



Centre for
Alternative
Technology

SOLAR PHOTOVOLTAICS

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Solar water heating or solar electricity?

Although both involve roof-mounted panels, these are very different technologies. With solar water heating, water is circulated, heated up and fed into your domestic hot water supply. For more advice, see our free information sheet on **Solar Water Heating**.

Solar photovoltaic (PV) panels produce electricity, which can be used to run domestic lighting and appliances. A PV system can be linked to the grid, or used to charge batteries.

Off the grid or grid-connected?

PV technology is suitable for homes which are connected to mains electricity as well as for those which are "off-grid" and have to produce their own power.

For year-round off-grid power, solar works well with wind as the two balance each other across the seasons. See our free sheet **Electricity for Off-grid Homes** for more

advice on sizing and installing a battery-charging system in a remote location.

If you are already connected to mains electricity, or if connection would be relatively inexpensive, there's no need for batteries. A grid-connected PV system will be cheaper, require less maintenance, and be generally simpler to run than a battery-charging set-up. Electricity can be sold to the grid when the PV modules are generating more than you are using - read on for further advice.

Is my home a good site?

Ideally, PV panels should be roughly south-facing and free of shade at an angle of 20 to 50 degrees. Rooftops are excellent sites, but panels can also be mounted at ground level. Unlike wind or hydro (water) power, solar PV panels can easily be sited in urban areas.

Roof mounted panels are usually a 'permitted development', so you won't need planning permission. Exceptions include

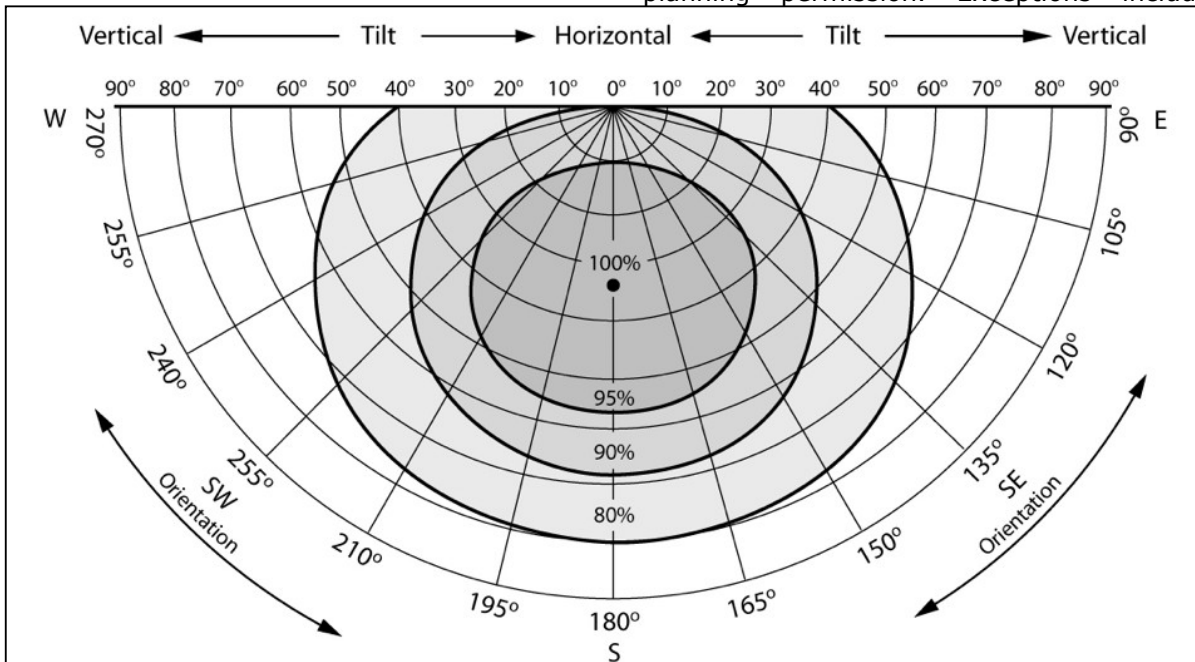


Figure 1: PV panel output varies with orientation and tilt.

Courtesy of Max Fordham & Partners (1999) 'Photovoltaics in Buildings: A Design Guide' DTI URN: 99/1274.

National Parks, conservation areas and listed buildings.

How much roof space will I need?

For each 1 kW of rated capacity (explained below), a PV system will require between 6 and 9 square metres (m²) of roof space.

How much electricity will it produce?

The most important number describing a PV system is its "rated output" or "rated capacity". This is the power (in watts) that a given PV module or system would produce under maximum sunshine conditions.

So a 1-kilowatt (kW) PV roof can produce a maximum of 1000 watts.

The actual amount of electricity produced over a period of time will of course depend on factors such as weather. Under UK conditions, a PV system rated at 1 kW will produce between 700 and 900 units (kWh) of electricity per year. In our example calculation in Box 1 (below), we assume that a typical domestic 2.5 kW system on a south-facing roof will produce about 2000 kWh units per year. In the UK, PV produces much more energy in summer than in winter. A 1 kW array may produce more than 100 units in July but only 20 units in December. To get an estimate for how much electricity you could produce in your location, you can use the following website:

<http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php>

What's the likely cost?

A grid-connected PV system is likely to cost

from £5,000 to £8,000 per kilowatt (kW). Maintenance costs are generally low as there are no moving parts, and the panels are expected to operate 30 years or longer. The only major part that will probably require replacement over a system life span is the inverter, which costs £1,000 - £2,000 in a domestic system. Against this you need to factor electricity savings and income from the new Feed-in-Tariff scheme (see below).

A domestic PV system will be particularly financially attractive if you're undertaking substantial renovation work or building a house from new, as the panels can be used in place of roof tiles, and many associated costs (such as scaffolding) will be incurred when roofing anyway.

How will 'Feed-in Tariffs' benefit me?

The Feed-in-tariff (FiT) scheme for renewable electricity will pay a very significant subsidy, called the generation tariff, for every unit of electricity produced by a PV system. For typical domestic (less than 4kW) systems fitted onto an existing roof, this tariff is currently 41.3 pence for every kWh unit produced, independent of whether the electricity is used directly or sold to the grid. Even off-grid systems, which are not connected to mains electricity, are eligible for generation tariff income. FiT income for PV will be guaranteed for 25 years.

If you have installed a PV system on a grid-connected home, you'll have additional income from selling electricity to the grid (3p per unit) or savings from using it directly (around 12p per unit). This is illustrated in Box 1 below.

Box 1: Feed-in-tariff example calculation

A family installs a solar PV array with a maximum output of 2.5 kW on their existing unshaded south-facing roof. The system cost £14,500, this includes a 25 year warranty extension for the inverter unit (inverters are unlikely to last 25 years without replacement or repairs). The roof produces around 2,000 kWh of electricity per year. They use 50% of the electricity directly at the time when it is produced and sell the other 50% on to the grid. They can expect to receive:

Total electricity produced:	2,000 kWh x 41.3p/kWh generation tariff:	£826
Electricity sold to the grid:	1,000 kWh x 3p/kWh export tariff:	£30
Electricity used directly:	1,000 kWh x 12p/kWh electricity savings:	£120
Total annual income:		£976

The scheme will pay its cost back in 15 years and generate income for at least 25 years.

Any PV system installed after July 2009 will be eligible for FIT income, as long as it was installed by a Microgeneration Certification Scheme accredited installer (see below).

How do I find an installer?

To qualify for feed-in tariffs you'll need to use installers and equipment accredited under the Microgeneration Certification Scheme (see below). You could also check if the installer belongs to a professional body that promotes high standards, and you should always get a few quotes to compare.

What type of PV panel should I go for?

A number of different types of PV panels exist. The most widely used type for domestic applications are monocrystalline and polycrystalline silicon panels. From a practical perspective, there is very little difference between the two panel types.

Polycrystalline panels consist of visible crystals in different shades of blue and slightly less efficient than monocrystalline panels (which are dark blue with no visible crystals). However, this efficiency difference only means that a 1 kW polycrystalline array may be slightly larger than a 1 kW monocrystalline array. Under identical conditions, both panels will produce the same amount of electricity.

PV manufacturers are developing panels from many other materials, with 'thin film' technologies offering the chance to produce power from a smaller amount of material – so reducing costs and environmental impact.

If you're considering installing a PV system, it's worth speaking to a few installers to see what's currently on the market. You'll need to weigh up factors including cost, efficiency and lifetime. PV panels are expected to last a very long time (30 years or longer), but their power output decreases over time. With cheaper panels, this decrease may be quicker. Good quality crystalline PV panels come with a guarantee that they will still give at least 80% of their maximum output after 25 years.

What's the environmental impact of PV?

It is sometimes claimed that PV systems require more energy for their manufacturing

than they produce during their lifetime. This is not true. Under UK conditions, PV panels will "pay back" their energy cost in 4 to 8 years (US DoE study). In other words, over a 30-year lifetime, a PV system on a south-facing UK roof will produce between 3 and 8 times as much energy as was required to manufacture the modules.

A study of life-cycle impacts published by the World Energy Council reported that 1kWh of electricity from PV would be linked to carbon dioxide (CO₂) emissions of between 0.01 and 0.1 kg. By comparison, emissions were 0.4 to 0.5 kg CO₂ per kWh from gas-fired power stations, and 0.8 to 1.4 kg CO₂ per kWh from coal-fired power stations.

Higher demand for PV panels is leading to more efficient manufacturing processes, and recycling schemes to reclaim high-value components. This will reduce economic and environmental costs.

On the other hand, it is worth putting the environmental benefits of PV in context: a 2.5 kW PV roof costing around £15,000 will reduce your carbon footprint by around one tonne per year. Energy efficiency measures (e.g. insulation, replacing old boilers) can often achieve comparable results for less money - with better financial and energy payback times. See our free information sheets on **Energy Efficiency & Saving Electricity** for advice.

Other carbon reductions won't cost anything at all: reducing meat and dairy products in your diet is one way to significantly reduce your environmental footprint, while avoiding just one intercontinental flight will reduce your carbon footprint by several tonnes.

Contacts

Microgeneration Certification Scheme

Tel: 020 7090 1082

Web: www.microgenerationcertification.org

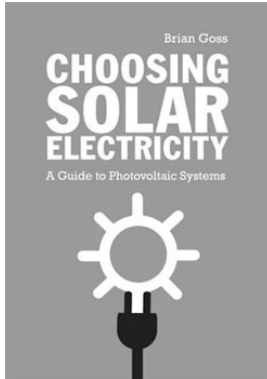
Lists installers and products accredited for the new system of feed-in tariffs.

Grants might be available in some areas; check with the **Energy Saving Trust**

Tel: 0800 512 012; web: www.est.org.uk



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Choosing Solar Electricity

The first book to help customers take advantage of feed-in tariff incentives. Shows you how to assess your site for solar potential and teaches you the ins and outs of solar power - so you can talk to a solar PV installer with confidence. Suitable for householders, businesses, government officials, housing managers, school governors and community planners. Fully illustrated with useful case studies. Written by CAT lecturer and PV researcher Brian Goss.

192pp, £14.00, Publication date: April 8th 2010

CAT Short Courses 2010

www.cat.org.uk/shortcourses/ ☎ 01654 704952

- 10 April **Renewable Electricity & Feed-in Tariffs**
This course introduces the new Feed-in-Tariff scheme and explains how photovoltaics and wind power will be supported under the scheme.
- 9-11 April **Introduction to Solar Electric Systems**
This course gives a good foundation for understanding the technology and will assist you to make informed decisions about small scale PV systems.
- 18-23 May **Photovoltaic Systems**
Participants will join students on a module from our Renewable Energy MSc, to look at solar geometry and resource, PV technologies, modelling & building integration.
- 7 August **Taster Day: Solar Electric**
Is PV suitable for you? This one day course will help you find out.
- 3-5 Sep **Off the Grid – Solar Electric Systems**
This course will concentrate on 'off grid' PV systems, for those locations where access to grid electricity is not easily available.

CAT Consultancy

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For in-depth advice on renewable energy you may find our consultancy service useful. Our experts can give detailed technical advice, either in person or over the phone.

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