

## Photovoltaics – Solar Electricity

Sunlight can be used to generate electricity and there are now many pieces of everyday equipment powered by the sun. These currently include things such as torches, calculators, battery chargers (from small portable batteries to large battery sets), some refrigerators and pay-and-display machines etc. In some countries, closer to the equator, it is being used for large-scale electricity generation. One of the major benefits of producing electricity in this way is that there are no CO<sub>2</sub> emissions (around 0.43Kgs of CO<sub>2</sub> is emitted for each kWh of conventional electricity used). There are no moving parts and electricity generation is silent.

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### **What is the technology called?**

The technology of electricity generation from sunlight is generally referred to as Photovoltaics (PV), but other descriptions include Solar Electric or Solar Power. Because they sometimes look physically similar and because the term *solar panel* is often used to describe both of them, solar electric systems are often confused with solar water heating systems. Solar water heating is a different technology and is dealt with in the *solar water heating* information sheets.

### **Basic working principles and construction**

Single PV 'cells' (which look like thin plastic sandwiches around 75mm square) generate a small electric voltage when exposed to light. The brighter the light, the more electricity generated. These cells are connected together and the more cells connected the higher the voltage and/or current produced.

Although there are many types under development there are principally four types which are readily available - Monocrystalline, Polycrystalline, Amorphous and Thin Film. For practical purposes, their main difference lies in their efficiency, which is typically 15%, 13%, 10% and 7% respectively. This means that for the same output a Monocrystalline

panel would be around half the size of a Thin Film panel.

Usually, cells are arranged into a single large flat panel and then the panels are connected together into an 'array'. Arrays can be large enough to produce the same output as a conventional power station. Although PV panels will produce electricity during all daylight hours, their output is much higher in direct sunshine than on a cloudy day or when the sun is low in the sky (10-100 times higher).

Arrays come in a variety of styles from simple, individually framed panels, to imitation roof tiles/slates, to semi-transparent glazing panels (Thin Film systems). The framed panels are often installed directly onto a south-facing roof or they can be fitted into an appropriately angled support framework in an unshaded south-facing area. Support frames are available that can automatically track the sun from sunrise to sunset thereby obtaining the maximum benefit from any available solar energy. Typical modules have a rated power output of around 75 – 120 Wp (watts at peak output) each. Therefore a system of 1.5 – 2kWp may comprise of some 12-24 modules covering an area of between 12-40m<sup>2</sup> depending on technology used and orientation of the array with respect to the sun. The imitation roof tiles/slates are laid in the same way as conventional roof

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slates and can be installed by any competent roofer. The wires from the cells are then connected up in the roof space by a specialist installer. There are different types of slates with different outputs but a 1kWp output would typically replace 12 – 16 m<sup>2</sup> of slates.

### **Will it work in Cornwall?**

Solar radiation is highest around the equator (about 5kW/square metre). In the UK we receive between a half and a third of that amount. Cornwall potentially has higher solar radiation than the rest of the country, this equates to about 1000 hours of useable sunshine per year. A PV systems tilted towards the sun should produce 750 kWh/ year per kWp installed. So a typical 1kWp system (20m<sup>2</sup> of multicrystalline) could produce 750kWh per year and a 2kWp systems will provide 1500kWh per year. The expected life-time of a solar array should be approximately 30 years.

### **Types of System**

#### **National Grid Connection**

The simplest practical way of utilising solar-generated electricity is to use it in combination with your mains supply. Electricity from the solar array is converted, by a special inverter (compliant with ER G77) to match the 240V AC mains national grid supply. Electricity generated by the array will preferentially supply your home while any electricity not being used is fed back into the national grid via an 'export meter'. You will be billed for the electricity you use from the grid and in return you will be paid for some or all of the electricity you generate. The price you are paid for the electricity you generate (as with the price you pay) varies considerably between companies (see info leaflet 1 – Buying and Selling Green Electricity). It is also necessary to obtain a 'Parallel Connection Agreement' from

your local Distribution Network Operator and a 'Combined Supply and Purchase Agreement' from an electricity supplier. Your installer should be able to assist you with this.

#### **Totally Independent System**

Here the solar electricity output is stored in batteries. The bigger the array used then the larger the battery storage system required. Car batteries are not really suitable as they are easily damaged by being repeatedly fully charged then fully discharged as often happens in solar systems. Deep cycle (traction) batteries are the most suitable. Leisure batteries can be used but they have a relatively short life (around 3-4 years). The supply from the batteries can be used directly but this requires the use of low voltage DC equipment (usually 12 or 24 volt). Alternatively, an inverter can be used which transforms the batteries' 12 /24 volt DC output to 240V AC (the same voltage as your mains supply).

Systems like this can, and often are, used in conjunction with a wind turbine (see information sheet 7 – *Wind energy*) and/or a diesel generator.

#### **Sizing**

For a PV system to be cost-effective, it is crucial that you use electricity sparingly and that your home is as energy-efficient as possible. Make sure your home is insulated to modern standards (call Cornwall Energy Efficiency Advice Centre on 0800 512012 for information on insulation levels and grants available). Use fluorescent lighting in place of filament bulbs (particularly avoid halogen lighting such as the mini-spotlights), ensure all domestic appliances are 'A'-rated for energy efficiency, avoid using electric tumble dryers, do not leave TVs/computers/music systems on stand-by etc.

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A small family in an energy-efficient non-electrically heated home might use around 2000Kwh of electricity per year (a non energy-efficient home might use three times this amount). A 2kWp PV system would be expected to generate towards 1500- 2000kWh per year depending on size and location of the array i.e. equal to most of an energy-efficient family's electricity consumption. With the right tariff, this could result in most/all electricity bills being offset.

## Example Costs

### Grid-connected system:

An installed 1kWp system would cost in the region of:

Photovoltaic panels - £7,000 before grants

Photovoltaic roof slates- £11,000 before grants

### Independent system:

If you buy the components and install it yourself, a 1kW system would cost about two thirds of the above plus the cost of appropriate batteries. Battery cost is entirely dependant on system size, but for example, a 500w array would probably employ a bank of 10 x 110ah (ampere/hours) batteries costing around £45 each for leisure batteries and £140 each for deep cycle batteries.

## Permitted development rights

In England, changes to permitted development rights for renewable technologies introduced on 6<sup>th</sup> April 2008 have lifted the requirements for planning permission for most microgeneration technologies.

The General Permitted Development Order (GPDO) grants rights to carry out certain limited forms of development, without the need to apply for planning

permission. GPDO in England now extends to cover Solar PV.

### Solar PV (roof mounted):

Permitted unless;

- panels when installed protrude more than 200mm.
- panels to be placed on the principal elevation facing onto or visible from the highway in buildings in Conservation Areas and World Heritage Sites.

### Solar PV (stand alone):

Permitted unless:

- more than 4 metres in height
- installed less than 5 metres away from any boundary
- above a maximum area of array of 9m<sup>2</sup>
- situated within any part of the curtilage of the dwelling house or would be visible from the highway in Conservations Areas and World Heritage Sites.

## Grants

From May 2007 the new UK Microgeneration Certification Scheme came into force replacing the existing Clear Skies accredited installer scheme. Therefore grants will now only be available to persons using both a BRE certified product and installer.

Visit [www.lowcarbonbuildings.org.uk](http://www.lowcarbonbuildings.org.uk) for more information.

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## **More Information**

### **Installers**

Please refer to the Low Carbon Buildings Programme's approved installer list for grant-funded installations. You can call them on 0800 9150990 or go to

[www.lowcarbonbuildings.org.uk](http://www.lowcarbonbuildings.org.uk)

### **Some installers working in Cornwall:**

<b>Company</b>	<b>Telephone</b>	<b>Website</b>
Beco Solar	01803 833636	<a href="http://www.becosolar.com">www.becosolar.com</a>
Microgeneration	0845 4348084	<a href="http://www.microgeneration.com">www.microgeneration.com</a>
Plug into the Sun	0844 8009512	<a href="http://www.plugintothsun.co.uk">www.plugintothsun.co.uk</a>

For up to date lists of local installers visit: <http://www.csep.co.uk/page140g.html>

*We advise that you obtain at least 2 comparable written quotes from different installers and check the VAT discount for renewable technologies has been applied. For more information on VAT discounts, please see:*

[http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?\\_nfpb=true&\\_pageLabel=pageVAT\\_ShowContent&id=HMCE\\_CL\\_000514&propertyType=document#downloadopt](http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageVAT_ShowContent&id=HMCE_CL_000514&propertyType=document#downloadopt)

### **Other information:**

Cornwall Energy Efficiency Advice Centre	0800 512012	<a href="http://www.cep.org.uk">www.cep.org.uk</a>
Energy Saving Trust		<a href="http://www.energysavingtrust.org.uk">www.energysavingtrust.org.uk</a>
PV-UK. The trade association of the UK PV industry		<a href="http://www.greenenergy.org.uk/pvuk2/">http://www.greenenergy.org.uk/pvuk2/</a>
Western Power – Distribution Network Operator for the South West	0845 601 2989	<a href="http://www.westernpower.co.uk">http://www.westernpower.co.uk</a>

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