Introduction

Wind energy has been used for several thousand years. In the nineteenth century, 10,000 wind mills were operating in England alone. The current resurgence of wind power has focused on the production of electricity, where the rotating axle is connected to a gear-box and then a generator. The electricity generated can be used on site, or more typically, sold to the national grid.

Wind energy can be utilised by large off-shore wind farms, large onshore turbines usually sited together in wind clusters or wind farms, and smaller scale turbines for domestic or business-scale use.

UK Wind Resource

The UK is estimated to have around **35-40%** of the total European economic wind resource, and the south west region in particular is an ideal location for wind energy generation. Wind energy is one of a range of different energy sources delivering electricity to the UK. Although there is enough energy in the world's winds to fulfil all of our energy requirements, the resource is limited by the availability of suitable, acceptable sites for wind energy development.

South West England Wind Resource

There are already over 100 wind turbines installed in the region. Most of these form part of seven wind farms in Cornwall, which produce enough electricity to power 25,000 homes and stop over 60,000 tonnes of carbon dioxide pollution entering the atmosphere.

The south west peninsula has a particularly good wind energy resource as it benefits from sea breezes on both its north and south coasts. Sea breezes are formed when coastal land warms during the day more rapidly than the adjacent sea. Hot air rising above the land is replaced by cooler air over the sea, giving rise to an on-shore breeze. At night the situation is reversed, the land cools more quickly than the sea and the breeze is from the land.

Resource studies undertaken for the region suggest that the South West could generate up to 18% of all its power needs from wind energy without encroaching on protected areas. Because of wind energy's favourable economics and the South West's strong resource, it is widely expected that the region will need wind energy to contribute at least two thirds of its 2010 target of 509-611MW. The South West still has a long way to go to achieve this.

Technology

The power produced by a wind turbine is proportional to the cube of the wind speed. Therefore, doubling the wind speed increases the power eight-fold so small differences in wind speed can have significant implications for energy output. It also explains why in many cases developers will tend to choose the windiest sites; many of which are in mountainous or

coastal areas where sensitivities about the landscape are greatest. Accurate data on local wind speed is normally required to assess the viability of a site and optimise the site layout. This will usually require long-term on-site measurements and is why developers often request planning permission for an anemometer prior to deciding if a site is suitable for a wind turbine or wind farm.

Currently, wind speeds of over 6.25 metres per second are generally required for commercial wind energy development. However, the economic viability of a wind farm site will also depend on other factors such as the availability and cost of turbines, the distance and cost of connection to the electricity distribution grid and the expected cost of achieving planning permission.
The length of wind turbine blades is also an important factor in the energy generated by a wind power project as power output is proportional to the swept area of the wind turbine blades. This means that even quite small increases in the blade length can significantly increase output.

Maintainance

Wind turbines should be inspected once a year. Where maintenance is required, single turbines can be shut down whilst work is carried out, allowing the rest of the windfarm to continue generating as normal. Turbines typically last about 25 years. Note: the construction of a wind farm requires access for very long lorries and large cranes, this might not be possible in some locations in the region.

Issues

Environmental Impact

Wind power has one of the smallest lifecycle environmental footprints of any energy generating technology, however an essential part of getting planning permission for a wind farm proposal is an assessment of its potential environmental impact. An Environmental Impact Assessment (EIA) may be required, particularly for larger developments (usually over 5MW). Ultimately, however, it is up to local authorities to decide whether a wind energy development requires an EIA.
Small wind turbines can have a tower made of steel in a lattice formation, like a miniature electricity pylon, however most turbines have towers made of steel or concrete, normally painted either off-white or grey to blend with the predominant sky colour. Wind turbines are normally spaced at least three to five rotor diameters apart to avoid problems with turbulence, however each turbines footprint is relatively small. The land between the turbines can still be used for agriculture and livestock are able to graze right up to the base of wind turbines allowing farmers to gain an additional income stream from wind energy.
Wind turbines are large, visible, man-made structures in the landscape. The planning system takes the role of balancing the effect of wind energy developments on landscape (and other local impacts) against the benefits of the development, such as offsetting fossil fuel use. Developers tend to avoid choosing sites in designated landscapes due to the increased risk that the project will be refused. Guidance on planning policy related to wind energy, including wind turbines in or near designated landscapes is available in PPS22 on renewable energy.

Wind farms should not be sited directly on migration paths of birds and offshore wind farms may also need careful siting in order to avoid discouraging birds from using traditional feeding areas. Although poor siting has resulted in significant numbers of bird strikes at wind farms outside the UK, the UK planning system has ensured that experience in the UK has shown the opposite and collisions are rare. As a statutory consultee in the planning process, Natural England advises on the potential impact of wind energy developments on wildlife and the RSPB has objected to very few wind farms. It should be noted that by far the greatest threat to Britain's wildlife is climate change.

Noise and Shadow Flicker

Turbine blades rotate at anything between 15 and 50 revolutions per minute, usually at a constant speed. If a wind turbine is viewed with the sun behind it, a stroboscopic effect, known as "shadow-flicker" can occur. Although some may find this annoying, modern machines are designed to operate at frequencies lower than those connected to epilepsy. The impact of shadow flicker varies as the sun moves across the sky and is only significant when the sun is low in the sky on a fairly clear, windy day. The movement of wind turbine shadows can be mapped in order to identify any properties that may be effected. If flicker is likely to be a problem, it can be mitigated against by, for example, turning the wind turbine off for the short period of time when the problem would occur. This mitigation can be conditioned by the local authority in a planning application.

Large wind turbines have the potential to interfere with radio, television and radar signals and with microwave communication links. Interference with domestic television and radio systems can be addressed through simple mitigation measures by the developer and can be conditioned by local authorities in planning permission. Potential interference with radar and microwave communications means that developers have to consult with a large number of organisations to ensure that their development will not disrupt mobile phone, emergency radio, airport and military radar systems prior to submitting a planning application. Small-scale installations are unlikely to cause such interference.

Some early wind turbines had noisy gearboxes, but modern turbines generate very low levels of noise. Aerodynamic noise is generated by the movement of the blades through the air. There can also be some mechanical noise, mainly from the gearbox and the generator, however by careful design and the use of anti-vibration couplings such noise can be greatly reduced. Some wind turbines use a gearless design which eliminates mechanical noise. Aerodynamic noise is more difficult to prevent and arises from the changes in wind speed experienced by the blades as they pass the tower. The amount of aerodynamic noise can be reduced by lowering the rotational speed or by reducing the angle of attack of the blades, both of which would reduce the power extracted by the machine. Variable or two-speed machines can do this when the wind speed is low and natural masking or background noise is at a minimum. Wind developers should follow detailed guidelines from the Government about noise to ensure background levels of noise are not exceeded and planning authorities can place conditions on the development in line with government guidance. This guidance can be found at ETSU-R-97.

Energy Payback

The average wind farm in the UK will pay back the energy used during its manufacture and installation within the first six months of operation. A lifecycle analysis of wind turbines undertaken by the Danish Wind Turbine Manufacturers Association found that during its 20 year design life, an onshore wind turbine will typically produce over 80 times more energy than was used in its manufacture, installation, operation, maintenance and scrapping.

Intermittency

As wind speeds vary, wind energy provides an intermittent energy supply so needs to be balanced with other forms of generation that are more constant such as biomass or gas-fired power stations. The majority of UK power generation has a fairly constant load already and backup capacity is already in place (designed to deal with a major coal or nuclear power station going offline at short notice). Therefore most experts suggest that wind energy could deliver at least 10-15% of the UK's electricity without needing any significant changes to the way the electricity system operates. A higher proportion of wind energy could be accommodated, but additional investment in energy storage or system management would be necessary.

Finance

The cost of electricity from wind energy has fallen dramatically in the last few years and wind turbines can now produce electricity cheaper than any other renewable energy technology. The British Wind Energy Association estimates that a wind farm in a good location can now produce electricity at 2.5p a kilowatt hour (kWh). This is cheaper than the cost of electricity from a new coal fired power station, but slightly more expensive than the cost of power from an existing gas or coal-fired power station. Sites with low wind speeds, room for a small number of turbines or more expensive grid connection may still be viable but will result in wind schemes generating power at a higher price.
Offshore wind currently costs 5-6p kWh, roughly twice that of good onshore schemes, because of the additional cost of turbine installation and maintenance at sea.

Wind farms can generate rents, rates, community funds and employment in construction and manufacturing. Farmers with wind turbines on their land can expect to receive rent of approximately £3,000-4,000 a year per Megawatt (MW). Wind farm owners pay rates on the turbines to local councils, and often also offer profit-sharing with local communities. This is typically paid to local charitable trusts so that the community will have a stake in how it is spent. For more information see the South West Public Engagement Protocol and Guidance for Wind Energy (see "More Information" section).

Costs and Grants

Wind farm developments generally cost around £600 per installed kW, which means an array of five 2 MW machines would cost around £6M. Due to this high capital cost, it is likely that a landowner would allow a development company to build and operate a wind farm and simply obtain income via ground rent. This might equate to 2% of the income from the electricity sales, or £21,000 per annum. The main form of government support for wind energy (and all renewable electricity) is the Renewables Obligation. This is an obligation placed on all electricity suppliers to buy an increasing percentage of renewable electricity each year, to reach 10% by 2010 and 15% by 2015. Tradeable certificates are generated for each unit (MWh) of renewable electricity, suppliers must have enough of these certificates to meet the obligation. The certificates are currently (as of February 2007) worth more than the wholesale price of electricity, more than doubling the price for renewable electricity.

Suppliers and Installers

The British Wind Energy Association has a list of contractors on its website – www.bwea.com/members/CompanyDirectory.asp
Regen SW maintains a list of developers on its web site: www.regensw.co.uk/directory

More Information

- **Wind farms, CE102, Energy Saving Trust www.est.co.uk/myhome/publications**
- **For information on connecting to and exporting to the grid see: ww.quietrevolution.co.uk/downloads.htm**
- **Best Practice Guidelines for Wind Energy Developments, available for download from – www.bwea.com/ref/bpg.html**
- **The Assessment and Rating of Noise from Wind farms, ETSU report for DTI www.dti.gov.uk/renewable/wind_environment.html and www.dti.gov.uk/renewable/publications.html** (also has guidance on aviation).
- **South West Public Engagement Protocol and Guidance for Wind Energy – www.regensw.co.uk/press/docs-info.asp**