The Royal Academy of Engineering

Renewable Energy-Generation Technologies

House of Commons Science and Technology Select Committee

July 2007

Introduction

The Royal Academy of Engineering is pleased to be able to respond to the House of Commons Science and Technology Select Committee Inquiry into Renewable Energy-Generation Technologies.

The Royal Academy of Engineering strongly endorses the Committee's interest in the subject of renewable energy generation in the UK, but notes that this is an extremely crowded policy area at present with consultations arising from the May 2007 Energy White Paper, March 2007 Draft Climate Change Bill and the May 2007 Planning White Paper. Additionally, the number of organisations involved in researching low-carbon technologies is large. In such an environment, there is always a danger of effort being duplicated.

An Engineering Led Response to Climate Change

In response to the Energy White Paper, the Intergovernmental Panel on Climate Change Fourth Assessment Report, the Draft Climate Change Bill, the Stern Review and the Energy White Paper, The Royal Academy of Engineering and the 35 UK engineering institutions, together representing nearly 250,000 registered engineers and over 600,000 members, formed a Round Table of industry experts under the Chairmanship of Lord Browne of Madingley. Their objective is to provide engineering led advice to Government on the reduction of greenhouse gas emissions from energy production and usage, and the sustainability of both.

Such a coming together of the engineering profession is unprecedented and reflects a conviction that engineering is essential to the provision of solutions to the urgent challenges posed by climate change.

Various targets have been set for the stabilisation of atmospheric CO_2. In the UK, these were historically derived from the Royal Commission on Environmental Pollution's report *Energy, The Changing Climate*[1], which advocated a 60% reduction in emissions. This was derived from the then perceived need to stabilise at 550ppm of CO_2. However, this target has, since 2000, become controversial and many experts have revised their estimates of the required target downwards to between 450 and 500ppm. The scale of the challenge to deliver the necessary reductions is such that delivery currently seems unlikely unless significant new initiatives are taken. Investment in new technologies and techniques will be required as well as investment in the engineering workforce expected to deliver and run these technologies. The most appropriate strategies to ensure robust, economic and effective actions are far from clear.

It is clear that if a suitable level of stabilisation of CO_2 is to be achieved, the trajectory of CO_2 increase needs to be reduced quickly. If there is no significant global progress by 2025, CO_2 levels of 450 to 500ppm will be unattainable. Given the long economic life of the electricity generating plant and energy using products that will be contributing to emissions over that period, the window for action in terms of designing and deploying low emissions technologies on a sufficiently large scale is significantly shorter.

Virtually everything that uses energy to function or to generate power is an engineered product, ranging from mobile phones to nuclear power plants. Similarly products that reduce energy demand such as loft insulation, double glazed windows

[1] Energy, The Changing Climate, Royal Commission on Environmental Pollution, June 2000

and heat pumps are also engineered products. From a position of understanding the processes involved in inventing, developing, designing, producing and marketing these products, the engineering profession is in a unique position to advise Government on the practical actions and priorities required to improve sustainability and energy efficiency, and to accelerate the development of new energy efficient products

Climate change is a global issue; the atmosphere cannot be segmented into particular national responsibilities. However, the technical advances which will make a global impact will, in all probability, need to be championed by the first world countries that currently have the highest *per capita* energy demand. Demonstrating leadership and a will to tackle climate change in the World's leading industrialised economies is prerequisite to catalysing Global action. Achieving UK technical and commercial leadership in moving towards a low-carbon economy is key to bolstering the UK's global leadership on climate change issues as well as underpinning the export potential for UK technologies through technology transfer to other carbon intensive and fast expanding economies.

The Round Table (see annex 1 for membership) believes that the engineering profession has a key role to play in the delivery of the CO_2 emission reductions envisaged in the Stern Review, firstly through the commercialisation and deployment of technologies in the UK and secondly through the export of those technologies including the use of the flexible mechanisms[2] under the Kyoto Protocol and its successors.

Furthermore, the Round Table believes that a detailed study should be commissioned that would set out an engineering led response to the climate change challenge, providing Government with recommendations that would bring forward the commercialisation and deployment of emission reducing technologies in a timely and optimal manner. This would be focused on the timescales for implementation, maximum impact and lowest abatement costs for reductions in emissions from energy production and usage.

In the opinion of the Round Table, a number of technologies show significant potential for near and medium term reduction in emissions and the proposed study will test the evidence behind them. Similarly, the Round Table is of the opinion that certain changes to regulatory and taxation structures could lead to early or immediate reductions in emissions from energy production and use throughout the economy as well as setting the foundations for sustained reductions into the future.

[2] Flexible mechanisms under the Kyoto Protocol allow Annex 1 signatory nations (those with binding emissions reduction targets) to claim credit for emissions reduction projects in other countries: by emissions trading between Annex 1 nations; by buying credits from non-Annex 1 nations under the Joint Implementation; or by receiving credits from non-Annex 1 nations for investing directly in local emission reduction schemes under the Clean Development Mechanism. Flexible mechanisms are administered by the United Nations Framework Convention of Climate Change (http://unfccc.int/2860.php).

1. The Current State of UK Research and Development

1.1. As well as addressing the state of renewable technology research in the UK, it should be remembered that a key product of university research is trained people. The lack of investment in wind energy research (onshore as well as offshore) is leading to a shortage of technical specialists entering UK industry in these important areas of major commercial activity. As technologies such as tidal stream and fuel cells become commercially viable, the same lack of trained engineers and technicians in these fields will become apparent.

1.2. The UK Energy Research Centre (UKERC) has produced an Atlas of UK Energy Research[3] which provides a concise and updated view of current energy research in the UK, who the key funders are and where the research is being conducted. The key outputs from this work are available as landscapes of roadmaps for the various technologies considered and the Committee may find these useful in its deliberation.

1.3. In general terms, the Academy would make the following points about the state of research and development of key renewable energy-generation technologies within the UK:

1.3.1. Offshore wind energy is significantly more expensive and risky than onshore wind energy and research is needed to lower costs and reduce risks. Without this research the development of offshore wind energy, where the UK is trying to move forward faster than many other countries, may be delayed.

1.3.2. Tidal stream energy research remains very fragmented with significant barriers to the development and dissemination of knowledge, particularly of the resource, arising from commercial sensitivities of the device developers. This may be contrasted with the then Department of Energy large wind turbine programme managed by ETSU in the 1980s. This undertook publicly funded research and monitoring the results of which were made publicly available into aspects both of wind turbine performance and wind resource characterisation. Such a programme gave very valuable information for the subsequent commercial development of wind energy and contributed to the establishment of Garrad Hassan and Partners and Renewable Energy Systems Ltd (both major UK successes in wind energy).

1.3.3. Wave energy remains at an early stage of development with no clear device architecture becoming pre-eminent. The “winner” will only emerge through a process of natural selection following field trials. Thus a priority is to facilitate full-scale field trials to increase experience of wave energy and to accelerate this process.

1.3.4. The key present problem in intelligent grid management is the “GB queue” of 16 GW of wind energy applications in Scotland and no mechanism to connect them within a firm time scale. Other than that particular issue there is a reasonable consensus of how to proceed up to the 2020 level of 20% of electrical energy from renewables. However research is now needed for the Grid implications of higher levels of low carbon generation i.e. to meet the 60%-80% CO_2 reductions by 2050 or the 20% of total energy from renewables. Given the length of life of transmission and distribution assets

[3] http://ukerc.rl.ac.uk/ERA001.html

and the very high rates of spend now being sanctioned by OFGEM (which are presently being expended on like-for-like replacements) this is becoming an urgent issue. At present, the issues associated with incorporating distributed distribution in the UK network are limited to wind energy, but will apply equally to other distributed technologies such as micro CHP when they become available.

1.3.5. Cost effective energy storage remains a key goal of energy research. Two major UK initiatives; high speed flywheels (URENCO) and REDOX flow batteries (Regenesys) were technically successful and were taken to beyond the prototype stage. However both manufacturers then withdrew from the market. It is very difficult to compete with fossil fuels, which store energy in chemical form, under present market conditions. Research should be continued on energy storage with the applications focussed on the longer term 2050 ambitions of very deep cuts in CO_2 emissions when the very onerous requirements that will be placed on the power system may allow a commercial case of energy storage to be developed.

2. The Feasibility, Costs, Timescales and Progress in Commercialising Renewables

2.1. The Academy currently has no properly researched information to offer on feasibility, costs, timescales and progress to commercialisation but the collection of this data will form a key part of the evidence base for the proposed engineering led study proposed by the Academy and the 35 UK engineering institutions.

2.2. In general terms, the Academy would endorse a holistic approach to considering the pathways to a low-carbon economy. In particular, a technology path should be considered where technologies which become commercially viable early on are replaced by later generations of technology that have better carbon footprints and reliability. This is important because investment in later generations of technologies is less likely to happen if markets for product have not been established by the earlier technologies. A good example of this is in the bio-fuels sector where bio-ethanol derived from corn or sugar beet does not perform well in terms of carbon footprint but plays an important role in paving the way to market for lingo-cellulosic ethanol technologies.

3. The UK Government's Role in Funding RDD&D for Renewable Technologies

3.1. Research spending on energy has declined dramatically in the UK since the privatisation of the industry in the mid-Eighties as can be seen in Fig 1.

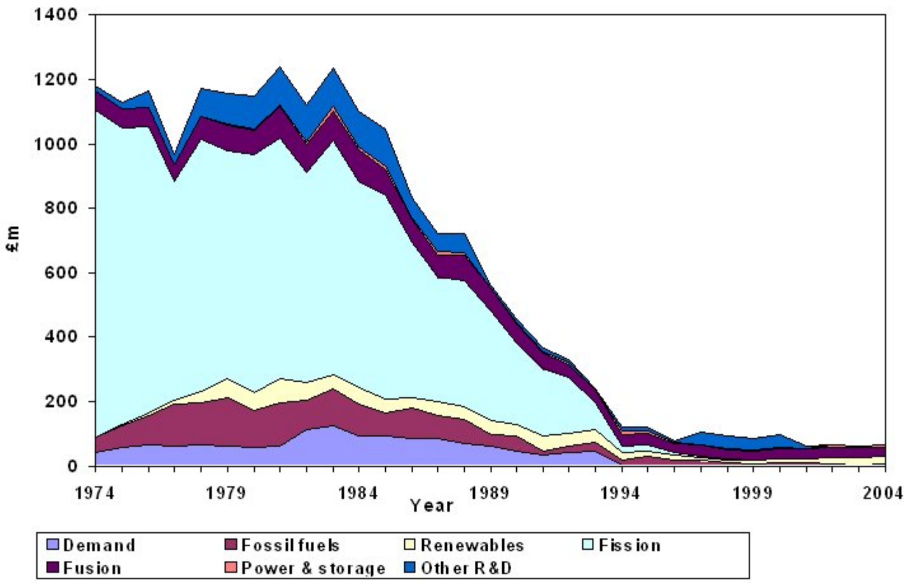

Fig 1 Energy R&D (Public) Spend

3.2. While the fall in R&D spending in the sector has been significant, it has also become more fragmented, making the roles of the Energy Research Partnership, Environmental Transformation Fund and the Energy Technology Institute vital in coordinating and directing the available funding.

3.3. Given that climate change is such a high priority concern for the Government, it follows that Government energy RDD&D spending should not be allowed to decline, but in fact be increased. The complexity and number of funding organisations currently in the field also means that best value for money may net be extracted for the funding available. As the Energy Research Partnership have recommended, the research landscape for energy RDD&D should be radically simplified leading to a national energy research programme consisting of the Research Council Energy Programme funding early stage university based research, the Energy Technology Institute funding development programmes and the Environmental Transformation Fund funding demonstration programmes.

4. Other Possible Technologies for Renewable Energy-Generation

4.1. Climate change is now accepted globally as a real threat, as is the role of anthropogenic CO_2 emission in accelerating climate change. It is currently estimated that atmospheric CO_2 levels must be stabilised at 450 to 500 ppm by 2050 in order to restrict global warming to 2°C.

4.2. In order to reach the goal of stabilising atmospheric CO_2 levels, the trajectory of the increase of CO_2 concentrations needs to be reduced urgently and it is estimated that unless significant results are seen before 2015, then it will be impossible to stabilise at the levels that climate scientists predict to be required.

The logic of this situation dictates that early and large wins are required that cannot be attained by diffuse technologies such as wind or still developing technologies such as tidal stream.

4.3. The urgency of the climate change problem means that while every effort must be made to develop the renewable technologies of tomorrow, some large scale carbon avoidance schemes must be considered now. Such schemes need to be rated at the gigawatt scale and include the replacement of current nuclear generation capacity, carbon capture and storage, and schemes such as the Severn Tidal Barrage.

4.4. It is well known that both nuclear fission and large tidal barrages carry significant environmental risks in terms of nuclear waste management and altering the ecology of tidal estuaries, but the urgency of the need to reduce CO_2 emission from the power sector suggests that these potential risks should now be balanced against the risks of failing to stabilise atmospheric CO_2 at acceptable levels.

4.5. Carbon capture and storage is rightly being championed by Government as it has the potential to provide gigawatts of low-carbon electricity generation in the UK as well as significant export potential for the technology. Public funding is essential to the large scale demonstration of carbon capture and storage as the risk profile, capital intensity and current pre-commercial nature means that industry will be unable to carry out the required RDD&D themselves. Industry does, however, have a strong desire to see carbon capture and storage succeed as a technology and recent developments have shown them willing to participate in the Government sponsored competition announced in the 2007 Budget and Energy White Paper. Other areas of research that must be addressed for carbon capture and storage include the safe storage of CO_2, the infrastructure required to handle the CO_2 and the legal aspects of sub-sea disposal.

5. Conclusions

5.1. An engineering led response to climate change involving all of the UK professional engineering institutions should be commissioned to help inform Government and industry on the optimal route to a low-carbon economy.

5.2. The number of bodies involved in funding energy research should be rationalised with oversight provided by the Energy Research Partnership.

5.3. Government spending on energy RDD&D should be increased from its current low levels.

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2 July 2007

Annex 1

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