CHAPTER 6

Research and Development, Demonstration and Deployment, and Skills

Our move to a secure and low carbon economy requires the development of technologies, products and processes to reduce the carbon emissions from energy. We need to harness cleaner sources of energy, such as wind, waves and tides, and find ways to decarbonise fossil fuels, including through more efficient production and use. We also need skilled people to develop, install and operate these technologies. Without these developments we will be unable to meet our carbon reduction goals and we will have fewer sources of energy to rely on within our energy mix. The Stern Review[235] notes that policy to support innovation and the deployment of low carbon technologies will be a key response to mitigating climate change. Stern also identifies a range of important associated actions to support increased take-up of new technologies including effective carbon pricing and removing barriers to innovation.

6.1 The Government and industry are already investing in low carbon energy technologies and we will continue to work together to overcome the barriers to development and deployment. The development and deployment of new technologies requires effective infrastructure, well-targeted funding, and the skills to bring forward a low carbon energy future.

6.2 Without support new energy technologies are unlikely to develop within the timescales necessary to reduce the risks of climate change. There are several reasons for this. Firstly, there are significant costs and risks in energy technology innovation including the long time periods involved in development. Secondly, it is difficult for new technologies to displace existing energy sources which are usually cheaper to produce and often benefit from the economies of scale from widespread deployment. Thirdly, displacing existing technologies is made all the more difficult if the cost of carbon is not adequately reflected in the price we pay for energy.

6.3 The objective of Government support is therefore to promote the development of new technologies from initial concept to the point where they can be deployed commercially. On its own, the private sector may not invest adequately, particularly in R&D, because individual companies cannot always

235 The Stern Review – *The Economics of Climate Change.* Nicholas Stern, 2006.

capture sufficient returns relative to the costs and risks involved. This is demonstrated by the fall in energy R&D since privatisation. The Government's role is to address this market failure and facilitate a level of spending that reflects wider economic benefits.

6.4 This chapter sets out:

- the benefits of developing new low carbon technologies and more efficient production and use of energy;
- how low carbon technologies, products and processes are developed and the new and existing funding programmes in place to support this;
- the objectives of the new Energy Technologies Institute and the Environmental Transformation Fund; and
- the challenges the energy sector faces in terms of longer-term skills development and the actions being taken to address them.

The benefits of development of low carbon technologies

6.5 Taken together, low carbon energy technologies now supply roughly 25% of the UK's electricity (4.6% excluding nuclear)[236], and less than 1% of our heat and transport fuels. If we can drive the development of low carbon technologies there could be many benefits beyond the obvious emissions reductions, including:

- **Reducing security of supply risk –** Diversity in the energy mix is important to security of supply as it spreads the risk across a range of technologies and reduces over-reliance on one particular source of energy.
- **Innovation and wealth creation –** Technology developments can bring opportunities for UK companies. The focus of applied research through the DTI's Technology Programme is wealth creation through innovation, and that programme and its predecessor have supported UK companies on the path to bringing energy technology developments to market. This will be continued through the Energy Technologies Institute and the Technology Strategy Board (see paragraphs 684 and 690). In addition, the Government has established the Commission on Environmental Markets and Economic Performance (CEMEP) which will report later this year. It will make recommendations on how the UK environmental goods and services industry can make the most of the opportunity that environmental protection can present for wealth creation and employment growth[237].
- **Supply chain and service companies opportunities –** Deployment of technologies that have overcome the technical hurdles brings opportunities for service organisations, from small scale installers of microgeneration technologies through entrepreneurial project developers to the major construction and finance houses required to develop offshore wind farms. Some technologies create business opportunities by bringing together new groupings of existing industries, for example carbon capture and storage where utilities, oil companies and process plant design experts are developing new relationships.

236 DTI: *Digest of UK Energy Statistics, 2006*.

237 A recent joint DTI/Defra report estimates that the UK environmental goods and services industry has the potential to increase its turnover to more than £34 billion by 2010 and £46 billion by 2015 (http://www.dti.gov.uk/sectors/environmental/index.html). CEMEP's membership is drawn from Government, business, NGOs, academia, trade unions and public sector organisations.

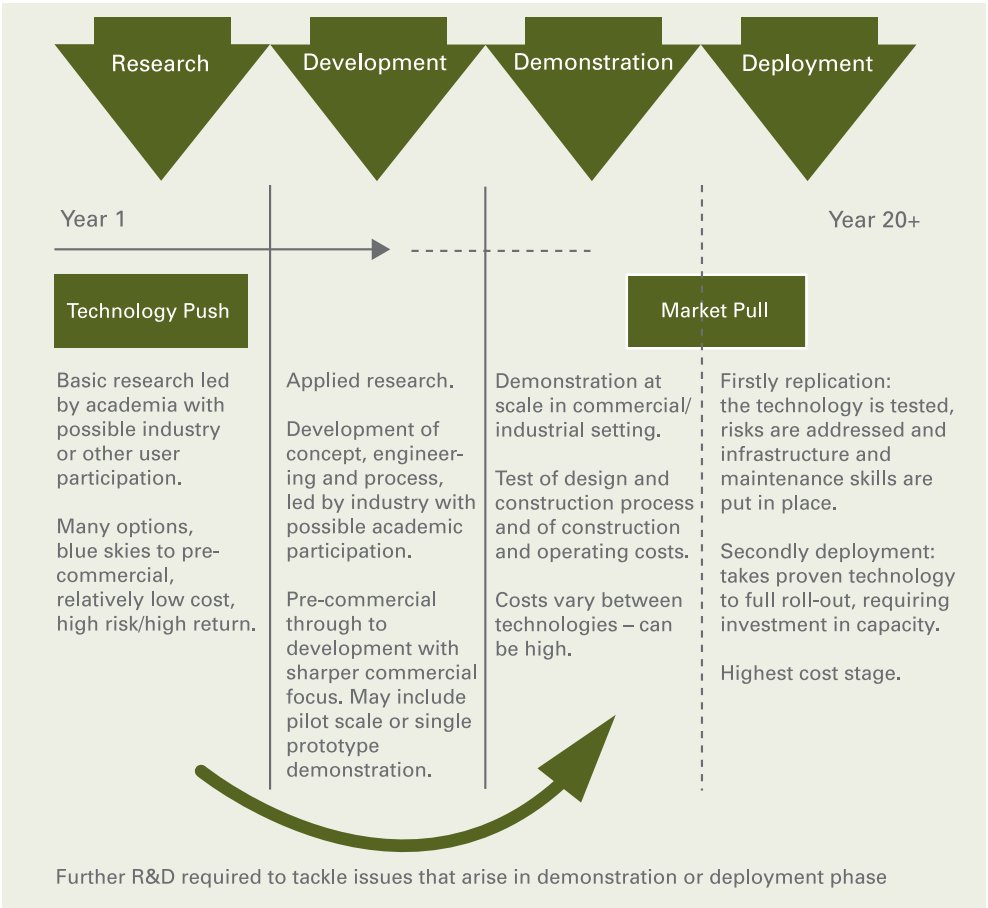
- **Informing our international strategy to drive rapid deployment globally of low carbon technologies –** Development and deployment of low carbon technologies in the UK contributes to our international climate change objectives. We build on experience and expertise in the UK to develop our strategy overseas, establishing relationships at both a strategic and technical level. These relationships influence the international debate on new carbon technologies and help to facilitate the cost-effective roll-out of technologies globally. International energy technology issues are covered in more detail in chapter 1, which gives examples of projects where the UK is collaborating with other countries to roll out new technologies.

The innovation system

6.6 All technologies broadly go through the same stages of development: research through to deployment, which collectively constitutes the innovation system (see Figure 6.1 below). In reality, the innovation system is far less linear than implied by Figure 6.1. For example a project at the demonstration and deployment stages may have further need for research and development. Support for the research, development and demonstration of new technologies forms the technology push aspect of innovation.

6.7 Market pull comes by providing the market mechanisms and incentives that help create the demand for the wider deployment of new technologies. One of the most obvious examples is the Renewables Obligation which has been very effective at deploying new renewables technologies to produce electricity; there is now over 2GW of wind power connected to the grid.

FIGURE 6.1. THE INNOVATION SYSTEM



6.8 The Government's aim is to speed the development and deployment of sustainable and affordable low carbon technologies which can help cut carbon dioxide emissions. Our strategy, both nationally and globally, is based on:

- building credible long-term policy frameworks for tackling climate change to provide clear long-term signals to industry which will shape their investment decisions (such as carbon pricing through the EU Emissions Trading Scheme) Also, through the draft Climate Change Bill, the UK is setting a target to reduce emissions by 60% by 2050, with a reduction of 26-32% by 2020;
- enabling private sector investment by setting direction and providing direct support for innovation. This creates and develops new technologies that have the potential to be rolled out affordably on a wide scale; and
- intervening to address other market failures through a stable framework of policies and incentives. This includes providing the right framework of legislation and economic incentives to encourage development investment. The Government can also put in place systems to enable technology collaboration and policies to overcome specific barriers to development, which can range from awareness-raising to identifying common standards and supply chain development.

6.9 As well as developing their viability, Government support also aims to reduce the costs of producing energy from technologies. Emerging technologies begin at a higher point on the cost curve. Over time the costs are expected to fall to the point where they become competitive with existing technologies, taking into account market pull measures such as the EU ETS.

6.10 The UK is focusing support on technologies that have the potential to produce cost-effective clean energy for use in producing electricity, heat or fuels for transport[238], and to help us use energy more efficiently.

Developing low carbon energy technologies

6.11 Low carbon technologies apply to all energy sectors; they can be large or small scale, and are for use by individuals, households, communities, business and the public sector. Key technologies include those already at or near commercial deployment (including renewables, fuel cells, and improved combustion technologies for fossil fuel and nuclear) and also those that will enable our move to a low carbon economy over the longer-term (such as carbon capture and storage, hydrogen, advanced biofuels, solar electricity, wave and tidal, and nuclear fusion).

6.12 New technologies can also help us to use energy more efficiently, by improving the efficiency of buildings, vehicles, power generation and distribution. Advanced demand management techniques allow us to monitor and regulate the use of energy, from smart meters in the home to the wide-scale distribution of electricity. Innovation can help us to use less energy by improving the efficiency of products. New technologies involving insulation could improve the emissions from buildings (the UK housing stock is currently responsible for around 27% of all carbon emissions in the UK). Further details on saving energy can be found in chapter 2.

238 The Low Carbon Transport Innovation Strategy is detailed in chapter 7.

6.13 Innovation in electricity networks is also required in order to allow renewable generation to access the electricity grid more quickly, maximise the utilisation of existing network assets, and generally manage the transmission and distribution of electricity more efficiently. A characteristic of some renewable electricity sources is that their output will vary, for example according to the strength of the wind. Innovation can help overcome the challenge of managing the impacts of this variability efficiently and at minimum cost.

6.14 The emerging technologies which could offer the most potential to the UK are shown in Table 6.1. This also indicates the stage of development of each of them. The development timescales in some cases are long, covering decades rather than years.

TABLE 6.1. EMERGING TECHNOLOGIES IN THE UK

Technology	Potential uses	Development stage
Offshore wind	For electricity	Early deployment stage. Further R&D is underway to help cost reduction
Bioenergy	For heat, transport and electricity (both dedicated biomass electricity and co-fired with coal)	Many proven technologies in deployment stage. Second generation technologies in early stages
Wave and tidal	For electricity – tidal barrage could also be integrated with transport infrastructure and coastal protection	Leading wave and tidal-stream technologies at demonstration stage. Tidal barrage is a mature technology
Microgeneration technologies (solar photovoltaics (PV) and water heating, micro-wind, micro-hydro, heat pumps, biomass, micro-CHP and small-scale fuel cells)	For heat and/or electricity to homes, community buildings, small commercial and public sector premises	Most technologies are proven and in the deployment phase. Micro-CHP (Combined Heat and Power) and small-scale fuel cells are at earlier stages

TABLE 6.1. Continued

Technology	Potential uses	Development stage
Hydrogen and fuel cells	Fuel cells – distributed stationary power generation, CHP, transport, portable power. Hydrogen – transport, heating, and possibly balancing intermittent renewables for power generation in remote situations	Fuel cells for portable power in, e.g. laptops and mobile phones are at early deployment stage. Other technologies are at the early demonstration phase and further R&D is required to deliver major cost reductions and improved performance
Carbon abatement technologies	For electricity generation. Efficiency improvements, and carbon capture and storage (CCS)	No commercial-scale CCS power stations have been developed yet in any country, although elements of the individual stages of the process have been demonstrated
Research technologies	For electricity, heat or transport	Technologies still in research e.g. next generation solar PV and, alternative ways to harness solar energy, biofuel cells, nuclear fusion
Demand management technologies	Technologies such as products, materials, networks and storage that use energy more efficiently for electricity, heat or transport	Products and processes at various stages of development; for example smart domestic metering at the early deployment stage
Battery technologies	For use in vehicles with hybrid systems as well as fully battery driven	Partial to full hybrid systems currently entering the market, purely battery vehicles at the demonstration phase or in niche applications

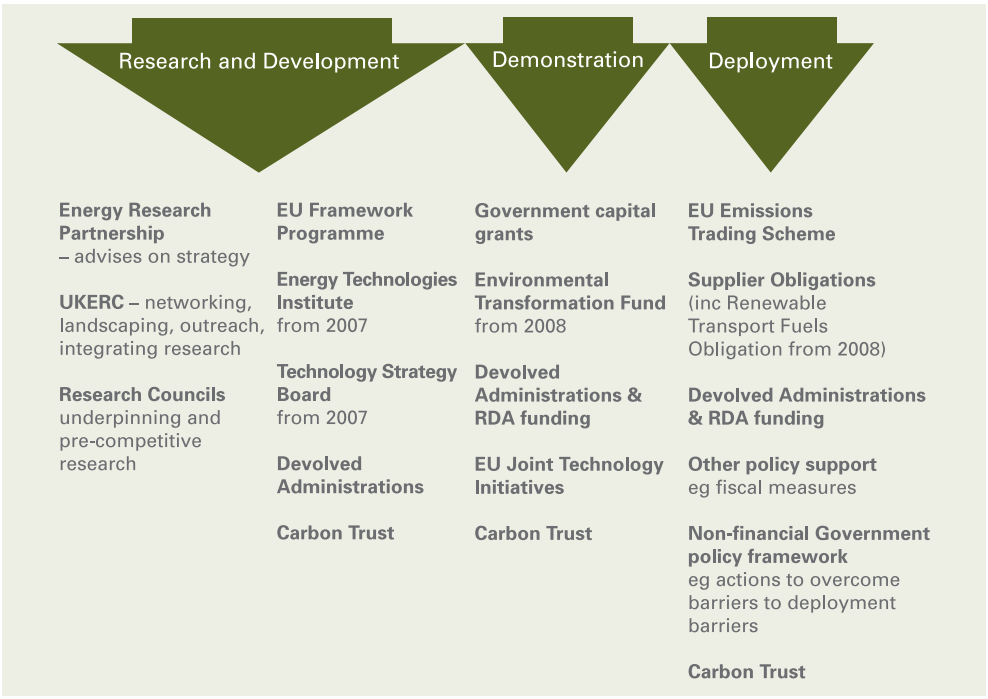
Energy technology support mechanisms

6.15 The Government strategy to develop low carbon sources of energy is devised and delivered in conjunction with a wide range of bodies including the private sector and academia. Different organisations work together to provide strategic advice, financial support and a coherent framework of policy and action in this area, both domestically and internationally. The Government sets the overall strategic direction: by ensuring that each part of the innovation system works effectively with the whole system and bringing together participants to set common goals; by setting the level of public funding to leverage the investment from the private sector; and by working to expand research and industrial capacity.

6.16 An important element of this work is to promote development and deployment of low carbon energy technologies globally. Almost all of the organisations and programmes discussed below are actively engaged in international collaboration with both developed and developing countries. For example, the Research Councils run joint programmes with developing countries for collaborative R&D, and both the new Energy Technologies Institute and the Environmental Transformation Fund have strong internationally focussed aims. The UK has initiated the joint EU-China project to build a commercially viable near-zero emissions coal power station in China (NZEC) with funding from the EU and UK. Further details on NZEC are provided in chapter 1.

6.17 Government support for energy innovation is rising sharply. In summer 2007 we shall be launching the new Energy Technologies Institute, with a minimum budget of around £600 million over the next decade for R&D into low carbon energy, drawing on private as well as public funding. The Environmental Transformation Fund will be established from April 2008. Figure 6.2 sets out the main support mechanisms. It also shows the public sector bodies that work together, and with the private sector, to support the energy innovation system. The organisations are shown under their main area of operation, although some operate across several parts of the innovation system.

FIGURE 6.2 ENERGY INNOVATION – KEY PUBLIC SECTOR PARTICIPATION



6.18 The **Energy Research Partnership** was established in January 2006 to bring together key organisations across Government, the research community and business. The Partnership is a key senior level forum where UK participants in low carbon energy innovation, including most of those shown in the table above, come together to maximise the impact and coherence of the UK's investments in all aspects of energy innovation, extending from fundamental research through to support for the deployment of emerging low carbon technologies in the market place.

6.19 The Partnership has been instrumental in developing the Energy Technologies Institute (see paragraph 684). Other work has focused on identifying priorities for UK R&D, and on exploring key training and skills issues. Its report on high-level skills shortages in the energy sector was published in March 2007[239].

Innovation system support mechanisms – Research and Development

6.20 The UK Energy Research Centre (UKERC) was established in 2004 following the 2002 Energy Review. With funding of £13.8 million over 2004-9, its objective is to provide a focus for energy research in the UK and for international collaboration. UKERC organises outreach, networking and integrating research activities with the involvement of research institutions across the UK. The UKERC Energy Research Atlas and National Energy Research Network were launched in October 2006.

6.21 The Research Councils' Energy Programme brings together within one framework all the Research Council activities on energy R&D and postgraduate training. The programme is led by the Engineering and Physical Sciences Research Council (EPSRC) and supports a full spectrum of energy research to help meet the UK's energy policy objectives, working to expand international collaboration and UK research capacity in energy-related areas. The programme has a high level of business and other user engagement. Current consortia delivering the programme include work in marine energy, solar pv, hydrogen (including storage and solar production), fuel cells (incuding biofuel cells), bioenergy, carbon capture and storage, wind, transmission and distribution (including the inclusion of intermittency and distributed generation), energy storage, conventional plant and nuclear fission. There are also teams working on energy demand reduction in buildings and in industry and on understanding the links between lifestyle, societal values and the environment. EPSRC funds the UK fusion programme (see Box 6.1). Research Council's expenditure on energy-related basic, strategic and applied research and related postgraduate training is planned to rise to over £70mpa by 2007-8.

BOX 6.1 RESEARCH AND DEVELOPMENT INTO NUCLEAR FUSION

Research is underway on nuclear fusion which may emerge as a major new source of energy in the longer term. A fusion power station would create no greenhouse gases nor other polluting emissions during its operation and no long-lived radioactive waste. Fusion uses basic fuels which are abundant and widely available – hydrogen (from water) and lithium. It is generally thought that technical feasibility of fusion power generation could be demonstrated within 25 years given adequate resources, with full-scale power generation in a prototype power plant within 30-35 years.

Fusion has been achieved in JET (the Joint European Torus) in Culham, Oxfordshire, and has resulted in the release of significant amounts of fusion energy in a controlled manner for very short periods. JET, which began operation in 1983, is the flagship of the European Fusion Programme.

239 Energy Research Partnership, *Investigation into high-level skills shortages in the energy sector*, March 2007 http://www.energyresearchpartnership.org/files/ERP-Skills-Brochure.pdf

BOX 6.1 Continued

Knowledge gained from JET is a valuable input into design of ITER (International Thermonuclear Experimental Reactor), a new experimental fusion facility to be built in France. ITER will aim to demonstrate the physics and engineering of fusion at the scale of a power station. International collaboration is the best way of addressing the complex science and technology questions and the scale of resources required in order to harness nuclear fusion. The seven parties co-operating on ITER are China, EU, India, Japan, Russia, Republic of Korea, and the US. The UK is participating through its membership of the European Atomic Energy community (EURATOM).

6.22 Applied research in the development stage benefits from substantial and increasing UK and EU sources of funding. See chapter 1 for information on the **EU Framework Programme** (FP). The current programme, FP7, has allocated €2.3 billion (or £1.6 billion[240]) for energy innovation over 7 years from 2006.

6.23. The **Energy Technologies Institute** will launch in summer 2007. It is a joint venture partnership which brings together public and private sector R&D in the UK to set strategic direction and fund its delivery. It will provide the UK with a world-class means for delivering applied energy technology research to underpin eventual deployment. To do this, the Institute will connect the best scientists and engineers working in academic and industrial organisations both within the UK and overseas. The projects these teams deliver will accelerate the progress of industrially applicable innovative energy technologies through the innovation system to enable some commercial deployment within 10 years.

6.24 The objectives of the Institute are to:

- accelerate the deployment of new low carbon energy technologies, including the efficient production and use of energy, in support of the UK's energy and climate change goals;
- provide a strategic focus in the UK for low carbon energy R&D;
- increase the level of funding in the UK for low carbon energy R&D;
- promote international technology collaboration;
- increase UK R&D capacity; and
- promote people, skills and knowledge sharing.

6.25 Some of the world's biggest energy companies are already involved in this unique venture and helping to drive the initiative forward – BP, E.ON UK, Shell, EDF Energy, Rolls-Royce, Caterpillar, and Scottish and Southern Energy Group. The funding contribution of members of the Institute, matched by Government, provides it with a budget of a minimum of around £600 million over a lifetime of a minimum of 10 years. Additional private sector partners are being identified to match the Government's commitment of up to £550 million over the next decade.

240 Based on May 2007 exchange rate.

6.26 The Institute will focus on a small number of specific R&D projects relevant to industry, both commissioning and funding its own research and supporting worthwhile projects run by third parties. This will include R&D in support of demonstration (including possible funding for small scale pre-commercial demonstrations) and eventual deployment, selected from within a framework of the following general themes:

- large scale energy supply technologies
- energy security of supply
- end use efficiency/demand management
- transport
- small scale energy supply technologies
- support infrastructures (such as energy supply networks, storage skills and capacity)
- alleviating energy poverty.

6.27 In selecting areas for investment, the Institute will be looking both for technical viability and commercial attractiveness. Consequently, part of its remit will be to consider longer-term energy market scenarios. This work will be informed by technology "roadmaps" covering all stages of the innovation system developed by DTI, the Energy Research Partnership and the UK Energy Research Centre amongst others. The Institute will play an important role in identifying and supporting the development of the technologies available to achieve our targets for 2050 and beyond. By regularly updating the market scenarios and technology roadmaps it will be able to provide strategic direction and pull for the work funded in UK universities by the Research Councils' Energy Programme.

6.28 The R&D will be carried out in centres of excellence across the UK and overseas. In deciding the Institute's programme of work it will pay particular attention to the technical and commercial viability of a technology, as well as existing work underway elsewhere around the world.

6.29 From July 2007 the DTI Technology Programme will be directed by a new executive body, the **Technology Strategy Board**, set up to drive forward the Government's Technology Strategy. The Technology Strategy Board will work closely with the Energy Technologies Institute to align the direction of funding of low carbon energy technologies. Requests for proposals for low carbon energy projects will be handled under existing arrangements during 2007 to ensure a smooth transition from the existing Technology Programme.

6.30 Other organisations are also active in funding development and other parts of the innovation chain. The **Carbon Trust**, an independent company funded by Government, works with research institutions and industry to identify and help accelerate innovative low carbon technologies. They offer a variety of mechanisms of support including grants for R&D; strategic and business development advice to start-up companies; funding to overcome barriers to commercialisation; and technical expertise and venture capital investment for low carbon businesses.

BOX 6.2 THE DEVELOPMENT OF WAVE AND TIDAL-STREAM TECHNOLOGIES

Wave and tidal-stream energy technologies have the potential to make a significant contribution towards our energy and climate change objectives. There are currently a number of concepts at various stages of development with a small number of devices having already been demonstrated at full-scale.

Since 1999, the Government has through the DTI, Research Councils and the Carbon Trust programmes committed in excess of £100 million funding to support RD&D of marine technologies. This includes support for new infrastructure such as the European Marine Energy Centre in Orkney, which provides dedicated testing facilities for marine energy technologies and the proposed "Wave hub" in the South West which could host a number of wave power projects.

The launch of the £50 million Marine Renewables Deployment Fund (MRDF) and a similar scheme funded by the Scottish Executive has also stimulated the interest of major power companies in the sector. The MRDF moved to an "open call" basis in March 2007, so that the MRDF can fund proposals at any time. The UK has in place the most comprehensive set of support measures for the development of wave and tidal-stream in the world. Even so, progress towards full commercialisation of these technologies has been slower than expected. The Government is working closely with the Renewables Advisory Board and others to drive forward progress in this sector.

The UK is a founder member of the International Energy Agency's Ocean Energy Systems (OES) Implementing Agreement. OES brings together the leading global players in marine energy to work on commercialisation issues that need to be addressed at a global level such as standards, testing and resource assessments.

Innovation system support mechanisms – Demonstration and Deployment

6.31 Demonstration stage support generally takes the form of grants to enable the capital costs and risks of full-scale demonstration of technologies to be shared between public and private sector. Sources of capital grant funding for low carbon energy technologies include the Government, Devolved Administrations and Regional Development Agencies. The EU has also announced its intention to support the demonstration of hydrogen and fuel cell technologies through a Joint Technology Initiative.

6.32 In June 2006, the Government announced the creation of a new cross-Government fund to invest in low carbon energy and energy efficiency technologies. Led by Defra, DTI and DfID the Environmental Transformation Fund brings together the Government's work within the UK and internationally to support, amongst other things, the demonstration and deployment of new energy technologies, and to promote the better use of energy. An international section of the ETF will support development and poverty reduction through environmental protection in developing countries, including

action to tackle climate change. The Fund brings a new level of coherence to our support for the transformation to a low carbon economy.

6.33 The Fund is a means to:

- support the demonstration and deployment of low carbon energy and energy efficiency technologies for heat, electricity and transport in the UK including biofuels and other renewables, and low carbon fossil fuel technologies such as carbon capture and storage (CCS).
- pick up technologies emerging from R&D and help fund them through the later stages of the innovation system. In turn, as we have seen, the lessons from demonstration and early deployment may point to a need for further research and development. To this end the Fund will work closely with the Energy Technologies Institute, the Technology Strategy Board and others to optimise the route to market within the UK and globally; and
- finance overseas development projects to support development and poverty reduction through environmental protection, and help developing countries respond to climate change. The international section of the Fund will be dedicated to overseas development aims. Its work will include bilateral projects in developing countries as well as multilateral facilities such as the World and Regional Development Banks' Clean Energy Investment Frameworks. It will also support adaptation and provide access to clean energy, and help tackle unsustainable deforestation.

6.34 The Fund will open in April 2008. Funding of £800 million for the international element of ETF was announced in the 2007 Budget, for the three years from April 2008-2011. Details of the domestic element over the same period will be announced during 2007, in the context of the Comprehensive Spending Review.

BOX 6.3 THE DEMONSTRATION OF HYDROGEN AND FUEL CELL TECHNOLOGIES

Hydrogen and fuel cells (which can be powered from hydrogen) are linked technologies with significant carbon-saving potential where the hydrogen is produced from renewable or low carbon sources.

Fuel cells and hydrogen technologies face significant technical and economic challenges if they are to displace the incumbent technologies. A huge international effort (both public and private) is being devoted to overcoming them. This will require fundamental and applied research, development and demonstration. Non-technical barriers such as codes, standards and regulations will become increasingly significant as the technology moves towards demonstration and deployment, and efforts are already being made at the international level to address this problem.

A new UK demonstration programme has been launched and the first call for proposals opened in September 2006. The programme offers a total of £15 million funding over three years for hydrogen and fuel cells. Basic research is being supported by the Research Councils, including the directed programme SUPERGEN, which is funding separate consortia working on hydrogen and fuel cells. The European Commission is

BOX 6.3 Continued

expected to come forward with proposals later this year, for a Fuel Cell and Hydrogen Joint Technology Initiative to support further applied research and demonstration activities of these technologies. The use of hydrogen as a transport fuel is also considered in chapter 7.

6.35 There are various mechanisms to support the deployment of low carbon technologies in all sectors. These include the Renewables Obligation, the EU Emissions Trading Scheme, the Climate Change Levy and the Renewable Transport Fuels Obligation (from 2008). These mechanisms either help reduce the operating costs and therefore make technologies competitive in the market or penalise those technologies that have high emissions. The Government also intervenes to address barriers to deployment, for example through the reforms to planning procedures which are discussed in chapter 8.

6.36 Building credible long-term frameworks for tackling climate change are a key part of providing clear long-term signals to industry about the future path of emissions. Establishing a price for carbon gives industry certainty about the value of emissions reductions while trading mechanisms such as EU ETS allow cost effective sharing of the burden of reducing carbon emissions.

BOX 6.4 CHP FACILITY

A biomass Combined Heat and Power (CHP) facility at Balcas Timber, near Enniskillen in Northern Ireland, was commissioned in 2005 and has benefited from £2 million of capital grant funding from DTI.

The CHP plant makes Balcas' Enniskillen sawmill site self-sufficient in electricity, with surplus electricity sold to the Northern Ireland grid. Its heat is used in the production of biofuel pellets. The plant is one of the largest biofuel pellet production facilities in the British Isles. The plant produces enough biofuel pellets each year to meet the energy needs of 10,000 households.

The company sees the potential for replication of the project elsewhere in the UK and announced in November 2006 plans for a £24 million plant at Invergordon, with funding from Highland and Islands Enterprise. As well as being carbon neutral and a direct replacement for fossil-fuels, biofuel pellets are generally a cost-effective source of heat compared with oil.

Developing the right skills

6.37 The skills and competencies of the workforce are of growing importance to the energy sector, as they are for the economy as a whole. It is crucial that employers have the trained staff they need for the safe and efficient operation of their businesses and the reliable supply of energy to their customers. It is also crucial that workers have the skills and flexibility to handle the new technologies and business practices that will emerge in the coming decades.

6.38 The Government's Skills Strategy[241] aims to ensure that employers across all sectors can recruit people who have the right skills. The recent Leitch Review[242] illustrated the significant challenges that face the UK. It recommended that the UK should commit to becoming a world leader in skills by 2020, benchmarked against the upper quartile of OECD. Government has an important role to play in providing the right framework and to work with employer organisations and trade unions to ensure that education and training is delivering the right skills. However, it is for employers to ensure that the workforce is equipped with the work-specific skills they need.

Skills challenges in the energy sector

6.39 Although the energy sector employs a broad range of people with a wide variety of skills, there are some challenges that are common to the workforce as a whole. There is evidence of skills gaps across the energy sector. For example, work undertaken for Cogent's[243] Sector Skills Agreement showed 72% of companies experiencing skills gaps, notably in project management, technical and practical skills. Skills gaps are also increasing because the workforce is faced with unfamiliar processes and technologies. Skills shortages, on the other hand, are likely to increase because the workforce is older than the population as a whole and many will retire in the coming decade. Workforce retirement will coincide with higher demand for people to deliver the increased investment needed to replace old power stations and infrastructure. Where they occur, skills shortages will affect all levels from apprentices to graduates and above[244].

6.40 Recruitment and training are key to developing a new workforce but there is the additional challenge of transferring knowledge and experience from the older generation. This is important because, even though new technologies are being introduced, a significant proportion of today's power stations, gas terminals, refineries, transmission and distribution systems will be in operation beyond 2025, albeit with more advanced and cleaner equipment. We shall also of course see significant new investment in power stations and in transmission and distribution networks.

6.41 Workforce mobility and retention place additional pressures on the energy sector. Skills shortages tend to produce a churn of workers as they move around the industry. Internationally, while the UK remains attractive to workers from overseas, there are also rewarding opportunities for our own workers in other countries. The UK must continue to be an attractive investment option for the international companies currently operating here, who have a key role in skills development and to new companies seeking to invest.

Impact of the skills situation

6.42 Analysis by the Sector Skills Councils[245] indicates that, over the next five years, skills gaps and shortages in the UK should not represent a critical threat to security of energy supplies. However, some labour market tightness

241 Skills: *Getting on in business, getting on at work.* White Paper, March 2005 and 14-19 Education and Skills White Paper February 2005.
242 Leitch Review of Skills. Prosperity for all in the Global Economy – World Class Skills. December 2006.
243 Cogent is the Sector Skills Council for the oil and gas, nuclear and chemical process sectors.
244 *Investigation into high-level skills shortages in the energy sector.* Energy Research Partnership, March 2007 (http://www.energyresearchpartnership.org/files/ERP-Skills-Brochure.pdf)
245 Sector Skills Agreements published by Cogent and Energy & Utility Skills

is likely and there could be upward pressure on wages and prices that will persist until supply/demand imbalances are resolved. These pressures will signal the need for increased recruitment and training but the delivery of skills takes time. Forward planning will require greater attention than it has in the recent past.

6.43 In cases where skills shortages become acute, training might not be able to fill immediate vacancies in time. Also, as older workers retire, know-how and experience will be lost. Immigration may have to play a part in maintaining the skills base in the short term and the Government will therefore ensure that work permit policy can respond to requests for recruitment from overseas when labour market tightness indicates that it is necessary. However, this will not provide a long-term solution to the problem; the international demand for skills is increasing and the UK will not be able to rely solely on immigration to supply large numbers of workers. Nor would we want to be reliant on overseas workers in place of developing our own people. Therefore, overseas recruitment will be only part of the solution to bolster experience levels whilst the skills of the UK workforce are further developed.

BOX 6.5 DIVERSITY

As might be expected from the age profile, the energy workforce is less diverse than the wider population. Overall, only around 25% of the energy workforce is female, compared to 43% nationally, and only around 4% are from a black/ethnic minority background versus 8% for the whole economy. Employers are now recruiting from a wider range of backgrounds and the proportion of women and ethnic minorities is increasing, although progress is not uniform. In companies that have made good progress, for example those specialising in engineering design and project management, diversity is working through to team leader and senior professional jobs.

The DTI provides funding to the UK Resource Centre for Women in Science, Engineering and Technology (SET) which works with a wide range of energy companies to encourage the recruitment, retention and progression of women in SET. This has included the provision of support and advice on planning, sharing best practice, building a network between companies and recognising success.

What is being done to address skills issues?

6.44 Much has already been done to tackle the skills challenge across the energy sector, both to improve the broad policy framework around education and training and to step-up recruitment and training. Current skills in the energy sector are built on a legacy of apprentice and graduate training by the previously nationalised industries, the oil industry and major manufacturers. While Government takes the lead in education, employers take the lead in work-specific skills development and they are best placed to continue to do this. For its part, Government will work with employers, Sector Skills Councils (detailed in driving the skills agenda paragraphs in this chapter), the trade unions and other interested parties to help achieve a well-skilled workforce for the future.

Setting the right framework

6.45 Many companies, especially in the supply chain, have been faced with short term business horizons, making it hard for them to justify taking on apprentices or graduate trainees for whom they feel there may be no clear future. The Government's aim is to set the right overall market and investment framework to enable companies to make investments in infrastructure and people over the longer-term. This objective, which is also supported by the regulator, will make it easier for companies to invest in people.

Investing in education

6.46 As well as continuing to invest in and improve the teaching of science, engineering and technology for all schools, the Government will work to increase the numbers of female students and those from ethnic minorities taking these subjects, support initiatives to increase apprenticeships, and encourage more students to study science and technology subjects at university. The Government will ensure that education and training policy, including the initiatives that result from the Leitch Review, are informed and guided by energy sector issues.

Driving the skills agenda

6.47 In the early years of this decade, Government replaced the industrial training organisations with 25 Sector Skills Councils. The Sector Skills Councils are employer-led and each includes at least 500 000 workers. They are charged with developing a strategic approach to skills, which is defined in a Sector Skills Agreement. This includes detailed skills and demographic analysis, which is being used to develop plans to ensure that the needs of the energy sector are met, both now and in the future. In addition, Sector Skills Councils have a key role in defining skills and competencies, setting standards and ensuring that training provision is of a high quality. They also network with employers in their sector to support specific activities, some examples of which are given in Box 6.6. In view of employers' key role in skills development, it is vital that they and their representatives are fully engaged in the Sector Skills Councils, especially those concerned with the energy sector.

6.48 The energy sector has two Sector Skills Councils, Cogent (for oil and gas, nuclear, refining and the chemical industries) and Energy & Utility Skills (for power generation, gas and electricity transmission and distribution), plus a training board (The Engineering Construction Industry Training Board) that covers the design and construction of capital plant.

6.49 Trade unions are represented on the Boards of the Sector Skills Councils – Unison on the Energy and Utility Skills Board; Transport and General Workers' Union, Prospect and Amicus on the Cogent Board. This gives trade unions a key role to play in helping to direct, with employers, the strategic skills agenda, as well as the valuable role they play in encouraging skills development at local level.

BOX 6.6 EMPLOYER ACTION ON SKILLS

The Power Academy is an initiative by 15 key employers in the power sector, six universities and the Institution of Engineering and Technology that is sponsoring up to 60 undergraduates each year to study power engineering at university.

Ambition Energy, a scheme led by Energy & Utility Skills that trained 2500 long-term unemployed to become Corgi-registered gas installers in the period 2002-2006, has provided a model example of how to address skills shortages by non-traditional routes of entry. Elements of both the Power Academy and Ambition Energy can be seen in power sector schemes being introduced in the USA to mitigate the impending retirement of the baby boom generation.

The engineering construction workforce (responsible for building power stations, refineries etc) faces a net loss to retirement at a time of increasing demand for its services. The Engineering Construction Industry Training Board, with the sector's employers, is planning a step change in recruitment and training that will deliver a highly-skilled workforce for the future.

6.50 Several Sector Skills Councils are making use of additional Government support to develop National Skills Academies for their sector. These will provide a central focus for workforce development and will ensure that all employers have access to the best quality training. Some details are given in Box 6.7.

BOX 6.7 SKILLS ACADEMIES

Applications led by Cogent for the National Skills Academy for Nuclear and separately for the Process Industries were given approval to progress to the development stage at the end of October 2006. The employer-led Academies will seek to deliver a coherent skills strategy that will address the specific needs of the nuclear industry (around 20% of the UK's electricity currently comes from nuclear power), and chemical process sectors. The Academy for nuclear intends, in its early years, to deliver 800 apprenticeships and around 150 Foundation Degrees for new entrants to the industry, while re-training or up-skilling 4000 existing employees each year to NVQ levels 2 - 4.

Energy & Utility Skills has begun a review, with its industry stakeholders, of the long-term skills needs and the potential benefits of National Skills Academies for the power and gas sectors. The Engineering Construction Industry Training Board submitted a proposal for a national Skills Academy earlier this year.

6.51 In England, regional economic strategies, prepared by the Regional Development Agencies (RDAs) on behalf of the nine English regions, capture the strategic skills priorities that will drive sustainable economic development and regeneration. Each RDA comes together with the Learning and Skills Council, employers, Sector Skills Councils and other partners in Regional Skills Partnerships to drive forward the skills agenda in each region. Skills and training is a devolved matter in Scotland, Wales and Northern Ireland and the Devolved Administrations set their own strategies for tackling skills priorities. Government will continue to work with RDAs and the Devolved Administrations to develop the energy skills agenda, to ensure that:

- energy skills issues are better understood at regional and local level; and
- The existing structures for co-operative working between sectors and regions on skills issues are made much more effective.

Supportive regulation and working with Ofgem

6.52 Skills development is recognised as a legitimate and very necessary area of expenditure for companies operating within the regulatory framework. The Regulator encourages investment in this area by clearly stating what companies need to deliver to their customers and putting incentives in place that reward those that innovate and enhance their efficiency and performance. A consistent approach by the Regulator and clear strategy from industry initiatives, such as the Power Academy, are also ways of encouraging companies to put longer-term plans in place.

6.53 Ofgem's Innovation Funding Incentive for electricity distribution companies aims to re-invigorate R&D within the sector by bringing industry and universities closer together, helping supply chain companies to bring in new technology and developing technical skills for the future. The scheme has recently been extended to include electricity and gas transmission companies. This increase in research and development across the sector will, in turn, further encourage the development of intermediate and high-level skills.

Skills for the future

6.54 All agree that the skills outlook is challenging and that we must ensure, not only a transfer of skills, but of know-how and experience, to a new generation of workers. In addition, we must develop new skills sets and competencies to deliver and operate the low carbon economy, and maintain the skills we need to deliver secure energy supplies.

6.55 We shall continue to work with the energy industry, the Sector Skills Councils, and other interested parties to ensure that the job market is able to provide the skills to match the deployment of new technologies. We are asking the Sector Skills Councils to report on the skills gaps in the energy sector and action being taken to address them.

6.56 The UK is fortunate to have excellent schools, colleges and training organisations that can rise to the challenge, together with strategic direction through the Sector Skills Councils to identify and manage what needs to be done. Meeting the challenge will not only ensure that the energy industry of the future has the skilled people it needs, but will also create a world-class education and training capability that can bring overseas business to the UK. Working together with the Sector Skills Councils and the National Skills Academies, Government, employers and trade unions need to highlight the

career opportunities in the energy sector for young people now at school or in higher and further education, so that the sector can better attract the engineers and other skilled people it needs.

RESEARCH AND DEVELOPMENT, DEMONSTRATION AND DEPLOYMENT, AND SKILLS SUMMARY OF MEASURES

We will facilitate the demonstration and deployment of sustainable and low carbon technologies by:

- **working with industry and key partners within the UK and globally, to speed the route to market for emerging low carbon energy technologies through a comprehensive programme of public sector support;**
- **increasing UK R&D funding through the new public/private sector Energy Technologies Institute;**
- **delivering the Environmental Transformation Fund in 2008 to support demonstration and deployment and energy efficiency;**
- **continuing to work with the energy industry, the Sector Skills Councils and other interested parties to ensure that the job market is able to provide the skills to match the deployment of new technologies; and asking the SSCs to report on the skills gaps in the energy sector and action being taken to address them.**