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Irish National Paper

Ireland and

New and Renewable Sources of Energy

IRELAND AND NEW AND RENEWABLE SOURCES OF ENERGY

1. Ireland is an island in north-west Europe, lying between 51° and 55° N latitude and 5° to 10° W longitude in the northern temperate zone. It has a total coastline of some 3,170 km, of which 1,500-2,000 km face the northern Atlantic Ocean to the west, and are touched by the warm waters of the Gulf Stream drift.

2. Ireland's climate is uniform - the sea is never further than 110 km away; winters are mild, summers relatively cool. Rain is well distributed by prevailing westerly winds and averages 970 mm per annum. Temperatures average 4°-7°C in winter and 14°-16°C in summer but may reach 21°-24°C. The topography is a flat central plain surrounded by coastal highlands. The longest river is 370 km long.

3. This paper relates to Ireland excluding Northern Ireland. The area of Ireland, exclusive of Northern Ireland, is 70,282 sq km and the population nearly 3.5 million, giving a population density of one person per 2 hectares.

4. Ireland is a country deficient in conventional energy sources with very limited coal reserves and no indigenous oil although hopes are high that commercial fields may be proven in the next few years. Indigenous hydroelectric power was developed early on, the first station on the river

Shannon being built in 1927. Development of the other recognised indigenous source of energy, peat, did not advance significantly until state intervention took place in 1933 at a time when development was not clearly economic.

5. The primary energy supply mix in 1960 was 30% each from peat, coal and oil, the balance coming from hydro-electricity (figure I). By 1978 75% of Ireland's total primary energy (TPE) came from oil; the contribution from peat and hydro-electricity had remained static and that from coal had declined. Between 1960 and 1978 Ireland's TPE consumption rose 85% to 7.69 million tonnes oil equivalent (MTOE), largely accounted for by increased imports of oil. The rate of increase between 1973 and 1978, however, averaged only 2% per annum.

6. The current level of Ireland's TPE consumption is very low when compared with other West European countries and the per capita consumption is also low. In this regard Ireland occupies an intermediate position between developed West European countries and the majority of developing countries. This intermediate position reflects Ireland's relatively late industrial development when compared with other European countries, and unlike the latter, energy consumption is expected to grow significantly in future years in line with industrial development. This position is shared with many developing countries.

7. In 1979 an off-shore gas field with reserves of some 30 billion cubic metres came into production, giving a small increase in the indigenous contribution to TPE. Nontheless, apart from being heavily dependent on one primary fuel (oil), the significant fact concerning Ireland's TPE is that over

80% is imported. In order to reduce the country's dependence on imported energy a vigorous search for off-shore hydrocarbons is under way. At the same time it is recognised that there is good potential in Ireland for new and renewable sources of energy and research and development work has been under way for a number of years.

8. Up to the present time (1981) the development or supply of energy in Ireland has been left to private or independently run energy agencies. The formation of the new Department of Energy in early 1980 reflects the importance now attached to energy matters and will enable central direction to be given to energy policy as a whole and towards demonstrating and implementing new and renewable sources of energy in Ireland.

9. A coordinated programme of research and development into certain new and renewable energy sources was brought into being following the 1973 disruption of oil supplies.The State's expenditure in 1980 on the various research, development and demonstration (R, D and D)programmes on peat and new and renewable energy systems which have potential in Ireland is as follows:

	IR£000's
Peat	252
Wind	127
Biomass	485
Ocean Power:	
-wave and tidal	254
Solar energy:	
-thermal, both active and passive	56
-photovoltaic	35
-photochemical	-
Small hydro	-
Geothermal energy	11

10. R, D and D programmes in Ireland on new and renweable energy sources involve the following stages:

(a) Assessment of availabliity of the resource
(b) Determination of the technical competence available
(c) Research, design and construction of a pilot scheme
(d) Design and construction of a demonstration scheme
(e) Carrying out of integration studies
(f) Large scale implementation.

The current position (end 1980) for each system is shown in Table 1.

11. It can be seen from Table 1 that only peat has reached the large scale implementation stage. This was reached in the 1940's after many years of developmental work, and development has continued up to the present. Of the other systems, those considered to have the greatest potential for Ireland are wind power and biomass in the medium term and wave power in the long term, although all those listed should make some contribution.

PEAT

12. Owing to the very limited reserves of coal, wood and natural gas and absence of indigenous oil reserves in Ireland, peat resources have been developed as the principal indigenous source of energy. Building on the knowledge accumulated by many pioneer peat producers during the past two centuries progress in increasing high quality peat production to its present level accelerated rapidly with the setting up by the Government of Ireland in 1947 of the semi state Irish Peat Authority (Bord na Mona - BnM). BnM was established to develop the peat production industry throughout the country in an economic and efficient mannner.

13. Whilst the reputed area covered by peat is some 1,095,600 hectares, the actual area considered to be deep or large enough for viable production units is about 80,000 hectares, taking into account present production methods and present competitive fuel prices. With the growing importance of peat as a fuel, however, some areas hitherto considered not viable might tend to become so with the increase in the cost of alternative imported fuels.

14. With some minor exceptions the methods of production in use centre around the following:

15. Machine Sod Peat - The traditional method of hand cutting peat is still practised widely in Ireland for domestic use by people requiring fuel near to peat areas (bogs). Nowadays about 800,000 tonnes per year of machine sod peat are produced by BnM using large fully automatic machines. Output varies from five to ten tonnes of dry peat per hour during about 2,000 hours cutting operation from April to July each season. Co-operatives and private firms also produce a substantial quantity. Air drying of the spread, wet peat takes place from April to late Autumn usually. A sod of dry, machine produced peat measures about 25 x 7 x 7 cm. These sods, about 320,000 tonnes/year, are used in electric power stations of the national electricity utility. The total installed capacity of these sod peat stations is 120,000 kW. The remaining 480,000 tonnes of sod peat are sold to industrial (150,000 tonnes) and domestic outlets (330,000 tonnes). The industrial sod peat is in some cases broken into pieces of about 5 to7 cm diameter to suit mechanical stokers.

16. Machine sod peat made for the above purposes is machine macerated - i.e. thoroughly mixed - after excavation and prior to being spread on the bog surface to dry naturally - and this maceration has the most important effect of promoting sod shrinkage, densification, irreversible drying and resistance to transport breakage. The calorific value at normal 35% moisture content is 3,500 Kcal/kg.

17. Milled Peat - The largest production of peat in Ireland is in the form of milled peat - i.e. peat which is cut from the surface of the peat bog in layers about 12mm thick into small pieces by fast rotating spiked drums. During suitable weather this dries in a few days to 55% moisture content or

less and is collected into long large piles beside railway lines. The peat is then loaded and transported to electric power stations or briquette factories as required. Some of the lightest quality milled peat is diverted to horticultural peat packaging plants.

18. Some 3,000,000 tonnes of milled peat goes to power stations per annum (of 330,000 kW installed capacity) and 900,000 tonnes to three briquette factories (360,000 tonnes per annum briquettes). One more briquette factory will be in production shortly (1981) and two more are planned to start production in 1984 and 1987.

19. Briquettes from milled peat contain 10% moisture, about 1% to 3% ash, and have a calorific value of about 5,300 Kcal/kg.

20. Horticultural Peat - BnM operates two Works for the production of horticultural sphagnum moss peat. A third Works is planned. This material is of low density, high water absorption and is greatly desired by horticulturists for soil improvement to give higher and better crop yields and to increase soil humus. It is not used for fuel purposes.

21. Reclamation of Bog Cutaways - After all the recoverable peat has been removed from a bog BnM prepares the cutaway area for other uses. These include the growing of biomass for energy purposes (described later in this paper paragraph 30) or other agricultural uses. This work is still at the R, D and D stage but will become of greater significance and extent as more bogs are exhausted in the future. Some 1,000 hectares are under reclamation at present.

22. Production of fuel peat per annum by BnM at present amounts to some 880,000 TOE, worth at least IR£200 million at 1981 prices. Some 16% of the national electricity requirements are generated from peat.

WIND

23. Ireland is considered to be well positioned to make use of wind power due to the relatively constant wind regime and relatively high mean wind speeds encountered across the county (Table 2 and Figure II). At present there are very few wind turbines in use and as yet wind power makes no real contribution to the country's energy supply. It could have a great impact, however, because of the relatively low energy demand and low population density in Ireland.

24. Several distinct market areas are foreseen for wind power. Notably water pumping for supply, irrigation or drainage; water heating by direct mechanical action; or electricity generation, whether by large units owned by utilities, or small to medium sized, private units.

25. At present there are no agreed national projections on the future contributions of wind energy to energy supply. One of the first tasks of the R, D and D work which the government is actively encouraging is to develop such projections as detailed data becomes available. It is expected that wind turbines generally will have to fulfill normal commercial criteria before making any impact on the energy supply situation. Exceptions may arise in the case of remote communities which occur particularly to the west of the country and in offshore islands; regions where the wind regime is most favourable.

26. Ireland has a demonstration programme in progress organised by the Department of Energy directly and through the State owned electricity utility (ESB). In this programme eight or ten small to medium sized (10-120 kW) commercially available machines will be erected. A range of different machines will be tested, each of them fully instrumented in a variety of locations chosen for their differing wind regimes, each machine serving a different purpose.

27. The programme is intended to demonstrate the present status of the various designs of small wind turbine generators and the energy potential of these machines under Irish conditions. The general experience thus gained, together with the particular experience of operating problems associated with interconnection of these machines and the electricity network, will give training and experience which will enable Ireland to progress smoothly to large machines currently under development elsewhere in the world. At the same time the programme is expected to increase public awareness of this renewable source of energy.

28. There is a limited manufacturing capability for wind machines in two Irish companies at present. On the research side theoretical studies using statistical methods have been undertaken on the effect of introducing large scale wind power into the grid. Some fundamental aerodynamic analysis has been carried out including a novel design for a balloon-borne wind generator.

29. Internationally Ireland participates in International Energy Agency (IEA), United Nations (UN) and European Economic Community (EEC) discussions and R, D and D programmes. Thus international activities in wind power are monitored and Ireland participates in international developmental work.

BIOMASS

30. The term 'biomass' encompasses essentially all growing plant material, ranging from trees, cereals and root crops to algae, either purpose grown or else waste material resulting from other activities such as forestry. It is generally recognised that purpose-grown biomass is best for energy purposes. Ireland is interested in purpose grown forest biomass but can also make use of forest wastes and agricultural wastes such as pig and cattle slurry.

Forest Biomass

31. Ireland is particularly well suited for the production and utilisation of forest biomass as a source of energy. Firstly the climate is appropriate for the quick growing of many species of both hard and soft woods. The country was originally heavily forested but was denuded in the 18th and 19th centuries. Secondly there is a broad experience in Ireland of commercial agriculture and specific experience in traditional forestry. This experience relates to planning and planting new forests and therefore results in efficient, high yielding plantations. Thirdly, for over thirty years substantial quantities of electricity have been generated from peat, either milled or sod peat, a material very similar to wood with regard to transportation and combustion. Finally the low population density of Ireland means that there are large areas of land available for the establishment of forest. In particular, as peat is harvested for use in adjacent electricity power stations the remaining cut-away bog has potential for afforestation.

32. Forest biomass produces fuels particularly applicable in Ireland. As a solid fuel, wood can be used domestically or to produce industrial heat or electricity. It can also be gasified and, in the longer term, liquified for use as a transport fuel.

33. Since 1976 an active research programme into forest biomass for energy has been carried out. Initial work at the Irish Agricultural Institute (AFT) concentrated on finding species most appropriate to Irish conditions. This work progressed to sylvicultural trials to establish the optimum conditions for growth in different locations, consideration of harvesting systems and tests on the burning properties of woods produced. Together with this practical work the programme included economic and systems analysis studies of forest biomass energy, including land use.

34. The above programme has now been superceded by a IR£9.2 million demonstration programme operated by the Irish Peat Authority (BnM) and drawing upon services from AFT, the Forest and Wildlife Service and the ESB. Under this demonstration, 400 hectares of short rotation forestry (SRF) and 200 hectares of single stem forestry are being established, a harvester for the former is being designed and built and existing electricity generating boilers are being adapted in order to burn the resultant biomass. This project will be completed in 1985 and it is expected that it will show the viability of electricity generation from purpose grown forest biomass.

35. Ireland leads the world in the above research programme on SRF. Yields from conifers in Ireland average 14 cubic metres per hectare per annum, although the range of yields is from three to over thirty cubic meters per hectare per annum depending on the soil quality and location. Yields from the species currently considered best for SRF, salix, populus and alnus are expected to exceed those of conifers, although again these will vary with soil quality and location. This is largely due to the high growth rate of these species in their early years when compared with conifers. It has been calculated that by the year 2000, 400,000 hectares of SRF coppice could yield at least 2MTOE each year for Ireland.

36. All the above programmes have been partially funded by the EEC as part of its solar energy research, development and demonstration programmes. Part of the demonstration programme, the design and building of a SRF harvester, is included in an IEA Forest Energy Agreement work programme.

37. Additional research work in Ireland is concerned with biomass systems analysis and modelling, work which is carried out within the IEA Forest Energy Agreement. A study is also being carried out into the economic and social impact of biomass production in certain economically depressed regions of the country.

38. Apart from international activities already mentioned the National Board for Science and Technology (NBST), on behalf of the Irish Government, is the Operating Agent for the IEA's Biomass Conversion Technical Information Service. This Service provides a source of scientific and technical data on all aspects of energy from Biomass. Information is presented at regular intervals in the form of abstract bulletins and literature reviews to the participating 13 IEA member countries.

Agricultural Wastes

39. Research and development work on the production of bio-gas from agricultural wastes has been carried out in Ireland for some years. Initially the work was stimulated by the need to neutralise and dispose of large amounts of toxic agricultural wastes, particularly pig slurry. The side effect of the production of bio-gas, however, has always been seen as a useful outcome of the work. Research into the more traditional type of digester at AFT converts pig slurry into methane which is used to generate electricity and hot water. Further treatment of the residue results in a high quality, slow release fertiliser. At the same time, the Department of Microbiology in University College Galway has been investigating anaerobic filter digesters. Laboratory scale filters have been tested successfully and experimental digesters have given encouraging results with both pig and cattle slurries. A fullscale digester is now being built in conjunction with a British university.

40. Apart from these studies on liquid slurry feedstocks, adaption is being considered to enable solid agriculture residue or energy crops to be utilised in the anaerobic filter digester. This could be in a two stage process, with liquefaction of solids as the first step, and could be devloped for use with solid industrial residues.

41. Ireland's research programme is partly funded by the EEC and is designed to take account of and fit in with other international developments in this field.

Conversion of Biomass

42. Apart from combustion the conversion of biomass to fuel has been carried out in Ireland in a small way since the early 1940's. At that time a state company, Ceimici Teo., began distilling ethanol from potatoes, the alcohol being used as an additive in gasoline; up to 10-15% blend. More recently with gasoline cheap and plentiful the average blend has gone down to less than 1% and more significantly, imported molasses have been used as feedstock being cheaper than potateos.

43. With the current need to reduce our dependence on imported energy, conversion processes are being looked at again. The NBST is to undertake a study of current R, D and D work on the direct combustion of wood in small, medium and large scale boilers. At the same time a close watch is being kept on the world-wide interest in the gasification and production of methanol from wood and the generation of ethanol by fermentation from various agronomic substrates e.g. sugar beet, grass, potatoes.

WAVE ENERGY

44. Ireland's position on the eastern shore of the Atlantic Ocean at latitudes in the low fifties means that it is ideally situated with regard to wave energy resources. The ocean-facing coastline is relatively long and is exposed to a wide range of wind directions. It has been calculated on the basis of available data that mean power levels off the west-coast amount to

40-50kW/m on an annual average basis or in excess of 400/MWh/m on a year round average. From these figures it appears that, at an efficiency of conversion of 50%, between 100 and 200 line kilometers of wave frontage could supply annual average power in excess of installed capacity in Ireland.

45. Whereas Ireland has this enormous theoretical source of energy, in practice it is far from being available for exploitation. Firstly it is diffuse and therefore requires large arrays of devices to extract the energy. Secondly it is variable and therefoe while back up facilities are necessary for periods of calm, devices have to be able to withstand the great destructive forces of storms.

46. A limited amount of research is carried out in Ireland. Analytical studies of wave phenomena and analysis of wave data are carried out in two universities, while in a third model devices are tested in a simple wave tank.

47. Internationally Ireland is participating in a European Co-operation in Science and Technology (COST) project which will result in the development of an oceanographic buoy in the atlantic west of Ireland. At the same time Ireland participates in the IEA's International Wave Energy Project. In this programme currently under way, a large Japanese prototype ship-shape device, fitted with eight turbines successfully completed eight months sea-trials. The resultant data is still being analysed and it is likely that further sea-trials with a modified or second-generation prototype will be carried out.

48. Ireland is trying to build up analytical and modelling experience to enable the IEA experience in the Sea of Japan to be put to use in determining the most appropriate means of exploiting wave-energy potential offshore Ireland.

TIDAL ENERGY

49. The economics of tidal energy exploitation are directly dependent on the tidal range available, which should be large, together with a favourable coastline configuration. A census has been taken of the important large tidal inlets in Ireland which might be suitable for the location of a tidal energy scheme (Table 3). It can be seen from the results that nowhere in Ireland does the Mean Tidal Range exceed 4m and in only two locations is it more than 3.5m. This figure is well below the tidal range limit which experts consider necessary before exploitation of tidal energy becomes worth considering.

50. Despite these indications that the basic resource is poorly developed in Ireland it is planned to have a study carried out of the most favourable site, the Shannon Estuary. This is with a view to determining a theoretically feasible way in which the maximum benefit could be obtained. This study will indicate, without regard to cost, the optimal locations for a barrage and appropriate size and location of turbines and sluices.

51. Apart from limited bilateral discussions Ireland is not involved in any international actions on tidal energy.

SOLAR ENERGY

52. The level of solar energy falling on Ireland has been recorded for many years. The ten year average 1964-1973 of global solar radiation on a horizontal surface month by month at Valentia Observatory (for location see Figure II) is given in Figure III. Whereas seasonal variation is seen to be marked it is calculated that the absolute availability of solar radiation in Ireland is close to half that in the most favourable locations in the world.

53. Ireland is a participant in the EEC's Solar Energy R and D programme on solar radiation data. Under this programme a European solar radiation atlas is being produced, the first volume of which was published in 1979 and shows maps including Ireland. From these maps calculated means of global radiation falling on Ireland can be read per month or per annum.

Low Temperature Solar Thermal

54. Research and demonstration work has been carried out in Ireland on both active and passive solar thermal systems. The design of passive solar houses has been studied and experimental buildings erected. By participation in EEC research projects Ireland monitors research in passive building design elsewhere. 1981 will see the first architectural competition in the country for the design of passive solar buildings suitable for Ireland.

55. Active solar thermal systems, particularly for the production of hot water have also been researched. The lack of interest in the use of solar water heaters in the country is largely due to the very marked seasonal variation in solar energy - only one tenth of the yearly total energy falls in the three winter months. At the same time the daily energy total can fluctuate enormously from day to day throughout the year.

56. Despite these drawbacks the design of solar water heaters and of selective absorption surfaces has been studied and pilot tests carried out. As part of an EEC research programme a pilot test facility which simulates a solar heated house has been under test for 18 months. This monitoring is accompanied by analytical work on solar systems design and systems modelling. Ireland is also participating in an EEC demonstration project involving the use of solar panels for heating swimming pools.

Photovoltaic

57. A limited research programme into new forms of photovoltaic devices and new production techniques has been under way in Ireland for a number of years. More particularly, in 1981 a 50 kW photovoltaic pilot plant will be built to supply electricity to run a dairy farm. The photovoltaic panels will be operated in association with battery storage, together with the existing electricity grid as back up. However, despite Ireland's relatively unfavourable level of solar insolation, a positive energy balance is expected for each month of the year. This pilot project is part of an EEC research project whereby such pilot plants will be built and operated in each of the member countries.

SMALL SCALE HYDROELECTRICITY

58. At present, hydroelectricity generating plant with a capacity of 219 MW is operated in Ireland by the ESB, accounting for some 7.5% of electricity generation. There are a limited number of locations where schemes from 1 - 40 MW could be built. These are under review by the ESB at present and it is possible that some of these will be developed in time. For the most efficient use of this hydro power it would be necessary to have associated storage, but as this would probably make development uneconomic, less efficient but cheaper schemes without storage would be likely.

59. The smallest scheme operated by the ESB has a capacity of 600 kW. This scheme was commissioned in 1980 and indicates the current interest in smaller hydro power. Below this capacity there are likely to be locations with potential for local industry or private use, the potential of which is enhanced by the ESB's willingness to buy power from anyone wishing to sell it. An advice service is available to give information to help private development of such schemes.

GEOTHERMAL ENERGY

60. Up until the present time geothermal energy has not been utilised in Ireland; indeed it is not even known whether there is any potential for this energy source in the country. There are no known hot springs and no known deep basins with permeable rocks. A few warm springs exist and a national programme is underway whereby all geothermal data in Ireland will be compiled and temperatures and geochemical characteristics of groundwater will be measured throughout the country.

61. Large scale geothermal energy sources are not expected to be discovered as a result of this survey. Technical progress in the field of hot dry rock geothermal energy appears to offer the most likely prospect for geothermal development in Ireland. This, however, must wait for a major break through in the technology of developing hot dry rock geothermal energy.

ENERGY SYSTEMS ANALYSIS

62. Ireland has been very active in energy systems analysis. The greatest effort to date has been in the development and use of models in conjunction with other countries in the IEA and EEC. These models have been designed particularly to enable the whole energy balance of the country to be projected at any time in the future, subject to defined constraints.

63. A second systems analysis effort has been oriented towards specific fuels or technologies. The system is designed so that a specific resource, e.g. biomass can be taken and the optimal line of development for that resource calculated; what contribution it can make, when, at what cost and with what environmental impact. When looked at together with other energy sources the potential in the market for any one source of energy can be measured.

64. For some renewable energy sources, whereas the technology for exploitation may be established and well known, basic data may be sparse and in need of verification or enhancement; an example for Ireland is geothermal energy. In other cases the technology may be poorly developed but data may already be available or easily obtained, e.g. wind energy in Ireland. Obviously such problems lead to difficulties in obtaining good results from systems analysis models.

65. For Ireland, the development of systems analysis of renewable energy sources is very appropriate. It is an area where technologies are relatively small-scale and are not highly concentrated. There is a need therefore for good analytical assessments to pull them all together and the work can easily be done in Ireland.

POTENTIAL OF PEAT AND NEW AND RENEWABLE ENERGY FOR IRELAND

66. Results of analyses carried out by the NBST have recently been published[1]. For a proper understanding of the results of these analyses it is necessary to consider in detail the information fed into the analyses and the constraints placed on options available in the analyses.

[1]R. Kavanagh and J. Brady, Energy Supply and Demand ... the Next Thirty Years (Dublin, National Board for Science and Technology, 1980).

67. For the purpose of this paper the projections with regard to renewable energy sources only will be considered:

(a) Between 1980 and 2010 contributions from renewable fuels are expected to rise from 0.2 to 1.76 MTOE, constituting 8% of TPE in 2010

(b) The hydro-electric contribution will remain virtually constant for that time because of the unavailability of suitable sites apart from some for small-scale exploitation. The expansion will come from biomass, solar, wind and wave energy, and this comes mostly after 1990.

(c) The earliest and greatest expansion comes in biomass, largely because existing peat technologies can be readily adapted for use with biomass.

(d) Electricity production dominates the use made of renewable resources.

(e) Residential and commercial usage is dominated by solar water heating.

68. Whether these projections are found to be accurate or not depends on whether the assumed constraints on the implementation levels of renewable technologies are correct. Research, development and demonstration programmes currently being carried out will indicate the feasibility of achieving or exceeding the assumed levels.

69. The projections of the contribution of both peat and renewable energy in Ireland, 16% in the year 2010, is given in detail on Tables 4 and 5. As has already been stated the validity of the projection depends on the assumptions

made and the constraints placed on options available. The most significant constraint in this analysis regarding new and renewable energy sources was that their rate of implementation would be conservative. Obviously if special efforts are made to develop and utilise new and renewable energy sources these projections will themselves be conservative.

70. For peat production it is calculated that reserves will only last for some 40 years. For two of the renewable energy sources, biomass and wind, Ireland is particularly well placed regarding availability or potential availability of the resource and technology is developing rapidly. Thus Ireland is a leader in short-rotation foresty biomass research but this is only at the demonstration stage. The contribution in 2010 could be greater than predicted if the results of the demonstration project are very favourable. Similarily Ireland is well placed to use wind energy. If there is a breakthrough in the efficiency and cost of the technology, wind could make a greater contribution to the energy supply than is predicted in this analysis.

CONSTRAINTS ON THE USE OF NEW AND RENEWABLE ENERGY IN IRELAND

71. In certain cases the basic resource is lacking or limited e.g. peat, tidal power, solar thermal for space heating, photovoltaic, small hydro power or geothermal natural hot water. For most of these renewable energies the technology is available for their commercial use where the resource is available in abundance. The exceptions are tidal power, which has only been fully implemented in one place, St. Malo in France, and photovoltaics where the technology is being improved rapidly.

72. In other cases the technology itself is not available or needs further development. This is true of solar photochemical energy, geothermal hot-dry-

rock energy, wave power and certain aspects of short-rotation biomass harvesting, processing and conversion. Further development is needed particularly for wood liquefaction, but also gasification and even direct combustion.

73. At the same time there is a general lack of training and experience in the utilisation of renewable energy sources effectively. Experience is being built up in many areas, but there is a need to place greater emphasis on renewable energy technologies in the existing engineering, architectural and scientific courses in Irish universities and technical colleges.

74. This lack of technology, training and experience is not unique to Ireland but is world-wide. In some cases technology or experience is available in other countries and can be drawn upon, but more generally the stage of full development of commercial technology has not been reached. This appears to be the most significant constraint to wide use of renewable energy in Ireland.

75. Allied with lack of technology is the unfavourable economics of most existing renewable energy technologies in Ireland. Only in a very limited way has renewable energy proved to be economic; wind is used for pumping water, small hydro is used in a few, small, local schemes and solar thermal techniques are used to assist in water heating.

MEANS OF OVERCOMING THESE CONSTRAINTS

76. Obviously in cases where the resource is not present in Ireland in the first place nothing can be done to overcome the constraint. The economics of renewable energies can be improved in a number of ways. As the price of conventional energy rises in real terms so renewable energy becomes more

attractive; subsidies could also be used to encourage the development and use of renewable energy; more particularly the development of more efficient and cheaper technology for production, processing and conversion of renewable energy will improve its economics.

77. Where technology or experience is lacking then research, development and demonstration is needed. This can be done at the national level if funds are available. In the case of Ireland only limited funds are available and this lack of finance is a constraint to rapid development of new energy sources. It is necessary and useful to maximise the national effort by participating in EEC research and demonstration programmes. Apart from assistance with funding this leads to a coordinated programme of work, avoiding unnecessary duplication and encourages mutual assistance.

78. Ireland also participates in some of the IEA's research, development and demonstration programmes. Again this is directed towards developing technolgy and obtaining experience through cooperation and coordination of effort.

79. This international cooperation is seen by Ireland as vital to the rapid and effective development of alternative energies for use in Ireland.

IRELAND AND OPPORTUNITIES FOR INTERNATIONAL CO-OPERATION

80. Ireland has unique experience in the exploitation of peat as a source of energy. This extends to all stages from harvesting through processing and utilisation. It is particularly available for the assessment of reserves in place and also for the design and manufacture of machinery for harvesting and handling peat.

81. Technical expertise from the peat production activities of BnM has been used to advise countries abroad on techniques for producing peat under their particular conditions of climate, peat type and national economy. Amongst the developing countries interested in developing peat have been Burundi, Rwanda, Jamaica, Tanzania and Zaire.

82. For two countries, Burundi and Rwanda, specific assistance in peat development has been provided under Ireland's Development Cooperation Programme. Both countries are without either coal or oil but have extensive peat deposits.

83. Burundi - Interest in the bogs date back to 1977 when the Burundi Government, through Catholic Relief Services, a US non-Governmental organisation, recruited the services of an experienced Irish peat cutter and supervisor. This was followed up in 1979 when an Irish team of experts from BnM conducted a detailed survey of the peat resources of the country. This initial survey indicated that the peat resources were sufficient to warrant exploitation. An economic evaluation was also completed and this likewise was favourable. Further investigations were carried out in 1980 by an Irish expert funded by Danida - the Danish Bilateral Aid Programme.

84. As a result of the findings of the Irish experts the Government of the United States of America became interested in the project and has agreed to make a substantial contribution to cover the cost of technical assistance, equipment and machinery, vehicles and costs for training and construction.

85. It is proposed to recruit further Irish expert personnel including bog supervisors, mechanics and engineers to commence the exploitation of the peat during 1981. Other experts will be recruited in Ireland and assigned to Burundi in 1982 and 1983. Training will also be provided in Ireland for Burundian personnel.

86. Rwanda - Interest in the bogs in Rwanda dates back to 1960. Experts, some working with UNDP - UNIDO aid, surveyed the boglands and proposed certain uses for peat in Rwanda. The latest of these reports 'Exploitation of Peat Resources of Rwanda' was prepared by a BnM expert, funded by UNIDO. Following the publication of this report and in order to commence operations immediately it has been agreed that Irish assistance will be provided.

87. The objectives of the project will be addressed in two stages:- a prospecting and experimental working stage, followed by a stage in which an exhaustive inventory will be made of all the country's bogs, sites will be prepared and exploitation and industrialisation proper will be initiated. At present (1981) the initial survey of deposits is underway accompanied by the preparation of some 1,000 tonnes of peat in order to train peat workers and to introduce some technical expertise from BnM.

88. The nature of the peat exploitation problem varies from country to country and within the country itself. The botanical origin of the peats encountered differs and the problems of excavation and treatment of the peat to produce acceptable fuel has to be carefully considered. The problems and constraints on drainage of the peat deposits so as to permit excavation are of importance. Swamp peats in Central Africa are generally of a fen type, highly humified and of non sphagnum origin. As a result many of the techniques used to produce high quality sod peat in more temperate climates apply to only a limited degree. Fen peat in equatorial swamps, or from the lower levels of temperate climate bogs, produces a friable sod but with special treatment this can be improved to a certain extent. When the drainage or drying characteristics of the peat produced do not yield an acceptable sod peat then the next technical step, briquetting, must be considered.

89. In conditions where drainage of the sometimes very deep and extensive peat deposits is not possible or acceptable (this is particularly so for deposits situated beside large river systems or in agricultural regions dependent on the swamps for regularising water level fluctuations) then serious consideration must be given to the use of the flooded peat as a growth medium for biomass for use as a fuel. In many areas such biomass is already growing densely in one particular form, papyrus, and this can provide a very acceptable fuel when cut, sun dried, collected and turned into briquette fuel using relatively simple technology.

90. Briquettes from papyrus have been made and are of high strength, calorific value (4,600 Kcal/kg) low ash and high density. Charcoal can be made from such briquettes, but only accompanied by the inevitable high losses in total heat associated with carbonisation. The annual yield of dry matter from traditional papyrus harvesting is known but the effects of sustained annual cropping are being investigated to see if papyrus is a viable renewable source of energy.

TRAINING

91. The importance of education and training in the field of new and renewable energy sources is recognised in Ireland. In response to demand, the Irish Industrial Development Authority is preparing a series of eight week specialised courses on energy. The first course, beginning August 1981, is intended for Government officials, members of Institutes etc. The course will be concerned with techniques in a number of areas;

(a) the design and implementation of national energy conservation programmes

(b) the measurement and analysis of national energy resources, and energy use by sector

(c) the measurement and utilisation of renewable energy resources such as wind, wave, water, biomass and solar energy and the associated technologies.

92. It will also include management techniques for the development of small industry programmes to create greater national energy self sufficiency. Emphasis will be placed on practical application rather than theory, and where possible the courses will be linked to actual projects.

CONCLUSION

93. The Irish Government is most anxious that the energy resources of the world be rationally managed and used, and to that end is concerned to expand indigenous energy supplies. The range of new and renewable energy sources unquestionably seems to have the greatest potential for such an expansion, and R, D and D in this area forms an integral part of a nationally coordinated approach to energy planning.

94. Ireland is furthermore most concerned that the technological constraints which currently prevent the implementation of new and renewable sources of energy should be overcome. As well as being active in national R, D and D for this purpose, to maximise these efforts Ireland participates in those EEC and IEA programmes of most relevance to the national efforts.

95. We feel that our experiences in the field of peat and new and renewable soruces of energy may be of value to other countries and we are in turn most eager to learn from them.

TABLE 1: STAGES OF R, D AND D PROGRAMMES ON NEW AND RENEWABLE ENERGY SOURCES IN IRELAND

SECTOR	RESOURCES	COMPETENCE	PILOT	DEMO.	INTEGRATE	IMPLEMENT
Peat	*	*	*	*	*	*
Wind Power	*	*	*	+	o	
Biomass	*	*	*	o		
Wave Power	o	*				
Tidal Power	o	*				
Solar: Thermal	*	*	*			
Photo-voltaic	*	*	o			
Photo-chemical	*	*				
Small Hydro Power	o	*	*			
Geothermal	o	*				

* Completed
o Underway
+ Planned

TABLE 2 MONTHLY AND ANNUAL VALUES OF MEANS HOURLY WIND SPEED (IN m/s) FOR 1961-1970

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Means
Belmullet	7.24	7.44	7.49	6.83	6.78	6.27	6.16	6.16	6.68	7.44	7.08	7.39	7.0
Birr	4.08	4.23	4.33	4.23	3.92	3.41	3.21	3.47	3.41	3.82	3.77	4.13	3.86
Claremorris	4.84	5.15	5.25	4.94	4.64	4.18	4.08	4.13	4.23	4.64	4.43	4.69	4.64
Clones	5.10	5.35	5.55	5.15	4.69	4.18	4.13	4.13	4.28	4.79	4.79	4.94	4.78
Dublin Airport	5.86	6.11	5.96	5.40	4.79	4.23	4.23	4.38	4.54	5.10	5.61	5.91	5.25
Kilkenny	3.77	4.03	4.03	3.92	3.57	3.11	3.00	3.16	3.11	3.36	3.46	3.72	3.55
Malin Head	8.05	8.31	7.95	7.34	6.62	6.06	6.47	6.32	6.83	8.00	8.40	8.56	7.47
Mullingar	4.38	4.74	4.89	4.64	4.08	3.87	3.87	3.87	3.77	4.18	4.23	4.64	4.33
Roche's Point	7.34	7.24	6.73	6.52	5.96	5.20	5.10	5.61	5.86	6.42	6.73	7.39	6.39
Rosslare	6.73	7.08	6.37	6.17	5.91	5.15	4.69	5.25	5.45	5.81	6.52	6.83	6.08
Shannon Airport	5.61	6.01	5.96	5.61	5.30	4.59	4.69	4.89	4.94	5.35	5.25	5.66	5.41
Valentia	6.37	6.22	5.81	5.55	5.45	4.64	4.38	4.74	5.15	5.71	5.86	6.32	5.56

TABLE 3

MEAN TIDAL RANGE AT SITES IN IRELAND

Mean Tidal Range (m)	Number of Sites
<2.5	14
2.5-3.0	12
3.0-3.5	2
3.5-4.0	2
>4.0	0

TABLE 4 PROJECT AVAILABILITY AND USE OF PEAT, 1985-2010

	MTOE				
	1985	1990	1995	2000	2010
Peat Availability	1.25	1.20	1.20	1.68	1.68
Peat Usage					
Electricity Generation	1.02	.74	.57	.87	.30
Coupled Production	-	-	.04	.06	.06
Briquettes Plants	.14	.12	.11	.09	.10
Industry	.03	.10	.22	.33	.49
Residential and Commercial*	.06	.24	.26	.33	.73
Total	1.25	1.20	1.20	1.68	1.68

*Excludes Briquettes

TABLE 5 PROJECTED AVAILABILITY OF RENEWABLE ENERGY 1985-2010

	MTOE				
Renewable Availability	1985	1990	1995	2000	2010
Hydroelectricity	.20	.19	.19	.19	.19
Biomass	-	.12	.39	.87	1.35
Solar	*	.01	.03	.04	.06
Wind	*	*	.10	.01	.09
Wave	-	-	*	.01	.07
Total	.20	.32	.62	1.12	1.76
Renewable Usage					
Electricity Generation	.20	.19	.34	.67	1.12
Industry	-	.10	.22	.33	.49
Residential and Commercial	-	.03	.06	.12	.15
Total	.20	.32	.62	1.12	1.76

*Small

FIGURE I TOTAL PRIMARY ENERGY (1960 - 1979)

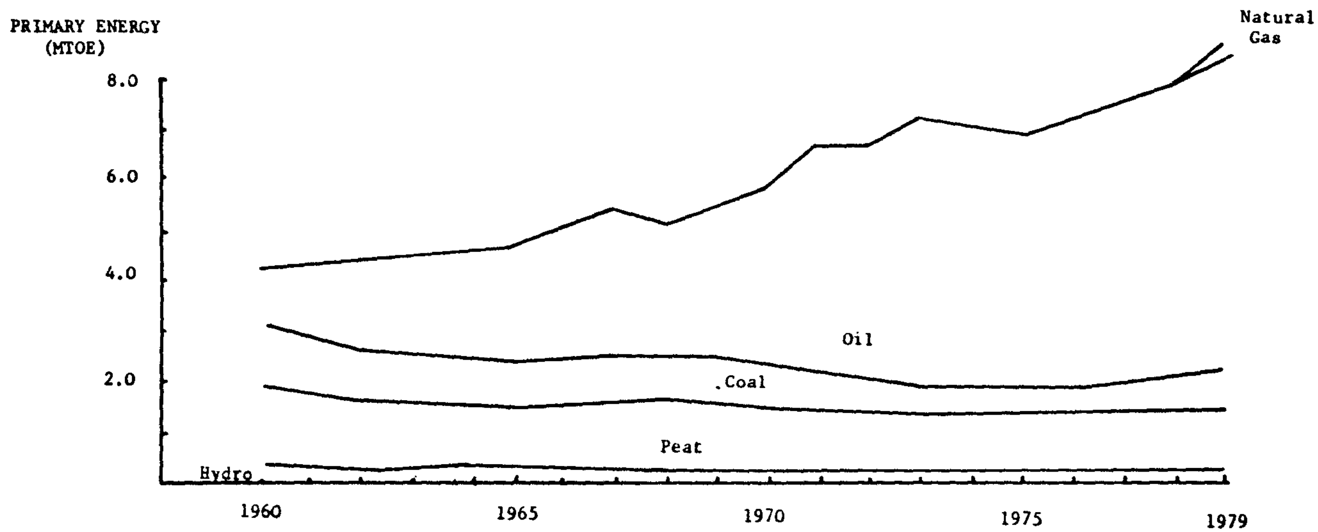
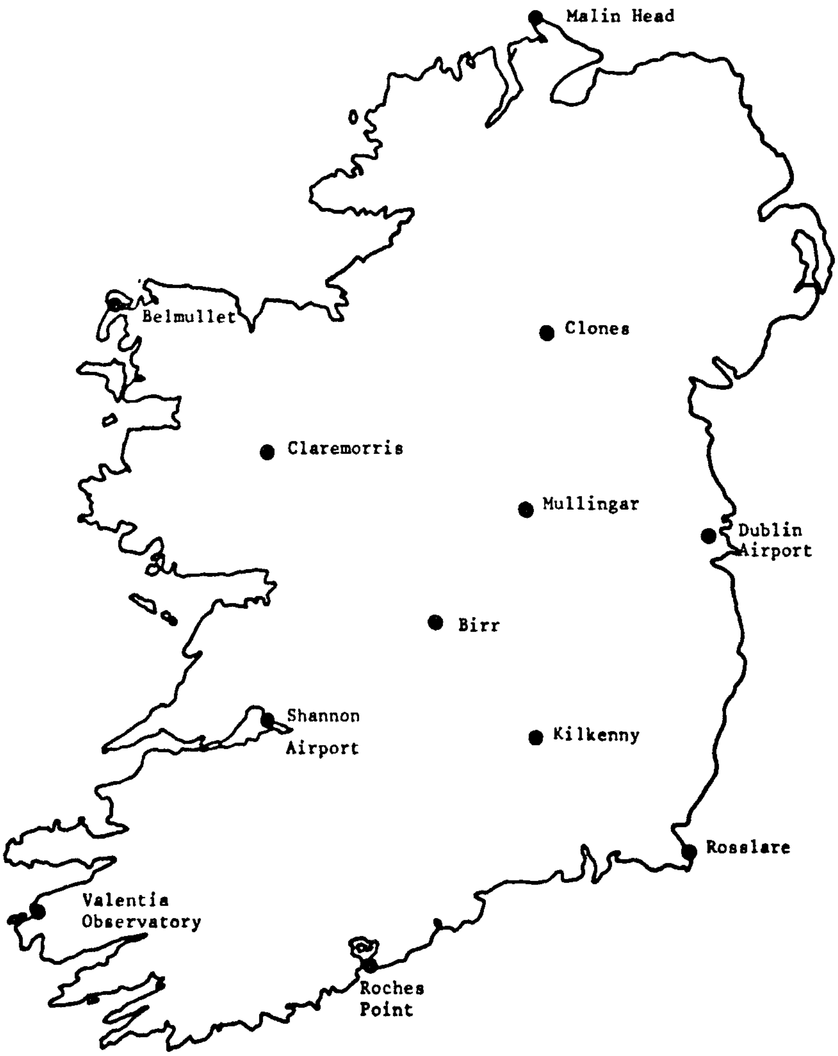


FIGURE II : IRISH METEOROLOGICAL SERVICE SYNOPTIC STATIONS



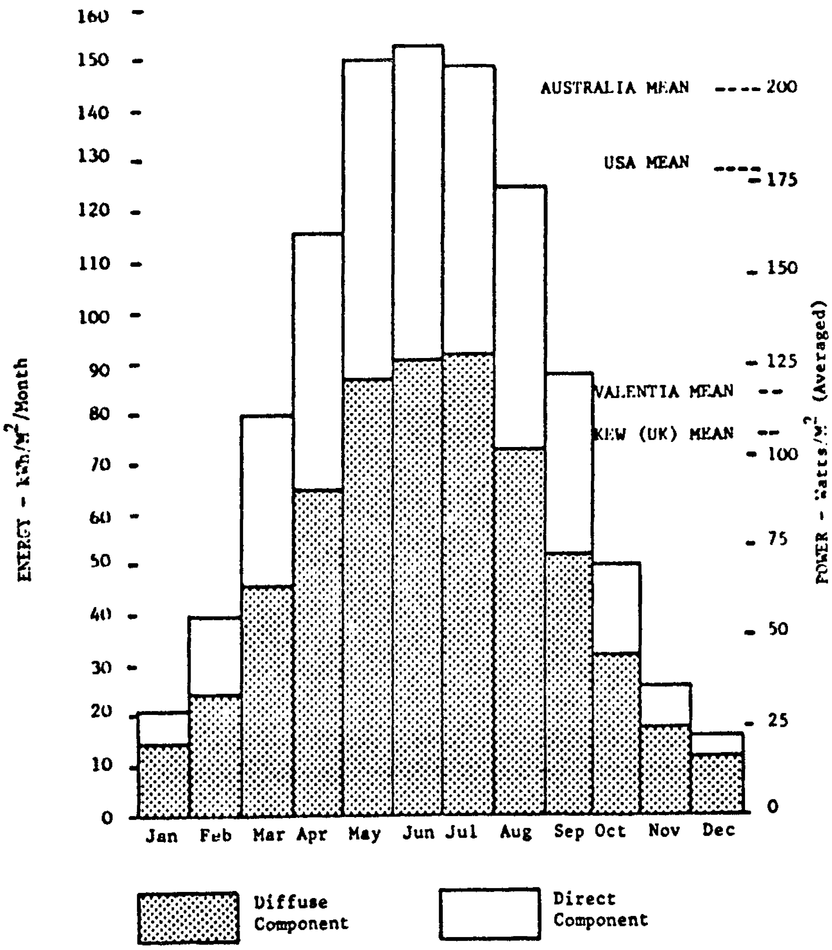


FIGURE III: Ten year average (1964/73) of Global Radiation on a horizontal surface, month by month, energy and average power.