

# Types of Photovoltaic Systems

Last week we talked about how the photoelectric system works. This week we shall look at the different types of PV systems.

Photovoltaic power systems are generally classified according to their functional and operational requirements, their component configurations, and how the equipment is connected to other power sources and electrical loads. The two principal classifications are grid-connected or utility-interactive systems and stand-alone systems. Photovoltaic systems can be designed to provide DC and/or AC power service, can operate interconnected with or independent of the utility grid, and can be connected with other energy sources and energy storage systems.

## Grid Connected PV Systems

Grid-connected or utility-interactive PV systems are designed to operate in parallel with and interconnected with the electric utility grid. The primary component in grid-connected PV systems is the inverter. The inverter converts the DC power produced by the PV array into AC power consistent with the voltage and power quality requirements of the utility grid, and automatically stops supplying power to the grid when the utility grid is not energized. A bi-directional interface is made between the PV system, AC output circuits and the electric utility network, typically at an on-site distribution panel or service entrance. This allows the AC power produced by the PV system to either supply on-site electrical loads, or to feed the grid when the PV system output is greater than the on-site load demand. At night and during other periods when the electrical loads are greater than the PV system output, the balance of power required by the loads is received from the electric utility. This safety feature is required in all grid-connected PV systems, and ensures that the PV system will not continue to operate and feed back into the utility grid when the grid is down for service or repair. This is very important in order to safeguard anyone working in the grid when it is down.

## Equipment Requirements for a grid fed system

- Solar PV Panels / PV Modules - The head end of a PV system that converts daylight into electrical current. As well as traditional Solar Panels, Solar PV panels can also be integrated into building materials where you may have traditionally used glass such as into canopies, skylights and balconies.
- A Grid-Tie Inverter - Is used to convert DC power into AC power ready for use and export to the grid.
- Cables & Accessories - Used to safely connect the various components, cables should be specified in relation to the maximum load current and the potential operating temperatures.
- Isolators - Used to disconnect parts or all of the system for maintenance and/or in an emergency.
- Mounting System - There is a wide choice of mounting systems. Solar PV panels and modules can be mounted onto roofs (bolted on top or integrated within) Free Standing Frames and Building Integrated PV solutions are also available.
- Monitor - Used for measuring how much energy is being generated.
- Export Meter - An export meter monitors how much electricity is generated in kWhrs, Most meters will also show you at a glance how

much electricity is being generated at the time..

## Stand-alone PV systems

Stand-alone PV systems are designed to operate independent of the electric utility grid, and are generally designed and sized to supply certain DC and/or AC electrical loads. These types of systems may be powered by a PV array only, or may use wind, an engine-generator or utility power as an auxiliary power source in what is called a PV-hybrid system. The simplest type of stand-alone PV system is a direct-coupled system, where the DC output of a PV module or array is directly connected to a DC load. Since there is no electrical energy storage (batteries) in direct-coupled systems, the load only operates during sunlight hours, making these designs suitable for common applications such as ventilation fans, water pumps, and small circulation pumps for solar thermal water heating systems. Matching the impedance of the electrical load to the maximum power output of the PV array is a critical part of designing well-performing direct-coupled system. For certain loads such as positive-displacement water pumps, a type of electronic DC-DC converter, called a maximum power point tracker (MPPT), is used between the array and load to help better utilize the available array maximum power output.

## Equipment Requirements for an off-grid PV System

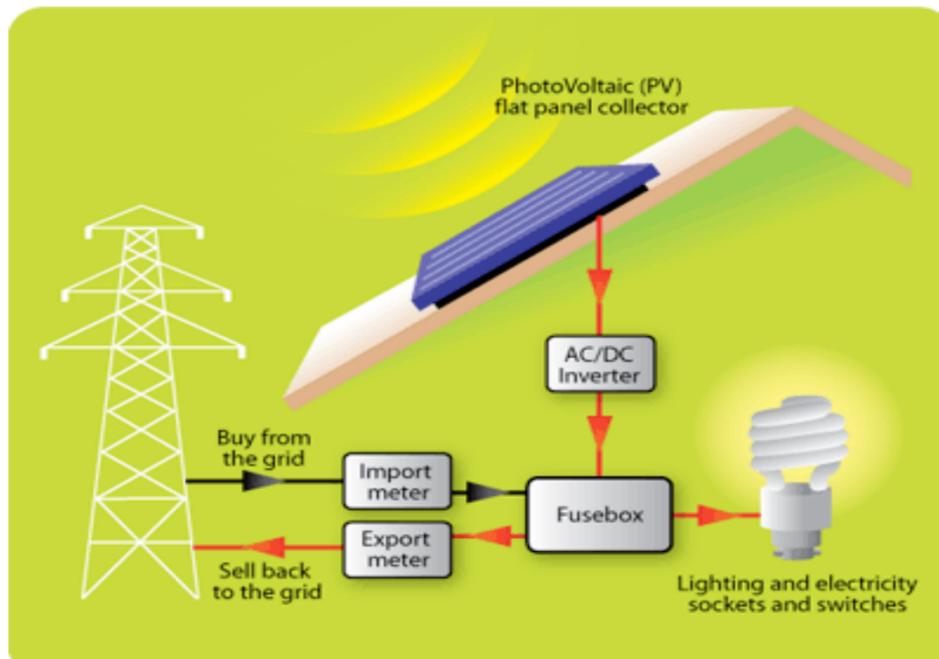
- Solar PV Panels / PV Modules - The head end of the system that converts daylight into electrical current.
- Power Inverters - Used to convert DC power provided by Solar panels and stored in batteries into AC Electricity to be integrated into the buildings electrical system.
- Charge Controller - Used to prevent damage to batteries through overcharging and reverse current.
- Cables & Accessories - Used to safely connect the various components.
- Isolators - Used to disconnect parts or all of the system for maintenance and/or in an emergency.
- Monitor - Used for measuring how much energy is being generated.
- Batteries - Used to store and release power.
- Mounting System - Used to install Solar panels on a roof or other suitable structure

## Hybrid Solar Photovoltaic (PV) Systems

If you were thinking that there is nothing stopping you from having both types of system installed at the same time you would be absolutely right. A Hybrid system gives you all the benefits of both systems with the added benefits from protection from power cuts and outages (from either solar or mains), coupled with the ability to live independently of fossil fuels whilst supplying others with clean, green energy.

A Hybrid Solar PV System would utilise a connection to the grid enabling power to be exported and also use batteries to protect against power cuts and store power for use locally.

Please note that as with all grid connected PV systems, in hybrid systems we need to protect against islanding, this is where the PV system would continue to generate and export power to the grid even if the mains power was unavailable. For safety the PV system will disconnect itself from the grid if the mains power is unavailable.



## Equipment Needed for Hybrid Solar Systems

A hybrid solar system is a combination of an off-grid and a grid tied system.

A system like this uses the utility grid whenever possible and has a backup battery bank in case of emergency. This solar system type is most expensive.

In addition to solar panels, a standard hybrid system consists of the following components:

- PV-Array Disconnect (DC)
- Charge Controller
- Battery Bank
- Power Meter
- Main DC Disconnect
- Battery-Based Grid-Tied Inverter
- Breaker Box (AC)

## Battery-Based Grid-Tied Inverter

Battery-based GTIs are also available, which you would need in case you are looking to buy a hybrid solar system. Together with a charge controller (as two separate components or integrated in one device), you can harness the energy stored in batteries in case of utility black-outs.

In short, if you are close to the electrical grid, in the vast majority of cases you should connect to it from an economical standpoint. Bear in mind that you need permission from the utility company to connect power to their grid. Also make sure they offer net metering. This will allow you to sell excess power back to the grid.

## PV systems for specific utilization without Grid

The same sunny days that dry out plants, make animals thirsty, and heat up buildings and cars are also good days for generating electricity with photovoltaics. This electricity can be used to power water pumps for irrigation and drinking wells, and ventilation fans for air cooling. For this reason, the most simple PV systems use the dc electricity as soon as it is generated to run water pumps or fans or other equipment.

These basic PV systems have several advantages for the special jobs they do. The energy is produced where and when it is needed, so complex wiring, storage, and control systems are unnecessary. Small systems, under 500 watts (W), weigh less than 68 kilograms (150 pounds), making them easy to transport and install. Most installations take only a few hours. And, although pumps and fans require regular maintenance, the PV mod-

ules require only an occasional inspection and cleaning.

## On Roof mounting Systems

The Alpha On-Roof: solar PV panel mounting system can mount most solar PV panel sizes and types on-roof with fixings available for tile, slate and metal.

Aluminum rails are available in 0.6m, 1.2m, 1.8m, 2.4m and 3m lengths, connected together to form exactly the right lengths using telescopic rails and rail splices.

Alpha On-Roof: Mounting systems are ordered by component,

selected based on the dimensions, number and orientation of the solar PV panels and the characteristics of the mounting area.

Fixings are supplied to secure the rails to the roof and clamps are provided to secure the panels to the rails. Rails and panels can be mounted in either portrait or landscape.

## The Roof Intergrated System (RIS)

The RIS (roof integrated system) is a robust, flexible, low maintenance and easy to handle PV mounting

system.

This low-cost mounting system for solar panels can be used for pitched roofs or facades, retrofit or new building applications.

The RIS system is suitable for all domestic applications and is particularly appropriate for new buildings or roof refurbishment projects.

It gives an aesthetically pleasing solution as the array merges more closely to the existing roof line. As the PV is integrated into the roof it becomes part of the roof and so one does not need to worry about the roof lifespan for the duration of the PV.

## The Flat Roof System (RIS)

This flexible and universal base system is available for all kinds of flat roofs constructions.

It will accommodate all module sizes and is thus able to meet most customer requirements. It has a variable tilt with precision fittings. It will accommodate tilts of 15°, 20°, 25° and 30° and other tilt angles on request.

## Open terrain mounting Systems

This system is used for open terrain for all module types. It will handle uneven terrain and is very easy to install, savings both time and money.

Once one has decided on the type of PV system one wishes to invest in the next question is the size of the system and where to install it and what is the return on investment. Next week we shall address these three issues. Please stay in touch.

# Appropriate Energy + Technology

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