Welcome to the PH Jones introduction to **Photovoltaic solar systems**

phJones

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THE PRINCIPLE

Photovoltaic solar systems convert light energy produced by the sun into direct current (DC) electricity. This electricity is then converted into alternating current electricity and rectified to a voltage that is useable for your property. In the UK this would be 220-240v AC. The device that converts the electricity from DC to AC and regulates the voltage is called an inverter.

Contrary to popular belief solar systems don't have to face south although this orientation gives the best peak performance. Having an array on the east and west elevations of a roof will give a more even power generation throughout the day.

INVERTERS

Inverters come in three main types, all are designed to achieve the same result, however certain technologies have advantages over others, including safety, efficiency and future expansion being the advantages of certain designs. The three main types are:

STRING INVERTERS

String inverters are the most common type of inverter found on solar PV systems. These are the original type of inverter and the most cost-effective option. They connect to the solar panels by chaining up the panels (called a string of panels) and connecting the DC output of the panels directly to the inverter. This design is ideally suited to installs where cost is a driver and the roof is simple with no shading. The disadvantage of this design is that if one panel in the string were to become fouled or shaded this would not just reduce the efficiency of the affected panel, it would in fact bring the entire string down to the reduced efficiency of the affected panel.

OPTIMISED STRING INVERTERS

Optimised string inverters work in much the same way as string inverters but have the addition of optimisers that connect directly onto the rear of each panel. This technology gives two main advantages

1. Each panel is optimised at panel level meaning that if one panel were to be fouled or shaded only the impacted panel will lose efficiency. The other panels on the string will maintain their own individual optimum generation..
2. Optimisers have the ability to shut down the voltage at panel level, this is a major improvement in safety, as with a standard string inverter if you isolate the inverter and the sun is out every DC cable from the panels to the inverter remain live. DC electricity is considered more dangerous that AC electricity as it attracts rather than repels. If you were to touch an unshielded live AC cable it is likely to give you a shock and repel you, sometimes across the room. If you were to put your hand on a live DC cable the direct current will cause your muscles to contract and grip onto the cable prolonging the duration of the shock. The inability to isolate the DC cables is a particular risk for works around these cables and to the fire service, if they attend a fire at your property during daylight hours there is an electrical contact risk even with the string inverter isolated. However, with optimisers fitted when the inverter is shut down the DC cabling in the loft is also reduced to a safe level by the optimiser on the back of each panel improving system safety.

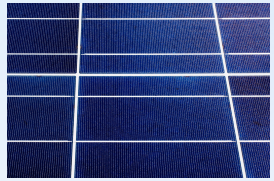
These units are usually slightly higher cost than a standard string inverter but have improved efficiency and safety.

MICRO INVERTERS

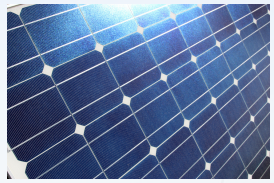
Micro inverters are as the name suggests much smaller inverters and are designed to support a single solar PV panel. They fix to the back of an individual panel and convert the DC electricity into AC of the correct voltage. This gives them the same advantages of optimised inverters with an additional benefit of making the systems modular. When a string inverter system is designed regardless if it is optimised or not, the inverter is sized to the number of panels so if the system were to be expanded increasing the number of panels a larger or second inverter would be needed. With a micro inverter-based system you can easily increase the systems size at any point by simply buying the same number of extra micro inverters as you do panels. Micro inverters are often the costliest inverter option

PANEL TYPES

The two main types of solar panel are mono crystalline and polycrystalline both panels work by converting light energy into DC electricity.



Poly crystalline panels have a blue appearance and are usually made up of rectangular shapes in the panel itself. The efficiency of these panels is slightly less than that of mono crystalline panels with poly being approxomatley 17% efficient and mono 20% meaning that you would need more panels to achieve the same output with poly panels. It is worth noting that any cost saving on the panels themselves may be lost if using optimisers or micro inverters as the more panels will mean more optimisers or microinverters.



Mono crystalline panels have a black or very dark blue appearance they also have rounded edges to each piece of the panel, this can usually be seen if a white backing plate is used as you will see white diamonds where the corners of each piece are rounded. Being a more efficient panel, you would need less panels for the same output system. This is an advantage where using micro inverters or optimisers or where space is an issue. Poly panels are also slightly better in lower light conditions making them better in areas with slight shading etc, although micro inverters and optimisers have overcome this to a large extent.

PVT (photo voltaic thermal) is a hybrid solution combining solar PV and thermal panels. The advantage of this design is to capture the heat energy from the sun at the same time as the light energy. This heat can then be used, with the main uses being to heat up a large body of water like a swimming pool for example or to re charge a ground array in a ground source heat pump system. Recharging the array simply means pumping the heat generated by the panels through the ground loop in the summer, increasing the ground temperature ready for heating demand in the winter. Using this variant of panels with ground source systems can also reduce the number of bore holes needed for the ground array, reducing installation costs for the ground source. Another advantage of solar PVT is that by removing heat from the panels by pumping a glycol solution round them, also cools the PV part of the panel. Solar PV panels loose some efficiency above temperature of 25 degrees Celsius and cooling helps to keep them at optimal operating temperature.

SYSTEM OPTIONS

Home batteries are becoming a popular option they allow any excess electricity generated by the system to be stored for later use. Storing the energy makes it available for the hours that the solar is not generating. Batteries can connect to the solar system in two ways, the most efficient being to connect directly to a DC output on the inverter, this prevents any losses caused by converting to AC and then back to DC for the battery, not all inverters have this option although it is becoming more common. Batteries can also connect via AC, this is not as efficient as connecting via DC although opens batteries up as an option for inverters without a DC output. Some batteries can also support advanced optimisation such as demand response for example.

EV (electric vehicle) charging points can also benefit from the energy generated from a solar PV system. Some inverters can communicate with an EV charger to divert any surplus electricity generated to charge the electric vehicle. A non-connected EV charger fitted to a property with solar PV can still use the electricity generated by the panels, but won't have the smart integration to maximise the amount of surplus electricity used to minimise the energy drawn from the grid.

Hot water cylinder links allow your hot water cylinder to heat up via the immersion heater, by diverting surplus energy generated from going back to the grid. Some of these systems can even modulate down to 100w ensuring even the smallest amount of energy generated can be captured to reduce the homes carbon emissions and energy use.

FIXINGS

Sky hooks are the most common fixing used for residential solar PV installs, they are a metal angled bracket that secures to the rafters, the tile slides back over them and a mounting rail is then secured to multiple sky hooks giving a secure system for the panels to mount to.

Replacement tiles with integrated mounts are designed to be used as a replacement for sky hooks, these completely replace the tiles where a mounting point is needed, then rails are secured directly to a factory fitted mounting point on the tile. This is a more costly option than sky hooks but can be preferential for roofs with delicate tiles.

Frame systems can also be specified to mount panels to a flat roof or in a field etc. The frames can be adjusted to provide the optimum angle for the panels to capture as much light energy from the sun as possible

It is worth noting that when installing solar onto a roof it is advisable to have a structural survey carried out on the roof to ensure the roof can support the additional load