Solar Photovoltaics

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Solar electricity or solar water heating?

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

To provide hot water, solar water heating panels would be needed. In these, water is circulated, heated up and fed into your domestic hot water supply. For more advice, see our free **Solar Water Heating** sheet.

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 so 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 already have 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 much 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, free of shade, and 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, 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 to this rule include National Parks, conservation areas and listed buildings.

How much roof space will I need?

For each 1 kW of rated capacity (explained overleaf), a PV system will require between 6 and 9 square metres (m^2) of roof space.

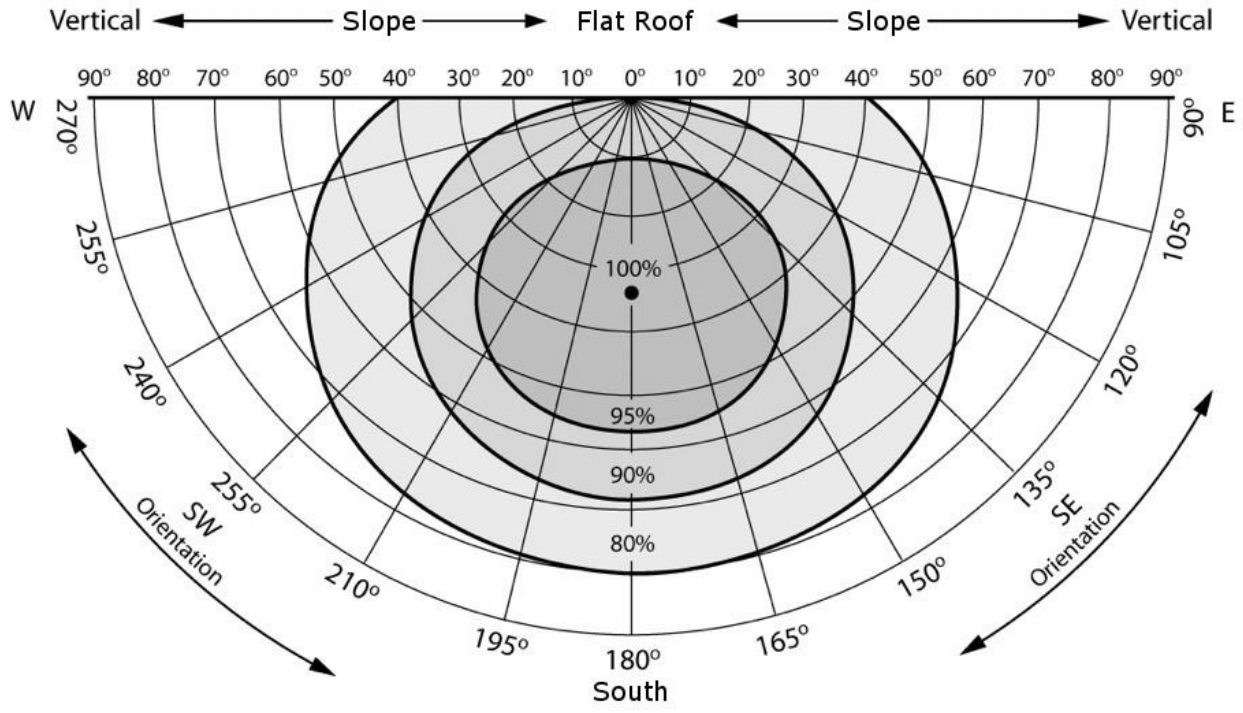

Figure 1: PV panel output varies with orientation and slope.

How much electricity will it produce?

A key number for PV systems is the 'rated output' or 'rated capacity'. This is the peak power in kilowatts (kWp or just kW) that a PV system will generate in bright sunshine.

The amount of electricity actually produced over time will of course vary with sunlight levels. In the UK, a 1kW PV roof will produce 700-900 units (kWh) of electricity per year. So a 3.5kW south-facing domestic system will produce about 3,000kWh per year. Bear in mind that there's much more sun in summer than in winter - a 1kW array may give over 100kWh in July but only 20kWh in January. To estimate PV system output for your home, use our Solar Calculator: *http://info.cat.org.uk/solarcalculator*

How will 'Feed-in Tariffs' benefit me?

The Feed-in-tariff (FIT) scheme pays you a subsidy for every unit of solar electricity produced. For a domestic system you'll get 4.07p per kWh generated - irrespective of whether the electricity is used in your home or exported to the grid. FIT income for PV is guaranteed for 20 years, is normally tax free and is index linked.

You'll also get some additional income of 5.03p per unit for selling electricity to the grid, or savings worth about 16p per unit from using it in the home - see table below.

To get the FIT, homes must achieve an Energy Performance Certificate (EPC) rating of at least Band D. Also, your installer must be accredited by the Microgeneration Certification Scheme (MCS).

In theory, homes not on mains electricity are eligible for FIT income, but in practice suitable off-grid metering equipment is not (as yet) actually available.

What about larger PV systems?

Feed-in tariffs are also paid to larger scale systems, such as for a school, a commercial building, or a block of flats. As installation costs will be less per kW for bigger systems, the tariff drops as system size increases:

Scale	p/kWh
Up to 10kWp (peak output in kW)	4.07
Over 10kWp, up to 50kWp	4.29

The FIT rate available for new installations will gradually drop each quarter. For larger systems and other details, see the Ofgem website: *http://www.ofgem.gov.uk/fits*

What's the installation cost?

A 3kW to 4kW domestic PV system is likely to cost £5,000 to £7,000. Maintenance costs are low as there are no moving parts, and the panels are expected to operate for 30 years or more. The only major part that will require replacement every 10 years or so is the inverter, at a cost of perhaps £1,000. Against this you need to factor electricity savings and income from the Feed-in-Tariff scheme (see the box below).

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

Example calculation of feed-in-tariff (FIT) income for domestic PV

A family installs a 3.5kW PV array on an unshaded south-facing roof, for an up-front cost of £6,000 including installation. The roof produces about 3,000kWh of electricity per year. They can use between one quarter and one half at the time when it is produced, while 50% of output is deemed to be exported to the grid. They can expect to receive:

Total electricity produced:	3,000kWh x 4.07p/kWh generation tariff:	£122
Electricity sold to the grid:	1,500kWh x 5.03p/kWh export tariff:	£75
Electricity used directly:	750-1500 kWh x 16p/kWh electricity savings:	£120 - £240
Total annual income:		£315 - £440

Including a replacement inverter after 10 years (at a cost of around £1,000) this scheme may take 15 to 20 years to recoup the installation cost. Crystalline silicon PV panels should continue generating electricity well beyond 20 years. FIT income is index-linked (so will rise with inflation) and tax free for domestic installations. To calculate figures for your home, use our solar calculator: ***http://info.cat.org.uk/solarcalculator***

How do I find an installer?

The MCS (details below) lists accredited installers and equipment. You could also see if the installer belongs to a professional body that promotes high standards.

Ensure you get companies to do a proper technical site survey - not just a sales visit. Get a few quotes (at least 3) to compare. If a company attempts 'hard sell' tactics (e.g. pressure-selling techniques like an on the spot discount), avoid them and tell the MCS and your local trading standards.

Microgeneration Certification Scheme
Tel: 020 7090 1082
web: www.microgenerationcertification.org

Do companies install free PV panels?

In the past, some companies offered to install PV panels for free in good locations. In return they took the Feed in Tariff income, leaving you with some free electricity (whatever could be used during sunny weather). The drop in the FIT may have put an end to this as a viable business model. It should always be more financially attractive to install your own PV panels if you can afford it, and there some things you should check before signing up for a free PV scheme - see our website for a list of these.

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 are slightly less efficient than monocrystalline panels, which are dark blue with no visible crystals. However, this small efficiency difference just means that a 1kW polycrystalline array will be slightly larger than a 1kW monocrystalline array. Under identical conditions, both arrays 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 more), but their power output decreases a bit over time. With cheaper panels, this decrease may be quicker. Good quality crystalline PV panels should come with a guarantee that they will still give at least 80% of their maximum output after 25 years (or similar).

What's the environmental impact of PV?

It is sometimes claimed that manufacturing PV panels uses more energy than they will produce during their lifetime – but this is not true. Even under UK sunshine, PV panels will 'pay back' this energy cost in about 3 years.

A study of life-cycle impacts (so including manufacture) published by the World Energy Council reported that 1kWh of electricity from PV is linked to carbon dioxide (CO_2) emissions of between 0.01 and 0.1kg. In comparison, life-cycle emissions from gas-fired power stations were 0.4 to 0.5kg of CO_2 per kWh, and from coal-fired power stations, 0.8 to 1.4kg of CO_2 per kWh.

The growing demand for PV is leading to more efficient manufacturing processes and to recycling schemes to reclaim high-value components. This will reduce both economic and environmental costs further.

Is PV the best way to go low carbon?

A 4kW PV roof costing about £6,000 will reduce your carbon footprint by roughly 1.5 tonnes of CO_2 per year. Energy conservation measures such as improving insulation or replacing an old boiler will often achieve more carbon savings per pound spent, with better financial and energy payback times, so do invest in these measures before going for a PV roof. See our free information sheet on **Energy Conservation** for advice.

If you currently rely on oil or electricity for heating, see our sheets on **Wood Fuel** and **Heat Pumps**, as changing your heating system may be a better investment than PV.

Many other carbon reductions won't cost anything at all: reducing how much meat & dairy you eat will significantly reduce your environmental footprint, as will cycling more and driving less, while avoiding just one intercontinental flight will reduce your carbon footprint by several tonnes. See our Zero Carbon Britain website for more on how we can reduce the UK's carbon emissions: *www.zerocarbonbritain.org*

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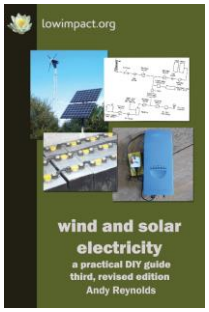

Wind & Solar Electricity, a Practical DIY Guide (Andy Reynolds)
The author has been generating his own electricity from wind and sun for several decades. This third edition has new chapters, drawings, schematics, and photographs. The hands-on approach is retained, with lots of practical tips, as well as advice on using second-hand components where feasible. He provides practical advice on all aspects of building and maintaining a low-cost, low-carbon home-generation system. **Paperback, £13.95.**

CAT Short Courses 2018

http://courses.cat.org.uk/ ☎ 01654 704966

3 Feb 2018 ***Introduction to Solar PV (one day)***
How PV modules work, inverters, cable sizes, calculating load demands, difference between on-grid & off-grid systems, feed in tariffs & planning for on-grid PV.

4 Feb 2018 ***Solar PV Off-grid Systems (one day)***
To follow the above course, with more on designing off-grid systems, such as using batteries, calculating load demands, and other considerations.

16–21 Apr 2018 ***Energy Generation from Solar***
This week-long deep-dive in to solar energy generation is part of CAT's new degree course, Sustainability in Energy Provision and Demand Management.

CAT's Graduate School of the Environment

http://gse.cat.org.uk/ ☎ 01654 705953

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MSc Sustainability and Adaptation in the Built Environment – Designing buildings to be sustainable & take account of the effects of climate change. Energy management & low energy design, sustainable materials, environmental performance assessment & energy provision.

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