REPORT

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GROWING PAINS

BRITISH INDUSTRY AND THE LOW-CARBON TRANSITION

David Nash, Will Straw
and Reuben Balfour

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ABOUT THE AUTHORS

David Nash is a research fellow at IPPR.

Will Straw is associate director for globalisation and climate change at IPPR.

Reuben Balfour is a research intern at IPPR.

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IPPR
4th Floor
14 Buckingham Street
London WC2N 6DF
T: +44 (0)20 7470 6100
E: info@ippr.org
www.ippr.org
Registered charity no. 800065

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EXECUTIVE SUMMARY

As the economy continues to falter, the strains on the low-carbon agenda are becoming visible. Yet aside from some recent overblown rhetoric, the government remains committed to pressing ahead with plans to tackle climate change. Last year's carbon plan set out how the government intends to fulfil its legal requirement under the 2008 Climate Change Act to reduce greenhouse gas emissions (GHGs) by up to 34 per cent by 2020 and 80 per cent by 2050 compared to 1990 levels. The government also supports recent European Commission proposals to set ambitious EU-wide emissions milestones through to 2050.

The rationale underpinning this approach is that long-term sustainable growth, productive British businesses and an ambitious decarbonisation policy go hand in hand. Sticking to a high-carbon growth trajectory is an untenable and costly policy for the UK in the long run. Given that future growth and low-carbon investment will primarily need to come from the private sector, businesses have a crucial role to play. But what does business make of current policy on climate change at the domestic and European level?

This report explores the views of British industries that are critical to the low-carbon transition. The findings draw on a series of private roundtable discussions and interviews with senior executives from different sectors, which together shed light on the barriers to, and the opportunities presented by, the transition to a low-carbon economy. A sister paper, *Europe's next economy: The benefits of and barriers to the low-carbon transition,* is published alongside this study and is the result of similar analysis undertaken in other EU member states (Straw et al 2012).

Industries at the heart of the transition

This report focuses on industries that are at the forefront of, and therefore critical to, the low-carbon transition:[1] energy, transport and manufacturing. Energy-intensive industries (or 'EIIs'), a subgroup of manufacturing, are also considered.

In 2009, these sectors accounted for nearly three-quarters of UK emissions, and going forward they are destined to shoulder a significant proportion of the required carbon cuts if the government is to meet its long-term goals. The weakness of the economic recovery is focusing minds, however, and many businesses are increasingly wary of any measures that may hamper their competitiveness and increase short-term operating costs. Some in the business community also argue that ambitious climate change policies in the UK and Europe may even be self-defeating if they lead to 'carbon leakage' – where production (and therefore emissions) is merely offshored to countries with less stringent carbon regulation. Hence, it is unsurprising that proposals to raise the EU's 2020 target to 30 per cent have been met with stiff resistance from some industry quarters.

Despite these risks, other businesses take a different view of the low-carbon agenda. For many companies, climate change targets, policies and regulations are helping to create new market opportunities and boosting turnover. The global market for environmental goods and services is estimated to be $3.5 trillion and growing by 4 per cent each year. New clean-tech industries are sprouting up, and established companies are adjusting their business models to take advantage of low-carbon technologies. By harnessing energy efficiency opportunities and cleaning up production processes, manufacturers are cutting costs and increasing their productivity. Even for energy-intensive industries – often

1 Given their critical role in funding the transition, representatives of the finance sector were also interviewed. They are referred to throughout the report as and when appropriate.

described as the chief losers in the transition – such as steel, there are opportunities to tap into supply chains for clean-energy infrastructure projects.

The challenge facing policymakers, therefore, is to establish a low-carbon policy framework that balances these conflicting interests and manages the trade-offs. The aim should be a suite of policies that enables innovative businesses and start-ups to capture new low-carbon growth opportunities and helps existing and hard-to-treat industries adapt their business models to the transition. According to industry executives from the sectors we consulted, there is some way to go to achieve this.

Policy challenges, barriers and opportunities

In some sectors, such as electricity supply and automotive, the policy framework guiding decarbonisation is already relatively advanced. Elsewhere, it is either underdeveloped or muddled and inconsistent. Aviation has only recently been brought into the EU emissions trading scheme (ETS), a decision that has led to a major legal dispute with non-EU airlines, which will be charged for flying in and out of European airports. British shipping will be subject to an international energy-efficiency standard for the first time in 2013. Both industries lack policy incentives to innovate and invest in greener fuels and energy-saving technologies. At the same time, many manufacturers complain of an overly complex regulatory regime and overlapping policies, while others, such as those in energy-intensive sectors, argue that policy often takes the form of an arbitrary 'one-size-fits-all' approach.

Furthermore, a government that 'is constantly shifting the goal posts' does little to maintain business and investor confidence in the low-carbon agenda. Many of the business representatives we consulted criticised the Coalition for recent changes to policies, in particular cuts to feed-in tariffs (FITs) for solar photovoltaic (PV) installations and the much-criticised carbon reduction commitment (CRC). Turning an incentive-based scheme into a revenue raiser for the Treasury has jeopardised the government's credibility on low-carbon policy within the business community.

Representatives from many industries suggested that the lack of detail on what industry could expect from policy after 2020 was unhelpful. Given the long lead times for investment in many of these sectors, participants asserted that the sooner a post-2020 policy regime is established at the UK and EU levels (including a fourth phase of the EU ETS), the easier it will be for industry to plan and deliver the necessary investments. This point is particularly important for major infrastructure projects and breakthrough technologies in sectors such as aviation and paper, which plan investment programs 20–30 years in advance.

The costs of investing in new technologies and infrastructure will continue to present a major barrier for many industries. Decarbonising the electricity grid could, according to the government, cost as much as £110 billion by 2020, and there is some concern within the sector of how these costs will be met. Nevertheless, there is a case for investing now in order to avoider costlier investments later on. However, a persistently low carbon price in the EU ETS continues to be a significant drag on investment. Elsewhere, the government's decision to reduce capital allowances has created a further disincentive for manufacturers to invest, at a time when access to capital is tight.

There are also a number of technological barriers to decarbonisation. Even in the automotive sector – a hugely innovative and successful UK industry – executives maintained that there was a limit to what could be achieved with modern combustion engines and that new technologies will be needed. In energy-intensive industries, many

of the 'low-hanging fruits' for carbon reduction have, according to sector representatives, already been picked. Participants thought the focus now should be on supporting breakthrough technologies through intensive research and development (R&D) and innovation. For the most part, these are either nascent ideas or else hugely costly and, for many businesses, simply unaffordable in the current climate without additional support from institutional investors and policymakers.

Without innovation and investment, it will be difficult for EIIs to remain competitive in the low-carbon economy. Our findings suggest that while there is little evidence that carbon leakage is already happening, it may well become a problem in the future if energy costs for British-based EII facilities rise as the government has projected (DECC 2011a) and carbon regulation in the UK and EU becomes more demanding. In such a scenario, additional measures may be needed to support EIIs and help ensure that UK firms operate on a level playing field with industries overseas. The decision to introduce a unilateral carbon price floor risks harming UK industry relative to its European and international counterparts and is unlikely to reduce emissions (Maxwell 2011).

Despite these challenges and barriers, the potential gains are nonetheless promising for many sectors. There is also strong evidence to suggest that the transition will provide important benefits to the wider economy. 'Retrofitting' the UK's housing stock, for instance, would bring a welcome boost for growth and jobs, not least in the construction sector.

In many industries, it is possible to identify emerging low-carbon technologies that have 'game-changing potential' for carbon reduction, as well as those that offer genuine competitive advantage for UK businesses. Many industry representatives identified wave, marine and offshore wind as technologies that complement the UK's natural resources and could, should we acquire 'first-mover advantage', bring substantial export opportunities. The UK is already home to a number of world-leading technology developers in, for example, hydrogen fuel cells, which the car industry has identified as an important future technology for decarbonisation and which could potentially also revolutionise domestic heat and power systems. The market value of hydrogen fuel cells is predicted to hit $180 billion globally by 2050, and with the right policy framework UK firms could secure a sizeable proportion of this market.

Nevertheless, most sectors identified a number of supply-side barriers, in areas such as skills, infrastructure and finance, which are impeding innovation and the development of new technologies. The inability to secure funding remains a key pitfall for many technology start-ups and mid-stage firms. While the Technology Strategy Board (TSB) and Energy Technologies Institute are providing grants and early-stage funding to the former, many of the latter are struggling to raise the equity finance necessary to further enhance their products, scale up manufacturing and break into existing markets. Unless technology firms are able to access financing, many promising technologies – which could lead to significant emissions reductions, including in the hardest-to-treat sectors – will not see the light of day.

Conclusions and recommendations

Policymakers have a major role to play in addressing the barriers to low-carbon growth. Emissions are an externality of economic activity and will not be addressed by the market alone, so the case for active government is strong. However there remains a disconnect between government ambition and policy in this area.

While some climate regulations are imperfect and others pose risks for certain industries, this is not a sufficient reason to backslide on our low-carbon goals and risk stifling emerging clean-tech sectors. Nor is it a reason to relinquish the productivity and market opportunities that could be accrued by businesses that adopt clean technologies and production processes. Instead, measures must be taken to make sure that all industries are able to invest, innovate, adapt and – ultimately – remain competitive in the future low-carbon economy. With this in mind, we recommend the following six policy interventions.

- **Provide stable, consistent and long-term policy.** Industry representatives were united in their views that the low-carbon transition requires a policy framework that is stable, consistent and sufficiently long term. Periodic changes to policy reduce certainty and discourage the private sector from investing in the technologies and infrastructure that will be critical to curbing emissions. Long-term policy planning and interim milestones will therefore be important, and a 2030 target to reduce emissions in the energy sector should be introduced to speed up carbon reductions and provide longer-term clarity.
- **Develop sectoral industrial strategies to spur low-carbon energy, transport and manufacturing.** To speed up the transition and knock down barriers to growth, the government should work far more closely with industry. Strategic public-private partnerships at the sector level, based on the model successfully pioneered by the Automotive Council, should be established in other industries to identify and harness opportunities for low-carbon growth and innovation, and to address supply-side barriers such as infrastructure, skills and financing needs.
- **Ensure more nuanced policy for energy-intensive firms.** Energy-intensive firms face challenges and barriers that at times are specific to their individual sectors. Policy should therefore be as sector specific and as nuanced as possible. It should target the most suitable and cost-effective avenues for emissions reductions – and positive incentives such as support for R&D – on an industry-by-industry basis.
- **Introduce a targeted 'green deal' for manufacturers.** Manufacturers need more incentives to invest in low-carbon and energy-efficient technologies. A new green deal targeted at manufacturing businesses with high energy costs (relative to total costs) should be introduced. A pilot scheme for small and medium-sized manufacturers should be established, with a view to rolling out the scheme on a wider basis if it is successful.
- **Collaborate with European partners on low-carbon innovation to target possible technological breakthroughs.** There is a strong case for greater EU coordination on major strategic low-carbon investments. Pooling member state resources and encouraging countries and businesses to work in partnership in areas of mutual interest is cost effective, attractive to investors and could deliver greater returns. Developing and demonstrating carbon capture and storage (CCS) technologies and offshore wind are priority areas for the UK; an ambitious European programme, modelled on the governance structure of the EU's NER 300 programme, should be launched.
- **Work proactively with industry to promote international sectoral agreements.** Representatives of many globally traded industries argue that international sectoral agreements are the best way to make progress on emissions reductions. Although not a replacement for binding country-level emissions reduction commitments, sectoral cooperation can be a precursor to greater regulatory action at the national and global levels. We believe that the government should be far more proactive in promoting

opportunities for international industry self-regulation and work with other countries to inject fresh momentum into initiatives that have stalled.

1. INTRODUCTION

Industry has two crucial roles to play in the economy today. On the one hand, policy-makers have placed enormous faith in business, particularly the manufacturing sector, to help spearhead the economic recovery, generate jobs and rebalance the economy away from its dependence on property and financial services. On the other, many industry sectors are at the forefront of efforts to move towards a low-carbon economy.

Despite evidence of tensions within the cabinet over the low-carbon agenda and recent statements[2] by chancellor George Osborne to the contrary, the UK government believes the two roles can and should be pursued simultaneously. The Coalition remains committed to action on climate change and has set out how it plans to meet legally binding targets to reduce GHG emissions by 34 per cent by 2020 and 80 per cent by 2050, relative to 1990 levels (HM Government 2011). Behind the scenes, it has also been pushing for greater ambition in Europe and has backed the EU's 2050 roadmap proposals – which, if agreed, would compel member states to collectively cut their emissions by 40 per cent by 2030, 60 per cent by 2040 and 80–95 per cent by 2050 compared to 1990 levels (European Commission 2011a).

Meeting these goals will require transformational shifts in all sectors of the economy, particularly industrial sectors such as energy, transport and manufacturing. This presents significant challenges. Despite progress in recent years, these industries represent the lion's share of UK emissions: in 2009, the energy sector was responsible for 35 per cent of UK emissions, the domestic transport sector produced 22 per cent, while business and industrial processes (which includes manufacturing) accounted for 17 per cent (HM Government 2011). In the short term, many industries face a challenging economic outlook both at home and in key export markets. Manufacturing output has grown more slowly than expected over the last year, while the latest figures for industrial production – down 2.3 per cent in February compared to last year[3] – are disappointing. Weak growth makes it harder for businesses to expand and invest in their core operations, let alone in carbon-saving measures.

It is therefore unsurprising that some industries have expressed concern about the pace and extent of efforts to stem emissions, and have voiced their opposition to proposals to further raise the EU's 2020 emissions reduction target. For some businesses – particularly in energy-intensive industries, such as steel, paper and chemicals – there is a fear that, in the absence of internationally binding agreements, stringent UK and European climate targets and standards will weaken their competitiveness and lead to 'carbon leakage' (the process whereby production shifts to jurisdictions with less stringent low-carbon regulations). The current economic climate exacerbates these concerns.

For others businesses, however, there are significant benefits and opportunities in making the transition to a low-carbon economy. Climate change policies are opening up new markets for low-carbon goods and services, which have an estimated global value of over £3.5 trillion and are expanding by 4 per cent each year (HM Government 2009). In the UK – which, according to the previous Labour government had a £107 billion stake in this market in 2008 – new industries are springing up in clean energy and transport, while businesses in existing industries are reducing their carbon emissions and adapting their business models to tap into new 'green' commercial opportunities. For these companies, far from being a burden, climate change policies and regulations are helping to create new

2 http://www.telegraph.co.uk/finance/budget/8924405/George-Osborne-carbon-targets-threaten-British-jobs.html
3 http://www.ons.gov.uk/ons/rel/iop/index-of-production/february-2012/stb-iop-feb-2012.html

markets and providing important investment signals that are critical for growth. However, they need clarity and stability in policy, which has not always been forthcoming.

This report provides a snapshot of the perspectives of a number of industries on the low-carbon transition, including how they view the current UK and EU policy framework and the barriers to, and opportunities for, low-carbon growth in their sectors.[4] These findings are based on a series of roundtable discussions hosted by the Institute for Public Policy Research (IPPR) in late 2011 and early 2012 and a number of targeted interviews with senior executives from businesses based in the UK. The analysis focuses on four industry sectors that are key[5] to the UK's low-carbon transition.

The **energy** sector is at the forefront of the UK's decarbonisation effort and has taken important steps to reduce its emissions in recent years. The policy framework, however, is far from certain and significant investments are needed to decarbonise the grid and support a diverse range of clean-energy and low-carbon technologies if long-term goals are to be achieved. Ensuring that costly clean technologies can compete with incumbent forms of high-carbon energy – without incurring substantial costs for businesses and consumers – will be particularly important in the years ahead.

Transport is also crucial to achieving the UK's emissions reduction goals. Aggregate emissions from this sector rose before the recession, but have since stabilised. Regulatory standards and an impressive commitment to innovation have helped drive down emissions in industries such as automotive, but more needs to be done to boost the market for low-carbon vehicles and encourage greater use of public transport. Rising emissions in other transport sub-sectors, such as aviation and shipping, are also a growing area of concern.

Manufacturing is less often thought of in isolation in these debates, but is nonetheless critical. British manufacturers are already producing technologies that are helping to curb emissions in energy, transport and other clean-tech sectors such as waste recycling. But manufacturers who do not typically operate in the clean-tech space also have an important role to play, not least in developing more efficient technologies and production processes to reduce emissions and clean up their supply chains. Many small and medium-sized manufacturers are feeling the pinch of rising energy prices, which provides additional incentives to invest in energy efficiency.

Finally, **energy-intensive industries** – a subgroup of manufacturing – are a particularly important sector and are most at risk during this transition. Policymakers need to help them manage their energy consumption in order to limit the impact of rising energy costs, adapt their business models (for instance, by exploring opportunities to power their plants with renewables) and develop transformative technologies so that they too can remain competitive in the low-carbon economy. A particular priority is helping these industries broker ambitious international sectoral agreements for curbing emissions, which in turn will reduce the threat of businesses moving overseas and the probability of carbon leakage.

If policymakers in Europe and the UK are to garner the support of industry during the low-carbon transition, they must first understand industry's concerns and then break down

4 The study's sister report, *Europe's next economy*, explores similar issues in relation to the challenges, barriers and opportunities to decarbonisation in four other European member states: Germany, France, Spain and Poland (Straw et al 2012).

5 We also consulted with investors and representatives of the finance sector. Their views are touched upon throughout this report where appropriate.

barriers to low-carbon growth. Their aim should be to develop a clear and consistent set of policy levers that simultaneously address the key challenges facing each sector and provide the conditions for UK industry to adapt, innovate and remain competitive, while ensuring it does its bit to tackle climate change. This report strives to chart a way forward.

2. INDUSTRIES AT THE FOREFRONT OF THE TRANSITION

2.1 Energy

The energy sector[6] is the UK's single largest emitter, accounting for 35 per cent of GHG emissions in 2010.[7] While the 'dash for gas' period during the 1990s – which saw natural gas plants replace much of the country's coal-fired power station fleet – and recent efforts to increase renewable energy-generating capacity have helped curb emissions, there remains much to be done. Without a major boost in clean-energy supply and a parallel reduction in fossil-based energy use, businesses and households will struggle to curb their emissions and will be at the mercy of global fossil fuel price volatility.

The government and the independent Committee on Climate Change (CCC)[8] have indicated that emissions in the power sector must be close to zero if the UK is going to have any chance of reducing its emissions by 80 per cent relative to 1990 levels by 2050. A similar assumption is made for Europe as a whole in the EU's 2050 energy roadmap (European Commission 2011b). This objective will require a major transformative shift in the electricity market away from high-carbon-powered generation towards low-carbon sources such as renewables and nuclear, and a rapid increase in energy efficiency. Over the next two decades, emissions from the power sector will need to fall by two-thirds if the UK is to hit its fourth carbon budget (DECC 2011b).

The policy framework that guides decarbonisation in the UK energy sector is relatively advanced. Emissions from power stations fall under the EU's ETS, which foresees CO_2 reductions of 21 per cent by 2020 relative to 2005 levels in the facilities it covers.[9] The sector is also affected by two other targets that feature in the EU's 2020 climate and energy package: to reduce primary energy use by 20 per cent and to generate 15 per cent of all energy consumed using renewables, both by 2020. To meet the latter target, the UK has until now relied on the renewables obligation – the main support mechanism for larger commercial-scale generation – and FITs, which since their introduction have led to a huge surge in small-scale solar PV installations, as well as wind and micro hydropower. The proposed electricity market reforms (EMR), which have been subject to repeated delays but are expected before parliament in 2012,[10] are intended to streamline (and limit the cost of) the subsidy scheme for renewable energy and nuclear power. By 2020, the government estimates that investments of up to £110 billion will be needed in the UK's electricity infrastructure alone (HM Government 2011: 15).

Perspectives on policy

Given its share of emissions, the EU and UK government's decarbonisation objectives pose significant challenges for the energy sector. Representatives from the energy sector that we consulted – including executives from utilities, industry associations and energy technology firms – were broadly supportive of the 2020 ambitions. In general terms, they concluded that the 2020 targets were 'pulling in the right direction', although many agreed that there was some way to go to reach the 15 per cent goal for renewables. There were also some concerns about the cost of the technology pathway chosen for the UK – namely, whether micro renewables and the prominent role given to nuclear power offered the most cost-effective route to decarbonisation, and how these costs would be passed on.

6 This figure is for energy supply only and includes power stations, refineries and the manufacture of solid fuels.

7 http://www.decc.gov.uk/assets/decc/11/stats/climate-change/4282-statistical-release-2010-uk-greenhouse-gas-emissi.pdf

8 The CCC has stated that the majority of electricity decarbonisation will need to take place by 2030.

9 This figure includes industrial processing and manufacturing plants, as well as power sector installations.

10 EMR legislation is now not expected to be finalised until 2013 at the earliest.

Roundtable participants generally agreed that policy execution at the domestic level has been problematic. Government policy has at times displayed a lack of stability, certainty and consistency, particularly towards low-carbon energy generation. Many participants described policymakers as continuously 'moving the goal posts', making investment decisions difficult and creating uncertainty. For instance, the October 2011 decision to cut FITs for new solar panel installations, from 43.3p to 21p per KWh of energy generated, was described as 'poorly executed' and caused concern both within and outside the solar industry.

Although many felt the FIT reduction was necessary, participants were critical of the way the government handled the decision. They suggested, as others have done,[11] that the short notice given to companies damaged industry, public and investor confidence. The protracted legal dispute that followed, in which the government was defeated in three successive court rulings, has also not helped. Some clean-tech investors consulted for this report said they were increasingly cautious of investing in technologies that are dependent on subsidies, given their susceptibility to rapid and seemingly arbitrary policy changes; they preferred regulatory-based incentives to stimulate technology deployment. Participants who invested in subsidy schemes tended to be global investors, who invest in various markets simultaneously in order to diversify policy risk and generate more stable returns.

In terms of the EU's flagship policy, the ETS, participants were reasonably supportive of its overarching aim to find the most cost-effective way of reducing carbon. However, many energy sector representatives questioned whether it was sufficiently reducing emissions levels. While some reports have indicated that the emissions of companies covered by the scheme have fallen by approximately 8 per cent since 2005 (European Commission 2010a), others have found that the over allocation of allowances in phase I actually resulted in emissions growth of 1 per cent (Sandbag Climate Campaign 2010). There were also serious concerns about the low price of carbon under the ETS – €6.55 per unit as this report went to press[12] – and its affect on emissions reductions within the traded sector, and on energy investment decisions. Consequently, participants expressed some support for proposals – such as a recent communication from Shell, SSE and Dong Energy[13] – to remove excess allowances from the system and introduce a pan-European reserve price, in order to provide greater stability and certainty and help salvage the scheme's reputation.[14]

Further policy measures to spur energy efficiency at the EU level may also be needed. One participant at the roundtable was surprised that the 2011 energy efficiency directive – which is currently undergoing final amendments after negotiations between the commission, member states and the European Parliament, and is expected to be finalised in early July – has been 'the last piece of the jigsaw' (that is, the '20-20-20 package') to be addressed. There was a general sense that the UK is ahead of the EU on energy-efficiency policy, however more needs to be done to address the UK's legacy of poorly insulated housing stock, encourage businesses to be more energy efficient and promote demand reduction. Regarding the first, some participants were uncertain whether the green deal – the government's flagship home energy-efficiency scheme – would yield sufficient demand among homeowners. At the EU level, several participants agreed that greater movement towards common energy-efficiency product standards and labelling

11 MPs in both the DECC and DEFRA select committees criticised the decision in a joint report: see Energy and Climate Change Committee and Environmental Audit Committee 2011.

12 By contrast, the price of carbon permits was almost €30 per tonne in 2008.

13 See 'A baseline correction for the EU ETS', http://blogs.shell.com/climatechange.

14 See http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/1476/1476vw19.htm

was important – although others thought EU regulation in this area needed to be more nuanced and sensitive to national circumstances.

While the majority of EU and UK policy tends to focus on electricity decarbonisation, there is a relative dearth of initiatives to support low-carbon heat production. While the government's renewable heat incentive was generally welcomed, it was felt that a more holistic approach to integrating power and heat decarbonisation was needed. Such an approach should go hand in hand with a strategy for heat technology innovation to bring down the costs of existing technologies (Pendleton and Viitanen 2011). Although participants acknowledged that there were opportunities to roll out heat pumps and heat efficiency measures, they raised doubts about the maturity and cost of existing technologies and questioned whether other potential solutions, such as heat electrification, could achieve the planned emissions reductions in the sector.

Several participants were optimistic about the future of UK energy policy. Despite delays to the legislation, they felt that EMR could provide 'the answer to the future' for the UK energy sector and would simplify the existing policy regime. Others saw the policy in a less favourable light, questioning whether it will be sufficient to drive investment and trigger the mass deployment of low-carbon energy technologies that the government envisages. As a result, some saw it as 'at best a transitory policy'. Several participants also criticised the introduction of a unilateral carbon price floor – a key part of the EMR package – since they argued it would distort the carbon market and put UK industry at a disadvantage relative to their international (and European) competitors.

Barriers and opportunities

The high costs associated with clean-energy and low-carbon technologies represent the biggest barrier to decarbonisation of the energy grid. The question 'who will pay for renewables?' was raised frequently in discussions with energy sector representatives – although it is equally applicable to other forms of low-carbon energy, such as nuclear. There was significant concern – particularly (and unsurprisingly) among representatives from renewable industries – over the erroneous public perception that policies to support renewables were primarily responsible for driving up consumer energy bills. This perception is despite findings by the Department for Energy and Climate Change (DECC) (2011a) and the CCC (2011) that soaring energy prices have predominantly been driven by the rise in wholesale gas prices (which increased by 65 per cent between February 2004 and January 2011, adding approximately £290 to the average household bill). Nevertheless, the proportion of costs attributed to low-carbon policies – to support renewables, nuclear and energy efficiency – is expected to increase between now and 2020, given the scale of the investments required in the UK's energy infrastructure. While the CCC suggests that these costs may be overstated, it is nevertheless likely that energy utilities will pass on much of the additional costs to businesses and consumers.[15]

From a technological perspective, the main challenge for renewables is to make sure that technologies move down the cost curve sufficiently and rapidly enough to compete with less reliance on subsidies. Innovation policy will be critical to this objective. The UK has historically struggled to commercialise promising research, with many ventures failing at the stage between pilot demonstration and commercial deployment – the so-called 'valley of death' (Grubb 2004). This failure is often caused by a lack of available finance, a situation that is currently exacerbated by the drying up of venture capital funding in the

15 The CCC argues that most estimates of future cost increases fail to take into account the relatively low running costs of renewable projects such as wind generation, and are therefore likely to be overstated (CCC 2011: 6).

UK and across Europe. Several participants suggested that greater government support was needed in clean-energy research, demonstration and deployment (RD&D) – provided by institutions such as the TSB, the Energy Technologies Institute[16] and the new Offshore Renewable Energy Catapult Centre in Glasgow (which has been granted up to £50 million for offshore wind, wave and tidal power projects) – to bring down the costs of renewables and help commercialise new technologies.

Another way to bring down costs associated with renewable energy investment would be to move towards greater interconnection and integration of the EU energy grid (WWF 2011). This approach could potentially reduce supply costs (by increasing stability and security of supply) and help overcome some of the uncertainties surrounding intermittency and the base-load capacity of renewables. It would also allow EU countries, including the UK, to export any surplus energy. Several member states have expressed support for greater integration of the EU energy market as a way to boost renewables, while a recent report from the energy and climate change committee (2011) asserts that a European 'super grid' would reduce the capital costs of connecting new renewable capacity, such as marine and offshore wind energy, by up to 25 per cent. Without integration, several roundtable participants thought the UK would struggle to meet its 2020 renewables target.

Despite the constraints outlined above, participants described decarbonising the energy sector as a key opportunity for the UK economy. Representatives from the sector outlined the significant growth potential for developing new energy technologies and services – areas in which the UK has a comparative advantage – and stressed that the government should do all it can to harness this potential. Britain already has a number of world-beating firms in sectors such as wind. For instance, David Brown – a UK gearing company that previously served mainly the defence, oil and gas markets – is now a key exporter of tailored gearbox technology products and maintenance services for wind turbines (see box 2.1). Similarly, participants identified wave and tidal energy as areas in which the UK has a competitive edge. Rolling out smart metres and retrofitting the UK's housing stock could generate significant job opportunities and stimulate a welcome boost to growth in industries such as construction. One participant suggested that the positive outcome of last year's UN conference in Durban – namely, the pledge by China, India, the US and others to commit to emissions reductions targets in 2015 – could potentially open up big export opportunities for energy technology manufacturers and utilities based in the UK.

In addition to renewable technologies, the UK still has the potential to take a lead in the development of CCS technologies, particularly for gas power stations. For many energy sector executives interviewed for this study, this will be critical if – as the government suggests – natural gas is to remain an important part of the energy mix in future years. However, the cancellation of the UK's first planned demonstration projects last year and the announcement in the 2012 budget that natural gas plants will be exempt from a new emissions performance standard until 2045 may put investment in CCS technology on hold and enable other countries to press ahead at the UK's expense.

16 The Energy Technologies Institute is an initiative backed by government and spearheaded by a consortium of businesses that together are contributing £1 billion over 10 years to bring promising technologies to demonstration phase (in combined heat and power, distributed energy and marine).

Box 2.1: David Brown Gear Systems Limited

David Brown has developed and engineered gear systems for 150 years. A global technology solutions provider with UK facilities in Huddersfield and West Bromwich, the company prides itself on its cutting-edge design and engineering expertise, specialising in gearboxes and customised drive trains for a wide range of industrial applications.

David Brown provides an interesting case study of how a firm can fundamentally change its business model to tap into the opportunities provided by the low-carbon transition. Previously, 50 per cent of the company's UK work involved providing gearing solutions for the defence industry – nuclear submarines and army land vehicles were a core part of its business – as well as for the oil and gas, mining, rail and conventional power industries. However, demand for David Brown's products and services decreased markedly as the UK and US governments reigned in their defence spending.

The company was then presented with a new opportunity. Four years ago, with little previous experience in the wind industry but a strong reputation for gear technology and innovation, it started to service requests to inspect and repair wind turbine gearboxes. Within a short space of time, it began to develop specialised gearbox products and system upgrades for wind turbines, and in 2009 launched David Brown Windserve, the firm's dedicated wind service business.

For David Brown, the wind sector was at first something of a lifeline and is now a core market for the business. UK orders for the firm's products and services in wind have grown substantially over the last two years, making the company an integral part of the UK wind sector supply chain. Last year it received a £2 million grant from the regional growth fund to invest in a state-of-the-art R&D centre for wind gearbox technologies.

The company is optimistic about the future and is targeting the development of the offshore wind industry in the UK as well as further expansion into overseas wind energy markets (it already has facilities across Europe, China, North America and Australia). Earlier this year, it signed a multimillion pound contract with Samsung Heavy Industries to design an innovative new 7MW wind turbine gearbox that will use lightweight and compact modular architecture to reduce the lifetime costs for turbine operators globally. In addition to wind, David Brown is also developing gear systems for solar, hydro and tidal technologies and is engaged in large-scale commercial installations as well as R&D projects in each of these sectors.

Looking ahead

Clearly, much of the heavy lifting on decarbonisation will need to come from the energy sector if the UK is to meet its long-term emissions reductions ambitions. To this end, many representatives from the sector stressed the need for more clarity and strategic detail on what steps the industry needs to take in order to meet its 2020 targets and longer-term goals. While EMR and future phases of the EU ETS are expected to be at the centre of a post-2020 policy blueprint, participants maintained that government should provide more guidance on what industry should expect. Given the relatively long lead times for infrastructure investment, the sooner a stable post-2020 policy regime is established at

the EU and UK levels, the easier it will be for the industry to plan and deliver the necessary investments. Interim milestones will also be important: a 2030 target to reduce emissions from energy supply, for instance, could help both the energy sector and other industries better manage their timelines and horizons for investment in R&D and infrastructure (EEF 2011, European Commission 2011c). Indeed, industry groups have criticised the failure to include a 2030 energy target in the commission's recent *Energy roadmap 2050* draft communication as a 'missed opportunity' to increase investor certainty in climate change and energy policy.[17]

Participants agreed that while there is a lot of policy affecting the sector, a joined-up, coordinated strategy for energy is still lacking. They noted that while the EU's 2050 roadmap provides the right overarching context and signals for decarbonisation clear and consistent national regulations, targets and delivery policies are also needed – and that relying on the carbon price will not be sufficient to drive investment.

At the same time, participants felt that a more proactive government approach to support RD&D in nascent low-carbon industries – such as wave, tidal, CCS and offshore wind – was critical if these technologies are to be broadly deployed anytime soon. They also suggested that the government and private sector should work more closely together to identify a diverse portfolio of low-carbon energy technologies that will feature in the UK's long-term energy mix. These technologies should be consistent with the country's natural strengths and resources and stand out as areas in which a competitive advantage could be developed. Possible barriers to development and deployment should also be mapped out and appropriate steps taken to address them. Given that government funds are currently limited, there may be a rationale for greater EU coordination of strategic R&D investments (for instance, by pooling member state resources and collaborating in areas of mutual interest such as CCS research and demonstration projects) rather than having individual member states conduct relatively small and overlapping R&D initiatives. Pooling investments (and the sharing of risk that it implies) may also increase the attractiveness of projects to private sector investors.

2.2 Transport

The domestic transport sector accounts for 21 per cent of UK emissions. After rising steadily between 1990 and 2007, aggregate emissions from this sector have stabilised as a result of the recession, improvements in vehicle fuel efficiency and the increasing use of biofuels. In 2009, road transport accounted for 91 per cent of total domestic transport emissions, while rail accounted for 3 per cent, and domestic aviation and shipping together made up 5 per cent of emissions (DECC 2011b). International aviation and shipping – to and from the UK – have a far larger footprint, however, which is expected to rise. According to the CCC, if no action is taken, emissions from UK international and domestic aviation could account for 35 per cent of the total UK's allowable emissions by 2050.[18] It also predicts that UK international shipping emissions will grow by up to 18 $MtCO_2$ and by 2050 could account for 11 per cent of total allowed emissions under the UK's proposed carbon budgets.[19]

The domestic transport sector is covered by a number of mode-specific policies, the most comprehensive of which relate to road transport. The automotive sector is subject to a series of EU fuel efficiency standards, including a mandatory target to achieve a fleet

17 http://www.euractiv.com/energy/eu-energy-roadmap-2050-seen-missed-opportunity-news-509750
18 http://www.theccc.org.uk/sectors/aviation
19 http://www.theccc.org.uk/sectors/shipping

average of 130g CO_2/km[20] for all new cars registered in the EU by 2015, falling to 95g CO_2/km by 2020. The European Commission is currently assessing the feasibility of a 70g CO_2/km target by 2025, while similar targets have been set for newly registered vans. While the UK has to comply with emissions standards set at the EU level, it has also introduced its own complementary policies to incentivise the uptake of low-carbon vehicles. These measures include a plug-in car grant scheme, which offers motorists up to £5,000 for the purchase of cars with tailpipe emissions of 75g CO_2/km or less. A similar grant has been created to encourage the purchase of ultra-low emissions vans (HM Treasury 2010a).

Two key EU policies are worth mentioning. First, under the 2009 renewable energy directive, fuel suppliers are required to source 10 per cent of their transport fuel from renewable sources (although this policy has been met with controversy due to concerns over unsustainable biofuel cultivation). Second, the aviation sector was brought into the EU ETS on 1 January 2012, which requires carriers to purchase emissions permits from April 2013. Under the European Commission's recent *Roadmap to a single European transport area* white paper (2011d), the aviation sector will be expected to source 40 per cent of its fuels from low-carbon sources by 2050. This requirement forms part of a vision to reduce EU-wide transport carbon emissions by 60 per cent by 2050. In addition, the previous Labour government set a UK-specific target to reduce CO_2 emissions from UK aviation to 2005 levels by 2050.[21]

Decarbonisation of the rail sector is largely subject to domestic policy and is being conducted through the electrification of the rail line – with £1.4 billion set aside by the current government (DECC 2011b) – and industry efforts to reduce traction energy. The shipping and maritime sectors do not currently have EU or domestic targets or policies to curb emissions.[22] However, the International Maritime Organization (IMO) recently brokered an industry agreement to introduce an energy efficiency design index, which sets energy-efficiency standards for all new ships weighing 400 tonnes or more. It will come into force in 2013.[23]

Perspectives on policy

Representatives from each of the main transport sub-sectors consulted – automotive, aviation, maritime and rail – were broadly supportive of EU and UK ambitions to decarbonise the transport industry. In terms of road transport, participants viewed the EU's fuel emissions standards for car and van fleets favourably. There was a general feeling that the 2015 targets (130g CO_2/km) will be 'universally met' by the industry[24] and several representatives from the automotive industry indicated that they were confident in their ability to meet the 95g target by 2020. What is more, participants suggested that aggressive EU standards were a critical – if not the primary – driver behind innovation in modern combustion engine design. Prior to the EU's mandatory targets, a voluntary sectoral agreement – between a number of national automotive industry associations inside and outside of Europe – was struck, but several countries failed to meet the target

20 The EC had originally aspired for a 120kg target by 2012, but this was considered unfeasible due to the late implementation of the legislation.

21 http://www.theccc.org.uk/sectors/aviation

22 However, the 2008 Climate Change Act requires a decision to be made on international shipping emissions by the end of 2012 and the CCC have stated that it is crucial for international shipping targets to be included in the 2050 80 per cent target.

23 See http://www.imo.org/MediaCentre/PressBriefings/Pages/42-mepc-ghg.aspx

24 Volkswagen recently announced it would overreach the 2015 target by 10g, despite being initially hostile to the regulation: http://www.euractiv.com/climate-environment/vws-turn-co2-emissions-shows-green-revamp-news-511331.

(Oberthur and Kelly 2008). The disappointment of this initiative effectively paved the way for the current EU-wide regulatory approach, a transition that potentially provides lessons for other internationally traded sectors that are looking to bridge the gap between minimal regulatory oversight and mandatory industry standards.

Participants from the transport sector generally considered the 2020 targets for the UK to be a step in the right direction, but thought that longer-term targets (for example, to 2050) needed more clarity and strategic detail to guide industry on the technological steps needed to reach these targets – a point that energy sector executives also raised. This issue was particularly important for aviation and maritime representatives, who pointed out that it took longer to design, manufacture and commercially deploy major new technologies than in other, less capital-intensive sectors like automotive. Usually, these industries operate on a 20–30 year investment schedule for 'game-changing' technological innovations.[25]

The decision to include aviation in the EU ETS has generated significant controversy in recent months – China, the US, India, Russia and other countries have questioned its legality[26] under international aviation law and have warned of retaliatory measures (Spence 2011, Chaffin 2012a). There are fears that aviation manufacturing exports could be harmed as a result. Airbus recently revealed that China has placed $14 billion worth of orders for long-haul jets on hold because of the dispute. Representatives from the sector claimed that their inclusion in the scheme was unnecessary to some degree, given that high fuel costs incentivise them to reduce emissions and invest in efficient aircraft design and research. They did, however, state that inclusion in the EU ETS was 'an inevitable occurrence', given that many other transport sectors were already subject to emissions reduction policies. Some analysts have suggested that airlines are likely pass the costs of participating in the scheme onto passengers (Malina et al 2012).

As the majority of shipping emissions come from international shipping, participants asserted that a global sectoral emissions reduction target would be the best way forward for the industry.[27] The IMO has been working on this, but progress has been slow, not least because the IMO's principle of equal treatment is viewed by some developing countries as contravening the United Nation's principle of 'common but different responsibilities', which states that industrialised countries must take the lead in reducing emissions and help developing countries limit their own emissions.[28]

Barriers and opportunities

Participants identified a number of opportunities for further decarbonisation of the transport sector, and anticipated future progress in the automotive, aviation and shipping sectors. They also highlighted opportunities for modal shift and changes to consumer transport behaviour. Promoting eco-driving,[29] car sharing and public transport were all deemed important areas of opportunity in which policy could play a greater role.

25 It is important to note, however, that the current economic outlook and financial constraints are shortening many manufacturers' investment horizons, with businesses increasingly looking for immediate or short-term returns. For more information, see the section on manufacturing below.

26 In contrast, the European Court of Justice has ruled in favour of the scheme and found that it complied both with the principles of customary international law and the 2007 Open Skies Agreement between EU and US airlines: http://atwonline.com/international-aviation-regulation/news/ecj-including-aviation-eu-ets-legal-1221

27 This view was also shared by aviation industry executives.

28 See http://unfccc.int/files/methods_and_science/emissions_from_intl_transport/application/pdf/imo_awg-lca_8_submission.pdf

29 'Eco-driving' is a cost-free way to reduce vehicle emissions and combines a number of operational techniques, such as driving smoothly, changing gear earlier, sticking to speed limits and turning the engine off when stuck

Decarbonisation of the transport sector will also help the UK economy. More so than in the other roundtable discussions, participants were optimistic about the significant growth potential and comparative advantage that could be accrued by developing and deploying low-carbon technologies in this sector – as well as the emissions reductions that would result.

Opportunities have already started to flow to Europe as a result of low-carbon transport policies. According to sector representatives, mandatory fuel efficiency regulations have benefited the global competitiveness of the EU and UK automotive industries since other nations, such as the US and China, have now started to implement their own emissions standards. Not only will other countries have to enhance their own standards if they are to sell into the European market, but participants agreed that EU manufacturers are now in a good position to sell into overseas markets as demand for more fuel efficient vehicles increases. Gaining this so-called first-mover advantage could deliver competitive benefits for the EU and the UK and improve the UK's export position.

A commitment to innovation – fostered by the correct regulatory environment, incentives and standards – has been a key ingredient in the success of the UK car industry. It is also an important feature of other sectors such as aviation. For instance, Rolls-Royce, one of the UK's leading manufacturers of aircraft engines, attributes much of its success to its extensive innovation programmes. By working in partnership with other industry players, it is driving down emissions from its products (see box 2.2). Providing the right conditions for innovation is also helping to create new breakthrough technologies that have the potential to radically transform existing markets. Several participants mentioned hydrogen fuel cells as a technology in which the UK is rapidly developing world-leading expertise. Two UK firms, Acal Energy and ITM Power, were recently reported to be working with a Japanese car manufacturer to bring a new low-cost hydrogen fuel cell to the market. This market is predicted to be worth $1 billion in the UK and $26 billion globally by 2020, and up to $19 billion in the UK and $180 billion globally by 2050.[30]

However, technological barriers do remain, even for the most innovative sectors. Several automotive representatives suggested that while the 90g CO_2/km target for 2020 was achievable, there is a limit to the emissions reduction potential of conventional combustion engines (although advances in lightweight engines and vehicle parts were continuing to improve emissions performance). In the aviation sector, many representatives agreed that although liquid biofuels have been used in some demonstration flights, major technological breakthroughs are needed if the sector is to significantly reduce its dependence on kerosene to power commercial aircraft.

Specific barriers were also identified in relation to demand for electric vehicles (EVs). Despite government efforts to stimulate the EV market, relatively high upfront costs, technology features and lower residual value (due to uncertainties over battery life) were identified as potential barriers to uptake. As a result, several participants were sceptical about the 'EV race'. A lack of charging infrastructure has also been identified as a key barrier to further growth in the EV market. In London, for example, this has led to slow uptake with only 2,313 EVs registered, leaving the city some way off meeting its target of 100,000 EVs on London's roads by 2020 (London Assembly Environment Committee 2012). Participants suggested that more could be done to encourage the private sector – such as supermarket chains and airports – to invest in EV charging infrastructure.

in traffic. The Automobile Association claims it can save up to 10 per cent on an average weekly fuel bill.

30 http://www.ft.com/cms/s/0/750ca820-5631-11e1-8dfa-00144feabdc0.html

Box 2.2: Rolls-Royce

Rolls-Royce is one of the UK's best-known companies and has a strong position in civil and defence aviation, as well as the marine and energy markets. The company is renowned for producing high-performance engine systems and has a far-reaching customer base, which includes over 500 airlines and 4,000 corporate and utility aircraft and helicopter operators worldwide. At any one time, 200,000 people are reportedly flying in a Rolls-Royce powered aircraft.

In order to remain globally competitive and provide the best technology possible, Rolls-Royce is in constant pursuit of innovation. The company invests approximately £900 million in R&D each year, of which a significant proportion is directed towards improving the environmental standards of its products. It is currently running a number of technology programmes aimed at reducing CO_2 and nitrogen oxides from Rolls-Royce's two- and three-shaft engines by targeting improvements in combustor technology, turbine efficiency and pressure compressors, as well as developing highly efficient lightweight composite fans.

These R&D programmes operate in three stages – strategic research, applied research and technology validation – and their time horizon is usually 20 years. Past technology programmes have met with success. The company's signature Trent 1000 engine is reputedly the most efficient engine in service today, while the new Trent XWB is 16 per cent more fuel efficient than the company's first Trent engine.

Collaborative innovation is a key part of Rolls-Royce's approach to R&D. The company is a lead partner in the Advisory Council for Aviation Research and Innovation in Europe, which aims to reduce aircraft CO_2 emissions by 75 per cent per passenger kilometre by 2050 relative to 2000 levels (European Commission 2011f). As part of this initiative, Rolls-Royce and partners – including Airbus S.A.S. and a number of European airlines – are collaborating on the development of 'game-changing' technologies such as the open rotor engine, which has the potential to reduce emissions by 10 per cent compared to the best turbofan technology. It is also working with British Airways to develop and test alternative aviation fuels.

Rolls-Royce has also invested in more energy-efficient buildings and made improvements in its manufacturing technology to reduce its facilities' energy consumption and emissions. The company's total energy usage has fallen by one-third over the last 12 years, a period in which it has more than doubled in size.

Another potential barrier facing the lower-carbon vehicle market is the lack of tax harmonisation on vehicles – and therefore a *de facto* variation in carbon price – across EU member states. Because the type and range of vehicle taxation associated with CO_2 emissions vary substantially from country to country (for example, vehicles purchased in the UK are subject to a suite of fiscal arrangements including vehicle excise duty (VED)[31] while France operates a *bonus malus* system[32]), the same car model can effectively be taxed at different rates in different countries. One participant suggested that a move

31 VED taxes a vehicle's owner based on the amount of grams of CO_2 per km his or her vehicle emits.

32 Vehicles purchased in France are either subject to additional tax (*malus*) or are financially rewarded (*bonus*) depending on whether their CO_2 emissions are above or below certain thresholds.

towards vehicle tax harmonisation would help reduce transaction costs to manufacturers and was in the spirit of completing the single market. Addressing this issue, however, is a huge political challenge since taxation policy is largely the preserve of member states.[33] Another participant suggested that intra-governmental difficulties may arise in the future as greater uptake of EVs and hybrids – as promoted by the Department for Transport and the Department of Energy and Climate Change (DECC) – is likely to reduce the amount of VED the Treasury is able to raise.

Many automotive manufacturers pointed to skills gaps and difficulties in recruiting new talent. Participants suggested that schools and universities should focus more on science, technology, engineering and maths subjects, and noted that more qualified technician-level engineers with sector-specific experience are needed. There was also a strong sense that current immigration policy is hampering the UK's ability to attract world-class graduates and technicians to work in the UK-based R&D facilities of several global car manufacturers. Access to finance was also raised as a problem facing smaller suppliers in the sector, a point that is addressed below.

Looking ahead

Many representatives in the transport sector asserted that a clearer policy framework for long-term decarbonisation is needed. While many welcomed the proposals in the European Commission's transport white paper (2011d) for their ambition, participants in general thought that 'current policies will only get us a third of the way to where we want to be' by 2050.

Participants maintained that far more integration is needed between the energy and transport sectors to secure a low-carbon future for transport, particularly with respect to electrification. One participant argued that EVs would be largely pointless in terms of reducing emissions if electricity continues to be sourced mainly from high-carbon energy. The independent advisory group to the EU's energy roadmap 2050 has echoed this view and called on the commission to integrate the transport and energy roadmaps[34] and include 'explicit modelling of the consequences of the electrification of transport for the electricity and gas sectors'.

Several representatives of the automotive sector suggested that, in addition to policy, a clearer strategic sense was needed from government about the envisaged long-term technology mix. There was a general sense that a suite of existing technologies – including combustion engines but also EVs, plug-in hybrids and emerging technologies such as hydrogen vehicles – will be required to meet planned carbon reductions in the future.

Participants agreed that an industrial strategy for individual transport sectors was important in this regard. One transport representative pointed to the work of the Automotive Council. Established in December 2009, this organisation convenes leading industry representatives and academics in an ongoing strategic dialogue with policymakers to support growth, investment and innovation in the industry. It is currently developing a series of technology roadmaps for low-carbon vehicles and fuels, which will help individual manufacturers prioritise the development of particular technologies that suit their brand values and market sectors (Jackson 2010). A number of participants advocated the possibility of replicating this model in other transport sectors, such as aviation.

33 Another option for harmonising the price for transport emissions is to integrate oil fuels, including transport fuels, into a cap-and-trade scheme. The Potsdam Institute argue that this approach could complement existing technical standards and provide a consistent pricing approach to all CO_2 sources across different sectors in Europe if it is integrated with the EU ETS (Creutzig et al 2011).

34 See European Commission (2011b: 4).

Participants concluded that the current level of government R&D support and policy to foster innovation across the different modes of transport was positive, but maintained that more could be done. Representatives from the aviation sector suggested that government incentives and procurement were needed to foster the commercialisation of sustainable drop-in fuels, and pointed out that the US was making great strides in this area, primarily as a result of military procurement. A representative from the shipping industry raised concerns about the lack of government technological support for the sector relative to other transport modes.

Despite the focus on technology, some participants questioned whether meeting the transport sector's ambitious decarbonisation targets could be done through technology alone. They thought policies to encourage modal shift – so that individuals choose alternative, less polluting modes of transport (including public transport) as a matter of preference– and demand management will also be important.

2.3 The role of manufacturing

A thriving manufacturing sector is key to the UK's low-carbon ambition, which presents significant opportunities for British firms to innovate, develop and deploy energy-efficient and low-carbon technologies and produce low-carbon goods. While this paper has touched on the role of manufacturing in supplying products for the energy and transport sectors in the previous two sections, these are not the only areas of manufacturing that are affected by – or that stand to gain from – the low-carbon transition.

In fact, several different categories[35] of manufacturers are relevant to this debate. On the one hand, the UK is home to established and emerging clean-tech firms that are developing low-carbon technologies for domestic and export markets. These companies supply products primarily for the clean-energy and low-carbon transport markets, as well as other emerging sectors such as recycling, low-carbon agriculture and waste.

Then there are the rest: namely, manufacturers that are not typically engaged in clean-tech markets (although many are increasingly exploring opportunities in this field) – from pharmaceuticals to electronics to precision machinery – but nonetheless have an important role to play in the low-carbon economy. With the size of manufacturing in the UK estimated at £140 billion in gross value added in 2009 (BIS 2010) and growing by approximately 1 per cent per annum, this group of manufacturers is expected to curb their emissions and produce lower-carbon goods. Many firms are also finding opportunities to access supply chains for new low-carbon technologies. For some manufacturers the transition poses challenges in areas such as R&D and product and process innovation. At the same time, the rising cost of energy provides incentives to find more energy-efficient methods of operation. Other manufacturers are interested in change but are not doing much to harness the opportunities, for reasons explored below.

According to DECC, manufacturing and process industries accounted for 23 per cent of the UK's total emissions in 2009 (DECC 2011b). Significant progress on carbon has been made since 1990; emissions have fallen by approximately 46 per cent (ibid), due in part to energy-efficiency measures but also because of overall improvements in manufacturing productivity over this period. Although UK production is gradually becoming more concentrated in areas with relatively low emissions (such as advanced manufacturing), increasing the size of manufacturing – an explicit aim of the government – is likely to increase energy usage, emissions (and therefore costs) unless steps are taken in response.

35 There is of course significant overlap between these groupings.

A number of policies to reduce emissions affect the manufacturing sector. The climate change levy (CCL)[36] covers all manufacturers, while some are also subject to the CRC energy efficiency scheme, although this is primarily aimed at non-energy-intensive private and public sector organisations. Larger energy-intensive manufacturing industries are covered by the EU ETS[37] and can also negotiate climate change agreements (CCAs), which are discounts on the CCL agreed by DECC with sector associations or individual facilities. Given the importance of energy-intensive industries to these debates, they are discussed in a separate section below.

Perspectives on policy

Understandably, many clean-tech manufacturing representatives spoke positively about the EU and UK policy vision for decarbonisation. In contrast, many representatives from other manufacturing sectors had mixed views on how the industry was coping with climate change policies. Beyond this, there was a general sense that government rhetoric towards manufacturing had improved over the last few years, but participants stressed the need to back up this rhetoric with action.

Uncertainty about government policy on climate change is a particular worry for manufacturers. Participants singled out the CRC scheme in this regard. Initially this was an incentive-based policy that sought to recycle revenue to businesses that performed well in a carbon reduction performance league table. But in the 2010 autumn statement, the government announced that revenues would instead be passed on to the exchequer (HM Treasury 2010b). This change disappointed manufacturers, which now perceive the scheme as little more than a stealth tax – and one that comes at significant administrative expense. The chancellor has since indicated in the 2012 budget that the CRC will be reformed to alleviate administrative costs on businesses, and unless significant progress is made, the scheme will be scrapped (HM Treasury 2012).

Several executives at our manufacturer's roundtable claimed their companies were keen to become more energy independent by installing solar panels at their facilities, but were put off by changes to FITs. Another UK manufacturer selling precision technologies to the solar industry pointed to a reduction in sales as a result of changes to the FIT. Participants criticised such unpredictable changes to policy, which undermine business confidence in policymakers and create investor uncertainty.

Policy at the EU level was also criticised, with many suggesting that EU policymakers give the impression that they are unaware of how their decisions affect businesses on the ground. Regulation and policy directives were described as 'often complex and inconsistent'; one participant was particularly concerned about what they interpreted as an unnecessary overlap between the EU ETS (which, they argued, was created to improve companies' energy efficiency) and the proposed energy efficiency directive. Furthermore, one interviewee claimed that the complexity of existing EU and UK policies (CCAs, CCL, CRC and EU ETS) raises the risk of 'double counting', whereby a manufacturer may be charged under different policies for emitting the same amount of carbon.

Nevertheless, participants considered EU legislation to be important for setting standards that drive manufacturing innovation (participants from the transport and energy sectors

36 The CCL is a tax on the consumption of fossil energy (and some renewables such as hydro power) by industry, business and the public sector. The levy is applied to the transport and energy sectors and to domestic energy use.

37 In principle, manufacturers that are covered by the EU ETS do not have to participate in the CRC, although in practice there is some overlap with some manufacturers affected by both.

expressed similar sentiments) and creating a harmonised market for products across member states, which helps to reduce costs and support free trade. Yet, although many agreed that policy implementation should be left predominantly to member states, there was a sense that EU directives are often inconsistently applied from one country to the next.

The vast majority of manufacturing executives interviewed for this study were unaware of the long-term vision set out in the various EU 2050 roadmaps. This uncertainty could reflect the increasingly short-term perspective within which many manufacturers, particularly small and medium-sized companies, are operating as economic uncertainty and financial constraints are putting a brake on longer-term investment decisions. In principle, however, participants supported long-term roadmaps that drive decarbonisation by providing policy direction and milestones that businesses can work towards. They also considered mid-term targets (to 2030) to be important, not least for providing greater clarity and consistency with current investment timeframes – a point that was reiterated in discussions with energy sector (above) and energy-intensive sector executives (below).

Barriers and opportunities

The low-carbon transition presents UK manufacturers with opportunities to innovate and develop greener products across a whole range of sectors, not just energy and transport. At the same time, rising energy prices and carbon regulations are spurring many manufacturers to reduce costs by improving the energy efficiency of their plants, production lines and supply chains. In time, these changes could potentially help improve the cost competiveness of UK manufacturing. But in the short term, it also brings significant challenges.

For many companies, cost is a significant concern: it is both a barrier to decarbonisation and a challenge to manufacturing competitiveness. A number of executives from smaller firms claimed they were increasingly taking a short-term view on investment decisions, with some stating their predominant concern at present is 'survival'. Where capital is available, it is typically being channelled into areas that provide certain and relatively swift returns (such as replacing existing equipment) as opposed to low-carbon technologies which are typically characterised by high upfront capital costs and typically longer-term returns. Even for those companies expressing a desire to invest in energy-saving measures, the rise in energy costs was described as 'not easy to absorb' and an increasing strain on competitiveness (as much as 4–5 per cent of monthly expenditure for some small and medium-sized enterprises (SMEs), up from approximately 1–2 per cent a few years ago).

Several supply-side issues are holding back progress. Access to finance has been one of the main barriers to low-carbon investment, particularly for smaller companies that lack the capital to fund clean-energy projects or invest in new efficient equipment. One participant claimed that they had 'solid, low-carbon plans' that were ready to be implemented, but banks were simply unwilling to lend to them. As a result, these plans kept being postponed. Another manufacturer suggested that his company was looking to retrofit its main UK factory, but pointed to the high cost of insulation materials, the lack of available finance and policy disincentives.

Indeed, the recent trajectory of government policy is not helping. Participants identified the Treasury's decision to cut capital allowances as a particularly retrograde step that jeopardises manufacturing investment. Although enhanced capital allowances (ECAs) which enable businesses to claim 100 per cent in capital allowances for the first year only on a limited range of energy-saving plants and machinery are still being offered, these

will only benefit a small pool of manufacturers. In addition, participants described the procedure for qualifying new technologies for ECA as complex and bureaucratic. As a result, businesses that wish to invest in energy-efficient equipment that is not currently ECA eligible may struggle to persuade the technology manufacturer to apply for eligibility – and will therefore miss out.[38] The abolition of regional development agencies and the minimal funding allocated to local enterprise partnerships (which in turn have limited revenue raising powers) have also reduced the amount of capital available to manufacturers. Several SME manufacturers claimed that the decision-making process involved with grant applications for capital funding took too long. In addition, some participants criticised enterprise zones and instead thought that tax incentives should be offered to businesses that could most effectively use the money, regardless of where they are located.

Lack of finance is a particular problem for mid-stage manufacturers that do not yet have commercially ready products (and therefore lack sufficient revenue with which to invest). Several industry representatives claimed that the limited public funds available to support manufacturers were either targeted at larger, established technology firms that are already profitable (through initiatives such as the regional growth fund), or used as seed or start-up finance to support very early-stage companies and promising university initiatives. Mid-stage companies are struggling to secure funds, particularly equity finance – a problem that has been exacerbated by the decline in venture capital finance and moves by banks to shed their private equity divisions since the recession began.[39] As a result, some mid-stage technology companies – such as Ceres Power, a UK fuel cell manufacturer – are considering opportunities for commercial venturing with established corporations in their sector. At present, however, there are limited incentives for major companies to take part in these ventures (see box 2.3).

Box 2.3: Ceres Power

Ceres Power is a small, UK-based low-carbon technology manufacturer that is developing innovative fuel cell technology, primarily for use in small-scale combined heat and power (CHP) systems. Founded in May 2001 as a spin-off from Imperial College London, the company has designed and built a mass manufacturable technology platform, known as the fuel cell module, which uses the firm's patented solid oxide fuel cell.

The technology has the potential to revolutionise the energy grid and bring fuel cell technology to the household level. Stationary power generation products based on fuel cells have been selling in niche markets for years, but most are designed for use in larger facilities (with outputs typically in the tens or even hundreds of kWs). Using Ceres Power's technology, a typical home needing approximately 1kW of energy could be powered year round by replacing the existing gas boiler with a simple wall-mounted 'micro CHP' fuel cell unit. The benefits are potentially huge:

38 This issue is particularly problematic if an equipment manufacturer is based overseas. More broadly, although ECAs are welcome, they are less visible than the overall cuts to the capital allowance regime, which is generally dissuading manufacturers from investing. As one participant at our roundtable put it, in the current economic climate 'anything that is not an incentive is a disincentive to invest'.

39 Several manufacturing representatives, and a number of investors we consulted, suggested that regulations proposed under Basel III and the Vickers commission will further damage the funding environment for mid-sized businesses because in order to achieve capital ratios, banks are likely to pay down their balance sheets by taking on fewer new liabilities, targeting longer-term projects with higher investment risks first.

BOXED TEXT CONTINUED

the technology's low heat-to-power ratio and unique load-following ability means it uses far less fuel than conventional centralised power plants, which would significantly reduce household energy costs and carbon emissions.

Ceres Power's technology is currently at the pre-commercial stage and the company is aiming for a market launch in 2014. Yet despite its potential (the company identifies an addressable market of 14.5 million households in the UK alone), taking the next leap forward is far from straightforward. In particular, the firm requires a significant injection of capital to finalise product development and scale up its manufacturing.

This capital needs to come via equity finance, since raising debt is not a realistic option at this stage. In November 2004, the company went public on the Alternative Investors Market of the London Stock Exchange in order to raise capital. However, since the onset of the global financial crisis, lower risk tolerance in the markets has made raising additional equity finance significantly more difficult, so the company has decided to examine alternative solutions.

One option is corporate venturing: partnering with a large energy utility or manufacturer would help plug an immediate financing gap and allow Ceres Power to sustain production in the longer term. However, company representatives believe that incentives for corporations to invest in start-ups like Ceres Power are currently limited. Introducing tax incentives for corporate investments in SMEs, together with any capital gains and dividends from these investments, could help stimulate the necessary step-change in corporate investment behaviour.

Nevertheless, a corporation could substantially benefit from taking an equity stake in Ceres Power. Not only would it have access to a new, patented and readily available technology, an investor would also benefit from the company's value-added activities. In particular, Ceres Power's employees have developed a protected intellectual property (IP) platform that contains patents and trademarks for their products, as well as know-how in product design, materials and manufacturing processes. This platform gives it a strong position from which to enter supply chains and market relationships. If and when fuel cell micro CHP takes off, the company will be able to capture a substantial share of this market.

As with representatives from the transport sector, many manufacturing executives pointed to a lack of adequate skills and difficulties recruiting highly qualified workers as a major barrier facing the sector. Many participants asserted that there was a limited pool of talent from which to recruit throughout all manufacturing ranks, from basic electricians to top-level engineers. They claimed that some manufacturing industries were unattractive to graduates and suggested that they found it difficult to attract good apprentices, with the best engineers going into aerospace and mechanics (which may help explain why UK automotive and aviation engine manufacturers are performing relatively well). Participants criticised the Coalition's immigration cap on skilled workers and university graduates from outside the EU as a counterproductive and wholly damaging policy that hinders the manufacturing sector's ability to attract the best possible graduates.

By and large, roundtable executives agreed that innovation and R&D were key to manufacturing growth and harnessing low-carbon opportunities. Participants spoke positively of the work of the TSB as a mechanism to identify and support nascent technologies and innovative energy-saving manufacturing techniques, but asserted that the institution would need more funding to have a real impact (the TSB currently has funds worth £1 billion over four years, until 2015). The same was thought to be true of institutions such as the Energy Technology Institute (see above) and the Green Investment Bank (GIB), which despite receiving £3 billion in initial capital will not be granted full borrowing powers until 2016–2017, and only then if public debt is falling as a percentage of GDP. Participants also called for changes to rules on IP to make it easier for manufacturers to obtain IP rights when they engage in collaborative partnerships with universities – which could it make it easier to attract investment and ensure that high-calibre technologies do not succumb to the 'valley of death'.

Participants asserted that there are significant opportunities to decarbonise supply chains in the manufacturing sector. Some companies have found it to be in their business interest to reduce emissions and energy consumption in their supply chain. JCB, for example, has set up its own integrated carbon and supply chain management programme, which involves gathering information about the carbon and energy footprint of its supply chain, consulting with suppliers on how they could reduce emissions, setting appropriate targets and providing practical assistance on energy and resource efficiency and renewables (see box 2.4). The company has a principally financial rationale for this programme: to limit its supply chain's exposure to rising energy prices and carbon regulatory costs (which suppliers will typically pass on). While this practice is not limited to JCB, it is far from common. Other manufacturers expressed an interest in these sorts of programmes, but noted the difficulties and expense of monitoring their supply chains.

Box 2.4: JCB

JCB is a well-known UK manufacturing business and one of the world's top three producers of construction equipment. It employs 7,000 people across four continents and sells its products in 150 countries worldwide. While technological innovation and investment in R&D to develop cutting-edge machinery has been at the heart of its 64-year history, it has recently demonstrated innovative strategies in the operational side of its business as well.

JCB has sought to reduce the carbon footprint of its production methods and has taken a more holistic view of sustainability issues associated with the resources used during production. Financial and business motivations are behind this change – namely a desire to reduce energy costs and a visible increase in customer demands for more environmentally responsible products. In recent years, the company has invested in solar, wind and renewable heating to power its premises and make it more energy independent. It has also taken steps to downsize its machinery and packaging, enabling it to transport more equipment per load. According to JCB, these measures have reduced the company's direct carbon emissions by 23 per cent since 2007 and have the potential to reduce indirect emissions by a further 16 per cent through its machinery's improved fuel consumption. The Carbon Trust calculated that JCB saved £728,000 in 2009 as a result of implementing energy- and carbon-saving measures.[40]

40 http://www.carbontrust.co.uk/about-carbon-trust/case-studies/large-business/pages/jcb.aspx

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A particular area of interest is JCB's attempts to clean up its supply chain. The company has developed a carbon management programme, and for the last two and a half years has been working with its 800-strong supply chain to find ways to reduce suppliers' energy consumption, improve the efficiency of their operations and curb embedded carbon. Again, the rationale behind the scheme is primarily financial. JCB found that rising energy and commodity prices and carbon-related regulatory costs were increasingly appearing on its suppliers' invoices, and decided that unless action was taken, these costs would continue to be passed on. Hence it has been in the firm's own commercial interest to help its supply chain in this way.

An initial pilot scheme covering six suppliers identified annual savings of over £250,000 and helped reduce emissions by 1,500 tonnes of CO_2 from the previous year. In order to do this, JCB gathered a wide variety of information about the companies in their supply chain, including their energy spend, carbon intensity, turnover and other production costs. They then ranked suppliers in order of risk – which companies were most likely to pass on increases in their own energy bills to JCB. JCB then sent energy consultants and engineers to work with their suppliers and implement management and technical strategies to reduce these risks.

Since the pilot project, JCB has expanded the scheme to cover the rest of its supply chain and has turned down tender responses from suppliers that fail to meet certain criteria for carbon and energy efficiency.

Looking ahead

The vast majority of sector representatives agreed that the UK can be a global leader in new low-carbon technologies. However, they maintained that pursuit of this goal should not come at the expense of manufacturing competitiveness in other areas. Participants noted that it was critical to ensure a balance between both objectives – particularly when uncertainty in the wider economic environment is hitting the sector.

Being more energy and carbon efficient will boost manufacturers' productivity and – in a climate of rising global energy prices – could in the long run potentially help UK firms compete for contracts on a cost, as well as value-added, basis. However, participants thought government could do far more to help manufacturers invest in more energy-efficient equipment and clean sources of energy. Introducing a 'green deal' for manufacturing businesses – mirroring the Coalition's energy-efficiency scheme for homeowners – would be one way to make the UK's plants and production lines more energy efficient and would also give a welcome boost to the UK's construction and retrofitting industry. A pilot phase could target small and medium-sized British manufacturers with the highest energy costs as a proportion of total expenditure. A wider roll-out could then be explored.

Participants also asserted that an industrial strategy to boost low-carbon manufacturing was important. As in other sectors, this would bring government and the private sector together in an ongoing strategic dialogue that would seek to address problems such as access to finance, technology funding gaps, skills shortages and other market barriers. It could also help UK manufacturers capture the growing number of export opportunities for lower-carbon goods. A number of participants cited the need for better export assistance and suggested that the UK Trade and Investment (UKTI) department lacks 'sufficient clout'.

This chimes with previous IPPR research that has argued that the UKTI should be expanded to offer additional financial safeguards to businesses – such as a debt recovery facility – and promote particular sectors via tailored guarantee schemes (Lent and Nash 2011).

At the EU level, many participants maintained that the single market could have a more important role to play in driving up product standards on energy efficiency and boosting manufacturing innovation. They also agreed that consumer demand was important. One participant argued that promoting a wider view of sustainability and emphasising the importance of resource stewardship is more likely than a narrow focus on climate change to influence consumer choices for more sustainable and less polluting products – which would in turn shape manufacturing practices and investment decisions. This broader policy aim could be reflected in new EU product standards and supported by government procurement initiatives for major infrastructure projects.

2.4 Energy-intensive industries

Energy-intensive industries (EIIs) are a sub-group of manufacturing, defined by the European Commission as sectors with energy costs equal to 3 per cent or more of their production costs.[41] They are typically considered to include industries such as steel, cement, aluminium, chemicals, paper and pulp, food and drink, ceramics and glass. Due to their high energy consumption, these industries are particularly at risk from the low-carbon transition.

Carbon emissions from manufacturing industries have fallen in recent years,[42] but still account for approximately one-quarter of UK emissions, with energy-intensive sectors responsible for the lion's share. According to the government, the heat generated for industrial processing of materials such as steel and ceramics accounts for approximately 80 per cent of these emissions, while the remainder is produced by chemical reactions during the production processes for materials such as cement and steel. Both the government and the CCC envisage large reductions in industrial emissions of up to 70 per cent if the UK is to meet its 2050 target. According to DECC, such a reduction would require these industries to reduce their energy demand by 25 per cent and energy intensity by up to 40 per cent through fuel switching, efficiency savings and use of CCS technologies (DECC 2011b).

The scale of this challenge should not be underestimated. The majority of energy-intensive industries have locked-in business models that are difficult to alter due to the high levels of energy required in the production process. As a result, they are particularly vulnerable to rising energy prices, and as globally traded sectors their competitiveness is at risk – especially if the cost of energy continues to exceed that faced by their competitors overseas. Although UK climate change policies currently account for a relatively small proportion of the overall energy costs of a typical energy-intensive facility, these are projected to rise, which is likely to increase the potential for 'carbon leakage' – the process whereby industry plants (and therefore jobs) are offshored to jurisdictions with less stringent carbon reduction regimes (see box 2.5).

The UK government and the EU recognise these risks and have sought to ease the pressure on energy-intensive firms through the free allocation of EU ETS allowances and the use of CCAs to provide relief – currently 65 per cent – on the climate change levy. Organisations

41 EU Directive 2006/32/EC. It is worth noting that the European Commission's definition would suggest that the number of energy-intensive industries is likely to be increasing year on year as energy costs increase.

42 By an average of 1.3 per cent each year since 1990 (DECC 2011b).

such as the Confederation of British Industry (CBI) have called for additional measures, and have argued that failing to secure the future of these industries may force the UK to begin importing goods at a time when exports are vital to the recovery (CBI 2011).

Box 2.5: Carbon leakage

'Carbon leakage' occurs when emissions targets set at the regional or national level create an uneven playing field between companies in one jurisdiction that have a cost imposed on them for emitting carbon and companies in other jurisdictions that do not. In theory, this can negatively affect the competitiveness of affected companies and can potentially cause them either to move plants to less carbon-regulated countries or transfer production to companies outside the regulated country or region. Either of these outcomes could cost domestic jobs, lead to an increase in imports and reduce the effectiveness of domestic climate change policies (European Commission 2010b).

Energy-intensive industries in the UK, such as steel, aluminium and cement, have been identified as being particularly vulnerable to carbon leakage, and could therefore become less competitive than their European counterparts as well as other global competitors in the future. It is important to remember, however, that climate change and energy policy costs are one in a series of costs to doing business in the UK. The CBI (2011) and Waters Wye Associates (2010) have drawn attention to the cumulative impact of soaring wholesale energy prices, unilateral climate change policies – such as the proposed carbon price floor – and the poor economic environment on energy-intensive industries based in the UK. However, other factors also affect business competitiveness and can determine where firms choose to locate, including labour costs, profit margins and demand growth (Summerton 2010). Transportation costs and barriers also affect investment decisions, and for some industries will significantly reduce the risk of carbon leakage: ready-mixed concrete, for instance, is best produced in close proximity to the end user because it has a low value-to-weight ratio and is highly perishable.

What is more, the costs attributed to climate change policies and regulations as a proportion of total energy costs facing energy-intensive industries are still relatively small. Figures taken from DECC (2011a: 72) suggest that a typical energy-intensive business consuming 100,000MWh of electricity would have incurred an average electricity bill of between £9.75 and £10.20 million in 2011, of which between 7.5 and 11.6 per cent would have been attributable to climate change and energy policies. Nevertheless, these costs are projected to increase. DECC estimates that the average electricity bill of an energy-intensive user consuming 100,000MWh of electricity will rise to £10.31–12.22 million in 2020 and £12.78–14.17 million in 2030. Of these totals, between 2.4 and 17.7 per cent of the average energy-intensive user's electricity bill will be attributable to climate change policies in 2020 and between 18.6 and 26.6 per cent in 2030.[43]

43 The estimated impact of climate policies on the average gas bill paid by a typical EEI is also expected to rise in proportional terms, but only slightly. DECC (2011b: 71) calculates the average gas bill in 2011 for an average EEI consuming 100,000 MWh of gas to be £2.84 million, rising to £3.33 million in 2020 and £3.55 million in 2030. Of this, -0.7 per cent is attributable to climate policies in 2011 (due to CCA relief outweighing the cost of the CCL), 1.8 per cent in 2020 and 2 per cent in 2030. The majority of the bill in each year is attributed to wholesale gas costs.

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Based on these estimates, the risk of carbon leakage is therefore likely to be an increasing problem for the UK in the future and could affect investment decisions – particularly those of globally operating energy-intensive businesses – as long as climate policies and regulations remain weak or non-existent elsewhere, and unless steps are taken to mitigate the costs on energy-intensive industries.

Perspectives on policy

Although the industry representatives that we consulted – including company executives and trade associations representing the sub-sectors outlined above – were sympathetic to the need to reduce carbon emissions, many were deeply concerned about how UK and EU ambitions and policy prescriptions might affect business in the absence of international agreements to reduce carbon emissions.

While the majority of participants reiterated their desire to remain in the UK, they feared that the cumulative impact of rising energy prices, regulatory costs and the poor economic climate are damaging business competitiveness. One participant suggested that, in the future, industries may 'follow the path of least resistance' and potentially explore opportunities to build new plants outside the UK and Europe, where the cumulative costs of business are lower. Participants also feared that this combination of costs could affect inward investment to the UK for manufacturing. Others acknowledged, however, that transportation is a factor that affects investment decisions – certain products, such as concrete, need to be produced in close proximity to market.

In terms of EU policy, participants agreed in principle that the EU ETS is an important way to reduce emissions. Participants acknowledged that energy-intensive industries have benefited from free allowances and that these industries will be entitled to roll over some of their leftover allowances into phase III of the scheme. However, some participants were confused about the aims of the scheme. The majority suggested that the original objective was purely to deliver cost-effective emissions reductions over time, while others argued that the EU ETS is also intended to be a mechanism to drive low-carbon investment. Participants maintained that these two objectives may not necessarily be compatible.

Some industry representatives criticised the EU ETS for its low carbon price and suggested that a persistently low price threatened the EU's long-term decarbonisation objectives and reduced investor confidence. However, others were hesitant about political interference in the market. The UK's carbon price floor – which is set to come into effect in 2013 – was strongly criticised. Participants argued that such a unilateral move would distort the ETS market and put UK businesses at a further disadvantage, relative to both their international and European competitors. A recent IPPR report showed that the policy would also do little to reduce emissions and was unlikely to enhance investor certainty, given its flawed design: the possibility of having two separate carbon prices could give contradictory signals to investors (Maxwell 2011). Some participants instead favoured adoption of an EU-wide carbon price floor, which would level the playing field at the EU level and provide stronger investment signals. Others remained concerned about the additional costs that an EU floor price could place on European industry.

EII representatives were more united in their views on the overarching policy framework. Many complained about a 'serious policy overlap' between the CCL, CCAs, EU ETS[44] (and in some cases the CRC), and were unhappy about the complexity of these policies. They noted that the disjointed and complex policy landscape poses additional administrative costs on businesses – which the Chancellor acknowledged in his recent budget – and could lead to double counting of emissions. In addition, participants criticised current policy as being heavily skewed towards negative incentives and lacking in sufficient positive incentives to encourage energy-saving measures and low-carbon innovation; this was said to have a detrimental affect on industry's acceptance of the low-carbon agenda. Participants asserted that without additional policy 'carrots', the scope for industry action on emissions reduction is limited. One industry executive drew attention to the clean development mechanism, which financially credits industries in developing countries for reducing their industrial process emissions and switching fuels and lamented the fact that similar mechanisms do not exist in the UK and Europe.

Climate change agreements could be deemed a dual 'carrot and stick' approach, because industries are only eligible for CCL relief if they meet certain agreed energy-efficiency and emission-reduction targets. While several participants spoke favourably of this approach, they expressed dismay that CCL relief had been cut from 80 per cent to 65 per cent. While many welcomed George Osborne's decision to bring in a higher (90 per cent) rate in 2013 for electricity (although gas will remain at 65 per cent) – as well as the additional one-off £250 million rebate for energy-intensive businesses announced in the 2011 autumn statement – participants thought that this should happen sooner. Others suggested it was difficult to keep track of the constant changes to the rate of CCL relief, which adds to business uncertainty.

The relative lack of policy support for industry in the UK was contrasted with other European countries. Germany, for instance, provides a 98.5 per cent rebate to its most energy-intensive companies through its renewable energy levy, which has helped German companies remain competitive relative to their European counterparts and strong in export markets.[45] This rebate is provided despite the fact that energy prices for German energy-intensive industries are approximately 10 per cent lower than for UK industries, and are expected to be some 15 per cent lower in 2013 following the introduction of the UK's carbon floor price. Although raising the rate of CCA relief in 2013 will go some way to ensuring parity of energy costs with German industries, UK firms are still likely to be at a disadvantage.

While EII representatives considered the EU's 2050 goals to be highly challenging, they generally supported the need for long-term decarbonisation targets. Some participants suggested that although it would be 'at least two investment cycles' until the 2050 targets would be fully factored into business plans, this would come about quicker than expected.[46] In order to best plan capital-intensive investments, participants agreed that energy-intensive industries require a clear sense of the policy trajectory until then. This understanding will be particularly important for breakthrough technologies, which would require investment now in sectors such as paper and pulp in order to be 'market ready' within the next two decades if they are to be incorporated into normal investment cycles in time for 2050 (see CEPI 2011). Once again this points to the importance of medium-term milestones for decarbonisation – such as 2030 targets – and planning ahead for a post-2020 policy regime.

44 Overlap between CCAs and the EU ETS will be less likely from 2013, as newly agreed CCAs will not include energy that is covered by the ETS.

45 See http://www.eef.org.uk/releases/uk/2011/Climate-change-policy-making-UK-energy-prices-uncompetitive-.htm

46 Others welcomed the fact that longer-term targets would give them time to adapt their long-term investment cycles.

Barriers and opportunities

It is important to remember that a large share of decarbonisation in energy-intensive industries will need to come from the heat and electricity they consume. The industries themselves have little direct control over this. Indeed the energy sector must shift its sources of supply away from fossil fuels towards renewables, gas with CCS and nuclear power. Some energy-intensive sectors are generating a small proportion of their own low-carbon energy, although recent cuts to FITs for combined heat and power and biogas – technologies that, for example, the UK paper and chemicals industries have considered investing in – have made this option less attractive.

Energy-efficiency measures will continue to be important, however, as a means to reduce these industries' energy use and process emissions. Several industry representatives said they had made important progress in these areas in recent years, and some thought they had 'picked much of the low-hanging fruit' available to them – for instance by improving the design processes for kilns and furnaces. In other sectors, there are additional options to improve energy efficiency. In the steel industry for example, a production technique known as 'fastmelt', which lowers energy use and emissions per unit of output (and therefore overall operating costs) could be deployed more widely (Centre for Low Carbon Futures 2011).

Cost is an important factor in determining whether or not these investments are made. Some energy-intensive firms are spending millions each year just to maintain existing machinery and equipment, meaning that investing in new, more efficient plants and production processes – which have higher upfront capital costs – is often considered impossible. The Centre for Low Carbon Futures (2011) estimates that building new, more efficient, ceramics plants would cost approximately £12–25 million per plant – which many companies in this sector can ill afford in the current economic environment.

The majority of EII representatives concluded that making their plants and processes more energy efficient by using available technologies would only deliver a limited amount of further emissions reductions, and that they needed new transformative technologies and innovative production processes in order to make a substantial impact. Rigorous innovation and R&D will be critical to this task. One representative said, in reference to energy-intensive industries often being described as 'sunset industries' in the context of the low-carbon transition, that 'innovation is the key to keeping the sun from setting'.

Some participants were optimistic about the potential for innovation and breakthrough low-carbon technologies in their sectors and identified emerging technologies that could significantly help to reduce emissions, but which are not yet commercially viable. For instance, UK-based manufacturer e2v technologies – in partnership with a consortium of industrial and academic collaborators and supported by a grant from the TSB – has been developing a new highly efficient pulsed power system for industrial processes that uses radio frequencies. The company estimates that the technology, known as HiPPoS, could enable certain industrial production techniques – such as breaking down ores to extract minerals – to be carried out using up to 60 per cent less energy than current processes.[47]

There are also interesting technological and process innovations that could be developed and deployed widely to decarbonise the energy consumed by energy-intensive industrial production plants. In the steel and iron industries for example, plants can be fitted with integrated technology systems that recycle energy from the production process by

47 http://www.innovateuk.org/content/case-study/results/big-energy-savings-for-process-industries.ashx

creating steam to generate electricity. If done on a large enough scale, this process could potentially enable plants to be energy self-sufficient. Another option is remote net metering. Successfully trialled in New York, this mechanism lets energy-intensive firms that cannot provide onsite renewable power generation (but that may own generation facilities elsewhere) use the grid as a private wire.[48] Electricity suppliers to these firms would only charge for net usage (any additional electricity used above and beyond the power produced by the firm's own facility) and any net charges for transmission and distribution (Johns 2011).

In sectors such as steel, chemicals and cement, industrial CCS potentially offers a transformative solution to their emissions profile. CCS technology[49] is one area of focus for the ultra-low carbon dioxide steelmaking initiative – a consortium of European steel companies, energy and engineering firms and research institutes engaged in R&D across a range of promising technologies for the steelmaking process. With a stated aim to cut steelmaking CO_2 emissions by 50 per cent, the initiative is the largest of its kind and has a budget of €75 million spread over a six-year period.[50] Yet the amount of capital invested is still fairly small compared to what steelmakers suggest might be required to demonstrate these technologies on a wider basis, let alone ensure that they are sufficiently developed to roll out commercially.

Financial constraints are not only preventing established energy-intensive companies from investing more funds in RD&D. They are also affecting the ability of small- and mid-scale technology firms, which are developing innovative technologies for energy- and carbon-intensive industries, to break into the market. Access to finance is a particular problem. For example, Novacem, a spin-out from Imperial College London, has developed a form of carbon-negative cement – a technology that could revolutionise the cement industry – but needs financial support to get its product through the final development stages and expand its demonstration facilities. So far this is has been challenging (see box 2.6).

Government has a role to play in addressing these problems. A number of representatives from EII sectors suggested that greater support for R&D, assistance with pilot projects and positive incentives to invest in low-carbon technologies such as Novacem and HiPPoS would be helpful, not least because payback periods are long and the current investment environment is inhibiting their progress. While some representatives welcomed the decision to focus part of the £3 billion allocated to the GIB on industrial energy-efficiency projects, they thought that additional government funding assistance would be needed in the area of breakthrough technologies.

As with other representatives from the energy and manufacturing sectors, EII representatives identified additional supply-side barriers to technological innovation and deployment. They maintained that an insufficiently skilled workforce – particularly a lack of university graduates with the right kind of tailored engineering knowledge – and strict immigration policies that make it difficult to attract skilled professionals from overseas are impeding innovation. In CCS research for example, where highly qualified chemical and high-voltage engineers are needed to lead projects, this expertise is inaccessible.

48 http://energy.gov/savings/new-york-net-metering

49 In the steel industry, the technology is known as top gas recycling blast furnace with CCS.

50 Sixty per cent of funding has been provided by the consortium's business participants, while the European Commission has provided the remaining 40 per cent under its coal steel programmes research fund: http://www.ulcos.org/en/about_ulcos/home.php.

Despite the significant challenges posed by, and barriers inhibiting, decarbonisation for energy-intensive industries, it is nevertheless important to remember that many of these industries can play, and are already playing, a critical part in the low-carbon transition. Far from being 'sunset industries', they too are taking advantage of the commercial opportunities of the transition. For example, glass production is obviously required for enhanced double and triple glazing, which will be crucial for insulating buildings to the highest standards, while steel and aluminium are important component parts for wind turbine blades and towers.

Box 2.6: Novacem

Novacem is a UK technology firm that has developed a form of carbon-negative cement. Established in 2007 as a spin-out from Imperial College in London, the company uses magnesium silicates to manufacture its product as opposed to the carbon-intensive limestone that is used to make Portland cement, the industry's staple. According to the company, 1 tonne of Novacem cement will absorb between 30–100 kg more CO_2 than it emits. And for every tonne of Portland cement substituted with Novacem cement, CO_2 emissions from the industry could be reduced by up to 850kg.

This technological breakthrough has the potential to transform the cement industry. Cement is responsible for 5 per cent of carbon emissions worldwide, and global demand is set to almost double between now and 2030. Hence, if rolled out commercially on a mass scale, Novacem's innovation could significantly reduce CO_2 emissions from the industry, help increase the competitiveness of manufacturers and minimise carbon leakage. Part of the appeal for the industry is that existing cement plants could be used to manufacture Novacem, at the same cost as Portland cement.

In 2009, the company received £1.1 million in seed capital from a syndicate that included Imperial Innovations, the London technology fund and the Royal Society enterprise fund. It has also won a £1.5 million collaborative R&D grant from the TSB to prove the technical and commercial viability of the product and received another £1.6 million in follow-up funding from its financial investors and Laing O'Rourke. These investments have enabled Novacem to build a pilot facility capable of producing 4–5 tonnes of carbon-negative cement each year. Its aim is to launch its first commercial-scale plants in 2017–2018 by licensing its technology to cement companies.

However, securing next-stage equity funding – vital for scaling up manufacturing prior to commercialisation – is proving to be difficult. Venture capital is increasingly hard to come by, and there is a dearth of government support for mid-stage firms like Novacem. In 2010, the company issued a 'green cement bond' in an attempt to raise funds to accelerate the development and commercialisation of the product, giving investors an opportunity to secure early access to the product for testing, certification and pilot application in return. Lafarge, the French building materials group, initially subscribed to the bond and invested over £500,000 in the process, but is now unable to continue its backing after being hit particularly hard by the recession. Indeed, the cement industry as a whole has seen share prices tumbling since 2007–2008, by up to 80 per cent in the case of some of the major Western manufacturers, leaving little appetite to invest in new products that are often perceived as high-risk investments with long-term returns at best.

BOXED TEXT CONTINUED

Novacem's small group of staff are now spending the vast majority of their time fundraising: time that would be better spent further enhancing the technology. But they are hoping that the effort will pay off. In 2010, MIT's *Technology Review* listed Novacem as one of the world's ten most important emerging technologies, recognising in it a massive opportunity for decarbonisation. With the right financial support and backing, its cement has the potential to be a world-class, transformative technology that could change the nature of the industry.

Demand for steel, which is expected to double over the next 20 years, is forecast to increasingly come from the wind industry as the technology is rolled out to meet renewable energy targets (CBI 2011). Tata Steel – which has established a dedicated 'wind power hub' in Scunthorpe – recently secured a contract from Siemens Wind Power to supply 25,000 tonnes of high-quality steel plate for wind towers.[51] Other industry participants – from both large energy-intensive firms and smaller manufacturers looking to break into clean-tech markets – suggested that the government could improve procurement access for renewable energy projects. They explained that renewable energy project developers, particularly multinationals, tend to rely on existing supply chains that are often based overseas and therefore difficult for UK companies to break into.

Looking ahead

The majority of energy-intensive industry executives we consulted agreed that a concerted government effort to ease the cumulative cost burden on industry was essential. Manufacturers concluded that they needed to work together to make sure that policymakers identify policies that are sensitive to industry's competitiveness concerns, in particular the rising cost of energy. One participant raised the possibility of joint negotiated contracts with energy suppliers – with a view to securing better tariffs – which the government could play an active role in brokering.

If industry is to play an active part in the transition in the longer term and have any hope of meeting the 2050 targets placed on it, then the government will also need to play a far more active role in supporting technological innovation and providing additional incentives for investment in R&D, as well as new energy-efficiency measures and low-carbon energy supply. Given the fiscally straightened times, participants agreed that the government would need to find novel ways of raising and leveraging funds. Several participants suggested that the EU could play an important coordinating role in this regard, by facilitating and funding collaborative technological R&D projects in areas such as industrial CCS, pooling knowledge, expertise and finance from interested EU member states.

Another option would be to recycle revenues from the sale of EU ETS allowances into R&D for low-carbon projects.[52] This approach would follow the precedent set by the CCL, under which a portion of the revenue accumulated from the levy is invested back into energy-efficient and low-carbon technologies,[53] and the EU's NER 300 fund. The latter

51 http://www.tatasteeleurope.com/en/news/news/2001_major_plate_order_for_Siemens_wind_towers

52 For some EII representatives, using funds in this way would also boost the credibility of the scheme and green taxation in general.

53 The rest is recycled back into businesses covered by the scheme in the form of a 0.3 per cent cut in employers' national insurance contributions: http://www.decc.gov.uk/en/content/cms/emissions/ccas/cc_levy/cc_levy.aspx.

contains a provision to raise up to €4.5 billion through the sale of 300 million allowances held back from the EU ETS' new entrants' reserve. These funds are already being used to co-finance CCS demonstration projects, smart grids and deployment of a suite of renewable technologies (European Commission 2011e).

While several participants urged the government to exercise caution before backing specific industries and technologies, many thought that energy-intensive industries would benefit significantly from more nuanced policies that recognised sector-, industry- and process-specific challenges. Participants agreed that government has a tendency to lump energy-intensive industries and manufacturing industries together under 'one-size-fits-all' policies, which invariably fail to recognise the complexity of concerns and diversity of opportunities available to individual sectors. Others suggested that policy could be better tailored across product systems.

As part of a more tailored policy approach to specific sectors, many EII executives also said the government should play a far more proactive role in advocating global sectoral agreements. They argued that sectoral deals would level the playing field for energy-intensive industries, reduce the risk of carbon leakage and better tackle emissions (EEF 2012). In recent years, several attempts to broker international sectoral agreements have been made but have since stalled.

For instance, the World Steel Association (WSA) has attempted to secure worldwide industry participation in its voluntary benchmarking and data collection programme. This scheme – known as the climate action member recognition programme – is the first of its kind in the industry and uses a commonly agreed methodology, soon to be recognised as an ISO standard, and an online reporting tool to track steelmakers' CO_2 emissions on a plant-by-plant basis. Data is held confidentially, but individual steel plants are able to compare their CO_2 ratings against average and best performance emissions and identify areas for improvement (WSA 2010). Although 70 per cent of WSA's members – approximately 200 plants, representing 30 per cent of global production – and several non-members have signed up to the scheme, the association has failed to persuade the majority of China's steel manufacturers to participate (EEF 2012). Chinese participation is deemed crucial if the scheme is to be successful and help pave the way for further initiatives, including agreement on an international sectoral emissions target.

Other sectors, such as maritime and shipping, have been more successful in brokering international sectoral agreements, and their achievements offer important lessons for EIIs (see the deal on energy efficiency design standards recently secured by the IMO on page 16, for example). However, many industry representatives stated that while they were keen to secure international sectoral agreements, without government assistance their levels of diplomacy and leverage over industry bodies in other countries would be limited. They suggested that UK policymakers, working with allies in Europe, have a significant role to play in supporting industry to secure sectoral agreements at the global level.

3. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this report is to provide a snapshot of the views of key UK industry sectors on the low-carbon transition. As the government pushes to meet its 2020 carbon targets and plans the terrain for further emission cuts after 2020, it is important that the policy framework takes business concerns into account and breaks down barriers to low-carbon growth in key sectors.

In some industries, such as energy and transport, this is likely to require greater strategic planning to secure the substantial infrastructure investment envisaged and a concerted effort to bring down the cost of deploying renewables and low-carbon transport. In other areas, such as manufacturing, the policy approach will need to centre on promoting emerging clean-tech industries and helping other firms reduce their energy footprint and decarbonise their production processes and supply chains. Despite the bleak economic outlook, some businesses are already taking the necessary steps, as several case studies included in this report demonstrate.

The transition creates many opportunities. The possibility of the UK and other European countries becoming global leaders in the low-carbon economy and home to a number of competitive industries in this area is very much alive. Many industries recognise this and are tapping into new markets that are underpinned by climate change regulations and policies, while others are gaining a competitive advantage by deploying low-carbon products. For these industries, low-carbon regulations are a driver of growth and core to their business model. But they need to be consistent and clear, otherwise there is a risk that UK firms will miss out on opportunities both in export markets and at home.

Yet it is also clear from industry that there are a number of significant barriers to this transition. Cost remains the major roadblock in many sectors – particularly those in which substantial investments are needed, such as the electricity generation sector. Current economic and fiscal concerns will dictate how much capital the private sector and government can dedicate to this cause, but it is important that newly created institutions such as the GIB are able to deploy and leverage capital as soon as possible. Elsewhere, access to finance continues to be a problem that inhibits innovative clean-tech start-ups and mid-size companies seeking to break into the marketplace. A persistently low carbon price within the ETS does little to encourage emissions reduction or investments in clean technologies.

For many energy-intensive industries, rising energy costs and competitive pressures are *the* core concern at present. Although there is little concrete evidence to suggest that it is already occurring, carbon leakage remains a risk for globally traded industries – such as steel and cement – so long as climate regulations remain weak or non-existent in other countries. This trend may or may not affect future investment decisions. The report's findings suggest that the cost of climate change policies and low-carbon regulations are one in a set of cumulative costs to doing business in Europe for these industries, including higher labour costs, soaring oil and gas prices and a suite of other regulations that affect business. Currently, the proportion of energy-intensive users' energy bills that is attributed to low-carbon policies is fairly small, as the government's own analysis shows, and is likely to be overstated. But the proportion is set to rise and measures will therefore need to be taken to limit the impact on energy-intensive businesses.

Nevertheless, while some climate regulations are imperfect, this is not a sufficient reason to backslide on low-carbon policy goals and risk stifling emerging clean-tech sectors and the potential productivity and market opportunities that could be accrued to businesses in

others. Rather, industries and government should work together to explore how they can adapt their business models to the transition through innovation, break down unnecessary barriers and chart out new growth opportunities presented by the low-carbon transition – in areas such as supply chains for renewable energy projects. Pursuit of international sectoral agreements that will ensure a level playing field on carbon regulation and cushion the impact of rising energy prices on energy-intensive industries should also be prioritised.

With these points in mind, and based on the findings of this report, we recommend six measures to help industry harness the low-carbon transition. The first three are general in their scope; the remaining three are more specific.

- **Provide stable, consistent and long-term policy.** The low-carbon transition requires a policy framework that is stable, consistent and sufficiently long term in its vision and application. Many business representatives that we spoke to complained that the government constantly 'moves the goal posts', citing changes to FITs, CCAs and the much-criticised CRC as examples. These changes not only affect business confidence but also discourage the private sector from investing in the technologies and infrastructure that will be critical to curbing emissions. It will also make the transition more expensive in the long run, as the private sector is more likely to put off investment and place R&D projects – which are necessary to bring down the cost of expensive clean-energy technologies – on hold.

  Where applicable, measures to reduce regulatory complexity should also be introduced. For instance, some energy-intensive businesses are subject to overlapping regulatory regimes (the EU ETS, CCL and the CRC, for instance), which adds to administrative and cost burdens, and can provide contradictory signals (for example, when the carbon price in the ETS, the cost of the CRC and the UK's unilateral carbon price floor could potentially differ substantially). In the absence of an EU-wide carbon reserve price, the UK's carbon price floor is likely to harm UK industry relative to its European counterparts, and should therefore be scrapped (Maxwell 2011). By and large, however, the majority of businesses are calling for better and clearer regulation, rather than a bonfire of red tape.

  Long-term policy planning is also needed. Whilst the work of both the European Commission and the UK's climate change committee in setting out a long-term vision for decarbonisation by 2050 is an important step, it is now time for policymakers to think seriously about the types of policies that will be needed in the post-2020 period to meet its goals. Too often there is a disconnect between ambition and delivery. For some industries, such as the aviation sector, long lead times require them to plan investment decisions 20 to 30 years in advance. For others, interim milestones for 2025 and 2030 will be critical, especially given the shorter investment horizons under which many businesses are increasingly operating, due to the weak economic outlook. In both cases, appropriate EU and UK regulations, standards and incentives will need to be announced sooner rather than later in order to make sure this investment goes ahead. Participants at our roundtable hoped that the EMR process, when legislated, will provide a certain degree of clarity for the UK energy sector, however the same is needed in other sectors.

  Similarly, the sooner the parameters for a fourth phase (post-2020) of the ETS are agreed the better. Several reforms should be made to the scheme. Although some industry representatives were concerned that measures to raise the carbon price may contradict the scheme's initial objective of reducing emissions in a cost-effective

way, others suggested that with such a low carbon price, it would struggle to reduce emissions sufficiently. What is more, if the ETS carbon price is to become a driver of investment in low-carbon technologies, as policymakers intend, greater price certainty and stability will be needed. Removing some of the excess allowances from phase III of the scheme, which could help raise the carbon price by as much as 20 per cent, would be the least interventionist measure and should be given the go ahead, as the European Parliament suggests.[54] However, additional measures may be needed in the short term to protect energy-intensive firms from an elevated carbon price, depending on their ETS allowance requirements and the number of excess permits they currently hold.

- **Develop sectoral industrial strategies to spur low-carbon energy, transport and manufacturing.** To speed up the transition and knock down barriers to growth, the government should work far more closely with the sectors indentified in this report. Strategic public-private partnerships at the sector level – based on the model successfully established by the Automotive Council, which brings together leading industry players, policymakers and expert academics – will be critical in helping these sectors identify and harness opportunities for low-carbon growth, and in helping businesses engage in technological and process innovation and access niche markets. Partnerships will also be crucial for determining how government-backed RD&D funds can be best spent – to ensure a balance between supporting basic research and new innovations, as well as bringing down the cost of existing low-carbon technologies. Close collaboration between the TSB, the Energy Technologies Institute and the new catapult centres will be important in this respect.

  An active industrial strategy will also require the government to help industry identify and address skills and financing gaps specific to individual sectors, as well as infrastructure needs. Many industry representatives reported difficulties in hiring skilled workers, particularly specialist and technician-grade engineers with prior professional experience in their sectors. The government's ill-conceived cap on skilled migrants from non-EU countries was singled out as a brake on attracting foreign talent and should be reconsidered. At the sector level, public-private partnerships could help industry identify specific skills gaps that need to be plugged if businesses are to sufficiently harness low-carbon opportunities. Equally as important, they should encourage businesses to recognise the merits of, and identify opportunities for, investing in workforce training and development to ensure they are equipped with the necessary human capital for low-carbon innovation. Furthermore, policymakers should be far more proactive in helping innovative technology manufacturers capitalise on their staff's know-how and design and engineering expertise by helping them secure access to IP rights in promising new low-carbon technologies, such as hydrogen fuel cells.

  Improving access to finance should be another specific focus of active industrial strategies. Special attention should be given to supporting innovative low-carbon technology firms that are struggling to access mid-stage finance and face the looming 'valley of death'. The GIB could have a role to play here. In addition to providing finance for infrastructure projects, it could also offer to provide joint equity finance for promising new technology companies looking to finalise their products and break into the market place, but struggling to raise the necessary funds. Using the bank in this way would help leverage capital from private investors who are reluctant to invest alone in what are often perceived as risky ventures, particularly in the current

54 http://www.risk.net/energy-risk/news/2156349/eu-ets-set-aside-takes-step-forward

economic environment. Another option to help bridge the equity gap would be for the government to encourage corporate venture partnerships, for instance by offering tax incentives on investments made by large-scale manufacturers and utilities in promising technology start-ups with emissions-saving potential.

- **More nuanced policy for energy-intensive firms.** There are many common challenges facing energy-intensive firms. The potential for carbon leakage may increase in the years to come as energy prices in the UK rise. Boosting the carbon price – an important signal for low-carbon investment – will lead to further economic losses for some sectors unless additional support mechanisms are put in place. In general terms, many industry executives asserted that current policy affecting each of these industries is skewed heavily towards negative incentives and is far too light on positive incentives. Without the latter, energy-intensive industries are likely to struggle to take further steps to decarbonise their operations and invest in the big breakthrough technology solutions that will make a difference.

  But given that the challenges and opportunities are specific to individual sectors, it is also important that policy is sector specific and as nuanced as possible. Too often industries are treated as identical. Yet there are huge differences in the barriers they face and the solutions open to them. Steel, for instance, will require major technological breakthroughs in areas such as industrial CCS to curb emissions, while the paper industry is more suited to investment in afforestation, sustainable biomass and more efficient recycling processes.[55] Policy should target the most suitable and cost-effective avenues for emissions reductions on an industry-by-industry basis, and in the same manner should tailor positive incentives in areas such as support for R&D. The challenge facing policymakers is to ensure that policy helps the right sectors in the right ways.

- **Introduce a targeted green deal for manufacturers.** The government should introduce a green deal for manufacturing firms. At present, there are few positive incentives for conventional manufacturers to reduce process emissions and retrofit their plants and premises – those that have done so tend to be large multinational firms with strong balance sheets and the ability to raise capital. The government's decision to reduce capital allowances has meant a further disincentive for manufacturers to invest, at a time when access to capital is tight. Although ECAs are available to firms looking to purchase certain types of energy-efficient equipment, the scheme is complex and bureaucratic.

  The secretary of state, Ed Davey, has expressed a desire to expand the green deal to businesses (Davey 2012), but few details are currently available. We believe he should press ahead. He should first target small and medium-sized manufacturing businesses with the highest energy costs relative to total costs, with a view to rolling out the scheme on a wider basis if it is successful.[56] In addition, 100 per cent capital allowances for two years should be made available to manufacturers looking to invest

55 See CEPI (2011) for more detail on the sorts of areas in which breakthrough technologies will be needed if the paper and pulp industry is to meet the objectives outlined in its own 2050 low-carbon bio-economy roadmap.

56 Since the upfront costs of any green deal measure would be paid by the finance sector and paid back by the recipient over time through the savings on their energy bills, the scheme would not require public funding. However, the government may wish to introduce limited, time-bound incentives to encourage take-up. One option would be to set aside funds for 'early adopter' incentives, perhaps offered in the form of a temporary cut to business rates for firms that sign up during an initial introductory period. This approach would mirror proposals for the current green deal scheme for homeowners, for which the Treasury has set aside £200 million for early-adopter incentives.

in a broader array of clean-energy-supply technologies and more energy-efficient production equipment and processes. The additional costs could be funded by a small allocation of ETS revenues.

- **Collaborate with European partners on low-carbon innovation and target possible technological breakthroughs.** In the current climate of austerity, and given that government funds will be limited for some time, there is a strong case for greater EU coordination of major strategic low-carbon investments. Instead of having relatively small and overlapping RD&D initiatives conducted by individual member states, pooling member state resources and encouraging countries to work in partnership in areas of mutual interest is likely to be more cost effective and could deliver greater returns. Developing and demonstrating CCS technologies – coal, gas and industrial CCS – and offshore wind are priority areas for the UK, and progress is already being made in these areas through the EU's NER 300 programme. However, more impetus is needed. By pooling investments and sharing risk, EU governments are likely to increase the attractiveness of major innovation projects to private sector investors.

  There is huge potential to unearth breakthrough technologies even in the most hard-to-treat sectors such as cement, ceramics and chemicals. Some technologies already exist, but the capital to develop, demonstrate, fine tune and deploy them at scale is lacking. In addition to pooling major low-carbon investments, the government should look at new ways of raising funds for low-carbon innovation in individual sectors. One option would be to recycle revenue that is raised from the sale of EU ETS permits at the start of each new phase into nascent low-carbon and energy-efficiency technologies – a precedent that has been set by the climate change levy (CCL), which channels a small portion of revenue in this way, and the NER 300 programme.

  Indeed, NER 300 is a particularly useful model for collaborative innovation at the EU level. Using funds raised from the sale of allowances held back from the EU ETS' new entrants' reserve, the programme aims to leverage additional finance for low-carbon projects from member states and the private sector. Importantly, while the programme operates at the EU level, member states select eligible projects while the European Investment Bank carries out the financial and technical due diligence on proposed projects. By relying on the ETS however, the amount of capital the programme can disburse (and subsequently leverage for the private sector) is constrained by the low carbon price. Notwithstanding, serious consideration should be given to replicating the best features of the NER 300 model as the basis of a bigger, more ambitious programme of collaborative low-carbon RD&D initiatives between European member states.

  UK policymakers should also be pushing hard for greater resources to be allocated to low-carbon innovation in the next EU budget, as part of the ongoing negotiations over the 2014–2020 multiannual financial framework. The commission's proposal to raise the portion of the budget for science and innovation to €80 billion (an increase of €25.5 billion on the 2007–2013 budget) is welcome, but not all of these funds will be used to support low-carbon and clean-energy investments. The UK should make the case for the biggest allocation possible.

- **Work proactively with industry to promote international sectoral agreements.** Many industry bodies – including aviation, paper and steel – have argued that international sectoral agreements are the best way to make progress on emissions reductions. Although it is no substitute for binding country-level emissions reduction

commitments, sectoral cooperation is nevertheless critical and can be a precursor to greater regulatory action at the national and global levels. The government needs to be far more proactive in this area and promote opportunities for international industry self-regulation, particularly in globally traded energy-intensive sectors. Policymakers should learn from past initiatives and use diplomatic channels to inject fresh momentum into talks and initiatives that have stalled, such as the World Steel Association's benchmarking exercise (see page 36).

If progress at the international level remains slow, EU policymakers should explore the possibility of temporarily incorporating imported goods from energy-intensive sectors such as steel, chemicals and cement into the EU ETS in a WTO-comliant manner (see *Europe's next economy* for more detail on this recommendation). Although this approach could pose a risk for existing trade relationships – and would therefore need to be examined carefully – it would nevertheless help put UK industries on a level playing field relative to international competitors for goods coming into the European market. Countries that are taking comparable measures to reduce emissions in these sectors could be excluded from the scheme.

The inclusion of aviation in the EU ETS sets a precedent for this type of policy. Such a move would be intended to spur governments and industry to broker global industry-specific agreements, and could be withdrawn once ambitious global sectoral agreements are struck – in the same manner that EU climate change commissioner Connie Hedegaard has argued that aviation would be withdrawn from the EU ETS if and when the UN Civil Aviation Authority brokers a global agreement for the sector.[57] Similarly, if the international community fulfils its pledge at last year's UN climate talks in Durban for all major emitters to sign up in 2015 to legally binding emissions reductions commitments from 2020 onwards, this would also signal the end of any temporary extension of the EU ETS.

57 See, for instance, Chaffin 2012b

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APPENDIX
ROUNDTABLES AND INTERVIEWS

This report is based on findings from four roundtable discussions, which were convened by IPPR and conducted under Chatham House rule between December 2011 and February 2012, and a number of private interviews with senior executives from the various sectors.

Some of the organisations that were consulted in the course of our research are listed here. They include businesses, industry and trade associations, academic institutions and several non-governmental organisations.

- The AA
- ADS Group
- Atkins Global
- Avingtrans Group
- BASF
- BMW
- British Airways
- British Ceramic Confederation
- British Chamber of Shipping
- British Gas / Centrica
- British Glass
- Calor Gas
- Cambridge Electricity Policy Research Group
- Campaign for Better Transport
- Caparo
- Caterpillar UK
- Ceres Power
- Confederation of Paper Industries
- Combined Heat and Power Association
- David Brown
- e2v Technologies
- EDF
- Emerald Technology Ventures
- Energy Intensive Users Group
- Energy Saving Trust
- Engensa Energy Solutions
- Environmental Technologies Fund
- E.ON
- Evo Energy
- Food and Drink Federation
- Good Energy
- Green Alliance
- Greenpeace
- Harwin plc
- Institute of Mechanical Engineers
- Jaguar Land Rover
- JCB
- Johnson Matthey
- London Technology Fund
- Low Carbon Vehicle Partnership
- McKinsey & Company
- Mineral Products Association
- National Grid plc
- Network Rail
- Novacem
- RAC Foundation
- Renault
- Renewable Energy Association
- RenewableUK
- Renishaw plc
- Rolls-Royce
- Siemens UK
- Shell
- Society of Motor Manufacturers and Traders
- Tata Steel Europe
- Toyota
- TUC
- UK Energy Research Centre_
- Virgin Atlantic
- Warwick Manufacturing Group