Royal Society response to the House of Lords Science and Technology Committee Inquiry into 'How will the UK meet its greener energy targets? '

November 2003

This document is the Royal Society response to the House of Lords Science and Technology Sub-Committee II inquiry into the practicalities of developing renewable energy[1].

This submission has been prepared in consultation with our Energy Policy Advisory Group (EPAG) and has been approved by the Council of the Royal Society. This response follows the order of the questions as asked in points 3 and 4 of the Science and Technology committee inquiry.

Introduction

1 Anthropogenic production of greenhouse gases, particularly carbon dioxide, is now almost universally accepted as a major contributor to global climate change (IPCC 2001). The consequences of this climate change threaten the health and livelihoods of thousands of people across the world.

2 The Royal Society has concerns over expressing renewable targets as percentages. Any reduction in tonnes of CO_2 emitted, from attaining percentage targets for renewable energies, could be more than offset if any increase in the total demand for electricity is met by fossil fuels. A target set in terms of maximum mass of CO_2 emitted from electricity generation would be more appropriate. Having stated this fundamental reservation, the rest of our response will concentrate on attaining the Government' s targets and aspirations as set out in the Government Energy White Paper (DTI 2003*a*) to place the UK on a path to a 60% reduction in its CO_2 emissions by 2050.

3 There is no doubt that renewable technologies have the theoretical potential to satisfy the demand for electricity generation in the UK. The offshore wind resource alone could supply more than the UK's entire electricity requirement. However, a number of factors currently restrict the growth and development of the renewables industry and the chances of meeting the UK 10% target.

4 For greener generating technologies to become cost effective we consider the introduction of the correct economic instruments is the single most important factor. We have assessed the level of a carbon tax necessary to make a number of technologies viable against natural gas - currently the cheapest fossil fuel. The level of tax needed to make a technology viable can be used as an indication of current costs and potential in the future. Additional implementation issues, such as planning difficulties, provision of supporting infrastructure and solutions to address intermittency, could also be resolved through the use of well-designed economic instruments.

5 We consider the Government target to provide 10% of electricity from renewable sources by 2010 an admirable but ambitious target. In the short to medium term it is difficult to see how the UK can reduce its dependence on fossil fuels without the use of mature non-emitting technologies such as nuclear power. We welcome Government efforts to develop alternative methods to reduce carbon emissions, such as the recent

[1] http://www.parliament.uk/parliamentary_committees/lords_s_t_select/energy.cfm

DTI study assessing the feasibility for CO_2 capture and storage in the UK (DTI 2003*b)* and hope research is continued in this area.

Question 3 - We invite comments on what practical steps are needed to achieve a move towards renewable energy sources at the rate proposed in the recent White Paper.

6 The recent Energy White Paper (DTI 2003*a*) outlines that the UK has currently one of the most open energy markets in the world, with Government having responsibility to provide long-term policy measures within this market framework. As a result, energy markets and the influence on these by Government policy have a large impact on the practicalities of developing renewable technologies.

7 Most alternative forms of energy cannot compete with the cheapest fossil fuels – currently natural gas – particularly when the latter's environmental costs are not yet factored into the price of the fuel. However, we consider that a number of instruments currently employed by this Government do not provide the necessary incentives to make renewables and non-emitting technologies economically viable.

8 The Renewables Obligation in England and Wales (and the associated Obligation in Scotland) legislates electricity suppliers to supply 3%, rising to 10.4% by 2010, of their electricity from renewables. We welcome this initiative to make the market more favourable to renewables, but are concerned that the level of the statutory payment, at 3 pence / kilowatt hour (p/kWh) above the current cost of electricity, for energy produced from non-eligible sources is too low. This payment allows suppliers, if they are unable to, or do not wish to provide the required proportion of electricity from renewables, to buy-out their obligation – essentially pay a fine. We believe this figure is not high enough to encourage the more expensive technologies such as offshore wind that will be needed to meet the Government's 2010 renewable target. In addition, the previous instrument, the NFFO (Non Fossil Fuel Obligation) used a price branded system to reflect the different cost for technologies and offered contracts over a number of years. Therefore the new arrangements have in some ways made it more difficult to invest and develop in more expensive technologies.

9 We believe that attaining a reduction in UK CO_2 emissions by setting renewable targets as percentages is flawed. Any reduction in tonnes of CO_2 emitted, from achieving percentage targets for renewable energies could be more than offset if any increase in the total demand for electricity is met by fossil fuels. A more appropriate target should be set in terms of maximum mass of CO_2 emitted from electricity generation.

10 Development of the renewables industry in the UK is further complicated by the New Electricity Trading Arrangements (NETA). It would appear to discourage some renewable energy schemes (wind, tide and solar) as a consequence of their variability of supply and thus their inability to guarantee to supply a contracted amount of electricity within a specified period.

11 The current Climate Change Levy is an inefficient economic instrument to reduce carbon emissions, as it targets energy use rather than carbon emissions. The tax penalises nuclear power and other non-emitting sources, which are effectively carbon free. It also excludes certain energy users, including households and transport. It would be simpler to set a carbon tax that would place a charge on carbon content of fuel and therefore benefit non-carbon emitting sources of energy.

12 We believe the introduction of well-designed economic instruments, is the most cost-efficient way to reduce greenhouse gas emissions. We recommend the implementation of either a carbon tax or auctioned permits to move the balance of the energy market in favour of renewables. Given a high enough level of taxation it would lead to the ultimate abandonment of fossil fuels, which some analyses suggest might be needed by the end of this century (Royal Society 2000, 2002*a*).

13 The Royal Society report (2002*a*) considers the impact of a 'small' carbon tax. An initial level of the tax would change the cost of electricity by no more than 1 p/kWh – less than the variability of electricity costs between various countries in Europe. Analysis within the report has shown that the impact of a carbon tax on long-term global GDP for drastic reductions in carbon dioxide emissions would be small, with estimates in the region of 1%. The success and benefits of economic instruments are greatly improved as their introduction is extended to European and beyond.

Question 3a - Cost-effective technologies available now for the generation of renewable energy, and those that are likely to become available in the next 10 years or so.

14 This section provides a summary of the analysis contained within the Royal Society report (2002*a)* of the extent to which a carbon tax could affect the prospects of non-fossil fuel energy. With gas generation currently costing around 1.8-2 p/kWh (IAG 2002), it is possible to assess the potential for these technologies and the necessary economic incentives required to make them viable. We consider that in the short to medium term the competitive technologies are likely to be wind and tidal energy. The report (Royal Society 2002*a)* notes that assessing the impact of a carbon tax lies in the fact that the technologies involved are in the most cases not fully developed, and have not been tested in full-scale demonstrations.

Wind energy

15 In calculating the cost of wind power one needs to count the direct costs as well as the cost of intermittency. Taking just the direct costs it would appear that for on-shore wind farms the cost of electricity produced at the best sites could be as low as 2.5p/kWh. Ignoring the intermittency problem, on-shore wind power is within range of being economically viable. However intermittency is a considerable issue, with some experts suggesting wind can only be relied on to supply a third of the total capacity installed and would require back-up power to ensure supply. The Royal Academy of Engineering (2002) recommend as much as 75-80% of the installed wind capacity would have to be available in the form of conventional plant capacity to back-up days with little or no wind.

16 Due to the issues of site placement, the capital cost of offshore wind is around 4 p/kWh. This cost is calculated by discounting at 10% a year over a 20-year lifetime of an estimated capital cost of £10,000/kW. Additional costs for connections to the grid and some maintenance costs lead to a figure in the range of 5.5-6 p/kWh.

Solar thermal energy

17 It is unlikely that a 'small' carbon tax could bring in solar-thermal concentrating systems such as the 354MW system in the Mojave Desert or the new Spanish 15MW Solar Tres, into the realms of commercial viability. However, there are possibilities for increasing the uptake of flat-plate solar collectors for water heating.

Photovoltaic cells

18 Currently available single-crystal silicon cells can convert sunlight into electricity with an efficiency that in the most advanced models can reach 24%. Standard commercial cells will have efficiency nearer 16%. In low incoming solar energy areas such as Western Europe, the cost of electricity produced by such modules is high, at around 40p/kWh and 15 p/kWh in Southern Europe, the USA and most developing countries. Photovoltaic modules are economically viable for applications where there is no easy access to the grid, but as a direct competitive source of electricity, photovoltaics are currently well out of range. Photovoltaic technology is an exciting area of materials science, advancing rapidly, which we consider will provide an important energy source in the future.

Hydrogen and fuel cells

19 There are many technical and logistical problems to be solved, and it is not yet possible to make a realistic estimate of cost. However, hydrogen is potentially an important energy vector and could be generated from renewables and used to overcome some intermittency issues. In addition there are now real prospects for the wider application of fuel cells. A carbon tax would provide additional support for this development.

Tidal and wave energy

20 Moving water has the energy density of nearly two orders the magnitude above that of air, and the power can be extracted far more simply than those [already close to perfection] for wind. Tides are also highly predictable and in many situations the phase of the tide changes as one goes along the coastline thus allowing the peak of the nominally sinusoidal power distribution to be greatly widened. Tidal systems can be made to be completely unobtrusive and noise-free. Costs have been modelled and come into the range of 3-5 p/kWh. If estimates can be confirmed, a carbon tax of just 1 p/kWh would suffice to make the system viable at the lower cost estimate range.

21 For wave energy it is hard to estimate ultimate costs until the results of major demonstrators for each of the competing technologies have been completed. The engineering problems are formidable, although it may be more financially viable for application in isolated areas where it does not have to compete with grid electricity prices.

Energy crops from biomass

22 Energy crops are grown specifically for their energy content. Biomass is organic material derived from plant, and animal life and can be burned as fuel. Biomass, of which wood is the largest store and source of energy, currently supplies 14% of final global energy consumption and about 25% in developing countries.

23 Economics associated with electricity generation of energy crops has become more favourable where crops are located in the vicinity of an existing conventional plant and the biomass is used in conjunction with coal or gas. Further cost reductions may be found using more advanced technologies than direct combustion such as those based on gasification and or pyrolysis.

24 At the time of the Royal Society report (2002*a*) biomass power in the UK was 200 MW. Five years ago prices for energy crops were estimated at 5.5 p/kWh DTI (1997) and 4-5 p/kWh (Toft & Bridgewater 1997). More recently a study by Future Energy Solutions AEA Technology predicts that by 2025 costs could be in the range of 3-4.5 p/kWh (IAG 2002).

Electricity from waste

25 We recognise that waste is not strictly a renewable energy source. If waste or landfill gas is to be incinerated then we would wish to see the correct economic incentives put in place to ensure greater use of Combined Heat and Power (CHP) rather than electricity only schemes, therefore reducing UK greenhouse gas emissions.

Question 3 b - The number of sites potentially available for such technologies, and the obstacles to taking these up.

26 Some of the implementation issues examined below could be resolved if well-designed economic instruments were in place.

Planning and consents

27 The current position in the UK suggests that planning regulations are still a major barrier to new renewable generators and anything that can be done to ease this situation is commended. Of particular concern, and an

area that requires addressing, is the number of wind projects objected to by the Ministry of Defence on the grounds of military or civil air safety, and the interruption of line-of-sight communication links.

28 It is vital to ensure that the information available to planning committees is not out of date, in particular for wind farms where noise and visual intrusion are often cited as reasons for denying permission. Technology has progressed and can now mitigate some of these objections, but planning committee members need to be made more aware of the progress. We welcome projects that aim to raise awareness of the benefits of renewables to local communities.

Manufacturing and installation capacity

29 In 2000 the Royal Society (Royal Society 2000) reported that despite some significant engineering issues, which are still to be solved, the build rate to meet the Government's 2010 targets for renewable installations was attainable. The report also highlighted that the target would have to be met by increasing the amount of wind generation. The scale of this build was calculated at the time at between 3,000 and 5,000 new turbines by 2010, which is in excess of 1 per day.

Providing the supporting infrastructure (such as access roads and extensions to the electricity network)

30 In the UK it must be recognised that the geographical areas which offer the most potential for renewables are remote from suitable connection points. Many are in the North of the country where connection will add to the already significant North-South movement of power. There will also be significant implications for the Scotland/England interconnectors. Responsibility for the connection and maintenance costs of the new supply is still a major issue that needs to be resolved.

Question 3c - The logistics of providing stand-by capacity for times when intermittent sources are not available

31 A modern power system cannot operate with more than a limited amount of randomly intermittent power. As the relative quantity of power from intermittent sources, (wind, wave or solar) increases the quality of supply may decline in terms of the stability of the frequency and the presence of unwanted harmonics. As our response to the PIU scoping note states (Royal Society 2001), there is currently no mature technology for storing electricity and there is a clear need for energy buffers. According to the International Energy Agency, this becomes necessary as the contribution from intermittent sources approaches 12% of power supplied. At a 20% level a buffer is absolutely necessary (Royal Society 2001). There is a technical limit to the development of renewable energy supplies if their output is geared solely to direct connection to the electricity supply system. To maintain development of renewable resources, in order to mitigate carbon dioxide emissions and to improve security and sustainability of energy supplies, new technologies need to be developed. Among other possibilities hydrogen from electrolysis could provide such a buffer. In this context the development of fuel cells requiring hydrogen should be a complementary activity to the development of renewable energy sources.

Question 4 - Should it emerge as the Inquiry proceeds that the milestones are unlikely to be met, the Committee will examine the practicalities of other ways of attaining the White Paper's carbon reduction targets.

Energy efficiency

32 We welcome the Government's energy efficiency targets outlined in the Energy White Paper that are aimed at contributing to around half of the carbon savings required by 2020. However, recent DEFRA figures show that approximately 72% of English councils are failing to meet government targets for saving energy and

cutting fuel bills (DEFRA 2003). It is clear that much is currently required in terms of funding and development if energy efficiency measures can achieve the Government targets.

Carbon sequestration

33 In the Royal Society and the Royal Academy of Engineering report (1999) we recommend the need for further research and development to establish the feasibility, cost and safety of submarine saline aquifers for carbon sequestration. We welcome the Government's progress in this area and look forward to further research and funding being made available to fully assess the feasibility of CO_2 capture and storage in the UK.

Nuclear energy

34 Most experts agree that the UK target of generating 10% of electricity from renewable sources by 2010 is an admirable but ambitious target. Currently the UK relies on nuclear power to generate about a quarter of the UK electricity. However, the majority of power stations will reach the end of their lives within the next 30 years. To prevent an associated rise in CO_2 emissions, this capacity must be replaced by other non-emitting sources or electricity demand must be reduced.

35 The Energy White Paper stated concerns that the current economics of nuclear power make it an unattractive option for new generating capacity. However, as the Royal Society report (2002*a*) concludes, if well-designed financial instruments are implemented, nuclear power would become a more economic energy source. Analysis from the Markal model used to underpin the figures in the Government Energy White Paper show that relying on energy efficiency and renewables alone to reach a 60% cut in CO_2 emissions by 2050 and excluding nuclear power would significantly increase abatement costs (DTI 2003*c*).

36 The Government White Paper proposes no new nuclear build unless it is clear that the option is required to attain the Government's carbon targets. We recommend that Government keep the nuclear option open as in the short to medium term we are not confident that energy efficiency measures and renewables will be enough to meet the needs of environmental protection while providing a secure supply of electricity at an acceptable cost. The Royal Society/Royal Academy of Engineering report (1999) addresses this complex issue, and outlines the important factors to be considered for new nuclear build. If nuclear power is to play a long-term role in reducing greenhouse emissions, the decision to build new nuclear power plants must be taken in the very near future.

37 The problem of existing radioactive waste is serious and urgent. It needs to be resolved regardless of whether a new generation of nuclear power stations produces fresh volumes of waste. We are pleased to see the Government following a Royal Society recommendation (Royal Society 2002*b*) to establish a Committee on Radioactive Waste Management (CoRWM) and look forward to their recommendations and subsequent implementation of the chosen strategy(s).

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