



Solar photovoltaics



What is it?

Certain materials produce an electric current when exposed to light known as a photovoltaic (PV) effect. The use of this phenomenon is widespread from consumer products like watches and calculators to households providing some of their own electricity needs. There are about 1500 buildings in the UK benefiting from this technology whilst Germany by contrast has 100,000 installations. PV arrays may be roof mounted or incorporated into a buildings 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 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 generates particles with positive or negative charge which move randomly in all directions within the cell. The electrons (negative) tend to collect in the n-type semiconductor, whilst the positive charged particles move to the p-type semiconductor. When an external load, such as an electric bulb or an electric motor, is connected between the front and back electrodes, electricity flows in the cell.

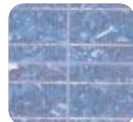
PV cells work in daylight and the greater the intensity of the light, the greater the electricity generated. The electricity from a single cell is low so many cells are connected to form a solar panel. Small panels may be joined together in what is called a PV array.

PV arrays are rated in peak watts (Wp). This is the maximum power that a panel will produce in very bright sunlight and this depends on several factors:

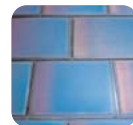
- the size and number of panels – more and bigger gives more power.
- the strength (intensity) of the sun - greatest when the sun is high in the sky.
- how long the sun shines on the panels - clear summer days are best, and avoid shading
- angle and direction of panels - roofs inclined at 35-37° and due south are best, but SE to SW are nearly as good.
- the efficiency of the panels. This varies with the three types of panel:



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



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



Amorphous, thin film 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 very 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 any excess electricity can be 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. With a typical system efficiency of 10% a 1 kWp PV array might produce 1100 kWh of electricity per annum. This would be sufficient to provide the base-load of your electricity use i.e. things that are left on all the time such as fridges and electric clocks. This is about 33% of your yearly requirements.

How much roof space is required?

A 1 kWp system would require an area of 10 m² of south facing roof space. As for solar water heating, if your roof, or a wall, 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 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 £6,000 - £ 9,000 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.

It is most cost effective to use all the electricity that you produce. However, if you wish to export surplus to the grid you will need an export metre costing £400. If a house already requires re-roofing, it becomes more economical as the savings on building materials can counter the cost of the PV system.

Can I get a grant?

Grants are available from the Government's Low Carbon Buildings Programme for households, at a maximum of £3,000 per kWp installed, up to a maximum of £ 15,000 and subject to an overall 50% limit of the total installed cost. Community groups can get 50% funding through this same programme and can also apply to energy companies with green energy funds.

What is the pay back?

An £8000 PV system producing 1100 kWh per annum would save about £154 against electricity bought on a green tariff. The system would be expected to last for 25-30 years but electricity prices would need to increase by a further 50-60% to see a pay back during its life time even with a grant. The Government are looking at ways to make solar PV more cost competitive such as price banding (a guaranteed electricity price set above other more mature

renewable technologies) but this won't come in until at least 2010, if at all.

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



PV roofs on ecohomes

Are there any planning issues?

Always check with your local authority, before installing a system. The visual impact of PV systems is an issue for listed buildings, in conservation areas and Areas of Outstanding Natural Beauty (AONBs). Planning permission is required under current regulations if the system is planned for a front roof slope or visible from the public domain.

What is the potential for this technology in Dorset?

In relative terms, PV technology is still a very expensive form of electricity generation. However, the efficiency of solar cells is slowly starting to increase, and as the market grows, mass production will hopefully lead to a reduction in the price of PV modules. 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.

Pros and cons of photovoltaics

Pros

- Easy to integrate into existing buildings
- Virtually no maintenance

Cons

- Most expensive micro renewable technology with no payback
- Might require lifestyle changes to gain maximum benefits
- Need large area of roof space and aspect between SE and SW
- 5 year carbon payback



(Energy Saving Trust)

PV installers operating in the South West

It is best to check that a product and installer are approved by the Low Carbon Buildings Programme. Always get several quotes before committing to an installer.

| Company | Telephone | Web address |
|----------------------------------|---------------|--|
| BP Alternative Energy | 01932 764800 | www.bpsolar.co.uk |
| Barum Solarheat | 01271 343377 | n/a |
| Beco Solar | 01803 833 636 | www.becosolar.com |
| Cholwell Energy Systems Ltd | 01803 762628 | www.cholwell.org.uk |
| Equinox Renewable Energy Ltd | 01425 673560 | www.equinox-energy.co.uk |
| ICB | 01202 579208 | www.alwithra.co.uk |
| Imagination Solar Ltd | 0117 9426668 | www.imaginationsolar.com |
| PV Facades | 01794 830154 | www.pvfacades.co.uk |
| Plug into the Sun | 01736 871291 | www.plugintothesun.co.uk |
| Solarsense UK Ltd | 01275 394139 | www.solarsense-uk.com |
| Sunpowered Energy Systems Ltd | 02392 614925 | www.sunpowered.co.uk |
| Sustainable Energy Installations | 01256 392704 | www.sei-energy.co.uk |

More information

| | | |
|----------------------------------|--------------|--|
| British Photovoltaic Association | / | www.pv-uk.org.uk |
| Renewable Energy Association | 0207 7471830 | www.r-e-a.net |
| Energy Saving Trust case studies | 08451 207799 | www.est.org.uk/myhome |
| Renewable Energy Officer | 01305 228530 | k.lindegaard@dorsetcc.gov.uk |
| Low Carbon Buildings Programme | 0800 9150990 | www.deac.co.uk |
| Dorset Energy Advice Centre | 0800 512012 | www.deac.co.uk |
| Dorset Agenda 21 | 01305 213721 | www.dorsetagenda21.org.uk |