FACT SHEET

SevernWye
ENERGY AGENCY

Solar Photovoltaics
Basics

Turning sunlight directly into electrical power

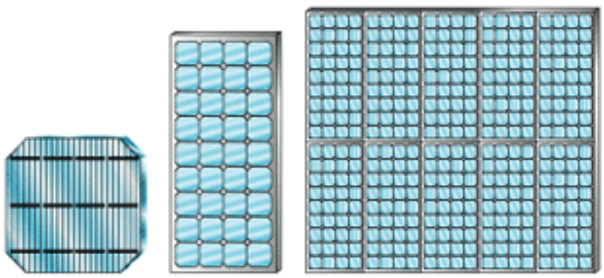
Key Points

- Provides free electricity from the sun—yes, even in the UK on cloudy days!
- No air pollution or emissions in operation
- 25 year lifetime with almost zero maintenance
- Energy cost could match grid electricity before 2020
- Also useful for off-grid sites and small appliances

How does it work?

Electricity can be generated directly from sunlight using solar photovoltaic (PV) cells. These usually comprise layers of doped crystalline silicon sandwiched beneath glass to create a photodiode, arranged such that photons hitting the upper layer create a flow of electrons in one direction across the cell—a direct current (DC).

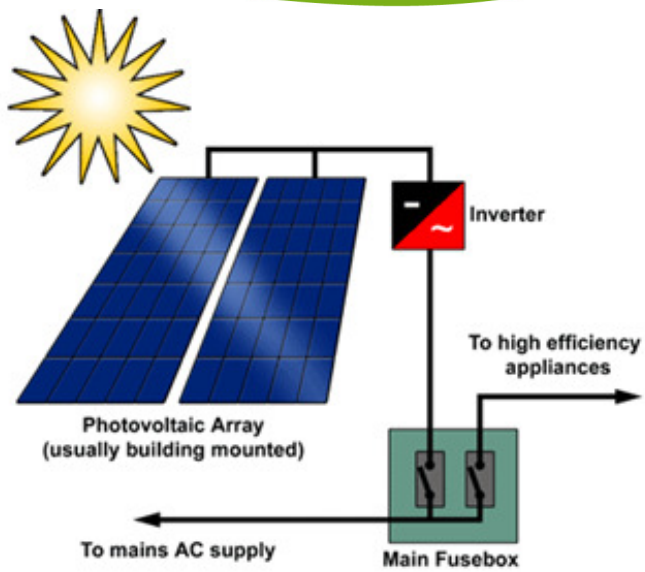
Cells are assembled into modules or panels, which in turn can be linked together into larger arrays. The total output of a PV system depends on the size and efficiency of the panels. There are a number of different panel types, which are suited to different uses.



Cell ***Module*** ***Array***

PV panels in the UK are usually mounted onto the structure of buildings, or built into appliances, rather than deployed as dedicated power plants. This means that their electricity is generated close to where it is needed, minimising transmission losses. Roof-integrated PV modules can fully replace roofing materials and provide weather-proofing.

The energy captured by PV panels can be used directly or stored in batteries for off-grid applications. For the more common grid-connected systems, the DC power is fed through an inverter, which generates AC power at 230V, synchronised with the grid frequency. Three-phase inverters are also available for larger sites. With grid-connected systems, electricity is imported or exported completely automatically, depending on the balance of the building's supply and demand. This means that batteries are not needed. Special meters are installed to record generated or exported units (or both).



The components of a typical grid-connected solar PV system

Performance

In the south-west, a well-positioned roof-mounted PV system will generate 850—900 kWh per year for each kilowatt of rated capacity. A typical 2 kW domestic system will thus produce around 1,700 kWh, which is half the annual electricity consumption of a typical household.

The raw panel efficiency is 13—18%, but this continues to improve with research. Monocrystalline cells, which use single-crystal silicon, achieve higher efficiencies than the common polycrystalline alternatives, albeit at higher cost.

Why is PV important?

By harnessing energy directly from the sun, PV panels produce electricity without releasing carbon dioxide (CO_2), which contributes to climate change.

They do not produce air pollution during operation. Furthermore, the manufacture of PV panels does not cause any major environmental impacts compared to other industrial processes, and silicon modules are largely recyclable.

Solar photovoltaics have been used to power spacecraft since the 1960s, but are only now experiencing a global boom in production and deployment on land. The technology is readily applicable to domestic, commercial and public sector buildings in both rural and urban settings, and PV is likely to become a common sight in these latitudes.

Clockwise from top left: PV shingles, roof-mounted PV modules, thin film PV glass laminates, PV tiles (Pictures courtesy of Solar Century)

How much does it cost?

Solar PV has long remained quite expensive compared to other power generation technologies, but costs have fallen consistently over the last three years. Typical prices now range from **£3,800** to **£5,000** for each kilowatt of installed capacity (kWp), depending on the system type.

Research by the PV industry and environmental groups suggests that, with the right level of investment, PV could be competitive with fossil-generated electricity by the end of this decade, and the feed-in tariffs—already very successful in Europe—will accelerate this progress.

In off-grid locations, PV can used to charge a bank of batteries in order to provide an electricity supply; this can be a cost-effective option when set against the cost of bringing in a new grid link over even short distances.

Maintenance

PV panels require minimal maintenance, and are designed for a 25-year working life, with performance even after 30 years being 80% of that when new. Although the panels need to be reasonably clear of dust and debris, the rain is sufficient to clean them on a standard pitched roof.

Siting a PV system

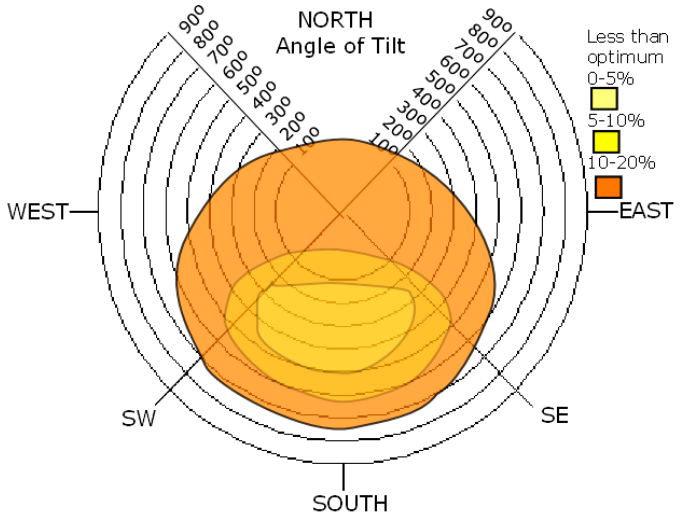
Look for a roughly SE to SW facing location (the closer to due south the better). Shading of PV panels severely reduces the amount of energy produced, so it is vital to choose a site that is unshaded for the majority of the time.

PV can be placed on pitched roofs or even vertical walls. On horizontal surfaces, such as flat roofs, panels can be frame-mounted to raise them to optimum elevation. PV does not have to be located on the roof; It could, for example, be ground-mounted or attached to a pergola in the garden.

Common examples of off-grid PV siting are:

- Remote households or telecommunications systems.
- Remote holiday chalet or a boat; where the electricity demand is highest in the summer, when a PV system is most productive.

Small appliances powered by their own PV panel and battery are now common. Examples of these are: torches, radios, battery chargers, garden lights and fountains, door-bells and even road signs.



Solar capture chart—variation with orientation and tilt

Tariffs

Although mainstream grant support for PV has now ended, Britain's new **feed-in tariffs** mean that payback times are shorter than ever, with 11 years being achievable. The following fixed unit rates are payable since April 2010, for all solar PV systems installed after July 2009:

- Solar PV new build (< 4 kW) **36.1** p/kWh
- Solar PV retrofit (< 4 kW) **41.3** p/kWh
- Solar PV retrofit (4—10kW) **36.1** p/kWh

These rates are paid for all units generated, and are index-linked and guaranteed for 25 years.

Further Information

Microgeneration Certification Scheme
Find approved PV products and installers
www.microgenerationcertification.org

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