plug into the sun
invest in a brighter future
Unit 5E Longrock Ind Est, Penzance, TR20 8HX
Tel: 0844 800 9512 or Email info@plugintothesun.co.uk
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Factors affecting output

There are six main factors that will affect the output from a solar PV system:

1. **Total size of the PV array**
   Each kWp requires approximately 8m2 of area. Solar PV systems are rated to the maximum that they will produce in kW. This is denoted as the kWp (kilowatt peak).

   A certain area should ideally be left around the perimeter of the array to minimize wind loading and extra turbulence. We aim to leave a border of approximately 1m around all the edges, top, bottom, left and right.

2. **Type of module used**
   Plug Into The Sun are an independent Solar PV installer so we can use the most suitable module for each installation. We only use equipment that has been certified and accredited by the Government on the Green Book Live.

   There are numerous manufacturers and makes of solar modules and different types of technologies. The main ones are:

- **Amorphous**
  These are approximately 8-10% efficient. An advantage of these modules is that they are not too susceptible to shading and are suited to low light levels. We use the UNISOLAR modules. You can even get flexible modules of this type which can be stuck onto a metal seemed roof.

- **Polycrystalline**
  These modules are made from silicon crystals. They are approximately 14% efficient and are extremely good value for money. We use the extremely high quality KYOCERA modules made in Japan. We often use these modules on PHASE 2 installations for the Low Carbon building Partnership.

- **Mono-crystalline**
  These modules are made form pure silicon crystals. These are approximately 16% efficient. We often use SHARP modules - these also have the added advantage of being manufactured in the UK in Wrexham.

- **Hybrid**
  Hybrid modules combine mono-crystalline technology along with amorphous. These are top of the range and have an efficiency of 20%! However they are also the most expensive option. We often use either SUNPOWERED modules or SANYO modules.

3. **The orientation from due South**

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The array should ideally face due south. Any deviation from due south will reduce the potential yearly output.

4. The latitude of the installation

The further south, the better.

5. The angle from horizontal

The ideal angle from horizontal is between 30-45 degrees. Other angles are also suitable but slightly less efficient. To capture the maximum amount of solar radiation over a year, the solar array should be tilted at an angle approximately equal to a site's latitude, and facing within 15° of due south. To optimize winter performance, the solar array can be tilted 15° more than the latitude angle, and to optimize summer performance, 15° less than the latitude angle. At any given instant, the array will output maximum available power when pointed directly at the sun.

To compare the energy output of your array to the optimum value, you will need to know the site's latitude, and the actual tilt angle of your array-which may be the slope of your roof if your array is flush-mounted. If your solar array tilt is within 15° of the latitude angle, you can expect a reduction of 5% or less in your system's annual energy production. If your solar array tilt is greater than 15° off the latitude angle, the reduction in your system's annual energy production may fall by as much as 15% from its peak available value. During winter months at higher latitudes, the reduction will be greater.

6. Anything which shades the panels

Shading of a module can dramatically reduce the output from the whole array. Shading should therefore always be avoided, especially from any trees or buildings to the South of the array.

PV modules are very sensitive to shading. Unlike a solar thermal panel which can tolerate some shading, many brands of PV modules cannot even be shaded by the branch of a leafless tree.

Shading obstructions can be defined as soft or hard sources. If a tree branch, roof vent, chimney or other item is shading from a distance, the shadow is diffuse or dispersed. These soft sources significantly reduce the amount of light reaching the cell(s) of a module. Hard sources are defined as those that stop light from reaching the cell(s), such as a blanket, tree branch, bird dropping, or the like, sitting directly on top of the glass. If even one full cell is hard shaded the voltage of that module will drop to half of its unshaded value in order to protect itself. If enough cells are hard shaded, the module will not convert any energy and will, in fact, become a tiny drain of energy on the entire system.

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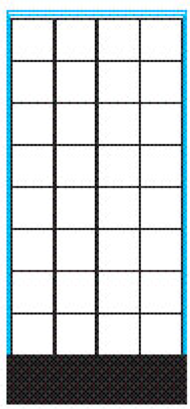
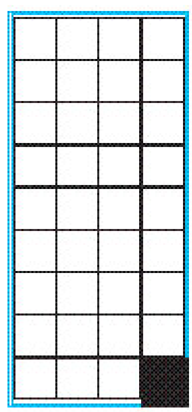
Partial-shading even one cell of a 36-cell module, such as the KC120, will reduce its power output. Because all cells are connected in a series string, the weakest cell will bring the others down to its reduced power level. Therefore, whether ½ of one cell is shaded, or ½ a row of cells is shaded as shown above, the power decrease will be the same and proportional to the percentage of area shaded, in this case 50%.

When a full cell is shaded, it can act as a consumer of energy produced by the remainder of the cells, and trigger the module to protect itself .The module will route the power around that series string. If even one full cell in a series string is shaded, as seen on the right, it will likely cause the module to reduce its power level to ½ of its full available value. If a row of cells at the bottom of a module is fully shaded the power output may drop to zero. The best way to avoid a drop in output power is to avoid shading whenever possible.



Example of full-cell shading that can reduce PV module power to zero



Example of full-cell shading that can reduce PV module power by ½