Dorset Agenda 21

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SOLAR PHOTOVOLTAIC (PV) FACT SHEET

BACKGROUND: a long history, through transistors to rocket science.
In 1839, Becquerel discovered that certain materials produced an electric current when exposed to light. This **photovoltaic (PV) effect** means turning light (photo) into electrical (volts) energy. In 1948, researchers in America at Bell Telephone Laboratories developed the **transistor,** using semiconductors like **silicon**. Then, in 1959, solar PV cells, made in a similar way to transistors, were used to power the second US space satellite, Vanguard 1. From then on, the aerospace and electronics industry made rapid progress in increasing the efficiency of PV cells, while reducing their cost and weight.

THE PRESENT DAY
Now the terrestrial use of PV panels is widespread, from consumer products like watches and calculators to grid-linked households, providing some of their own electricity. There are even some small PV power stations, also linked to the local utility grid. Efficiencies have risen (to around 18% for the best silicon PV modules) while costs have fallen, to around £ 2 per peak watt for bulk purchasers. Unfortunately, we consumers will have to pay about twice that sum per peak watt for the relatively small number of panels we may buy!

THE POTENTIAL IN BRITAIN: enormous!
It is estimated that about half of the buildings in Britain (including our 24 million homes) are suitable for solar PV installations, mostly as grid-linked systems. The main barrier to this **microgeneration**, households generating their own electricity, is the high capital cost of the PV panels, but this cost is steadily falling and there are grants available to greatly reduce this initial high cost. I had installed a 5.1kWp solar PV roof at a school in Hertfordshire, with a 65% government grant and a 35% grant from the electricity supply company. Thus the cost to the school was minimal and they have their own mini-power station running for the next 20 – 30 years

HOW DOES IT WORK?
Most PV cells are made from the very plentiful element silicon – every grain of sand contains silicon as silicon dioxide – by adding tiny amounts of the elements boron and phosphorous to very pure molten silicon. This “doping “ process gives two very thin layers:

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

When light shines on the top layer, electrons are “excited”, gain energy and flow from bottom to top of the PV cell. Thus electricity (which is a flow of electrons) will flow through an external circuit. PV cells work in daylight to generate electricity and do not need direct sunlight, but the greater the intensity of the light, the greater the current of electricity. Most PV panels are made up of cells, each of which produces about 0.5 volts (V), connected up to give 12 V DC. Bigger panels give more current (amps) and so produce more power (watts). Panels are made in a range of sizes from about 10 watts (W) up to 120 W or more. The peak power rating (e.g 120 Wp) is the maximum power that a panel will produce in very bright sunlight.

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IS MY HOME SUITABLE FOR SOLAR PV?
As for solar water heating, if your roof, or a wall, faces between East and 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.

SIZE AND PERFORMANCE
The power in watts (W) generated by a PV system 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 – long clear summer days are best.
- angle and direction of panels – S is best, but E to W nearly as good.
- the efficiency of the panels. This varies with the three types of panel:

1. Monocrystalline, made from thin slices cut from a single crystal of silicon. A typical efficiency is 15% and these are the most expensive.
2. Polycrystalline, made from thin slices cut from a block of many silicon crystals. Typical efficiencies are around 12%.
3. Amorphous, thin film, made from a very thin layer of semiconductor atoms deposited on a glass or metal base. Typical efficiency is about 7%.

Individual **cells** are connected to give **panels**/**modules**, usually giving 12V. Panels are linked and sized to meet a particular load/need. These linked panels form an **array** which 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.

CAPITAL COSTS AND GRANTS
The major cost is the array of panels. For an average domestic system, total costs can be around £ 4000 - £ 9000 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. Typical household systems are often around 1.5 – 2.0 kWp and this size array would cover from 10 – 15 sq. m. of roof area. A 2.0 kWp system could provide almost half of of the average family's annual supply, assuming this to be around 4000 kWh (units) per year and also assuming that gas is used for heating.
Grants are available from the government Low Carbon Buildings Programme (LCBP) for households, at a maximum of £ 3000 per kWp installed, up to a maximum of £ 15,000 and subject to an overall 50% limit of the total installed cost.

ARE THERE PLANNING ISSUES?
In a conservation area or with a listed building, you will probably require planning permission. Always check with your local authority, before installing a system.

SOLAR PV INSTALLERS
Check the LCBP website for approved installers in the SW. Your chosen installer must be approved for you to qualify for a grant.

CONTACTS:
Low Carbon Buildings Programme: www.lowcarbonbuildings.org.uk or Tel: 0800 915 0990 for details of the grant scheme and how to apply.
The British Photovoltaic Industry (PV-UK): www.pv-uk.org.uk for useful information
Dorset Energy Advice Centre: Tel: 01202 469907 or www.est.org.uk for advice on energy efficiency measures and on renewable technologies.

John Tomblin, Project Officer, Dorset Agenda 21, 13 Sept 2006

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