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Electricity Association

Environmental Briefing

Renewable Electricity in the United Kingdom

Sustainable Power - at a Price

What is Renewable Electricity?

Renewable electricity is derived from sources which are considered sustainable - i.e. their use does not deplete a non-renewable resource. Renewable sources include rivers, the sea, wind, the sun, heat from inside the earth and sustainably grown crops. The Government also includes electricity derived from municipal waste within its renewables programme.

In the UK today, renewable sources provide about 2-3% of total electricity generation. As part of its response to the climate change commitments agreed at Kyoto in 1997, the Government has proposed a target to nearly quadruple the amount of UK electricity to be generated from renewables during the coming decade. This Briefing provides an overview of recent developments affecting renewable electricity in the UK.

Why use Renewable Electricity?

Over 97% of UK electricity was generated from coal, natural gas, oil and uranium in 1998. These forms of generation are currently more economic than most renewable energy but pose important concerns for the environment such as emissions, wastes and long-term sustainability (see other *EA Environmental Briefings*[1]). In contrast, generating electricity from wind, water and the sun largely avoids such consequences. Substituting these or other low-emission renewables for existing fossil fuel capacity contributes to meeting national and international emissions targets while, in parallel, increasing the diversity of supply in the UK energy market.

In the 1993 Coal Review White Paper, the Government set a target of 1,500 MW of new renewable electricity generating capacity (i.e. excluding the large-scale hydro schemes in Scotland and Wales) by the year 2000; at June 1999, there was about 815 MW. Following its election in 1997, the Labour Government proposed an even more challenging target, to use renewable technologies to produce 10% of the country's electricity by 2010, with 5% by 2003. This target links directly to the strategy for meeting the UK's international climate change commitments and to the national target of reducing CO_2 emissions by 20% (from 1990 levels) by the same year, and was included in the Government's Draft UK Climate Change Programme published for consultation in March 2000.

[1] No. 3, Acid Rain; No. 5, Nuclear Power; No. 17, Climate Change; No. 23, Sustainable Development

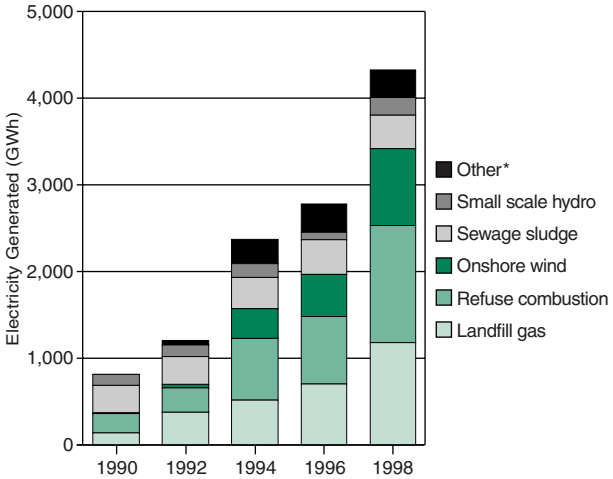
[2] New and Renewable Energy: Prospects for the 21st Century, DTI, 1999

The Challenge for Renewable Electricity

Certain characteristics of renewable energy resources, however, pose barriers to their widespread adoption. Most renewables are diffuse. For example, utilising wave power would require around 300 km of wave energy devices to supply 20% of UK electricity needs. The output of some renewables also tends to be variable and to a degree unpredictable. The electricity system as a whole therefore has to provide stand-by generation capacity or energy storage to ensure supply stability. Nevertheless, it has been estimated that up to 20% of UK generating capacity from the variable output of wind plant could be absorbed within the current UK network.

The relatively small share of renewable electricity capacity in the UK to date stems from its economics, particularly the high capital costs of the plant, and the difficulties faced in obtaining planning permission. However, capacity and output have grown significantly in recent years as a result of research and development, and increasing design replication (see Figure 1). The costs of electricity from renewables have fallen with, in particular, wind power, energy from waste and landfill gas now approaching the prices of other forms of generation.

Figure 1: Renewable Electricity Generated (excluding large scale hydro)



* 'Other' includes farm waste digestion, tyre combustion and poultry litter combustion

A Government consultation paper[2] estimated the UK's accessible renewable resource by 2025 to be over 250,000 GWh pa (cf. Figure 1) at prices below 5 p/kWh (cf. Table 2). Around 60% of this would be onshore and offshore wind, with energy crops, agricultural/forestry wastes and wave power as the other main technologies.

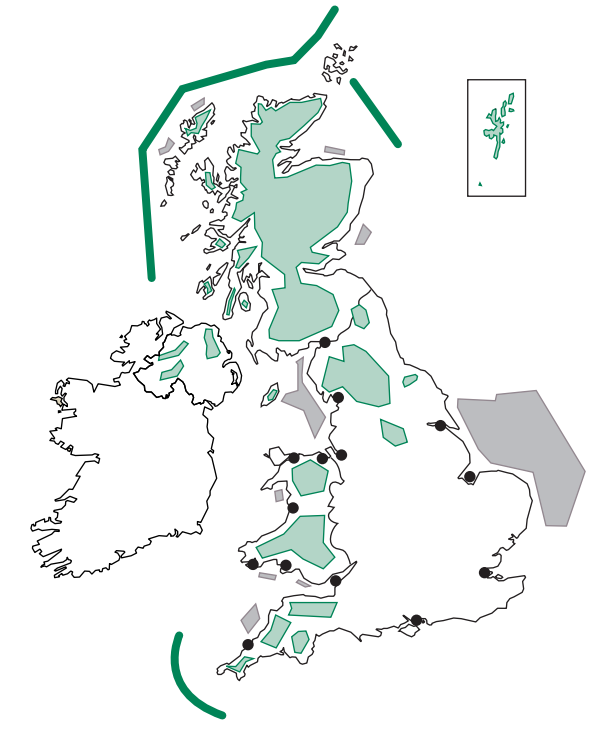
Power from Water

Hydro-electricity. In 1998, around 56% of UK renewable electricity (nearly 1.5% of total electricity) was generated by hydro-electric schemes. These are mostly long established large scale projects (over 5 MWe) in Scotland and Wales which use water from high level reservoirs maintained by natural catchment areas. The topography and hydrology of the country limits the potential for further such schemes and today it is the opportunities for small scale hydro-electric schemes (below 5 MWe) that are being investigated.

Tidal energy. The high tidal ranges on the west coast offer substantial potential capacity from tidal energy (see Figure 2) and studies have considered the engineering, environmental and economic feasibility of tidal barrages on rivers. It has been estimated that a barrage on the Severn could generate around 17 TWh pa, or around 5% of current UK electricity supply, or one on a river such as the Mersey 1.5 TWh pa[3]. Research has also examined the potential environmental effects of such schemes on wildlife as many estuaries are important to bird and fish populations. The economic studies however do not yet favour commercial development of tidal energy.

Wave energy is also a potentially large resource (see Figure 2), but a review[4] of its feasibility in 1992 concluded that it would not be economic in the short to medium term. An experimental prototype of an oscillating water column device off Islay was nevertheless run between 1991 and 1998, and it was announced in 1999 that two new wave projects were being given official backing in the third Scottish Renewables Order.

Figure 2: Wind, Tidal and Wave Power Areas in the UK



[3] An Assessment of Renewable Energy for the UK, ETSU, 1994
[4] A Review of Wave Energy, ETSU, 1992
[5] Waste Strategy 2000 for England and Wales, DETR, May 2000

Power from Biofuels

In 1998, biofuels accounted for 35% of renewable electricity generation in the UK, mainly from landfill gas and municipal waste combustion.

Landfill gas. Waste buried in landfill sites decomposes gradually to produce CO_2 and methane. Collecting landfill methane and burning it in either reciprocating engines or turbines to generate electricity is commercially viable, and accounted for 13% of renewable electricity in 1998. It reduces emissions of methane, which is some 30 times more powerful as a greenhouse gas than CO_2. Growing pressures to reduce landfill and the proportion of biodegradable waste will limit the future availability of landfill gas.

Energy from burning municipal waste, for electricity generation or combined heat and power, is economically attractive, providing 14% of renewable electricity in 1998. Landfill is used for the disposal of around 85% of municipal solid waste in the UK, but increasingly stringent regulation is resulting in higher costs and pressures to incinerate a greater proportion of waste. Although the Government waste strategy[5] requires that preference should be given to waste minimisation, recycling and re-use, it accepts that where it does not make sense to recycle waste, consideration should be given to using it as a fuel. Green campaigners are concerned that Government's inclusion of waste incineration in the renewables programme displaces more benign renewables, while local objectors to schemes sometimes cite potential emissions from burning some constituents of unsegregated waste, although emissions have to be controlled within limits set by EU Directives on waste incineration.

Other wastes. The energy produced by incineration of dry agricultural and forestry wastes can be used to provide heat and power. Other technologies use sewage (4% of UK renewable electricity in 1998), organic wastes and wet agricultural wastes to produce methane, which can be used in a similar way to landfill gas.

Energy crops, grown specifically for burning (e.g. willow and poplar coppice) or conversion into other fuels (e.g. oil seed), offer substantial potential in the medium term, helped by the increasing availability of 'set-aside' land under the reform of the EU's Common Agricultural Policy. The first UK projects are now operating to assess their commercial feasibility. Although carbon dioxide is released on combustion, there is no net increase in atmospheric concentrations, as the crop is continuously absorbing CO_2 during growth.

Power from Wind

Wind power is among the more developed and promising renewable energy technologies for the UK, providing over 9% of UK renewable electricity in 1998 from turbines located onshore, mainly in upland areas (see Figure 2). It is technically possible that onshore wind power could provide 10% of the country's current electricity needs by 2025. Development has resulted in larger turbine capacities, with the UK's first 1.5 MW turbine becoming operational in 1999. Prospectively, offshore wind is attractive given the scale of the UK resource and its more limited environmental impacts. Generation costs will be higher and operating conditions will be much more severe than onshore plant.

Wind farms are not free from environmental impacts. Problems include their visual impact and the risk of bird collisions. Careful consideration needs to be given to such environmental factors during design and planning in order to minimise the impacts.

Power from the Sun

Photovoltaics (PV) generate electricity from light energy by means of special semiconductors, and recent developments have greatly reduced their costs. World PV markets are expected to grow substantially, particularly in developing countries lacking a widespread electricity grid, and UK companies are becoming major players in this market. Application in the UK is mainly considered in terms of systems mounted on, or integrated into, building exteriors and widespread use in this way could substantially reduce costs.

Photoconversion technologies, which convert sunlight into electricity, heat or chemical fuels via chemical or biological processes, are potentially cheaper than PV but are still at the research stage.

Support for Renewable Electricity

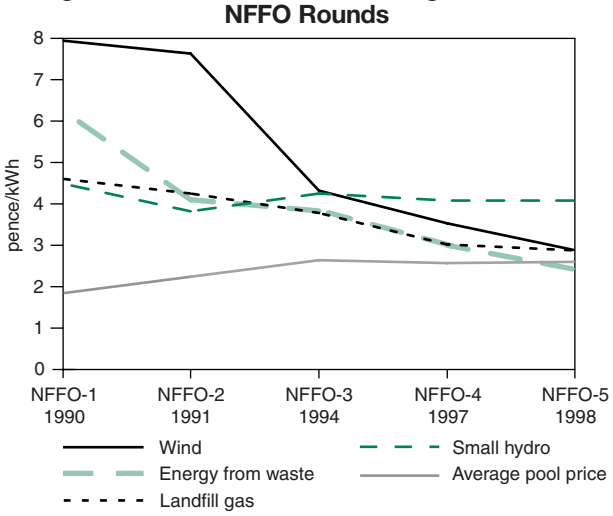
As most renewable energy technologies are unable to compete directly on cost with conventional generation techniques, Government supported projects between 1990 and 2000 via the Non-Fossil Fuel Obligation (NFFO). The Electricity Act 1989 gave the Secretary of State powers to effect Orders requiring public electricity suppliers to purchase energy from renewable sources over a specified period. There have been separate Orders in England and Wales, Scotland and Northern Ireland (see Table 1). Potential generators were able to propose projects in any of several technically designated categories. A competitive bidding process reduced the cost of renewables so that, over time, they moved towards the commercial generating market (see Figure 3). By 1998/99, the negotiated prices for some technologies were approaching the wholesale prices of other forms of generation (see Table 2).

Table 1: Summary of Renewables Orders

Orders	Contracted projects		Projects operational at 31 March 2000	
	Number	Capacity MW	Number	Capacity MW
England and Wales				
NFFO-1 (1990)	75	152	61	145
NFFO-2 (1991)	122	472	82	174
NFFO-3 (1995)	141	627	73	251
NFFO-4 (1997)	195	843	51	113
NFFO-5 (1998)	261	1,177	16	24
Scotland				
SRO-1 (1994)	30	76	13	32
SRO-2 (1997)	26	114	3	7
SRO-3 (1999)	53	145	-	-
Northern Ireland				
NI NFFO-1 (1994)	20	16	13	15
NI NFFO-2 (1996)	10	16	5	3
All renewables obligations	**933**	**3,639**	**317**	**762**

The higher costs of the NFFO renewables were met through a *fossil fuel levy*, raised by a charge on all electricity consumers. This was redistributed to those suppliers who purchase NFFO electricity to make up the difference between the pool price of conventional generation and the price agreed for the renewable supplies. This support amounted to around £130 million in 1998/99. The first two renewables Orders provided support to projects for eight years while the subsequent Orders are offering support for 15 years.

Figure 3: Reduction in Generating Costs over NFFO Rounds



NB: Data adjusted to allow for shorter contract lengths in NFFO-1 and 2
Source: New and Renewable Energy - Prospects for the 21st Century, DTI

Table 2: Prices for Recent Renewables Orders

Technology	Number of projects contracted	Capacity of projects contracted MW	Average contract price p/kWh	Range of contract prices p/kWh
NFFO-5 (1998)				
Landfill gas	141	314	2.73	2.59 - 2.90
Energy from waste	22	416	2.43	2.39 - 2.49
Energy from waste using CHP	7	70	2.63	2.34 - 2.90
Small scale hydro	22	9	4.08	3.85 - 4.35
Onshore wind energy >0.995 MW	33	340	2.88	2.43 - 3.10
Onshore wind energy <0.995 MW	36	28	4.18	3.40 - 4.60
Total	**261**	**1,177**	**2.71***	**-**
SRO-3 (1999)				
Energy from waste	16	49	2.79	2.64 - 3.14
Small scale hydro	5	4	3.49	3.40 - 3.59
Onshore wind energy >0.995 MW	11	63	2.02	1.89 - 2.19
Onshore wind energy <0.995 MW	17	14	3.06	2.63 - 3.38
Biomass	1	13	4.69	-
Wave	3	2	6.62	5.95 - 7.00
Total	**53**	**145**	**2.72**	**-**

* Average cost of generation under NFFO-5 of 2.71 p/kWh compares with the average Pool Selling Price in 1998 of 2.60 p/kWh

Current Prospects

The likelihood of delivering the target of 10% renewable electricity by 2010 depends in particular on the continuance of an economic support mechanism and on resolving the planning and network issues for renewables projects. Table 1 shows that 81% of contracted NFFO-1 projects were operational by March 2000, compared to 67% for NFFO-2 and only 52% for NFFO-3 (each of these Orders has completed the project development phase).

The costs of conventional generation will also affect the prospects for renewables. It is expected, for example, that the New Electricity Trading Arrangements (NETA) will have the effect of lowering costs.

Replacing the NFFO. Changes to the industry under the Utilities Act 2000 mean that the NFFO regime will no longer be feasible (although existing NFFO contracts will be honoured).

The Government is proposing to place a statutory obligation on electricity suppliers to purchase a certain percentage of their electricity from renewable sources. Suppliers can meet their obligation by any combination of:

- purchasing renewable electricity directly
- purchasing green certificates for renewable electricity provided by another supplier
- paying a buyout price to Ofgem (which will redistribute the funds among electricity suppliers).

The buyout option (suggested to be around 2 p/kWh) will effectively put an upper limit on the extra cost of the renewable obligation which electricity customers will be expected to bear.

Other support. A number of electricity suppliers have introduced 'green' tariffs to allow customers to support renewables directly. Such tariffs, generally at a premium rate, are used either to support existing renewable projects, notably many of the earliest projects whose NFFO support has now expired, or to create a fund to promote the development of further renewables. The Energy Saving Trust, on behalf of the Government, has established the 'Future Energy' scheme which can accredit green tariffs, and is designed to promote customer confidence in them.

In 1999, the Chancellor announced a Climate Change Levy to start in 2001 on most energy used by business, with a rate of 0.43 p/kWh for electricity. It is proposed that electricity from renewable sources (other than large hydro plant) will be specifically exempted from the levy, and some levy funds will be recycled to support developing renewable technologies. The levy will therefore help renewables compete with conventional generation.

The UK Government spent around £80 million on renewables research and development between 1994 and 1998. In parallel, the European Commission has introduced a number of funding programmes such as ALTENER to encourage renewable energy R&D and will be pressing for further implementation of renewable projects. The Commission has also been developing a directive to set targets for and promote renewables development, within the context of increasing the share of gross (inland) energy consumption throughout the Union from 6% to 12% by 2010.

Planning issues. The environmental impacts of renewable projects and the views of local communities are considered through the processes of either Town and Country Planning for smaller schemes, or Section 36 consents under the Electricity Act 1989 for projects over 50 MW. The acceptance of a project under a renewables Order did not bypass the planning system or guarantee its eventual implementation. In particular, concerns over the visual impact of wind turbines on the landscape and local objections to municipal waste burning plants caused a decline in the completion rate for such projects between the first and later renewables Orders. Recognising that planning delays could prejudice its targets, the Government is developing guidance for local authorities with the aim of removing delays due to uncertainties in the application of planning procedures and policy. Renewable developers now seek to encourage local involvement and support at an early stage of proposals.

Network issues. The generally small scale of renewable projects means that most operate as 'embedded generation', feeding into local distribution networks rather than the national transmission system. This can potentially provide benefits by reducing overall transmission losses and may, in some instances, help defer system reinforcement. Such generation can however cause switchgear and transformer ratings to be exceeded, so that replacement is needed. The impact of swings in import/export flow on the quality of the electricity supply, particularly given the ever wider use of sensitive electronic equipment such as computers, means that there are limits in each part of the network to the amount of embedded generation which can readily be absorbed.

It is generally considered that the 10% share for renewable generation by 2010 will not require major changes to the management or design of the overall network. However, the existing arrangements of transformers, safety systems and quality control systems were designed primarily for energy flowing from large scale generators through the national transmission network, feeding into local distribution networks and on to the end users. A long term increase in renewable generation, and other forms of embedded generation such as CHP, will increasingly require changes in the networks together with, perhaps, new forms of energy storage and back-up generation. The full nature, extent and likely cost of these changes are as yet unclear.

Summary

- ❑ The Government has proposed a target of 10% of UK electricity from renewable sources by 2010; 2.6% of electricity was generated from renewables in 1998.
- ❑ Increased use of renewable energy resources helps progress towards energy sustainability and diversity and reduces pollutant emissions, particularly CO_2 which is the major contributor to global warming.
- ❑ Under present market conditions, new sources of renewable energy are rarely economic. The Non-Fossil Fuel Obligation has helped renewables move towards commercial viability, and Government is now developing new mechanisms to support their further expansion.
- ❑ Local environmental concerns associated with renewables can conflict with national environmental objectives. The Government is seeking to address this through improved planning guidance.
- ❑ A significant increase in embedded generation will require adaptation in the design and operation of the electricity system.

EA *Environmental Briefing* is a publication of the electricity industry to improve understanding on environmental issues.

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