



## Wind Power Basics

*Modern engineering meets a centuries-old concept*

### Key Points

- The UK has the best wind energy resource in Europe
- Large wind farms now produce power as cheaply as coal-fired generation
- Small-scale wind power is possible in many different locations
- Careful site selection is crucial

### How does it work?

Wind power is a completely clean way to produce electricity. The principle is exactly the same at both small and large scales: aerodynamically-tuned blades are driven by the wind. The rotor turns, driving an electrical generator (sometimes via a gearbox) in the hub. The power is conditioned and transformed to an appropriate voltage, and is then supplied either directly to a building (small-scale) or to the grid via a substation (large-scale).

### How much can it generate?

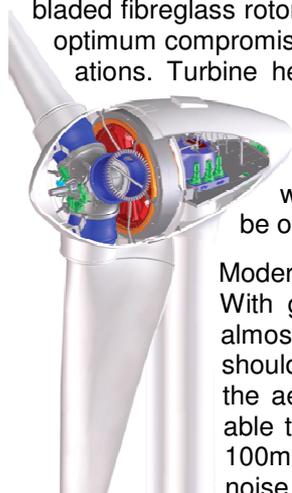
A wide range of different sized wind turbines is available, for example:

- A single turbine at Swaffham in Norfolk—the only one in the world with a viewing platform—produces around one third of the town's electricity. The blades are 31m long, and the tower is 67m tall
- Very small wind turbines are also available to provide electricity for boats, caravans or outdoor lighting. These turbines might have rotors only half a metre across, mounted on 1-2m high poles
- In Northumberland, a US company is testing an offshore turbine with a 150m rotor, rated at a huge 7.5 MW: existing offshore turbines are in the 3-5 MW class.

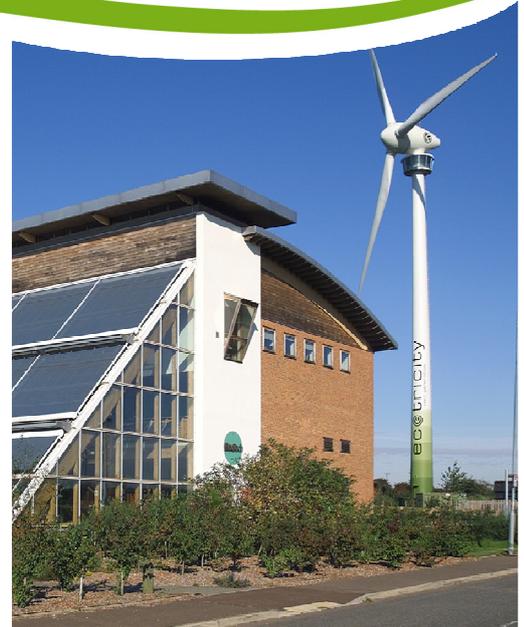
Denmark, traditionally the world leader in wind power, now derives around 20% of its electricity from wind turbines. Their future contribution to UK electricity will also be large, both offshore and onshore.

### Visuals and noise

Modern wind turbines almost always consist of a slender steel tower with a 3-bladed fibreglass rotor mounted on a nacelle at the top. This represents the optimum compromise between structural, aerodynamic and cost considerations. Turbine heights vary: in general a taller tower raises a site's energy yield, as wind speeds are greater and more consistent at height. The largest onshore turbines can be over 130 metres high (to the blade tip), whereas small turbines for household or farm use will be only 10—15 metres high.



Modern wind turbines are designed to be quiet in operation. With gearless direct-drive machines, mechanical noise is almost undetectable. However, commercial scale turbines should still be sited away from housing. 300 metres away, the aerodynamic 'swoosh' of a turbine should be comparable to the noise of the wind blowing in the trees or a car 100m away at 40mph. The best way to find out how much noise wind farms make is to visit one for yourself.



**Top: the Ecotricity turbine at Swaffham, providing up to 1.5 MW of power**  
**Bottom: a domestic 6 kW turbine**

### Efficiency

Myths abound regarding the 'efficiency' of wind turbines. There are two distinct metrics that matter:

**Power coefficient** is the true efficiency of a turbine at extracting energy from the wind: this can be up to 85% of the theoretical maximum energy capture, at the design-optimized wind speed

**Capacity factor** measures the annual energy production compared with the idealised turbine operating continuously at maximum power: it is typically 25-30%, but this is a reflection of the wind resource, *not* the turbine efficiency.

## Environmental effects

The manufacture of wind turbines causes no major environmental impacts. The energy used in the assembly and construction of a modern large-scale turbine is paid back within 6-8 months of operation.

Wind turbines are likely to have a lifetime of around 20 years—indeed, many are only given planning consent for 25 years. At the end of their life, they can (subject to planning) be replaced by newer and better turbines, or removed altogether, with the land restored to its original use. Unlike many forms of industrial development, wind farms cause no long-term contamination of land.

Although wind turbines need to be carefully spaced, the actual “footprint” of the turbines and associated access roads is only 1-2% of the total area of a wind farm. The land can therefore still be used for agriculture, and animals can often be seen grazing right up to the turbine bases.

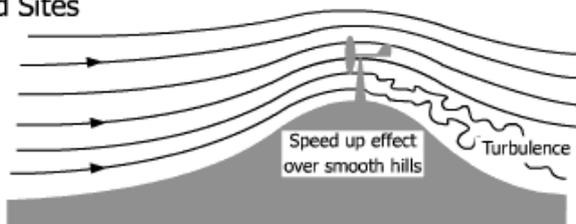
As a precaution, bird migration routes should be always be considered at the planning stage. But research suggests that bird strikes on wind turbines are no worse than on other similar-sized structures such as pylons. Far more birds are killed by buildings, road traffic and domestic animals than by wind turbines—indeed, the RSPB is now looking to install small-scale turbines at some of its bird reserves.

## Siting a wind turbine

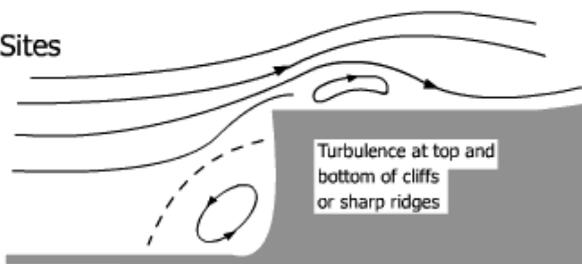
Wind turbines can be sited in many different locations. Careful site selection is crucial to a successful wind energy project. Here are some of the features to look for in a good wind energy site:

### Flow over hills and obstacles

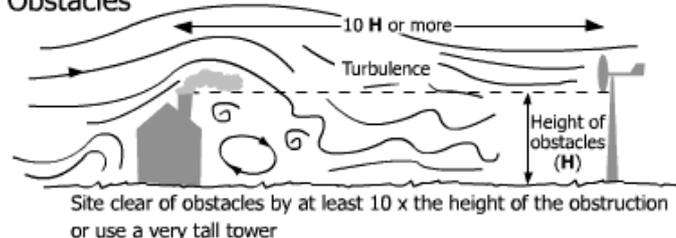
#### Good Sites



#### Bad Sites



#### Obstacles



**Guidelines for locating wind turbines (courtesy of BWEA)**

- High average wind speeds are vital: energy in the wind is proportional to the *cube* of its speed. Local knowledge and tell-tale signs such as trees bent over by the wind are useful in spotting possible sites. However, on-site monitoring of wind speeds (for a year or more) is the way to get a detailed, realistic picture.
- Wind turbines should be placed away from trees and buildings, as these features cause turbulence, reducing energy output and increasing wear and tear.
- Placing turbines a reasonable distance away from homes can ensure that noise is not a problem.
- The wind speeds up over hills, so hill-tops make excellent wind power sites, although clearly these exposed locations are more visually controversial.

For grid-connected turbines, the distance to a suitable connection point is a factor, as long cable runs can be expensive. Wind energy can also be used at off-grid sites by linking it to battery storage banks.

## Costs

A pole-mounted domestic or farm turbine, rated at 5 kW and producing around 9,000 kWh annually in a good site, costs around £15-20,000 fully installed (before grants). Running costs are very low, but an annual maintenance check is usually required. Larger turbines are much cheaper per unit of capacity—the economics of wind energy improve dramatically with scale.

## Tariffs

Although mainstream grant support for wind turbines has now ended, Britain's new **feed-in tariffs** mean that pay-back times are shorter than ever. The following fixed unit rates are payable from April 2010, for all MCS-accredited turbines installed after July 2009:

- |                                  |                   |
|----------------------------------|-------------------|
| • Micro wind turbine (< 1.5 kW)  | <b>34.5 p/kWh</b> |
| • Small wind turbine (1.5—15 kW) | <b>26.7 p/kWh</b> |
| • Small wind turbine (15—100 kW) | <b>24.1 p/kWh</b> |

These rates are paid for all units generated, and are indexed and guaranteed for 20 years.

## Further Information

### Microgeneration Certification Scheme

Find approved products and installers  
[www.microgenerationcertification.org](http://www.microgenerationcertification.org)

### RenewableUK—Small Wind Systems

[www.bwea.com/small](http://www.bwea.com/small)

### Severn Wye Energy Agency Ltd

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