Dorset Marine and Coastal Topic Paper Series 2011

# Renewable Energy

**Renewable energy is the term used to describe energy obtained from unlimited naturally occurring elements within the ecosystem e.g. from the sun, the wind and the oceans, and from plants and the fall of water. In 2009 7.1% of the UK's electricity supply was generated from renewable sources. Government targets require this level to be increased significantly in the coming years.**

## Need For Renewable Energy

Population growth, fossil fuel burning, and deforestation are all factors, which have contributed, in recent years to altering the mixture of gases emitted into the Earth's atmosphere. Some of these gases, known as greenhouse gases, have become concentrated within the atmosphere leading to increases in the Earth's average temperature and causing our climate to change. The UK has some of the best renewable energy resources in Europe, especially wind, but yet is one of the worst at harnessing it.

The UK is responsible for the emission of 3% of global greenhouse gas emissions even though it only has 1% of the world's population. UK energy industries are the largest single contributors to UK greenhouse gas emissions, contributing over a third (54 million tonnes) of the total amount of carbon dioxide (CO2) emitted in the UK. At the same time, the energy industry is relying on finite, diminishing and potentially unsecured sources of fossil fuel such as coal, oil and gas. Currently around 77% of the UK's electricity supply comes from these sources, with an additional 15.6% being generated by the nuclear power sector.

## The UK Government's Response

Renewable energy is seen by the UK Government as vital to helping cut harmful CO2 emissions, as set out by the UK governments Climate Change Programme and subsequent Energy White Paper.

The Energy White Paper states that by 2010, renewable energy should be contributing 10% of the UK's electricity supply, and the aim is to double this by 2020, thus helping the country to reach its ambitious target of UK carbon emission reductions. An even more ambitious target is that the UK has reduced its CO2 emissions by 80% below the 1990 levels before 2050!

In April 2002, the Government introduced the Renewables Obligation which calls on all licensed electricity suppliers in England & Wales to supply a specified and growing proportion of their electricity sales from a choice of eligible renewable sources, and provides financial incentives for them to do so. These incentives include a Feed-in-Tariff that will support small scale projects. A new renewable heat incentive will be implemented in 2010/11.

## Where Are We Now In The UK?

In 2009 7.1% of the total amount of electricity generated in UK came from renewable sources. This can be broken down as follows;

- *Bio-mass :*
  *2.6% (9.1 TWh)*
- *Energy from waste combustion (organic fraction)*
  *0.4% (1.5 TWh)*
- *On-shore wind :*
  *2.1% (7.5 TWh)*
- *Offshore wind*
  *0.5% (1.7 TWh)*
- *Hydroelectric :*
  *1.5% (5.3 TWh)*
- *Wave :*
  *0.001% (0.003 TWh)*
- *Solar PV*
  *0.006% (0.02 TWh)*

1 Terrawatt hour (TWh) is 1 billion kilowatt hours. The total UK electricity demand is 350 TWh per year

To meet the Governments 10% renewable target by 2010, approximately 10,000 megawatts of additional renewable generation will be required.

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The UK has signed the legally binding EU Renewable Energy Directive which requires 15% of total energy consumption (heat, electricity and transport fuels) from renewable energy by 2020. The whole EU has a 20% renewable energy target by 2020. Some countries have more ambitious targets, for example Denmark intends to have 100% renewable energy by 2050.

## The Regulators

**International**

Kyoto agreement – UK to cut carbon emissions by 12.5% below 1990 levels by 2008-2012 The requirements for undertaking the Environmental Impact Assessment (EIA) of onshore wind farm developments are set out in EC Directive 85/337/EEC.

**National**

Government white paper Hydroelectric power schemes need an abstraction licence from the Environment Agency.

The Crown Estate is landowner of the seabed out to the 12 nautical mile territorial limit and will grant leases after statutory consents have been received form the various Government departments involved.

The Department for Environment, Food and Rural Affairs (DEFRA) has responsibility for fisheries, marine nature conservation and environmental protection. DEFRA gives consent to works covered by the Food and Environment Protection Act 1985

The Department for Transport (DfT) oversees sea and air navigation issues and gives consent for works under the provisions of the Coast Protection Act 1949 Section 34.

The Department of Trade and Industry (DTI) has the responsibility for commissioning Strategic Environmental Assessments (SEAs) for the UK continental shelf

The UK Department of Trade and Industry (DTI) administers the provisions of the Electricity Act 1989 requiring developers to seek development consent from the Secretary of State for Trade and Industry for the construction, extension or operation of a generating station of 1 MW and over, offshore in England and Wales. An alternative route is to apply for an Order under the Transport and Works Act 1992.

**Regional**

Government Renewables Obligation on electricity suppliers to provide a certain amount of their energy per year from renewables. Currently 4%, up to 10% by 2010 and 15% by 2015, County Town and Country Planning Act, The EIA Directive is applied in England and Wales through The Town and Country Planning (Environmental Impact Assessment) Regulations 1999, Energy Act 2010.

## What are the Types of Renewable Energy available Nationally?

There are a wide range of renewable energy types both being developed and available in the current market. However specific location-dependant attributes or resources often govern the use of these different energy types. The following energy types are dealt with further in this paper.

- *Biomass*
- *Geo-energy*
- *Hydroelectric*
- *Solar*
- *Tidal*
- *Wave*
- *Wind*

**Biomass**

Biomass is obtained either directly from plants (woody biomass) or indirectly from industrial, commercial, domestic or agricultural products (non-woody biomass). Energy is obtained by converting the biomass into heat and electricity by burning, gasification, anaerobic digestion or fermentation.

Although currently the second largest contributor, biomass has the potential to make a significant contribution to UK heat and energy generation in the future. Development of some forms of biomass may be constrained by limited resources (e.g. landfill gas), while energy crops are difficult to import

economically. There is the potential for many energy crops to be grown within the UK.

**Geo-Energy**
In geologically suitable areas, heat from deep within the Earth's interior can rise up to the surface. Such heat is referred to as geothermal energy. If water is forced to enter fissures in this hot rock, it can become heated and will emerge on the surface as hot springs, or steam.

Geothermal energy can be used directly for providing heating or geothermal power plants can use the steam, heat or hot water from geothermal reservoirs to provide a force to turn generators and thus produce electricity. There is currently only one geothermal power plant in the UK which is situated in Southampton.

**Hydroelectric Power**
Hydroelectric power is created when water from rivers or dammed reservoirs is channelled through an enclosed space where it turns a turbine creating electricity. At times of low demand, generally at night, electricity can be used to pump water from the lower to the upper basin. This extra water can then be released to create power at a time when demand is high.

Hydroelectric power not only requires a suitable river flow regime or dammed body of water in order to create a flow, but also requires the generator to be either relatively close to the site of power usage, or to a suitable grid connection.

**Solar**
Energy from the sun can be captured and harnessed through a variety of methods;

- **Passive Solar Design:** is where new buildings are constructed to ensure that a building's form and fabric captures the sun's energy and reduces the need for artificial light and heating.

- **Active Solar Water Heating:** uses collectors, usually on the roof of a building, to capture and store the sun's heat via water storage systems. The collectors provide heat to the fluid, which circulates to a water tank. The heat is primarily used for heating water in domestic dwellings, industrial facilities and commercial buildings.

- **Photovoltaics (PV):** involve the conversion of energy from the sun into electricity. Solar PV cells can be arranged in panels on a building's roof or walls and often directly feed electricity into the building for use as lighting or power.

**Tidal**
Tidal energy exploits the natural ebb and flow of coastal tidal waters via mechanical devices to produce electricity.

The most common form of tidal energy capture is a dam or 'barrage' across a tidal bay or estuary. Gates and turbines are installed along the dam. When there is an adequate difference in the height of water on either side of the dam the gates are opened. This 'hydrostatic head' that is created causes water to flow through the turbines, turning a generator to produce electricity. Water flowing both into and out of a bay can generate electricity.

As there are two high and two low tides each day, electrical generation from tidal power plants is characterised by periods of maximum generation every 12 hours. In order to produce practical amounts of electricity, a difference between high and low tides of at least five metres is required.

A variant of tidal energy is tidal stream (or marine current) technology which harnesses energy from fast sea currents created by the tides, often magnified by topographical features such as headlands, inlets and straits or by the shape of the seabed when water is forced through narrow channels.

In tidal stream technology, which is still in its infancy, devices similar to submerged wind turbines are used to exploit the energy from tidal currents. Cost-effective power generation from tidal streams is estimated to require a mean spring peak velocity exceeding 4.5 to 5 knots with a depth of water of 20 to 30 metres.

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**Wave**

Waves are a dense form of energy compared, for example, to the wind. Because water is much denser than air, the energy required to move a volume of water is far greater than that needed to move the same volume of air. Wave energy can be extracted and converted into electricity by wave power machines. They can be deployed either on the shoreline or in the deeper waters offshore.

There are three main types of wave power machine:

- **Oscillating Water Column:** is a partially submerged, hollow structure installed in the ocean. It is open to the sea below the water line, enclosing a column of air on top of a column of water. Waves cause the water column to rise and fall, which alternatively compresses and depresses the air column.

- **Buoyant Moored Device:** A buoyant moored device floats on or just below the surface of the water and is moored to the sea floor. This type of device uses the mooring as a fulcrum, or a point against which to move.

- **Hinged Contour Device:** is able to operate at greater depths than the buoyant moored device because it does not require mooring but finds resistance to the waves as the alternate motion of the waves raises and lowers different sections of the machine, working hydraulic pumps to generate electricity.

**Wind**

Wind represents a vast source of energy which man has harnessed for hundreds of years. The UK is said to have the largest potential wind energy resource in Europe and as a result wind energy is regarded as one of our most promising renewable energy technologies, already providing electricity for over 390,000 households. Almost 20% of the overall contribution of 3.86% from renewable energy sources in the UK comes from wind energy.

Wind turbines are mounted on a tower to optimise energy capture. At 30m (100 feet) or more above ground, they can take advantage of the faster and less turbulent wind. Turbines catch the wind's energy with their propeller-like blades. Usually, two or three blades are mounted on a shaft to form a rotor. Wind turbines use aerodynamic forces ('lift' and 'drag') to produce mechanical power that can then be converted to electricity.

Wind farms can be situated either onshore or offshore: the latter is an arena, which is just beginning to be significantly developed, but which has enormous potential.

**Onshore:** wind energy is a relatively mature renewable energy industry and has become established as a viable option for renewable energy contribution. The biggest issues facing its future development are obtaining planning consent, objections from the MoD and concerns from civil airports.

**Offshore:** wind energy also has huge potential, although there have been advances in technology, further development is crucial to withstand the most severe offshore conditions.

## Where are we now in Dorset?

Rough estimates of energy consumption in Dorset can be deduced based on UK energy statistics as a whole divided by the population; giving a pro rata figure. Using this formula for 2001 gives the total energy use across all sectors in Dorset at approximately 19,300 GWh per year. For the sake of comparison this equates to each person in Dorset continuously leaving 2 electric kettles switched on for the whole year (DTI, 2001).

Dorset has been set a renewable energy target of 64-84MW by 2010. At the present time Dorset generates in the region of 18MW (22- 28% of the target range) of large-scale renewable energy per year mainly from biomass sources. This includes 6MW of landfill gas, at White Pit in Poole and 3MW of anaerobic digestion from sewage sludge at Wessex Water sewage treatment sites.

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In addition there are a small number of solar PV and other small-scale electricity generating installations throughout the county including a small (600W) wind turbine at the National Trust Visitor Centre on Studland.

## How could Dorset meet their target?

Reports produced by REvision 2010 suggested that the bulk of the renewable target capacity for Dorset is likely to come from on shore wind technology. In addition biomass, landfill gas, thermal treatment of waste and centralised thermal anaerobic digestion could also play a significant role.

### Onshore Wind

In recent years there have been several proposed wind farms in Dorset, including a proposal for 10-12 wind turbines in Portland Harbour. However due to planning policy, public opposition, designated landscapes and central government regulations there are currently no operating commercial scale wind turbines in Dorset.

The management plan for the Dorset Area of Outstanding Natural Beauty, 2004, includes a policy position on wind turbines as follows:
'wind turbine farms of current design and technology standards, would be inappropriate within the AONB'

However government policy and guidance states the inclusion of 'buffer zones' around such designations for visual or amenity protection purposes should not be considered in the planning process.

### Biomass

The use of energy crops is a strong possibility within Dorset although care would need to be taken with landscape and visual impacts especially in AONB's and along the Heritage Coasts.

It is estimated that around 7MW of energy could be produced from energy crops using land outside of these designations so added selective crops within these areas could significantly increase this value whilst assisting with farm diversification and landscape management issues.

DEFRA policy states that energy crops must be grown within a 40km radius of a power plant so available areas are constrained by the present infrastructure. In addition to energy crops, the utilisation of small scale sources of landfill, sewage and biogass adds to the possible total energy production in Dorset (The White Pit Landfill currently has a renewable electricity capacity of 6.02 MW).

### Offshore Wind

Due to advances in technology, there is now more scope for offshore wind farms to be developed off the UK. Previously, the steep sloping shelves of the seabed would have meant that wind farms would have to be placed close to the coastline, thus limiting viable areas. West of Isle of Wight offshore wind project (zone 7) directed by Eneco has been granted permission to go ahead with plans by Crown Estate. The total zone area equates to 723km2 of which realistically 30% of the area will be developed. Using 5MW capacity turbines this will ensure about 900MW of total capacity, therefore supplying power to over 500,000 homes and the CO2 emissions avoided is approximately 1,186,000 tonnes. A minimum of 180 turbines will need to be constructed for this project to be successful. Offshore construction will begin in 2016 and should be completed in 2018. This project has undergone major engagement with many stakeholders and should promote long term employment benefits to the local areas.

### Wave Power

Wave energy is determined by the length of time the wind blows and the length of the path over which it blows (fetch). Therefore the waves reaching the Dorset Coast are not as powerful as west facing coastlines bordering the Atlantic. A report produced earlier this year by METOC on behalf of SWRDA entitled: Seapower SW Review: Resources, Constraints and Development Scenarios for Wave and Tidal Stream Power in the South West of England indicates that there is no exploitable wave resource off the Dorset coast.

### Tidal Stream

The main tidal stream development areas are where tidal current speeds of greater than about 1 m/sec

occur at the peak of average spring tides; these are usually associated with flow through channels and past headlands. In Dorset, the area lying just to the south east of Portland Bill has been identified as a possible site for this type of technology. This area has been shown to exhibit tidal current movements of around 2.6 m/sec at the peak of an average spring tide.

However, as stated, this type of technology is relatively new and much environmental and sub littoral data would need to be gathered in order to ensure that there would be no significant environmental impacts. In addition any possible effects on Portland Harbour, The Fleet or the adjacent coastline dynamics would also have to be considered and researched.

**Solar**

The REvision 2010 report suggests that Dorset has the potential to generate in the region of 0.3MW of solar energy by 2010 (about 0.5% of Dorset's renewable target).

Currently two larger scale solar schemes in Dorset have received government grants; Weymouth & Portland Sailing Academy and Bournemouth Exhibition and Leisure Centre.

**Micro Hydroelectric**

Dorset has only a limited resource for this type of power. Currently two potential sites have been identified both on the River Stour; Durweston Mill, Stourpaine and Fiddelford Mill, Sturminster Newton. It is suggested that these two sites would have the potential to generate around 0.1MW of energy.

However, several additional mill owners have expressed an interest in developing their properties to enable electricity production. This would involve the regeneration of old mills providing possible cultural and historical benefits in addition to the environmental ones.

## Issues Affecting Development

**Electricity Grid Connections**

The presence of the national grid network close to the coast in the South West, in the form of a network of overhead lines and substations - represents a positive attribute to renewable energy development.

The value of these assets to a potential developer of renewable energy generation depends on there being capacity in the networks to which cost-effective connection of generation can be made. Current reports of discussions with National Grid Transco (owner and licensee for the high voltage transmission system) and with Western Power Distribution (owner and licensed operator of the distribution system) indicate that there is potentially capacity for more input connections to the system.

In addition offshore energy devices must be connected to the electricity network so that the power generated can be sold. It is likely that the impact of the generators will be subject to scrutiny in securing marine consents, together with the infrastructure required to bring the power ashore and connect to the electricity network.

**Strategic Environmental Assessment (SEA)**

In order for an area to develop offshore technologies, EU legislation requires the area to have undergone a Strategic Environmental Assessment. The completion of the SEA is a key barrier for the deployment or consideration of offshore energies in Dorset. At the current time the DTI (who are responsible for overseeing the SEA process) have indicated that the Western approaches (which includes the area off Dorset) are likely to be the final area (8 of 8) to be concerned under the SEA process.

Extrapolating from the timetable of the current SEA being carried out in the northern North Sea (SEA 5) suggests that the process may not be completed in our relevant area until around 2009-2010.

## Opportunities

- **Economic Gain**

Currently the total annual expenditure of energy in Dorset is estimated to be in the region of £806 million, including transport. At present virtually all this revenue flows out of the local economy to

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purchase imported fuel. Providing just 1% of this energy locally through community schemes or other initiatives would mean an extra £2 million per year going into Dorset.

In addition issues such as local employment during the construction and operation of energy projects, farm diversification with energy crop production and community benefit would all add to a local economic gain.

- **Social Benefits**

There are a number of both direct and indirect social benefits, which can be achieved using alternative energy sources. Enhanced waste management through energy from waste plants and wood in biomass energies and the disposal of animal slurry into anaerobic digestion plants assist with disposal whilst providing an energy source.

- **Proactive Planning**

The installation of small scale energy systems such as solar panels, biomass fired community heating and small turbines in new residential and community building schemes would not only contribute towards cheaper running costs but it would also demonstrate the possibilities and benefits of added value within the planning system.

## Barriers

**Landscape, Seascape and Wildlife**

Dorset is a particularly attractive county with numerous conservation designations. The cliff line from Old Harry Rocks in the east through West Dorset into Devon is designated as a World Heritage Site. 53% of the county is designated as an Area of Outstanding Natural Beauty (AONB). In addition, there are 114 Sites of Special Scientific Interest (SSSI's), 10 of which have been designated as National Nature Reserves. There are also 4 RAMSAR sites, 4 Special Protection Areas (SPA's) and 9 candidate Special Areas of Conservation (SAC's). Offshore, the marine life is particularly rich in cetaceans. Important habitats, such as Sabellaria reefs and Seagrass beds are also found offshore. Individual species which are either considered rare or protected include the Pink Sea Fan, Devonshire cup coral and Ross coral.

Both offshore and onshore wind power tends to be highly visible affecting the local landscape character; however the cultivation of energy crops would also require a change in current landscape and agricultural uses and practices.

**Awareness and Understanding**

A number of organisations suggest that the levels of awareness and understanding about the impacts and benefits of, and the necessity for renewable energies are very low in Dorset. This is an issue that needs further consideration.

**Technical and Financial risk**

There are concerns about the levels of technical and financial risk associated with larger scale renewable energy projects such as biomass and anaerobic digestion. The Centre for Sustainable Energy suggests that this is due to a 'chicken and egg' scenario. Farmers will not grow energy crops unless they feel confident that there is a market and developers will not invest in plant unless they are confident that there will be a supply of fuel.

Contributors to the paper:
Peter West, Dorset County Council

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