Contents

1 Introduction .......................................................................................................................... 5
   1.1 Background .................................................................................................................. 5
   1.2 Objectives .................................................................................................................. 5
   1.3 Partners involved in the low carbon cluster ................................................................. 6
   1.4 Low carbon Standard Industry Classification code coverage .................................... 7
   1.5 A framework low carbon industrial analysis ............................................................... 8

2 Strategic context .................................................................................................................. 10
   2.1 Climate Change ........................................................................................................... 10
   2.2 International commitments to address climate change ............................................... 11
   2.3 Demographic and societal factors ............................................................................. 11
   2.4 Demand for fossil fuels ............................................................................................ 12

3 Drivers of change ............................................................................................................... 13
   3.1 Legally binding targets ............................................................................................. 13
   3.2 De-coupling economic growth from emissions ......................................................... 13
   3.3 The ‘green’ economic potential ................................................................................. 13
   3.4 First mover advantage .............................................................................................. 13
   3.5 Greater energy security ............................................................................................ 14
   3.6 Resource efficiency .................................................................................................. 14
   3.7 Correcting market failure ......................................................................................... 14
   3.8 Low carbon economic areas ................................................................................... 15
   3.9 New industrial activism ............................................................................................ 15
   3.10 Emerging and nascent technologies ....................................................................... 15

4 Current and future skills needs for delivering a low carbon economy ..................... 17
   4.1 Decarbonising the power industry .......................................................................... 17
      4.1.1 Large-scale renewable power generation ......................................................... 17
      4.1.2 Development of new nuclear energy capacity ................................................. 20
      4.1.3 Energy from waste ......................................................................................... 24
      4.1.4 Carbon capture and retrofitting carbon capture ............................................. 26
   4.2 Decarbonising industry ............................................................................................ 28
      4.2.1 Improved energy efficiency ............................................................................. 28
      4.2.2 Reduced emissions and wastage ..................................................................... 32
      4.2.3 Alternative fuels – hydrogen, biofuels, etc. ..................................................... 34
      4.2.4 Low carbon processing .................................................................................. 37
      4.2.5 Land management and the natural environment ............................................ 38
   4.3 Decarbonising the transport sector .......................................................................... 41
      4.3.1 Low carbon engines and vehicles .................................................................. 41
      4.3.2 Fuel efficiency ............................................................................................... 44
      4.3.3 Air traffic management .................................................................................... 46
      4.3.4 Hybrid vehicles .............................................................................................. 48
      4.3.5 Modal shift ..................................................................................................... 49
   4.4 Decarbonising buildings ........................................................................................... 51
      4.4.1 Retrofitting existing buildings (energy efficiency) ......................................... 51
      4.4.2 Zero-carbon homes (new build) ..................................................................... 54
      4.4.3 Retrofitting commercial buildings (energy efficiency) .................................. 57
      4.4.4 Micro-renewables ......................................................................................... 60

5 Cross-cutting themes ......................................................................................................... 62
5.1 Ageing workforce.......................................................... 62
5.2 Uptake of STEM subjects................................................. 62
5.3 Management and leadership.......................................... 63
5.4 Low carbon procurement............................................... 64
5.5 Latent demand.............................................................. 64
5.6 ‘Greening’ of existing jobs rather than new jobs.............. 64

6 Key messages and priority actions........................................ 66
6.1 Key messages for Government and other policy makers... 66
6.2 Priority actions............................................................. 67
If the world continues emitting greenhouse gases like carbon dioxide at today’s levels then, the scientific consensus is that, the average global temperatures could rise by six degrees Celsius by the end of this century.

Such a change in the climate would be without precedent, and would be enough to make extreme weather events like floods and drought more frequent.

It would increase global instability, conflict, public-health related deaths and would force a migration of people to levels beyond any recent experience.
## Introduction

### 1.1 Background

The publication of the White Paper New Industry, New Jobs\(^1\) by the Department for Business, Innovation and Skills in April 2009 marked a significant shift in government strategy towards a more activist approach to industrial policy. While fundamentally continuing to believe in the vital role played by markets in the building of a vibrant, healthy and competitive economy, the White paper sets out a more active role for government in supporting Britain’s economic renewal and future growth.

At its centre the White Paper sets out the opportunities for future growth afforded by the forecast doubling of the world economy over the next few decades and the new opportunities for British businesses from: growing populations and rising prosperity in other parts of the world; new technologies; the transition to low carbon and the green revolution; changes in the age profiles of different societies; and the spread of international supply chains. The White Paper also specifically identifies six clusters as having particular potential for growth:

- Advanced manufacturing;
- Professional and financial services;
- Low carbon industries, including low carbon vehicles;
- Engineering construction;
- Digital products;
- Life sciences and pharmaceuticals.

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\(^1\) New Industry, New Jobs, BIS, 2009.
1.3 Partners involved in the low carbon cluster

The diverse and encompassing nature of the low carbon agenda and the technologies involved is amply demonstrated by the large number of SSCs and other Standards Setting Bodies (SSBs) which have wanted to contribute to the development of this report.

Provided below is a full list of partners which have collaborated in producing this report, together with a brief summary of the industries they represent.

Defining the coverage of low carbon industries has proven to be a challenging task. As can be seen from the list of contributing organisations above, many, if not all, sectors of the economy can lay claim to being integral to the low carbon agenda. Reducing the usage of carbon-based materials and/or emissions in order to avoid its negative effects on the world’s climate is something that all aspects of the UK economy are concerned with.

Therefore, transforming UK industry into a low carbon economy is a process which will require the commitment of all employers. In response to this, this report takes a wide-ranging view of low carbon industries and of the skills needs affecting them.

**Table 1: SSC and SSB partners**

<table>
<thead>
<tr>
<th>Partners</th>
<th>Industrial Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset Skills</td>
<td>Property, Planning, Facilities Management, Housing, Cleaning and Parking</td>
</tr>
<tr>
<td>Cogent</td>
<td>Chemical and Pharmaceutical, Oil, Gas, Nuclear, Petroleum and Polymers</td>
</tr>
<tr>
<td>ConstructionSkills</td>
<td>Construction</td>
</tr>
<tr>
<td>ECITB</td>
<td>Engineering Construction</td>
</tr>
<tr>
<td>GoSkills</td>
<td>Passenger Transport</td>
</tr>
<tr>
<td>Lantra</td>
<td>Environment and Land Based Industries</td>
</tr>
<tr>
<td>Proskills</td>
<td>Building Products, Coatings, Extractive and Mineral Processing, Furniture, Furnishings and Interiors, Glass and Glazing, Glazed Ceramics, Paper and Pulp and Printing</td>
</tr>
<tr>
<td>Semta</td>
<td>Science, Engineering and Manufacturing Technologies</td>
</tr>
<tr>
<td>Skills for Logistics</td>
<td>Freight Logistics and Wholesaling Industry</td>
</tr>
<tr>
<td>Skillfast-UK</td>
<td>Fashion and Textiles</td>
</tr>
<tr>
<td>SummitSkills</td>
<td>Building Services Engineering</td>
</tr>
</tbody>
</table>
1.4 Low carbon Standard Industry Classification code coverage

In order to help map out the extent of the low carbon cluster, and to provide a mechanism for extracting information from existing data sources, partners involved in producing this report were asked to provide definitions for those elements of their individual sector footprints involved with the low carbon agenda using the Standard Industrial Classification (SIC) 2003 framework. Table 2 below provides an overview of the information collected.

Great care should be exercised when using this or any other SIC code definition of new and emerging clusters, such as low carbon industries. SIC codes are by their very nature historic, reflecting the industrial base as it was when the framework was last updated. SIC code systems are also developed in partnership with international partners to aid cross-nation comparability. This again makes them slow to react to changes in, and growth of, emerging sectors.

Table 2: Low carbon SSC/SSB SIC code map

<table>
<thead>
<tr>
<th>SSC/SSB</th>
<th>SIC code coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>GoSkills</td>
<td>31.1, 31.61, 34.1, 34.3, 35.2, 35.3, 50.2, 62.1, 62.2, 63.23</td>
</tr>
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<td>SummitSkills</td>
<td>45.31, 45.33, 74.2, 25.21, 27.11, 28.13, 28.14, 28.25</td>
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<tr>
<td>Skills for Logistics</td>
<td>60.24, 63.12</td>
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<tr>
<td>Asset Skills</td>
<td>70</td>
</tr>
<tr>
<td>EU Skills</td>
<td>40.11, 40.12</td>
</tr>
<tr>
<td>Lantra</td>
<td>01, 01.1, 01.5, 02, 03</td>
</tr>
<tr>
<td>ECITB</td>
<td>11.2, 28.11, 28.21, 28.3, 28.52, 29.11, 29.12, 29.21, 29.22, 29.23, 31.1, 33.3, 40.1, 40.11, 40.12, 45.11, 45.2, 45.21, 45.22, 45.25, 45.32, 71.32, 74.2, 74.3, 74.5, 74.7, 90</td>
</tr>
<tr>
<td>Semta</td>
<td>27, 28, 28.3, 29, 29.1, 30, 31, 31.1, 31.4, 32, 32.1, 33, 33.3, 34, 35.1, 35.3</td>
</tr>
<tr>
<td>Skillfast-UK</td>
<td>10.11, 13, 14, 15, 17.22, 17.24, 21.20, 20.60, 32.50, 32.99, 43.33, 46.11, 46.16, 46.24, 46.41, 46.42, 46.47, 46.49, 46.76, 74.10, 77.29, 95.23, 95.24, 95.29, 96.01</td>
</tr>
<tr>
<td>ConstructionSkills</td>
<td>45.2, 45.21, 45.22, 45.23, 45.24, 45.25, 45.3, 45.32, 45.4, 45.42, 45.44, 74.20</td>
</tr>
</tbody>
</table>
1.5 A framework low carbon industrial analysis

The pervasiveness of the low carbon agenda across wide and varied sectors of the economy means that it is sensible for this report to brigade issues under a number of broad headings. Work previously undertaken by the consultancy firm WS Atkins on behalf of the Committee for Climate Change produced the following four headings, each of which currently represents significant sources of carbon production:

- Decarbonising the power industry;
- Decarbonising industry;
- Decarbonising transport;
- Decarbonising buildings.

In order to make the task of producing this report manageable within the timeframe allowed, lead partners were identified for each of the 18 separate aspects of low carbon industries falling under the four broad themes. It should be noted, however, that this does not infer that each lead partner identified below will take the strategic lead on addressing the skills issues affecting each aspect of the low carbon industries outside of this report. Table 3 below provides details of lead and supporting partners involved in producing this report.
<table>
<thead>
<tr>
<th>Broad Themes</th>
<th>Individual Aspects</th>
<th>Lead Partner</th>
<th>Supporting Partners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decarbonising the Power Industry</td>
<td>Large-scale renewables</td>
<td>EU Skills</td>
<td>Semta, Cogent, Lantra, ECITB</td>
</tr>
<tr>
<td></td>
<td>New nuclear energy capacity</td>
<td>Cogent</td>
<td>Semta, ECITB</td>
</tr>
<tr>
<td></td>
<td>Energy from waste</td>
<td>Lantra</td>
<td>EU Skills, ECITB</td>
</tr>
<tr>
<td></td>
<td>Carbon capture &amp; retrofitting carbon capture</td>
<td>EU Skills</td>
<td>ECITB</td>
</tr>
<tr>
<td>Decarbonising Industry</td>
<td>Improved energy efficiency</td>
<td>Semta</td>
<td>Cogent, Proskills, Skillfast-UK, Asset Skills,</td>
</tr>
<tr>
<td></td>
<td>Reduced emissions and wastage</td>
<td>Proskills</td>
<td>Lantra</td>
</tr>
<tr>
<td></td>
<td>Alternative fuels</td>
<td>Cogent</td>
<td>Lantra, ECITB</td>
</tr>
<tr>
<td></td>
<td>Low carbon processing</td>
<td>Cogent</td>
<td>Lantra</td>
</tr>
<tr>
<td></td>
<td>Land management and natural environment</td>
<td>Lantra</td>
<td></td>
</tr>
<tr>
<td>Decarbonising the transport sector</td>
<td>Low carbon engines and vehicles</td>
<td>Semta</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fuel efficiency</td>
<td>Skills for Logistics</td>
<td>GoSkills</td>
</tr>
<tr>
<td></td>
<td>Air traffic management</td>
<td>GoSkills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hybrid vehicles</td>
<td>GoSkills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modal shift</td>
<td>Skills for Logistics</td>
<td></td>
</tr>
<tr>
<td>Decarbonising buildings</td>
<td>Retrofitting existing buildings</td>
<td>ConstructionSkills</td>
<td>Proskills, Asset Skills</td>
</tr>
<tr>
<td></td>
<td>Zero carbon homes</td>
<td>ConstructionSkills</td>
<td>Asset Skills, Proskills</td>
</tr>
<tr>
<td></td>
<td>Retrofitting commercial buildings</td>
<td>Asset Skills</td>
<td>Skills for Logistics, Proskills</td>
</tr>
<tr>
<td></td>
<td>Micro renewables</td>
<td>Summitskills</td>
<td>ConstructionSkills, Semta</td>
</tr>
</tbody>
</table>
2 Strategic context

2.1 Climate Change

As concluded by the highly influential Stern Review\(^2\) on the economics of climate change: ‘the scientific evidence is now overwhelming: climate change exists and presents very serious global risks which demand an urgent global response.’

The current level of greenhouse gases in the atmosphere are equivalent to around 430 parts per million as compared with only 280 parts per million before the Industrial Revolution. These concentrations have already caused the world to warm by more than half a degree Celsius and will lead to at least a further half degree warming over the next few decades.

If the world continues emitting greenhouse gases like carbon dioxide at today’s levels then, the scientific consensus is that average global temperatures could rise by six degrees Celsius by the end of this century.

Such a change in the climate would be without precedent, and would be enough to make extreme weather events like floods and drought more frequent. It would increase global instability, conflict, public-health related deaths and would force a migration of people to levels beyond any recent experience. Such a change in global average temperatures would also transform the physical geography of the world, as low lying areas disappeared into the oceans impacting on where people live and how they live their lives.

The sources of greenhouse gasses leading to climate change are many and varied. Chart 1 below is taken from the Stern Review and clearly demonstrates that most sectors of the economy are contributing to the generation of emissions. An economy-wide response is therefore called for in responding to this issue.

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\(^2\) The Stern Review on the Economics of Climate Change, published October 2006
The true economic costs of failing to address climate change are difficult to accurately estimate. However, the Stern Review found that at best a ‘business as usual’ response to climate change in which no action was taken to reduce emission levels would result in at least an average 5% reduction in per-capita consumption now and forever and could, when all factors are accounted for, increase this to a 20% reduction in per-capita consumption. Furthermore, the impact of not addressing climate change now would be disproportionately felt by people in the poorer regions of the world, which face the loss of up to a quarter of their per-capita consumption potential.

The effects of actions taken now on future changes in the climate will take time to bear fruit. What society does now can only have a limited effect on the global climate over the next 40-50 years. However, there is widespread agreement that what we do in the next 10-20 years can have a profound effect on the climate in the second half of the 21st century and the next.

2.2 International commitments to address climate change

International efforts to address climate change have resulted in the development of a framework of bilateral and multi-lateral agreements and commitments. The Kyoto Protocol signed in 1997 is almost certainly the most important of these international agreements. As of November 2009 187 countries, including the UK, have ratified the protocol which commits nations to reducing their collective greenhouse-gas emissions by 5.2% from the level emitted in 1990.

Recognising that developed countries are principally responsible for the current high levels of greenhouse-gas emissions in the atmosphere as a result of more than 150 years of industrial activity, the Kyoto Protocol places a heavier burden on developed nations. The UK along with European Union nations is therefore committed to reducing its emissions to 92% of its 1990 emissions levels by 2012.

By the end of the first commitment period of the Kyoto Protocol in 2012, a new international framework needs to have been negotiated and ratified that can deliver the stringent emission reductions that are clearly needed if the worst impacts of climate change are to be avoided or minimised. In December 2009 delegations from 192 countries will hold two weeks of talks in Copenhagen aimed at establishing a new global treaty on climate and any resulting commitments will have implications for the UK economy.

While the exact scale of the UK’s future emissions reductions remain unclear, the need for further movement towards a low carbon, low emissions economy is obvious.

2.3 Demographic and societal factors

Population projections suggest that the UK population will increase by around 10.5 million between 2006 and 2031. As much as 47% of this projected increase is expected to be the result of net migration, while the remaining 53% is attributable to projected net natural change. This significant increase in the country’s population will undoubtedly result in increasing demands for energy, waste management, transport, housing as well as a broad range of goods and services, all of which have the potential to increase the volume of emissions produced by the UK.

The number of single-occupancy households in the UK has also increased from 22% in 1981 to 29% in 2007. This trend is predicted to extend into the future and will be driven by factors such as
greater life expectancy and increasing rates of marital breakdown. Societal changes, such as the trend towards single occupancy households, will again impact upon the level of aggregate demand as single-occupancy households use more energy and resources per person than multiple-occupancy households.

2.4 Demand for fossil fuels

As energy demand increases there is a danger that consumption will slip the UK into a net fuel deficit with a rise in fuel imports and an increase in emissions as most traded fuels are of the fossil fuel variety. Moving to alternative fuels will allow the UK to nurture its indigenous supply of carbon fuels and feedstocks and to deploy these in conjunction with low-carbon technologies of the future.
3 Drivers of change

This section sets out the key factors driving the demand for low carbon industries, and the goods and services they provide.

3.1 Legally binding targets

As a result of its international commitments made under the Kyoto Protocol and European Union Climate Change Programme the UK is committed to legally binding targets to reduce harmful greenhouse-gas emissions. Specifically, the UK is committed to cutting, relative to the 1990 base year:, 12.5% of greenhouse gas emissions between 2008-2012 (Kyoto Protocol); reducing by 26% CO₂ emissions by 2020 (Climate Change Act 2008); and reducing by 80% greenhouse-gas emissions by 2050 (Climate Change Act 2008).

3.2 De-coupling economic growth from emissions

Recovery from the current recession together with the increasing needs of society and a growing population require the UK economy to quickly return to at least its long-term economic growth trend. The unique challenge of this recovery will be, however, returning the UK economy to growth while simultaneously breaking the historic link between increasing levels of national wealth and environmental emissions.

The low carbon agenda, and specifically the emerging technologies it encompasses, provide perhaps the only real answer to effectively decoupling economic growth and environmental emissions, which has been a fact of economic life since the Industrial Revolution.

3.3 The ‘green’ economic potential

The environmental imperative to migrate the UK economy away from its historic dependency on high carbon generating sources of production towards a more sustainable footing offers substantial economic opportunities as well as threats.

Internationally, the global market for low carbon and environment goods and services is already worth an estimated £3 trillion annually, and is forecast to grow by almost 50% to £4.3 trillion between now and 2015. Such rapid growth offers UK firms a significant opportunity to gain access to new markets for their goods and services, and in so doing support highly paid ‘green’ jobs in manufacturing and services in the UK.

The potential of the green agenda to support new jobs is already apparent with an estimated 880,000 people in the UK already working directly in the low carbon cluster and its supply chain. This growth is also forecast to continue with the UK low carbon environmental goods and services market predicted to grow by over 4% per annum up to 2014/15.

3.4 First mover advantage

The UK’s traditional strengths in sectors such as advanced manufacturing, engineering, and offshore oil and gas exploration are believed by some, including the government, to provide the country with an opportunity to capitalise in low carbon industries from what economists define as First Mover Advantage (FMA). FMA is the advantage gained by the initial occupant of a new market segment and stems from the fact that: the first entrant can gain a technical advantage that later entrants cannot match; that the first entrant can gain control of key assets; or that the switching costs act as a barrier to later market entrants.
While FMA may exist in the low carbon industries there remains controversy over whether the UK has acted, and is acting, quickly enough to capture any sustainable advantage from it. In some aspects of the research and development, design and manufacture of new technologies, the UK has fallen behind some other European countries.

### 3.5 Greater energy security

Governments across the globe, including the UK, now recognise the importance of implementing measures to improve the security of future sources of energy. Key threats to energy security include: the political instability of several energy producing countries; the potential for manipulation of energy supplies, competition over energy sources, attacks on supply infrastructure, as well as accidents and natural disasters. Diversification of the UK’s power generation base and the push towards much greater use of low carbon cycles of energy are, in part, a response to concerns around energy security as well as the need to reduce the level of harmful greenhouse-gas emissions.

### 3.6 Resource efficiency

Management of resources in businesses is important both to meeting UK CO₂ emission reduction targets and in mitigating the costs of the transition to a low carbon economy. It has been estimated that UK businesses lose 2% annual profit through inefficient management of energy, water and waste, and the sooner these businesses start to adapt to more energy efficient practices the earlier they can make cost savings. Greater resource efficiency helps insure businesses against uncertainty in the supply of materials and price volatility in global markets and could save British businesses £6.4 billion per year, from measures that cost little or nothing. Although the advantages of greater resource efficiency are clear, many organisations encounter barriers that prevent take-up of measures. These include scarcity of time and capital; a limited awareness of useful actions and how to implement them; a low priority given to a move to low carbon by senior management; and the regulatory framework that may also be unintentionally increasing the cost or complexity of changing technologies or practices. The government hope to overcome these barriers through the establishment of strong environmental policies and the provision of financial support and incentives for businesses to purchase energy saving equipment.

### 3.7 Correcting market failure

As recognised by the Stern Review, climate change is almost certainly the greatest and most wide ranging market failure ever seen with, until recently, those responsible for emitting carbon not paying the true economic costs of production. The UK government, in common with governments across the world, have been seeking to correct this failure through the systematic introduction of legislation which forces producers to pay the true costs of production, including the costs of mitigating the impact of carbon produced. Policies to correct such externalities include: the European Union Emissions Trading Scheme; the Landfill Tax and the Climate Change Levy.

Effective action to address market failures will, it is believed, incentivise producers and consumers to be both more efficient in their use of resources as well switch to low carbon alternatives which do not attract the financial penalties associated with high carbon production techniques. They will also improve the economic case for large-scale investment in low carbon technologies, which until recently have not been able to compete with carbon-intensive production processes.
3.8 Low carbon economic areas

The government is developing ‘Low Carbon Economic Areas’ (LCEA) to accelerate low carbon economic activity in areas where the UK’s existing geographic and industrial assets give a locality clear strengths. The first LCEA will be located in the South West of England and will focus on the development of marine energy demonstration, servicing and manufacture. The South West has an obvious marine resource, successful existing activity with high potential and a high level of regional expertise in marine research, development and engineering.

Over the next few months, central government will work with national, regional and local partners to identify further LCEAs, examining where key opportunities exist, where there are local and regional advantages and where local partners are strategically aligned and focused on delivery.

3.9 New industrial activism

The government has over recent months, principally through its White Paper New Industry: New Jobs set out a new, more activist approach to industrial policy than that seen in the UK for many years. While still fundamentally believing that open markets are the main source of efficiency and dynamism, the New Industry: New Jobs White Paper states:

‘Government can promote investment, growth and jobs in Britain through more policy consistency across departments, greater regulatory certainty, smarter public procurement and a readiness to intervene where necessary. This involves government acting creatively and pragmatically in new ways to supplement the market, not the government substituting itself for the market.’

Specifically in the area of low carbon industries, the government’s industrial strategy sees three roles for national policy makers. Firstly, providing a long-term strategic approach that enables businesses and consumers to see that the direction of travel towards a low carbon future is irreversible; secondly, that government will need to intervene to correct market failures in order to facilitate the development of the required infrastructure to support a low carbon economy, and, thirdly, that the UK needs to be equipping its people with the skills needed to meet the demand created by climate change targets.

3.10 Emerging and nascent technologies

Increasing energy demand and awareness of the environmental costs of energy generation and use has required the adoption of new, low carbon technologies. As noted by the Stern Review, a range of technologies is already available, but most have higher costs than existing fossil-fuel options such as coal. Bringing forward a range of technologies that are competitive enough for adoption in the near future is an urgent priority. Recent technologies such as anaerobic digestion and combined heat and power (CHP) have proven the potential for low carbon technologies to be commercially viable on a large scale, however many further technologies, such as carbon capture and storage (CCS), marine energy technology offshore wind power, organic LED materials technology and ultra-efficient panel lighting are still being developed. Development is required to ensure these technologies have the sufficient build engineering capability and are full-system solutions to long-term energy challenges. The UK’s strengths in science and the development of previous technologies have been drawn upon to enable its positioning as a leader in development of a number of low carbon technologies that will play an important role in the future.
Although the potential for new technologies to contribute to emission reduction is great, there are many barriers to their development including policy clarity, funding issues, the high risk nature of technology development for businesses and unproven success.
4 Current and future skills needs for delivering a low carbon economy

The following sections describe each of the 18 individual low carbon aspects outlined in Section 1 (grouped within their broad themes), and sets out the factors driving the demand for skills both now and in the future. The extent to which the supply of skills meets current demand, and is likely to meet future demand, is also discussed.

4.1 Decarbonising the power industry

4.1.1 Large-scale renewable power generation

Industry overview

This industry consists mainly of the following technologies:

- Wind (onshore and offshore) – utilising wind energy to drive turbines, electricity is generated without the side-effects of either using or emitting carbon at the point of generation;
- Hydroelectric – similar, although uses the natural flow of in-land water to drive turbines;
- Marine – uses the natural motion of tides and waves to drive various technologies which result in the generation of electricity;
- Biomass – uses various fuel sources (e.g. waste, crops and other sustainable natural sources) which are either incinerated in order to produce heat or power or they can be digested to produce biogas.

These technologies do not use carbon-based fuel sources in the generation of electricity. However, biomass, unlike the other three technologies, does emit carbon during the incineration process. The development of CCS will go some way to improving the low carbon credentials of this means of power generation.

Current skills needs

The wind industry is suffering from skills shortages currently, primarily in the areas of turbine technicians, project managers and electrical engineers. It is also likely that when the marine industry becomes more established, that these roles will be similarly in demand.

The need for these roles is highlighted in the Bain report (2008) commissioned by British Wind Energy Association (BWEA). ‘The industry is already facing a considerable staffing challenge today: more than half of companies currently have vacancy levels of above 5%. In certain specialist roles that shortage is significantly higher. The urgency of the shortage is directly linked to the maturity of the industry: roles critical to the planning and development stage (e.g. project managers) are currently in particularly short supply. Acute areas of shortage are:

- Project managers: 46% of companies find this role hard to fill. Project managers are usually qualified engineers who are responsible for managing either the development or the construction process;
- Electrical engineers: 40% of companies find this role hard to fill. Electrical engineers are qualified to design and construct the high-
voltage connections between the wind farm and the national grid;

- Turbine technicians: 25% of companies find this role hard to fill. Turbine technicians have the skills and qualifications required to operate inside the nacelle of a wind turbine.

The marine industry, due to being in the early stages of research and development, is currently demanding high-level engineering skills.

The hydroelectric and biomass industries do not currently seem to be expressing high levels of concern in terms of skills deficiencies, over and above those already being experienced in the wider power generation industry. However, a deeper knowledge of safe handling and storage of bioethanol and biodiesel, agronomy and in forestry/woodland management are certainly needed to aid the development of the biomass industry.

Graduates and post-graduates with multi-disciplinary experience of (i) nanotechnologies and (ii) biosciences and engineering are in increasing demand.

Factors driving the demand for skills

Generally speaking climate change/carbon reduction legislation, emerging technologies, increased demand for biofuels and global competition are driving the demand for skills in the UK’s renewables industry.

The wind industry is the fastest growing of the large-scale generating technologies and has the most potential to meet the government’s 2020 renewable energy targets, particularly offshore. In addition to this expansion demand for skills, current shortages of skills are exacerbated as employees are being lured away to work in other sectors.

As marine energy production is still in the research and development stage, the demand for skills is being driven largely by the need for skilled engineers to assist in design and testing of the new technology. There is also some potential growth, and therefore demand for skills, in the final manufacture of such equipment.

The factors driving demand for skills in the hydroelectric and biomass industries are similar to those being experienced across the wider power generation industry (e.g. grid connections, ageing workforce, lack of Science Technology Engineering and Maths (STEM) graduates, sector attractiveness and increased competition from other sectors).

Evidence of skills mismatch

Further to the Bain report (2008) which sets out the current need for turbine technicians, electrical engineers and project managers, the Institute for Public Policy Research (IPPR) report ‘the Future’s Green : Jobs and the UK Low-Carbon Transition’ summarises a selection of evidence on skills gaps and shortages in the large-scale renewables industry.

Sources include the Confederation of British Industry’s (CBI) 2009 employer survey, which describes a shortage of STEM graduates, workers with STEM at all levels, technicians and graduates in energy industries. Also cited is the Department for Innovation, Universities and Skills (DIUS) 2009 STEM survey, which mentions shortages of marine engineers, mechanical and electrical engineers.

Further to these sources, for their 2009 ‘Mapping Renewables Skills’ report, the National Skills Academy Power (NSAP) interviewed employers in the large-scale renewable generation industry.
Key findings were:

- Wind and marine technologies require ‘new combinations of old skills’ which are in much shorter supply, leading to poaching of staff and therefore high levels of churn;
- Employers reported that they were currently compelled to train on the job, as ready-made combinations of skills are not currently available in the market place;
- There is a shortage of experienced trainers, both for STEM generally, and renewables specifically.
- Recruitment for remote sites (such as the north of Scotland, where many renewable assets will be based) is particularly difficult.

**Future demand**

An ageing workforce and STEM deficiencies will continue to be a factor which will affect the industry for some time to come. Coupled to this, the rapid expansion in renewables will result in a greater demand for skills at a time when such skills are increasingly being demanded in other areas of both the power industry and the UK economy as whole.

The upgrades required to the grid in order to handle the greater volume, and intermittent nature, of renewable energy will themselves add to the demand for electrical engineering skills.

The future growth of the marine industry is strongly dependent upon enabling actions and policies from government. Therefore, skills demand will be dependent upon the extent to which government promotes the growth of the industry.

The future of hydroelectric power generation is likely to lie in the area of small-scale/ micro-generation.

**Will anticipated demand meet skills supply?**

The Bain report (2008) states that; ‘current market estimates suggest that the number of engineers graduating each year in the UK is likely to remain broadly flat over the next 12 years’. As a result, the current share of new engineering graduates entering the wind industry is unlikely to be sufficient to support the growth demands of the industry.

Some of the historical issues driving the low percentage of engineering graduates entering the sector have been addressed, such as unclear industry prospects, concerns about career path progression, and salary levels, but more needs to be done. Given that fresh graduates will not satisfy the demand for specific skills, firms must also look inward and make significant investments in training and Human Resource (HR) processes to generate in-house capabilities and experience.

It is extremely difficult at this point in time to anticipate future demand for skills. The expansion of wind and marine (and biomass to some extent) is very much linked to the success of planning applications. The current complexities of the planning process make it difficult to accurately predict the extent and location of future skills needs.
4.1.2 Development of new nuclear energy capacity

Industry overview

Nuclear power generation has contributed to the UK electricity supply since 1956. After a varied history subject to fuel economics and public perception, the industry is being encouraged into a renaissance by the demand for low carbon power sources. Currently, nuclear power is overwhelmingly the largest component of low carbon electricity – zero at point of generation – and recognised by government as an important contribution to the UK energy mix, along with renewable sources and energy conservation. Furthermore, it is the only low carbon alternative with demonstrated generating capacity to match, if not exceed, that of traditional fossil fuels on a station for station basis.

The existing nuclear fleet contributes 11 GWe, corresponding to around 18% of the peak demand level. In fact, as a stable base load supply, the nuclear contribution increases during periods of reduced demand when (mainly) coal-fired stations are taken off-line. However, as the ageing Advanced Gas Cooled Reactor (AGR) fleet is decommissioned, an energy gap threatens to open up eliminating up to 80% of the UK’s low carbon electricity. In the absence of a new build programme, only one nuclear powered electricity station (Sizewell B) will continue to operate after 2025.

Filling the low carbon energy gap, whatever the source, is compounded by the prospect of a switch to electrically powered transport that, in turn, will require secure low carbon primary energy sources if there is to be a net reduction in emissions. Clearly such a scenario can only add to the challenging targets already faced by renewables and energy conservation activities. In response, government has now taken the facilitating actions to support a nuclear new build programme. To date, utilities and vendors have shown an interest in developing at least 16 GWe of capacity by 2025. Around 1000 workers per year will be required for the planning, construction, maintenance, operation and regulation that will take place over a 13 year period.

Currently 55% of the civil nuclear workforce is directly employed by the nuclear operators across three sectors; electricity generation, decommissioning and fuel processing, split across both public and private ownership. The remainder of the industry is formed by the nuclear supply chain providing manufacturing, maintenance, operations and regulations support.

Nuclear power manufacturing represents one low carbon technology where the UK can establish itself as a world leader. The nuclear manufacturing market is currently worth around £30 billion a year globally and is expected to grow to £50 billion a year in 15 years creating 15,000 jobs over 25 years of which 45% will be engineers.

The UK’s Nuclear Advanced Research Centre (NAMRC), a development led by Rolls-Royce, is expected to open in 2011. The Government-funded centre will bring together an industrial consortium of around 30 companies from the UK nuclear supply chain and will develop key manufacturing, management and training

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processes and support nuclear accreditation. These strategic partnerships between industry and universities develop and share technologies and processes for high-value added manufacturing. It will also provide a focus for the UK supply chain’s response to the increasing global market for nuclear power.

In the nuclear energy efficient manufacturing industry the future lies in the cost, competitiveness and growth of reduced weight manufacturing equipment (through the use of lighter components), manufacture of nuclear island equipment, including steam generators, pressurisers, primary circuit pipework and its engineering support heat generation technologies (solar thermal hot water, geo thermal energy, ground source and air source heat pumps, bioenergy) manufacture of control systems and turbines.

**Current skills needs**

Recent research has analysed the projected civil nuclear workforce from 2009 to 2025\(^6\). Today the industry employs 44,000 personnel, of whom 24,000 are employed directly by the operators, and of those, decommissioning (12,000) is the largest sector, followed by electricity generation (7,500) and fuel processing (4,500). Importantly, the workforce is older than, and retires earlier than, the UK in general. Up to 70% of the current workforce will retire by 2025. Modelling of a new build programme based on 16 GWe shows a requirement to recruit in excess of 1000 new works each year, mainly as new Apprentices and graduates. The combined technical, professional and senior management skill levels typically form around 70% of the workforce, as would be expected for a safety critical industry. Detail on the actual areas in highest demand is the subject of on-going research.

As with most modern engineering manufacture, in addition to the development of the components themselves there will be developments in the design and manufacturing processes to make material and energy use more efficient, minimise waste and reduce the time taken to get a new product from the design stage through to manufacture and sale. The current skill needs are:

- More graduates and posts graduates with a multi-disciplinary experience as the emerging technologies crosses the boundaries between such areas as natural sciences and engineering;
- Technicians capable of running the complex equipment associated with the technology particularly in the metals and welding sectors;
- Skills needs still largely based in the research and development environment as this is where the main use and development of the technology currently resides.

Within the engineering construction industry, demand growth is likely to weaken in 2009 and rise again in 2010-2014. By 2014 the new build programme for nuclear stations is expected to be underway and demand in that particular sector will rise substantially.

**Factors driving the demand for skills**

The government’s desire to include nuclear power in the UK energy mix is at the heart of the nuclear skills requirement. On a more fundamental level, climate change legislation, emerging technologies, investment in research and development and global competition are the four primary factors driving the demand for skills. The Bain Report (2008) predicts a plateau in the number of engineers graduating for the foreseeable future, and thus sets out to

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encourage employers to train the existing workforce and attract younger people into engineering. This position extends to the provision of STEM trained personnel more widely and combines with an age related loss of skills from the industry that will cause a short fall against the expected building programme.

Waiting for nuclear new build work to start will be too late for the UK workforce to respond. Pump-priming is essential, either from the client or government or both.

**Evidence of skills mismatch**

A number of skills issues have been identified in recent research that poses a significant risk to nuclear new build. These include the supply of project and programme managers, safety case authors, design engineers, control and instrumentation engineers and high integrity pipe welders. Set against that, there is some concern amongst employers in the Semta sector that the installation and commissioning of new build of nuclear power stations could draw technicians, particularly welders, from the manufacturing sector thus creating a skill shortage.

Furthermore, there is a general issue of the degree of nuclear awareness within the supply chain. Certainly, this is not an intensive training requirement, compared to the professional specialisms, but it is a broad one which will apply to much of the directly and indirectly employed workforce. The National Skills Academy for the Nuclear Industry has recently developed a certificate in Nuclear Awareness to meet this need. The efficient integration of the Nuclear Skills passport with non-nuclear accreditation systems will also be an essential component to meet skills gaps. The regional demand for skills will depend on the location of new build sites. As the regional futures become clearer, drill-down research will be required to inform the development of local skills strategies.

At present industrial roles are only partially ‘green’ with staff moving between conventional and renewable tasks as required during the transition to production of low carbon components. It is likely that graduates of the future will need some multi-disciplinary understanding of both mechanical and electronic systems, and also roles may emerge for people with a background and understanding of composites and renewable energy. There are also likely to be roles for managers and experts with knowledge of manufacturing process improvement and business improvement to increase efficiency and save on time and costs in the workplace. There is also a potential skill shortage for welders.

The development of new nuclear energy capacity will begin to have a significant manpower impact from 2015/16 onwards. The Engineering and Construction Industry forms a key element of the supply chain and will fall short in both numbers and quality unless skills investment rises.

**Future demand**

A highly skilled workforce will be needed if we are to become a leading nation in new low carbon technologies. With government help to re-train some of the thousands of workers who have recently lost their jobs in traditional manufacturing, they may be able to take up new highly skilled posts in the new, greener firms, and become part of the transition to a new style low carbon economy. Future skill needs will include:

- Project management skills to provide the ability to generate products from the technologies being researched, adhering to quality control and health and safety guidelines;
- As the technology becomes more embedded in industry and cost effective, the need for
technicians/operators will increase with a subsequent increase in the need for materials handling and fabrication.

The nuclear industry investors recognise the criticality of effective engineering construction performance in delivering value for money capital plant and for its ongoing performance by effective maintenance.

Maximising portability and recognising the skills from conventional engineering will greatly ease skills supply issues. A key component of this will be to ensure that the Strategic Skills bodies and the Regulator work together to ensure the quality standards, accreditation and validation systems are aligned and work effectively and efficiently. On a pragmatic level, up-skilling to meet regulatory requirements in limited specific areas of a new nuclear station will be more rapidly achieved. However, this will ultimately be a matter for the site licence companies in satisfying the regulatory requirements. Nuclear new build will add to the engineering construction industry's skills demand projection of around 3-5,000 people across the skills mix when the new build programme is underway.

**Will anticipated demand meet skills supply?**

Within the manufacturing supply chain, there are likely to be roles in the near future for people skilled with the ability to source and utilise low energy materials and the workforce will need to be trained to understand use of passive designs and modelling. There is also an increasing need for technical safety skills. Low carbon technologies present both the catalyst and the opportunity for the industry to continue to reinvent itself, reinvest in existing sites and secure long-term employment and technology capability.

Lack of current training places will constrain the rate of proof of competence to meet regulatory standards. The engineering construction industry skills base can be trained outside of nuclear initially and then flow into nuclear later with appropriate add-on training.

The industry needs reassurance that ‘policy’ is or will be turned into ‘effective demand’, that is demand backed by the ability to pay, if skills investment is to be boosted.
4.1.3 Energy from waste

Industry overview
Waste can be used to generate energy through combustion of solid fuels and via anaerobic digestion of wet food and agricultural waste. Generating energy from biomass waste could significantly reduce the amount of waste that is landfilled in the UK.

Waste biomass is an under-used resource which could provide a significant contribution to our renewable energy targets. The UK Renewable Energy Strategy highlights that currently only 6 TWh of heat and power is generated from biomass municipal solid waste collected by local authorities, and about 18 TWh from landfill gas. However, the government estimates that six million tonnes of waste wood and nine million tonnes of waste food are currently landfilled each year. If all of this were used for energy it would generate 42 TWh, or approximately 18% of our renewable energy target.

Waste can be turned into energy by conventional waste processing companies, water companies or on farms. Anaerobic digestion is a well-proven renewable energy and waste management technology. The water industry is a major user of this technology, and currently treats 66% of the country’s sewage sludge by anaerobic digestion. It plans to generate 0.8 TWh/yr of electricity from anaerobic digestion by 2010. Anaerobic digestion is, however, still under deployed within the UK waste and farming sectors.

On farms the development of anaerobic digestion technology now enables farms to breakdown organic matter in a closed digester vessel. Defra (2009) ‘Anaerobic Digestion: Shared Goals’ highlighted the volume of farm based waste. The UK produces over 100 million tonnes of organic material per year that could be used to produce biogas. Approximately 12-20 million tonnes of food waste, 90 million tonnes of agricultural material such as manure and slurry, 1.73 million tonnes of sewage sludge.

Anaerobic digesters produce a methane-rich ‘biogas’. This gas can be used for electricity and heat generation, and possibly upgraded for other applications. The remaining organic matter comprises an odour-free ‘digestate’ rich in nitrogen which can be spread on the land as a fertiliser.

Apart from its potential contribution towards improved energy security, on-farm anaerobic digestion offers multiple environmental benefits, including:

- Reduced emissions of methane from manures and agricultural residues, helping farmers and growers to achieve climate change mitigation commitments;
- Air quality benefits through the control and reduction of odours such as ammonia;
- Water quality benefits from improved management of nitrogen and other nutrients present in manures and slurries;
- Replacement of increasingly costly manufactured fertilisers with digestate.

Current skills needs
The research community, including academics, government, research councils and the private sector will provide the underpinning knowledge to enable technical solutions which are cost effective.

The development of infrastructure will require high level engineering and design skills together with ConstructionSkills. The skills required to do this
already exist within engineering construction contracting.

There needs to be improved knowledge transfer onto farms to understanding of the technology and its use. Anaerobic digestion is under deployed within the UK farming sector. However, the skills to run digesters and use the fertilisers which will be produced are already present within farming.

**Factors driving the demand for skills**

Government legislation provides a significant driver along with rising energy and fertiliser costs and general concern about the environment. Landfill tax provides a powerful driver to divert waste from landfill to other uses, and this has been strengthened with the further increases in the escalator announced in the 2009 Budget.

In July 2008 the government announced its plans to revise Nitrate Vulnerable Zone (NVZ) designations. The requirement for individual farms to increase slurry storage capacity over the next few years could mean that farmers look to anaerobic digestion as an alternative option for manure management. Rather than each investing up to £50,000 in upgraded slurry tanks, a group of farmers might choose to collaborate and invest/borrow a total of around £1 million for an income-generating anaerobic digestion project.

**Evidence of skills mismatch**

At present the use of waste to generate energy, and generating of energy from biomass more generally, is at an early stage in the UK. There is no evidence of a mismatch in skills. Other issues, such as a lack of knowledge about the costs and benefits, and problems getting necessary planning permissions, are the major barriers to increased uptake.
4.1.4 Carbon capture and retrofitting carbon capture

Industry overview
CCS describes the technology and process whereby the CO\textsubscript{2} emissions of power generating plants, produced as a by-product of the burning of fossil fuels and biomass (e.g. coal, gas, waste, crops, etc.) to generate electricity, are captured and prevented from being released into the atmosphere. This technology can be fitted to both new build and existing power generating plants.

Current skills needs
The experience gained by the contracting workforce in the oil and gas sectors is critical because storage of CO\textsubscript{2} will demand many of the same engineering skills. The potential scale of CCS technology is largely akin to retrofit of flue gas desulphurisation (FGD) on coal stations and also allied to major transportation issues. The limiting factor is proof of large-scale and UK engineering knowledge base for scalability.

Site supervision (as in all areas) is key to good productivity and is being strengthened by the new engineering construction industry supervisor programme.

Factors driving the demand for skills
With new gas and coal-fired power stations being built and more planned, coupled with the increasing number of biomass plants coming on-stream, the flow of people into this aspect of the industry is insufficient to meet anticipated volume, especially alongside competing sectors pursuing the same skills base.

Evidence of skills mismatch
Currently, primarily due to financial constraints, there are few new projects being initiated and the contracting workforce is experiencing lay-offs. Therefore, the issue of supply meeting demand is not one that is of major concern at the moment. However, as and when the construction industry picks up the demand for associated skills will increase, thereby creating greater competition for a pool of workers that is unlikely to be sufficient to meet UK-wide needs.

Future demand
The regulatory landscape for sustainability continues to change and this brings uncertainty to any predictions regarding skills and employment in the CCS industries. This lack of strategic direction is also an issue for companies in the supply chain, such as those producing coal. Demand for products and fuels as well as for implementation and engineering skills will alter significantly depending on government backing for CCS schemes, hence the importance of industry and government(s) giving strategic demand signals.

Existing latent demand needs to be converted into actual demand so that engineering construction employers can make investment decisions ‘to fill gaps that are not yet there’ with greater confidence.

Will anticipated demand meet skills supply?
The engineering construction contracting industry is dependent on client orders. Contracting strategies that share the risk with the investor/owner until the market is mature enough is essential for contractors to execute projects with a greater share of the risk. Due to the relatively small scale of CCS implementation at the moment, forecasting skills demand and establishing appropriate training provision is difficult. Also, clarification is required
of the strategic commitment to the UK’s future energy mix and the extent to which different fuel types will play a part. This area lacks the necessary certainty at the moment and further research would be a vital first step.
4.2 Decarbonising industry

4.2.1 Improved energy efficiency

Industry overview

Increased energy efficiency is central to meeting the UK energy and low carbon emission targets. There are strong business reasons for adopting energy efficient technologies including lower operating costs and less waste, leading to more competitive businesses. There has been significant progress made in this area in several industries, including paper and ceramic manufacturing, but to achieve significant reduction in carbon emissions in the long term there is a need to promote innovative energy efficient technologies in the manufacturing processes across all of the science, engineering and manufacturing sectors.

Many of the process and manufacturing industries within the Cogent, Skillfast-UK and Proskills sectors and the water industry within EU Skills’ sector are large consumers of energy. A reduction in their total demand through efficiency measures will be an important contribution to reducing green house gas emissions. Essentially, there are two strands to the required developments: industry specific business improvement measures and the application of technology to use less energy intensive processes. One of the key technological changes that will benefit energy reduction in the sector is the expansion of Industrial Biotechnology.

Improved energy efficiency manufacturing is essentially about using less energy to provide the same level of service/output. Advances in green manufacturing and rationalising energy use will help improve levels of recycling and waste reduction (hazardous and non-hazardous) as well as emission reduction (lead, solvents, decomposition products and carbon). Changes in manufacturing processes and product design will include eco-efficient processes such as:

- Extraction of recyclates for reuse and recovery, life cycle assessments and business improvement techniques to build capacity and capability of the workforce;
- Application of lean manufacturing methods i.e. six sigma and continuous improvement techniques to increase productivity and efficiency;
- Use of cogeneration methods (combining heat and power) thus enabling operations at a higher temperature whilst burning less fuel;
- Energy minimisation by integrating waste recycling to energy;
- Improved supply chain management.

Adoption of these methods will drive increased efficiency and produce fewer pollutants and other emissions. In addition to reducing the environmental impact of existing products, there are opportunities to invest in the application of new low impact eco-technologies and products. Waste reduction technologies can reduce waste and the costs associated by 30-70% per year.

Current skills needs

A key challenge is in the development of skills needed in the manufacturing of instrumentation for measuring, monitoring and controlling emission and waste generation. Technology can help with mapping processes so that environmental initiatives can be aligned with cost savings.

In addition to the skills needed to implement efficient waste disposal, most modern manufacturing industries will need to develop the
design and manufacturing processes to make material and energy use more efficient, minimise waste and reduce the time taken to get a new product from the design stage through to manufacture and sale. The need for technical skills such as mathematical modelling, rapid prototyping and computer simulation which take into account the sustainability agenda is a growing area for development.

The largest skills shift is in the area of supply chain development, outsourcing, after market support, innovation management and sales and marketing. There is move towards higher value added activities such as system design, technical support, advanced materials selection and processing. In addition skills such as corporate social responsibility, environmental product analysis, legislative compliance and Information Computer Technology are needed.

Cogent’s industries will be needing skills in process improvement and basic laboratory skills and industrial biotechnology skills including those qualified at Masters level.

Many UK based fashion and textiles businesses manage complex global supply-chains in which energy is used at all stages, but particularly intensively at the dyeing and finishing stages. A recent pilot between Continental Clothing and the Carbon Trust demonstrated that a 90% carbon reduction is possible in the production of commercial T-Shirts. The most pressing skills gap is for those in design and management roles to understand the contribution of the fashion and textiles supply-chain to carbon emissions and the potential manufacturing and management techniques to reduce emissions. It will also be important for technical staff in UK based factories to understand how their decisions impact on climate change. Skillfast-UK is about to publish a report on sustainability skills in the sector entitled; ‘Material Impact’.

There is a need for upskilling and multi-skilling across the Proskills footprint to account for the changes that are being driven through low carbon implementation. The focus is not only on developing broad new skills in management, product and process knowledge and design, but also in adapting existing skills to new products and situations, and adding ‘modules’ of knowledge and competence to complement existing knowledge. This will be helped by recognising the low carbon agenda in existing qualifications and National Occupational Standards (NOS), as well as creating the new qualifications.

**Factors driving the demand for skills**

Climate change legislation and statutory regulations, emerging technologies, commercial competitiveness, investment in research and development and global competition are the four primary factors driving the demand for skills. The Bain Report (2008) predicts a plateau in the number of engineers graduating for the foreseeable future, thus encouraging employers to train the existing workforce.

Business Improvement will modify existing processes to create the same (or increased) output with reduced material and energy waste. The large energy requirements for many of the process and manufacturing industries mean that energy reduction is a significant factor in generating competitive advantage. As a positive environment for energy efficiency develops, potentially coupled with an increased statutory requirement, demand for business improvement skills will accelerate. This will require an understanding of the whole manufacturing process, from primary products to the finished
article, and a need for cross disciplinary and cross industry training.

Customer concern about sustainability issues is driving business responsiveness. This is often mediated through codes, standards and labels which may include energy use as a factor. In the future independent carbon labelling may be more influential. For those using significant energy in the UK new regulatory schemes such as the Carbon Reduction Commitment play an important role. For the most strategic businesses expectations of future energy prices are significant.

Evidence of skills mismatch
At present industrial roles are only partially ‘green’ with staff moving between conventional and renewable tasks as required during the transition to production of low carbon products. It is likely that graduates of the future will need some multi-disciplinary understanding of a range of high level skills, from high temperature metal processing to chemical manufacturing, and also roles may emerge for people with a background and understanding of alternative sources of power generation such as battery and low carbon fuels. There are also likely to be roles for managers and experts with knowledge of manufacturing process improvement and business improvement to increase efficiency and save on time and costs in the workplace. Currently there are not enough people trained in B-IT nor are there enough trainers to deliver the qualifications that relate to these process improvements. A paradigm shift has occurred requiring a change from narrow specialism to interdisciplinary expertise due to the convergence of technologies and a shift away from more traditional job roles to wider ranging activities. From a regional perspective, large plant is likely to be replaced with a more geographically distributed industry.

In terms of providing more efficient energy sources, the challenge is to bring together a well established bioscience heritage and the large-scale production experience of the existing chemical, pharmaceutical and liquid fuel industries. However, to do this a step change is required in the approach to providing an appropriately skilled workforce, both in terms of capacity and capability. Indeed, the industrial biotechnology innovation and growth team identify skills as one of the five barriers that need to be addressed to enable IB to realise its potential. The theme of ‘inter-disciplinarity’, and the ability to understand the whole process cycle, continues here as it does generally in the low carbon economy.

In some cases employers have a good track record in implementing sustainable solutions, clearly articulated demand for sustainability skills and methods of meeting this demand. In other cases demand for sustainability skills is new, not clearly articulated or latent. However it is clear that universities are not yet providing students with the skills required to operationalise sustainability within sector businesses upon graduation. There are also skills gap relating to operational understanding of sustainability at management and technical levels. However, SSCs are responding to this need. For example, the new facilities management qualification developed by Asset Skills includes a module on managing sustainability.

Future demand
A highly skilled workforce will be needed if we are to become a leading nation in new low carbon technologies. With government help to re-train some of the thousands of workers who have recently lost their jobs in traditional manufacturing,

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they may be able to take up new highly skilled posts in the new, greener firms, and become part of the transition to a new style low carbon economy. Demand for technical skills is likely to rise across all manufacturing industries.

**Will anticipated demand meet skills supply?**

To meet such challenges, there are likely to be roles in the near future for people who are skilled at designing and running manufacturing departments with consideration for how products will be recycled at the end of life as well as being able to design products and manufacturing processes that minimise wastage in the amounts of material and energy used. Low carbon technologies present both the catalyst and the opportunity for manufacturing industries to reinvent themselves, reinvesting in existing sites and securing long-term employment and technology capability.

The rate of change is potentially large. Pinch-points may become apparent where the long lead time for higher level skills makes meeting demand difficult. STEM skills are critical for the future low carbon industries, but an acute situation will arise if the supply of school and university students studying STEM subjects is not enhanced. This situation is exacerbated by the age profile of the workforce of many industries. All sector specific skills and qualifications should have sustainability and low carbon practices incorporated at a basic level, and will have to recognise the need to understand and respond to consumer behaviour and demand in this context.
4.2.2 Reduced emissions and wastage

Industry overview
For the UK to successfully adapt to a low carbon economy, industry will need to play its part through reducing emissions, energy use, and wastage. The ways in which this can be achieved are many and there are examples of good practice across the UK to draw upon and disseminate, particularly in high energy usage industries such as paper, brick and glass manufacturing, where reducing emissions and wastage have been economic drivers for many years.

Current skills needs
Low carbon practices are being built into the industrial process, but it takes detailed knowledge of processes, products, and materials to achieve this. This means current skills needs tend to be at higher levels, specifically around:

- Management and leadership – leadership will be important to both individual companies and the industrial sectors as the government seeks to develop low carbon practices and reduce emissions.

- Process control and improvement – reducing wastage is a key component of profitability for companies in all sectors. It is also an important part of achieving a low carbon economy, and continuing advances in process control will lead to ever-improving results in this area. Again, the current skill needs tend to be at a higher level here, as the adoption of new working practices through schemes such as business improvement techniques requires top-down stimulation from enlightened management before roll out is possible on a wider basis. Low carbon practices will need to be built into the qualifications and materials supporting the introduction of these procedures and will affect most areas of the business, from rationalising transportation costs and reducing waste of materials, to improving product design and changing suppliers.

- Materials, supply chain, and product design – detailed knowledge of both the materials used by and the products manufactured by industry is essential in making improvements to the efficiency of the supply chain and product design. These advances will require higher-level STEM skills, in particular knowledge of materials, mechanics, and engineering. A greater supply of people with these skills will help directly benefit product design as well as the sourcing and use of materials, which will in turn help boost efficiency and reduce wastage. Knowledge of global and domestic businesses and industries will also prove critical to rationalising supply chains and adding value.

Factors driving the demand for skills
The most important driver in achieving the decarbonisation of industry will be the ‘normalisation’ of low carbon practices. Industry leaders will need to be approached and convinced of the benefits of taking a low carbon approach to their businesses, and that the required changes will improve their prospects and competitiveness rather than deterring from them. The promotion of low carbon as an opportunity rather than a threat will be key to achieving this, especially in light of ever increasing international competition from the likes of India and China.

It will take pressure from the market to drive the adoption of low carbon practices. Downstream and final consumer demand for low carbon products and for greater knowledge about the environmental cost and carbon footprint of industrial processes will be vital to provide stimulus for change.

Alongside this, top-down pressure from the government through regulatory and legislative levers will also help set the direction. Enforced
compliance to schemes such as REACH will help stimulate innovative thinking in industry, and the subsequent application of low carbon ideals to existing practices will help to make the step change necessary for large-scale adoption.

**Will anticipated demand meet skills supply?**

Though the demand for the higher-level skills described above will continue to exist as constant improvement is pursued, other skills needs are likely to emerge as low carbon becomes more established as a driver for industry. Mass market implementation of low carbon practices will need input from workers at all levels, and the skills needs are likely to grow at lower levels to ensure that the necessary consistency is maintained. Content will need to be built into NOS and the qualifications that are based them through consultation with industry led by SSCs, much the same as Health and Safety practices are currently represented. Adoption and recognition of the required skills into standards of competences in this way will ensure that low carbon practices form a central tenet of industry in this country in the future.
4.2.3 Alternative fuels – hydrogen, biofuels, etc.

Industry overview

Alternative fuels are typically non-carbon (such as hydrogen) or use the carbon cycle for neutrality.

The UK Renewable energy strategy concludes that using biomass to generate heat and electricity is a cost-effective way to meet the 2020 renewable energy target. Biomass, whether used to produce heat, electricity or biofuels, can make a significant contribution to our greenhouse gas targets and support wider sustainable development objectives at home and abroad. The strategy indicates that around 30% of the UK renewable energy target could come from bioenergy for heat and power, rising to around 50% if biofuels for transport are included. In addition, it can provide the feedstock for a wide range of sustainable low carbon renewable materials and products. The government is promoting this through the UK Biomass Strategy (including the revised Non-Food Crops Strategy Action plan).\(^9\)

Currently, two primary biofuels are in commercial production. Bioethanol made from fermenting agricultural crops such as sugar cane, sugar beet or wheat; and biodiesel produced from oily crops such as soy and oilseed rape or by processing oily wastes such as used cooking oil and animal fats. In the future, second generation or advanced biofuels may be manufactured from a wider range of biomass such as wood, energy crops and waste, using processes that also produce heat and power.

In 2008-09 around 2.6% of all UK road fuels used were biofuels, producing 10 TWh of renewable energy and reducing UK carbon emissions by around 3 MtCO\(_2\) from the displacement of fossil fuels (UK Renewable Energy Strategy). The supply of biofuels in the UK is driven by the Renewable Transport Fuel Obligation.

Hydrogen can either be burnt in a heat engine, or used in fuel cells which are energy dense and have a higher theoretical efficiency. In the UK, the fuel cell industry is growing, with over 100 UK companies contributing to a global market. Over 50% of home production is exported.\(^10\) In 2009 the Department for Energy and Climate Change (DECC) allocated a total indicative budget of £7.2 million for capital funding for a fuel cells and hydrogen demonstration programme, to be delivered by the Technology Strategy Board.

Safe transport and storage of hydrogen gas is a significant challenge. The gas is odourless and burns with an invisible flame, although the petrochemical industry already has an extensive history of many of the issues involved.

Current skills needs

The main skills needs in the engineering construction industry are in relation to the volume of new entrants and upskilling across the full range of occupations, including; project managers, technological understanding, environmental compliance and design standards. Adaption of skills is possible from existing installation and construction practices (i.e. top-up).

More generally there is a need for multi-disciplinary skills for industrial scale-up, safe handling and storage of bioethanol and biodiesel, purity control. Research and development skills...
for fuel cell development, hydrogen generation (including nuclear research and development), safe handling and storage.

**Factors driving the demand for skills**

UK Renewable Energy Strategy, Carbon reduction obligations are increasing the demand for biofuels generally, and UK sourced fuel specifically. Biofuel production is an emerging industry which has a strong overlap with traditional liquid fuel production but also requires highly skilled personnel at the interface between biosciences and industry.

Infrastructure for H\(_2\) handling, distribution and storage will need to be designed and built. The safety case for such facilities will be important to get right in the planning and design phases. New processing plant will need to be built alongside upgrading of current plant to both make H\(_2\) and utilise it effectively in place of current fuel sources.

The demand is currently low. The flow of people into the industry is insufficient to meet anticipated volume, especially along side competing sectors pursuing the same skills base. The result is a lag effect, where there is a lack in confidence until orders are placed.

**Evidence of skills mismatch**

Emerging industries are more likely to define skill demands ahead of their supply. The particular requirement here is for high level multi-disciplinary training that can bridge the gap between biosciences and engineering, the laboratory and the industrial plant.

Currently, there are fewer new projects initiated and the workforce is experiencing industry wide lay-offs. This is exacerbated by company administrations and failures and/ or reported losses. It is a situation that is unsustainable, since the margins in the contracting community are low and the volumes are insufficient to sustain UK capability.

For feedstock production, farmers will need to develop knowledge of agronomy of different crops for biofuels, marketing and development of supply chains.

**Future demand**

Crop-based biofuels face ethical and practical hurdles. The former is due to the effect on the global price of staples in a world with growing populations; the latter is an issue for developed economies like that of the UK with little accessible landmass for production. However, oil companies are exploring marine-harvested algal biofuels which would have minimal impact in both these regards. The UK as an island nation has yet to explore this potential.

The engineering construction contracting industry is dependent on client orders. Contracting strategies that share the risk with the investor/ owner until the market is mature enough is essential for contractors in the engineering construction industry to execute projects with a greater share of the risk.

The regulatory landscape for sustainability continues to change and this brings uncertainty, hence the importance of giving strategic demand signals. The latent demand needs to be converted into actual demand so that engineering construction industry employers can make investment decisions ‘to fill gaps that are not yet there’ with greater confidence.

**Will anticipated demand meet skills supply?**

The building and installation of new low carbon plant will compete with other engineering
construction work generally and the replacement of ageing petrochemical and conventional power plant in particular. The rate of change is potentially large. Pinch-points may become apparent where the long lead time for higher level skills makes meeting demand difficult. STEM skills are critical for the future low carbon industries, but an acute situation will arise if the supply of school and university students studying STEM subjects is not enhanced. This situation is exacerbated by the age profile of the workforce of many industries.

The planned supply of engineering construction industry skills will meet anticipated demand if it is recognised that skilled individuals may be obtained from outside the low carbon sector. This would minimise the top-up required and utilise the skills base that is already there. At present the scale is inefficient and the mix of low carbon (nuclear, coal, alternative fuels etc.) lacks the necessary certainty.
4.2.4 Low carbon processing

Industry overview
The emerging field of industrial biotechnology is grounded in fundamental research using biological systems to produce materials, chemicals and energy. This provides the possibility of novel processes that reduce energy demand, typically in areas such as pharmaceuticals and high value, low volume speciality chemicals and, as discussed elsewhere, biofuel.

Government identifies 42 core industrial biotech companies, of which 37 are small and medium-sized enterprises (SME). Although industrial biotechnology currently accounts for less than 5% of total chemical and pharmaceutical sales, it is described as being in an embryonic growth phase. Continued growth is expected, driven by the low carbon economy, which will result in it becoming a significant contributor to the European economy over the next 20 years.\(^{11}\)

Although the industry is seeing renewed relevance in helping to meet national greenhouse gas emission targets, 85% of the core companies were established before 2005. To further develop the sector, the Department for Business, Innovation and Skills is funding the development and commercialisation of new biotechnology processes through a competition operated by the Technology Strategy Board\(^{12}\).

Current skills needs
In this growth phase skills are required at all levels. More specifically, high level interdisciplinary skills, with the ability to integrate laboratory practice with industrial scale production are in demand. This applies to both technical and managerial roles. A wide range of specialisms is required, from the cultivation of feedstocks and land management to the operation, control maintenance of industrial plant.

Factors driving the demand for skills
The demand for skills is being driven by the expansion of the industry, itself led by the low carbon agenda and the competitive demand for novel chemistry, new chemical functionality and biologics in pharmaceuticals.

Evidence of skills mismatch
The skill supply is identified by the industrial biotechnology innovation and growth team as one of five key areas that need to be addressed to release the industry’s potential.

Future demand
Overwhelmingly the demand will be determined by the rate of growth of the industry. This is partly a commercial and economic issue, but also a scientific and technological one. The strong base in fundamental research means that laboratory developments can in principle find their way to the market place relatively quickly, leading to what might be termed, ‘opportunistic’ research led growth.

Will anticipated demand meet skills supply?
The rate of change is potentially large. Pinch-points may become apparent where the long lead time for higher level skills makes meeting demand difficult. STEM skills are critical for the future low carbon industries, but an acute situation will arise if the supply of school and university students studying STEM subjects is not enhanced. Interdisciplinary high level STEM skills are the key to this area, and others.

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\(^{11}\) IB 2025 Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy, BERR.

\(^{12}\) http://www.innovateuk.org/deliveringinnovation/forthcoming/competitions/developinghighvaluechemicals.ashx
4.2.5 Land management and the natural environment

Industry overview

Active management of the natural environment can underpin many facets of a low carbon economy and mitigate the impact of climate change. Carbon sequestration involves capturing and storing carbon for the long-term naturally in soils, vegetation and the oceans. These carbon sinks play a vital role in regulating the climate. Research by Natural England highlights that better management of our habitats, peatlands, woodlands, agricultural land and seas can play a role in our move to a low carbon economy.

Through biomass, the use of timber and other natural materials in construction and renewable energy sources the environmental and land-based sector and its skilled workforce can contribute to a number of themes outlined in this report.

For instance, many of our peatlands have been degraded by drainage, burning and conversion to other land uses. Peat soils store an estimated 296 million tonnes of carbon (the equivalent of two years of UK emissions). In an undamaged state, peat sequesters between 0.1 to 0.5 tonnes of carbon per hectare per year. Another example is provided by the Forestry Commission who released research in 2009 which identified that increasing the UK’s area of planted woodland by 4 percentage points by 2050 would lock up 10% of our predicted greenhouse gas emissions.

Green spaces in urban areas also absorb carbon. Research funded by the Horticultural Trades Association highlights that planting in urban areas absorbs more carbon, reduces the urban heat island effect and can reduce the summer energy load on buildings by 20-40%. Commission for Architecture and the Built Environment (CABE) argues that shifting public spending from grey projects (like heavy engineering projects), to green schemes, like street trees, parks, green roofs and waterways will have a range of environmental, social and economic benefits, thereby contributing to a low carbon economy.

Within agriculture there are opportunities to increase carbon sequestration in soils and grassland by adopting minimal cultivation techniques which release less carbon held within the land. The use of technology allows for ‘precision farming’ which increases efficiency, ensure farming uses less energy and reduces the release of carbon from the land. The increased use of CO₂ digesting crops together with this ‘low impact’ farming and resource efficient practices are currently the subject of much debate.

Through adopting a more sustainable system of farming, integrating technology with traditional methods the sector can become more efficient and environmental friendly and environmentally responsible. This has been termed Integrated Farm Management (IFM). Defra’s Farm Practices Survey 2008 estimates that nearly 20% of farmers practice IFM. Measures such as improving manure and slurry storage (or digesting this waste to create biogas) and changing livestock diets, enhanced breeding programmes both in crops and livestock will reduce emissions.

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16 Horticultural Trades Association (2009) Greener Planting, Greener UK.
Many parts of the land-based sector do not have low carbon practices at present. The UK agricultural sector is a significant contributor of greenhouse gases. Whilst the sector accounts for only 1% of CO$_2$ emissions it accounts for 30% of methane and 60% of nitrous oxide$^{19}$. The Stern Review identified agriculture as contributing 14% of our total greenhouse gas emissions. This is higher than both industry and the transport sector.

A further way we can benefit from land management is by utilising biomass as a resource. The UK renewable energy strategy highlights the great potential of biomass. Biomass has three main sources - conventional forestry management, agricultural/energy crops (such as willow grown as short rotation coppice (SRC) or miscanthus grasses) and biodegradable waste. The strategy highlights that around 30% of the UK renewable energy target could come from bioenergy for heat and power, rising to around 50% if biofuels for transport are included.

**Current skills needs**

There is a need for skills at a mix of levels. These include high level scientific research skills for identifying and developing the underpinning knowledge to enable technical solutions which are cost effective, technical skills of farming and forestry practices to implement and business management skills to enable business to identify and address new market opportunities.

Many of these essential skills required are already present, but there may be a need to add to existing knowledge and skills. For instance, farmers will need to develop knowledge of agronomy of different crops for biofuels.

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$^{19}$ Defra (2009) Agriculture in the UK.

Smooth knowledge transfer from science and research into everyday practice will be key to underpin this. Work is ongoing to identify the key skills and processes which need to be adopted. Knowledge in areas such as soil science, organic chemistry, genetics and efficient resource management are now missing in many of the managers in the agricultural and horticultural sector, but these will become increasingly important as farming practices change.

Rapid advances in the science base of a number of industries including agriculture, horticulture and forestry and the effective dissemination of new techniques for both existing workers and new entrants will be required.

**Factors driving the demand for skills**

Businesses within the environmental and land-based sector will move into new markets and adopt low carbon practices when it makes sense for them to do so. Government legislation provides a significant driver along with rising energy and fertiliser costs and general concern about the environment.

Changes were made in 2005 (CAP reform) to the way subsidies are paid to farmers. To receive their single farm payment, farmers are required to meet specified cross compliance criteria based on adopting environmentally sensitive management techniques. The preparation of environmental impact assessments and soil management and protection plans are a requirement of cross compliance. Land, including uncropped land, has to be kept in good agricultural and environmental condition.

Retailers and consumer demand for low carbon products and the demand for more information on carbon footprints will also impact on producers.
There is going to be a critical drive from the retailers and land-based and food assurance schemes.

The development of an Agri Skills Strategy by industry, Lantra and government will provide an overarching approach to skills development in agriculture and horticulture. Key aims of the strategy are to increase the professionalism of farmers and support more sustainable approaches.

**Evidence of skills mismatch**

The environmental and land-based sector is experiencing a high level of skills shortages, which account for 29% of vacancies (compared to 21% across all sectors)\(^{20}\). This shortage is greatest in both volume and proportion terms within the agricultural sector.

There is a need to increase forestry/woodland management skills. Many woodland owners require skills development to assess and manage their land sustainably (by thinning, pruning, replanting).

The CABE research\(^{21}\) reveals skills shortages within local government for horticultural skills as well as higher level planning and management skills to enable better design and manage green infrastructure.

**Will anticipated demand meet skills supply?**

Information is crucial; a good system of knowledge and technology transfer will support the adoption of mitigation activities. Governments can intervene to ensure that the appropriate information is available through the network of advisors and the non-governmental organisations, and that such higher level and management skills development can be supported as a priority growth area.

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4.3 Decarbonising the transport sector

4.3.1 Low carbon engines and vehicles

**Industry overview**

Low carbon technologies focus on the many emerging industrial technologies which promise to deliver low or zero carbon emissions when fully developed and implemented. The saving of energy and manufacturing products that use less fuel and produce less pollution in the atmosphere are the focus of government, European Union and world legislation. Such legislation will certainly lead to developments and innovations in the automotive, marine and aerospace manufacturing sector.

Transport systems are essential for connecting people to businesses and are fundamental to our economic growth. However, transport contributes around a quarter of man-made carbon emissions and the sector’s share has grown²² and constitutes a major barrier to the transition to a low carbon economy. The shift to low carbon technologies has a twofold environmental and economic impact. Making transport engines more fuel efficient could make the biggest single contribution to cutting carbon dioxide emissions in the UK. There is intensive research and development under way in many of these areas, much of it co-funded by bodies such as the Technology Strategy Board. This has implications for both public transport (buses, trams²³, caravans, HGV)²⁴ and private vehicles.

A vehicle’s carbon dioxide emission is directly related to its fuel efficiency. The more fuel a vehicle uses the more carbon dioxide it emits. Improved engine technology in the low carbon economy is a fantastic opportunity for advancement. A recent government review of low carbon vehicle use has concluded that, in the long-term, road transport can be made almost carbon free by using electricity or hydrogen as power source. In the short term, the focus must be on improving the fuel efficiency of existing petrol and diesel vehicles. In the medium and long-term there is a whole range of approaches to decarbonising road transport, from increasing the efficiency of existing engines and systems, to developing possible future power sources such as the hydrogen fuel cell. There are many ways in which this can be achieved, including:

- Reduced weight through the use of lighter components (e.g. composites) improving aerodynamics (especially for marine, aerospace, HGV and cars. E.g. Jaguar are using aluminium welding materials);
- More advanced tyres with decreased tyre to road friction and rolling resistance (e.g. Michelin²⁵);
- Improved engines (such as hybrids (e.g. Toyota, Honda), which combine petrol or diesel and electric engines (e.g. Nissan²⁶ and Smiths²⁷), solar power;
- Providing a electric charging infrastructure²⁸;
- Stop-start technology (which turns off the engine when a car is stopped in traffic);
- Alternative fuels: Compressed Natural Gas (CNG), biogas and hydrogen, biodiesel,

²² Low carbon vehicle partnership July 2009.
²³ www.forthports.co.uk/.../WebSiteTRAMCOAnnouncement07FINAL.pdf
²⁴ http://www.publicservice.co.uk/feature_story.asp?id=12631
²⁷ http://www.smithelectricvehicles.com/
²⁸ http://news.bbc.co.uk/1/hi/england/8246009.stm
• biomass-to-liquids and hydrogenated vegetable oil;

• Fuel cell technology\textsuperscript{29} could see mass production of fuel cell powered cars and buses.

\textbf{Current skills needs}

The innovations in skills are likely to be related to those of lighter material for body parts in the form of composites, in fuel and engine efficiency and also in improving the way in which the power is transferred from the engine to the wheels. The accelerated introduction of low carbon vehicles and fuels is a vital part of the drive to avoid dangerous climate change. Cars are currently being manufactured with hybrid engines, electric and alternatively fuelled vehicles and improvements in the structures and materials used in the vehicles manufacture.

As with most modern engineering manufacture, in addition to the development of the vehicles and components themselves there will be developments in the design and manufacturing processes to make material and energy use more efficient, minimise waste and reduce the time taken to get a new product from the design stage through to manufacture and sale. Skills in composite manufacturing, design, ICT, mathematical modelling and simulation, systems design and engineering skills for use in advanced manufacturing and quality control is prevalent.

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\textbf{Factors driving the demand for skills}

Climate change legislation, emerging technologies, investment in research and development and global competition are the four primary factors driving the demand for skills. The Bain Report (2008) predicts a plateau in the number of engineers graduating for the foreseeable future, thus encouraging employers to train the existing workforce.

The vision for ultra-low carbon vehicles in the UK is to promote infrastructure, support technology development and encourage manufacture in the UK, whilst incentivising customers\textsuperscript{30}. The government has already committed around £400 million of support to encourage development and uptake of ultra-low emission vehicles.

UK’s aero-engine industry and supply chain has been boosted by investment in innovative new technology by the SAMULET\textsuperscript{31} (Strategic Affordable Manufacturing in the UK with Leading Environmental Technology) programme. It is a collaborative programme between industry and academia led by Rolls-Royce working in a consortium alongside other high profile manufacturers, SMEs and several of the UK’s top universities. The total cost of the project including industry investment is expected to be around £90 million.

\textbf{Evidence of mismatch}

At present industrial roles are only partially ‘green’ with staff moving between conventional and renewable tasks as required during the transition to production of low carbon vehicles. There are also likely to be roles for managers and experts with knowledge of manufacturing process improvement and business improvement to increase efficiency and save on time and costs in the workplace. National Employer Skills Survey (NESS) (2007) and Semta’s Labour Market

\textsuperscript{29} http://www.carbontrust.co.uk/News/presscentre/091009_Polymer_fuelcell_challenge.htm

\textsuperscript{30} Ultra-low carbon vehicles in the UK (2009).

\textsuperscript{31} http://www.eurekalert.org/pub_releases/2009-07/eaps-s072809.php
Survey (2007) study both indicate that there is a shortage of technical skills in the Semta sector.

With the growth in the low carbon area there is some concern amongst employers in the Semta sector that other low carbon sectors e.g. nuclear and construction, could draw technicians particularly welders from the manufacturing sector thus creating a skill shortage. This together with the fact that young people are not easily drawn to the sector could create skills gaps and shortages.

**Future demand**

A highly skilled workforce will be needed if we are to become a leading nation in new low carbon technologies. With government help to re-train some of the thousands of workers who have recently lost their jobs in traditional manufacturing, they will be able to take up new highly skilled posts in the new, greener firms, and become part of the transition to a new style low carbon economy. It is likely that graduates of the future will need some multi-disciplinary understanding of both mechanical and electronic systems, and also! roles may emerge for people with a background and understanding of alternative sources of power generation such as battery and low carbon fuels.

Structural testing such as physical testing in wind tunnels of vehicle sized models is likely to move towards modelling and testing using computer simulations. Rapid prototyping will become more prevalent, where computer drawings and designs are converted to a 3D model using something similar to a photocopier that works in three dimensions. There are likely to be roles for people involved in developing and producing prototypes using software to virtually test and explore new vehicle designs. As technologies are increasing in complexity there is more of a need for human interfaces to technology to become more supportive.

**Will anticipated demand meet skills supply?**

To meet such changes, there are likely to be roles in the near future for people who are skilled at designing and running manufacturing departments with consideration for how a vehicle will be recycled at the end of its life as well as being able to design products and manufacturing processes that minimise wastage in the amounts of material used in making the vehicle or its components. The level of training undertaken by employers (in particular those ‘at risk’ through complacency or lack of understanding and funding) in the Semta sector will need to improve (NESS 2007). There is a move towards higher value added activities such as system design, technical support, advanced materials selection and processing which need specific training such as in the use of composites, etc are not often locally available as standalone courses and often form part of a larger qualification. Thus there is a need to make these courses more accessible for workforce development.

Low carbon technologies present both the catalyst and the opportunity for the industry to continue to reinvent itself, reinvest in existing sites and secure long-term employment and technology capability.
4.3.2 Fuel efficiency

Industry overview

Fuel efficiency is just one area which the transport sector can contribute to a low carbon economy. Thinking about how much fuel (as an input) is required to perform a specific task (the output), the less input required to achieve a given output, the more efficient the process must be.

Driver behaviour plays a significant role in the efficient use of fuel. Not all driving is the same and there are significant benefits to be had, in both ecological and environmental terms, from increased levels of fuel efficiency. The less fuel that is used to perform a task, the less emissions are released. Thus, driving techniques which mean fewer tank refills mean cost savings for the operator but also reduced levels of emissions. With training such as Safe and Fuel Efficient Driving (SAFED), companies can not only help the environment, but can also benefit from a 5-15% cost saving on their operations.  

Eco-driving will improve the technical skills of drivers. It is estimated that by training 90% of HGV and van drivers in Eco-driving, such as the SAFED programme, up to 3 million tonnes of CO₂ over a five-year period and £300 million in fuel costs for the industry per year could be saved. The challenge is to ensure the required level of take up if this training. By alerting companies that programmes like SAFED are an investment to improve bottom line benefits and not a cost it will be more likely.

It is also worth considering the associated spill-over effects of training professional drivers in efficient techniques. We anticipate that the trained individual will apply these skills in private driving and may influence the driving practices of others.

Current skills needs

In the logistics sector there are two main areas of skills needs in this area. At the very front line we can improve the skills of the operators – warehouse workers and drivers, and secondly, the management skills required to ensure that the practices are followed.

Warehouse operatives are crucial in ensuring that goods are stored, picked, loaded and unloaded in an accurate and timely fashion. They are a major influence on the condition of loads when delivered and help to reduce the number of damaged goods, preventing extra journeys to and from customers and any adverse effects on the company’s reputation.

Drivers, if trained and managed correctly can save fuel and money. Research indicates that a SAFED course, incorporated as part of the Driver Certificate of Professional Competence (CPC) training, is seen as the most beneficial course to drivers.

Management and support staff help to ensure records are kept, performance, such as fuel use, is monitored, systems and machinery operate properly, vehicles are maintained, routes are planned and deliveries made on time. If these functions are operating efficiently and effectively, fuel and money can be saved by the warehouse and delivery functions.

32 http://www.safed.org.uk/SAFEDCoaches/index.html
Factors driving the demand for skills

Pressure from the government and government institutions at all levels, as well as increasing campaigns by the environmental lobby will ensure that attention continues to be given to ‘green’ issues and the need to mitigate the impact of transport on the environment. The publication of Department for Transport’s (DfT) Low Carbon Transport: A Greener Future, a key component of the UK Low Carbon Transition Plan, has set the course towards a low carbon transport system for the future.

New low carbon vehicles will also benefit a company’s profitability as well as helping the environment\(^\text{35}\). The low carbon sector is an area of growth and high on the government’s agenda, so there are likely to be more changes in the sector in the future.

Corporate Social Responsibility across the entire supply chain, combined with consumer pressure, will also drive companies to look for sustainable solutions. A further driver for these skills is industry-wide recognition of the bottom line benefits: Eco is often the same as efficiency.

Evidence of skills mismatch

Understanding and awareness of low carbon resource efficiency is crucial. This must be in place to stimulate demand for low carbon skills and more effective implementation. The introduction of the Driver CPC is anticipated to increase demand for eco-driving training\(^\text{36}\). Accreditation by Joint Approvals Unit for Periodic Training will ensure that quality is maintained and the balance between supply and demand can be monitored.

Future demand

Acknowledging that the green agenda is not a cost, indeed it is actually a way to reduce costs, consequently increasing the bottom line, will drive demand for these skills. As will recognition by the sector of the benefits that programmes such as SAFED can bring.

The DfT’s suggestion of making eco-driving a mandatory part of the European Union Driver CPC could see significant numbers of drivers trained each year in this area. Currently this would mean that 312,000 HGV drivers and up to 202,000 van drivers would need to complete the training within each five-year period.

Will anticipated demand meet skills supply?

Research\(^\text{37}\) undertaken by Skills for Logistics and GoSkills indicates that the supply of training in place for the Driver CPC will be sufficient if completed over the 5 years. However, there are still questions on how the industry will complete the require training. If all drivers leave the training until 2014, then there may not be sufficient supply. Skills for Logistics and GoSkills are working with the industry to try and ensure training is delivered evenly over the next five-years.

It is anticipated that employees will be required with different skills; for instance if there are changes in engine/ fuel types. As part of Skills for Logistics and GoSkills remit, we will continue to work with employers to develop relevant and fit for purpose skills development solutions.

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\(^{35}\) http://www.safed.org.uk/financial_savings.html


4.3.3 Air traffic management

Industry overview
An idea being explored by airline companies is the towing of its aeroplanes to their take off point in an effort to cut down on carbon emissions. Virgin carried out a trial with 13 of its Boeing 747-400 aeroplanes at airports in London. They estimate that 120,000 tonnes of carbon emissions could be saved if the process was applied across all of its fleet\(^38\).

Air India has also taken a number of measures to save money and reduce carbon emissions. In the six months up to February 2009 they saved £6.25 million by implementing measures including the towing of aircraft. Projections for carbon dioxide emissions have been cut by 145,000 tonnes per year based upon the new measures\(^39\).

The routing of aircraft between destinations is also an area being explored by those in the industry. If aircraft were routed in the most fuel efficient way, this would not only have environmental benefits but also financial benefits\(^40\).

Airport stacking can also be an issue (whereby there are several planes are circling in the sky waiting to land). Obviously these planes are using energy and thus there is more CO\(_2\) entering the atmosphere. The problem of stacking at Heathrow Airport has been well documented in the media\(^41\).

Current skills needs
Current skills needs include the requirement for employees and management to be upskilled in the latest methodologies for improving efficiency, as well as the employment of staff to operate ground facilities that provide the power used to tow the vehicles. Employees with transport planning skills will also be required to help plan the most efficient routes for aircrafts and minimise stacking time.

Factors driving the demand for skills
The government’s objective to lower CO\(_2\) levels is a primary driver for the demand for skills. The publication of DfT’s Low Carbon Transport: A Greener Future, which is a key component of the UK Low Carbon Transition Plan, has set the course towards a low carbon transport system for the future.

The desire of businesses to lower costs and improve efficiency has also driven the demand for skills. A recent employer survey carried out by GoSkills listed employers main priorities as maintaining profitability, increasing business efficiency and coping with rising fuel costs. Corporate Social Responsibility across sector, combined with consumer pressure, will also drive companies to look for the sustainable solutions.

Future demand
Influential factors include the possibility that towing aircraft is adopted by all airlines and rolled out full scale, efficient routing of aircrafts and a reduction in stacking. The possibility of using greener fuel or different systems such as hybrid power could also influence skill demand in the future. Carbon emission restrictions for the individual person and higher flight prices have the potential to lead to fewer flights, which will have implications for skills and employment demand.

\(^38\) http://news.bbc.co.uk/2/hi/business/6203636.stm

\(^39\) www.Businessgreen.com

\(^40\) http://www.omega.mmu.ac.uk/Studies/Environmental%20effects%20of%20aircraft%20operating%20and%20airspace%20regimes.pdf

\(^41\) http://www.independent.co.uk/travel/news-and-advice/targets-urged-to-cut-heathrow-stacking-1740427.html
Will anticipated demand meet skills supply?
More up skilling of the workforce is required, particularly for planning and scheduling skills for reducing aeroplane stacking and developing optimum routing. Operation of machinery for towing equipment and hybrid engines may require further employees, yet fewer jobs may exist in the industry if flights are restricted or if prices increase.
4.3.4 Hybrid vehicles

Industry overview
One move Transport for London (TfL) has taken is the introduction of Hybrid Buses. Compared with the conventional diesel buses, the new hybrid powered vehicles reduce the output of harmful pollutants. Having completed successful trials, all new TfL vehicles entering service after 2012 will be Hybrid powered.

Compared to diesel buses, hybrid buses offer the following benefits:

- 89% reduction in oxides of nitrogen;
- 83% reduction in carbon monoxide;
- 40% reduction in fuel use;
- 38% reduction in carbon dioxide;
- 30% reduction in perceived sound levels.

In London, the aim is to get 500 hybrid buses on the roads of London every year in order to cut carbon emissions. In total, there are around 8,000 buses due to be replaced with more environmentally friendly vehicles. A complete hybrid fleet in London would produce 200,000 fewer tonnes of carbon each year.

Current skills needs
Different types of engineering and installation skills may be required when new vehicles enter service, as well as additional training and up skilling for maintenance and repair of hybrid vehicles. Procurement skills will be required to provide knowledge for evaluation and choosing of best products for the company to invest in.

Factors driving the demand for skills
The government’s objective to lower CO₂ levels is a primary driver for the demand for skills. The publication of DfT’s Low Carbon Transport: A Greener Future, which is a key component of the UK Low Carbon Transition Plan, has set the course towards a low carbon transport system for the future.

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Future demand
The possibility that hybrid engines are rolled out across all bus and coach companies in the UK is likely to influence skill and employment demand in the future, as will the potential to use hybrid engines in other industries such as rail and aviation.

Will anticipated demand meet skills supply?
More up skilling is required as the current supply of skills is not expected to anticipate demand. It will be needed particularly for engineering and maintenance skills. Procurement skills will also be required in each company who are considering purchasing new vehicles.

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43 www.guardian.co.uk
4.3.5 Modal shift

Industry overview
A modal shift occurs when one mode (A) has a comparative advantage in a similar market over another (B). Comparative advantages can take various forms such as costs, capacity, time, flexibility or reliability. Depending on what is being transported, the importance of each of these factors varies. For some, time is of the essence and a modal shift will occur only if the new mode offers time improvements, while for others it is mostly a matter of costs. The outcome is a series of decisions made by firms (for freight) to shift to a more convenient mode if comparative advantages are significant enough.

Freight transport, although vital to the economy, has a number of environmental impacts. The transport sector accounts for 21% of UK’s domestic greenhouse-gas emissions\(^44\) with CO\(_2\) representing about 96% of the emissions. Freight transport (HGVs and vans) accounts for 31% of these emissions, which represents around 7% of the overall figure.

Intermodal transport (involving greater use of rail and sea and transfer of containers between modes) can offer a solution for a lower carbon economy. The government supports the shift from road to rail and/ or water, which are generally more carbon efficient modes for freight transport, by providing targeted capital and revenue support to enable companies to transfer from road to rail or water\(^45\). In a recent survey\(^46\), the shift from road to rail transport scored as the most popular initiative to support the green agenda. But crucially, and often overlooked is the fact that modal shift is only appropriate for certain freight movements.

The contribution to a low carbon economy is potentially massive. Rail produces around 0.05 kg of CO\(_2\) per tonne km compared to around 0.17 kg of CO\(_2\) per tonne km for road transport. Companies such as Tesco/ Stobart have implemented a long haul service between Daventry and Grangemouth with considerable CO\(_2\) savings\(^47\).

Current skills needs
While it appears that immediate changes in the transport of goods to multimodal will not happen rapidly, government policy indicates that the sector should look at the future planning of goods movement, particularly using multi-modal.

Interest in the NOS for international trade and logistics operations, which contains units on transportation of goods by sea, waterway or rail, is strong. However, it is widely recognised (by government and research bodies) that more research needs to be done into the various impacts of modal shift in terms of skills and infrastructure.

Additionally, with companies accessing revenue support from the government to embrace multimodal transport, strong management skills that involve putting together business plans for funding and knowledge of sustainable solutions will be required.

Factors driving the demand for skills
The Climate Change Act (2008) sets a target to reduce UK greenhouse gas emissions by at least 80% by 2050. With greenhouse gas emission

\(^{47}\) Freight Best Practice (2009) case study.
from transport representing 21% of the total UK domestic emission, decarbonising transport must be part of the solution.

The government provides targeted capital and revenue support to enable companies to transfer from road to rail or water where the economic benefits indicate that this support is justified. In 2008/09 £18 million was spent to promote intermodal and bulk freight journeys through modal shift grants schemes. This programme is estimated to have removed 870,000 lorry journeys from British roads and saved 130,000 tonnes of CO₂.

However, the reality indicates that it will be difficult to ensure it becomes the norm in the short term. Data from the DfT indicates that within the UK 68% of road freight movements are within the same region and the option for multimodal transport solutions is not currently feasible.

**Future demand**

The number of vehicles on our roads is predicated to keep growing, with many roads and motorways already operating at or near capacity. The Eddington study reports that if this growth is left unchecked, congestion is set to rise considerably by 2025, costing the economy £22 billion every year and impacting on the environment⁴⁸.

For the logistics sector, where the majority (68%) of freight is moved by road, congestion can have serious consequences for businesses. As a consequence companies will look for alternative solutions like multimodal.

The government is currently revising the rail revenue support scheme to include inland bulk transport from April 2010, providing incentives to companies to utilise different modes of transport. Continued investment in rail, sea and air infrastructure will also influence future transport decisions and thus the skills requirements. Forecasts by the Freight Transport Association (FTA) and the Rail Freight group suggests that rail freight is expected to double in tonne-kilometre terms by 2030, with growth in intermodal traffic increasing five-fold in the same period.

4.4 Decarbonising buildings

4.4.1 Retrofitting existing buildings (energy efficiency)

Industry overview

Almost half of CO₂ emissions are connected to our built environment – houses, offices, power stations etc. (see table 4). This means increasing emphasis on built environment based solutions, for example by renovating existing homes and non domestic buildings to be more energy efficient and building renewable power systems. This has the twin benefit of stimulating the economy and helping shape a low carbon future.

Table 4 shows tackling CO₂ in new buildings alone will not provide the required improvement – a major programme of adaptation and refurbishment of existing buildings will also be required. The domestic sector represents 27% of total emissions in the UK and will increase as the number of households rise due to increasing population and falling household size. If we add to this the fact that around 80% of the homes that will be standing in 2050 have already been built, the size of the issue and potential market opportunities is apparent.

Table 4: Total carbon emissions from UK construction industry

<table>
<thead>
<tr>
<th>Source of Carbon Emission</th>
<th>% of UK Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>New construction</td>
<td>13</td>
</tr>
<tr>
<td>Existing domestic buildings</td>
<td>27</td>
</tr>
<tr>
<td>Existing non domestic buildings</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total of UK carbon output</strong></td>
<td><strong>47</strong></td>
</tr>
</tbody>
</table>

The low carbon retrofit business is estimated to be worth around £3.5 billion - £6.5 billion per year on top of the £24 billion already spent on repair, maintenance and improvement work. Moving to a low carbon economy will require a fundamental transition in behaviour and application of skills and knowledge.

While the energy efficiency of the UK’s building stock varies enormously from solid walled properties with electric heating and little insulation through to highly energy efficient homes, the market for energy efficiency solutions is also complex and highly fragmented and extremely diverse, ranging from DIY products through to major upgrade project management services. It is clear that there will be no single solution to a low carbon built environment, and the skills and knowledge required.

Current skills needs

As knowledge of retrofitting existing buildings to make them more energy efficient has increased, a general rule has been established that you need to deal with the fabric first prior to enlisting other solutions such as renewable. If the building is leaking heat any saving by adoption of renewables is less efficient. The relatively new roles of Energy Assessor and Energy Advisor within the Asset Skills footprint will be equipped with the skills and knowledge to identify those aspects of the building which need attention to ensure that any adoptions are effective and lead to a real decrease in carbon emissions.
Essentially, existing buildings require the skills to improve the building fabric, for example walls, windows, lofts etc. While the skills issues for loft and cavity wall insulation are addressed, there is a need to ramp up skills in relation to aspects of fabric such as solid wall insulation and hard to treat properties. Skills such as installation of cavity wall insulation are reasonably well understood and sufficient given current demand. Skills for more complex retrofit, such as solid walls do not exist in any numbers.

It is evident that in retrofit, and to a lesser extent in new build, it is the main ‘new knowledge’ rather than ‘new skills’ that are required. This aligns with the recent recognition that it is how skills are utilised that is critical, as the wrong application of skills in this area can be damaging. Broadly, in the current market, the capacity for the industry to respond to demand for low carbon exists. There needs to be greater confidence in the market to invest in skills development, and in time an independent quality assurance and skills accreditation to build consumer confidence in supply chain.

**Factors driving the demand for skills**

Currently demand in both low and zero carbon solutions are driven by government policy, legislation and regulation. Zero Carbon Hub research suggest consumers, while supporting the need for improving energy performance of new and existing buildings, are very conscious of upfront costs and this deters demand. According to the Green Building Council it seems there is a significant market failure when it comes to delivering low carbon existing homes, and that addressing this will require a suite of regulatory and fiscal measures from government, together with measures designed to address consumer behaviour and support industry, as part of a comprehensive policy package.

However, it should be noted that since the UK Green Building Council (UKGBC) made this statement, the government has published its Heat and Energy Saving Strategy for consultation. This strategy sets out how existing buildings will become almost zero carbon by 2050. The consultation will become the Home Energy Management (HEM) Plan and will be published at the beginning of 2010.

It will set out a number of targets such as ensuring that all homes that are suitable have the loft and cavities insulation by 2015 and that by 2020 seven million homes will have received whole house packages including cost effective energy saving measures plus renewable heat and energy measures as appropriate. It will also set out a number of incentives to help deliver these targets such as the extension of the Carbon Emissions Reduction Target (CERT) measures and the introduction of the Community Energy Saving Programme (CESP). This programme will target households across the UK in low income areas to improve energy efficiency standards and permanently reduce fuel bills.

It is evident that while there is potential demand for skills and knowledge development there is some concern from industry that policy is not creating this demand which in turn deters investment in training.

**Evidence of skills mismatch**

As noted, current demand is limited nationally but there are differences in scale and time across England, Scotland and Wales. There are also regional and local authority variations in the level of commitment to carbon reduction. It is unlikely...
that if there is a surge in demand in any particular region, Further Education alone could cope with the variety of skills/knowledge solutions required. Closer relations between the skills supply side and the product supply side will be required and this in turn has implication for skills, qualifications and certification and accreditation systems.

**Future demand**

Recent research in these areas suggests a number of factors will impact on future demand but those that are key are changing legislation and consumer attitude. There is still much industry/government debate on what future targets should look like and as such this area is very much a moving feast. Legislation is less pronounced in the area of existing homes, however it still relates to the UKGBC’s observation that government lacks a clear strategy and suggests government needs to put in long-term targets and that this should be supported by a number of ‘skills’ actions.\(^{50}\)

**Will anticipated demand meet skills supply?**

According to the government’s Foresight Group the potential demand from refurbishment is enormous and could add around 50% to the current domestic building repair and maintenance spend of around £24 million pa. This level of demand could cause a massive mismatch in the capacity of industry to deliver.

We need now to be putting in place the building blocks to enable the industry to be able to respond flexibly and quickly to new and emerging markets while at the same time retaining the integrity of learning provision. This means that simply having skills is no longer enough, rather it is the ability to utilise those skills in different environments that is key.

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\(^{50}\) Using existing structures for skills and training to disseminate information and deliver low carbon refurbishment training courses.

- Developing regional/national centre(s) of excellence in energy efficiency to improve the skills of builders and product installers.
- Developing a national competency standard for low carbon refurbishment.
- Establishing independent quality assurance and skills accreditation to build consumer confidence in supply chain.
4.4.2 Zero-carbon homes (new build)

Industry overview
Budget 2008 confirmed the government's ambition that all new non-domestic buildings should be zero carbon from 2019. The main focus in this section is however Zero Carbon Homes. Zero carbon tends to be related to 'new' building. An industry definition of zero carbon is being developed as part of the Zero Carbon Homes and Non-Domestic Buildings consultations. The Code for Sustainable Homes has been introduced to drive a step-change in sustainable home building practice. The government is proposing a three stage hierarchy to achieve zero carbon:

1. Energy efficiency
2. Carbon compliance
3. Allowable Solutions

Form of carbon off-setting in high quality
On-site, near site and off site low and zero carbon energy generation
Compliance with part L of Building Regulations

In June 2007 the government published its Building a Greener Future: Policy Statement which confirmed the government’s intention for all new homes to be zero carbon by 2016. It outlined a progressive improvement in the energy efficiency building regulations of 25% by 2010, 44% by 2013 and zero carbon by 2016.

Each of the stages has implications, for example stage 1 compliance requires improved performance from the building fabric. Allowable solution, a process that is yet to be fully developed, will have wider implications as things such as renewables may be part of the allowable solutions, but may not be delivered by the housing sector.

Current skills needs
The Zero Carbon Hub (ZCH) has been established to take day to day responsibility for the operational responsibility for co-ordinating the delivery of low and zero carbon homes. SSCs are currently working with the ZCH to ascertain the current level of knowledge within the industry to build to low and zero carbon home standards and determine the areas where additional skills, knowledge and training are required.

Zero carbon housing is something new to the industry. As with 'low carbon' the 'potential' demand for firms to adopt skills and capacity building are not yet creating 'effective' demand from the market. Changes to Part L of the Building Regulations will increase the 'potential' demand for new skills and knowledge. This will be compounded as demand rises in response to the zero carbon targets.

For these reasons it is problematic to define 'current' skill needs with accuracy as this is a 'work in progress'. Skills, for example in design, project management and installation, such as air tightness are among the skills already recognised as critical to enabling zero carbon solutions. It is also imperative that planners, who are central to the development of the built environment, gain an appropriate understanding of this subject to ensure that they are able to respond to the governments agenda by 2016.

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51 www.communities.gov.uk

52 CLG Select Committee. Call for Evidence: Planning Skills. February 2008. LGA.
Factors driving the demand for skills

As mentioned above agreed targets for the move to ‘zero carbon’ homes and increasing regulation are the key drivers behind increasing the demand for workers with the capability to build to zero carbon standards. As with existing buildings the additional cost (in most cases) of building to higher standards can be prohibitive for both the end user and the developer. As the market matures these cost differences are likely to narrow.

In recent research for the Zero Carbon Skills Group ten drivers were identified, workforce availability considerations were ranked sixth, the top three were the zero carbon target, legislation and energy costs, interestingly consumers were ranked last of the ten.

Evidence of skills mismatch

The current state the housing market has huge implications for supply and demand mismatches and regional issues. Government targets to build 240,000 new homes a year by 2016 will mean the industry expanding from an expected output this year of around 80,000 at a rate never achieved by the home building industry historically. As will be discussed below this has implications for how we build as we come out of recession and implications for materials and methods, and consequently skills needs.

Currently while there is numerically an oversupply of home builders and associated trades, these people will require some adaptation of skills and ‘culture’ to have the flexibility to deliver to the increasingly stringent zero carbon homes targets. The Royal Institution of Chartered Surveyors (RICS) has launched a campaign to heighten awareness and actual working knowledge of sustainability amongst their members due to the crucial role they play in shaping the built environment53.

It must be remembered that in the main we are talking about England in relation to zero carbon targets, Wales has its own more demanding time frame, for example. Also there are regional differences in terms of local authorities and some seek levels above those currently being considered as minimum standards for England. This again highlights the need for ‘flexibility’ in relation to skills development. It must also be recognised that in volume home building there is a good degree of workforce mobility and this can solve regional limitations when demand is high.

Future demand

As mentioned if, as we emerge from recession, the ambition to deal with the housing shortage remains, there will be a need to change the approach to home building and much more use of techniques such as ‘off-site’ production. Already, anecdotal evidence suggests certain manufacturers and suppliers are developing whole house packages. In parallel with the zero carbon hub skills work stream National House-Building Council (NHBC), ConstructionSkills and a number of partners from the housing supply chain are looking at what this need to build at higher rates that ever achieved means for products, process and skills.

As with ‘low carbon’ there has been much debate as to the need for some form of accreditation/certification for companies/individuals working in the area of zero carbon delivery areas. Department for Communities and Local Government (CLG) will be consulting on revisions to, and wider use of the Competent Person’s Scheme in England. It is likely that

53 RICS to ‘value’ sustainability. 9 September 2009. www.rics.org
either statutory or voluntary compliance would increase the propensity of firms and individuals to train. In some areas local authorities are adding ‘skills’ and training clauses to sustainable procurement.

CLG recognise a need for more focused guidance for renovation work coupled with a substantial training and dissemination campaign for both industries and end users. Training for the code for sustainable homes and assessor training to carry out assessment on new homes under the code is also required.

**Will anticipated demand meet skills supply?**

The factors here are broadly similar to those for the existing housing stock, however regulation and legislation are more immediate drivers. As mentioned above the speed with which the housing market comes out of recession will be a large influence on supply/demand equilibrium. For this reason it is problematic to predict with accuracy the level of skill demand and exactly what skills, products and process will be required.

As with existing buildings a flexible qualifications structure is required to allow more rapid response to changing patterns of demand. New skills and knowledge will require new/adapted qualifications. The Qualifications and Curriculum Framework (QCF) will be operational from September 2010 and will provide a greater flexibility for companies and individuals in meeting occupational needs. The Built Environment Skills Alliance is exploring how this framework can provide the future qualifications and training required by industry to support the new products and processes. This framework will cover craft, management and professional occupations. This may require a sectoral approach rather than an occupational approach with housing focused skills as part of the solution.

As noted above much of the need in relation to low and zero carbon is a new ‘knowledge’, rather than a ‘skills’, issue. This is in large part true for craft, supervisory and management and professional levels. In general the industry needs some assurance of a sustained market prior to investment and skills and training. Some form of compliance, such as the Competent Person’s Scheme, may create this environment.

The scope of skills involved in this area varies widely and it is not all about the ‘build’ process for example, facilities managers who are responsible for managing larger buildings (usually commercial but could be private homes in blocks of flats etc). They may have both a strategic and operational function – with a wide range of skills and knowledge around building construction, legislative requirements, energy supply and usage, defects, repairs and maintenance of the structure and building services such as air-con, heating etc.

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54 EU Skills, Cogent, SummitSkills, ConstructionSkills, AssetSkills, Proskills and ECITB.
4.4.3 Retrofitting commercial buildings (energy efficiency)

Industry overview

Commercial properties and public buildings currently account for nearly 25% of the UK’s carbon emissions, with domestic buildings adding another 35%, both being important in the drive to combat global climate change. The way in which we light, heat and use buildings all contribute to this. By making small improvements to the energy performance and the way in which we use our buildings it could have a significant effect on our fuel bills and carbon emissions.

As a result of the European Performance of Buildings Directive (EPBD), CLG introduced measures in England and Wales to improve the energy efficiency of our buildings, including:

- Introducing Energy Performance Certificates (EPCs) for properties providing A-G efficiency ratings and recommendations for improvement;
- Requiring public buildings to Display Energy Certificates (DECs);
- Requiring inspections for air conditioning systems;
- Giving advice and guidance for boiler users.

Current skills needs

EPBD has resulted in the introduction of a number of key roles that contribute towards improving the energy efficiency of our buildings. Asset Skills has since produced the NOS which identify the current competency and knowledge required to carry out these roles, these include:

- Commercial energy assessors – contribute to the maintenance of health, safety and security; develop and maintain effective working relationships; conduct energy assessments; agree and confirm instructions to undertake energy assessment; investigate matters relating to the property and energy usage; conduct energy assessments of new-build non-dwellings; produce energy performance certificates; recommendation reports and reports on regulation 17C calculations; inspect existing non-dwellings to determine energy performance;
- Air condition system inspectors – contribute to the maintenance of health, safety and security; maintain effective working relationships; conduct energy assessments; review information of simple and complex air conditioning systems; inspect air conditioning systems; record inspections and report on the energy performance;
- Display energy certificate providers – contribute to the maintenance of health, safety and security; develop and maintain effective working relationships; conduct energy assessments; agree and confirm instructions to undertake energy assessment; investigate matters relating to the property and energy usage; determine operational ratings for non-dwellings; issue display energy certificates; obtain information, produce and issue advisory reports.

Factors driving the demand for skills

Legislation – As mentioned above the EPBD is a key driver influencing the demand for skills. In addition the Climate Change Act of 2008 has created a wide range of low carbon initiatives, including the retro-fitting of buildings to improve their energy efficiency and an increasing drive in the domestic sector to provide behavioural advice to householders as part of the Home Energy Savings Programme (HESP). Building Regulations, again controlled by CLG and based on legislation are continuing to require new buildings and larger retro-fits, to be increasingly energy-efficient and this again affects skills.
Economy – Although pay-back periods vary, energy efficiency measures are increasingly seen as being cost-effective with, as an example, cavity wall insulation and condensing boilers playing a major part. More radical areas of interest such as micro-generation are also seen as playing an increasingly important part in the medium term. Recent research has also demonstrated that some companies are willing to pay a premium for occupying ‘green’ space.

Future demand
The EPBD Directive Implementation Advisory Group (DIAG) was established in 2002 to advise the UK Government on the energy performance of buildings and the implementation of the EPBD. The European Commission has now published proposals for a recast of the Directive. The key proposals in the recast are:

- DEC to be displayed in buildings larger than 1,000m² that are occupied by a public authority;
- EPC to be displayed in commercial buildings larger than 1,000m² that (a) are frequently visited by public and (b) where an EPC has previously been produced on the sale, rent or construction of that building;
- The energy performance of existing buildings of any size that undergoes major renovations to be upgraded in order to meet minimum energy performance requirements. Currently, there is a threshold of 1,000m²;
- Minimum energy performance requirements to be set in respect of technical building systems, e.g. boilers, air conditioning units etc.;
- Commission to establish common principles for definition of low and zero carbon buildings;
- Requirement to set targets for increase in low carbon zone buildings with separate targets for:
  - New and refurbished dwellings;
  - New and refurbished commercial buildings;
  - Buildings occupied by public authorities.

In August 2009, the UK government published its consultation document summarising the UK position regarding the European Union recasting proposals. The commission are proposing that the Directive should be implemented by 31 December 2010 where proposals affect the public sector and 31 January 2012 for other buildings.

Proposed changes to Part L (Conservation of Fuel and Power) and Part F (means of Ventilation) of the Building Regulations are planned to come into force in 2010. The UK government is currently considering transferring responsibility for Buildings regulations in Wales to the Welsh Assembly Government.

Beyond 2010 there will be an initial review of possible revisions relating to the 2013 and 2016 reviews, and beyond. The government has announced an ambition for all new non-domestic buildings to be net zero carbon from 2019. Different approaches to constraining energy demand are being considered along with end-use energy demands in new non-domestic buildings covering vertical transportation, security lightning, feature lighting, air curtains and demand controlled ventilation. Future issues on Part F relate to the likely increase in mechanical ventilation in domestic properties (in response to reduced levels of air permeability), demand controlled ventilation, installation and commissioning issues and possible pollutant source control.

There is increasing focus on mitigating climate change through planning. The current policy statements in England include:

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• PPS 1 Delivering sustainable development and the supplement on climate change;
• PPS 22 Renewable energy.

The carbon reduction commitment has created an increasing pressure to reduce energy in large energy intensive businesses.

**Will anticipated demand meet skills supply?**

It is difficult to identify whether the supply of commercial energy assessors, air condition system inspectors and display energy certificate providers is at the right level.
4.4.4 Micro-renewables

Industry overview
The transformation of the energy market in the UK is being driven by changing legislation to promote renewable energy as an answer to environmental concerns. A string of new European Directives, most notably a new Renewable Energy Directive (2009) under which the UK has a national target to source 15% of its energy from renewables by 2020.

The energy efficiency and renewable energy sector has experienced a rapid change over the last decade due to new legislation, government initiatives and increased awareness of climate change. The main difficulty facing the energy efficiency and renewable energy sector is in terms of skills and training required for new jobs so that the workforce is equipped to exploit the new economic opportunities created by responding to the climate change challenge.

Much of the policy drive for micro renewables, will require the plumbers, heating and ventilation engineers, electricians and air conditioning and refrigeration engineers to install these technologies as part of their every day working lives. Currently, the sector is not sufficiently engaged in understanding the technologies, or incorporating the installation of them into their business plans or portfolios.

In the micro renewables manufacturing industry the future lies in the cost, competitiveness and growth of:

- Reduced weight manufacturing through the use of lighter components;
- Solar power technologies or photovoltaic systems;
- micro turbines;
- Heat generation technologies (solar thermal hot water, ground source and air source heat pumps, bioenergy) combined heat and power (CHP).

Current skill needs
Nanotechnology is providing the next generation systems that rely on micro-generation of storage technologies (e.g. thin film batteries). The innovations in skills are likely to be related to those of lighter material for parts in the form of composites and plastic electronics.

As with most modern engineering manufacture, in addition to the development of the components themselves there will be developments in the design and manufacturing processes to make material and energy use more efficient, minimise waste and reduce the time taken to get a new product from the design stage through to manufacture and sale. The current skill needs are:

- More graduates and posts graduates with a multi-disciplinary experience as nanotechnology crosses the boundaries between such areas as natural sciences and engineering;
- Technicians capable of running the complex equipment associated with the technology;
- Skills needs still largely based in the research and development environment as this is where the main use and development of the technology currently resides.

Factors driving the demand for skills
Climate change legislation, emerging technologies, investment in research and development and global competition are the four primary factors driving the demand for skills. The Bain Report (2008) predicts a plateau in the

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number of engineers graduating for the foreseeable future, thus encouraging employers to train the existing workforce and attracting younger people into engineering.

Within the SummitSkills footprint, research has suggested that the demand for skills is affected by the demand for installation, or government driven legislation. BSE companies are reluctant to invest off their own initiative.

**Evidence of skills mismatch**
At present industrial roles are only partially ‘green’ with staff moving between conventional and renewable tasks as required during the transition to production of low carbon components. It is likely that graduates of the future will need some multi-disciplinary understanding of both mechanical and electronic systems, and also roles may emerge for people with a background and understanding of composites and plastic electronics. There are also likely to be roles for managers and experts with knowledge of manufacturing process improvement and business improvement to increase efficiency and save on time and costs in the workplace.

As indicated above, currently there is little demand and little supply. Were the market to be stimulated by government, either through grants or legislation, then the supply of environmental technology courses would be unable to cope with potential demand.

**Future demand**
A highly skilled workforce will be needed if we are to become a leading nation in new low carbon technologies. With government help to re-train some of the thousands of workers who have recently lost their jobs in traditional manufacturing, they will be able to take up new highly skilled posts in the new, greener firms, and become part of the transition to a new style low carbon economy. Future skill needs will include:

- New product development and project management skills to provide the ability to generate products from the technologies being researched;
- As the technology becomes more embedded in industry and cost effective, the need for technicians/operators will increase with a subsequent increase in the need for materials handling and fabrication.

Any stimulation of demand for environmental technologies in the future will increase employer demand to respond for training purposes, although currently the supply is not there to meet any increase in demand.

**Will anticipated demand meet skills supply?**
To meet such changes, there are likely to be roles in the near future for people skilled with the ability to source and utilise low energy materials and the workforce will need to be trained to understand use recyclates. There is also an increasing need for electronics and organic electronic skills. Low carbon technologies present both the catalyst and the opportunity for the industry to continue to reinvent itself, reinvest in existing sites and secure long-term employment and technology capability.

Currently supply of training will not meet an increase of demand. SummitSkills is working to develop a provider network to address this issue, and put the training and validated courses in place to meet the expected increase in demand within the sector to install these environmental technologies.
## 5 Cross-cutting themes

### 5.1 Ageing workforce

Many of the individual industries which make up the low carbon cluster appear to be suffering from an ageing workforce, with the issue being particularly concerning in areas such as conventional, renewable and nuclear power generation which are all forecasting large percentages of their workforce retiring over the course of the next 10-15 years. The causes of these demographic problems affecting the low carbon cluster are many and varied but include: the long-term consequences of the de-layering and downsizing that occurred following the privatisation of former public sector industries; the retirement of 1960’s baby-boomers; the relatively low level of female employment across much of the low carbon sector; and the difficulties many employers have found in recruiting young people because of the perceived unattractiveness of many jobs in these industries.

Effectively tackling the demographic challenges of the low carbon cluster workforce is absolutely fundamental to delivering the government’s low carbon agenda as well as maximising the associated economic benefits. Unless addressed the demographic problems faced by the low carbon cluster will mean it is unable to deliver key national infrastructure projects such as the new fleet of nuclear power stations.

Key issues which need to be addressed include: changing young people’s perceptions that many low carbon industries do not offer sustainable, high quality employment; addressing the lack of diversity in the current workforce, and in particular increasing the level of female employment. The growth in interest among young people in environmental matters does, perhaps, offer some new hope in tackling this issue.

### 5.2 Uptake of STEM subjects

The take-up of STEM subjects at school and university is important for ensuring the future workforce for a low carbon economy is large enough and can provide the necessary skills. The supply of STEM graduates and postgraduates has increased in recent years, with the number of STEM first degree qualifiers increasing by 11% between 2002 and 2007, and the number of STEM Masters qualifiers increasing by 35% over the same period. However, with demand for specific skills in the low carbon industries expected to increase greatly over the next decade or so, the supply of STEM skills is not predicted to increase at the same rate, which will have implications for the future workforce. A perceived unattractiveness by young people of many careers relevant to STEM subjects, especially in engineering, is a major concern also for future skill provision.

Europe-wide research indicates that children appear to form strong attitudes towards occupations at an early age which will influence their later choice of study. Currently only 7% of pupils study triple science at GCSE and figures for take-up for A Levels in STEM subjects are in a similar vain, with a flat trend in the study of chemistry, biology and mathematics and a fall in the study of physics. The supply of STEM graduates is determined by subject choice earlier in the educational system and therefore if not enough people qualify with the appropriate
combinations of GCSE and A Level subjects the number of First Degree entrants of STEM course in Higher Education (HE) will be limited.

Evidence suggests that pre-school intervention is critical in creating more positive attitudes towards Science and Technology, and other associated subjects. If we are to increase interest in Engineering and Technology as a career in the long-term, the government, employers, institutions, policy-makers, funders and other stakeholders need a greater recognition of the need for interventions designed to interest and enthuse young people at a much younger age.

5.3 Management and leadership

Effective and far-sighted management among employers involved in developing low carbon industries is vital if the sector is to meet its potential as a source of significant wealth and jobs for the UK economy in the future. A recent review by Pro Enviro Ltd determined that the key leadership and management skills needed to deliver a low carbon future were: an ability to effectively communicate the low carbon message within organisations; strategic business planning with low carbon principles in mind; lifecycle analysis; managing change; and financial investment modelling with low carbon understanding. It was also noted that, while these skills are ones that all effective organisations should already possess, they need to be applied day-to-day within a low carbon ethos across all sectors of the economy, not just in those classified as being part of the low carbon industries.

In certain industries within the low carbon cluster, such as the building services engineering sector, the level of business management skills held by managers remains low and may well have contributed to the difficulties some low carbon industries have faced in weathering the economic downturn.

At an operational level, project management skills have also been identified by a number of low carbon industries as skills in short supply which are absolutely vital to the successful implementation and creation of a low carbon industrial base. These skills are particularly important during this start-up and infrastructure development phase.

5 Skills for a low carbon and resource efficient economy, Pro Enviro Ltd, 2008.
5.4 Low carbon procurement

A large element of the perceived risk of investment in low carbon industries is tied to the uncertainty over the scale of demand for, and price of, the end-products. Used wisely, the purchasing power of the public sector can help to reduce this risk.

One example of effective procurement creating the foundations for the accelerated development of low carbon markets was the government's announcement in the 2007 Energy Review that it would set up a new programme to procure innovative, low carbon vehicles for use in public sector fleets, as part of a package of measures to support new technology development in this area.

Similar initiatives across the low carbon industries could ‘jump start’ the demand for both low carbon goods and services as well as the associated demand for labour and skills.

5.5 Latent demand

There is evidence that at the moment the level of economy-wide demand for low carbon related skills is lower than what, ceteris paribus, could be expected. This is believed to be because a significant proportion of the total potential demand for low carbon skills is latent, as employers do not yet fully recognise the importance and potential benefits of integrating low carbon skills into their businesses. Only when these links and a clear business case are made will the aggregate level of demand for low carbon skills move nearer to the required level.

The existence of latent demand creates a further problem in a demand-led skills system such as that which exists in England. Until employers start to recognise their need for greater levels of skills and expertise around low carbon techniques and technologies the skills supply system is unlikely to begin the process of increasing the number of individuals with the required skills.

5.6 ‘Greening’ of existing jobs rather than new jobs

While the rapid development of a low carbon economy and industrial base will create a range of specific, new roles which have not existed previously, there is also much emerging evidence that low carbon activities will need to be carried out by existing workers adding new ‘green’ skills to their existing activities. Such a situation will require individuals to undertake additional ‘top up’ training to familiarise themselves with new concepts and practices which will enable them to operate in low carbon industries.

A recently published reported by the IPPR, The Future’s Green: Jobs and the UK low carbon transition\textsuperscript{58} produced the examples listed below of existing jobs which, with the benefit of additional low carbon skills, will allow people to work within the low carbon sector.

\textsuperscript{58} The Future’s Green: Jobs and the UK low carbon transition, IPPR, 2009.
### Table 5: Top-up training for low carbon

<table>
<thead>
<tr>
<th>Current Job</th>
<th>Core Training requirement</th>
<th>Additional low carbon skill requirement</th>
<th>New low carbon job</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrician</td>
<td>Apprenticeship, BTEC or NVQ/SVQ</td>
<td>Working on roofs; installation of solar PV panels</td>
<td>Solar PV fitter</td>
</tr>
<tr>
<td>Offshore oil and gas maintenance technician</td>
<td>Apprenticeship, BTEC or NVQ/SVQ</td>
<td>Offshore wind technology</td>
<td>Offshore wind technician</td>
</tr>
<tr>
<td>Aerospace technician</td>
<td>Apprenticeship, BTEC or NVQ/SVQ</td>
<td>Technology-specific knowledge</td>
<td>Wind turbine technician</td>
</tr>
<tr>
<td>Architect</td>
<td>Undergraduate degree, masters degree and paid work experience</td>
<td>Energy efficiency and zero carbon knowledge</td>
<td>Low carbon architect</td>
</tr>
<tr>
<td>City trader</td>
<td>Undergraduate degree</td>
<td>Carbon literacy, understanding of carbon trading schemes</td>
<td>Carbon trader</td>
</tr>
<tr>
<td>Facilities manager</td>
<td>No specific qualification required</td>
<td>Sustainability and energy management issues</td>
<td>Low carbon facilities manager</td>
</tr>
</tbody>
</table>

Source: The Future’s Green: Jobs and the low carbon transition, IPPR.

Use of the freedoms introduced through the QCF will be important in meeting these top-up skill requirements, as will the implementation of accompanying flexibilities in the funding regimes regarding support for units and non-first qualifications that will aid multi-and up-skilling.
6 Key messages and priority actions

6.1 Key messages for Government and other policy makers

Low carbon industries have the potential to create many thousands of new jobs over the course of the next decade if steps are taken now to address some of the barriers and impediments facing them. The opportunities of shifting to a low carbon economy are particularly attractive as the skills needed by many of these new industries are complementary to those from Britain’s industrial heritage, and they therefore offer those who have lost out through deindustrialisation the chance to return to high quality, highly paid jobs.

Capturing the potential economic benefits of the shift to a low carbon economy requires all economic agents to work quickly, and in tandem, in order to put in place the necessary infrastructure and building blocks. SSCs and SSBs, as employer-led bodies, have a critical part to play in shaping this agenda. It is therefore essential for government, nationally, regionally and locally, to include SSCs/SSBs at the planning stage of projects involving the development of low carbon industries.

By their very nature, low carbon industries are, in many cases, still in their infancy and relatively little is known about the precise nature of their future skills requirements. Government needs to support SSCs in their work over the next two-three years in actively working with these emerging sectors and helping them to articulate the true nature of the skills required.

The demand for skills is a derived demand for the goods and services provided by low carbon industries. In order to kick-start the development of these industries, government needs to continue to ‘ramp up’ the demand for low carbon goods through its own procurement activities as well as through the legislation and regulations it creates.

More needs to be done to raise awareness amongst the private sector of the significant domestic and international opportunities afforded by the move to a low carbon world economy. This needs correcting quickly if the UK is to gain first-mover advantage from low carbon opportunities. It is also essential for employers to understand the skills implications of a low carbon future and to begin demanding these skills from schools, colleges and other demand-led skills providers.

A number of low carbon industries operate within regulated markets and it is essential that industry regulators work with SSCs and SSBs to ensure quality standards, accreditations and validation systems are aligned and work well together.

In order for private sector businesses to commit to considerable investment in new low carbon manufacturing plant, government needs to send strong, consistent messages about the irreversible drive towards a low carbon economy.
6.2 Priority actions

Effectively tackling the demographic time bomb facing many low carbon and manufacturing industries is almost certainly the most important issue. With large numbers of skilled people forecast to leave these industries over the course of the next decade the cluster needs to find new sources of recruits to fill the looming gaps. Engaging with under-represented groups, such as women and ethnic minorities, must be seen as an important way of addressing this issue.

Many low carbon industries are inter-related and inter-dependent and they therefore need to develop in unison in order to succeed. The development of low carbon building materials is, for example, essential if the construction sector is to meet its aspiration of delivering zero carbon homes. The development and growth of greater manufacturing capacity in areas such as wind turbines is also essential for the successful development of renewable energy.

Understanding these supply chain linkages and providing effective support across the supply chain is essential for the development of a strong and vibrant low carbon sector.

An adequate supply of STEM qualified individuals is both a critical short and long-term issue for the low carbon sector. In the short term action needs to be taken now to ensure that UK firms have access to sufficiently qualified staff to make the shift to low carbon technologies, techniques and markets. This could be through incentives to retain engineers and other STEM qualified individuals in the labour market for longer, or through use of the government’s new points based immigration system which seeks to give priority to would be immigrants with skills the country needs. In the longer term more needs to be done with young people (including those as young as seven) to change attitudes about the attractiveness of STEM subjects and the career opportunities they can lead to. The demand for STEM subject entrants to the labour market is forecast to rise significantly and supply needs to be able to match this.

Public subsidies towards the costs of training in England are mostly directed towards the achievement of whole qualifications at Level 2 and below. While this may be based on a sound economic rationale for the economy as a whole, a significant part of the skills challenge in low carbon industries is for technician and professional level skills at Levels 3, 4 and 5 which fall outside the scope of public subsidy. The government’s focus on funding full qualifications may also work against the needs of the low carbon cluster where there is a need for ‘top up training to bridge gaps between traditional industrial skills and knowledge and those necessary to operate in a low carbon environment. Government needs to recognise the specific requirements of the low carbon economy and ‘bend’ funding streams so that they can be deployed to meet these particular requirements.

Effective project management skills are vital building blocks for developing many low carbon industries. Skills deficits in this area must be overcome in order to capture the economic potential of the transition to low carbon. It remains unclear at this time whether there are any specific low carbon project management skills over and above those required by all sectors, and more research would almost certainly be useful in this area.
Despite their embryonic stage of development, a number of low carbon industries are reporting specific hard-to-fill vacancies and associated skills shortages. Amongst the most acute are: electrical engineers; wind turbine engineers; marine engineers; and energy efficiency contractors. Quantifying these gaps and working with providers and others to address them is a clear priority for all parties.

SSCs and SSBs can play an important role in providing short term relief to skills bottlenecks by working with the Migration Advisory Committee (MAC) to identify those specific low carbon skillsets which are in short supply indigenously and across Europe.

The nature of many low carbon industries means there is a need for more multi-disciplinary working with new graduates, for example, needing both engineering and natural science knowledge and skills in order to operate. Those designing HE courses need to recognise and respond to this trend for holistic skills and knowledge programmes.

In common with many other sectors of the economy, the quality of leadership and management across the low carbon cluster needs to improve. Research has highlighted that, in particular, managers need to improve: how they communicate the low carbon message within their organisations; strategic business planning within a low carbon mindset; lifecycle analysis; managing change; and financial modelling.

The rapid pace of change among many roles in low carbon industries means there is a genuine need to monitor regularly whether NOS developed by SSCs and SSBs remain up-to-date and comprehensive.

While broadly in balance at present, available learning provision is likely to be inadequate to meet the level of demand generated by many low carbon industries in the future. One of the downsides of a demand-led skills system is that for emerging sectors (such as low carbon) a lag is likely to occur between when employers actually start to demand specific skills and when education providers can respond. Finding ways of mitigating such a lag between demand and supply is vital if the UK is to gain an advantage among low carbon industries.

Across a number of low carbon industries there are insufficient numbers of individuals trained in both lean manufacturing and Business Improvement Techniques (BIT). BIT refers to a philosophy or practices focusing on continuous improvement in manufacturing activities or business activities in general. It is believed that BIT can play a significant part in helping both emerging low carbon industries as well as traditional industries adapt to low-carbon thinking and operating.

The demand for generic low carbon skills is likely to increase alongside the development of the sector. These skills include: sustainable procurement; carbon accounting; performance reporting; environmental management systems; risk management; whole life costing; cost benefit analysis and commercialisation skills.
Many individuals in traditional occupations are now, as a result of changing legislation and other drivers, having to embrace the low carbon agenda. These drivers are resulting in hybrid job roles which contain low carbon activities and require individuals to retrain and upskill. More work needs to be done to precisely identify these ‘top-up’ skills requirements and appropriate provision needs to be developed by training providers.

SSCs have developed a range of training programmes that address the emerging demand for ‘top up’ skills in low carbon industries. These programmes have been developed in partnership with employers and can be delivered flexibly through the QCF to meet the businesses’ operating requirements. National Skills Academies also have a key role to play in leading the upskilling of many already in the working population.