includes information about more than 3 million UK-based businesses, was used to compile a group of businesses that would have behaved in a way that was similar to that of EU ETS companies, had these not been regulated. A matching method was applied whereby each EU ETS firm was compared with a firm outside of the EU ETS with similar turnover, number of employees and assets in the five years before the EU ETS (2000-2004), and which were operating in the same economic sector (defined at 3-digit SIC code level). Firms were also matched for CCA participation. EU ETS firms tend to be systematically larger than firms outside of the EU ETS, which made it difficult to find good comparators. Nevertheless, it was possible to construct 45 pairs of similar firms within and outside of the EU ETS. The impact of the EU ETS on turnover and employment was then estimated for the six years after the regulation (2005-2010).

The analysis revealed no statistically significant difference in turnover or employment between EU ETS businesses and the control group during the first six years of the policy (2005-2010). In other words, there is no evidence that the EU ETS affected the competitiveness of firms subject to the regulation.

This result might not be surprising, given that the price of carbon in the European market has been low for most of this period. Indeed, in a recent study using a similar matching methodology, Calel (2013) found that the EU ETS had no impact on improvements in carbon dioxide efficiency during its first three years of operation.

Calel (2013) also investigated the impact of the EU ETS on innovation for low-carbon technologies. He found that the EU ETS increased the number of low-carbon patents filed by around 50 per cent among regulated businesses. He also found that low-carbon research and development expenditures increased by about 25 per cent among regulated companies.

How can the markedly positive increase in the low-carbon innovation activities of businesses regulated by the EU ETS be explained when the price of EUAs has been so low, and there has been no detectable impact on carbon dioxide intensity? Innovation activity is fundamentally driven by expectations, and businesses regulated by the EU ETS expect carbon prices to increase over time, as shown by Martin *et al.* (2012). Thus, this result suggests that firms have been devoting resources in preparation for tougher carbon reduction targets in the future.

4.3 Summary of findings

Overall, the available evidence suggests that the CCL has driven greater energy efficiency improvements than CCAs. These improvements were not achieved at the expense of competitiveness, as measured by output and employment. This suggests that the CCAs are not fully justified and that extending the CCL to all businesses could induce more energy savings at no cost to competitiveness.[19]

Furthermore, and unsurprisingly given the low price of EUAs, the EU ETS has not had any noticeable impact on the carbon intensity of regulated firms. It is not surprising, then, that it did not affect the competitiveness of regulated companies either. However, the EU ETS seems to have encouraged the development of new low-carbon technologies. This is consistent with the idea that firms expect the price of EUAs to be higher in the future and hence they have devoted resources to prepare for tougher carbon reduction targets. This suggests that, however weak, climate change policies with a credible long-term commitment are able to encourage the development of new and cleaner technologies.

5 A proposal for simplification

For a given long-term emissions abatement target, the marginal cost should be the same at any particular time. The carbon price should therefore ideally be the same at any particular time, regardless of location or sector, and give an incentive to equalise the marginal cost of abatement across technologies, locations and firms (Bowen & Rydge, 2011).[20] The carbon price such rise over time at a rate that is equal to the interest rate.

However, a harmonised international carbon price is unlikely to be agreed and adopted in the near future and so countries have tended to apply unilateral and uneven carbon prices through different domestic policies (see e.g. Advani *et al.*, 2013; Vivid Economics, 2012). The UK is no exception.

All the climate change policies analysed in this paper provide inconsistent carbon price signals, not only between policies, but also between fuels and sectors. This chapter outlines a proposal for policy reform that aligns carbon prices at a uniform value.

[19] It is important to keep in mind that the CCA targets may have had an impact on the competitiveness of businesses if compared with the case of no regulation at all. In the absence of a counterfactual scenario, it is impossible to analyse the full impact of CCAs. One can only compare the impact of CCAs with the only available alternative, which is payment of the full CCL.

[20] Some recent studies justify different marginal abatement costs between sectors once investment costs and the time profile of emission reductions are taken into account (for example, Vogt-Shilb *et al.*, 2013). Hence, a common carbon price is not necessarily a sufficient condition for obtaining the optimal level of low-carbon investment. Potential investors also need to consider the future path of carbon prices over the life of their investment.

5.1 Simulating an energy policy reform

Given the differences in carbon prices between policies, fuels and firms, and the complexity created by policy overlaps (discussed in Chapter 3), there is scope for streamlining the UK policy landscape and moving towards more consistent carbon pricing across the economy.

First, a reform of existing energy and climate change policies is arguably needed to reduce inconsistences between different policies, and to simplify the current policy landscape, including the reduction of relatively high administrative costs - as in the case of the CRC and the CCAs.

Second, a single effective carbon price would eliminate current fuel price distortions that encourage higher consumption of coal and gas relative to electricity, and which are therefore a barrier to further electrification of the economy.

A firmer and more consistent carbon price signal can also help improve businesses' energy efficiency and innovation, as discussed in Chapter 4. In its latest progress report on meeting UK carbon budgets, the Commitee on Climate Change (CCC, 2013a) found limited evidence of increased energy efficiency in industry in 2012, and highlighted that there is significant potential for further improvements.

Furthermore, it may not always be effective to apply a reduced carbon price to some trade-exposed sectors in order to limit impacts on competitiveness. As discussed in Chapter 4, previous studies have found no or negligible evidence that the CCL has had a negative impact on output and employment, compared with the performance of businesses under the regime for CCAs operating in the same economic sectors and therefore facing the same international competition (see for example Martin *et al.*, 2011). This suggests that CCAs may not be fully justified on competitiveness grounds alone.

However, CCAs are popular among firms. Our interviews with energy managers revealed that they see the need to meet targets, together with the possibility of receiving a discount on the CCL, as a powerful justification for engaging senior management about the issue of energy savings, and an incentive for investment in low-carbon technologies. Nevertheless, the empirical evidence suggests that the full rate of the CCL provides an even stronger incentive. Compared with a full application of the CCL, the tax discounts provided by CCAs seem to have led to less innovation for energy efficiency technologies (Martin & Wagner, 2009) and to worse energy performance (Martin *et al.*, 2011).

For these reasons, we suggest the simplification of the three key downstream policies, namely the CRC, CCA and CCL. We propose that they be merged into one single policy, which, in the short term, would broadly retain the design of the CCL. For simplicity we refer to it as the CCL+. It would apply a single and consistent carbon price for all firms and fuels.

The CCL+ would have the following characteristics:

- It would be levied on all businesses, including the small activities that are currently exempted from the CCL.

- Tax rates would be revised so that the same implicit carbon price applies to all the main fossil fuels, that is, natural gas, coal and LPG.

- The tax rate for electricity would be lower than for other fossil fuels, as electricity is already subject to the implicit carbon price of upstream policies - notably the EU ETS, CPF through the CPSR, RO or CfDs, FITs – the costs of which is passed on to electricity users by energy suppliers. The CCL+ tax for electricity would be calculated as the difference between the carbon price charged on gas, coal and LPG, minus the implicit carbon price of upstream policies.

- The carbon price applied to sectors covered by the EU ETS and to those outside of the EU ETS would be the same. The carbon price for natural gas, coal and LPG which is levied on EU ETS installations would be reduced by the EUA price which businesses pay through the trading scheme, so as to avoid them been charged twice for the same emissions. In order to determine what the CCL+ tax rate should be, a mechanism conceptually (although not operationally) similar to the current CPF could be adopted (see also recommendations on the CPF in a companion paper by the Institute for Fiscal Studies, Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment – Advani *et al.*, 2013).

The current and proposed policy regimes are outlined in Table 5.1

Table 5.1 Overview of current policy regime and proposed policy reform for the EU ETS traded and non-traded sectors

Sector	Policy application	Current policy regime		Proposed policy reform	
		Electricity	*Other fuels*	*Electricity*	*Other fuels*
Other EU ETS industries	Direct	CCL/CCA	CCL/CCA, EU ETS	CCL+	EU ETS, CCL+ (minus EU ETS)
	Pass-through	*EU ETS, CPSR, RO, FIT*	-	*EU ETS, CPSR, RO, FIT*	-
Non-EU ETS sectors	Direct	CCL/CCA, CRC	CCL/CCA,CRC	CCL+	CCL+
	Pass-though	*EU ETS, CPSR, RO, FIT*	-	*EU ETS, CPSR, RO, FIT*	-

Source: Authors' calculations

The proposed reform would help simplify businesses' administrative requirements. As the new CCL+ rate would apply to all sectors and firms, there would not be a need for businesses to establish whether they are subject to a particular policy nor not, which is the case today.

Setting the right CCL+ rate would be a sensitive issue, and we do not make any firm recommendations about the appropriate carbon price. This should be devised by the Government, in consultation with the business sectors and other stakeholders. As a reference point, however, we have looked at the two sets of carbon prices estimated by the

Government for policy appraisal: one for the traded sectors, applying to companies participating in the EU ETS, and one for the remaining non-traded sectors. These prices reflect the cost of meeting emissions reduction targets, which are different for the traded and non-traded sectors. The former are subject to the EU ETS emission cap, while the latter are constrained by the UK carbon budgets, which are more stringent that the EU ETS cap.

The carbon prices for the traded sector are currently very low. DECC (2013b) estimates they will be on average £3/tCO_2 in 2013, and rise to £5/tCO_2 in 2020. The carbon price for the non-traded sector by contrast is around £59/tCO_2 in 2013, increasing to £66/tCO_2 in 2020. The UK Government's estimated carbon price trajectories for the traded and non-traded sectors are shown in the

Table 5.2 (DECC, 2013b). A further discussion of the carbon prices in the UK traded and non-traded sectors can be found in Section 6.5 of a companion paper by the Institute for Fiscal Studies, the Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, 2013).

The UK Government envisages that the carbon prices in both the traded and non-traded sectors will reach £76/tCO_2 in 2030, consistent with emissions reductions offering a 50 per cent chance of avoiding a rise in global average temperature of more than 2 Celsius degrees above pre-industrial level. In principle, there is an argument for aligning the carbon price of the traded and non-traded sectors to a single value sooner rather than later. This would ensure that greenhouse gas externalities are priced uniformly across all fuels and sectors, at a level consistent with the UK carbon budget. However, it is not clear in practice how quickly carbon prices in the traded sector could be brought in line with those in the non-traded sector without risking competitiveness impacts and carbon leakage in the short term.

As pointed out in Section 4.2, there is no empirical evidence showing that current carbon pricing levels applied by the CCL have had a detrimental effect on competitiveness, when measured in terms of output, employment or re-location. However, the carbon price rates implicitly applied by the CCL are relatively low (between £4 and 13/tCO_2 in 2013) compared with the theoretical carbon price for the non-traded sector. Theoretical analysis suggests that, under certain assumptions, leakage risks from raising carbon prices, which would be the case if all businesses and installations were subject to a higher carbon rate, may exist (see, for example, Monjon & Quirion, 2009; Ritz, 2009; Varma *et al.*, 2012; Dröge *et al.*, 2009).

It would be crucial for the reform, therefore, to assess the carbon price trajectory against these risks in more detail. Intermediate targets may then be considered, in order to smooth the transition from the current relatively low carbon price to the higher non-traded rates. This would buy time to better identify those businesses most vulnerable to leakage and to devise appropriate compensation measures.

Table 5.2 Carbon prices for traded and non-traded sectors over the 2013-2030 period, £/tCO$_2$ (Real £2011)

Sector	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Non-traded	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	76	76
Traded	3	4	4	4	4	4	5	5	12	19	26	33	41	48	55	62	69	76

Source: DECC (2013b)

However, to illustrate the impact of the reform, we assume, for simplicity, that the CCL+ rate would be aligned to the non-traded sector as from today, without considering any intermediate target. The carbon price for each policy is calculated using marginal conversion factors (for electricity), as discussed in Section 3.2.

Figure 5.1a and b show how an illustrative policy reform would apply across different sectors if it was introduced in 2013. For simplicity, only gas and electricity are included.

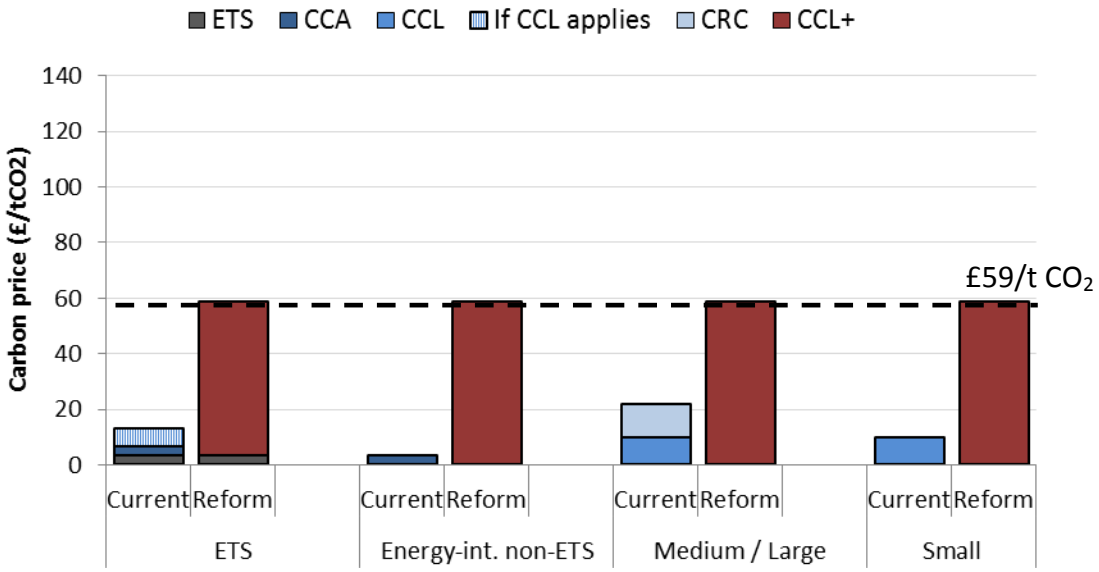
The realignment of carbon prices is likely to produce both winners and losers. It would result in a substantial increase in the tax rate on fossil fuels, as the current carbon price charged is significantly lower than the target carbon price for the non-traded sector. For gas, the increase would range between £37/tCO$_2$ for medium-large businesses, to £56/t CO$_2$ for energy-intensive businesses outside of the EU ETS (around 0.7 to 1 p/kWh).[21]

However, for electricity, the resultant tax increase would be much lower, because the implicit carbon price applied to it is already relatively high.

Changes in fiscal burdens, should the CCL+ be implemented, would depend on the combination of policies a business is currently subject to. For instance, for medium-large businesses currently subject to the CCL and CRC, the proposed reform would result in a reduction in the carbon price they face (a decrease of about £7/tCO$_2$, or 0.2 p/kWh[22]) compared with the present policy regime, while large energy-intensive businesses with a CCA would be subject to an increase (of around £22/tCO$_2$, or about 0.9 p/kWh[23]).

[21] Assuming a conversion factor for natural gas of 0.185 tCO$_2$/MWh in 2013 (DECC and HMT, 2012).
[22] Assuming a marginal conversion factor for electricity of 0.368 tCO$_2$/MWh in 2013 (DECC and HMT, 2012).
[23] As above.

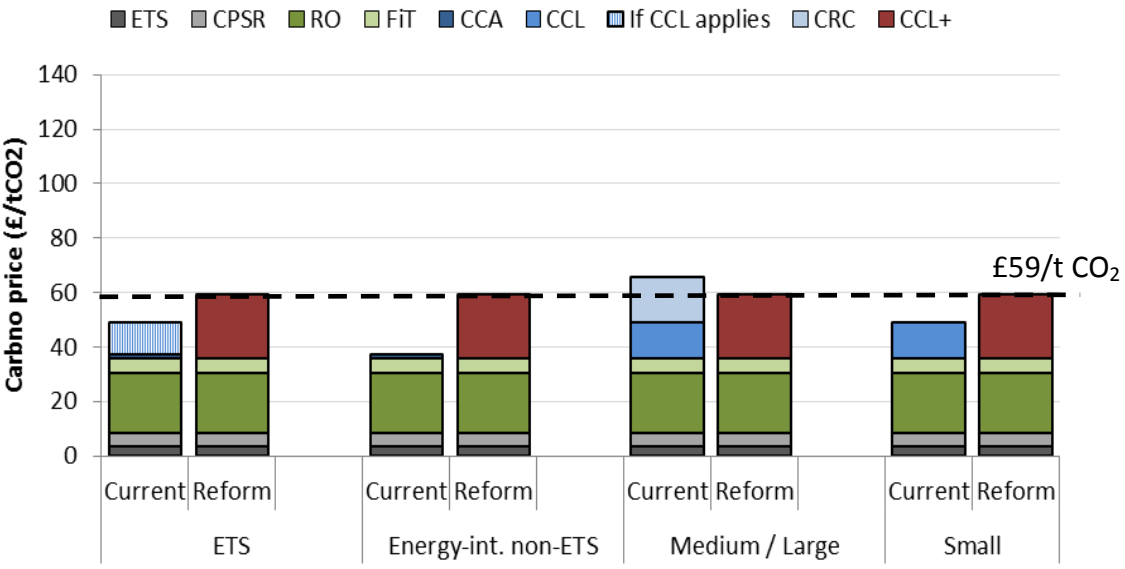
Figure 5.1a Illustrative reform of energy taxation in 2013 – natural gas



Notes: Businesses that are subject to the ETS include both firms which are subject to CCAs and those subject to the full CCL (if the full CCL applies, the additional tax rate is marked with a striped bar); Energy-intensive businesses not covered by the ETS are those which are subject to a CCA but are not traded; Medium-large businesses are assumed to be subject to both the CRC and the full CCL rate; Small businesses are subject to the CCL only. Very small companies which are not subject to the CCL are not included in the chart.

Source: Authors calculations based on Advani et al. (2013).

Figure 5.1b Illustrative reform of energy taxation in 2013 – electricity



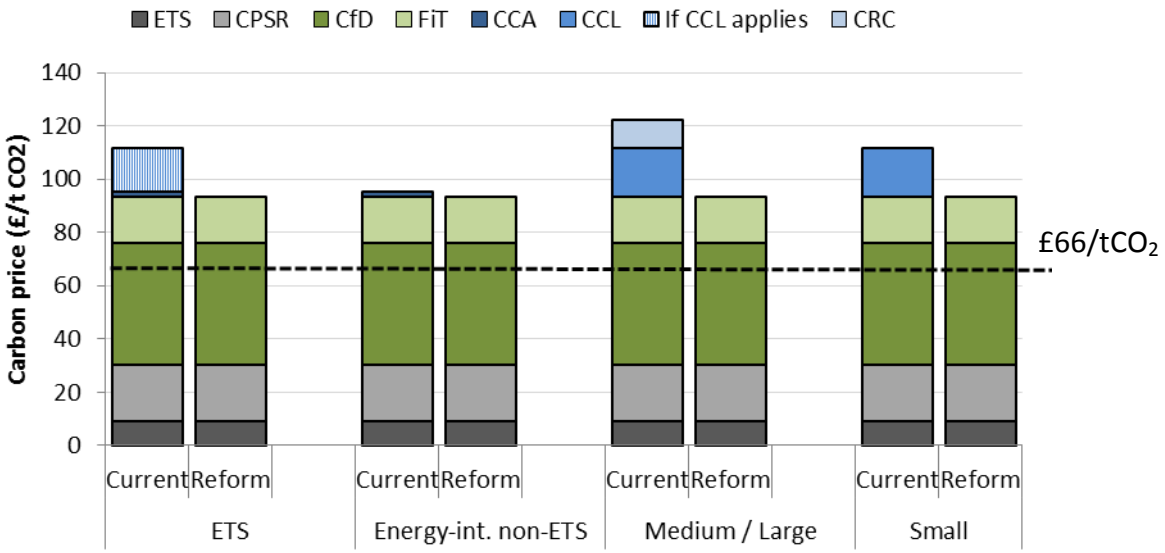
Notes: As above
Source: Authors' calculations based on Advani et al., (2013).

As the policy costs of the EU ETS, CPSR, RO and FITs, which are passed on through electricity prices, increase over time, the CCL+ rate for electricity would be adjusted periodically so

that the sum of their implicit carbon price and the CCL+ rate for electricity matches the carbon price target for the year.

Interestingly, by 2020, the cost of these policies would have overtaken the target non-traded carbon price for that year (£66/tCO_2)- see Figure 5.2. In such a case, the CCL+ rate for electricity should be zero. Compliance with the current EU Energy Tax Directive (2003/96/EC), however, may require electricity to be taxed at least by 0.5€/MWh for use in the business sector, corresponding to around £1.71/tCO_2.[24]

Figure 5.2 Illustrative reform of energy taxation in 2020 – electricity



Notes: As above

Source: Authors calculations based on Advani et al., (2013).

It is important to stress that, even if no CCL+ tax is applied to electricity, the implicit carbon price passed through from upstream policies will be well above the proposed carbon price target in 2020. This would effectively make carbon emissions from electricity more expensive than those from other fossil fuels. This would be a signal in the wrong direction, as it would encourage the use of energy sources with higher carbon content, such as coal and gas, at the expense of increasingly decarbonised electricity.

A careful examination of the interaction of these policies with the carbon price would be needed in order to understand potential distortions, for example, when objectives other than emissions reduction need to be met, such as promoting research and development of low-carbon technologies and improving networks and grids, as in the case of CfDs and small scale FITs. As some of these policies, such those supporting low-carbon technologies, arguably benefit the whole of society and not only energy users, a potential option might be to fund these polices through general taxation rather than though a levy on energy bills.

[24] Assuming a future marginal conversion factor of 0.293tCO2/MWh in 2020 (as forecasted by DECC, 2013b; Table 1).

In the longer term, we suggest replacing the CCL+ with a single carbon pricing policy that imposes a uniform carbon tax on coal, gas and LPG further upstream i.e. at the point of import or manufacture. Levying upstream taxes on fuels can reduce administrative costs and the scope for tax evasion. Whether downstream taxation can be entirely replaced by an upstream instrument will also depend, again, on the requirements of European Union legislation that sets taxes at the point of business use (such as the Energy Tax Directive (2003/96/EC) and its future revisions).

The reform would result in higher carbon price rates for many firms and higher tax revenues for the Government. The OECD (2013) notes that the use of tax revenues can determine how taxes are perceived by the public, and outlines three possible options: using the tax revenues to reduce debt, reducing other taxes, or allowing higher government expenditures. We do not assess how this might best be done, but the recent public debate about rising energy bills in the UK suggests that, in practice, the suggested reform may only be politically palatable if most of the extra revenues were recycled back to business or energy users in general. Options might include lump sum payments or reductions in business taxes, perhaps in proportion to carbon performance. Revenues could also be used to fund other climate-related policies, such as the RO or FITs (the costs of which are currently borne by energy users), therefore reducing their net impact on energy bills. Revenues could also be used to reduce public debt, effectively reducing the need for potential increases in other taxes (such as income or business taxes). However, some revenue would undoubtedly need to be devoted to reducing negative impacts on international competitiveness and carbon leakage.

We estimate the approximate revenue from the reformed energy package in 2013 and 2020, and compare it with the revenues from the current policy regime (HMT, 2013). The method used is explained in Appendix 2 [available online].

First, we estimate the revenues from current taxation and observe how they compare with Government estimates (based on HMT, 2013), to ensure that our approach is a sufficiently good approximation of actual values. The Government's estimates take into account revenues from the auctioning of EUAs, and from the CPSR, CCL, CCA and CRC. We compare these with our own estimates of revenues from the EU ETS and CPSR (unaffected by the proposed reform) as well as from the CCL+, assuming this is charged so as to reach a uniform carbon price of £59t/CO_2. Government estimates for EU ETS revenues in 2013-14 are higher than our estimates, but this is most likely due to the recent drop in the price of EUAs. On the other hand, our estimates point to higher revenues from the CCL, which suggests that we may have over-estimated the results for the policy reform.

If the reform was applied today, and without any form of compensation, it would more than double (to £6.7 billion) the estimated revenues from current policy regimes (raising around £2.7 billion according to HMT, 2013).

Revenues from existing policies are expected to rise to £4.4 billion in 2017-18 (HMT, 2013). Should carbon prices be reformed in line with our recommendations, revenues could be up to £8.7 billion by 2020. This, however, assumes no changes in the level of energy

consumption, and hence no response to higher prices. It therefore should be seen as an absolute upper estimate.

Table 5.3 Estimated revenues from existing policy regime and proposed reform, £m (2013 values)

Policies	Current			Future
	Existing policy regime		Proposed reform	Proposed reform*
	2013-2014	2013	2013	2020
	HMT	Own estimates	Own estimates	Own estimates
CCL/CCA	600 (est.)	800	5,600	2,700
CPF	700 (est.)	800	800	3,700
EU ETS	700	300	300	2,300
CRC	700	700	-	-
total	2,700	2,600	**6,700**	**8,700**

Notes: Numbers may not add up due to rounding; ETS estimates for 2020 assume full auctioning, as recommended in Advani *et al.* (2013).
*Assuming no change in energy consumption from 2012 levels.

Source: Authors' calculations and HMT (2013).

As modelled price increases are substantial, businesses are likely to change their consumption of electricity and fossil fuels, both in the short and long term. Indeed, this is one of the objectives of the policy. First, an approximate estimate was obtained by using 2020 forecasts by the Commitee on Climate Change (CCC, 2013b), which take into account energy consumption reductions associated with the current policy landscape. Total revenues would be expected to be £8.1 billion in 2020, compared with £8.7 billion in the case of no change in demand. These values probably under-estimate the reduction in energy consumption that the proposed policy reform would drive by 2020, given its higher carbon price in comparison with existing policies. These results should, therefore, still be considered to provide an upper bound.

Second, we carried out a wider sensitivity analysis, assessing the impacts of changing consumption patterns by businesses on three important goals of the reforms: revenues, consumption and emissions. For simplicity, we only focused on electricity and gas, the main energy sources used by businesses. We modelled a range of elasticities, from 0 (no behavioural response) to -1.0. Results are shown in Table 5.4, and the method used is explained in Appendix 2 [available online].

Table 5.4 Impacts on revenue, consumption and emissions of different assumptions about price elasticity of demand

Elasticity	Revenue (£m)	Relative to elasticity=0 (£m)	Change in consumption (MWh, millions)		Change in CO_2 emissions (million tonnes)			Change as % of 2011 industrial emissions
			Electricity	Gas	Electricity	Gas	Total	
0	5,303	-	0.00	0.00	0.00	0.00	0.00	0.00
-0.1	5,160	-143	-3.43	-8.68	-1.78	-1.60	-3.38	-2.72
-0.2	5,016	-287	-6.86	-17.35	-3.54	-3.21	-6.75	-5.44
-0.3	4,873	-430	-10.28	-26.03	-5.32	-4.81	-10.13	-8.16
-0.4	4,730	-573	-13.71	-34.70	-7.09	-6.42	-13.51	-10.89
-0.5	4,587	-716	-17.14	-43.38	-8.86	-8.02	-16.88	-13.61
-0.6	4,443	-860	-20.57	-52.05	-10.63	-9.63	-20.26	-16.33
-0.7	4,300	-1003	-24.00	-60.73	-12.41	-11.23	-23.64	-19.05
-0.8	4,157	-1146	-27.42	-69.41	-14.18	-12.84	-27.02	-21.77
-0.9	4,014	-1289	-30.85	-78.08	-15.95	-14.45	-30.40	-24.49
-1.0	3,870	-1433	-34.28	-86.76	-17.72	-16.05	-33.77	-27.21

Source: Authors' calculations based on Advani et al. (2013), DECC (2012; 2013a; 2013b) and DEFRA (2012).

The results clearly show that as elasticity increases, the demand response to the price signal also increases. This reduces revenue, consumption and emissions.

But what elasticity can be expected from firms in reality? The available literature suggests that elasticity in the short run may be around -0.3 (see e.g. Adeyemi & Hunt, 2007). At this level of elasticity, electricity demand is expected to fall by 5 per cent and gas demand by 12 per cent, leading to an emissions reduction of about 10 million tonnes of carbon dioxide compared with a baseline case of zero elasticity. Revenues from the CCL+ from gas and electricity are estimated to be around £4.9 billion, or 8 per cent less than in a scenario with no behavioural response (£5.3 billion).

The literature indicates a stronger reaction of demand to price increases in the long run. A plausible value for average elasticity could be -0.6 (see, for example, Agnolucci, 2009). At this level, electricity and gas demand are estimated to reduce by 10 and 25 per cent, respectively. This is likely to lead to an emissions reduction of around 20 million tonnes of carbon dioxide. Revenues from the CCL+ would be expected to decrease to £4.4 billion, or 16 per cent below the baseline.

The results suggest demand responses to the reforms would be moderate in the short run, compared with a case in which no behavioural response is assumed. However, in the long run, as industries are able to replace older equipment with newer and less energy-intensive capital stock, elasticities are estimated to increase more substantially, reducing revenues, energy demand and emissions significantly.

However, as our results are averages across sectors, they should be interpreted with caution. Different sectors have different energy intensities and production functions so own-price elasticities vary greatly. Future research may be able to estimate elasticities using micro-level firm data.

5.2 Summary of findings

In the UK, effective carbon prices differ widely between policies, sectors and fuels. This offers scope for streamlining the policy landscape and moving towards simpler and more consistent carbon pricing across the economy.

In this paper, we suggest a policy simplification for the three key downstream policies, namely the CRC, CCAs and CCL. This would involve merging them into one policy, applying one single carbon price and which, in the short term, would retain the broad design of the CCL. We refer to it as the CCL+.

Setting the right CCL+ rate would be a sensitive issue. In principle, there is an argument for setting the carbon price of the traded and non-traded sectors to a single value that is consistent with the UK carbon budgets. This could result in a significant increase in the carbon price currently charged for gas, coal and LPG. The increase for electricity would be lower, as this already bears the implicit carbon price of upstream policies, such as the CPF, RO FITs, the costs of which are passed on by energy suppliers to electricity users. As these upstream costs are expected to rise, electricity would eventually be exempt from any downstream tax.

In the longer term, we suggest replacing the CCL+ with a single policy that imposes a uniform carbon tax on coal, gas and LPG further upstream i.e. at the point of import or manufacture.

The reform would result in higher carbon price rates for many firms and could in practice be introduced only if a significant share of the extra revenue for Government were recycled back to business. We do not assess how this might best be done. Options might include lump sum payments or reductions in business taxes, or decreasing the impact of other climate related policies, for instance by reducing the burden of the RO or FITs on energy bills. In the future, revenues could also be partially used to reduce public debt if needed, and hence reducing the need for tax increases in other areas of the economy. However, some revenue would have to be devoted to mitigating negative impacts on international competitiveness and carbon leakage.

6 Policy conclusions and recommendations

Current policy overlaps lead to businesses paying a form of carbon price several times over, depending on the number and combination of policies they are subject to. This leads to effective carbon prices varying significantly across the economy. This can cause inefficient allocation of abatement activity across sectors and distort relative prices of final goods and services. Importantly, it can jeopardise achieving policy objectives, particularly improvements in energy efficiency and reductions in emissions.

As an example, the CCAs are designed to meet concerns about competitiveness in energy-intensive sectors which risk facing disproportionately high energy costs compared with their foreign competitors. However, studies that have compared firms paying the full rate of the CCL with similar firms that do not but which operate in the same economic sectors – and therefore face the same international competition – while paying the reduced CCA rate, did not find any evidence that the CCL has adversely affected businesses' output and employment. And businesses subject to the CCAs appear to perform less well, in terms of energy efficiency, than those which pay the full CCL (see Martin *et al.*, 2011). This suggests that the discounts offered by the CCA are not fully justified on competitiveness grounds.

Layering policies has also created institutional complexity, adding to the administrative burden for businesses. This is the case, for instance, with the CRC, the administrative complications and costs of which, together with a history of frequent revisions to its design, monitoring and eligibility criteria, have made it an unpopular measure.

There are also a number of improvements which could be made to upstream energy and climate change policies affecting the power sector, such as the EU ETS, RO and FITs. These are discussed in a companion paper by the Institute for Fiscal Studies, the Centre for Climate Change Economics and Policy and the Grantham Research Institute on Climate Change and the Environment (Advani *et al.*, (2013) and Grover (2013).

Ideally, an energy tax should:

- Be levied on all businesses, including the small activities that are currently exempted from the CCL, effectively removing any administrative requirement to determine eligibility.
- Apply the same carbon price to each of the main fossil fuels i.e. natural gas, coal and LPG.
- Apply a lower rate to electricity, which should be equivalent to the carbon price charged on fossil fuels minus the implicit carbon rate of upstream policies, as this would be already included in electricity prices.
- For (downstream) sectors covered by the EU ETS, apply a carbon price on natural gas, coal and LPG reduced by the EUA price which businesses pay through the trading scheme. In order to determine what the resulting tax rate should be, a mechanism similar to the current CPF could be adopted (see also Advani *et al.*, (2013) for suggested improvements to the CPF).

To achieve this, we recommend that the main downstream carbon and energy taxes, namely the CCL, CCA and the CRC, are reformed into a single policy that applies an even carbon price across all sectors and fuels.

However, setting the right carbon price would be a sensitive issue. In principle, there is an argument for equalising the carbon price of the sectors regulated by EU ETS with the (theoretical) carbon price imposed on the non-traded sectors. This would ensure that greenhouse gas externalities are priced consistently across all fuels and sectors, at a level consistent with the UK carbon budgets. The Government envisages the carbon prices for the

traded and non-traded sectors will converge in 2030, when they will both reach £76/tCO_2. At this point the CPF and a reformed energy tax would also converge, bringing the upstream and downstream sector onto a level playing field.

One way to reach this target would be to gradually align the reformed energy tax rate with the Government's estimated carbon price trajectory for the non-traded sector. This is currently £59/tCO_2e and is expected to rise to £66 in 2020 and £76 in 2030. This, however, may result in a considerable increase in financial burden for some businesses, especially energy-intensive firms currently benefiting from reduced energy tax rates through CCAs. Other intermediate targets could be considered, in consultation with firms and other stakeholders, to smooth the transition from the current relatively low prices of carbon.

These reforms imply higher fiscal revenues. The objective of such reforms, however, would be to make carbon pricing more effective, not to raise additional revenue. The recent public debate about rising energy bills in the UK suggests that, in practice, the recommended reform may only be politically palatable if most of the extra revenues it generates were recycled back to businesses or energy users. We do not assess how this might best be done, but we acknowledge that options might include lump sum payments or reductions in business taxes, in particular for those sectors with the highest energy intensity and most exposed to international competition, provided that they can be adequately identified (see also Advani *et al.* (2013) on issues relating to competitiveness impacts and carbon leakage). Revenues, or part of them, could also be used to cover the expenditures associated with other climate-related policies, for instance by reducing the burden of the RO or FITs on energy bills. In the future, revenues could also be partially used to reduce public debt if needed, and hence reduce the need for tax increases in other areas of the economy.

In the longer term, the downstream energy tax could be replaced by a single upstream carbon pricing policy, imposing a uniform carbon tax on fossil fuels i.e. at the point of import or manufacture. Levying upstream taxes on fuels can reduce administrative costs and the scope for tax evasion. Whether a downstream taxation can be entirely replaced by such an upstream instrument will depend on European Union legislation on taxes at the point of business use, such as the Energy Tax Directive (2003/96/EC) and its future revisions.

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