The Parliamentary and Scientific Committee

INFORMATION FOR MEMBERS

From the

Parliamentary Office of Science and Technology

Briefing Note

32

February 1992

RENEWABLE ENERGY

Renewable sources of energy are receiving increasing attention as they emit less 'greenhouse' gases than fossil fuels and increase diversity and security of supply. Measures to encourage the development of 'renewables' are in place and are currently under review by both Government and Parliament[1].

This briefing note considers the potential of renewable energy technologies and factors affecting their implementation.

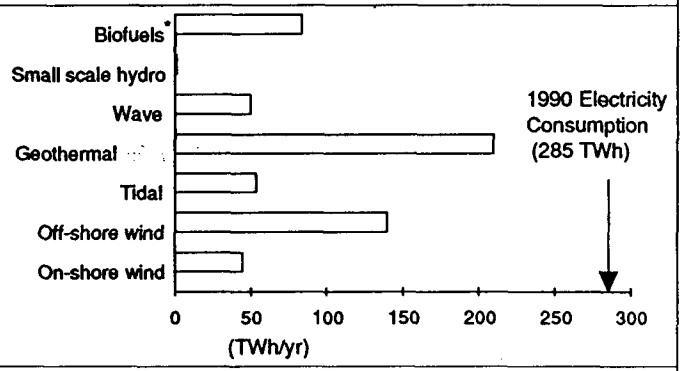
POTENTIAL AND CURRENT STATUS

The **theoretical** potential for renewable energy in the UK is very large. The Department of Energy (DEn) estimate that the upper practical limit of supply could be 585 TeraWatts (TWh) per year[2] (see Figure 1 for the potential from each source considered); this is over double the UK's electricity consumption for 1990 (285 TWh). The **actual** contribution made by renewable sources will depend on many factors - particularly the state of technology available, environmental considerations, and economic feasibility.

Wind turbines are a commercially proven source of renewable electricity with 8 MegaWatts (MW) of capacity already installed on land, and a further 220 MW planned at 58 sites over the next 2-3 years. Costs depend on the wind speed, and on the rate of return and payback period required for capital. A typical UK cost for a 20 year payback period and a 15% rate of return on capital is 6p/kWh. Denmark, which provided capital subsidies for wind turbines until 1989, now has 340 MW of installed capacity and plans to generate 10% of its electricity from wind power by 2000; the USA has 1600 MW of wind-generated capacity.

Wind power from off-shore sites is also feasible, and would be less likely to attract objections on amenity grounds. Off-shore turbines would take advantage of the higher windspeeds, but technical problems need to be overcome, and the DEn is funding a feasibility study for an experimental trial. Full scale demonstration projects for off-shore wind generators are under-way in Sweden and Denmark, where initial experience suggests that costs are currently 40% higher than on land.

Figure 1
THEORETICAL POTENTIAL OF RENEWABLE ENERGY SOURCES



*Assumes that biofuels generate electricity with the same efficiency as a fossil-fuel fired power station

Hydropower supplies about 2% of UK electricity demand, but the most promising sites have already been developed. Some small schemes could be economically exploited now; others where heads of water are under 3m, require further technological development.

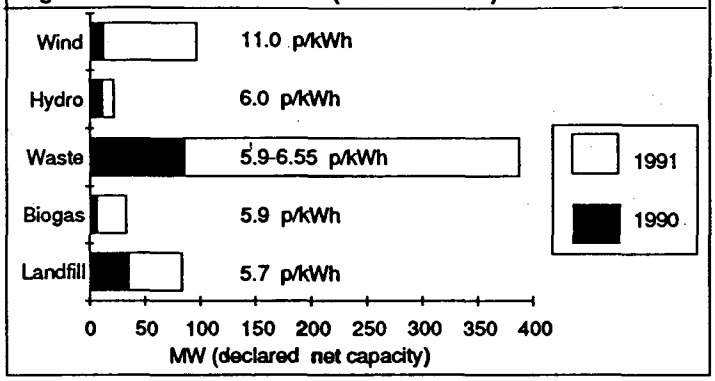
Biofuels may be regarded as 'renewable' since they utilise wastes (domestic refuse, industrial, agricultural, or forestry wastes, sewage etc.), or crops grown specially for energy purposes. Techniques to extract energy from biofuels include incineration, anaerobic digestion to produce gas, fermentation of sugars and starches to produce bio-ethanol for petrol, and heating (pyrolysis) to produce gas or liquid fuels. Biofuels provide 4% of energy used in the USA. Usage is much less in the UK (0.24%) and derived from waste incineration and by burning gas from landfill sites or sewage treatment. The economics are most favourable if the avoided costs of waste disposal can be taken fully into account.

Research into **solar cells**, which convert sunlight directly to electricity, has reduced costs three-fold in the last decade, and promises further substantial falls. Nevertheless, a recent Energy Technology Support Unit (ETSU) review for the DEn estimated that even good technical progress was unlikely to make generation for the UK grid economic (8-13 p/kWh). Panels of cells mounted on roofs or walls to supply electricity directly to a building might however be cost-effective (4-5 p/kWh). The same review forecast export sales of up to £700m a year by 2025 for solar cell systems supplying power in remote sites. One UK company (BP Solar) is the world leader in the development of a new low-cost type of cell, cadmium telluride.

1. The House of Commons Select Committee on Energy is conducting an enquiry into renewable energy which is expected to report in April; the Minister of Energy has also appointed a Renewable Energy Advisory Group.

2. Power output is measured in MegaWatts (MW) which is a thousand kiloWatts (kW). A typical fossil fuel powered station would be 500 to 2000 MW in size. A TWh is one billion units (kWh) of electricity, and would be produced by a 1000 MW plant operating continuously for 1000 hours.

Figure 2 NFFO CONTRACTS (1990 AND 1991)



The contribution of **solar energy** to heating and lighting a building can be maximised through careful design. When used in conjunction with energy efficiency measures, these 'passive' solar features can significantly reduce a building's energy need. The DEn estimate that energy savings worth £230m a year could be achieved by 2025 if designers were to incorporate such features in new buildings, but report a lack of awareness within the building design profession. 'Active' solar thermal collectors use the sun's rays to heat a fluid, typically water or oil, which can then be used to provide heating. Applications in the UK, apart from some specialist markets such as swimming pool heating, currently appear to be uneconomic with 20 years required to payback the investment.

Attempts to exploit the UK's considerable potential for wave power have had a mixed history. In the 1970s, DEn-supported research concentrated on designs for a large (2000 MW) off-shore wave generation station, but funding was stopped in 1982 when an economic assessment predicted costs of over 10p/kWh. The assessment is now accepted to have contained assumptions which overestimated the real costs (designers of the 'Salter Duck' floating generating device at Edinburgh University estimated costs of 5.2p/kWh). A further review by the DEn is underway and due to report early in 1992. Meanwhile, work has proceeded on smaller shoreline devices, and a prototype (based on an oscillating water column) is operating in a natural rock gully on the Isle of Islay. The potential for such shoreline devices in the UK is small (1 TWh/yr) but there may be a substantial overseas market.

Tidal energy can be obtained from estuary barrages, such as the 240 MW La Rance barrage in France which has been operating for 20 years. Industrial interest in the UK is centred on developing the Severn (8640 MW) and the Mersey (700 MW) estuaries. Barrages have a high capital cost, long construction period and long lifetime (120 years) so that generation costs are very sensitive to the accounting assumptions made. Thus electricity from the Severn Barrage (capital cost £10 billion (B) over 7-10 years) would cost 6.5 p/kWh at an 8% (typical public sector) rate of return, but 14.7 p/kWh at a 15% (typical private sector) rate of return; both with a payback period of 120 years.

Heat flowing outwards from the interior of the earth comes relatively close to the surface in some areas, and it may be possible to tap this **geothermal energy** by pumping water into the hot rocks and producing steam for electricity generation. A DEn-funded pilot project was set up in Cornwall in 1977, and by the mid-80s, the technology was seen as promising generation costs of 3-6p/kWh. Since then, the project has run into technical difficulties, and recent reviews estimate costs of 12-60p/kWh, largely dominated by drilling costs. Although the latter are still falling sharply, DEn have announced that funding will be reduced, from £2.6m in 1990/91 to £3.3m over the next three years, and efforts concentrated on collaborative European research.

CURRENT REGULATIONS

Renewable sources of electricity are encouraged via the Non-Fossil Fuel Obligation (NFFO), which requires the regional electricity companies (RECs) to distribute a certain proportion of electricity from nuclear and renewable sources. Until the end of 1998, NFFO electricity attracts a premium price which is financed by a levy on electricity generated from fossil fuel. The levy raised £1.25B in 1990/91, of which 98% went to support nuclear power and 2% to renewables. The Government plans to make orders for renewables under NFFO totalling 600 MW declared net capacity (DNC)[3] by 2000. In addition, it is expected that some schemes may proceed without NFFO support to reach a target of 1000MW by 2000.

NFFO contracts are secured by a competitive bidding process. Once the Government has announced its intention of issuing a new NFFO order, operators of renewable energy schemes submit proposals to the Non-Fossil Fuel Purchasing Agency, which acts collectively for the RECs. The Office of Electricity Regulation then advises which projects it deems viable after assessing the technical, economic, commercial and planning status of the proposals (termed the 'will secure' test). Those projects deemed viable are considered by the Secretary of State, who decides the final level and composition of the order, and the price that will be paid. The first bidding process resulted in an order for 102 MW DNC in September 1990 and the second supported 457 MW in November 1991.

Figure 2 shows the contracts to fulfill these two orders and, for the second order, the price each generating technology receives (the 'strike' price). Both orders were heavily oversubscribed; in the second order, 282 schemes bid for inclusion, 205 passed the 'will secure' test and 122 were awarded contracts.

The NFFO applies only to England and Wales but it is planned to introduce one for Northern Ireland in 1992.

3. The declared net capacity allows for the intermittent nature of some renewable sources.

In Scotland, an arrangement has existed since July 1991 to buy (until 1998) a set amount of electricity from 38 renewable energy projects (total capacity of 16MW) at a premium price of 5.3 p/kWh.

CURRENT ISSUES

Environmental Considerations

One of the perceived benefits of renewable sources is that they generate less atmospheric pollution (carbon dioxide, sulphur dioxide and nitrogen oxides) than fossil fuel generating stations. Some argue that these environmental benefits should be recognised financially, either by providing support for renewables or by ensuring that the price of fossil fuels includes the environmental costs of the pollutants produced. The NFFO scheme, which offers a premium price to renewable energy, can be seen as taking the first approach. The carbon and energy tax being proposed by the European Commission (EC) would be a step towards the second.

But renewable sources also have environmental impacts. Waste incineration can produce toxic emissions; wind farms can cause noise, TV and radio interference and visual intrusion on the landscape. Tidal barrages can lead to changes in the natural ecology of the estuary, particularly with regard to wading birds, migratory fish, and intertidal flora and fauna, as well as impeding the dispersion of water pollutants. Environmental organisations, while supporting an expansion in renewable energy, argue that it is important to assess critically the environmental impacts of renewable energy schemes, and to minimise them by careful design and siting of projects.

The EC Environmental Assessment (EA) Directive specifies projects for which an EA must be completed before decisions are made by planning authorities. The Directive applies to large thermal power plant (over 300 MW), but smaller plants (which includes most renewable energy projects) are only covered where they are likely to have a significant effect on the environment. There is thus some uncertainty over whether a developer should carry out an EA, and practice varies, as do the approaches taken by different local authority planning departments. As a result, environmental and local government organisations have suggested that national guidance on asessing planning applications should be provided, and a Planning Policy Guidance Note on Renewable Energy has recently been issued for consultation by the Department of Environment (DoE).

The position of wind turbines under EA legislation is not clearly stated in the relevant UK law which implements the Directive (The Town and Country Planning Act (Assessment of Environmental Effects), 1988). The DOE's guidance is that wind turbines are not covered by current EA legislation, but amenity groups believe that an EA should be conducted for such schemes. They point out that wind power has considerable potential for visual intrusion, since turbines must be spread out over a large area to catch the available wind. Many of the windiest (and hence the most efficient) sites are in exposed upland areas and coastal areas, including National Parks and Areas of Outstanding National Beauty. Some (e.g. the Countryside Commission) argue that wind turbines should not be sited in, or be visible from such designated areas, but developers argue that economic pressures under NFFO force them to consider the most profitable (i.e. windiest) sites.

The Non-Fossil Fuel Obligation

The NFFO has been welcomed as providing a protected market for an immature industry. However, after 1998, the wholesale 'pool' price applies which independent operators consider is too low to support most renewable projects. Operators are thus under pressure to recoup their investments by the 1998 expiry date. They argue that the NFFO premium price should be available for a period more typical of other financial investments (10-12 years), or for the technical lifetime of a project (typically 20 years); with the period of support beginning on the date of planning consent or commissioning rather than on the date of the NFFO order. A clearer indication from the Secretary of State of the intended size and timing of future NFFO orders would also assist in planning by the industry. In the longer term, continued support for renewables may depend on how far the full environmental costs of fossil fuel generated electricity are reflected in the generating price. Some argue that only when all such costs are properly included should renewables have to compete on their economic merits.

The 1998 deadline for NFFO payments followed an EC ruling that the premium price constituted unfair assistance to nuclear generators, and thus breached Community competition rules. The ruling was not targetted at renewable sources, and the Government has recently begun to discuss with the Commission a possible extension of the NFFO scheme specifically for renewables. The EC are believed to be sympathetic.

As mentioned above, Scotland's scheme for renewables limits support to 16 MW of capacity. As over half of the UK's potential for wind power is in Scotland, many in the industry view this provision as inadequate and see it as important that Scotland be fully integrated into the NFFO arrangements. Scotland currently exports excess power to England, so that extra capacity from renewables would require increased exports or reduced use of existing power stations. The amount that can be exported is presently limited to 850MW, although planning consent has been granted to upgrade the grid interconnector to 1600 MW (a 250 MW connection to

Figure 3
DEPARTMENT OF ENERGY EXPENDITURE ON RENEWABLES R & D

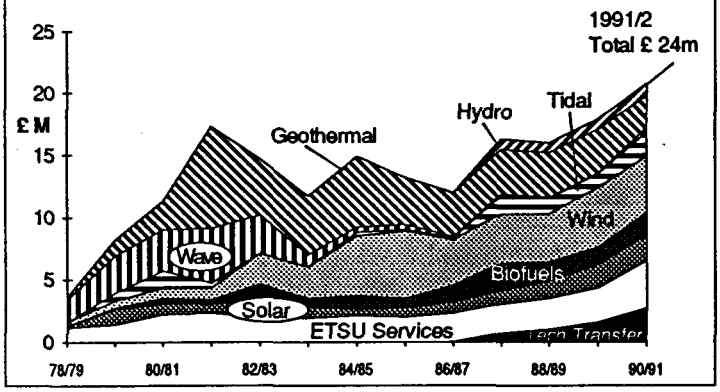


Table 1 TARGETS FOR WIND ENERGY

Country	Target	Year	% of grid capacity
Netherlands	1000 MW	2000	6%
Denmark	10% of electricity demand by 2000		
Italy	600 MW	2000	1.0%
Germany	250 MW	1995	0.2%
Greece	400 MW	2000	4%
Spain	90 MW	1993	0.2%
UK - all renewables	1000 MW	2000	2%

Northern Ireland is also planned). Some (e.g. the Watt Committee) believe that even the larger link will be inadequate to allow full development of renewables in Scotland. However others believe that sufficient existing plant will be retired over the next 10 years to accomodate an expansion in renewables.

Some independent generators are concerned that NFFO discriminates against small projects through the complexity of the bidding process, and because fixed costs such as arranging financial backing and carrying out EAs have a disproportionate effect on the generating costs of small projects. They suggest that NFFO arrangements should be simplified for small projects. Neither does NFFO provide any reward for harnessing heat as well as electricity. There is thus an economic incentive in combined heat and power schemes based on renewable sources (e.g. waste incineration) to maximise electricity generation rather than produce the most efficient combination of heat and electricity.

Very large projects such as the Severn and Mersey Barrage do not fit well with the current NFFO scheme - both because they could not be completed before the 1998 deadline, and because they would swamp the 600 MW NFFO renewables target. Independent experts and developers doubt that it will be possible to fund such schemes in the private sector because of the large capital costs and long lifetimes involved and consider that some form of public support may be required.

Targets for Renewables

The Ministerial Renewable Energy Advisory Group is reviewing the current target of 1000 MW by 2000, which is now accepted to be unambitious given the large potential of UK resources (e.g. other EC countries, with a smaller wind resource, have set the targets in Table 1). The target is thus likely to be increased, particularly since the DEn estimated in 1988 that up to 20% of the UK's energy supply might be derived economically from renewable sources by 2025. A more ambitious target, or a national energy strategy encompassing renewables would recognise the environmental benefits and diversity of supply that renewables offer, as well as helping to stimulate market development and R&D.

Research, Development and Demonstration

The DEn supports R&D on renewable energy with the aim of encouraging the commercialisation of economically attractive technologies, and of reducing the economic and technical uncertainties in promising new technologies. Funding since 1978/9 is shown in Figure 3, and is currently planned to be phased out by the end of the 1990s. Other countries have sizeable R&D programmes (e.g. $270M in the USA for 1991, $105M in Germany for 1990, and $55M for Italy for 1990).

The level of support for renewables R&D has been contrasted with the support for nuclear R&D by *inter alia*, the Commons Energy Select Committee (in 1991 nuclear power accounted for 62% of the DEn's R&D funding, and renewables 11%). The Government has pointed out that each energy technology requires a different level of investment for R&D and commercial development. However, supporters of renewable energy argue that long term support for renewables R&D should be increased, particularly as some technologies (e.g. off-shore wave power) still require several years of research before deployment would be possible. Some (such as the House of Lords Select Committee on the European Community) see a need for a specific body or agency with responsibility for renewables development, as in the USA where the National Renewable Energy Laboratory has a budget of $125M per year. While ETSU would be a logical centre for such a body, some feel that it should become completely separate from the UK Atomic Energy Authority if it is to discharge an enhanced role. An important function would be to ensure better co-ordination between Departments, such as DEn, MAFF, DOE and DTI, all of which have an interest in renewables.

FURTHER READING

Additional details and background information are available from POST, 2 Little Smith St., London SW1P 3DL, tel: (071)-222-2688.

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