UK climate change policy: how does it affect competitiveness?

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Contents

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Executive summary

The Committee on Climate Change has recommended that setting a target to reduce UK emissions of greenhouse gases to an average of 57 per cent below their 1990 levels during the period of the fifth carbon budget (2028-2032) is consistent with a least cost path to meeting the UK's long-term climate objectives. This policy brief compares the ambition of UK climate change policy with its major international competitors and explores the impact it could have on economic competitiveness.

The key findings of this analysis are:

The UK is an international leader in cutting greenhouse gas emissions, but is not acting alone. The UK is part of a leading group of nations that is taking ambitious policy action on climate change. Also in this group are many of the UK's major competitors, including France, Germany, Norway, South Korea, Mexico, and China. This conclusion is based on a comparison of three indicators of climate change policy ambition: the presence and stringency of national greenhouse gas emissions targets, the adoption of climate change legislation, and the resulting implicit or explicit price of carbon.

The European Union (EU) should be prepared to raise the ambition of its emissions reduction target for 2030. The EU has set a target to reduce its annual emissions of greenhouse gases by at least 40 per cent compared to their 1990 level by 2030. The UK's share of meeting this goal is likely to be a target in the range of 51 and 57 per cent. The Committee on Climate Change's advice for the fifth carbon budget is at the top end of this range. However, the EU's 2030 target is at the lower end of ambition compared to the cost-effective path to its 2050 objective of reducing emissions to 80 to 95 per cent below 1990 levels. EU Member States should be prepared to raise the ambition of their collective target as a contribution towards closing the gap between projected annual global emissions in 2030 and a pathway that is consistent with avoiding dangerous climate change.

Current policies to tackle climate change have not damaged the competitiveness of businesses. A review of empirical studies suggests that the policies currently in place to meet the UK carbon budgets have had little or no negative impact on business competitiveness and carbon leakage. Similar results emerge from studies at the European level. In particular, there is no compelling evidence that investments in the EU have been cancelled, or production moved, because of the EU Emissions Trading System or, in the UK, because of the Climate Change Levy. Carbon prices are likely to rise in the future, but evidence from other countries with higher carbon prices than the UK's shows that countries can have a high carbon price and remain competitive. The OECD has also shown that countries that implement stringent environmental policies do not lose export competitiveness when compared against countries with weaker regulations.

Evidence shows that climate change policies can increase the competitiveness of the UK in the long term by encouraging greater innovation and efficiency. Well-designed climate change policies could offer business opportunities in fast-growing global markets, as countries, such as the United States, China and the Member States of the EU, implement ever more stringent carbon reduction and energy efficiency policies in the wake of the Paris Agreement. The UK is well-positioned to benefit from a global transition to a more resource-efficient and renewable economy, provided flexible structural policies allow it to utilise its comparative advantages. Furthermore, evidence shows that climate change policies generate low-carbon innovation and that low-carbon innovation has significant economic benefits – greater benefits than innovation in high-carbon sectors.

Carbon-related energy costs remain small relative to other production costs in the economy. Differential energy costs do matter in location decisions of carbon-intensive firms. But, other costs, such as labour, tend to be more important. Other determining factors are non-cost issues such as access to national/regional markets, access to skills and technologies, raw materials, the investment climate and the fiscal regime.

Competitiveness concerns are valid for a small number of sectors representing approximately four per cent of the economy. These sectors are affected more than others because they are both energy intensive and exposed to international trade. They include manufacture of coke and refined petroleum products, mining of coal and lignite, manufacture of iron and steel and other metals; manufacture of dyestuffs and agro-chemicals, and cement. That impact can be offset by well-designed compensatory measures.

Policies to support vulnerable sectors are already in place in the UK in the form of free emissions trading permits and sector discounts or exemptions from national policies. However, there is evidence to suggest that current measures are often too generous and target too many sectors. In some cases they can provide firms with windfall profits. New compensatory measures should therefore be carefully targeted to avoid costly over-compensation and undesirable market distortion.

More needs to be done over the next decade to actively manage structural change in the economy. Combatting climate change requires long term structural change to the UK economy. The correct policy response is not to resist the transition to a low-carbon economy, but instead to identify vulnerable sectors and buffer them against acute effects in the short-term.

1. Introduction

The Committee on Climate Change has recommended that a setting a target to reduce UK emissions of greenhouse gases to an average of 57 per cent below their 1990 levels during the period of the fifth carbon budget (2028-2032) is consistent with a least cost path to meeting the UK's long-term climate objectives. This policy brief compares the ambition UK climate change policy with that of its major international competitors (see section 2) and explores its impacts on UK competitiveness (see section 3).

2. The ambition of UK climate change policy compared to its competitors

This section compares the ambition of UK climate change policy to its competitors in three respects:

– the stringency of emissions reduction targets (section 2.1)

– the strength of climate change policy and legislation (section 2.2)

– carbon prices (section 2.3).

2.1 Emissions reduction targets

National emissions targets provide a clear metric against which the success of climate change policies can be measured. It is encouraging therefore that over 75 per cent of annual global emissions are now covered by national targets for economy-wide emissions reductions. The 2015 Global Climate Legislation Study (Nachmany *et al.*, 2015) showed that 43 countries, plus the European Union (EU) as a whole, have economy-wide targets to reduce their emissions in absolute or relative terms. Of these, 40 have economy-wide targets up 2020 and 21 have targets beyond 2020.

Table 1 lists the 2020, 2030 and 2050 (where available) emissions reductions targets for the UK's main competitors.[1] It shows that the UK is part of a leading pack of countries with ambitious climate change targets. However, other countries have more ambitious targets than the UK, including Germany's goal for reducing emissions by 2050 and China's goal for reducing the carbon intensity of its GDP by 2020.

1 Countries have been selected on the basis of key UK competitors listed by the Committee on Climate Change (CCC, 2013) and other key developed and developing trading partners identified by the authors (Australia, Brazil, Canada, Mexico, New Zealand, South Africa, and South Korea).

Table 1. Economy-wide targets of the UK's non-EU trade competitors

Country	Year	Target	UK equivalent (If UK targets expressed in the same way)
Australia	2020	GHG 5% below 2000 levels	GHG 28% below 2000 levels
	2030	GHG 26-28% below 2005 levels	GHG 51% below 2005 levels
Belgium	2020	GHG 20% below 1990 levels (EU target)	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
Brazil	2020	GHG 36.1%-38.9% below BAU	n/a
	2030	GHG 43% below 2005 levels	GHG 51% below 2005 levels
Canada	None	None	n/a
	2030	GHG 30% below 2005 levels excluding LULUCF (28% below 2005 including LULUCF)	GHG 51% below 2005 levels
China	2020	Carbon intensity of GDP 40-45% below 2005 levels	Carbon intensity 39% below 2005 levels
	2030	Peak CO_2 emissions, with the intention to peak early; carbon intensity of GDP 60- 65% below 2005 levels	Carbon intensity 67% below 2005 levels
European Union	2020	GHG 20% below 1990 level	GHG 35% below 1990 level
	2030	GHG 40% below 1990 level	GHG 57% below 1990 level
	2050	GHG 80-95% below 1990 level	GHG 80% below 1990 level
Egypt	None	None	n/a
Germany	2020	GHG 40% below 1990 levels	GHG 35% below 1990 levels
	2030	GHG 55% below 1990 levels	GHG 57% below 1990 levels
	2050	GHG 80-95% below 1990	GHG 80% below 1990 levels
Finland	2020	GHG 20% below 1990 levels (EU target)	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
	2050	GHG 80% below 1990 levels	GHG 80% below 1990 levels
France	2020	GHG 20% below 1990 levels (EU target)	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
	2050	GHG 75% below 1990 levels	GHG 80% below 1990 levels
India	2025	Carbon intensity of GDP 20-25% below 2005 levels (excluding emissions from agriculture)	Carbon intensity 58% below 2005 levels
	2030	Carbon intensity of GDP 33-35% below 2005 levels	Carbon intensity 67% below 2005 levels
Ireland	2020	GHG 20% below 1990 levels (EU target)	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
Italy	2020	GHG 21% below 2005 levels	GHG 25% below 2005 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels

Japan	2020	GHG 3.8% below 2005 levels	GHG 25% below 2005 levels
	2030	GHG 26% below 2013 levels (25.4% below 2005)	GHG 51% below 2005 levels
Lithuania	2020	GHG 20% below 1990 levels (EU target)	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
Mexico	2020	GHG 30% below BAU	n/a
	2030	GHG 22% below BAU (and 51% reduction in black carbon)	n/a
Netherlands	2020	GHG 30% below 1990 levels	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
New Zealand	2020	Unconditional 5% GHG reduction below 1990 levels; conditional 10-20% reduction below 1990 levels if global agreement	GHG 35% below 1990 levels
	2030	GHG 30% below 2005 levels	GHG 51% below 2005 levels
Russia	2020	GHG 25% below 1990 levels	GHG 35% below 1990 levels
	2030	GHG 25-30% below 1990 levels	GHG 57% below 1990 levels
South Africa	2020	GHG 34% below BAU[2]	n/a
	2030	GHG at 398 - 614 Mt CO_2eq	GHG 345 Mt CO_2eq
South Korea	2020	GHG 30% below BAU[3]	n/a
	2030	GHG 37% below BAU, excluding LULUCF	n/a
Sweden	2020	GHG 40% below 1990 levels	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
	2050	Carbon neutrality	GHG 80% below 1990 levels
Spain	2020	GHG 20% below 1990 levels (EU target)	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels (EU target)	GHG 57% below 1990 levels
Turkey	2030	GHG 21% below BAU	n/a
Ukraine	2020	GHG 20% below 1990 levels	GHG 35% below 1990 levels
	2030	GHG 40% below 1990 levels	GHG 57% below 1990 levels
	2050	GHG 50% below 1990 levels	GHG 80% below 1990 levels
USA	2020	GHG 17% below 2005 levels	GHG 25% below 2005 levels
	2025	GHG 26-28% below 2005 levels	GHG 43% below 2005 levels

Notes: (1) Countries have been selected on the basis of key UK competitors listed by the Committee on Climate Change (CCC, 2013) and other key developed and developing trading partners identified by the authors (Australia, Brazil, Canada, Mexico, New Zealand, South Africa, and South Korea) **(2)** Unless otherwise specified, targets are assumed to include LULUCF emissions. **(3)** UK BAU data comparable with those of developing countries are not available for the UK, since future projections already take into account of existing UK policies which are expected to meet domestic targets; it was therefore not possible to asses UK equivalent targets in terms of BAU (n/a = not available).
Sources: Targets up to 2020 based on Nachmany *et al.* (2015); Targets up to 2030 based on Intended Nationally Determined Contributions (UNFCCC, 2015) and Nachmany *et al.* (2015); UK GDP from World Bank (2015a); UK GDP growth rate forecast (2012-2030) from OECD (2012); UK emissions based on UNFCCC (2016) and CCC (2015b).

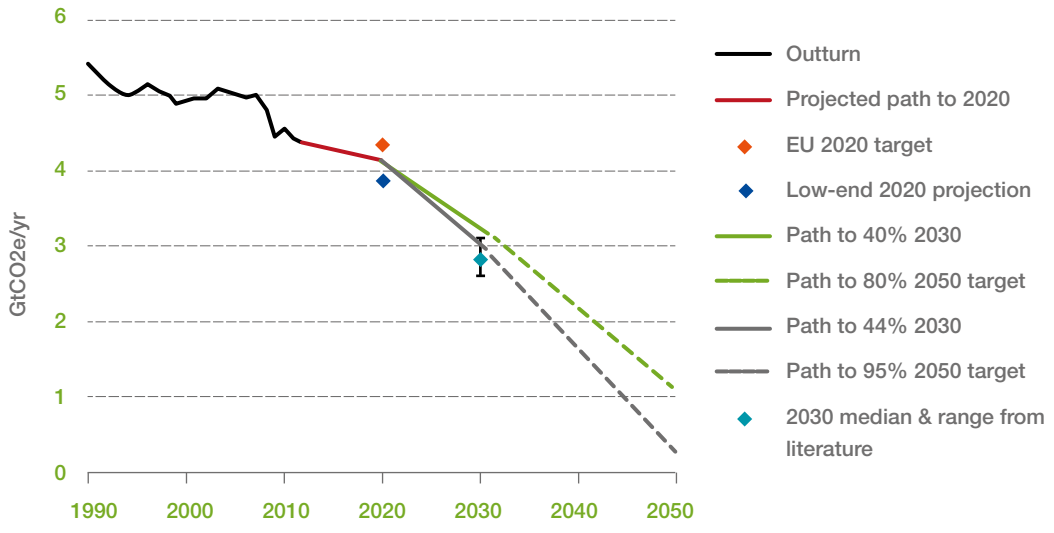
2 Informal voluntary pledge under the Copenhagen Accord (2009)
3 Framework Act on Low Carbon Green Growth, regulated by Enforcement Decree of the Framework Act on Low Carbon Green Growth, (2010)

Table 1 highlights two further points. First the level of ambition of targets depends on the baseline year against which future action is calibrated. It should be noted that baselines many years in the past do not provide a good indicator of the implications for competitiveness, since the economy has had time to adjust. For instance, the proposed UK fifth carbon budget target of reducing annual emissions to 57 per cent below their 1990 level by 2030 is the equivalent of a cut of about 33.4 per cent compared with 2014 and a 38.5 per cent cut compared to 2013. By comparison, the European Union's reduction of 40 per cent by 2030 compared with 1990 is the same as a cut of 18 per cent compared with 2014 or 22 per cent cut compared with 2013.

The European Union has set a target to reduce its annual emissions of greenhouse gases by at least 40 per cent compared to their 1990 level by 2030 (European Council, 2014). The effort-sharing arrangements among Member States for the 2030 target have yet to be agreed. However, the Committee on Climate Change (2015) has calculated the effort-sharing goals for 2030 for Member States if the same methodology is applied as used for the European Union's 2020 target. This analysis indicates that the UK's share would be between 51 and 57 per cent, with a 'best estimate' of 54 per cent. The Committee's recommendation for the fifth carbon budget of a 57 per cent reduction compared with 1990 is clearly at the top end of this range. However, as the Committee has pointed out (Committee on Climate Change, 2015), the European Union's 2030 target is at the lower end of ambition compared to the cost-effective path to its 2050 objective of reducing emissions to 80 to 95 per cent below their 1990 level (see Figure 1).

It should be noted that such calculations of cost-effectiveness do not take into account the economic benefits of avoiding climate change impacts, nor co-benefits, such as reduced air pollution from fossil fuels. The omission of such benefits means that calculations of cost-effectiveness provide incomplete information about the impact of climate policies on competitiveness.

Figure 1. Cost-effective pathway for EU emissions 2050



Source: European Environment Agency data viewer; European Environment Agency (2014) *Trends and projections in Europe 2014*; Sandbag (2014) *is Europe's new climate target a walk in the park?*; Knopf *et al* (2013) Beyond 2020 – Strategies and costs for transforming the European energy system, *Climate Change Economics.*

Notes: Excludes international shipping emissions.

The Committee on Climate Change (2015) has also indicated that the Member States of the European Union should be prepared to raise the level of their collective ambition as a contribution to closing the projected gap in 2030 between global annual emissions and a pathway consistent with avoiding dangerous climate change.

The UK is due to hold a referendum on 23 June 2016 on its membership of the European Union. If the outcome is that the UK withdraws, it is not clear what the consequences would be for UK or European Union climate policy.

2.2 The strength of climate change policy and legislation

The UK's emissions targets are underpinned by a range of policies that are designed, administered and overseen by government departments, regulators, independent advisors and executive agencies. Further to this, the Climate Change Act (2008) provides strong legislative depth for UK climate change policy. The following sections compare these legislative arrangements with those in other countries.

2.2.1 Framework legislation

Encouragingly, framework legislation like the Climate Change Act is becoming an increasingly common aspect of climate policy worldwide. Framework legislation is defined in the 2015 Global Climate Legislation Study as a 'law, or regulation with equivalent status, that serves as a comprehensive, unifying basis for climate change policy and addresses multiple aspects or areas of climate change mitigation or adaptation (or both) in a holistic, overarching manner'. Research has shown that that framework legislation is a key driver of national climate change policy (Fankhauser *et al*., 2014). Of the 99 countries covered in the 2015 Global Climate Legislation Study, 58, including many of the UKs trade competitors, have framework legislation (see Table 2).

Table 2. Selected competitor countries and their flagship laws

Jurisdiction	Flagship climate change law
Denmark	Climate Change Act (2014)
European Union	2030 framework for climate and energy policies (2014)
France	Grenelle I and II (2009/2010)
Germany	Action Programme on Climate Protection 2020 (2014)
Italy	Climate Change Action Plan (2007)
Japan	Law Concerning the Promotion of Measures to Cope with Global Warming (1998, rev. 2005)
Netherlands	National Climate Change Agenda (2014)
New Zealand	Climate Change Response Act (2002)
Australia	Carbon Farming Initiative Amendment Bill (2014)
Brazil	National Policy on Climate Change (2009)
China	National Plan for Tackling Climate Change 2014-2020 (2014)
India	National Action Plan on Climate Change (2008)
Mexico	General Law on Climate Change (2012)
South Africa	National Climate Change Response Policy White Paper (2011)
South Korea	Framework Act on Low Carbon Green Growth (2009)

It should be noted that although the US does not have a framework law or policy, since 2010 greenhouse gases have been subject to the Clean Air Act after the Environmental Protection Agency finalised an 'endangerment finding' under Section 202[4]. The Clean Air Act provides a robust basis for climate policy in the US but because its remit is not specific to climate change, but rather a whole range of pollutants, it does not meet the definition of framework legislation described in the 2015 Global Climate Legislation Study.

2.2.2 Comparing institutional frameworks

All of the UK's main competitor have government departments or agencies (either central or arms-length) that oversee the formulation and implementation of climate change legislation and policy, and provide roadmaps for the accomplishment of targets.

Brazil has an Inter-Ministerial Commission on Climate Change, composed of nine ministries, South Africa has an Inter-Ministerial Committee on Climate Change, and Denmark has a Climate Council. In the US, the Environmental Protection Agency is instrumental in climate policy, and the European Union has the European Commission's Directorate-General on Climate Change and Energy (DG Climate and Energy). Recently, China strengthened its top-level planning on climate change, appointing the Premier as the leader of the National Leading Group for Addressing Climate Change, and placing provincial governors at the head of sub-national groups.

Overall, the UK's strong institutional framework, which supports its climate action, is regarded as a leading model. The Danish Climate Council, for example, was modelled on the UK Committee on Climate Change. Many competitor countries have equivalent provisions suited to their institutional contexts, so while the UK's arrangements can be described as robust and inspiring, they are not unique.

2.3 How UK carbon prices compare with its competitors

Pricing carbon is at the core of climate change policy. Carbon prices can be imposed explicitly, in the form of a carbon tax or emissions trading system, or implicitly, in the form of costs imposed by climate change regulation. The UK has several instruments in place that result in an explicit or implicit carbon price. These include energy taxes like the Climate Change Levy, discounted rates embedded in the Climate Change Agreements, and the CRC Energy Efficiency Scheme. The UK is also part of the EU ETS, and has recently introduced a carbon price floor for electricity generators involved in emissions trading.

The UK is not alone in pricing carbon domestically. The 2015 Global Climate Legislation Study (Nachmany *et al.*, 2015) indicates that 39 of 99 countries surveyed have carbon pricing policies in place, including the European Union and several other European countries, as well as other developed and developing countries, including Canada, China, Japan, India, Mexico and Russia. In addition, the World Bank (2015b) reports that 40 countries and over 20 cities, states, and regions—representing almost a quarter of global greenhouse gas emissions—are putting a price on carbon.

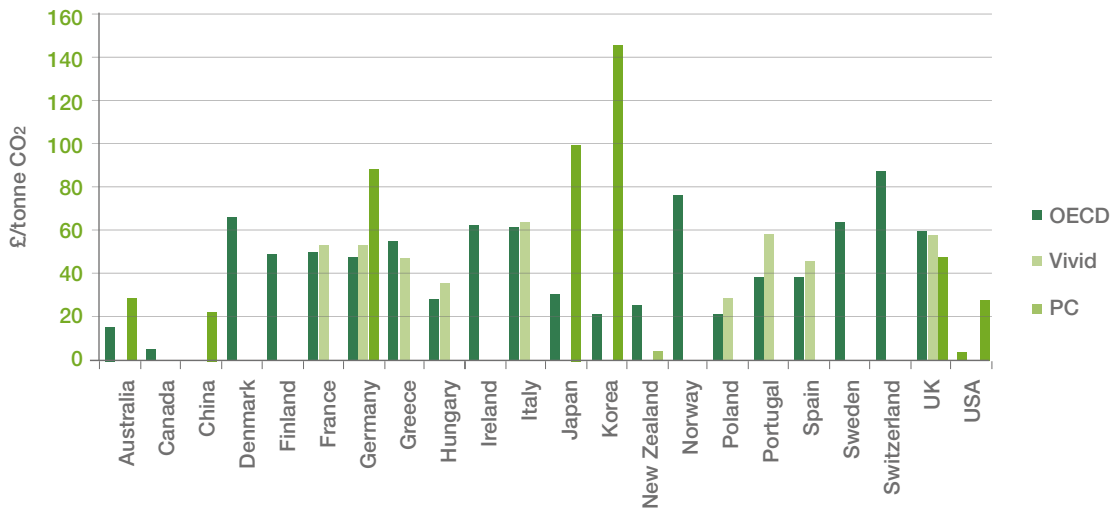
Because domestic policies are typically heterogeneous and can overlap, it is not always easy to compare the effective carbon prices in place across the world. A few studies have attempted such a comparison, with differing results due to differences in methodology. For example, methods may differ in relation to which policies they take into account and how prices are averaged across fuels (like electricity, gas, coal) and energy uses (residential, industrial, or sector-specific). The main findings of three studies (OECD, 2013; Vivid Economics, 2012; Australian Productivity Commission, 2011) are summarised in Figure 2.

4 See: http://www3.epa.gov/climatechange/endangerment/

Despite the variations between estimates in the various studies, two robust conclusions can be made. First, most of the UK's competitor countries impose carbon prices on businesses and households. Second, UK carbon prices, at £48 to £59/tCO_2, are in the middle to upper range compared with prices in competitor countries. Some countries have lower carbon prices than the UK, but several countries have carbon prices that are at a similar level, or higher than, those in the UK.

Section 3 examines the impact of carbon pricing and other climate policies on UK competitiveness in more detail.

Figure 2. Estimated carbon prices in selected countries, averaged over energy products and users (£/tCO_2)



Source: *Based on OECD (2013); Vivid Economics (2012); Australian Government's Productivity Commission (2011)*

3. The competitiveness impact of climate change policies

3.1 Theoretical impact of climate change policies on competitiveness

Economic theory generally suggests that if domestic climate change policies are introduced unilaterally they can increase production costs and prompt the relocation of emissions-intensive activities – and the emissions they cause – abroad. This is described as 'carbon leakage', and means that no benefit is created through avoided impacts of climate change.

Carbon leakage can occur in sectors that are trade-exposed and either highly-polluting (e.g. steel), electricity-intensive (e.g. aluminum), or both. In the UK, analysis by the Committee on Climate Change (2008, 2013b) suggests that iron and steel, refined petroleum products, aluminium, other inorganic chemicals, pulp and paper and rubber tyres are all vulnerable sectors. A few other sectors are also considered to be significantly exposed, although they play a smaller role in the UK economy, including, malt, coke oven product, non-wovens, other textile weaving, copper, and silk and filament yarn. Taken together, these sectors represent a small, but not insignificant, part of the UK economy.

3.2 Measured impact of climate change policies

Although theoretical studies suggest that carbon pricing can create significant costs for some sectors, UK climate policies appear to have had no detectable impact on competitiveness to date. For instance, research shows that neither the Climate Change Levy nor the European Union emissions trading system (EU ETS) have had a negative impact on the competitiveness of regulated firms in terms of employment, output or their likelihood of market exit (Martin *et al*., 2011; Bassi *et al*., 2013).

The impact of policy on UK businesses to date may be small because of relatively low carbon prices. In 2013, the Climate Change Levy charged between £4 (for LPG) and £10 (for electricity) for each tonne of carbon dioxide emitted by regulated firms. The price of EU ETS allowances has oscillated between almost £0 and £24 (€30) per tonne of carbon dioxide since its introduction, reaching a plateau at around £3.50 (€4)[5] per tonne of carbon dioxide in 2013 (EEX, 2014).

However, evidence from the OECD shows that countries can have a relatively high carbon price (compared to the UK) and remain competitive. For instance, estimates of carbon prices applied to electricity in Norway, Sweden, the Netherlands and Denmark are around £445, £134, £74 and £64/tCO_2[6] respectively, compared with about £59/tCO_2 in the UK.[7] Despite relatively high carbon prices in these countries they all perform highly in the World Economic Forum's competitiveness ranking (Schwab, 2015): Norway is ranked eleventh, Sweden is ninth, Netherlands is fifth and Denmark is twelfth, while the UK is tenth. Furthermore, 'input-output' analysis shows that imposing a £20 uniform carbon price on the UK economy would have no significant competitiveness impact on the vast majority of sectors (Grover *et al*., 2016).

In addition, other recent evidence published by the OECD (2016) shows that countries that implement stringent environmental policies do not lose export competitiveness when compared with countries with weaker regulations.

5 Using an average exchange rate of €1 = £0.811 in 2012.
6 These carbon prices are typically accompanied by some form of revenue recycling and/or compensation for energy-intensive companies which mitigates the economic impact.
7 Using an average exchange rate of €1 = £0.811 in 2012.

3.3 The impact of energy costs on competitiveness

Concerns over competitiveness, related to the costs created by unilateral climate change policies, should be seen in the broader context of energy price differentials. Carbon pricing is in fact but one component, and often a relatively small one, of total energy prices. For example, in the European Union in 2013, the average electricity cost for a medium industrial energy user[8] was around £0.13/kWh. Of this, taxes (including carbon prices and excluding VAT and other taxes recoverable in future periods) were around £0.03/kWh. By comparison, the cost of electricity for similar users in the UK was £0.12/kWh, and taxes accounted for only £0.01/kWh[9] (Eurostat, 2014b). Thus, while carbon policies often create a small cost for households and businesses, it is energy wholesale prices and network costs that constitute the largest component of energy bills.

Further to this, while differential energy costs do matter in location decisions of carbon-intensive firms, other costs, such as labour, are also important. As are non-cost issues such as access to national/regional markets, access to skills and technologies, raw materials, the investment climate and the fiscal regime.

This issue has been highlighted recently in the UK because of concern over the future of the steel industry. On 30 March 2016, Tata Steel announced that it was planning to sell its production operations in South Wales, including a large facility in Port Talbot. In its announcement, Tata Steel outlined the reasons for the sale: 'While the global steel demand, especially in developed markets like Europe has remained muted following the financial crisis of 2008, trading conditions in the UK and Europe have rapidly deteriorated more recently, due to structural factors including global oversupply of steel, significant increase in third country exports into Europe, high manufacturing costs, continued weakness in domestic market demand in steel and a volatile currency' (Tata Steel, 2016).

Some commentators, for example Dominic Lawson (2016), have suggested that UK climate policies were primarily responsible for the financial difficulties of the UK steel industry. Such claims do not stand up to scrutiny. Stuart Wilkie, Director of Tata Steel's operation in South Wales, told the House of Commons Select Committee on Welsh Affairs in February 2016 that he expected to spend £100 million on energy in 2016, compared with an annual turnover of £1 billion (House of Commons Welsh Affairs Committee, 2016). Most of these energy costs are accounted for by the wholesale price, transmission and distribution. Calculations by the Committee on Climate Change reveal that perhaps two per cent of the costs of the loss-making steel plant production at Port Talbot were due to climate policies (Stern and Gummer, 2016).

3.4 Supporting sectors a genuine disadvantage

The UK Government monitors the impact of climate change policies on sectors that are vulnerable to carbon leakage. Policies to support vulnerable sectors are already in place, in the form of free emissions trading permits and sector discounts or exemptions from national policies. At present these policies provide sufficient support and in some cases they can provide firms with windfall profits. Compensatory measures should therefore be carefully targeted to avoid costly over-compensation and undesirable market distortion.

It is likely that more action will be needed over the next decade to actively manage the structural changes associated with the transition to a low-carbon economy. Consideration should be given to a 'trade adjustment' policy for carbon pricing, similar to the trade adjustment policy that the US and other countries use to facilitate labour market adjustments (Grover *et al.*, 2016).

8 According to Eurostat (2014a), a medium standard industrial consumer has an annual electricity consumption between 500 and 2 000 MWh.

9 Using an average exchange rate of €1 = £0.849 in 2013.

For example, the Trade Adjustment Assistance program in the US offers assistance to the workers, firms, farmers and communities that are most affected by trade-related structural change in key industries, through worker retraining and relocation assistance. Japan also provides a good example of actively managing structural change in industries that are in decline. From 1987, the Japanese Government provided long-term support to ease the decline of 'structurally depressed' industries, such as textiles and shipbuilding. This support reallocated resources both within and outside the depressed industries, provided financial assistance for firms to adjust, and mitigated negative impacts on the labour force. Hence, the correct policy response is not to resist the structural changes resulting from the transition to low-carbon economic growth, but rather to identify affected sectors and buffer them against its sudden and acute impacts.

3.5 Climate change policies, innovation and economic growth

Evidence shows climate change policies induce innovation in low-carbon technologies and that low-carbon innovation can help to support economic growth.

While the EU emissions trading system (EU ETS) has had no measurable negative impact on business competitiveness (see section 3.2), it has increased innovation activity (based on the number of patents filed) in low-carbon technologies among regulated firms. Figure 3 shows that this effect was most marked in 2007-2008 when the market price of emissions permits in the EU ETS was around €30 per tonne (Dechezlepretre *et al.*, 2016).

Figure 3. Low carbon innovation activity of regulated companies in the European Union Emissions Trading System compared with comparable companies outside the System

Source: *Dechezleprêtre et al (2015)*

Recent evidence has also shown that low-carbon innovation in the energy and transport sectors has larger economic benefits than high-carbon innovation in these sectors. These benefits arise from low-carbon innovations having high social value, broad application in other areas of the economy – what is known as a large knowledge spillover effect – and often high economic value (Dechezlepretre et al., 2016). In particular, the knowledge spillover effect of low-carbon innovations (measured by patent citations) is comparable to the knowledge spillover effect in the information and communication technologies (ICT) sector.

Taken together these benefits can help to offset the cost of climate change policy on firms.

It should be recognised that climate change policies can increase the competitiveness of the UK in the long term by encouraging greater innovation and efficiency. Well-designed climate change policies could offer business opportunities in fast-growing global markets, as countries, such as the US, China and the Member States of the EU, implement ever more stringent carbon reduction and energy efficiency policies. The UK is well-positioned to benefit from a global transition to a more resource-efficient and renewable low-carbon economy, provided flexible structural policies allow it to utilise its comparative advantages.

4. Conclusion

A number of conclusions can be drawn from the analysis presented in this policy brief.

The UK is an international leader in cutting greenhouse gas emissions, but is not acting alone. The UK is part of a leading group of nations, along with many of its international competitors, which are taking ambitious policy action on climate change.

The European Union (EU) has set a target to reduce its annual emissions of greenhouse gases by at least 40 per cent compared to their 1990 level by 2030. The UK's share of meeting this goal is likely to be a target in the range of 51 and 57 per cent. The Committee on Climate Change's advice for the fifth carbon budget is at the top end of this range. However, the EU's 2030 target is at the lower end of ambition compared to the cost-effective path to its 2050 objective of reducing emissions to 80 to 95 per cent below 1990 levels. EU Member States should be prepared to raise the ambition of their collective target as a contribution towards closing the gap between projected annual global emissions in 2030 and a pathway that is consistent with avoiding dangerous climate change.

Current policies to tackle climate change have not created measurable damage to the competitiveness of businesses. Policies currently in place to meet the UK carbon budgets have not led to any detectable 'carbon leakage'. There is no compelling evidence that investments in the European Union have been cancelled, or production moved, because of the EU ETS or, in the UK, because of the Climate Change Levy. Carbon prices are likely to rise in the future, but evidence from other countries with higher carbon prices than the UK's shows that they have remained competitive.

Climate change policies can increase the competitiveness of the UK in the long term by encouraging greater innovation and efficiency. Well-designed climate change policies could offer business opportunities in fast-growing global markets, as countries, such as the United States, China and the Member States of the European Union, implement ever more stringent carbon reduction and energy efficiency policies. The UK is well-positioned to benefit from a global transition to a more resource-efficient and renewable economy, provided flexible structural policies allow it to utilise its comparative advantages. Furthermore, evidence shows that climate change policies generate low-carbon innovation and that low-carbon innovation has significant economic benefits – more than innovation in high-carbon sectors.

Carbon-related energy costs remain small relative to other production costs in the economy. Differential energy costs do matter in determining location decisions of carbon-intensive firms, but other costs, such as labour, are also important. Also key are non-cost issues such as access to national/regional markets, access to skills and technologies, raw materials, the investment climate and the fiscal regime.

Competitiveness concerns are valid for a small number of sectors representing approximately four per cent of the economy. These sectors are affected more than others because they are both energy intensive and exposed to international trade. They include manufacture of coke and refined petroleum products, mining of coal and lignite, manufacture of iron and steel and other metals; manufacture of dyestuffs and agro-chemicals, and cement. That impact can be offset by well-designed compensatory measures.

More needs to be done over the next decade to actively manage structural change in the economy. Combatting climate change requires long term structural change to the UK economy. To manage this trade adjustment policy for carbon pricing should be considered to facilitate labour market adjustments.

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