Fells Associates
consultants in energy and environment

Practicalities of Developing Renewable Energy
Sub Committee II, Science and Technology Select Committee.
House of Lords
Practical steps needed to achieve a move towards renewable energy sources at rates proposed in the Energy white Paper.

Summary: The UK is unlikely to meet the 10% renewable electricity target for 2010, 6-7% will be nearer the mark. Engineering and financial constraints are the problem. It is wishful thinking to suppose that renewable electricity should, or could, replace nuclear power. In terms of security of supply and protection of the environment we need clean, secure energy, provided by as much renewable and nuclear energy as we can muster.

The Government's renewable energy programme, designed to provide 10% renewable electricity by 2010 and an "aspirational" 20% by 2020, is largely predicated on wind and biomass. It is already falling behind schedule with the 3% renewable electricity due to come on stream in 2003 not now likely to become available.

1. **Cost effective technologies**

No renewable electricity technology is cost effective compared with fossil generated electricity unless the environmental damage caused by burning carbon containing fuels is taken into account; "internalising the externalities" in the arcane language of the economists. A Carbon Tax would deal with this ("Economic instruments for the reduction of carbon dioxide emissions" Royal Society, November 2002, Policy document 26). In consequence, all renewable electricity technologies have to be subsidised one way or another. Those countries such as Germany and Denmark, with high rates of renewable electricity growth (wind and solar), subsidise most heavily. Not all costs are quoted, in the case of wind for example, costs of connection to national or local distribution grids systems (which can be substantial, £1m for 20 miles), provision of stand-by capacity where renewable supply is unpredictable and intermittent, decommissioning costs, removal of wind farm structures, access roads in environmentally sensitive areas, on or off-shore, are not included. The quoted generation costs for wind of 2-3p/unit on-shore and 5.5p, or more, off-shore, are consequently considered to be optimistic. (the current wholesale price of electricity is less than 2p/unit or kWh)

1.1 **Biofuels** such as wood, straw and so on, are quoted as 4-5p/unit for electricity generation. For transport, biodiesel costs twice as much to . . .

29 Rectory Terrace. Newcastle-upon-Tyne. NE3 1YB. Tel/Fax + 44 (0) 191 2855343
E-Mail ian@fellsassociates.com

manufacture as diesel from oil or gas, so that substantial reduction in the tax(or duty) levied on biodiesel compared with regular diesel has to be made if it is to be a profitable proposition. The same is true for bioethanol. The current reduction of 20p/l is not enough incentive to grow the business. (the EU requires that 5.75% of transport fuels will be biofuels by 2010). Biofuels are carbon dioxide neutral rather than carbon dioxide free.

1.2 **Marine Renewables,** wave,tidal stream and tidal barrages have been neglected in government policy but the matter is now being addressed; it will take time. There is only one wave device, Limpet, on the island of Islay, currently generating 130kW of an anticipated 500kW with a quoted generation cost of “over 5p/unit” (Wavegen). New devices are being tested.

1.3 Tidal stream systems are still very much at the first demonstration stage with a 300kW machine being tested off the North Devon coast of the UK (Marine Current Turbines Ltd), five years on costs are predicted to be in the 4-6p range. A system is also being tested off Shetland by The Engineering Business. Engineering still has to be developed to counteract the hostile environment of the North Sea.

1.4 Tidal barrages have real promise but require high capital input. The 240MW barrage at La Rance in Brittany, which has run for over 40 years is an example of what can be done. A barrage could be built across the River Severn and would generate 6% of UK electricity. It would take 12 years to build and would cost £12-15 bn. It would not need new technology to be developed. At an 8% discount rate it would generate at around 5p/unit, less after amortisation and would last for 100 years. Finance would probably have to be via a public/private partnership.

1.5 **Hydrogen** is often referred to as a renewable fuel but this is only true if it is made from renewable sources. It is a secondary fuel and has to be manufactured from fossil fuels such as methane, which puts carbon dioxide into the atmosphere. On the other hand it can be made by electrolysing water, but it is only “clean” if the electricity used for the process is renewable or nuclear. Neither process is very efficient but hydrogen can provide storage in compressed or liquefied form, which is important for intermittent renewables such as wind and wave. The hydrogen can then be used in a fuel cell to generate electricity and power a car. The notion that it could replace gasoline to any great extent is fanciful. Such a move would mean doubling the whole electricity generation capacity of the UK to produce the hydrogen. It is very expensive.

2 **Potential sites for renewable systems.**

2.1 Renewable energy such as wind and solar is dilute and variable. To meet the 20% aspirational target in the White Paper by 2020 requires between 400 and 500, 3MW wind turbines, each the size of the London Eye, to be installed offshore each year from now to 2020, that is 10 machines every week of each year. The construction and installation

industry is confident this could be achieved but it will require enormous investment in jack-up barges and heavy lifting gear. The number of installation vessels will have to be quadrupled immediately to meet even the 2010 target. The most the Danish offshore industry has achieved is to install 2 machines per week in the Horns Rev field in the North Sea. This can only be done during a 3 month window of opportunity during the summer.

2.2 **Biofuels** require considerable stretches of land to grow crops. To replace Dungeness B power station off the Kent coast (1200MW) would require the whole of Kent to be covered with coppiced willow to supply wood for several wood burning power stations of the same capacity. This take no account of the energy (diesel fuel) used to harvest and transport the wood, which is considerable.

2.3 **Marine Renewables** sites for Tidal Barrages have been identified in 6 places, wave and tidal stream sites have also been identified, with potential running to thousands of MWs. However, if the Islay wave machine were to be upgraded to 1MW it would require 5000 machines to replace Scotland's 2 nuclear stations, which provide 50% of Scotland's electricity. The capacity for construction of concrete works for marine renewables is available but industrial strength for manufacturing water turbines, frame structures, moorings etc, in any numbers, will have to be developed.
The biggest unknown factors are the cost and logistics of connecting renewable supplies, often in remote places or offshore, to the electricity grid network, which will have to be reconfigured to accept them. The question of "who pays", in a market led system, has yet to be resolved. The UK has the best firms in the world for laying undersea cables.

3 **Stand-by Capacity**. There are several periods during a year when the UK is covered by an anticyclone and there is no wind and often no waves as well. Danish experience suggests wind power falls to 1% of its capability for 50 days per year. At such times, which often occur during the winter, 100% back up is required. In Denmark, where 20% of their electricity comes from wind, which is where the UK hopes to be in 2020, back up is provided by coal-fired stations and connection to Norway, Sweden and Germany. The UK has one such connection to France, of 2000MW capacity, which is usually fully operational, bringing cheap nuclear power into the UK and could not be called upon in an emergency. Nuclear and gas-fired stations will have to provide this back up and operating stations only intermittently, when the wind is not blowing, is extremely expensive. Connection to Norway, Germany, Belgium etc could be an advantage but will also require substantial investment whilst leaving a large proportion of the UK's safe operating margin for electricity to the vagaries of the international trading market. Tidal stream and tidal barrage systems have entirely predictable power supply regimes but it will be some time before they can make any significant contribution.

4 **Milestones** are in place for the 10% renewable electricity target for 2010. The first, 3% by 2003, has already been missed. What penalties are to be exacted and on whom is unclear.

5 **Success.** It seems unlikely that the UK will meet the 10% target for 2010, 6-7% is the best that can be expected. Perhaps 10% by 2020 would be a better working figure, particularly with the increased electricity demand, which is expected over the next 16 years. The biggest constraint, bigger even than the engineering constraints, is the availability, or otherwise, of private sector finance for renewables. The fact that the "carrot" provided by OFGEM of renewable obligation certificates (ROCs) is not being seen as providing sufficiently reliable collateral to allow project finance to be secured, is the main problem.
If the Government is serious in its determination to reduce carbon dioxide emissions by 20% (on 1990) by 2010 and 60% by 2050 the only source open, other than renewables, is nuclear power. Nuclear power currently provides 23% of UK electricity, this figure will have fallen to 3% by 2020 as stations are decommissioned. If this capacity is replaced with gas-fired stations we have no chance of meeting Kyoto and subsequent obligations. A decision to replace these stations with new stations cannot be shelved until we see if renewables are going to save the day, as the White Paper suggests. Lead times in the nuclear power station building business are long.
The, much vaunted, improvements in the efficiency of energy use, flagged up in the Energy White paper, are notoriously difficult to achieve. The most sensible, and transparent, way of reducing the use of fossil fuels to minimise carbon dioxide emissions is by instituting a **Carbon Tax** whilst also developing a new indicator, under the auspices of OfGem, giving the carbon intensity of the generation mix across the UK. This could work well with the forthcoming EU emissions trading regime where emission caps will be imposed on generators and lower emission outputs will be credited with tradable certificates.

Security of supply and reduction in damaging carbon dioxide emissions, will not be achieved by leaving energy policy to the market place. But the market is a powerful tool and should be used as such. If a framework for electricity supply is instituted in which 10% is renewable, 30% gas, 30% clean coal (with carbon sequestration) and 30% nuclear then the market could work within that framework. Only 30% would then be gas-fired and the supply would also be cleaner than letting the market deliver 80% gas-fired electricity with 90% of the gas imported by 2020, as DTI anticipate.

For and on behalf of Fells Associates

Professor Ian Fells CBE FREng FRSE