HIenergy
HIGHLANDS AND ISLANDS OF SCOTLAND
HARNESSING NATURE'S POWER

Factsheet

Solar Photovoltaics


Image Courtesy of SgurrEnergy

Solar Photovoltaic cells (Solar PV for short) convert the energy contained in the sun's rays into DC electricity.

PV cells consist of a silicon based semiconductor. There are three principal types of cell:

- Monocrystalline (£3-4/Wp)
- Polycrystalline (£3-4/Wp)
- Amorphous Silicon (£1-2/Wp)

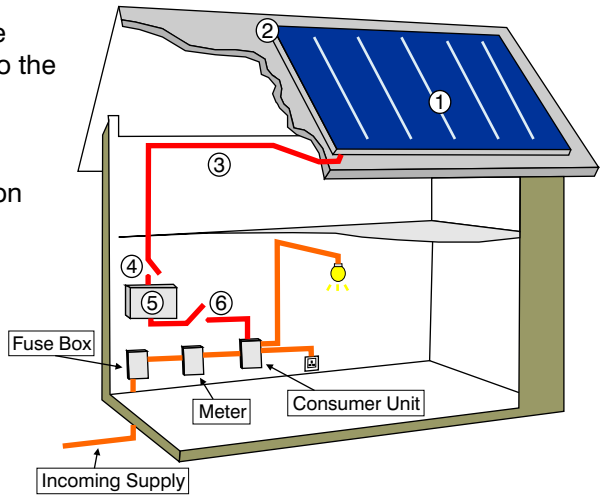
Cells are connected in series to form modules. When the silicon is exposed to light, an electrical charge is generated. The greater the intensity of light, the greater the level of electrical charge. Typical modules have a rated power output of around 75 - 120 Watts peak (Wp). A domestic system of 1.5 - 2 kWp may therefore comprise some 12 - 24 modules covering an area of 10-20m^2.

In a domestic installation PV modules are mounted onto an array and fixed to a building's roof. The electricity generated by them can then be converted to AC electricity for use within the property or sold back to the grid.

The components of a typical grid connected domestic PV installation are shown here.

1) PV Array
2) Roof Support Structure
3) DC and Earth Cable
4) DC Switch Disconnector
5) Inverter
6) AC Switch Disconnector

For a domestic installation suppliers will normally offer a 12 month warranty on the system, together with 2 years on the inverter and a performance warranty of 10 - 25 years on the modules.



If you require further information, please contact the renewable energy team at Highlands and Islands Enterprise
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Solar Photovoltaics
Costs & Considerations

Costs
Typical domestic solar PV installations range in size from 1 to 2kWp and would cost from £7,000 to £12,000 fully installed.

At these prices PV is an expensive renewable energy generation method. Their application can look more viable if installed in an off grid area. Some PV products (e.g. solar tiles - shown below) also have the potential to replace traditional building materials therefore negating the cost associated with purchasing them.


Image Courtesy of SolarCentury.com

Installation
PV systems should only be installed by accredited professionals. This is also likely to be a requirement to obtaining grant funding. A link to accredited installers located throughout the UK can be found in the 'Useful Links' section at the end of the factsheet

Stand Alone Systems
PV installations are well suited to off-grid applications, where a grid connection is not available or too expensive to obtain. In Scotland PV is often used to power telecommunications masts or road signs. They can also be used to provide power to caravans and boats. Such systems would normally use batteries to store the power in which case a suitable charging regulator would be required for protection.

If larger amounts of electricity are required PV can be combined with another stand alone source of power - e.g. a wind turbine or diesel generator to form a hybrid power supply system.

Connecting to the Grid
As well as generating electricity that can be consumed in your property, there may be times when your PV system produces more than you need. In this situation, any surplus electricity will be fed into the local network. It is the responsibility of the installer to contact the local Distribution Network Operator to advise that a new PV system is being connected in their area. It is also their responsibility to ensure your system is installed according to the existing electrical installation regulations (known as G83/1).

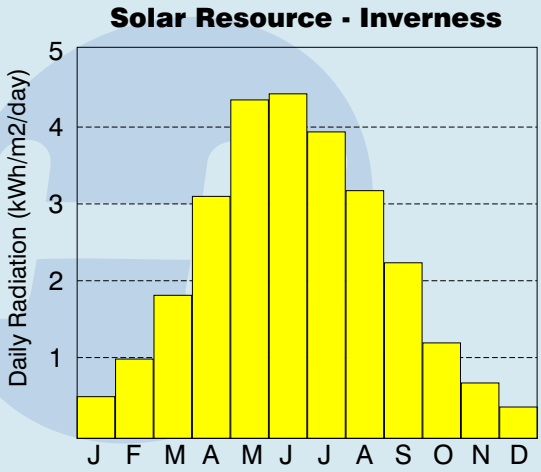
Being connected to the grid also has other benefits. As a renewable energy producer you should be eligible to accrue ROCs on the electricity you generate. ROCs can be traded thus improving the economics of your project. For small scale generators this can be a complex process. To remove this complication you may wish to investigate signing up with a green energy supplier who will take care of the whole ROC process and purchase the electricity you generate. Your PV supplier will be able to advise on which option suits you best. This will be dictated by factors such as how much excess electricity you generate.

Performance
The output of a PV system depends on a number of factors including orientation, pitch, shading and available solar resource (see foot of page).

The DTI state that an average grid connected PV system in the UK (unshaded, inclined and south facing) can be expected to generate around 750 kWh per kWp per year.
A 1.5-2kWp installation would therefore generate around half of a typical three bedroom home's electricity requirements.

Maintenance
The lack of moving parts within a PV system means that maintenance requirements are minimal. Arrays should be checked periodically to ensure they are clean and free from debris.


A PV array installed upon a caravan



Solar Resource in the Highlands and Islands
The power density of solar energy is made up of two components, the radiation in the direct beam from the sun, and diffuse radiation from the sky. Solar PV is able to harness both components. On a clear day diffuse energy may amount to 15-20% of the global irradiance whereas on a cloudy day it will be 100%. Global irradiance varies throughout the course of the day because the path length of the solar radiation through the atmosphere changes. For the same reason, there are variations with season and latitude. The total solar energy received in a day (known as the insolation or solar irradiation) can vary in the UK from around 0.5kWh/m^2 in the winter to 5kWh/m^2 in the summer. The graph opposite shows the typical solar resource available to Inverness throughout a year. This variability is an important aspect of any solar energy project as it will influence system design and economics.

If you know the Latitude and Longitude of your property you can calculate the solar resource available to it by following the link at the end of the factsheet.

Solar Photovoltaics
Is My Property Suitable?

Not all properties will be suitable for the installation of solar PV.

As virtually all domestic schemes will have the array mounted on the roof, the setting and orientation of the dwelling will have an effect on the performance of any installation.

Orientation & Tilt
Arrays should be oriented to maximize the level of daily and seasonal solar energy that they receive. The optimum orientation for a PV array in Scotland is due south.

Where this is not possible it should at least face within 45 degrees (east or west) of due south as per Figure 1.

As most arrays will be mounted on the roof of a property they will share the same tilt as that of the roof.

The optimum tilt for PV is between 30 and 40 degrees from horizontal. Should your roof have a tilt that is 20 degrees either side of optimum it will only suffer a reduced output of about 5%.

Overshading
Even a small degree of shading on part of the array can have a very significant impact on its overall output. This is because the cell with the lowest illumination determines the operating current of the series in which it is connected. Bearing in mind that the sun moves throughout the day the array should be positioned carefully so as to avoid all potential obstructions.

Planning Permission
PV arrays are generally integrated into the slope of a property's roof. This method of installation gives the collector the appearance of a rectangular glass skylight. In Scotland, such installations are generally regarded as permitted development and will not require planning permission.

There may be circumstances where permitted development status does not apply (installing upon a listed building or in a conservation area) therefore it would be prudent to first check with your local planning department.

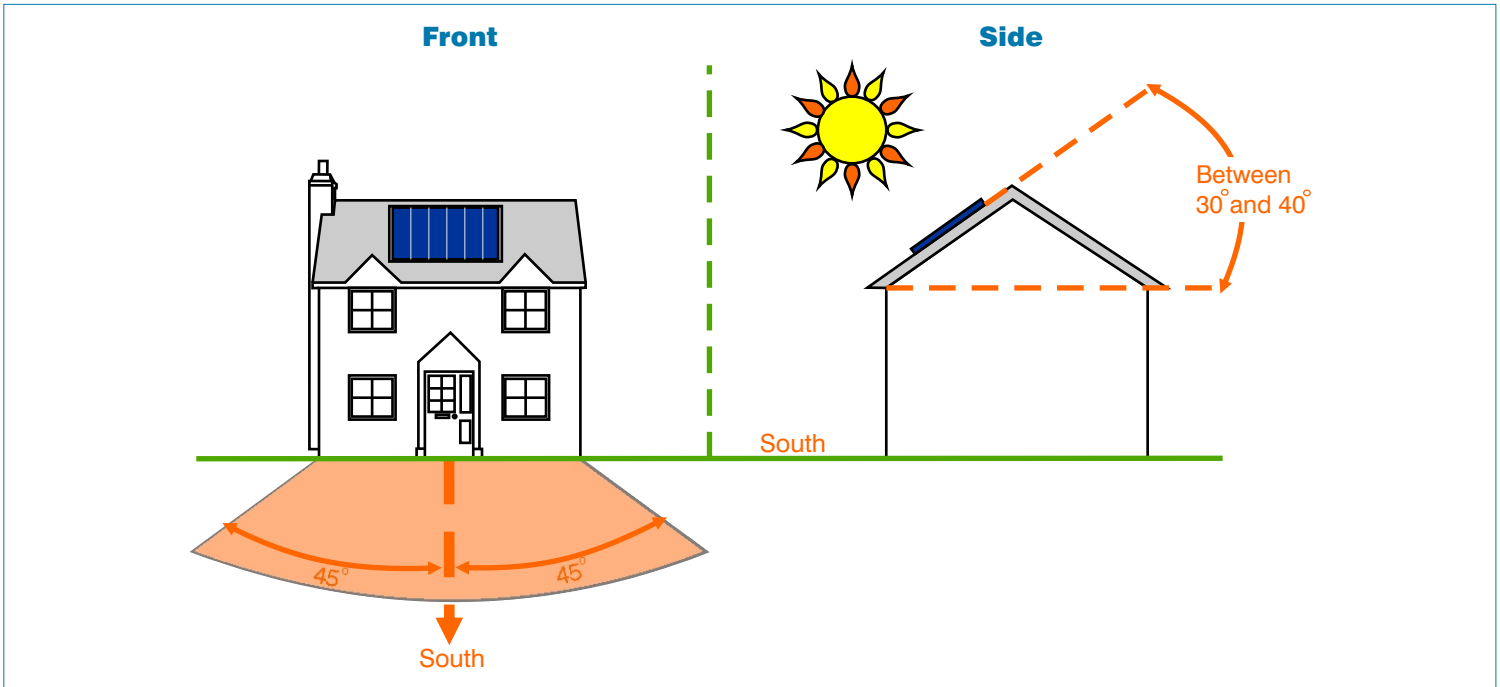


Figure 1: Optimum Orientation and Tilt of a Solar PV Array

Useful **Links**

The Energy Saving Trust - Solar PV
www.energysavingtrust.org.uk/generate_your_own_energy/types_of_renewables/solar_pv

British Photovoltaic Association
www.greenenergy.org.uk/pvuk2

Scottish Solar Energy Group
www.sseg.org.uk

NASA Surface Meteorology and Solar Energy Data - Calculate the solar resource at your property
http://eosweb.larc.nasa.gov/sse/RETScreen

A comprehensive list of accredited manufacturers and installers of PV equipment can be found here
www.lowcarbonbuildings.org.uk/info/installers