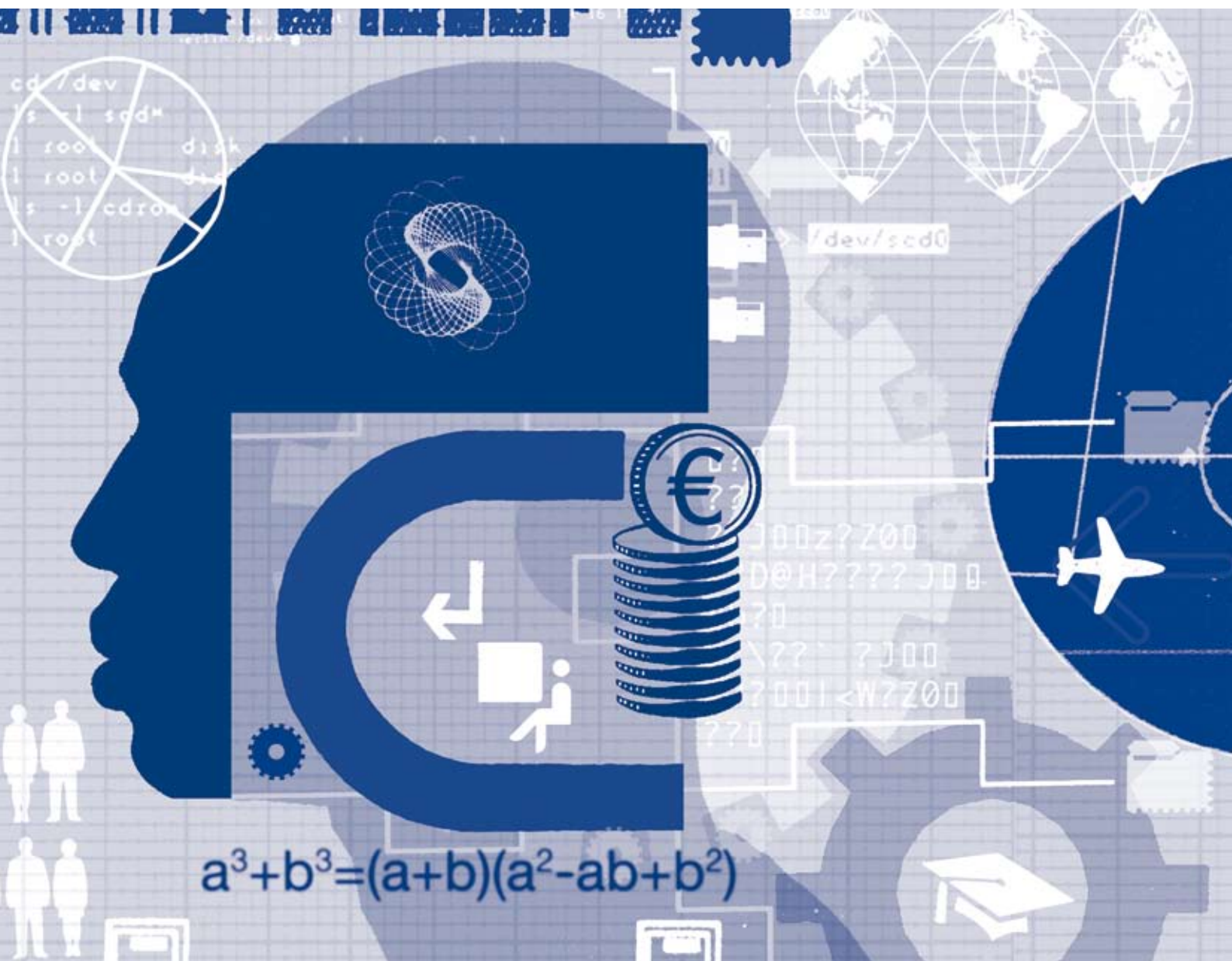


A 2020 Low Carbon Economy

A Knowledge Economy Programme Report

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Executive summary

The shift to towards low carbon ways of working is increasingly associated with the creation of a broad range of new employment opportunities. A central theme of our 2020 Knowledge Economy research programme is the development of our understanding of the likely nature of the knowledge based industrial structure of the UK in 2020. This paper considers the potential for the low carbon economy to form a major part of this. It explores the topic through a scenario based analysis to map what we can say with confidence about the future scale and nature of employment generated by a low carbon economy. The opportunity of the low carbon economy is clear from the analysis, but so is the need for stronger and simpler public support for the development of these activities.

Context Our desire to cut carbon dioxide emissions has been associated with the creation of activities focused directly on using fossil fuels more efficiently (such as hybrid vehicle technology), activities which prevent the release of emissions into the atmosphere, or remove carbon dioxide from the environment (such as carbon capture and storage facilities) and which support the transition to less carbon intensive operations (such as carbon finance and carbon trading activities). However, precisely defining and identifying the current scale of activities which derive their demand from this desire remains a challenge. The concept is often confused with wider notions of green jobs, the green economy, green collar jobs, the environmental economy and eco-industries. Also, their cross-sectoral nature results in a poor match with standard industrial and occupational classifications.

Fundamental challenges face those who attempt to predict the future growth of these activities. Such a diverse range of sectors comprise the low carbon economy that the collective prediction of their future growth is not viable. The task of forecasting individual low carbon economic activities is no less daunting. The future development of demand for these goods and services, technical aspects relating to their likely supply and the future availability of an appropriately skilled workforce remain highly uncertain. In predicting these activities, forecasters are forced to make assumptions about each of these. The outputs from these exercises are dominated by such decisions, rather than the fundamental drives of the low carbon economy.

The low carbon agenda will place employment in the most carbon intensive industries at risk. While it is possible to identify such high-carbon activities, understanding how these challenges will present for each before the full force of the drivers for change bite is a highly ambitious task.

Future scenarios for the low carbon economy

Given these uncertainties, and the challenges facing the forecasting and prediction of these activities, we have followed a scenario based approach to consider the future of the low carbon economy. By looking forwards and developing visions for the future of these activities it is possible to explore and understand the full spectrum of low carbon opportunities. It is possible to consider their job creation potential, the likely nature of this employment, and to think more broadly about what of these futures is particularly desirable.

This paper presents three scenarios for the development of low carbon activities over the next decade. All see increasing demand for activities which reduce carbon dioxide emissions, but differ in how this is reflected within economic activity:

- **A low carbon technology implementation sector** – the successful development of economic activities focused on reducing carbon emissions through the implementation of existing and developing technologies;
- **Manufacturing led growth in low carbon activities** – the development of world class, export orientated low carbon activities based on manufacturing;
- **A Low carbon services led sector** – the development of world class, export orientated low carbon activities based on business, financial and technical services.

The analysis confirms that the low carbon agenda represents a major opportunity to create significant new employment in an area of expanding global activity. There is likely to be a focus on low skill employment for the installation and construction of many of the technologies and infrastructures associated with the low carbon agenda. There is also potential to create a wide range of highly innovative activities, which would demand high-level technical as well as soft management or consumer product development skills. These will be developed by expanding advanced manufacturing and service offers that help to meet domestic and global demands to cut carbon dioxide emissions. This is particularly positive since the wider low carbon agenda does place some existing employment at risk.

Policy considerations

A clear rationale exists for the government to intervene to support the development of low carbon economic activities. The government are in a position to take a long-term, strategic perspective regarding the future development of these activities. The government have identified the low carbon economy as an area for global economic growth over the coming decade. In addition, the government's commitment to cut the UK's carbon dioxide emissions implies a long-term shift towards these low carbon activities. It is sensible therefore that they exploit their foresight, by supporting change within the economy to exploit existing UK advantages.

Recognising this, the low carbon economy has been the subject of considerable political interest in recent years. This has been reflected through the development of a large number of policy documents and a range of public spends aimed at supporting this activity. However, as our scenario analysis has highlighted, support is falling short of offering leadership in the form of consistent signals regarding the future value and demand for these activities. It is failing to establish clear frameworks which can support investment in the agenda and to successfully promote the development of a workforce with adequate and relevant skills.

Current public policy and financial support for the low carbon economy is complex and highly nuanced. Entrepreneurs looking to invest in the development of low carbon service offers need to engage with a number of public sector bodies. An even larger number of organisations are involved with supporting the development of demand. Also, clear signals are still not being offered to individuals who might be looking to invest in the skills required to work in future low carbon activities. While many of the nuances of these arrangements reflect the exceptional quality of background analysis, the support offered appears to lack the commitment and weight of that of many of our trading partners.

Policy recommendations

Given the strengths of the justifications for public intervention in these activities, the scale of the opportunities presented by this agenda and the apparent shortcomings of existing support, urgent policy action is required to better support the continued development of a strong low carbon economy.

Action is required to better understand the nature of current public support for these industries before this can be simplified and rationalised:

- **A cross cutting audit of current spending** is required to better understand current spending patterns, and identify areas for potential rationalisation;
- There is a need to establish a **single point of contact for businesses**, responsible for supporting access to public funding and advice. It would be sensible to distance such support from short term political debates. This could be achieved by collating existing funds to form a single low carbon economy fund, **linked to the long-term ambitions of the Climate Change Act**;

- Action is required to ensure consistent, co-ordinated and supportive regulation of these activities from across the public sector. The **creation of a ministerial role** dedicated to championing the needs of these business, and ensuring that all departments take responsibility for this commercial agenda would help to meet this need.

There is also a need for government to better support the development of demand for these activities, offering greater confidence regarding the likely returns from investments in this agenda:

- The rapid **establishment of a vision for the development of the UK's low carbon infrastructure** covering all areas of infrastructure including transport, telecommunications, housing, green belts and open space, waste management, as well as energy supply;
- This vision must be **articulated and implemented in ways which support private investment**. Specifically this must include clarity regarding the required **balance between public and private funding** for infrastructure items and the rapid translation of this vision into **planning policy** to support its physical delivery;
- In addition to these infrastructure-specific needs, **stronger signals regarding the future costs of emitting carbon dioxide** are required to support the development of demand for all low carbon economy activities.

By offering clarity in public support for these activities and sending clear signals regarding their future development, the successful implementation of these recommendations has the potential to establish a positive and self reinforcing process. The expansion of these activities will support the attraction of additional investment in the UK's low carbon economy as the uncertainties detailed above come closer to resolution.

The need to end our dependence on carbon dioxide releasing fossil fuels is perceived to be a defining issue of our time. Concerns about climate change and energy security are increasing interest in technologies and processes, which reduce our reliance on carbon dioxide producing activities. Although originally viewed with some scepticism, the potential for this transition to create new employment is of increasing interest.¹

Such opportunities are winning particular attention in the current economic context. The boom years up to the collapse of Northern Rock in September 2007 were fuelled by growth in financial services, property and construction and a dramatic expansion in publicly funded employment. In economic terms, the past two and a half years have been exceptional. The Office for National Statistics have confirmed that the UK saw the greatest annual contraction in the output from the economy since the Great Depression of the 1930s. While the UK has now left recession, economic challenges persist. As set out by Will Hutton in his recent essay *The Landscape of Tough Times*, organisations face years of stringency. Private sector demand is likely to be held back as consumers re-build their savings, and business their balance sheets. Banks remain highly risk adverse, and the next government will focus on deficit reduction. In short the industries of the bubble are unlikely to drive growth in the 2010s.

In such a context, supporting the economy in tapping into new and expanding areas of global demand appears to now be of some interest for all of the major political parties. This is particularly the case for low carbon activities, where the rationale for intervention appears to be less controversial.²

The challenge for Britain will be to rebuild its economic model around investment and innovation with little direct public money. Over the last three decades the knowledge economy has been the fundamental engine of growth. Through this period, the number of jobs that require degree level of professional skills has steadily risen, while the companies and sectors that have grown are those that have found new and innovative ways to add value.

A central theme of our 2020 Knowledge Economy research programme is the development of our understanding of the likely nature of this knowledge based industrial structure over the coming decade. This working paper considers the potential for the low carbon economy to form a major part of this knowledge economy. It explores the topic through a scenario based analysis to map what we can say with confidence about the future scale and nature of employment

¹ For example, the growth in news stories on the 'Low Carbon Economy' (as tracked by Google News which show a ten fold increase in relative media coverage between 2005 and 2008) highlights growing media interest in the concept

² See for example common ground on specific investments highlighted during interview between Labour, Conservative and Liberal Democrat business spokespersons, BBC Newsnight 18 March 2010

generated by a low carbon economy and how this development can be best supported to maximise its contribution to our future prosperity.

Context

The risks associated with climate change are now well understood and a link to carbon dioxide emissions has been well articulated. There is evidence of growing consumer support for sustainable goods and services. The prominence given to the Copenhagen climate change talks demonstrates high level political interest in these issues, if not a willingness to commit to action.

In the UK, fears over the costs and security of future oil and gas supplies are adding to pressure for a shift away from these carbon intensive energy sources. Long-term oil and gas prices are expected to increase as the growth of identified global reserves slows.³ Of particular concern for the UK is the understanding that North Sea oil and gas reserves will soon cease to be economically viable. There is a concern that relying on less stable external supplies presents a risk to our future prosperity.⁴

The drive away from fossil fuels is no longer viewed solely as a burden, or an economic cost for UK firms and consumers. The economy's response to demands for lower emissions of carbon dioxide is increasingly seen as a source of new job creation. A range of studies have demonstrated the job creation potential of industries based around the low carbon agenda. The decarbonisation of the economy has been associated with job creation through three broad mechanisms.

- There is a commonly held belief that decarbonisation will inevitably result in the de-mechanisation of society and a switch away from capital intensive modes of production. Renewable energy sources are understood to be significantly more labour intensive than fossil fuels (GHK 2007). A switch towards renewable energy supplies, for example, can therefore be associated with the creation of new jobs. However, it is possible that the mainstreaming of these industries will be accompanied by new more capital intensive ways of working;
- It is expected that high transport costs caused by fuel price increases will prevent the import of many goods.⁵ It is hoped that these could be substituted by British goods, stimulating employment at home, although this would depend on the availability of domestic sources;

³ See www.peakoil.com for detailed coverage of the topic

⁴ Concerns reflected within the UK Renewable Energy Strategy (HMG 2009)

⁵ See for example the Sustainable Development Commission's work on the impacts on the sustainability of food supply of significant increases in fuel costs

- The desire to maintain our current way of life and consumption patterns, while also reducing carbon emissions, has been associated with the creation of a range of entirely new economic activities. Attempts to capture and store carbon dioxide as it is released from gas-fired power stations is a good example of this process. This industry has been associated with the potential creation of up to 60,000 new jobs by 2030 (AEA 2008).

Viewed together this body of thought describes a 'New Ecological Age' (Head 2009), where ecological footprint is a central consideration for any activity, or even a 'Green Revolution' (as advocated by Gordon Brown (Observer 2009)). This would be characterised by a shift in production patterns on a scale equivalent to that of Britain's industrial revolution.

This research

Forming part of the knowledge economy programme's 2020 forward looking research, this paper considers the potential job creation impacts of low carbon economic activities. It explores what is meant by the term low carbon economy, and how it is represented within the UK economy.

Our research has identified a number of fundamental challenges facing attempts to predict the future growth of these activities. Recognising these issues, we have held back from the employment projection approach used elsewhere within the 2020 programme. Instead we have looked to understand the UK's low carbon economy based on the analysis of three plausible scenarios for its future development. All are based on the assumption that demand to cut emissions of carbon dioxide from our activities will continue to increase, but each focus on a different representation of this within the economy.

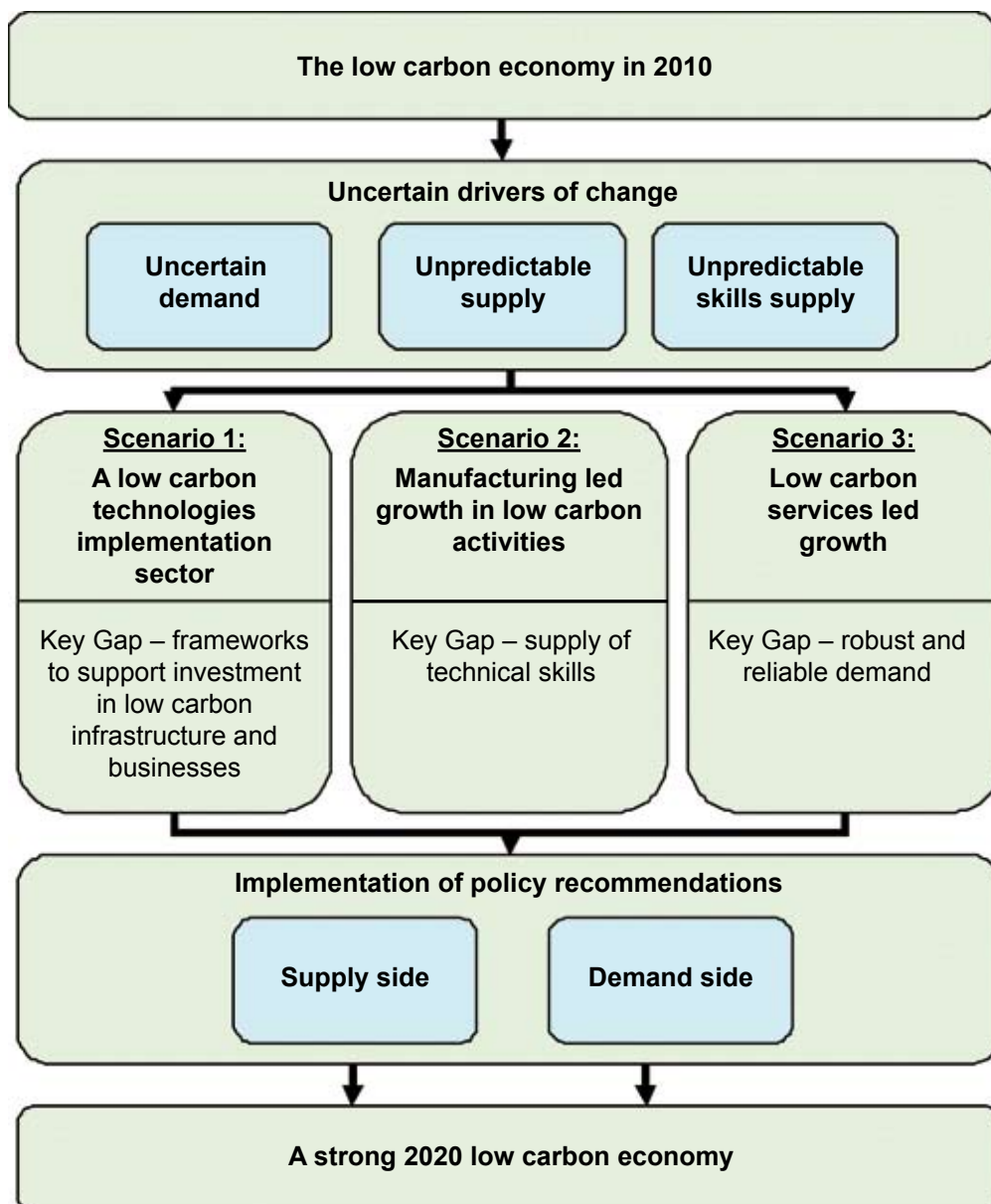
The analysis highlights that this agenda represents a major opportunity to create significant new employment in an area of expanding global activity. But, but contrasting the current direction of travel of the UK economy with these scenarios it is possible to identify a number of blockers which are holding back investment in the development of the UK low carbon economy.

This paper considers the public support for the development of these activities. It concludes that despite considerable policy effort, and widespread political optimism, urgent action is required to simplify and rationalise how the government support the developing supply of these goods and services. Action is needed to establish clearer frameworks which can support investment in this agenda, and offer potential investors confidence regarding the likely future demand for the outputs of the low carbon economy.

This approach and the structure of the paper is set out here and illustrated in Figure 1 below.

- Section 1 explores the concept and definition of the low carbon economy;
- Section 2 considers the issues associated with the prediction of these activities;
- Section 3 introduces the scenario analysis;
- Section 4 covers policy issues and presents our recommendations for development.

Figure 1: A scenario based approach to understanding the future development of the low carbon economy



1. The low carbon economy in 2010

**A confused
concept**

Ultimately, a low carbon economy is one which is characterised by activities which emit low levels of carbon dioxide into the atmosphere. With estimated emissions of 15.4 million tonnes of carbon dioxide equivalents per person each year, the tenth highest globally⁶, the UK is some way from this standard. The 2008 Climate Change Act has committed the UK to reduce its emissions by 18 per cent from 2008 levels by 2020 and 80 per cent by 2050. Through the EU we have committed to cut our emissions by 20 per cent of 1990 levels by 2020 and to renewably source 15 per cent of our energy by 2020. Meeting these targets will require a switch away from the use of fossil fuels, or a dramatic expansion in forms of carbon offset.

The drive to cut carbon dioxide emissions is repeated in many economies across the globe. This is increasing demand for activities which promote more efficient use of fossil fuels and prevent the release of carbon dioxide. New fuel efficient hybrid engines, the insulation of older buildings and intelligent building control systems are examples of technologies, processes and services which meet this need. Collectively these activities are also known as the low carbon economy. This work orientated interpretation of the term is the focus of this research.

The low carbon economy can be best understood as the range of activities which are materially supported by the need to reduce the release of carbon dioxide into the atmosphere. This umbrella concept covers activities:

- Focused directly on using fossil fuels more efficiently (such as hybrid vehicle technology);
- That prevent the release of emissions into the atmosphere, or remove carbon dioxide from the environment (such as carbon capture and storage facilities);
- That support the transition to less carbon intensive operations (such as carbon finance and carbon trading activities).

Despite coining a range of related descriptive titles (green economy, green-collar jobs, the environmental economy, eco-industry⁷) agreement on a consistent working definition of the low carbon economy has proved impossible. This chapter describes progress towards a definition and looks at the existing scale of the activities which they describe.

⁶ Calculation by the Norwegian University of Science and Technology (<http://www.carbonfootprintofnations.com/index.php>) includes the carbon footprint of our imports and exports

⁷ See GHK (2009) for a detailed list of examples and sources

**Towards a
definition of
the low carbon
economy**

While it is easy to point to individual examples of the low carbon economy, the development of a definition which can support meaningful analysis has proved particularly problematic. A fundamental difficulty relates to the breadth of activities which could conceivably contribute to lowering carbon dioxide emissions. Polin et al. note that these span research and development, design, production, marketing and retail, transport and distribution, assembly, installation, maintenance and support services including, legal, information technology and technical consultancy (Polin 2008). The United Nations Environment Programme (UNEP) report highlighted that ‘Green Jobs’ are not confined to private business, but also span ‘government offices (standard setting, rule-making, permitting, monitoring and enforcement, support programs, etc.), science and academia, professional associations, and civil society organisations (advocacy and watchdog groups, community organisations, etc.)’ (UNEP 2009). Given this diversity, it is immediately apparent that standard industrial classifications or occupational groupings cannot adequately describe the low carbon economy.

The debate is further complicated by confusion between the notion of low carbon economic activities described above and the concept of ‘green jobs’. The latter is a much broader notion which also spans natural resource dependant activities (such as agriculture and fishing), environmental protection and management (such as pollution control), and activities which derive benefits from environmental quality (such as eco-tourism).

To address these issues a number of typologies have been developed.⁸ These fall into three broad groups:

Environmental goods and services:

These definitions focus on the provision of goods and services which are viewed as directly environmentally beneficial. The EU and OECD have developed a definition of eco-industries based on the notion of activities which ‘measure, prevent, limit, minimise or correct environmental damage’. The Centre for Economic Environmental Development (CEED) have developed a list of industries based on a similar rationale (CEED 2009). These definitions are appealing as they are easily understood. They also broadly correspond to sub-divisions of existing industrial classifications, meaning they are typically easy to measure.

However, by focusing only on activities which are directly environmentally beneficial, they exclude a range of important aspects of the low carbon economy. Carbon trading activities are only of benefit to their environment indirectly, through the impact of price signals which arise

⁸ A number of these have been summarised within Annex Table A1: Contrasting definitions of low carbon economic activity

because of their activities. They would therefore be excluded by this definition, but represent an important part of the economy's response to pressure to reduce emissions. Similarly the construction and operation of new nuclear power stations is excluded from this definition, but perversely from the perspective of the low carbon economy, decommissioning existing plants would be included.

Cleantech business and activities:

A number of definitions have been developed which define low carbon activities based on the operations of individual business. Cleantech is a term which has been used to describe a focus on technologies and related business models which improve the efficient use of natural resources. Ernst & Young's green business definition identifies firms which 'have made efforts to introduce low-carbon, resource efficient, and/or re-manufactured products, processes, services and business models, which allow them to operate and deliver in a significantly more sustainable way than their closest competitors.' (Ernst and Young 2008).

Unfortunately, these definitions go beyond the notion of low carbon economic activities. Processes which use any natural resources in an efficient manor will meet these criteria and therefore be included. A firm that organises its production in ways that use less space (using land more efficiently), would, for example, be considered a cleantech business.

Beyond this theoretical consideration, the practical use of these definitions is severely limited. Identifying activity as cleantech may necessitate case by case study of businesses, or even individual plant or branch operations.

Market groupings:

In contrast to the operation-level definitions above, industry based groupings look to build up a picture of the low carbon economy by focusing on markets for individual low carbon goods and services. The definition developed by Innovas (Innovas 2009) and used by the government in the Low Carbon Industrial Strategy (BIS and DECC 2009) and the Low Carbon Transition Plan (DECC 2009) maps the sector in this way.

A strength of this approach is that grouping businesses into markets greatly supports data collection and analysis. This supports analysis across the breadth of low carbon economic activities. However, these definitions rely on the development of a list of markets deemed to be the low carbon economy. Therefore, rather than describing the low carbon economy on a fundamental principle, they analyse activity which is deemed to be low carbon on some other logic.

These definitions are therefore heavily reliant on the quality of the listing process. They can also only ever represent a snapshot of the low carbon economy – the list will need to be continually updated as innovations create new markets for new goods and services.

As noted above, a pervasive theme within these definitions is the joint consideration of goods and services which are of benefit to the environment and those that specifically relate to the low carbon agenda. These concepts are often related. Many environmental goods and services are inherently low in carbon nature. Similarly, the low carbon agenda is ultimately associated with mitigating the risks of environmentally damaging climate change. However, the notion of environmental limits and climate change risks are inherently different, and the study of the low carbon economy necessitates a distinction. This complexity, inherent to many of the definitions described above limits their power to describe and support analysis of the low carbon economy.

Given that the lists of markets approach can be broken down between low carbon and more general environmental goods and services, and the industry grouping based definitions' power to support the mapping of the diversity of the low carbon economy, we have focused on this definition throughout this report. It is worth noting however, that this breadth of definition does limit its conceptual power. By describing a broad range of activities the extent to which they can be expected to respond in a similar way is greatly diminished. This issue is explored in detail within the next section.

Box 1: Mapping the 2010 low carbon economy

A large volume of research has been produced which estimates the current scale and nature of activities related to this agenda, although these do cut across a range of different definitions. Headline figures include:

The global scale of the low carbon economy:

- UNEP (2007) – 2.3m workers employed in renewable energy sectors. The majority of which are located in countries at the forefront of renewable technology innovation and development – Germany, Japan, China, Brazil and the US;
- UKCEED (2006) – \$457bn valuation of the global environmental goods and services market in 2004;
- Innovas (2010) – £3.2trillion valuation of the global market for low carbon environmental goods and services in 2008/09, 48 per cent of these sales were identified within the emerging low carbon sector;
- GHK (2009) – 2.3m workers directly in 'green jobs' and 4.6m indirectly in the EU in 2007.

Cont.

Cont.

The scale of UK low carbon economic activities:

- DTI & Defra – £16bn valuation of the environmental goods and services sector in 2004, employing 400,000;
- UK CEED (2006) – 400,000 workers in emerging markets in the environmental sector;
- Innovas (2010) – £112bn valuation of the market for low carbon environmental goods and services in 2008/09, 50 per cent of these sales were identified within the emerging low carbon sector.

Analysis of trade data and FDI flows, conducted by Ernst and Young (2009), identified the following five key industries as potential areas for exploitation of strengths related to this agenda, related to specific sub-sectors:

- Software;
- Electronic equipment;
- Business services;
- Financial services;
- Machinery equipment.

Existing UK low carbon economic strengths (as noted by Innovas (2009)):

- Renewable energies – wind, photovoltaics, wave and tidal in particular;
- Nuclear power (operation in particular);
- Alternative fuels;
- Building technologies;
- Green finance.

Geographical concentrations of relevant economic activities (as noted by BIS (2009)):

- Green finance and carbon trading in London;
- Advanced engineering and materials in South Yorkshire;
- Clean technologies in Cambridge, Bristol and Bath, Manchester, a central region from Huddersfield to Sheffield and Greater London;
- Natural environment management/science, water management and water/wastewater treatment and energy management and emissions control in Peterborough;
- Renewable energy, waste management, water and waste water treatment and energy management in the West Midlands;
- Potential for cluster development around carbon capture and storage infrastructure and expertise in Yorkshire and the Humber, the Thames Estuary, Firth of Forth and Tyne Tees, and low carbon vehicles, perhaps in the West Midlands and North East, nuclear energy in the North West and marine energy in the South West.

2. Predicting the future growth of the low carbon economy

Given the UK's existing low carbon strengths, and the likely continuation of pressures to de-carbonise activity, we expect the low carbon economy to be a significant job creator over the next ten years. However, predicting the scale and nature of this employment is particularly problematic.

A number of studies have sought to predict the scale of all low carbon industries and their employment, both globally and in the UK. A selection of these are presented below:

- Innovas (2009) global growth of low carbon environmental goods and service markets from £3trillion in 2007/08 to £4.3trillion in 2014/15 – a rate of 5.3 per cent per annum;
- UNEP (2007) global growth in green jobs from \$1,370bn now to \$2,740 by 2020 – a rate of 5.5 per cent per annum;
- Innovas (2009) UK low carbon environmental goods and services growth from £107bn in 2007/08 to £155bn in 2014/15 – a rate of 5.5 per cent per annum This rate of growth has been lent credence by an update suggesting that the sector grew 4.3 per cent in the year to 2008/09 (Innovas 2010);
- ICCF Global (2005) UK annual job losses associated with Kyoto commitments estimated at 336,000 by 2010, increasing to between 394,000-673,000 depending on target levels;
- BERR, DIUS (2008) UK creation of one million jobs in the low carbon environmental goods and services sector by 2030.

A larger body of work focuses on the job creation potential of individual industries within the low carbon economy. By way of an example, a range of projections for the future development of the wind energy generation sector in the UK are presented below:

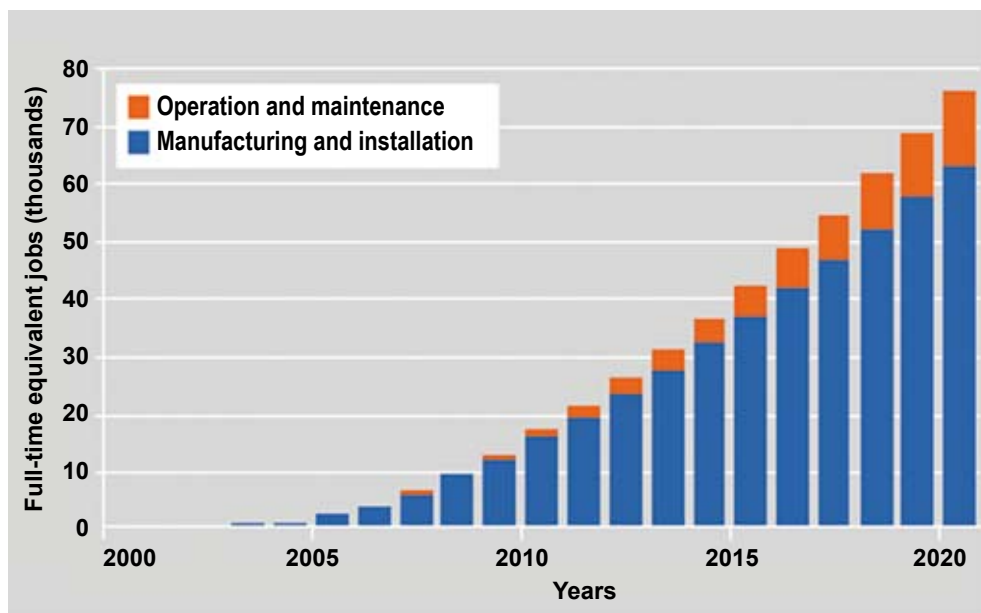
- SQW Energy predict growth in employment from 4,800 to between 23,100 and 56,900 (FTE) by 2020 – an increase of 25 per cent to 42 per cent per annum;⁹
- Innovas (2009) predict the sector will grow from 87,500 jobs in 2007/08 to 156,800 in 2014/15 – a growth of 8.7 per cent per annum;
- Carbon Trust (2009) estimate 40,000-70,000 new jobs could be created in a UK offshore wind industry spanning research and development, engineering and design, manufacturing and operation;
- Bird (2009) identified forecasts for the sectors job creation to 2020 of 23,000 to 70,000 jobs;

⁹ Research conducted for British Wind Energy Association, cited within GHK (2009)

- Estimates from the Crown Estate identify planned investment in UK offshore wind energy in excess of £100bn, which they have associated with the creation of 60,000 new jobs.

Figure 2 below graphically illustrates potential job creation benefits associated with one scenario for the future development of the wind industry.

Figure 2: Cumulative additional UK employment in offshore wind industries



Source: Taken from Greenpeace (2004)

These industry specific predictions show very high expected rates of growth, frequently in excess of 10 per cent per annum. Growth at this rate would be highly exceptional. The highest annual growth rate of any significant industry in the UK over the past ten years has been 12 per cent.¹⁰ These estimates predict a rate of growth dramatically in excess of those seen in the nineteenth century industrial revolution.¹¹

In addition to predicting such exceptional rates of growth, there is a notably high variance between the rates of growth predicted by different reports and broad ranges within forecasts. This divergence in findings relates to inherent difficulties predicting future employment in low

¹⁰ Between 1998 and 2007, all four digit (SIC2003) industries employing in excess of 1,000 workers – of 452 sectors, only four averaged double digit employment growth. Source: Annual Business Enquiry, Nomis (2009)

¹¹ Francis Crouzet (1982) which saw employment in mines grow by only 2.7 per cent per annum between 1844 and 1911, and employment in cotton factories grow by 3.0 per cent per annum between 1814 and 1860

carbon economic activities. The power of any projections are limited by the weakness of the definition, endemic uncertainty surrounding future job creation and unanswered questions about the likely extent of job losses associated with a reduction in carbon emissions.

**Predicting the
indescribable
– too broad
a definition**

As noted above, the concept of low carbon economic activities has proved illusive. The strongest definition is that of low carbon environmental goods and services. These represent a collection of industries and markets which currently derive value from the provision of goods and services that embody less carbon dioxide than their traditional alternatives.

The breadth of activities covered within this term has proved particularly attractive to policy makers, and forms the basis for industrial policy.¹² While this approach is very helpful when identifying low carbon activities, its breadth and the heterogeneity operations covered limit its power as an analytical tool.

Typically, when forecasters look to understand change or to predict the future growth of economic activities, similar operations are clustered together on the basis of commonalities such as skill requirements, markets or processes. These grouped activities can then be reasonably expected to respond in similar ways to external trends, drivers and shocks. For example, firms engaged in advanced manufacturing activities could be expected to be characterised by broad similarities in terms of skills needs, workforces, markets and supply chains. They can therefore reasonably be expected to provide a common response to external price shocks, for example.

Low carbon economic activities do not exhibit these common themes. Activities as diverse as carbon finance or the installation of loft insulation have been grouped together solely on the basis of their potential to meet demands to cut emissions. These industries are likely to respond in very different ways to increases in consumer demand for low carbon products.¹³ It is unreasonable then to expect these activities to respond in similar ways to changes in drivers unrelated to the low carbon agenda.

Since low carbon economic activities cut across such a broad range of enterprises they are only one of a range of defining characteristics for an industry. For example, the offshore wind industry is a manufacturing sector with close links to aeronautical engineering and offshore oil and gas exploration, a mechanical maintenance industry, an undersea electricity distribution

¹² In the form of the UK Low Carbon Industrial Strategy (BIS and DECC 2009) and the Low Carbon Transition Plan (DECC 2009)

¹³ For example increasing consumer demand for sustainable consumption could be expected to boost domestic energy efficient retrofitting activity, but not trade in corporate emissions permits

sector, as well as a source of renewable energy. These non carbon-related characteristics may be just as relevant in predicting their future development, but cannot be readily considered under a low carbon badge.

Since the activities of the low carbon economy are not primarily influenced by the same set of drivers, it does not necessarily make sense to predict their growth in a collective top-down fashion. In this way, the concept of the low carbon economy can be best viewed as a construction, rather than a suitable subject for industrial policy. Indeed, the government's own Low Carbon Industrial Strategy acknowledges that 'The low carbon 'sector' is not a sector as such, more an emerging 'cross-sector market'.¹⁴

This assertion does not deny the importance of low carbon economic activities, either in terms of their potential to create jobs or to mitigate against the risks of climate change. Instead it merely acknowledges the limitations on the power of the low carbon economy as a suitable sector for analysis.

**Predicting the
unpredictable
– endemic
uncertainty
of growth**

In the face of issues with the collective study of these activities, research has focused on individual industries. This avoids the typological issues discussed above, but unfortunately, demand and supply cannot readily be predicted for many of these activities. The high variance in predicted industry growth rates above is illustrative of pervasive uncertainty about the future of these industries.

Unreliable demand

Demand for low carbon activities is already substantial and is widely expected to increase. As noted above, future oil price rises are expected to increase demands for alternative sources of energy. More stringent environmental targets¹⁵ are also expected to boost demand for activities which mitigate against and reduce carbon dioxide emissions. However, the timing and scale of any increases in the need for, or willingness to pay for low carbon alternatives is less well understood. Three closely interrelated factors will determine the nature of demand in each low carbon market: scientific knowledge and understanding, consumer preferences and public policy.

Despite a developing consensus about the risks of climate change, there remains divergence in terms of the levels of carbon dioxide abatement measures required, or how these can be

¹⁴ Department for Business, Innovation and Skills, and Department of Energy and Climate Change (2009)

¹⁵ Even without any additional regulations, the implementation of existing agreements (such as the Large Combustion Plant Directive) will represent a regulatory tightening

best implemented.¹⁶ A recent poll from the Brookings Institute (2010)¹⁷ identifies a growth in the percentage of Americans who are sceptical about climate change, widely attributed to the recent 'Climategate' scandal. A new Ipsos Mori study found the proportion of British adults who believe climate change is 'definitely' a reality fell by over 30 per cent over the past twelve months, and the ranking of the importance of climate change within voters' biggest concerns has fallen significantly.¹⁸ This highlights the fragility of the consensus on the need to reduce emissions, which drives demand for these activities. Equally, future oil and gas supplies are notoriously hard to predict. There is a high level of uncertainty about the levels of reserves, and future costs of extraction. The notion of Peak Oil – the idea that oil production will in future slow compared to output, causing a dramatic increase in the price of oil – is also contentious.¹⁹

Given the scale of domestic and global markets for low carbon goods and services detailed above, consumer and business demand for these goods and services are already considerable. It appears that consumer demand for low carbon products and services has increased in recent years.²⁰ Research conducted for PriceWaterhouseCoopers found 75 per cent of the population claimed to have made significant changes to their lifestyles over the past two years as a result of their environmental concerns and show UK sales of sustainable goods growing to account for 4 per cent of total consumer expenditure on retail goods in 2007.²¹ Research by the polling organisation Populus (2009) suggests that consumer interest here has sustained well through the recession. It is also worth noting that interest in climate change issues is strong in many non-OECD Asian nations, including India and China.²² The continued growth of an increasingly affluent middle class could perhaps be associated with an expansion in demand for low carbon goods and services from these nations.

However, this consumer demand is a relatively new phenomenon, and it is hard to predict how this trend will develop or on which aspects of the low carbon economy it will focus. Environmental concerns, the environmental friendliness of products still represent a relatively small driver of consumer purchasing decisions.²³ Therefore a modest change in attitudes could

¹⁶ See, for example, Booker (2009) *The Real Global Warming Disaster: Is The Obsession With 'Climate Change' Turning Out To Be The Most Costly Scientific Blunder In History?* by Christopher Booker

¹⁷ Brookings Institute (2010)

¹⁸ Jowit, J. (2010)

¹⁹ Mcalister provides a succinct summary of this debate in an article posted on the Guardian's DataBlog site: <http://www.guardian.co.uk/news/datablog/2009/nov/13/peak-oil-iea-uppsala>

²⁰ See for example the growth of *Green* electricity tariffs DEFRA (2009)

²¹ PWC (2008). It is worth noting that it is not practical to separate consumption motivated by climate change concerns or that which is driven by wider environmental sustainability concerns

²² The National Geographic (2009) Greendex study identified the populations of many Asian countries including India and China as significantly more concerned about climate change than European and American nations

²³ When considering the features that consumers would be willing to pay more for in order to have a luxury product, environmental friendliness is consistently subordinate to aspects of quality – Future Foundation (2009) nVision Research

have a major impact on demand for these goods and services. Beyond this, it is particularly difficult to differentiate between consumer preferences for specifically mitigating against the risks of climate change and broader 'ethical living' and sustainability concerns. How the balance between these develops will have a major impact on the demand for low carbon goods and services.

Public policy has a major impact on the demand for low carbon economic activities. In addition to government procurement, taxes and subsidies directly influence the price of low carbon alternatives. Regulations placed on sectors as diverse as energy, manufacturing and construction will define how these sectors interact with the low carbon economy. As well as affecting the overall level of demand for low carbon activities, public policy can direct its focus. For example, the CBI have argued that the Renewables Obligation has biased energy production towards renewables at the expense of other low carbon alternatives (CBI 2009).

The Climate Change Act provisions within the Low Carbon Transition Plan (DECC 2009) and the new draft Nuclear National Policy Statement (DECC 2009) go some way towards providing some certainty around the likely shape of future government policy. However, the details of many aspects of policy are yet to be defined, such as long term energy policy.

Following Copenhagen, nine national governments and the EU have committed to some form of emissions targets, potentially setting the context for global public sector support for increased demand for low carbon goods and services. However, with the exception of the UK, these commitments are conditional of a global climate change deal.²⁴ It is, however, hard to predict how such an agreement will develop and therefore to anticipate the implications of this for future demand.

Unpredictable supply

The ability of UK low carbon industries to supply goods and services which meet this need, is also unknown. Across many low carbon sectors, technology is in its infancy. For example, despite not yet proving its commercial viability at full scale, we have noted above that the carbon capture and storage industry has already been predicted to create up to 60,000 jobs by 2030. Given the unpredictability of technological advances or their cost implications, there is inevitably a very high level of risk associated with such forecasts.

Many low carbon goods and services are highly tradable. The scale of these industries in 2020 will therefore depend on complex interactions between supply and demand in international

²⁴ United Nations Framework Convention on Climate Change, Annex 1 (2010)

markets. First mover advantages and cumulative circular causation patterns – where initial local strengths support the development of major export industries – are of particular relevance for these emerging markets (EUTC and SDA 2007). For example Germany's early implementation of investment in renewable energy is thought to have helped it to capture a significant proportion of the global renewables market (UNEP 2008). The development of global leadership in these industries in the past has been attributed to factors such as a secure and sizeable domestic market, strong political commitment and favourable economic support mechanisms (Bird 2009). It is not clear that this description characterises the current UK market very well.

The implication is that simply having the capacity to meet demand for low carbon goods and services will not necessarily translate into increased employment. Interactions with global markets can not be readily modelled at the macro level, and add another complexity to the already difficult task of predicting the future development of these new industries.

Uncertainty of future skills supply

The future supply of skills will be critical to the successful development of low carbon industries. In a skills supply system which is increasingly demand led, predicting long term skills supply for any industry represents a challenge. As noted by UKCES (2009)²⁵ weaknesses in matching employer needs with training provision and uncertainty about future funding mechanisms complicate analysis. These challenges are exacerbated in the case of skills for low carbon industries where there is a high level of uncertainty about the nature and scale of future demand for these skills, and because current demand from employers is particularly poorly articulated.

The broad coverage of the sector makes it very difficult to jointly consider the skills needs of all low carbon economic activities. In addition, as noted by the Sector Skills Councils many low carbon industries are in their infancy, and 'very little is known about their future skills requirements' (Sector Skills Councils 2009). The following broad ascertains regarding their nature can be made however:

- Manufacturing activities are highly relevant to existing low carbon economic activities – identified as 30 per cent of the low carbon environment goods and services (LCEGS) sector, compared to 20 per cent of UK employment by Innovas (2009). Assuming this level is maintained, technical skills are likely to be of particular relevance for this sector;
- In addition to general business skills (communication, leadership and management) science, technology, engineering and maths (STEM) skills have consistently been identified as of relevance for low carbon activities;²⁶

²⁵ UKCES (2009) *Ambition 2020: World Class Skills and Jobs for the UK*.

²⁶ See for example CBI (2008) or Sector Skills Councils (2009)

- Skills needs from a broad range of low carbon activities are understood to be significantly higher than in existing equivalents – as summarised below research commissioned by the European Commission has identified high level skills demands associated with a range of low carbon industries.

Table 1: Identified skills needs of low carbon activities

Carbon capture and storage (CCS)	<ul style="list-style-type: none"> • Technically more complex operations will involve workers with very different skill set.
Buildings	<ul style="list-style-type: none"> • Higher-skilled, higher-paying employment will arise due to energy-efficient equipment. • Jobs are likely to be performed by workers who already work in the building sector. However, these jobs will be redefined in terms of new skills, training, and certification requirements. • Potential will arise for highly skilled researchers and engineers. Extensive training needs in four main areas: diagnostic techniques, knowledge of renewable energy, installation, organisational skills (ie town planning).
Cement	<ul style="list-style-type: none"> • Jobs in this industry are expected to require higher levels of skills.
Wind power industry (renewables)	<ul style="list-style-type: none"> • Many of the positions will require highly skilled people. • Universities need to consider offering entirely new study fields and majors due to technology development.
Climate change	<ul style="list-style-type: none"> • Climate information and forecasting as well as R&D into crops adapted to new weather patterns have the potential to create specialized and high-skill employment.
Agriculture	<ul style="list-style-type: none"> • Jobs for agricultural skilled workers, for clerks and for craft and related trades workers will decrease. • The requirement for skilled agricultural and fishery workers will be about 2.2 million in 2015.
Electricity	<ul style="list-style-type: none"> • It is probable that together with technical competences management skills will be required.
Rail sector	<ul style="list-style-type: none"> • It appears that a dangerous shortage of skilled workers is emerging. This shortage of skilled workforce might take place by 2030.
Waste treatment and recovery/ recycling	<ul style="list-style-type: none"> • The quick technological changes in these sectors are creating an increasing demand for new skills.

Source: ECORYS (2008) commissioned by DG Environment (2008) Environment and Labour Force Skills

A number of studies have identified significant skills gaps across a range of low carbon industries, focusing on shortages of high-level STEM skills in particular.²⁷ The ways in which skills providers respond to these shortages will be a determining factor for the future development of UK low carbon economic activities.

²⁷ See Bird (2009) for a survey of recent literature

Box 2: EDF Energy and low carbon skills

Following its recent merger with British Energy, EDF Energy is Britain's largest energy generator, and the world's largest nuclear power generator. EDF Energy have stated their ambition to expand their nuclear operations in the UK and are already consulting on the development of a number potential sites.

They have however identified considerable skills requirements to support their operations. The age structure of their current workforce is expected to create a major demand for new technical staff. Over 50 per cent of their existing nuclear engineers, technicians and apprentices are over 45 and 18 per cent are scheduled to retire by 2015. In addition to this replacement need, they have estimated their new nuclear operations will require approximately:

- 750 qualified engineers;
- 600 technicians and craft skilled staff;
- 200 clerical and ancillary workers.

Given the high skill level of their existing workforce (75 per cent hold level 3+ qualifications compared to the national average of 50 per cent, and 43 per cent hold level 4+ compared to 31 per cent nationally), this expansion is likely to represent a major demand for highly skilled workers.

Source: EDF Energy (2009). Skills Opportunities and Challenges in a Low Carbon Economy

Uncertainty surrounding the future scale and composition of these low carbon activities also presents a major challenge for understanding how skills supply will need to expand to meet demand. Predicting the adequacy of skills supply requires an understanding of the likely future scale of activities which will generate demand. As argued throughout this section, we cannot reliably predict the scale of these activities, further complicating the future skills analysis. This is much more than an academic skills prediction issue. Individuals selecting what skills to invest in require clear signals and businesses need clear signals to invest in training. If these signals are not clear, then investment is less likely to occur.

International interactions in the supply of these skills complicate our understanding of the likely scale of future demand further still. If global demand is simultaneously increasing for these low carbon activities, then this may cause leakage as UK trained workers move abroad, and will directly impact on the ability of UK business to import skills to meet particular shortages.

In a demand led skills delivery system such as the UK, training organisations can only respond to the demands of students, rather than central targets, or government strategic objectives. Training cannot therefore be offered before individuals and corporations deeming it to be of value – strategic leadership is almost impossible. This is a particular issue for low carbon activities. Research conducted by Pro EnviRo for Defra (2009) concluded that while there were a number of skills gaps affecting the supply of workers for low carbon industries, there was only latent demand for low carbon skills.

'Demand is not currently being articulated by employers and as a result the current skills delivery framework is ill equipped to anticipate and respond. Organisations do not have the right levels of understanding of the skills requirements and implications of a LCREE [Low Carbon and Resource Efficient Economy] and consequently of the importance and potential benefits of integration of LCREE skills into their businesses. Only when these links and a clear business case are made will businesses demand LCREE training. This leaves us in a 'Catch 22' situation – understanding and awareness are the key to stimulating demand for skills but in a demand led skills delivery system, an expression of demand is required from the organisations for the skills delivery sector (especially SSC's) to respond to.'

Pro EnviRo (2009)

The government now accept that this lack of strategic direction within skills supply presents a challenge for these changing industries and have set out a range of initiatives to address this issue. These focus on addressing a perceived 'information gap' relating to skills needs in these industries. A collaborative approach has been advocated to produce this information, based on joint working between employers, Sector Skills Councils, the UK Commission for Employment and Skills (who are to produce an annual National Strategic Skills Audit), and the Regional Development Agencies (who are to lead on Regional Skills Strategies). A new Skills Funding Agency will be established to take account of this information and to implement the National Skills Strategy. It is hoped that this, together with a more skills aware approach to public procurement, will ensure that the needs of developing industries such as low carbon activities can be met in a more stable and predictable way. While it is too early to judge the impacts of these interventions, the challenges of predicting the future development of these activities (and therefore their skills demands) are likely to remain, both from the perspective of the UK, and from the added complexity of international interactions.

Implications

The significance of the many unknown factors listed above limits the extent to which we can rely on the results of such studies. In building projections for the future growth of individual low carbon industries, researchers are forced to make assumptions about future demand from science, from consumers, and from public policy, about how supply will be influenced by technology and skills and the ability of UK operations to win global market share. Research choices about these assumptions dominate projections, masking the core drivers of the low carbon economy.

Predicting net job creation and the low carbon economy

Job creation opportunities are not the only economic impacts associated with the transition towards a low carbon society. By restricting the operations of business, or by increasing the costs of continued operation, the transition towards a low carbon economy presents risks for a broad range of activities.

Very few studies have sought to quantify potential job losses as well as job losses associated with the transition towards low carbon activities. One study, commissioned by the EU did look to estimate the net job creation impact of 2020 targets for renewable energy (Ragwitz et al. 2009). This reached the rather unsettling conclusion that the likely net job creation impacts of these measures was likely to be negative or very slightly positive – the UK's limited manufacturing base for renewable energy technologies was thought to be a limiting factor. However it is worth noting that this study only focused on a subset of low carbon economic activities – renewable energy.

If carbon dioxide emissions are to be cut by 80 per cent by 2050, then most activities will face major challenges as they are forced to decarbonise. The more modest 2020 targets leave more room for flexibility in how this reduction is achieved. The sectors, and by implication the jobs particularly at risk over this horizon, are those which are particularly carbon intensive – release the largest amounts of carbon dioxide per unit of output. This implies that energy production from coal, oil and gas, extractive industries, air and land transport and energy intensive manufacturing industries are likely to be particularly at risk. Table 2 on the next page summarises current employment in these industries in Britain.

While identifying employment at risk is relatively straightforward, it is particularly difficult to translate this into a meaningful estimate of likely job losses by 2020. The challenges each subsector face are highly complex and difficult to predict. For each product a number of key factors will determine the level of risk:

Table 2: Carbon intensive industries in Britain

Sector	Employment
Mining of coal and lignite; extraction of peat	5,914
Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying	29,323
Electricity, gas, steam and hot water supply	86,213
Land transport; transport via pipelines	533,165
Air transport	91,830
Energy Intensive manufacturing (Carbon Trust Classification)	107,697
Total	854,142

Source: The Work Foundation calculations based on Nomis (2009) and Carbon Trust (2008) data

Note: Comparable estimates of employment in renewable and non-renewable sources of electricity, gas, steam and hot water supply not available.

Note: Further data requested from Carbon Trust to confirm manufacturing estimates.

- Availability of alternatives – The existence of renewable forms of energy supply increase the risk of job losses in fossil fuel consuming energy supply. Conversely in activities such as international air travel there remains little alternative but to rely on fossil fuels – implying these jobs may be less at risk. Unfortunately, predicting the future availability of all low carbon alternatives is not a practical exercise;
- Tradability – The future of these carbon intensive industries will depend on the ability of consumers to source carbon intensive goods and services from outside of the UK. This will in turn depend on future import regulations, and costs of transport;
- Ability of sector to adapt – Ultimately the level of job losses within these sectors will depend on how the sector adapts and moves towards new low-carbon ways of working. The automotive industry is an example of a sector which produces a product heavily reliant on fossil fuels, but one which is also investing in low carbon alternatives. The ability of industries to adapt to lower carbon ways of working is particularly difficult to predict.

It is clear that predicting the potential job losses associated with a move towards low carbon means of production is not a practical proposition.

Implications

Overall, it is clear that the transition towards a low carbon economy will be associated with creation of new work, but is also likely to make some employment obsolete. Attempts to predict the balance are hampered by the difficulty inherent to jointly considering these activities, pervasive uncertainty about the future of supply and demand for individual low carbon economic activities and the future of carbon intensive activities.

3. Future scenarios for the low carbon economy

Given the high levels of uncertainty surrounding the future shape of low carbon economic activities, we have not advanced another forecast of their likely development for our 2020 outlook. Instead, we have followed a scenario based approach to consider the future of the low carbon economy.

By looking forwards to imagine future options for development it is possible to explore and understand the job creation potential of the full spectrum of low carbon opportunities. It is possible to consider the likely nature of this employment, and to think more broadly about what is desirable about each of these futures. With a vision set for each scenario it is then possible to cast back to consider how such a vision could be realised. By comparing this path to the current direction of travel, it is possible to identify the blockers which are preventing the achievement of the positive aspects of these scenarios.

This paper presents three scenarios for the development of low carbon activities over the decade to 2020. All three are based on the expectation that demand for activities which require carbon dioxide will continue to expand, but differ in how this is reflected within economic activity. The scenarios reflect a future for the low carbon economy focused on:

- **Scenario 1** – The successful development of economic activities focused on reducing carbon emissions through the implementation of existing and developing technologies – a low carbon technology implementation sector;
- **Scenario 2** – The development of world class, export orientated low carbon activities based on manufacturing – a manufacturing led growth in low carbon activities;
- **Scenario 3** – The development of world class, export orientated low carbon activities based on business, financial and technical services – a low carbon services led sector.

Although it is highly likely that any future low carbon economy will be based on a mix of implementation, manufacturing and service activities we believe that these three scenarios make it possible to focus on different aspects of the debate, and highlight distinct activities, driven by very different drivers.

For each scenario we have developed a vision setting out how each might be plausibly achieved, building on existing relevant strengths and reasoned judgement. Drawing on existing research, we have considered the implications of such a vision in terms of the scale and nature of likely job creation. Thoughts on the likely implications of each scenario were refined and developed through a scenario development workshop hosted in February 2010 and attended by

a broad range of policy makers as well as those engaged in delivering and procuring low carbon goods and services. This event proved particularly helpful in considering the blockers that might prevent the realisation of each of these aspirational visions.

Scenario 1:

A low carbon technologies

implementation sector

A vision based on the creation of jobs using and installing technologies which reduce carbon dioxide emissions from the power sector, our homes and workplaces, and transport.

This vision is based on changes in three key areas of activity creating new work. These are the jobs most clearly associated with the low carbon agenda – activities related to directly mitigating against carbon dioxide emissions:

- **Power sector** – construction of renewable energy installations and new nuclear reactors. Focus on installation rather than technology development;
- **Homes and workplaces** – major building retrofit programme (insulation, glazing, smart metres, ground pumps, solar-thermal installations, combined heat and power (CHP) systems);
- **Transport** – promotion of low carbon vehicles (LCVs) for use in public and private transport as well as and increasingly sustainable travel and transport choices – ie increasing use of public passenger transport and use of rail and inland waterways for transport of goods.

It is clear that this vision can be associated with significant employment generation, particularly in the construction and maintenance activities given their highly labour intensive nature. It is less clear however that changes to transport will generate significant net increases in employment. However, the skills demands associated with any new employment from these construction and maintenance activities could be focused on relatively low skill level employment.

In the case of the power sector, the focus on installation rather than technology development implies imports of foreign technology, designs, major components, and even senior management services, all of which embody high-level skills inputs. UK based construction activities would be likely to focus on low skilled manual labour, although there would be substantial demands for highly skilled engineers. However, by their nature, contracts are likely to be predominantly short-term and works will be distributed across the country. As noted above, operational and maintenance activities associated with this infrastructure are understood to be more labour intensive for renewable energy supplies. However, it is not clear that this pattern would sustain, once the use of these was fully mainstreamed.

The construction and maintenance activities associated with a major building retrofit programme would also be highly labour intensive, implying that these activities may have substantial employment creation impacts. However demands will be strongly biased towards low skill employment since the skills required for these installations are very similar to those for non retrofit building maintenance – indeed, the installation of many low carbon technologies demands experience working with these technologies, but often does not require any additional technical skills.

An expansion in the use of public transport could represent a new source of employment, however, there is little reason to suspect that sustainable transport choices will be associated with net employment creation opportunities. Indeed a reduction in the total number and distance of journeys associated with the agenda could impact negatively on transport related employment.

As these activities focus on the delivery of predominantly local services (in that they require labour inputs to be located close to their applications), there is little scope for international penetration and competition in their delivery. Equally it is unlikely that this sector could generate substantial export revenues. Indeed, the purchase of these products and technologies used by the sector could inflate imports. This scenario should therefore be viewed as the least ambitious, or as a base case. It reflects activities and employment creation which can be expected to develop from public, consumer and business spending to mitigate against carbon dioxide emissions.

These comparatively modest ambitions do not imply however, that the development of this sector is inevitable. Two major uncertainties remain potentially blocking the development of a strong low carbon technologies implementation sector. These relate to the adequacy of frameworks to support the long term investment required in infrastructure items and concerns relating to demand for these activities. Together these retard investment, stifling the potential employment generation of this scenario.

Analysis by the Policy Exchange suggests that the UK's current infrastructure investment regime is inadequate to meet the needs of the UK over the coming decade, which include considerable investment in low carbon and energy infrastructure.²⁸ The analysis also notes issues with the PFI arrangements for financing many infrastructure investments, which have been favoured in recent years.

²⁸ Helm, D., James Wardlaw and Ben Caldecott. (2009)

Supporting this call for action, the Institution for Civil Engineers have made the case for a new investment institution (a national infrastructure investment bank, initially capitalised by government and then able to use the government's AAA rating to raise funds on international markets²⁹) to deliver schemes of national importance. Echoing this need for action is the call from the Green Alliance for the establishment of a green investment bank to support investment in low carbon projects where market barriers prevent investment.³⁰

Recent [evidence](#) from the Breakthrough Institute and the Information Technology and Innovation Foundation points to the scale of the issue.³¹ China, South Korea, Japan and the United States have together committed to invest close to \$700bn of public money over the next four years in clean energy technologies alone. In contrast, despite an identified need to attract £35-50bn investment in 'power stations wind farms and gas storage to hit government objectives for cutting carbon dioxide emissions while guaranteeing reliable electricity supplies'³² in the next three years and £136bn investment in renewable energy in the UK by 2020 (based on the Policy Exchange calculations noted above) no clear framework for how this will be funded between public and private sources yet exists. Without such a framework, the private sector cannot be expected to commit funds on this scale.³³

The announcement in the 2010 Budget of a green investment bank represents a much needed initiative. It will operate on a commercial basis, using public and private funds to invest in predominantly low carbon infrastructure schemes. The scale of investment in the fund (£1bn from the public sector, to leverage at least £1bn from the private sector) is, however, only a fraction of the investment required in this agenda. Andrew Simms, policy director and head of the climate change programme at the New Economics Foundation likened the scheme to 'sending someone out to organise a wedding with only enough money to buy a packet of peanuts' (NEF 2010).

Illustrating the issue of uncertainty regarding the future of these activities, the text box below highlights the broad range of options currently being considered for the future financial structure of the UK's energy supply. With such breadth of options, and uncertainty about which will bring results, private investors can not accurately estimate likely future returns from this sector and can not therefore be expected to invest. This uncertainty over energy policy and the regulatory framework has been associated with the risk of an 'investment hiatus'.³⁴

²⁹ Institution of Civil Engineers (2009)

³⁰ Green Alliance (2009). Establishing a Green Investment Bank for the UK

³¹ Breakthrough Institute and Information Technology and Innovation Foundation. (2009)

³² Ernst and Young research reported within the Financial Times (Crooks 2010)

³³ Existing policy and areas of committed spending are discussed in detail in the final section of this paper.

³⁴ Ernst and Young research reported within the Financial Times (Crooks 2010)

Box 3: Energy infrastructure policy options

The energy regulator, the Office of Gas and Electricity Markets (Ofgem), has recently launched a consultation on options for delivering future energy supplies in the UK. As well as presenting the issues and challenges facing the power sector, and the options for development, this document presents the uncertainty about the future nature of the industry.

Context:

The decline of indigenous gas supplies, the need to make demanding cuts in carbon emissions levels as well as to replace ageing parts of the energy supply infrastructure are cited as drivers for change within the UK's energy supply infrastructure. Ofgem estimate that £200bn of investment may be required by 2020.

Issues:

The analysis identifies five key issues, which together represent a major cause for action:

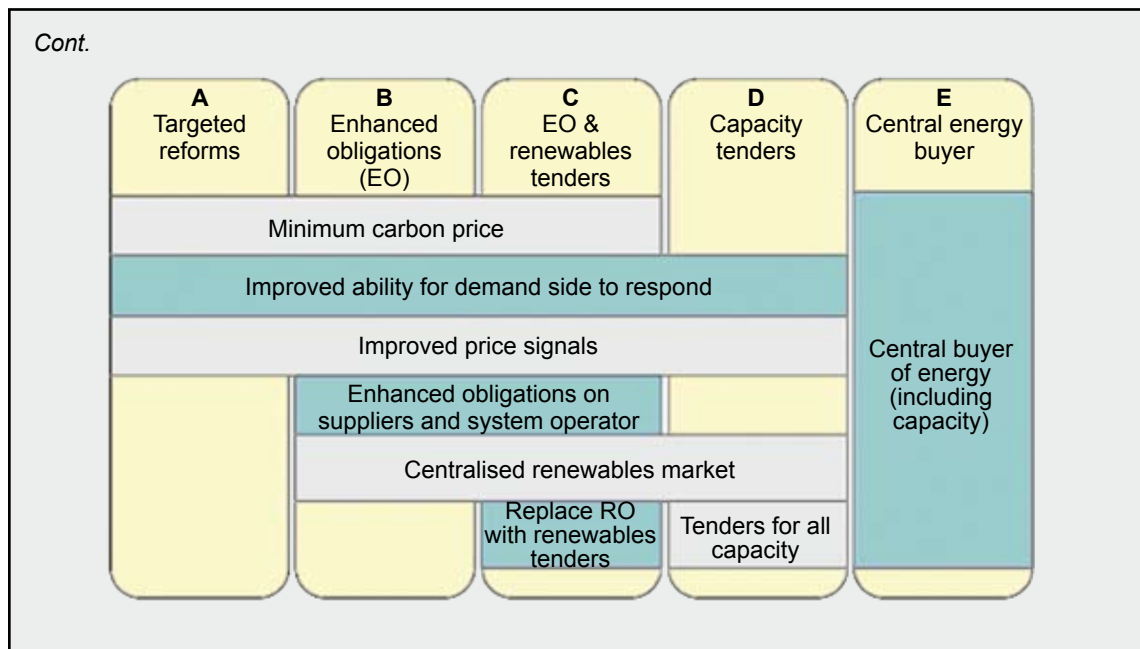
- The need for unprecedented levels of investment over an extended time period;
- Uncertainty relating to future carbon prices is likely to delay or deter investment in these technologies, increasing costs of action in the future;
- Short term energy price signals at times of system stress do not fully reflect the value that customers place on supply;
- Interdependence with international markets exposes Great Britain to a range of additional risks which undermine GB security of supply;
- Higher costs of gas and electricity may mean that increasing numbers of consumers are not able to afford adequate levels of energy, and that competitiveness of industries and business many be affected.

Options:

The policies proposed to respond to these issues range from minor adjustments to the existing de-regulated market model, to the creation of a command and control system based on a centralised purchaser of energy and production capacity. The breath of the potential packages are illustrated below.

Cont.

Future scenarios for the low carbon economy



Source: Ofgem (2010) *Options for delivering secure and sustainable energy supplies*

In addition to current weaknesses in funding and financial frameworks for investment in infrastructure, poor spatial planning frameworks have historically held up infrastructure investments and deterred investment in the UK.³⁵ The 2008 Planning Act has limited this uncertainty by introducing a set of national plans and a streamlined process for major infrastructure projects. However, the benefits of the new system have yet to be fully demonstrated.

Additionally, while the act provides for the planning of nationally strategic infrastructure in a range of infrastructure categories, it does not compel any co-ordination between these plans – it is perhaps surprising that a Draft National Policy Statement for Nuclear Power Generation was produced for consultation in November 2009, in advance of the as yet unpublished draft statement covering planning and climate change, and renewable energy.³⁶ Commenting on the new system from a transport perspective, Professor Sir Peter Hall, the Town and County Planning Association president noted that ‘England desperately needs an integrated transport investment strategy in which each piece of the system makes its own optimal contribution, linking together into a seamless web of efficient and sustainable connections’³⁷, however

³⁵ Extensive coverage of this legacy issue can be found within the 2007 Planning White Paper – Planning for a Sustainable Future <http://www.communities.gov.uk/documents/planningandbuilding/pdf/planningsustainablefuture.pdf> contains a summary of these issues.

³⁶ Department for Communities and Local Government (2010)

³⁷ 24dash.com (2010)

the criticism applies equally strongly to all forms of infrastructure. Without joined up planning systems, investors can not be confident about the future demand for, and returns from these assets.

The announcement in the 2010 Budget of a strategy for national infrastructure (from Infrastructure UK), and a Treasury and DECC energy market assessment offer some optimism that such a joined up strategy spanning water, waste, transport, energy and communications infrastructures may be developed. It is unclear how this strategy will relate to wider notions of infrastructure such as housing, urban growth boundaries or other social and environmental infrastructures.

The national infrastructure strategy is expected to take 12 months to produce an action plan. This is unfortunate, as noted by the CBI in response to the budget's measures 'time is of the essence, and we need to see decisive action by the end of the year to convince companies to locate large-scale, low-carbon investments in the UK' (CBI 2010). It also remains unclear how these two new pieces of work will relate to each other, the existing work of Ofgem (described above), or the developing national policy statements. It is also unclear how such a strategy would be implemented through funding and planning systems.

Similarly to the inability of private investors to buy into these infrastructure items, uncertainty appears to be deterring some individuals from investing in related skills. As highlighted above, the supply of the STEM skills related to this infrastructure development represent a particular challenge. This issue is central to the realisation of the second scenario and is discussed in detail below.

In addition to these issues with major infrastructure investments, demand appears to be lower than could perhaps be expected for the retrofit activities described within this vision. A range of studies have identified strong positive returns from investments in such technologies, although pay-back periods vary.³⁸

However, despite substantial expansion, demand does not appear to be fully presented for these activities. The complexity of the situation which is holding back investment was reflected within the all party urban development group report Greening UK Cities' Buildings which identified the following barriers to retrofit activities: limited availability of information, awareness of existing government programmes, principal-agent issues relating to owner-occupier responsibility dilemmas, and the low price of carbon.³⁹ In addition, uncertainty regarding the

³⁸ See for example analysis contained within RICS (2008).

³⁹ All Party Development Group (2008)

future costs of energy impact directly on retrofit activities. The Department for Energy and Climate Change's recent household energy management strategy, does look to address this demand issue, and establish targets in this area. However this strategy does not detail how achieving these targets for retrofit activities will be funded.

Scenario 2:
Manufacturing
led growth in
low carbon
activities

A vision of UK technology at the cutting edge of a range of low carbon activities, supporting the export of high value products and support services globally.

Vision to be realised by building on a range of existing UK manufacturing and manufacturing service strengths related to this agenda including:

- Rapid implementation of new nuclear build programme, decommissioning of existing sites and waste handling in ways which develop a British supply chain designing and manufacturing components, potentially supporting the export of nuclear components and support services to many of our trading partners who have announced their intention to invest heavily in these technologies in the future;
- Exploitation of Britain's exceptional offshore wind capacity, supporting the development of a domestic manufacturing industry in ways which can lead the design, installation and operation of turbines and related infrastructure. Expansion as other European countries reach market saturation could be used to gain advantage in global markets;
- Development of tidal barrages for the Severn and Thames estuaries used to support the development of expertise with the potential for global export;
- Existing UK strength in the design, manufacture and servicing of aero engines built on through the development and successful marketing of highly fuel efficient units;
- The development and export of new products for the retrofit of existing buildings, including those particularly well suited to temperate climates and historic buildings;
- Export of products, systems and expertise relating to carbon capture and storage.

The successful development of these industries to serve domestic and global markets could therefore be associated with a significant expansion of employment in these manufacturing related activities. This employment could perhaps be best thought of as additional to that identified within the previous scenario.

Our recent report⁴⁰ found that manufacturing employment in the UK is increasingly focused on knowledge based manufacturing. Here, the development of competitive advantage is dependent on investment in intangible assets such as R&D, software, design, brand equity, and human

⁴⁰ Brinkley (2009) Manufacturing and the Knowledge Economy

and organisational capacity, rather than physical capital and low cost labour. It is likely that the future expansion of manufacturing in the UK would continue to focus heavily on knowledge intensive processes. We can expect this to be associated with a demand for a highly skilled workforce heavily focused on STEM skills.

Unlike the development of a domestic implementation technologies market, the outputs from such a sector are highly tradable over distance. These activities therefore rely on the ability of British companies to win business in new and emerging global markets, a much more challenging proposition. This will demand continuous innovation to maintain position, and in many cases move up global value chains to ensure UK products are globally competitive. The carbon capture and storage market, described in Box 4 below illustrates the issues facing these industries.

Box 4: Carbon capture and storage (CCS) market

As noted above, CCS refers to technical processes which prevent the release of carbon dioxide from the combustion of fossil fuels. This technology is particularly attractive as it allows the continuation of existing patterns of energy use. This market therefore has the potential to be the focus of considerable investment – for example the IEA estimate that between \$3.5bn and \$4bn will be required each year to 2020 in order to support the development of demonstration projects (2009).

The UK is perceived to be an attractive place for investment in these technologies since the sector is likely to draw heavily on our experience extracting North Sea oil and gas, and has succeeded in attracting two EU funded demonstration projects (see for example its high ratings in Ernst & Young [2009] Carbon Capture and Storage Country Attractiveness Index). Given the rapid expansion of coal fired power plants the developing economies of India and China, it is hoped that this could support the future export of CCS related technology and support services to these economies.

However, these advantages are far from unique, and many other countries are investing in this area. One speaker at the CBI's recent Energy Conference suggested that, given the scale and history of Chinese state investment in this industry, it may be more likely that in the future the UK will be importing their systems and expertise, than exporting these to them. Clearly considerable additional investment will be required if we are to become a global leader in this field.

When considering these innovative activities, understanding the interactions between the scenarios is important. Strong domestic demand is commonly thought to be an important driver

of innovation, so we can expect that successful innovation around the low carbon manufacturing agenda to draw on a strong low carbon technologies implementation sector. However, the specifics of existing manufacturing and manu-service activities, the wider UK innovation system, and crucially, investment in innovation will be central to the development of these highly innovative activities. This investment in innovation will include both public and private spending on research and development, design, organisational capacities, training and skills development, software development, market research and advertising and copyright.⁴¹

A number of high value added low carbon manufacturing activities are developing in the UK such as the Rolls Royce led Nuclear Advanced Manufacturing Research Centre (NAMRC). However, a range of barriers are retarding the development of these activities. Given the links between this sector and the low carbon implementation sector described in the previous scenario, it is impacted by the same barriers noted above. The key additional obstacle to the full-scale development of these manufacturing activities appears to relate to a shortage of skills which can support these advanced low carbon manufacturing activities. As noted above, uncertainty regarding the future development of these industries are holding back investment in the skills which would support its continued expansion.

Individuals' valuations of the likely future returns from investment in these skills, or the benefits from using academic training in STEM areas to pursue related careers appear to be inadequate to deliver a strong supply of suitably trained individuals to these careers.⁴² Similarly, if business are not confident regarding likely returns from their investments in training they can not be expected to invest. This rationale is understood to be holding up direct investment in these activities and in the low carbon supply chain.

This message is consistent with those regarding the supply of STEM skills for the major infrastructure initiatives considered within the first scenario. As noted by Sir John Rose, the CEO of Rolls Royce in a recent speech at the Science Museum⁴³, the challenge of the low carbon agenda represents major opportunities for British manufacturing related activities to derive value by developing new technology based solutions which meet this need. It is indeed unfortunate that we do not seem to be able to attract young people to develop and use these skills.

⁴¹ This categorisation of innovation investment areas draws on that set out in NESTA (2009)

⁴² HM Treasury (2006)

⁴³ Rolls Royce Awards Dinner 2009 http://science.rolls-royce.com/prizes/awards_dinner_2009/index.jsp

In the recent past, the UK has been successful in plugging high-level skills gaps by attracting talent through inward migration of highly skilled workers.⁴⁴ However, since the global expansion of low carbon economic activities has been associated with increased demand for STEM skills, these skills are likely to be in high global demand. The implication of this is that in the future we may struggle to attract individuals with such skills. We may also find it difficult to retain our graduates in the face of intense competition from other countries, particularly where there is a stronger wage premium associated with STEM skills.

Scenario 3:
Low carbon
services
led growth

Vision based on the development of world class business, financial and other services related to the low carbon agenda, serving domestic and global markets.

Although a step removed from what the low carbon economy is often imagined to be, many service activities also derive value by supporting a response to demands to reduce carbon dioxide emissions. This vision builds on recent UK experience developing compelling global offers in related service areas such as:

- Regulatory expertise – export of services drawing on Britain’s extensive experience working with environmental legislation and regulations. This could come in the form of support for governments and regulators (such as drawing on recent experience exporting environmental, planning and sustainability services to the United Arab Emirates⁴⁵), or through the development of related business services (environmental legal services such as specialist litigation may become increasingly relevant, or the developing market for carbon auditing services);
- Financial service strengths – developed to exploit growing carbon markets could potentially offer opportunities for the financially sustainable development of existing sector strengths. The UK already has a 59 per cent global share in the purchasing of carbon credits.⁴⁶ Expansion of global use of such systems could perhaps be translated into additional UK activity. In addition there is potential to exploit recent experience using financial innovations to raise capital to finance public retrofit projects;
- Existing creative industry export strengths exploited to develop low carbon services potentially including:⁴⁷
 - Design – low carbon product design and architectural services;

⁴⁴ The latest report of the UK Migration Committee (2009) provides evidence regarding the history of migration into the UK

⁴⁵ See for example recent consultancy export: http://www.thepeninsulaqatar.com/Display_news.asp?section=local_news&month=july2009&file=local_news2009072315344.xml

⁴⁶ HM Treasury (2009).

⁴⁷ Understanding of current creative industry strengths draws on Work Foundation (2007).

- Software/computer services – providing innovative offers to support carbon-efficient applications such as energy management systems;
- Advertising – provision of services communicating increasingly relevant environmental brand messages to consumers, supporting behavioural change.

The successful development of these activities could be expected to create significant employment. Also, as with the manufacturing orientated activities considered above, this employment creation can best be considered as being additional to that generated directly reducing emissions in the first scenario.

Given the diversity of these activities it is hard to precisely define the likely nature of this employment. STEM skills are highly likely to be of relevance to the more technical services described above (consultancy for example). However, the core focus of these activities is on the management and integration of technical processes related to the low carbon agenda, rather than the technical aspects themselves. These services can perhaps be best thought of as packaging these technical aspects and presenting them in ways which meet the needs of consumers and businesses. This is likely to demand high-level communication, leadership and management and skills. This implies that the employment created is likely to be highly knowledge intensive.

While this vision is based on the development of existing economic strengths and advantages, as with the manufacturing scenario above, its realisation depends on the ability of British companies to win market share in emerging markets, and in many cases creating markets for new service offers. Its realisation therefore represents a major challenge and will depend on the innovative capacity of UK firms in this sector.

Despite the apparent advantages and strengths identified above, as in the previous two scenarios, persistent challenges relating to uncertainty appear to be slowing the progress of activities related to this vision. Here the most significant blocker appears to relate to deficiencies in demand and uncertainties regarding its likely future level.

The demand for low carbon services appears to be a particularly sensitive barometer of all services. Unlike the activities considered in the previous two scenarios the demand for low carbon service offers are derived indirectly from desires to reduce carbon dioxide emissions. Variations and uncertainties can therefore have a particularly significant impact on their development. As noted above, significant uncertainty about future levels of demand for these

activities persist from remaining questions and unknowns relating to the scientific knowledge, consumer preferences and public policy associated with the low carbon agenda.

While these uncertainties remain, entrepreneurs and existing business can not be expected to commit to the investment required to develop a full range of low carbon service offers.

**Reflections
on scenario
analysis**

The scenario analysis above confirms the potential for low carbon economic activities to be major employment generators. It also highlights that the low carbon agenda has the potential to create two very distinctive forms of employment.

The implementation of low carbon technologies can be associated with the creation of a large number of jobs. These are likely to be predominantly focused on relatively low skilled employment, delivering largely local services.

The agenda also has the potential to create a second group of jobs derived from developing new manufacturing and service related activities which derive value from the desire to cut emissions. These could potentially be characterised by high quality, highly knowledge intensive forms of employment, demanding high-level skills. The outputs from many of these activities will be tradable over distance. Therefore employment could serve both domestic and global markets. This is a particular positive given that the low carbon agenda is placing a range of existing employment activities at risk.

However, the analysis also identifies blockers retarding the continued development of these activities. Uncertainty regarding the future demand for low carbon activities, their supply and the supply of related training are holding back investment in new low carbon infrastructure, business offers, and skills. It is interesting to note that these uncertainties are the same as those identified above as preventing the accurate forecasting of these activities. Unfortunately these uncertainties are impeding the continued development of low carbon activities, rather than simply affecting their analysis.

This situation is particularly unfortunate since the potential for the UK to develop the second, highly desirable group of jobs described above depends on the rapid conversion of current economic strengths, such as those identified within the manufacturing and service sector scenarios, into industry strengths.

These activities are highly knowledge intensive, and are characterised by high levels of innovation. We can therefore expect strong external economies of scale to operate. These would reflect the benefits from the co-location of activities of different businesses which are not fully realised by each individual enterprise. As summarised by Duranton and Puga (2003)⁴⁸ these span:

- **Sharing benefits** – the joint use of facilities, research institutes and marketplaces reduce the cost for users;
- **Matching benefits** – scale provides opportunity for highly specialised suppliers, consumers and skilled labour pools to develop, potentially boosting productivity through greater division of labour;
- **Learning benefits** – close proximity to other firms and individuals in similar industries provides opportunities for face-to-face contact and facilitates the building of trusts, leading to the sharing of information, technological spillovers and the production of new ideas and innovation. This third group of economies are of particular relevance for these knowledge intensive activities, and often are responsible for creating highly territorialised and geographically rooted networks of activity.

Understanding this interaction between the knowledge intensity of activities and their likelihood to co-locate is of particular value since these characteristics have implications for the likely future geographic distribution of these economic activities.⁴⁹

The local service oriented activities (which dominate the first scenario) can be expected to develop evenly in many locations, provided that the barriers on their development can be overcome. However, given the particular economic advantages associated with the co-location of many of these highly knowledge intensive activities (which dominate the second and third scenarios) and given that many of the outputs from these activities can be traded over distance, we can expect only a discrete number of global value creation locations to develop for each.

Myrdal described a process of cumulative circular causation⁵⁰ which is likely to drive this. Initial advantages developed during the emergence of an industry become reinforced in a self sustaining process as external economies of scale operate in a self-reinforcing way. The initial concentration of activities acts to attract and support the development of further related work.

⁴⁸ The relationship between knowledge intensive services and external economies of scale is explored in detail within our forthcoming research paper on the knowledge economy and urbanisation.

⁴⁹ Please note this topic is explored in detail within our forthcoming research paper – Morris (2010) *Is the Knowledge Economy Becoming More or Less Urbanised?*

⁵⁰ Myrdal, G. (1957)

The implication of this is that where these highly territorialised concentrations of specific low carbon activities develop within the UK they may develop into major job creation and export generators. Where this is not the case, we can expect value creation locations to develop elsewhere, negating existing UK strengths. Not only would this represent a missed opportunity in terms of employment generation, but could also impact negatively on imports as we could find ourselves importing high-level skills embodied within the products and services that we are using to decarbonise our activities. Therefore there is an urgency in acting quickly to remove these barriers if we are to maximise the potential of the low carbon economy.

4. Policy issues

Despite the potential benefits from action to remove these blockers, the notion of policy support for the low carbon economy demands careful consideration. This section examines the rationale for intervention, summarises current policy, and concludes by presenting policy recommendations for how these activities could be further supported to maximise the potential benefits of the low carbon economy over the coming decade.

The role of low carbon industrial policy

While the analysis above does identify potential blockers which appear to be preventing the development of the industry, the rationale for intervention in the form of a low carbon industrial policy must rely on an explanation of why these activities demand particular support, over and above that offered to other sectors of the economy. Understanding this question is complicated by the fact that, as noted above, the low carbon economy represents a cross-sectoral grouping of activities rather than a tightly defined and consistent set. Therefore, practically considering any support that can target the core of what makes the low carbon economy distinctive is a particular challenge.

There are however a range of reasons why the low carbon agenda demands particular policy attention. The case for intervention in this area was made in the Department for Business Innovation and Skills's economics paper *Towards a Low Carbon Economy – economic analysis for a low carbon industrial strategy*. The arguments for this are summarised within Box 5 below.

Box 5: the rationale for public sector intervention in the low carbon economy

BIS's Economics Paper – Towards a Low Carbon Economy, identifies the need for public intervention to support low carbon economic activities on the following grounds:

- **Negative externalities** – the need to ensure that the costs resulting from greenhouse gas emissions are internalised in economic decision making processes;
- **Positive externalities** – spillovers from new investment in workforce skills, and innovation are not captured by firms and therefore lead to systemic underinvestment;
- **Information asymmetry and uncertainty** – inefficient markets created where information costs are high. In the case of the low carbon economy this includes:
 - Uncertainty regarding the benefits from investing in low carbon goods and services from the perspective of innovators and consumers. This is a particular issue when considering the returns to investments which will be in place for an extended time period, and can result in commitment problems;
 - Poor information available to consumers regarding the carbon and environmental footprints of alternative consumption decisions;
 - Many firms lack the managerial, risk assessment, finance and management capacities required to bring innovations to market;

Cont.

Cont.

- Time inconsistent preferences can lead to firms and individual deferring decisions that impose more immediate costs. This is a particular issue here since the rapidly developing nature of low carbon technologies may reduce early adoption as firms and consumer avoid committing to a single technology type;
- High search costs for information may deter change, leading to a sub-optimal rate of adoption for low carbon technologies.
- **Principal agent issues** – incomplete information and asymmetries give rise to a set of issues where principals and hired agents may have conflicting interests with respect to change associated with this agenda. Contrasts between the interests of tenants and landlords regarding the installation and use of energy efficient technologies is a readily understandable example of this;
- **Market power** – highly concentrated and uncontested market structures can result in lower output, higher prices and less consumer choice as well as reducing incentives to innovate, to be entrepreneurial, and to adopt new technology. Together these factors may reduce the drive for such organisations to peruse resource efficient behaviours;
- **Institutional and regulatory failure** – highlights the potential impacts of other government interventions on these markets such as:
 - Specific taxes, customs duties, subsidies and purchasing rules/standards can restrict the free movement of goods, services and capital across international borders, potentially negatively impacting on competition and innovation;
 - Planning regimes may be highly restrictive and cause delays to major new infrastructures;
 - Confusion caused by frequently changing regulations can impede investment decisions;
 - Policy conflicts can create uncertainty and unintended consequences;
 - The complexity of a regulatory system can impose significant costs on businesses.

Source: Department for Business Innovation and Skills (2009) economics paper – Towards a Low Carbon Economy – economic analysis for a low carbon industrial strategy

This analysis however, conflates a number of justifications for intervention including those based on environmental grounds (the negative externalities arising from carbon dioxide emissions), those based on general economic efficiency arguments (such as the market power arguments presented above) which apply equally well to all industries, and justifications based on the specifics of the economics of job creation in the low carbon economy. Only the last of these justifications is of direct relevance when considering industrial policy to support employment in the low carbon economy.

The logic for intervention in the form of industrial policy draws on the fact that the government are in a position to take a long-term, strategic perspective regarding the future development of these activities. The government have identified the low carbon economy as an area for global economic growth over the coming decade.⁵¹ This fact, coupled with the time critical nature of the development process for these activities (noted above), justifies public intervention. This therefore represents action to correct the market failure of positive externalities – benefits from the activities of firms which they can not capture.

Similarly, the government's commitment to reduce emissions of carbon dioxide (as embodied within the Climate Change Act) provide a justification for offering additional support to these industries. A long-term shift towards low carbon economic activities is perhaps an inevitable implication of the commitment to decarbonise the economy. It is sensible therefore, that the government exploit their foresight regarding this transition to maximise its potential benefit through policies supporting the development of the private demand for and supply of activities which meet this agenda. This will ensure the that process of transition is as smooth as possible, and maximise its potential job creation benefits.

Given these justifications the low carbon economy could perhaps expect the following forms of public support:

- **Leadership** – support in the form of consistent signals regarding the future value of and demand for these activities;
- **Establishment of clear frameworks for investment** – clarifying future public funding and investment in ways which offer opportunities for private investors to compete to fund and finance attractive related ventures;
- **Skills supply** – offer confidence that publically dominated skills providers will offer the skills required to develop these activities.

Existing policy

The low carbon economy has been the subject of considerable political interest in recent years from political parties of all hues– see Box 6 on the next page.

It is perhaps a surprise then that our scenario analysis suggests that the public policy expectations set out above are not being met. Consistent signals regarding their future vale and the demand for these activities are lacking. Frameworks for investment are poorly defined, and the supply of appropriate skills remains a persistent issue.

⁵¹ Department for Business, Innovation and Skills (2010)

Box 6: The political view**Gordon Brown, 9 March 2009**

'We are setting a clear national purpose that a low-carbon revolution is what we must have and we must take every possible course of action ... This is a tremendous economic opportunity.'

David Cameron, 5 January 2009

'So let me tell you my vision of a good future for our economy... It's a more modern economy, where we create rewarding, good-paying jobs in the green and technological industries of the future.'

Nick Clegg, 22 October 2008

'Can you imagine the jobs we could create if we really got behind a zero-carbon Britain? In wind, in marine and tidal, in solar and biogas? Imagine the jobs we could create by greening our existing industries. We could generate a whole host of new roles. In education, tourism, architecture, agriculture, engineering, design. If we really committed to a zero-carbon transport system. And signed up to a high speed rail link from North to South. That's thousands more jobs.'

**Public policy
support for the
low carbon
economy**

This topic has certainly been the focus of considerable public policy attention. The analysis supporting this has been of exceptional quality, and many actions have been ground breaking in nature.⁵² The most important legislative and policy outputs from this work are summarised within Table 3 on the next page.

One highly contentious policy related to this work is that of intervention to directly alter the financial costs associated with carbon dioxide emissions. Although usually advocated on environmental grounds, this policy has implications for low carbon job creation through its potential influence on demand. Since this debate cuts to the core of the environmental and economic debate regarding low carbon activities this analysis has explored this policy in detail. Box 7 on page 51 considers the specific economic issues in general terms and in the context of current UK policies.

⁵² For example, it is worth noting the fact that the UK was the first country to establish unconditional, legally binding commitments on emissions reductions

Table 3: Existing policy documents

Policy	Relevance
Climate Change Act (2008)	Act established legally binding targets for national carbon dioxide emissions reductions.
EU Renewables Directive (2008)	Sets a binding target for EU countries to source 20 per cent of all energy from renewable sources by 2020.
EU 2020 Strategy (2010)	Latest consultation document contains a strong emphasis on developing low carbon economy activities
Renewables Obligation Renewable Heat Incentives Feed-in-tariffs	Policies to directly affect the relative costs of renewable and non-renewable energy sources.
BIS/DECC, Low Carbon Industrial Strategy (2009)	Policy sets out the government's current framework of support for low carbon economic activities.
BIS Economics Paper No. 1 – Towards a Low Carbon Economy (2009)	Economic analysis providing the evidence base for the Low Carbon Industrial Strategy. Includes a detailed review of economic case for intervention
BERR, DECC, DIUS, Investing In a Low Carbon Britain (2009)	Sets out a programme of targeted investment linked to the Low Carbon Industrial Strategy
HM Government, Low Carbon Transition Plan (2009)	Sets out the government's plan to tackle climate change. This focuses on protecting the public from immediate risk (adaptation), preparing to reduce emissions (mitigation), as well as stressing support for a new international climate change agreement.
HM Government, New Industry New Jobs (2009)	Sets out agenda for creation of new employment from industries including low carbon activities.
Defra – Building and Low Carbon Economy – Unlocking Innovation and Skills (2008)	Policy document covering various aspects of the low carbon economy including innovation, skills and the role of partnerships.
DfT, Low Carbon Transport : A Greener Future, (2009)	A detailed low carbon reduction strategy for transport. Sets out actions DfT are taking to deliver cuts to meet obligations under carbon budgets to 2022 and beyond.
DTI, Meeting the Energy Challenge – A White Paper on Energy (2007)	Paper sets out a strategy to deliver energy security and accelerate the transition to a low carbon economy.
HM Government, Going for Growth : Our Future Prosperity (2010)	Sets out a strategy for recovery – acknowledging the challenge of decarbonising the economy, but also identifies opportunities for growth from the low carbon economy.
DECC, UK Renewable Energy Strategy (2009)	Strategy sets out governmental plans to meet the target of sourcing 15 per cent of our energy from renewable sources by 2020.
DECC, Marine Action Plan (2010)	Sets out a vision for the marine energy sector to 2020.
DECC, Warm Homes, Greener Homes (2010)	Strategy sets out government plans for the energy efficient retrofit of 7m British homes by 2020.

Box 7: The economics of carbon taxes, quotas and minimum prices

Carbon taxes, quotas and minimum prices represent ways to intervene to increase the costs associated with activities which contribute to the release of carbon dioxide emissions, by creating a carbon price.

In economic terms, the rationale for some form of global pricing of carbon is straightforward. The effects of carbon dioxide emissions are now widely understood to have major negative impacts which are not consistently paid for by producers – something Nicholas Stern described as ‘the greatest market failure the world has seen’.⁵³ This implies that public intervention which increases the costs of emitting carbon dioxide is desirable on economic efficiency grounds. Inaction will result in agents exploiting this gap and earning economic rents from pollution which will impose costs on current and future generations.

However, it now appears that we are moving away from a global consensus on establishing such a price. The failure of the Copenhagen conference to set binding global emissions reduction targets, the apparent reluctance of the EU to consider a tightening of current emissions trading arrangements, mounting Senate opposition to US President Barack Obama’s federal cap-and-trade proposals and similar political hurdles being experienced in Australia suggests that the UK may need to consider unilateral action.⁵⁴

Historically such action has been considered with great scepticism given the risks to UK competitiveness from action to effectively increase energy costs for most activities. There is also a fear that such a tightening of policy would result in carbon leakage – the relocation of economic activities which emit carbon dioxide to locations with less stringent environmental standards. However, recent research by Neuhoff (2008) considering the impact of carbon pricing on the economy and carbon leakage, suggest that such fears can only be justified for a very small proportion of economic activities:

‘For 98-99 per cent of economic activities the cost increase from carbon pricing is trivial relative to other cost components. Only in 24 sub-sectors the cost increases from carbon emissions are significant. Because of factors like transport costs, product differentiation, and sunk investment costs there is no concern about leakage in several of these sub-sectors. Thus only a few sub-sectors, like basic steel and cement production, are likely to require targeted measures to address leakage concerns.’⁵⁵

Cont.

⁵³ HM Treasury and Cabinet Office. (2006)

⁵⁴ EurActiv (2010)

⁵⁵ Neuhoff, K (2008)

Cont.

A number of countries (Sweden, Finland, Denmark, Norway and the Netherlands, and most recently the Republic of Ireland) have already introduced a carbon tax, although the levels at which these have been set vary considerably. These economies have returned varied results since implementation however, no clear causality can be established showing a link between economic growth and tighter controls on carbon dioxide emissions.

In the UK the argument for some form of price control is stronger since we have committed to reduce our carbon dioxide emissions. This has in effect introduced at least an expectation of future higher costs of carbon emissions. Therefore formalising this may be much less costly.

Similarly a number of existing schemes serve a related purpose:

- The European Emissions Trading system already imposes a cap and trade system influencing the prices of carbon dioxide in all EU countries. However the economic recession has seen a dramatic fall in the price of permits. A recent report for the National Audit Office concluded that caps had been set too high.⁵⁶ It is an interesting quirk of such a system that, since the UK government expect us to be a net purchaser of these credits by 2020, this scheme will result in us effectively paying for low carbon investments elsewhere in Europe;⁵⁷
- Existing Fuel tariffs represent a form of carbon tax, however these have fallen in real terms in recent years;⁵⁸
- Existing feed-in tariffs represent a similar form of carbon tax.

However, it appears that uncertainty regarding the future costs of emitting carbon dioxide in the UK remain. This prevents investors from fully understanding the likely returns to investments in low carbon activities. By reducing this remaining uncertainty, there is potential to support investment and therefore derive economic advantages from leadership of the international low carbon agenda.

Mechanisms for implementation

A carbon tax – levies a fixed amount on either production of emissions or consumption of fossil fuels. This is therefore a very simple concept and may be easier to implement than a quota system. It can also be used to raise revenues, and can guarantee a premium for fossil fuel energy sources.

Cont.

⁵⁶ NAO (2009)

⁵⁷ House of Commons Environmental Audit Committee (2010)

⁵⁸ Wilson, B. (2006)

Cont.

Tightening of the existing quota system – Is currently advocated by the UK for the EU ETS system. Environmental advantage of the quota system, is that it is possible to be confident about the rate of future emissions reductions since these are capped. A particular advantage of the quota approach is that it provides an additional automatic economic stabiliser for the economy, since the prices of quotas, and therefore the costs businesses and consumers must bare, are likely to be strongly correlated with economic growth. If the UK were to consider unilateral action, it would be possible to develop a secondary set of UK only credits, and there would be the opportunity for the government to raise revenue by auctioning these.

Price floor commitments – as has been apparent from the recent low EU ETS prices, the quota system does not however, guarantee a strong premium for carbon. Introducing a minimum price into a cap and trade system can however offer a simple and readily understandable way to offer investors certainty regarding the minimum return on low carbon investments, compared to those based on fossil fuels. The setting of a minimum price would require the stipulation of a minimum top-up price when permits are traded (trades below this would carry a premium), or for the government to commit to purchase credits at a given price. The second of these options could represent a financial liability to the exchequer.

Debate between advocates of carbon taxes and quota systems remains intense. The combination of a tightening of the quota system and price floor commitments appears to offer the best compatibility with any future tightened EU or new OECD system of emissions permits. This consideration is particularly important in ensuring continuity and stability for prospective investors.

It is worth flagging that since poorer customers spend a greater proportion of their income on energy-intensive goods and fuel in the UK, actions which increase the costs of energy may be regressive.⁵⁹ Coordinated policy may be required to mitigate the effects of this.

Public spending support Support for the low carbon economy has been associated with considerable public spending across a broad range of areas, and a large number of public bodies. Identifying this spending and understanding its focus represents a major challenge. Table 4 represents the headlines from our first attempt to identify this spending, and further details can be found within Annex Table A2. However, the cross-sectoral nature of the low carbon economy, the breath of funding measures and current reporting requirements make identification and analysis of this a particular challenge.

⁵⁹ Ekins and Dresner (2004) explore this issue in detail in the UK context

Table 4: Public spending supporting the low carbon economy

Total Spend*	Details	Information Source
Major strategies and funding documents		
£744.5m	As detailed in the UK Low Carbon Industrial Strategy	BIS (2009) – UK Low Carbon Industrial Strategy
£128m	As detailed in Going for Growth	BIS(2010) – Going for Growth
£38.5m	As detailed in the Warm Homes, Greener Homes Strategy	DECC (2010) – Warm Homes, Greener Homes
£610m	Feed-in Tariffs Scheme	DECC (2009)
£440m	Budget 2008	HM Treasury (2008) – Budget
£535m	Pre-Budget Report 2008	HM Treasury (2008) – Pre-Budget Report
£750m	Budget 2009	HM Treasury (2009) – Budget
£600m	Pre-Budget Report 2009	HM Treasury (2009) – Pre-Budget Report
£1,060m	Budget 2010	
Government departments and other public bodies		
£200m	Department for Energy and Climate Change	DECC (2009) – Low Carbon Transition Plan
£50m	Department for Transport	HM Treasury (2009) – Investing in a Low Carbon Britain BIS (2009) – Low Carbon Transition News
£353m	Local Authorities	DECC (2009) – Low Carbon Transition Plan
£94m	Technology Strategy Board	Treasury (2009) Pre-Budget Report BIS (2009) – Investing for Growth BIS (2009) – Low Carbon Transition News
£349m	Research Councils	DECC (2009) – Low Carbon Transition Plan DIUS (2007) – The Allocations of the Science Budget
£90m	Infrastructure UK	Treasury (2009) Pre-Budget Report
£174m	UK Innovation Investment Fund (UKIIF)	Treasury (2009) Pre-Budget Report BIS (2009) – UK Low Carbon Industrial Strategy
£400m	Environmental Transformation Fund	DECC (2009) – Low Carbon Transition Plan HM Treasury (2009) – Pre-Budget Report
<p>We have been unable to identify the scale of spending from the following organisations in these areas, but anticipate it to be significant:</p> <ul style="list-style-type: none"> • Department for Communities and Local Government • Department for the Environment and Rural Affairs • Environment Agency • Energy Technology Institute • Regional Development Agencies • Investment in the European Investment Bank 		

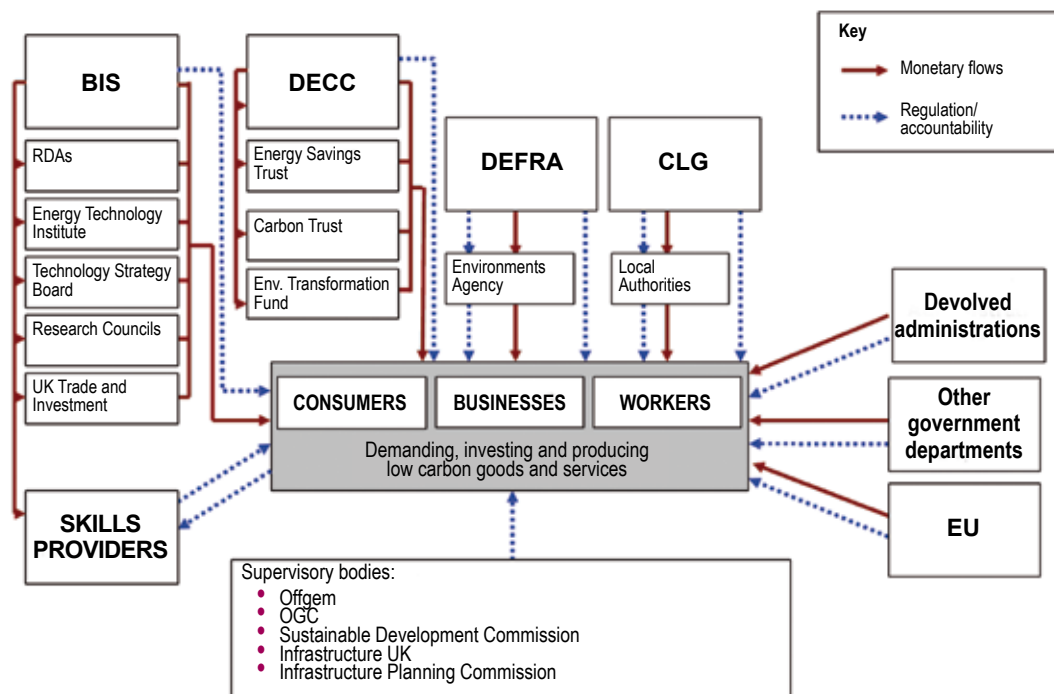
*Note: Spending identified may include instances of double counting across organisations and initiatives.

Analysis excludes the commitments of many public sector organisations to show leadership through investment to cut the carbon dioxide emissions from their operations⁶⁰ and the obligations placed on energy suppliers to support their customers in becoming more energy efficient.

However, as noted above within the scenario analysis, this system of public policy support and spending appears to perform weakly in terms of its ability to meet the needs of a low carbon industrial strategy. In particular, the policy and funding system does seem highly complex, and perhaps even confused. We would expect these new activities to demand new partnerships between businesses and the public sector, however funding and responsibility for supporting the development of and regulating these activities does appear to flow through a particularly large number of organisations.

In an attempt to better understand the interaction between these policymaking bodies, spending and the low carbon economy Figure 3 below presents a mapping of public sector interactions with the sector.

Figure 3: Complex public policy support for the low carbon economy



Source: The Work Foundation analysis

⁶⁰ Such as, seen in the commitment of public sector organisations to the 10:10 campaign (www.1010uk.org).

The complexity of the current system is immediately apparent from the figure. This initial audit has identified a large number of organisations engaged in offering support to and regulating the activities of the low carbon economy, as well as working to develop demand for its outputs.

Perhaps the complexity of the system is most clearly highlighted by the nature of ministerial responsibility for these activities.

- Within the Department for Business Innovation and Skills the Minister of State for Science and Innovation leads in this area, in addition to 14 others within the department as well as Strategic Defence Acquisition reform in the Ministry of Defence;
- Within the Department for Energy and Climate Change a Minister of State leads on the low carbon industrial strategy and developing a low carbon energy supply. In addition a Parliamentary Under Secretary leads on the sponsorship of the Carbon Trust and the vital issue of skills in the energy and low carbon sectors;
- The Department for the Environment, Food and Rural Affairs note their central purpose as 'to help build a low carbon, resource efficient economy'⁶¹ however no minister is listed as leading in this area. The Parliamentary Under Secretary of State (Minister for Rural Affairs and Environment) does however have responsibility for carbon budgeting.

While a number of ministers have roles which are of direct relevance to the agenda covered within this paper, there is no one minister with the clear responsibility for developing these activities as the core of their activities. This may cause issues of accountability.

The pattern of policy and spending outlined above does appear to be highly complex, detailed and subtle when compared to our international trading partners. While many of the nuances of the arrangements represent strengths which draw on the depth and quality of the analysis supporting UK policy, the support offered appears to lack the commitment and weight of that in many of our main trading partners.

⁶¹ All ministerial responsibilities identified from <http://www.cabinetoffice.gov.uk> on 19 March 2010

Box 8: International comparisons**China**

Spending	<ul style="list-style-type: none"> Chinese government earmarked \$440 billion until 2020 for development of clean and sustainable sources of energy¹ 40 per cent of \$580 billion stimulus package allocated to green business and infrastructure²
Target	<ul style="list-style-type: none"> Low carbon energy to be 20 per cent of total energy consumption by 2020³

USA

Spending⁴	<ul style="list-style-type: none"> Investments in energy research and development of \$150 billion over 10 years American Recovery and Reinvestment Act (ARRA) includes \$80 billion for clean energy investments
Structure of spending	<ul style="list-style-type: none"> ARRA⁵ \$26.8 billion on Smart Grid, home weatherisation, green federal buildings, and state and local renewable energy and energy efficiency efforts \$600 million in green job training programs American Clean Security Act (ACSA)⁶ \$90 billion in new subsidies by 2025 for clean energy technologies and energy efficiency \$100 billion for carbon capture and sequestration, electric and other advanced technology vehicles, and scientific R&D
Target	<ul style="list-style-type: none"> American Clean Energy and Security Act of 2009 requires a 17 per cent reduction in emissions from 2005 levels by 2020 and an overall reduction in US emissions by 80 per cent by 2050⁷

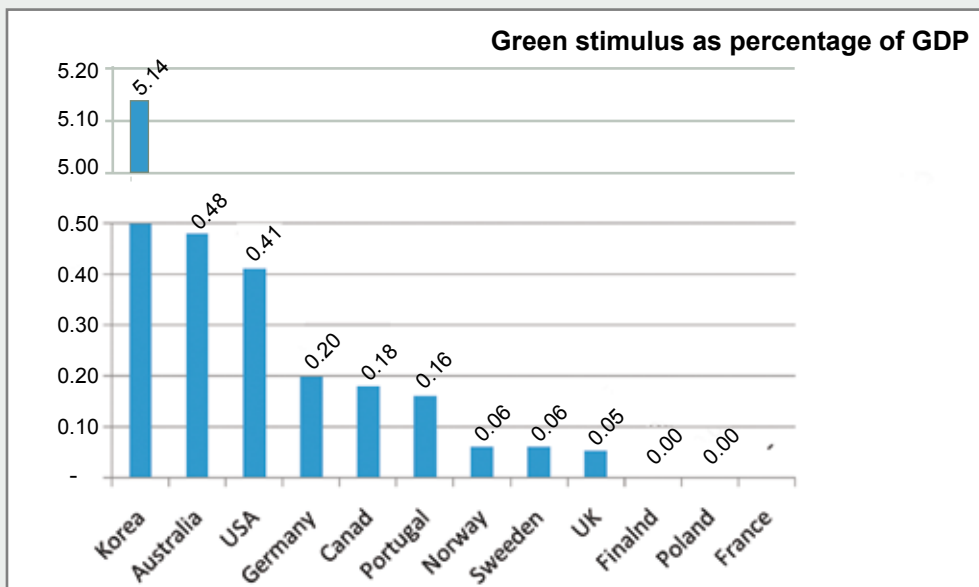
EU (central)

Spending	<ul style="list-style-type: none"> The total level of investment (public and private) required to achieve targets is estimated to be € 50 billion The European Commission has announced €105 billion in cohesion funds to be spent in 2007-2013 to create 'green jobs and growth' At the EU level, the share of green funds is around 60 per cent within the European Economic Recovery Plan European Investment Bank to provide additional support of €6 billion per year to annual investments for energy and climate-related infrastructure in the period 2009-10
Structure of spending	<ul style="list-style-type: none"> Economic Recovery Plan (only EU) breakdown of green funds:⁸ European Investment Bank low carbon investment – 41 per cent Energy efficiency – 21 per cent Energy grid – 21 per cent Carbon capture and storage – 7 per cent EBRD Low Carbon support – 7 per cent Renewable (Off-shore energy) – 3 per cent
Target	<ul style="list-style-type: none"> Targets set in Climate Energy Package adopted by EU Parliament in December 2008 by 2020 (based on 1990 levels)⁹ Reduction by 20 per cent of emissions of greenhouse gases, with a further 10 per cent conditional on multilateral action 20 per cent share of renewable energy in the energy mix Reduction by 20 per cent of the overall consumption of primary energy

Cont.

Cont.

The figure below illustrates the scale of the investment in green technologies within the stimulus packages implemented by OECD countries. This analysis draws on data produced by the OECD in May 2009, and information contained within the 2010 Budget for the UK. The relatively small scale of UK investment in this agenda is immediately apparent from these figures.



Source: OECD (2009), UK estimate taken from the April 2009 Budget

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- 1 China Daily (2009), 'China and Low Carbon Economy', August 20 http://www.chinadaily.com.cn/opinion/2009-08/20/content_8591605.htm
- 2 Climate Group (2009), 'China's Green Revolution' http://www.theclimategroup.org/_assets/files/Chinas-Clean-Revolution-II.pdf
- 3 Chinese Ministry of Commerce targets <http://english.mofcom.gov.cn>
- 4 White House Brief on the American Recovery and Reinvestment Act <http://www.whitehouse.gov/issues/energy-and-environment>
- 5 White House Brief on the American Recovery and Reinvestment Act <http://www.whitehouse.gov/issues/energy-and-environment>
- 6 Global Climate Network, 'Low Carbon Jobs in an Interconnected World' p. 29 http://www.globalclimatenetwork.info/%2Fecomm%2Ffiles%2Fqcn_low_carbon_jobs.pdf
- 7 White House Brief on the American Recovery and Reinvestment Act <http://www.whitehouse.gov/issues/energy-and-environment>
- 8 Europa, (2009) 'Investing in the Development of Low Carbon Technologies' http://ec.europa.eu/energy/technology/set_plan/doc/2009_comm_investing_development_low_carbon_technologies_en.pdf
- 9 Europa, (2009) 'The EU Climate Change Energy Package' http://ec.europa.eu/environment/climat/climate_action.htm

**Policy
recommendations**

Despite the apparent scale of policy effort, the analysis contained within this paper suggests that current support fails to meet the needs of the low carbon economy. Uncertainty relating to the future returns from investment in many low carbon activities remains a barrier to their full development. Demand in particular remains inadequate and too unreliable to support the development of many product and services offers.

Given these gaps, the scale of the potential opportunity of the low carbon economy and the strength of the justification for public intervention in this area, we advocate rapid action to better support the continued development of low carbon economic activities. However, reflecting the current constrained context of public finances, these recommendations are broadly spending neutral. Rather than calling for extensive additional investment there is a need to focus on developing clear long-term investment frameworks, and providing consistent and simple messages of support from the public sector. These recommendations focus on reducing uncertainty through policies focused on both the supply of and demand for low carbon economic activities.

Better supporting the supply of low carbon economic activities

Current confusion regarding public support for the supply of low carbon economic activities is a cause for concern. Action is required to better understand the nature of current public support for these industries before this can be simplified and rationalised:

- **A cross cutting audit of current spending** is required to better understand current spending patterns, and identify areas for potential rationalisation. It is essential that this audit allows a distinction to be drawn between how public monies support the supply of low carbon activities, and supports the development of demand;
- It is apparent that the public support available to business and individuals looking to invest in activities related to this agenda is highly confusing. There is a need to establish a **single point of contact for businesses**, responsible for supporting access to public funding and advice. This could be developed from one of the bodies identified above, and be funded from the rationalisation process.

We welcome the announcement in the 2010 Budget of UK Finance for Growth to streamline the government's SME finance support. However this organisation will focus solely on equity finance, therefore falling some way short of operating as a single point of contact for these businesses. By implementing such a new fund without first pursuing a wider rationalisation agenda, the picture for businesses may actually be more confused;

- In order to offer long-term certainty about the continuing public commitment to support these industries it would be sensible to distance financial support from short term political debates. The establishment of a single low carbon economy fund which is **linked to the long-term ambitions of the Climate Change Act** could support this. It is vital that such an organisation is set up in a way which can build on the strengths of the existing detailed analysis of the market failures and the nuances of the areas for intervention rather than loose this. It is also important that such an organisation be developed in co-ordination with any relevant technology innovation centres;⁶²
- Mirroring this call for clarity in support for low carbon activities, action is required to ensure consistent, co-ordinated and supportive regulation of these activities from across the public sector. The **creation of a ministerial role** dedicated to championing the needs of these business and ensuring that all departments take responsibility for this agenda would help to meet this need.

Better supporting the development of demand for low carbon economic activities

Uncertainty regarding the future demand for low carbon goods and services is limiting investment in these areas. Potential investors can not be confident about either the absolute level of future demand, or how frameworks will develop which allow them to earn returns from investment in low carbon product and service offers. Given that the government have committed the UK to a low carbon transition, that the need for investment in many areas of infrastructure has been agreed, and that additional private investment is required to develop new low carbon industries there is an urgent need to offer certainty in this area. The following actions would help to address this:

- The rapid **establishment of a single vision for the development of the UK's low carbon infrastructure** covering all areas of infrastructure including transport, telecommunications, housing, green belts and open space, waste management, as well as energy supply. It is essential that, unlike existing infrastructure planning, this vision reflects a joined up approach which recognises the importance of the interaction between these forms of infrastructure. It is equally important that this vision is developed in a way which is sensitive to the needs of the developing low carbon economy and fully linked into an awareness of the innovation system for these activities;

⁶² The recent review of technology innovations centres (Hauser (2010)) recommended the development of a network of elite national organisations. It is highly likely that, if implemented, a number of these would be of direct relevance for innovative low carbon economic activities

We welcome the approach of Infrastructure UK in developing a Strategy for National Infrastructure (released with the Budget 2010). However, the breadth of infrastructure covered is limited, and it is not clear whether this work will consider the specifics of a low carbon economy innovation system. Confusion also remains with respect to how such a strategy will fit with the work of Ofgem noted about, the Treasury and DECC's Energy Market Assessment, and the emerging National Policy Statements. It is also unclear how such a strategy will be implemented;

- This vision for the development of the UK's low carbon infrastructure must be **articulated and implemented in ways which support private investment in this infrastructure**. Specifically this must include:
 - Clarity regarding the required **balance between public and private funding** for infrastructure items is essential. This needs to be considered in the context of creating investment opportunities which can attract the private sector, and potentially the development of new institutions to support the financing of these schemes;
 - Ensuring that this vision is rapidly translated into **planning policy** to support its physical delivery;
- In addition to these infrastructure-specific needs, **stronger signals regarding the future costs of emitting carbon dioxide** are required to support the development of demand for all low carbon economy activities. A commitment to tighten the existing permit system, and to a future minimum cost of permit, could represent a credible way to achieve this and could allow for a smooth integration with any strengthened EU commitments, or any likely future OECD system.

We welcome the announcement in the 2010 Budget of a consultation on the most appropriate mechanism to deliver greater certainty for low carbon investments. We are concerned however, that an extended process could cause further confusion. Equally, it is essential that the process considers the implications of any changes for the full range of low carbon economic activities covered within this paper. A narrow focus on the energy supply industry would exclude the interests of a broad range of innovative low carbon economic activities.

By offering clarity in public support for these activities and sending clear signals regarding their future development, the successful implementation of these recommendations has the potential to establish a positive and self reinforcing process. The expansion of these activities will support the attraction of additional investment in the UK's low carbon economy as the uncertainties detailed above come closer to resolution.

Table A1: Contrasting definitions of low carbon economic activity

Source	Definition
EU / OECD Eco-Industry	'Activities which produce goods and services to measure, prevent, limit minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems' This includes pollution management activities as well as resource management – activity which takes a preventative approach to managing material streams.
Environmental Business International (EBI)	Definition based on business engaged in environmental activities including services, equipment and resources.
UK Centre for Economic and Environmental Development (CEED) 2006	List of industries defined as: <ul style="list-style-type: none"> • Air pollution control • Cleaner technologies and processes • Decommissioning/ decontamination of nuclear sites • Environmental consultancy • Environmental monitoring, instrumentation and analysis • Energy management/ efficiency • Marine pollution control • Noise and vibration control • Remediation and reclamation of land • Renewable energy • Waste management, recovery and recycling • Water supply and wastewater treatment
UNEP, ILO & ITUC Green Jobs (2008)	'Work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimise or altogether avoid generation of all forms of waste and pollution.'
	Definition excludes jobs related to the nuclear industry, and many recycling jobs.
	The definition also includes the notion that 'Green Economy' work should be 'decent' – a qualitative notion relating to 'occupational profiles and work skills, wage levels, and the degree to which worker representation (unionisation) and workplace involvement (empowerment) are advanced or not.'
Pro EnviRo/Defra (2009) Low Carbon and Resource Efficient Economy Skills	Presents a 'draft skills checklist' for low carbon and resource efficient skills covering: <ul style="list-style-type: none"> • Design • Waste • Energy • Water • Buildings • Transport • Materials • Financial • Management • Policy and Planning
Skills for the low carbon economy	Defines low carbon jobs based on the notion of 'low carbon and resource efficient economy skills' – the skills required to create an effective and expanding economy that minimises the amount of carbon emissions per unit of output through the development and implementation of technologies and behaviour that utilises carbon resources in an efficient way and breaks the link between economic growth and carbon emissions. These skills are distributed across the same range of sectors as those identified in the 'draft skills checklist'.
Ernst & Young Green Businesses (2008)	'Those businesses that, across the whole economy, have made efforts to introduce low-carbon, resource efficient, and/or re-manufactured products, processes, services and business models, which allow them to operate and deliver in a significantly more sustainable way than their closest competitors.'
Cleantech.com	Focus on technologies and related business models which improve the efficient use of natural resources. These activities: <ul style="list-style-type: none"> • Provide superior performance at lower costs; while • Greatly reducing or eliminating negative ecological impact, at the same time as • Improving the productive and responsible use of natural resources.

Source	Definition			
<p>Clean Edge Research www.cleandedge.com</p>	<p>'A diverse range of products, services, and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and cut or eliminate emissions and wastes'</p>			
<p>Innovas Low Carbon and Environmental Goods and Services (2009)</p>	<p>Research commissioned by BERR, presents a definition based on a collection of industries covering environmental, renewable energy and emerging low carbon markets.</p> <table border="0" data-bbox="435 577 1437 907"> <tr> <td style="vertical-align: top;"> <p>Environmental</p> <ul style="list-style-type: none"> • Air pollution control • Environmental consultancy • Environmental monitoring • Marine pollution control • Noise and vibration • Contaminated land reclamation • Waste management • Water supply and water treatment • Recovery and recycling </td> <td style="vertical-align: top; padding-left: 20px;"> <p>Renewable energy</p> <ul style="list-style-type: none"> • Emerging Low Carbon Markets • Wave and tidal energy • Biomass • Wind • Geothermal • Solar photovoltaic • Renewable consulting </td> <td style="vertical-align: top; padding-left: 20px;"> <p>Emerging low carbon markets</p> <ul style="list-style-type: none"> • Alternative fuels • Alternative fuels for vehicles • Additional energy sources • Carbon capture and storage • Carbon finance • Energy management • Building technologies </td> </tr> </table> <p>Definition also found (but not explicitly stated) in BERR (2009) Low Carbon Strategy HMG (2009) Low Carbon Transition Plan.</p>	<p>Environmental</p> <ul style="list-style-type: none"> • Air pollution control • Environmental consultancy • Environmental monitoring • Marine pollution control • Noise and vibration • Contaminated land reclamation • Waste management • Water supply and water treatment • Recovery and recycling 	<p>Renewable energy</p> <ul style="list-style-type: none"> • Emerging Low Carbon Markets • Wave and tidal energy • Biomass • Wind • Geothermal • Solar photovoltaic • Renewable consulting 	<p>Emerging low carbon markets</p> <ul style="list-style-type: none"> • Alternative fuels • Alternative fuels for vehicles • Additional energy sources • Carbon capture and storage • Carbon finance • Energy management • Building technologies
<p>Environmental</p> <ul style="list-style-type: none"> • Air pollution control • Environmental consultancy • Environmental monitoring • Marine pollution control • Noise and vibration • Contaminated land reclamation • Waste management • Water supply and water treatment • Recovery and recycling 	<p>Renewable energy</p> <ul style="list-style-type: none"> • Emerging Low Carbon Markets • Wave and tidal energy • Biomass • Wind • Geothermal • Solar photovoltaic • Renewable consulting 	<p>Emerging low carbon markets</p> <ul style="list-style-type: none"> • Alternative fuels • Alternative fuels for vehicles • Additional energy sources • Carbon capture and storage • Carbon finance • Energy management • Building technologies 		
<p>Michigan Department of Energy, Labor and Economic Growth: Green Jobs Report (2009)</p>	<p>The green economy is defined as comprised on industries that provide products or services in five areas:</p> <ul style="list-style-type: none"> • Agriculture and natural resource conservation; • Clean transportation and fuels; • Increased energy efficiency; • Pollution prevention or environmental cleanup; • Renewable energy production. <p>Green jobs are those which are directly involved in generating or supporting a firm's green related products or services – ie primary occupations of the green economy above and support jobs created by the firm's green related revenue.</p> <p>Green-related industry are sectors which are likely to contain firms that produce parts, components, products or services related to the green economy.</p> <ul style="list-style-type: none"> • Green-related occupations across a range of skill levels: • Scientists and engineers needed in energy research; • Skilled production workers utilised in a manufacturing setting; • Critical occupations at small start-up green firms, such as technical sales staff; • Construction labourers and skilled trades used in LEED (highly environmentally friendly) construction projects. 			

Table A2: Complex public funding support for the low carbon economy

Total Spend*	Details	Information Source
Major strategies and funding documents		
£744.5m	<p>As detailed in the UK Low Carbon Industrial Strategy</p> <ul style="list-style-type: none"> • £120m support for offshore wind; • £60m for Waver and tidal power; • £15m for civil nuclear power to establish a Nuclear Advanced Manufacturing Research Centre; • £10m for ultra low carbon vehicles (complementing £230m already announced to reduce the price paid by consumers of electric and plug-in hybrid cars from 2011); • £50m for the Technology Strategy Board to increase its capacity to support innovation in areas such as low carbon vehicles and buildings; • £90m to find detailed design and development work for the carbon capture and storage demonstration competition; • £150m (now, but growing to £1bn over 10 years) to create UK Innovation Investment Fund to address finance gaps in businesses who need funds to enter markets (some of which is targeted at LCE); • £230m support for consumers purchasing low carbon vehicles from 2011; • £19.5m from central government (£100m total) for Low Carbon Economic Areas; • Other spending including infrastructure commitment to facilitate a low carbon transition through a refurbishment of the UKs infrastructure, and through their procurement policy £175bn annually. 	BIS (2009) – UK Low Carbon Industrial Strategy
£128m	<p>As detailed in Going for Growth</p> <ul style="list-style-type: none"> • £125m investments in low-carbon area from UK Innovation Investment Fund; • Ultra Low Carbon Vehicles: The ETI will announce the first phase of its Plug-in Vehicle Economics and Infrastructure project, worth up to £3 million. 	BIS(2010) – Going for Growth
£38.5m	<p>As detailed in the Warm Homes, Greener Homes Strategy</p> <ul style="list-style-type: none"> • £25m for district heating schemes; • £4m for Home Energy Pay as You Save pilots; • £9.5m to develop a network of 'Green' home demonstration projects. 	DECC (2010) – Warm Homes, Greener Homes
No direct cost to public finances	<p>Renewables Obligation Scheme</p> <ul style="list-style-type: none"> • The proposed increase in the Renewables Obligation support for offshore wind announced in Budget 2009, which is subject to the outcome of the review, consultation and Parliamentary approval, would represent an injection of around £2-3 billion of support to help improve the profitability of many projects. 	HM Treasury (2009) – Budget
£610m	<p>Feed-in Tariffs Scheme</p> <ul style="list-style-type: none"> • Feed-in tariff for small scale low carbon electricity: Cash reward of £900 per household; • Proposed tariff: ground source heat pump installations could be rewarded with £1,000 a year; • Average annual costs of £610m estimated. 	DECC (2010) – Impact Assessment of Feed-in Tariffs for Small-Scale, Low Carbon, Electricity Generation

Total Spend*	Details	Information Source
£440m	Budget 2008 <ul style="list-style-type: none"> £40 million research, development and demonstration programme, which will focus on low-carbon vehicle concepts and the acceleration of their commercialisation; Allocation of £400m to an Environmental Transformation Fund to ensure that technologies that are in the later stage of development can be brought to market and demonstrated. 	HM Treasury (2008) – Budget
£535m	Pre-Budget Report 2008 <ul style="list-style-type: none"> £535 green stimulus mainly comprising of spending brought forward in areas such as home efficiency, low carbon transport and flood defence. 	HM Treasury (2008) – Pre-Budget Report
£750m	Budget 2009 <ul style="list-style-type: none"> £500 million of additional spending as part of an overall £1.4 billion package of targeted support to boost Britain's low-carbon sectors; £250m from a £750m Strategic Investment Fund to support advanced industrial projects of strategic importance, earmarked specifically for low-carbon projects. 	HM Treasury (2009) – Budget
£600m	Pre-Budget Report 2009 <ul style="list-style-type: none"> £200 million of additional funding for the Strategic Investment Fund that will include £150 million to support low-carbon investment; Establishing Infrastructure UK to leverage further investment in low-carbon projects including by investing €100 million in a European Investment Bank-led fund; £120 million for low-carbon industries in the UK; £200 million to improve energy efficiency and tackle fuel poverty; A further £30 million on low-carbon transport projects. 	HM Treasury (2009) – Pre-Budget Report
£1,060m	Budget 2010 <p>£1bn investment in an Green Investment Bank; £60m ports investment to support offshore windfarms.</p>	HM Treasury (2010) – Budget
Government Departments and other public bodies		
£200m, excluding £1bn Household Energy Saving Programme	Department for Energy and Climate Change <ul style="list-style-type: none"> Total amount of DECC funding under Low Carbon Buildings Programme (LCBP) around £30 million. In Budget 2009, the government announced a further £45m for LCBP; £1bn package of measures to extend and enhance the Household Energy Saving Programme; £13 million budget on ACT on CO2 campaign; £36m to Energy Saving Trust to support their activities in promoting the sustainable and efficient use of energy and a low carbon lifestyle to the public (£100 m over 2008-11); £90m to Carbon Trust; £550,000 on local authority best practice programme on climate change; £30m funding through Salix for the public sector as loans for energy efficiency technologies. 	DECC (2009) – Low Carbon Transition Plan

Total Spend*	Details	Information Source
£50m	<p>Department for Transport</p> <ul style="list-style-type: none"> £20 million for Low Carbon Vehicle Procurement Programme; £30m in government funding for the installation of charging points on streets, car parks and in commercial, retail and leisure facilities. 	<p>HM Treasury (2009) – Investing in a Low Carbon Britain BIS (2009) – Low Carbon Transition News</p>
£353m	<p>Local Authorities</p> <ul style="list-style-type: none"> Budget 2009 announced £100 million funding for local authorities to deliver new energy efficient homes, and Building Britain's Future announced up to £250 million for direct development by local authorities of around 3,000 new energy efficient homes; £3 million has been provided under the Best Practice Programme, which has helped local authorities take action by building capacity and spreading good practice (government funding through the Regional Improvement and Efficiency Partnerships). 	<p>DECC (2009) – Low Carbon Transition Plan</p>
£94m	<p>Technology Strategy Board</p> <ul style="list-style-type: none"> £50 million from economic stimulus package to TSB to expand its work with business, developing innovation and new technologies; £5 million additional funding to the Technology Strategy Board to set up new prize funds for emerging technologies; £30 million to support low carbon transport projects including an expansion of the TSB's current ultra low-carbon vehicles competition; A total of £9m investment from TSB on R&D on a new electric car project. 	<p>Treasury (2009) Pre-Budget Report BIS (2009) – Investing for Growth BIS (2009) – Low Carbon Transition News</p>
£349m	<p>Research Councils</p> <ul style="list-style-type: none"> Government direct funding, through the Research Councils, of over £30m for collaborative research in networks involving academia and industry on infrastructure; Funding of £319 million for the Cross-Council Research Programme on Energy (over 208-11). 	<p>DECC (2009) – Low Carbon Transition Plan DIUS (2007) – The Allocations of the Science Budget</p>
£90m	<p>Infrastructure UK</p> <ul style="list-style-type: none"> Set-up of Infrastructure UK (IUK) to leverage further investment in low-carbon projects including by: investing €100m (£90m) in a EIB -led fund to deploy up to €1.5 billion of equity and €5 billion of debt in low-carbon infrastructure; and considering the case for a low-carbon investment institution. 	<p>Treasury (2009) Pre-Budget Report</p>
£174m	<p>UK Innovation Investment Fund (UKIIF)</p> <ul style="list-style-type: none"> The government has invested €25 million for low carbon technologies in the UKIIF, which has leveraged £100 million of private sector investment; The government will invest £150 million to cornerstone the Fund and leverage additional private sector investment. 	<p>Treasury (2009) Pre-Budget Report BIS (2009) – UK Low Carbon Industrial Strategy</p>

Total Spend*	Details	Information Source
£400m	<p>Environmental Transformation Fund</p> <ul style="list-style-type: none"> • Up to £400 million have been allocated for the period 2008/09 to 2010/11 to encourage the development of low-carbon energy and energy efficiency technologies in the UK. Allocations include; <ul style="list-style-type: none"> • Carbon Trust technology programmes (over £90 million) – including offshore wind (joint with ETI), 3rd generation solar photovoltaic, sustainable bioenergy and low cost fuel cells; • Energy efficiency demonstration and deployment (over £45 million) – including trials and loans for energy saving in the public sector, small businesses and households; • Renewable energy and low-carbon technologies (at least £200m) – including offshore wind, marine, bioenergy, anaerobic digestion, microgeneration, carbon abatement technologies, hydrogen and fuel cells – including CCS. 	<p>DECC (2009) – Low Carbon Transition Plan</p> <p>HM Treasury (2009) – Pre-Budget Report</p>
	<p>European Investment Bank</p> <p>Up to £4 billion of new capital from EIB for energy projects within which:</p> <ul style="list-style-type: none"> • Up to £1.4 billion for offshore wind farms; • Up to £1 billion on onshore wind farms; • Implementation funds; • Manufacturing funds; • Funds for Carbon Capture and Storage. 	<p>HM Treasury (2009) – Investing in a Low Carbon Britain</p> <p>Treasury (2009) Pre-Budget Report</p> <p>DECC (2009)</p>
	<p>We have been unable to identify the scale of spending from the following organisations in these areas, but anticipate it to be significant:</p> <ul style="list-style-type: none"> • Department for Communities and Local Government; • Department for the Environment and Rural Affairs; • Environment Agency; • Energy Technology Institute; • Regional Development Agencies. 	

***Note:** spending identified may include instances of double counting across organisations and initiatives.

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