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Renewable Energy: Practicalities

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CONTENTS

Note: The Report of the Committee is published in Volume I(HL Paper 126-I); the evidence is published in Volume II (HL Paper 126-II). References in the text of the report are as follows:

(Q) refers to a question in the oral evidence

(p) refers to a page of written evidence

Renewable Energy: Practicalities

CHAPTER 1: EXECUTIVE SUMMARY

1.1. The Energy White Paper *Our energy future—creating a low carbon economy*, published in 2003, set out an energy policy that aims both to ensure security of electricity supply and to meet ambitious targets for reducing greenhouse gas emissions.[1] The Government wish to achieve this by market mechanisms while keeping electricity "affordable". The development of renewable energy sources is put forward as a key means to achieving these policy goals, and the Government have set a target that ten percent of the United Kingdom's electricity should be generated from such sources by 2010, and an "aspiration" of 20 percent for 2020.

1.2. In conventional terms, virtually no renewable source is economically competitive at present unless, notionally or through taxation, a substantial pollution cost is added to the cost of generation from fossil fuels. This means that market mechanisms must be supplemented by subsidies or other means of support for electricity generation from renewable sources.

1.3. By 2020 the Government's plan envisages a substantial change in patterns of generation. The changes roughly correspond quantitatively to replacing current nuclear generation with energy from renewable sources (20 percent), and generation from coal and oil by combined cycle gas turbines. A significant reduction in overall national electricity consumption is also implied.

1.4. Our study addresses the practicalities of meeting the Government's targets for renewables and some of their wider implications. We have found that unless some key problems are addressed within the next two years[2] the targets will not be achieved and the broader strategy on renewables seriously jeopardised. In particular:

- The current means of subsidising renewable sources must be modified to give longer term stability to the market;
- Planning processes must be co-ordinated at several levels and various means used to achieve more local acceptance of renewable developments;
- National electricity transmission and distribution arrangements may need serious attention to allow proper access and management of distributed and intermittent electricity generation;
- The Government must show that they are taking energy supply seriously both through ministerial commitment and commitment of resources to R&D.

1.5. To a large extent making use of renewable resources involves applying new technologies to take advantage of the special features of particular areas—for

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1 *Our energy future—creating a low carbon economy*, presented to Parliament in February 2003 (Cm 5761). Hereafter referred to as "the White Paper".

2 The planned review of the Renewables Obligation (see Box 7 below) in 2006 provides an opportunity for effecting some of the major changes recommended in our report.

example north-west Scotland is one of the windiest places in Europe, and the coastal waters have substantial waves. Other parts of the United Kingdom have exceptionally high tides. On the other hand technologies such as those that depend on sunlight may be more attractive in more southerly parts of Europe. There are different opportunities in different places.

1.6. Internationally, wind is the renewable energy source that has received the most attention and is in many ways the technology that is best understood (apart from some kinds of hydro). New installations on land can be assembled in a matter of days once planning and access provision are complete. Costs have declined steadily over the last twenty years although development has taken place almost exclusively outside the United Kingdom.

1.7. In the United Kingdom onshore wind turbines have not been universally welcomed on amenity and environmental grounds, and there can be interference with radar and aircraft. For these and other reasons the Government are encouraging the development of offshore wind farms. Installing turbines under these conditions is considerably more expensive than on land and servicing them may not be easy. However, better wind conditions and larger turbines in larger groups may offset these disadvantages. There is, however, no long-term experience of operating such offshore developments.

1.8. Another exceptional natural resource of the United Kingdom is the energy contained in waves and tides. These have received much less attention internationally and, in part because Government support for energy related R&D has been low by international standards, the technology largely remains too immature to attract substantial commercial interest. Some demonstration projects are now underway. Simple systems based on the rise and fall of tides do not require new technology and are in use (notably in France) but commonly attract objections because of their significant environmental impacts on river estuaries.

1.9. Electricity may also be generated from materials other than fossil fuels. "Biomass"—specially grown crops, or by-products of other activities such as straw or chicken litter, or even biodegradable urban waste—may be incinerated directly, co-fired with conventional fossil fuel, or gasified. All such fuels have a low energy content compared with their bulk and it does not make economic or environmental sense to transport them long distances before using them. There are several biomass plants in the United Kingdom, but it is unlikely that there will be more in view of the unhelpful and confused regulatory environment and the lack of financial encouragement. However, making use of biomass, both indigenous and imported, could be a cost effective way of meeting the Government's targets for renewable generation. We understand that this is now the policy of the Danish government.

1.10. Other renewable energy sources such as geothermal and solar (photovoltaic and direct heating) are likely to find only niche applications in this country unless there are major improvements in technology.

1.11. The greater part of the United Kingdom's renewable energy for the near and middle future is likely to come from sources that are, of their nature, intermittent. This applies pre-eminently to wind power. It has two major consequences: first, the annual generation for a wind turbine is only a

fraction of its nominal capacity. In Germany this fraction has stood at around 15 percent, and in Denmark a little over 20 percent, although in United Kingdom conditions, particularly offshore, wind farms are expected to do twice as well. Second, whatever overall contribution wind may make to the energy supply, there will be short periods when high demand for electricity coincides with low output. This should not raise serious difficulties until wind generation is more than 10 percent of the total national generating capacity. Beyond this point the situation will have to be handled in various ways: either by having standby conventional generating capacity that may be seldom needed (and is therefore expensive), or by importing electricity from other countries (though at present the United Kingdom's inter-connectors are inadequate), or by agreeing with some customers that in return for a lower tariff their supplies may be interrupted.

1.12. Electricity is distributed around the United Kingdom via the National Grid, which connects a limited number of power stations to major customers who sell on electricity to others. Large wind farms (more than 100 MW), can in principle be connected to the Grid as if they were power stations. Smaller generating units, however, will be connected to local distribution networks, and situations will arise of which there is little operating experience, with power flowing intermittently from multiple sources in complex patterns.

1.13. The Government are implementing their renewables programme by means of the Renewables Obligation (RO). This sets rising "targets" for the amount of renewable electricity to be generated each year (currently reaching as far ahead as 2015), and forms the basis for a complex and subtle market driven set of incentives to generators. The incentive in any one year is high until around 70 percent of the Government's "target" for renewables generation in that year has been attained, and then declines rapidly. We believe that this mechanism will in fact ensure that the Government's targets are not attained, even though offshore wind enjoys additional capital grants.

1.14. The Renewables Obligation, although described as "technology-blind" discriminates strongly in favour of generation technologies that can be brought to market within the next year or so, because the uncertainty surrounding the future value of the RO incentives means that investors look for an early return on their investment. Only wind can produce this early return. If the Government wish to achieve their renewable target of 10 percent by 2010, or to diversify the national renewable portfolio, and there are good reasons to do so, the RO will need modification in the near future.

1.15. We found almost no one outside Government who believed that the White Paper targets were likely to be achieved. This was partly for practical reasons—planning consents, availability of labour and equipment and so on—and partly as a direct consequence of the RO method of support. We judge that by 2010 the United Kingdom may have achieved 6-7 percent renewable generation.

1.16. We deplore the minimal amounts that the Government have committed to renewable energy related R&D (£12.2 million in 2002-03); the comparable figure for the US is $250 million for 2004-05. If resources other than wind are to be exploited in the United Kingdom this has to change.

1.17. We could not avoid the conclusion that the Government are not taking energy problems sufficiently seriously. Transport has not been tackled. Arrangements for combined heat and power generation, private or local, are

not attractive. The responsible minister carries other major responsibilities as well; R&D support is low; but most important of all we could find no one at the executive level whose responsibility it was to ensure continuity of supply. We were told simply that market forces would solve the problem. We are not convinced and urge the Government to give these matters further consideration.

Acknowledgements

1.18. Many organisations and individuals responded in writing to our call for evidence, and many also gave oral evidence or contributed to our seminar in December 2003. We are grateful to them all. Without their help, our inquiry and this report would not have been possible.

1.19. We are particularly grateful to the following, who offered great hospitality and many insights in the course of our visit to Denmark on 26-29 October 2003:

- The Ambassador, Sir Nicholas Browne, and staff of the British Embassy in Copenhagen;
- Knud Pedersen, Deputy Director-General, and staff of the Danish Energy Authority;
- Knut Conradsen, Deputy Rector, and staff of the Technical University of Denmark;
- Staff of Amagerforbrænding Waste Incineration Plant, Gaia Solar Installations, Elsam (operators of Horns Rev wind farm), Lintrup Biogas plant and Herningværket CHP plant.

1.20. We also wish to record our thanks to the following, who hosted seminars and visits within the United Kingdom:

- The Royal Academy of Engineering, and its President Sir Alec Broers (now Lord Broers), who hosted our seminar on 10 December 2003;
- Energy Power Resources, and Commercial Director Malcolm Chilton, who showed us round Elean and Thetford Power Stations on 30 January 2004;
- Councillor James Armitage, Leader of the Executive, and Mr Ray Morgan, Executive Director of Woking Borough Council, who gave the Committee a tour of installations within Woking on 8 March 2004.

1.21. We are fortunate to have had the assistance of two Specialist Advisers: Professor Dennis Anderson, Professor and Director, Imperial College Centre for Energy Policy and Technology, and Dr Chris Elliott FREng, Director of Pitchill Consulting. We are most grateful to them both for their help.

CHAPTER 2: INTRODUCTION

The case for renewables

2.1. We begin this report by asking the simple question, "why renewables"? Stocks of fossil fuel are sufficient to last until at least 2050, so there is no immediate need to find an alternative energy source. Experience suggests that converting energy from renewable sources into electricity is still expensive and not particularly effective in delivering the steady flow of electricity on demand that developed economies rely upon. Yet the assumption that it is desirable to encourage renewable energy is enshrined in the Government's Energy White Paper, as well as in a range of European Union policy statements and directives.

2.2. The obvious argument in favour of renewables is environmental: there is now ample evidence that the accumulation of greenhouse gases in the atmosphere, largely as a result of the combustion of fossil fuels, threatens the earth with accelerating climatic change. The United Kingdom is committed under the Kyoto Protocol to reductions in greenhouse gas emissions by 2010 of 12.5 percent, compared with 1990 levels, and the Government have also made a national commitment to achieving a 20 percent reduction in the United Kingdom's CO_2 emissions by 2010, and a 60 percent cut by 2050. The exploitation of renewable energy sources—abundant and inexhaustible—will assist in controlling emissions, and will in turn assist the United Kingdom to meet its environmental commitments.

2.3. However, renewable energy sources tend to be diffuse and some are intermittent. As a result their conversion into usable electricity is more expensive than the conventional alternatives, and is likely to remain so—certainly as long as fossil fuels do not carry the cost (of which estimates vary widely) of the environmental damage they cause. The environmental benefits of renewables will not be realised without extra cost to consumers.

2.4. In addition, the environmental benefits of renewables have to be seen against a back-drop of alternative strategies for reducing greenhouse gas emissions. Substantial reductions have indeed already been achieved as a result of moving from coal to gas-powered generation, while the rigorous cleaning of emissions, "clean coal" technology, the geological sequestration of CO_2, improvements in energy efficiency, and other technological innovations, hold out the prospect of further reductions. At the same time nuclear fission, whatever its other environmental impacts, remains a reliable source of carbon-free power, and the planned scaling down of nuclear power is likely to lead to increases in emissions as conventional replacement capacity is introduced. Provided that international research is adequately funded, nuclear fusion continues to offer the realistic prospect of clean, safe, and practically limitless electricity by the middle of the century. Other technologies, such as "artificial photosynthesis" to produce hydrogen, may also emerge.

2.5. Another factor, arguably of particular concern to the United Kingdom, is the risk inherent in increasing reliance on gas as a primary source of energy. United Kingdom production from the North Sea is now at its peak, and we will become a net importer of gas as early as 2006. As production from the United Kingdom continental shelf tails off over the next 15 years, and with the running down of the coal industry and the closure of coal-fired power

stations, we will become increasingly dependent on gas imports to meet our electricity needs. This carries a risk: although imports will come from a number of sources, by 2020 more than half of United Kingdom gas imports are likely to come from Russia. Political risk data provided by the insurance sector suggest that interruptions in such supplies of up to 180 days may occur as often as once every eight years.[3] The United Kingdom currently has gas storage facilities equivalent to only 14 days' supply, compared with an EU 15 average of 52 days.[4] We urge the Government to address this issue urgently.

2.6. Diversity of energy sources will thus be essential if the risk to United Kingdom power supplies is to be mitigated, especially if nuclear power is not available. Renewable energy, in which the United Kingdom is rich, thus has a significant part to play in ensuring the long-term security of power supplies.

2.7. However, set against the benefits of renewables with regard to long-term security are the difficulties they present in ensuring short-term reliability. Over a long period (and barring any effects of climate change) the average wind speed at a particular site is highly predictable. But in the short term the opposite is the case, and there is no guarantee that the wind will blow at times of peak demand. This may create serious difficulties for a Grid whose reliability and stability depend on maintaining a minute-by-minute balance between supply and demand. We consider this issue further in Chapter 7.

2.8. **We believe the Government are on balance right to encourage further development of renewable energy. The sources of renewable energy, such as the sun, wind and tides, are inexhaustible, indigenous and abundant, and their exploitation, properly managed, has the potential to enhance the long-term security of the United Kingdom's energy supplies and to help us cut carbon dioxide emissions. However, these sources are also diffuse, and uncertainties remain over the technical feasibility and cost of converting them into electricity reliably on a sufficiently large scale.**

The energy policy framework

2.9. We launched this inquiry by asking whether it was practicable to meet the Government's 2010 target and 2020 aspiration for renewable energy. Our report demonstrates just how difficult this will be. Moreover, as soon as one begins to reflect on the broader question "why renewables?", it becomes apparent that it is the long-term direction of energy policy that is of over-riding importance. Therefore, before analysing the practicalities of renewable energy, we comment on the energy policy framework, the "four goals" set out in the White Paper. These are:

- To put the United Kingdom on a path to cut CO_2 emissions by 60 percent by 2050;
- To maintain the reliability of energy supplies;
- To promote competitive markets in the United Kingdom and beyond;
- To ensure that every home is adequately and affordably heated.

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3 See OXERA, The Non-Market Value of Generation Technologies, June 2003, p. 8.

4 Source: "Security of gas supplies", information paper by the UK Offshore Operators' Association—see http://www.oilandgas.org.uk

2.10. Where do renewables, given the advantages and problems noted above, fit into these objectives? There appears to be a fundamental tension between on the one hand, the first and second objectives, which essentially cost money and mean higher prices, and on the other, the fourth objective, the reduction of fuel poverty, which depends in part on maintaining low energy prices. Renewables can undoubtedly contribute to reducing CO_2 emissions, and if properly managed they may enhance security (though not necessarily reliability) of supplies. But they can only do this at a price—which consumers will have to pay. Thus there appears to be a risk that the promotion of renewables may undermine the Government's fourth objective. The White Paper deals with this issue by stating that the ten percent target for 2010 is "subject to the costs being acceptable to the consumer".[5]

2.11. The relationship between the Government's policy on renewables and the third objective, the promotion of competitive markets, is also puzzling. The White Paper reiterates the Government's target that by 2010 renewables should supply ten percent of United Kingdom electricity. Yet it also states that the Government "do not propose to set targets for the share of total energy or electricity supply to be met from different fuels. We do not believe Government is equipped to decide the composition of the fuel mix". While the term "renewables" covers a range of individual energy sources, the setting of targets, and the provision of subsidies and financial support in order to achieve them, do not sit comfortably with the Government's commitment to the promotion of competitive markets.

2.12. In contrast, in 1998 the Government stated that its "central energy policy objective" was "to ensure secure, diverse and sustainable supplies of energy at competitive prices".[6] This appears to us to be a more straightforward energy policy: it places the emphasis squarely on the long-term security of energy supplies, while acknowledging the importance of environmental considerations and the overall limiting factor of cost. It is easier to see how renewables would fit into such a policy objective.

2.13. **The Government recognise that "there will inevitably from time to time be tensions" between the "four goals" of its energy policy.[7] We would go further, and agree with the House of Commons Environmental Audit Committee that to pretend that all four goals can be achieved simultaneously is a "cop-out: the Government is not facing up to the real issue, as in some situations trade-offs will almost certainly have to be made".[8] With no declared mechanism for determining the relative weights of the different goals, or indeed for assigning responsibility for them, there is a danger simply of confusion, and even a risk that none of the goals will be achieved.**

2.14. **We applaud the Government's emphasis on the importance of the cost of renewables. However, we are concerned that no figure has**

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5 White Paper, paragraph 1.22.

6 See the Government White Paper, Conclusions of The Review of Energy Sources for Power Generation and Government response to fourth and fifth Reports of Trade and Industry Committee, October 1998, paragraph 2.2.

7 See http://www.dti.gov.uk/energy/publications/whitepapers/review_sources/chpt02.pdf

8 House of Commons Environmental Audit Committee Report, *Energy White Paper—Empowering Change?* (8th Report, Session 2002-03, HC 618), para. 77.

been put on what will be deemed "acceptable to the consumer", or how acceptability will be measured.

2.15. **We recommend that the Government reconsider their energy policy goals, with a view to setting a "bottom line". We believe that the fundamental goal of energy policy, as was formerly acknowledged by the Government, should be the maintenance of secure, and hence diverse, energy supplies. In achieving this goal regard must be had to the United Kingdom's environmental commitments and to the need, in the interests of consumers, to promote competitive energy markets. We look forward to a fuller explanation of the Government's position on these issues.**

2.16. The White Paper, with its foreword by the Prime Minister, was published by DTI. The recent first annual report on implementation of the Energy White Paper[9] was published jointly by DTI and Defra, and its foreword is signed jointly by the two Secretaries of State. Inevitably energy policy has a bearing on environmental or social policy objectives. Nevertheless, the current uneasy division of responsibilities between Government departments does not inspire confidence. We are concerned that in a matter of such importance responsibility for delivering the Government's goals should be clearly assigned.

2.17. We note that the former Energy Minister, Brian Wilson MP, stated to the Environmental Audit Committee in April 2003 that "in an ideal world I think there should be a single Energy Department".[10] We agree, and are concerned that the current position, in which the Minister for Energy, Stephen Timms MP, also has responsibility for e-commerce and postal services, appears to down-grade the importance of energy policy. The White Paper draws attention to the profound challenges facing energy policy. In a time of environmental threat and rapid technological innovation, as well as political instability in the oil and gas producing regions of the world, and in view of the over-riding importance of energy supplies to the country's well-being, it is essential that the objectives of that policy be clearly defined, and that there be correspondingly strong leadership dedicated to their achievement within Government.

2.18. **We recommend that the Government review the allocation within Government of responsibility for energy policy, with a view to providing strong and coherent leadership. At the very least there should be a Minister of State, wholly committed to clear, energy-focused aims and objectives, who can bring together responsibility for all aspects of energy policy, including security of supply, along with those currently the responsibility of Defra, such as energy efficiency and conservation.**

The Government's targets: the scale of the challenge

2.19. At the heart of the White Paper is the Government's target that 10 percent of the United Kingdom's electricity should be generated from renewable sources by 2010. Beyond 2010, the Government have set an "aspiration" of

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9 Published April 2004—see http://www.dti.gov.uk/energy/sepn/firstannualreport.shtml

10 Energy White Paper—empowering change?

20 percent by 2020. The remainder of this Report focuses on the feasibility of achieving these objectives.

2.20. In focusing on renewables we have had to exclude much of the energy policy context: the development of renewables is taking place alongside the decline of coal-fired generation, the huge expansion in gas-fired generation, and an effective moratorium on further development in the nuclear industry—what the Government describe as "keeping the nuclear option open". We do not propose to refer to these wider developments except in passing. In particular, while we share some of the concerns that have been expressed on the floor of the House at the Government's apparent indecisiveness over nuclear power—which is at least reliable and carbon-free, whatever the issues regarding disposal of nuclear waste—we acknowledge that such issues fall beyond the scope of this Report. Nor have we looked at "clean-coal" technology, even though we received a significant amount of written evidence on the subject—this too is outside our scope.

2.21. Regardless of these wider considerations, the Government's targets for renewables in themselves represent a huge challenge. The figures speak for themselves: the first annual report on implementation of the Energy White Paper includes an estimate "that the share of electricity supplied to customers from energy sources eligible for the Renewables Obligation[11] rose from 1.7 percent in 2002 to 2.0 percent in 2003. Electricity from all renewables amounted to 2.9 percent."

2.22. Underlying the Government's optimistic tone are some unpromising statistics. Total generation from all renewables in fact fell from 3.0 percent in 2002 to 2.9 percent in 2003, according to the Government's 2004 energy indicators, published together with the first annual report. This fall is blamed on low precipitation and a corresponding drop in output from hydro installations.[12]

2.23. More detailed analysis shows that in 2002 some 5,508 GWh of electricity were generated from eligible renewable energy sources, which in fact represented less than 1.4 percent of the United Kingdom's total demand of just under 400,000 GWh.[13] This figure is consistent with the statement in the Energy Indicators that eligible renewables "accounted for almost 50 percent of generation from renewables in 2002" (in other words, just under half of the total of 3.0 percent).

2.24. It is worth underlining the fact that the Government's ten percent target is for electricity generated from renewable sources that are eligible for the Renewables Obligation. In the words of the DTI's evidence to this inquiry, the target "is normally referred to in terms of the percentage of electricity generated from renewable energy sources without more precise definition, but to be strictly accurate it refers to the contribution of those renewable

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11 For a discussion of the Renewables Obligation (RO), and of those technologies eligible under it, see Chapters 3 and 5 below. The principal technologies not eligible under the RO, which make up the balance of total "renewable" generation, are large hydro (that is, hydro with a declared net capacity greater than 20 MW) and energy derived from mixed waste.

12 UK Energy Sector Indicators 2004, p. 7.

13 Source: DTI energy statistics: http://www.dti.gov.uk/energy/inform/energy_stats/index.shtml In the first year of the renewables obligation (1 April 2002—31 March 2003) Ofgem issued certificates in respect of 5,563 GWh of eligible electricity, while in the calendar year 2003 Ofgem issued certificates in respect of 6,700 GWh. http://www.ofgem.gov.uk/ofgem/work/index.jsp?section=/areasofwork/renewableobligation

sources eligible for the Renewables Obligation" (see p. 156). The figures suggest that ten percent is a long way off—a dramatic change in the rate of introduction of renewable generating capacity will be required if the Government are to come anywhere near their target for 2010.

2.25. Furthermore, Governments have something of a habit of setting ambitious and unachievable targets. In 1999 the European Union Committee of this House, in its Report *Electricity from Renewables*, commented that "we have difficulty sharing the Minister for Energy's confidence that the United Kingdom's five per cent target by 2003 will be achieved."[14] The Government responded by reaffirming their belief that they would "secure its target of five per cent electricity supplies from renewable energy sources in 2003"[15]—but time has proved the Committee right and the Government wrong. It is worth noting that in 1999, along with the five percent target for 2003, the Government had already proposed a 10 percent target for 2010.

The structure of the Report

2.26. If the Government's targets for renewables are to be achieved, against the expectation of almost all witnesses in our inquiry, certain conditions will have to be met—conditions that apply as much to individual developments as to renewables as a whole. Each of these conditions is considered in turn in the chapters that follow.

2.27. The first condition is one simply of technological feasibility. There must be a reliable technology for converting a sufficient source of renewable energy into electricity.

2.28. The second condition is one of practical implementation. There must be no insuperable difficulties in installing the technology at the chosen site—in terms of manufacturing capacity, infrastructure, or the availability of skilled manpower. In the case of biomass there should be a reliable and affordable supply of fuel. The regulatory framework should not hinder development or operation unduly. Of course most practical problems can be overcome at a price—but such costs have to be kept to a minimum if development is to succeed.

2.29. The third condition is commercial acceptability—once the costs of a project are identified, the investment community must be willing to provide the necessary finance. To put it another way, investors must regard renewables as a reasonably secure and productive investment opportunity. In this regard, and given that no renewable sources of energy, with the exception of existing large hydro, can currently compete on price with fossil-fuelled generation, the incentives and subsidies offered as a result of Government policies in support of renewables are crucial.

2.30. The fourth and fifth conditions are the provision of transmission and distribution networks, capable of taking the electricity that is generated and delivering it to consumers; and the ability in managing these networks to balance fluctuations of supply and demand—in other words, given the inherent unpredictability of most of the United Kingdom's renewable energy sources, effective management of intermittency. We have treated these as two

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14 Twelfth Report of the European Communities Committee, Session 1998-99 (HL 78), para. 203.

15 Government Response, printed in the First Report of the European Union Committee, Session 1999-2000 (HL 18), *Energy from Renewables: Further Documents*.

conditions, though in reality they are closely linked. First we consider the Grid infrastructure, along with local distribution systems, and the overall control strategy, which should be able to cope with renewable developments—developments whose scale and character do not necessarily sit comfortably within the traditional Grid model, based on large production units and major conurbations. We then turn to intermittency. Renewables should not destabilise the Grid or make it impossible for the Grid operator to balance supply and demand. In this context the impact of renewable power on overall security of supply inevitably arose in the course of our inquiry, and we have explored this point in some detail.

2.31. Finally, renewable development must have acceptable impacts on the environment, local communities and use of the countryside. There must be a balance between local concerns and national requirements—if all the other conditions are met, but local planning requirements are not satisfied, and local support is not forthcoming, no development will be possible. Our penultimate chapter therefore addresses local, environmental and planning issues, including such matters as the impact of wind farm development on low-fly zones and radar.

CHAPTER 3: TECHNOLOGICAL FEASIBILITY

3.1. The scale of the challenge faced by the renewables industry, if the Government's targets are to be met, has been well documented. We have already noted that in 2002 some 5,508 GWh of electricity were generated from eligible renewable energy sources, which represented around 1.4 percent of the United Kingdom's total demand of just under 400,000 GWh.[16] Of this total wind generation, expected to make up the bulk of the 2010 target, contributed just 1,256 GWh, of which 5 GWh were from offshore wind. If the 2010 target is to be met, new renewable generating capacity roughly equivalent to the total in 2002 will have to be installed each year.

3.2. For this to happen there must be an adequate energy resource, and the technology for converting it into electricity must be sufficiently mature for it to be deployed rapidly and on a large scale. It must also, within the terms of the Government's targets, be eligible under the Renewables Obligation, and we therefore begin with the eligibility criteria, before going on to consider the feasibility of the major technologies in more detail.

Eligibility criteria for "renewables"

3.3. The Renewables Obligation (RO) is the Government's key policy tool for encouraging the development of renewable generating capacity. We consider the nature and effects of the RO in detail in Chapter 5. At this point it is necessary simply to note that it requires all licensed electricity suppliers in England and Wales to supply a specific proportion of their electricity from renewables (there is a separate Scottish Renewables Obligation). This proportion will increase each year, reaching 10.4 percent in 2010 and 15.4 percent in 2015 (the latest date for which a figure has been set). For the purposes of fulfilling their obligation suppliers must purchase electricity from generators using eligible technologies.

3.4. The main eligible technologies are, in summary:

- landfill and sewage gas;
- small hydro (under 20 MW declared net capacity), or larger hydro if commissioned after 1 April 2002;
- onshore and offshore wind;
- biomass (including biomass co-fired in conventional fossil-fuelled plant);
- geothermal power;
- tidal and wave power;
- solar power.

3.5. It is clear that various technologies that could potentially make a significant contribution to achieving one or more of the Government's policy objectives are excluded from the above list. We have already stated that we do not intend to comment on nuclear power or "clean coal" technology (the latter possibly including carbon sequestration technologies), which clearly fall

16 Source: DTI energy statistics http://www.dti.gov.uk/energy/inform/energy_stats/index.shtml

outside the scope of this Report, though they could potentially make a significant contribution to the reduction of CO_2 emissions.

3.6. The position for energy from waste is more complex. The eligibility of waste as a fuel source depends on the kind of waste, as well as the technical process by which electricity is generated. The exploitation of landfill gas—largely composed of methane, given off as the biodegradable portion of mixed waste decomposes—is already eligible under the Renewables Obligation. Indeed, landfill gas contributed about half of total eligible renewable electricity in 2002—more than twice as much as wind. However, we have not considered landfill gas in this inquiry, as it relies on relatively mature technology, and offers little scope for expansion. Production from existing sites may continue beyond 2020, but will ultimately decline. In the longer term, as the amount of fresh biodegradable waste sent to landfill is reduced, in accordance with the United Kingdom's obligations under the Landfill Directive, this source of renewable electricity is likely to diminish considerably.[17]

3.7. Although landfill sites contain mixed waste, landfill gas itself derives only from the biodegradable portion of that waste. The eligibility of other forms of electricity generation from waste similarly depend on whether or not that waste is biodegradable. Electricity generated from agricultural or forestry waste is eligible, as is that generated from municipal waste that is purely biomass. Such waste may be incinerated, subjected to pyrolysis, gasification or anaerobic digestion, or, until 2011, co-fired in conventional plant. However, electricity generated from the incineration of municipal mixed waste (what is normally referred to as Energy from Waste) is ineligible. Energy derived from the pyrolysis, gasification or anaerobic digestion of such waste, provided that the waste is not derived from fossil sources, is eligible.

3.8. The argument has been put to us that energy derived from the incineration of mixed waste should be treated as an eligible renewable. This argument has obvious attractions. We note that the United Kingdom's use of Energy from Waste is well behind that in some other EU states. In Denmark, for instance, we visited the Amagerforbrænding Waste Incineration Plant in Copenhagen, constructed in 1970, which without giving rise to unpleasant smells consumes the waste produced by 530,000 inhabitants and 36,000 businesses, supplying heat and power to 70,000 households.

3.9. However, we note that the incineration of waste cannot be taken in isolation. The European Union's long-standing strategy on waste has established a "waste management hierarchy"—prevention, re-use and recycling, energy recovery (including incineration to generate electricity) and final disposal.[18] Energy recovery is thus preferable to disposal, but below re-use or recycling. In addition, EU-wide policy, as set out in the preamble to the 2001 Renewables Directive, is that "support for renewable energy sources should be consistent with … the waste treatment hierarchy. Therefore, the incineration of non-separated municipal waste should not be promoted

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[17] The Landfill Directive (Council Directive 1999/31/EC on the Landfilling of Waste) sets a target for the United Kingdom of reducing the quantity of biodegradable municipal waste sent to landfill to 35 percent of 1995 levels by 2020. The Directive has been transposed by means of the Waste and Emissions Trading Act 2003; specific targets are set in the draft Landfill (Scheme Year and Maximum Landfill Amount) Regulations 2004, laid before Parliament on 22 June 2004.

[18] For further explanation see the Report of the EU Committee, *European Union Waste Management Policy* (47th Report, Session 2002-03, HL Paper 149), p. 8.

under a future support system for renewable energy sources."[19] The Government therefore have little room for manoeuvre on mixed waste.

3.10. We have also considered coalmine methane (CMM). Methane forms within the earth by natural processes and continuously leaks to the surface. These releases are concentrated in coal mining areas. The run-down of the coal industry has left a legacy of abandoned coal mines, which, according to the Association of Coal Mine Methane Operators, annually emit some 600,000 tonnes of CMM into the atmosphere. Methane is a powerful greenhouse gas, and these emissions are equivalent to some 13.8 million tonnes of CO_2—more than half the amount the Government hope to save in the country as a whole by 2020 through energy saving measures. Essentially the composition of this gas is the same as that of landfill or sewage gas, and the technology for collecting it and converting it to electricity is no different. Yet even though capturing CMM would bring substantial environmental benefits, as a "fossil derived gas" it remains ineligible under the RO.

3.11. We note the Government's announcement in November 2003 that electricity generated from CMM would henceforth be exempted from the Climate Change Levy—the tax on energy use introduced by the Government in April 2001. However, given the continuing exclusion of CMM from the RO, it is curious that the Minister announcing this concession, the Economic Secretary to the Treasury, referred to the desirability of "using methane gas to produce *renewable energy*" (our emphasis).[20]

3.12. **The treatment of coalmine methane is anomalous. While the exemption of coalmine methane from the Climate Change Levy is welcome, it is unlikely to stimulate the industry sufficiently. We therefore recommend that the Government review the eligibility under the Renewables Obligation of electricity generated from coalmine methane.**

Eligible renewable technologies

Wind

3.13. Of all renewable technologies wind offers the greatest potential for expansion in the United Kingdom in the short to medium term. This is a windy island, and with the exception of Ireland has the most favourable wind profile, both on- and offshore, in western Europe (see Box 1). Wind profiles are generally most favourable in the north and west of the British Isles, particularly in exposed hilltop or coastal locations. The south-east of the country is less favourable, with more obstructions and few hilltop sites. In contrast, offshore sites benefit from the lack of obstruction, and can offer wind profiles comparable to those at good hilltop sites onshore. Consultants Garrad Hassan, in a report commissioned by the DTI, estimate the mean wind speed for the "round 1" offshore sites, adjusted to reflect the height of wind turbines, at between 8.5 and 9.5 metres per second (around 18 mph).[21]

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19 Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L 283/33 (27 October 2001).

20 News Release dated 1 November 2003—see http://www.hmce.gov.uk/news/nat-nr-7303.htm

21 Garrad Hassan, *Offshore wind: economies of scale, engineering resource and load factors*, p. 27: see http://www.dti.gov.uk/energy/renewables/policy/garradhassanoffshorewind.pdf