



Solar photovoltaics



What is it?

Certain materials produce an electric current when exposed to light which is known as a photovoltaic (PV) effect. The use of this phenomenon is widespread from consumer products like watches and calculators, parking meters, traffic signals to householders providing some of their own electricity needs. There are about 2000 buildings in the UK benefiting from this technology whilst Germany by contrast has more than 100,000 installations. PV arrays may be roof mounted or incorporated into a building's facade. Mounting the array on an existing roof is the cheapest method although it is also possible to build a roof with solar tiles or slates.

How does it work?

Solar cells are composed of a semi conducting material, usually very pure silicon and tiny amounts of boron and phosphorous. A photovoltaic cell comprises two very thin layers:

- one, containing phosphorous, with spare electrons – the n-type (negative)
- the other, containing boron, with fewer electrons – the p-type (positive).

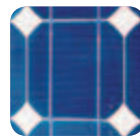
Sunlight striking the PV cell is absorbed and this energy causes electrons to flow from one side to the other when an external load, such as an electric light bulb or an electric motor, is connected between the front and back electrodes.

PV cells work in daylight and the greater the intensity of the light, the greater the electricity generated. The electricity from a single cell is low so many cells are connected to form a solar panel. Small panels may be joined together in what is called a PV array.

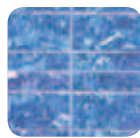
PV arrays are rated in peak watts (Wp). A 1kWp system will produce approximately 1kW of electricity at noon on a sunny day in midsummer. The electrical

output at any particular time will depend on several factors:

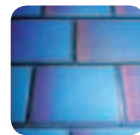
- the size and number of panels – more and bigger gives more power.
- the strength (intensity) of the sun – greatest when the sun is high in the sky.
- how long the sun shines on the panels – clear summer days are best.
- angle and direction of panels – roofs inclined at 30-50° and due south are best, but SE to SW is nearly as good.
- the efficiency of the panels, i.e. the percentage of sunlight falling on the PV panels which is converted into electricity This varies with the three types of panel:



Monocrystalline are thin slices cut from a single crystal of very pure silicon. These are the most expensive type with a typical efficiency of 15%



Polycrystalline are wafer thin slices of melted and re-crystallised silicon. They are less expensive but also less efficient (~8-12%)



Amorphous, thin film cells are made from a very thin layer of semiconductor atoms deposited on a glass or metal base. These panels are flexible and therefore allow a variety of shapes but the efficiency is low (~4-7%)

(British Photovoltaic Association)

A PV array usually supplies power to the building, through an inverter, which changes DC (direct current) to AC (alternating current) at mains voltage (240V). The inverter is connected directly to the main



fuse box and so the whole system is grid-linked, with any excess electricity generated being exported to the national grid. Where there is no mains supply, PV arrays can be used to charge batteries and a charge regulator prevents overcharging and over-discharge.

Can I produce all my electricity with this technology?

Dorset has an excellent solar resource – on average a south facing roof inclined at 30 degrees will receive between 1100-1200 kilowatt hours (kWh) of solar radiation per square metre per year. A 2kWp PV array facing due south at an angle of 45 degrees might produce 1800 kWh of electricity per annum. This is approximately half of the annual electricity requirements of an average house. However, there is evidence that householders with PV installations are also likely to install low energy lighting and appliances, power down adaptors to turn appliances off standby etc. In these circumstances a 2kWp PV array may meet $\frac{3}{4}$ of the annual electricity demand.

How much roof space is required?

A 1 kWp system would require an area of approximately 10 m² of south facing roof space. As for solar water heating, if your roof faces between south east and south west, with no buildings or trees overshadowing it, then it should be suitable. If the roof surface is in shadow for part of the day, the output of the system is significantly reduced.

How much maintenance is required?

Virtually none. You should check annually to see if any debris (such as leaves and bird droppings) has fallen on the array. The panels can be cleaned with soapy water and a soft bristled brush.

What does it cost?

For an average domestic system, total costs can be around £5,000 - £8,000 per kWp installed. Solar tiles cost more than conventional panels and roof-integrated panels are more expensive than those which sit on top of the roof.

In order to get paid for surplus electricity not used in the home, which is exported to the grid, you will need an export metre costing £400. If a

house already requires re-roofing, and for new build, there can be some cost savings in roofing materials and scaffolding for roof access.

Can I get a grant?

Grants are available until April 2011 (subject to availability) from the Government's Low Carbon Buildings Programme (LCBP) for households, at a maximum of £2,000 per kWp installed, up to a maximum of £2,500 and subject to an overall 50% limit of the total installed cost. However, domestic grants for renewable electricity systems may not be available once the Feed-in Tariff is introduced in April 2010 - see notes below.

Community groups can get 50% funding through the Community Sustainable Energy Programme, Low Carbon Buildings Programme Phase 2 and can also apply to energy companies with green energy funds.

What is the pay back?

Any domestic PV installation commissioned after 17th July 2009 will be eligible for a "Feed-in Tariff" starting from April 2010, even if the installation has received a LCBP grant of up to £2,500. Note this may not apply to community installations that may have to repay any grants in order to qualify for the Feed-in Tariff. As an example of potential payback, ignoring any grant support, a 2 kWp photovoltaic installation retrofitted to an existing house,



Solar PV at Underhill Primary School, Portland



Solar PV roof panels at the Magdalen project, Dorset

generating 1800kWh of electricity per year, assuming 50% of the power is exported to the grid and 50% used on site would produce an annual income from the Feed-in Tariff of approximately £700. In addition, there would be a saving of approximately £125 per year from the value of electricity used on site, assuming grid electricity costs 14p/ kWh. Total gross financial benefit, with the above assumptions, would be £825 per year, or a simple payback of 14.5 years on a £12,000 investment. Feed in Tariff premium prices will be guaranteed for 20 years from the time of installation. Note the above information on Feed-in Tariffs was verified with the Department of Energy and Climate Change (DECC) at the time of printing this information sheet, but should be checked before making a financial commitment.

PV cells are quite energy intensive to make and can take up to 5 years to repay the carbon debt of manufacture (the amount of CO₂ emitted during manufacture). If the system is used in conjunction with batteries the carbon debt might be 10 years.

Are there any planning issues?

Domestic solar PV panels are now permitted development except in Conservation Areas,

World Heritage Sites and on listed buildings. Planning permission is required in these areas if the system is intended to be installed on a front roof slope or visible from the public domain. If in doubt you are advised to contact your local planning authority. See also the link in "More information" below. Planning permission is still required for all community and commercial scale PV installations.

What is the potential for this technology in Dorset?

Dorset has one of the best solar energy resources in mainland UK. Of all the renewable electricity technologies, PV lends itself most to incorporation into buildings. It has the major advantage that it generates no noise, has no moving parts and requires virtually no maintenance. The output of PV modules is usually guaranteed by manufacturers for 25 years. Therefore with the introduction of a 20-year guaranteed income from Feed-in Tariffs, PV can be a safe "ethical" investment with a rate of return comparable to, or better than, average interest rates paid on savings.



Pros and cons of photovoltaics

Pros

- Easy to integrate into existing buildings
- Virtually no maintenance

Cons

- Technology with relatively high capital cost
- Might require lifestyle changes to gain maximum benefits
- Need large area of roof space and aspect between SE and SW
- 5 year carbon payback

PV installers based in the South West

In order to receive a grant or the new Feed-in Tariff householders must use an installer registered with the Microgeneration Certification Scheme (MCS) and also an accredited product.

To find an installer see:
www.microgenerationcertification.org
 or telephone **020 7090 1082**

The Dorset Energy Group recommends using a **local** accredited installer whenever possible and to always seek several quotes before committing to an installer.



Domestic PV installation, Dorchester

More information

Grants

Low Carbon Buildings Programme	0800 9150990	www.lowcarbonbuildings.org.uk
Community Sustainable Energy Programme	0845 3 671 671	www.communitysustainable.org.uk

Planning

Planning - permitted development rights for solar panels	0800 915 0990	www.lowcarbonbuildings.org.uk/info/permitted/
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Renewable energy advice for householders:

SW Energy Saving Trust Advice Centre	0800 512012	www.energysavingtrust.org.uk
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Renewable energy advice for businesses in Dorset:

Business Link	0845 600 9966	www.businesslink.gov.uk/southwest
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Renewable energy in Dorset and advice for community groups:

Renewable Energy Development Officer, Dorset County Council	01305 228530	p.west@dorsetcc.gov.uk www.dorsetforyou.com/climatechange
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Design & Print Service, Dorset County Council, October 2009, 4063 108440