



Centre for
Alternative
Technology

ELECTRICITY FOR OFF-GRID HOMES FROM WIND, SOLAR OR HYDRO POWER

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For more information sheets, see our web site: www.cat.org.uk/information

For those of us on the national grid, generating our own electricity is unlikely to make financial sense. You can now buy renewable electricity through the grid – see our 'Electricity from renewable sources' information sheet. To find out if the economics or environmental benefits of installing a solar roof or wind turbine and selling electricity to the grid would be right for you, see our 'Grid-connected domestic renewable energy systems' information sheet.

However, making use of one or more of wind, solar photovoltaics, or hydro-electric power is often viable if you are off the grid. A renewable energy system will be competitive with the other options, which will have associated environmental and financial costs:

1. Connection to the national grid can be very expensive, and you'll also have to take into account the cost of future electricity bills.
2. A diesel generator will be noisy and polluting, and you need to include the cost of fuel and replacement parts over time.

This sheet briefly outlines the factors determining whether or not renewable energy would be suitable for meeting your energy need, and the practicalities of setting up a small off-grid system; for full details see the publications mentioned. In particular, the book **Off the Grid** is a detailed guide to setting up an off-mains electricity supply.

You could take a DIY approach, but there are also many specialist companies who could design and install a system for you.

Sizing your system

To work out what size system you require you'll need an idea of how much energy you need to use. You can do this by estimating the total energy consumption of all the electrical appliances you intend to run. The power rating in watts (marked on the back of the appliance) multiplied by the time (in hours) that it will be used each day, gives the energy (in watt-hours) that you will need per day in order to run that appliance. Add all these figures up to see what size system you require.

The more energy you need, the bigger and more expensive the system becomes. Therefore, make sure you are using energy efficiently, and consider whether or not all the appliances are necessary. Fitting low-energy light bulbs and using sources other than electricity for heat (i.e.

heating and cooking with wood fuel or gas) will ultimately make a big difference in the overall cost of the system. Our publication **The Energy Saving House** looks at many ways to minimise energy consumption.

Wind turbines

Wind is an abundant source of power, and the UK is the windiest country in Europe. However, wind energy is still very site-specific: an ideal location will have a regular strong wind and no obstructions such as trees or buildings to cause turbulence, as this reduces power output and increases wear and tear on the turbine.

An ideal site is a smooth hilltop which is clear and open (at least in the prevailing wind direction). Rooftop sites are not suitable, as a turbine will create resonance that would damage the structure as well as being a nuisance.

To estimate average output from a wind turbine you need to know the wind speed at your site. A small increase in wind speed gives a large increase in output, so siting the turbine to get the fastest winds is important for optimum performance. Wind speeds also increase significantly with height, so a tall tower to mount it on is generally a necessity.

Approximate information on average wind speeds is available for free from an online database (see www.bwea.com/noabl), by entering the OS grid reference for the site (which you can find online using your postcode), or from the Met Office or the Retscreen web site (see below). You may need to monitor the site (using an anemometer) over 6 to 12 months to get more accurate measurements.

Installing a wind turbine usually requires planning permission. Do also consider your neighbours at the planning stage: wind turbines are very visible, and not everyone will like to look at them.

For more on choosing and installing a small wind system, including detailed guidelines on assessing a site and technical information about batteries and control equipment, see our book **Choosing Windpower**. For those with engineering experience, a well-equipped workshop and lots of time and enthusiasm, we publish **Windpower Workshop**, which describes how to build a wind turbine from second hand and scrap materials.

If you're off-grid and need power all year round, wind and solar complement each other well, with more wind in winter and more sun in summer. If you just need power in summer (e.g. in a caravan), you may want to use only solar power.

Solar power - photovoltaics (PV)

PV modules use light to generate electricity. The technology is very different from solar water heating (see our information sheet on this for more details). The output of a PV module varies with as sunlight varies - they're rated according to their peak output.

Start-up costs are higher than other renewables (about £5 to £8 per installed watt), but there are key advantages: no moving parts, so relatively easy to install and maintain; and more easily sited than wind or hydro turbines - a solar roof just needs to be in unshaded and south-facing.

Data on the amount of solar energy you could receive is available from the 'PV Potential...' web site (see below), the Met Office or the Retscreen web site. These data are usually given as either *peak sunshine hours* or *kilowatt-hours per square metre* - but these are roughly equivalent. To estimate daily power output in watt-hours, multiply a module's rated output (in watts) by the peak sunshine hours per day and then by 0.85

Small-scale hydro-electricity

This can be one of the cheapest methods of providing renewable electricity, but it is also very site specific, and you'll need an abstraction licence from the Environment Agency. One advantage is that on a good site you may not need batteries or an inverter - the turbines will often produce 240 volts AC and can just be turned on when needed.

A good hydro site depends on the 'head' of water (the vertical drop) and the flow rate. To estimate the energy in a water source, multiply the flow (in litres per second) by the head (in metres) by 10 (acceleration due to gravity). Halve your answer to account for losses and inefficiencies, and you'll have a rough idea of potential power generation in watts. Low head sites (a few metres or less) such as old water mills are often not viable, as a large, slow-moving body of water gives a high torque (which is good for mechanical work like grinding or pumping) rather than the high speeds needed to generate electricity. See our book ***Going with the Flow*** for more detail.

Inverters

To run some appliances, you may need an inverter to convert from 12 volts DC to 240 volts AC. There are different types of inverters for grid-connected and off-grid systems. They can be expensive, and rise in cost as the maximum power that they need to be able to cope with

increases, so it could be worth trying to run DC appliances where possible.

Batteries and cables

Batteries are essential in most off-grid wind or solar systems, but are expensive and will deteriorate. They store low voltage (up to 48V) DC electricity and need to be protected from over and under charging by using a shunt regulator or similar.

Lead-acid batteries are the most cost effective, although other types, such as nickel-cadmium, are available. Do make sure you follow proper safety procedures when dealing with batteries.

Deep cycle batteries are preferable for renewable energy systems, as they are designed to have up to 80% of their charge repeatedly removed and replaced over a period of 5 to 15 years (or 1000 - 2000 times).

Vehicle batteries are not suitable as they are designed to give a short burst of high current and be recharged immediately. They will perform poorly if allowed to discharge more deeply.

PV panels and small wind turbines usually operate at low voltages (e.g. 12 or 24 volts). The voltage drop in wires can have a significant effect at these levels. Cables must be thick enough to minimise this drop and carry the required current. As cables are expensive, this can affect wind turbine siting.

Further information

The CAT publications mentioned, along with many other books, are available from **CAT Mail Order**.
Tel: 01654 705959; web: <http://store.cat.org.uk>

We run many **residential courses** on renewable energy systems, wind power, and solar PV. See our Courses leaflet or www.cat.org.uk/courses

CAT's **free information service** can help with further details of suppliers and publications.
Tel: 01654 705989 or email: info@cat.org.uk

If you wish to discuss a particular project in more detail, our **consultancy service** may be of help.
Tel: 01654 705991; consultancy@cat.org.uk

Sources of wind and solar power

Wind Speed Database: www.bwea.com/noabl

PV Potential Estimation Utility:
<http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php>

Retscreen International: www.retscreen.net

Meteorological Office, Tel: 0870 900 0100
Can supply solar radiation (insolation) data with a few days notice. Likely cost is at least £250+VAT.