

Solar for the grid



Solar photovoltaic (PV) modules (for example: [SUNJACK 20W PORTABLE SOLAR CHARGER](#)) generate electricity from sunlight, which can be fed into the mains electricity supply of a building or sold to the public electricity grid. Reducing the need for fossil fuel generation, the growing grid-connected solar PV sector across the globe is helping create jobs, enabling families and businesses to save money, and cut greenhouse emissions.

How grid-connected PV systems are used

Most grid-connected PV systems are installed on the roof or walls of a building. This does not take up land that could be used for other purposes like agriculture. Ideally the PV faces towards the equator but the exact direction is not critical. However, it is important to make sure that there is minimal shading of the PV. If the PV electricity production exceeds building demand then the excess can be exported to the grid, and vice versa.

A typical grid connected system rated at 1 kWp has an area of between 5 and 6 m². If the PV system is installed during construction or refurbishment, it can sometimes be used as part of the

building fabric, such as a roof or wall-cladding. Ashden Award winner Solarcentury has integrated PV arrays into a wide range of buildings.

Where space and sun are available, large stand-alone PV arrays can be built and connected to the public grid. In 2016, several solar farms in excess of 500 MWp were in operation around the world, with many more planned.

Until recently, grid-connected systems have not usually included batteries for storage, because the mains grid can accept or provide power as needed. However, if rechargeable batteries are included, a grid-connected PV system can be used as a standalone ac supply in the event of a power cut, to allow essential loads to keep working. Ashden winner Deng solar provided a 9.2 kWp grid backup system for the central courts in Accra, Ghana, which maintains lighting and thus enables court business to keep going during power cuts. The Aryavart Gramin Bank has provided PV grid backup systems for its rural branches, so that their IT systems and cash machines still work during power cuts and voltage fluctuations. Battery storage is also being added to grid-connected solar in Europe, the USA and elsewhere to enable energy generated in the day to be stored for use at night, and to provide grid balancing services.

Benefits

By reducing the need for fossil-fuel generation, grid-connected PV cuts greenhouse gas emissions (and other air pollution), because no emissions are produced during PV operation.

In the past there has been concern about the greenhouse gases emitted ('embodied') in the manufacture of PV systems, particularly in the production of ultra-pure semiconductors. With current production techniques, these embodied greenhouse gases are saved within 0.7 to 2 years of use of grid-connected operation, depending on the amount of sunlight.

PV is the easiest renewable electricity source to incorporate into buildings. The electricity is supplied at the point of use, thus avoiding the losses which occur in electricity distribution (these average 7% in the UK). It can be used at any scale – from less than 1 kWp on an individual home up to MWp scale systems on large public buildings – and is simple and reliable.

Because of this, it is a valuable way to raise awareness of electricity supply and use, and helps highlight the potential for renewable energy. Several schools that have won Ashden Awards like Home Farm Primary School and Sir George Monoux College have installed PV, to supply part of their electricity and as an education aid.

How it works

PV modules use semiconductor materials (usually silicon) to generate dc electricity from sunlight. A large area is needed to collect as much sunlight as possible, so the semiconductor is either made into thin, flat, crystalline cells, or deposited as a very thin continuous layer onto a

support material, usually glass. The cells are wired together and sealed into a weatherproof module, with electrical connectors added. Modern modules for grid connection usually have between 48 and 72 cells and produce dc voltages of typically 25 to 40 volts, with a rated output (see below) of between 150 and 300 Wp.

According to stats from 2016

In order to supply energy into a mains electricity system, the dc output from the module must be converted to ac at the correct voltage and frequency. An electronic inverter is used to do this. Generally, a number of PV modules are connected in series to provide a higher dc voltage to the inverter input, and sometimes several of these 'series strings' are connected in parallel, so that a single inverter can be used for 50 or more modules.

Modern inverters are very efficient (typically 97%), and use electronic control systems to ensure that the PV array keeps working at its optimum voltage. They also incorporate safety systems as required in the country of use. Ashden winner Deng solar provided a 9.2 kWp grid backup system for the central courts in Accra, Ghana

Output

PV modules are specified by their 'watt-peak' (Wp) rating, which is the power generated at a solar radiation level of 1000 W/m², equivalent to bright sun in the tropics, and a temperature of 25°C. In practice, the actual power produced is affected by the weather, the angle of the sun relative to the panel, the temperature of the panel and whether the panel is free from dust and bird droppings. Even when conditions are not ideal, solar PV still produces a useful power output.

Cost

The capital cost of grid-connected PV varies between countries. As a guide, for the UK in 2016 the typical installed cost for a domestic system was £1,250-£2,000 per kWp, while a large solar farm cost around £1,100 per kWp. In Africa, the typical cost for a large-scale project was around \$1,400 per kWp in 2016, while in the USA it was around \$2,000 per kWp. The PV modules account for about a third of the cost, while the inverter, frame, wiring and labour for the rest. Costs have decreased substantially over the past three decades.

Translating these installed costs to the cost of electricity depends on a number of factors, most important being the location and orientation of the panels – sunnier locations will result in higher generation, as will having the panels angled towards the sun (i.e. facing south in the northern hemisphere).

In the past, the cost of electricity from solar PV has been higher than the consumer price for grid electricity, and substantially higher than the cost of fossil-fuel generation, so a number of

governments offered subsidies to support the industry. However, by 2016 the levelised cost of electricity from solar PV had dropped below the consumer price in several countries, and this trend is expected to continue.

The future

The future The price of PV modules has decreased rapidly in the past, although the rate of decrease has been slower since 2012. For crystalline cells, new ways of processing silicon and increased volume manufacture are driving down prices. The market share of thin film PV is growing rapidly as materials which have been proved in the laboratory go into volume production, and these promise even greater price reductions. The future potential for price reduction greater for the 'balance of system' than for PV modules or inverters, and these costs already dominate the overall system cost.

Because of the decreasing prices, the rapid growth in the market for grid-connected PV is expected to continue even if government support is reduced. The market is beginning to take off in regions where electricity from PV is cheaper than consumer grid prices. This is already the case in sunny regions, and will become more widespread as prices fall. Roadmaps produced in 2016 suggest that by 2030 PV could be supplying about 13% of global electricity.