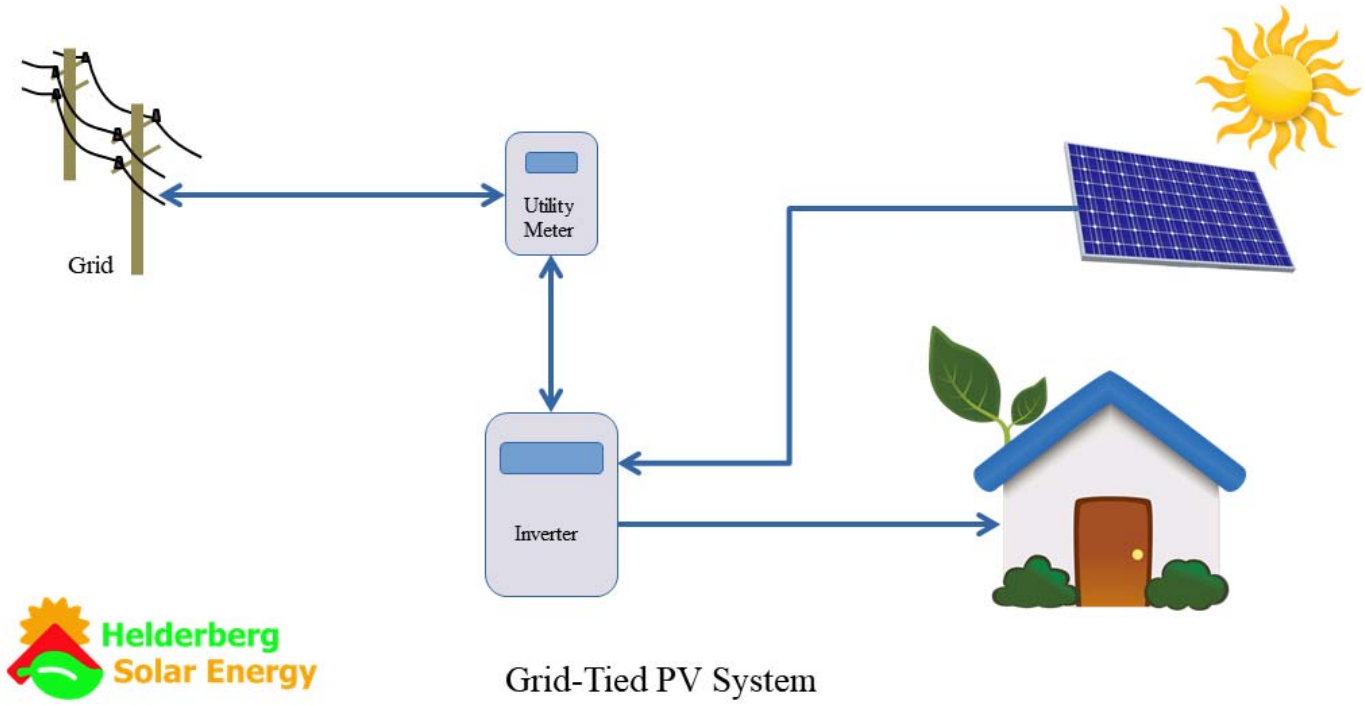
PV Systems

What is the difference between Grid-Tied, Hybrid and Off-Grid solar systems? What would be the best in your situation?

Let's look closer at the benefits and downsides of the various options.

Grid-Tied Solar Systems



Grid-Tied PV System

Grid-Tied is a term used to describe a solar system that is connected to the utility power grid.

Advantages of Grid-Tied Systems

1. It Cost Less

Batteries and other equipment are required for a fully functional Off-Grid solar system, which add to costs. Grid-Tied solar systems are therefore generally cheaper to install.

Solar panels will often generate more electricity than is needed for consumption. Homeowners can feed this excess electricity back into the utility grid if allowed instead of storing it in batteries.

In South Africa municipalities are currently buying electricity from homeowners at a lower rate than at which it sells it to them.

2. The Utility Grid is a Virtual Battery

Electricity has to be spent in real time. However, it can be temporarily stored as other forms of energy (e.g. chemical energy in batteries). The electric power grid is in many ways also a battery.

Equipment for Grid-Tied Solar Systems

There are a few key differences between the equipment needed for Grid-Tied, Hybrid and Off-Grid PV solar systems. Standard Grid-Tied solar systems include following:

- Grid-Tie Inverter (GTI) or Micro-Inverters
- Correct Power Meter to feed back into the Grid if choose to

Grid-Tie Inverter (GTI)

Solar Inverters regulate the voltage and current received from solar panels. Direct current (DC) from the solar panels is converted into alternating current (AC), which is the type of current that is utilized by the majority of electrical appliances.

In addition to this, grid-tie inverters, also known as grid-interactive or synchronous inverters, synchronize the phase and frequency of the current to fit the utility grid (50Hz in South Africa).

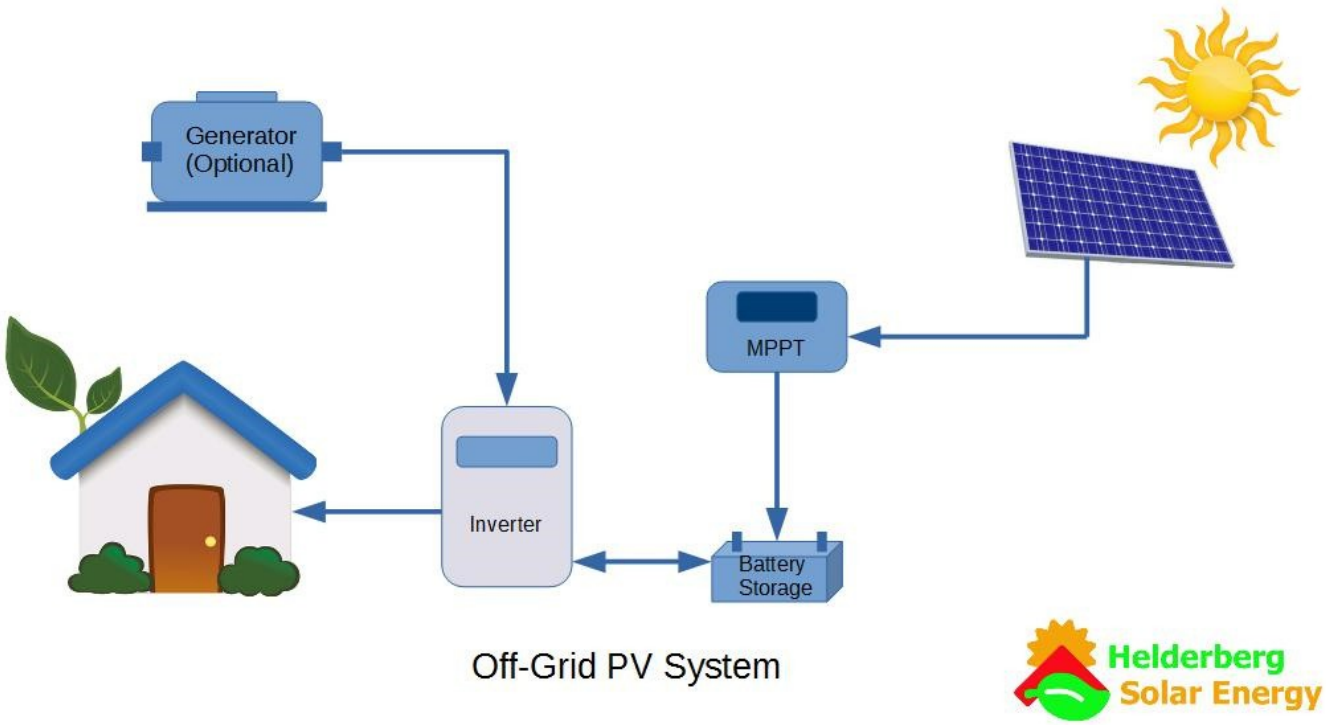
Micro-Inverters

Micro-inverters go on the back of each solar panel as opposed to one central inverter that typically takes on the entire solar array. Micro-inverters are more expensive, but in many cases yield higher efficiency rates. Buildings with shading issues should definitely look into micro-inverters to better the situation.

Power Meter

Homeowners might need to replace their current power meter with one that is compatible with net metering. This device, often called a net meter or a two-way meter, is capable of measuring power going in both directions, from the grid to the house and vice versa. Local municipalities should be consulted to see which net metering options are available.

Off-Grid Solar Systems



Off-Grid solar systems (off-the-grid, stand-alone) are an alternative to Grid-Tied PV systems. For homeowners who have no access to the grid, Off-Grid solar systems are a good option.

To ensure access to electricity at all times, Off-Grid solar systems require adequate battery storage and a backup generator (if you live off-the-grid). A battery bank typically needs to be replaced after 10-15 years.

Advantages of Off-Grid Solar Systems

1. No need for a utility grid

Off-Grid solar systems can be cheaper than providing power lines in certain remote areas. Consider Off-Grid if you are more than 100 meters from the grid. Erecting overhead transmission lines are very costly.

2. Become energy self-sufficient

Living off the grid and being self-sufficient feels good. For some people, this is worth more than saving money. Energy self-sufficiency is also a form of security. Power failures on the utility grid do not affect Off- Grid solar systems.

On the flip side, batteries can only store a limited amount of energy and during cloudy times, being connected to the grid is actually where the security is. You can however install a backup generator to be prepared for these kinds of situations.

Equipment for Off-Grid Solar Systems:

- Solar Charge Controller
- Battery Bank
- DC Disconnect (additional)
- Off-Grid Inverter
- Backup Generator (optional)

Solar Charge Controller

Solar charge controllers are also known as charge regulators or just battery regulators. Solar battery chargers limit the rate of current being delivered to the battery bank and protect the batteries from overcharging.

Good charge controllers are crucial for keeping the batteries healthy, which ensures the lifetime of a battery bank is maximized.

Battery Bank (Storage)

Without a battery bank (or a generator), it will be lights out by sunset. A battery bank is a group of batteries connected together.

Lithium Ion batteries are a much better option than lead acid or gel batteries. The initial cost is more but in the end it cost less because of a longer lifespan and better DoD (Depth of Discharge) – 80% compared to 50% of lead acid batteries.

DC Disconnect Switch

AC and DC safety disconnects are required for all solar systems. For Off-Grid solar systems, one additional DC disconnect is installed between the battery bank and the Off-Grid inverter. It is used to switch off the current flowing between these components. This is important for maintenance, troubleshooting and protection.

Off-Grid Inverter

Off-Grid inverters do not have to match phase with the utility grid as opposed to grid-tie inverters. Electrical current flows from the solar panels through the solar charge controller and the battery bank before the Off-Grid-inverter converts it into AC.

Backup Generator

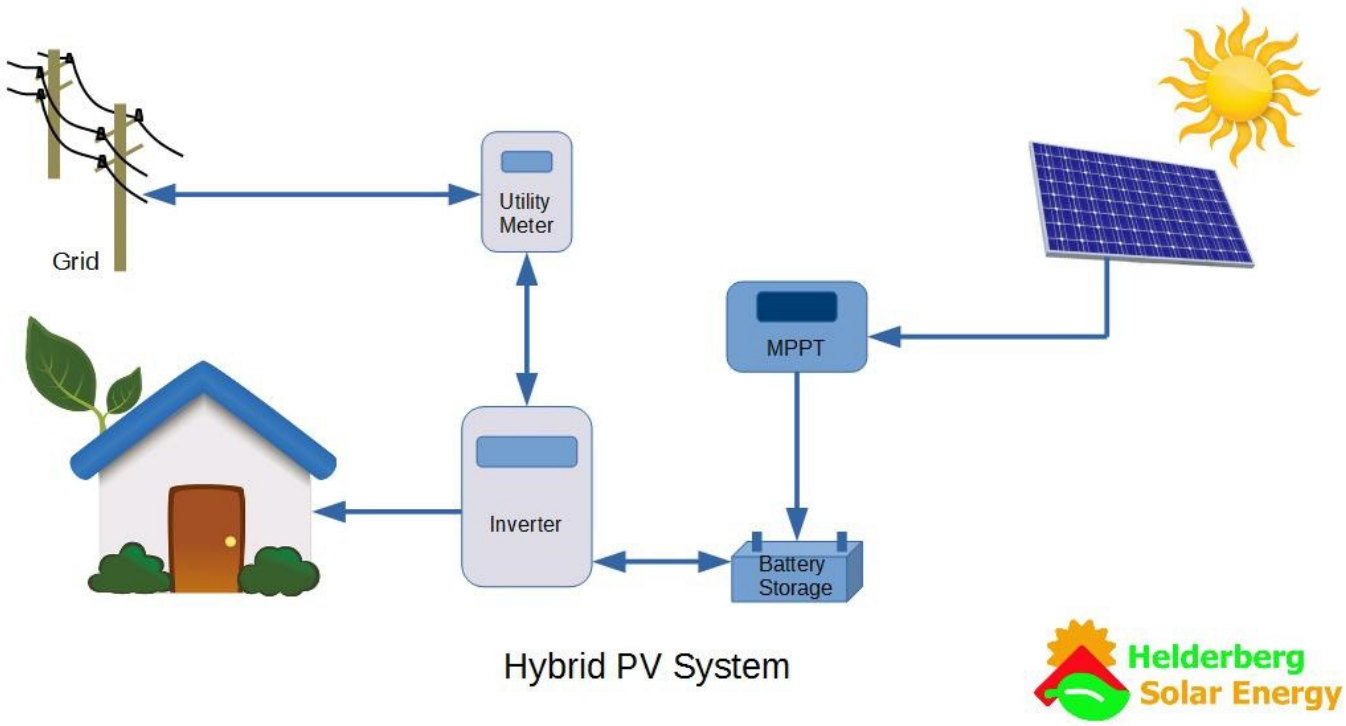
It takes a lot of money and big batteries to prepare for several consecutive days without the sun shining (or access to the grid). This is where backup generators come in.

In most cases, installing a backup generator that runs on diesel is a better choice than investing in an oversized battery bank, which seldom gets to operate at its full potential. Generators can run on propane, petroleum, gasoline and many other fuel types. Backup generators supply AC, which can be sent through the inverter for direct use or to be converted into DC for battery storage.

Micro Wind Turbines

Wind Turbines, which generate power from wind, are a great addition to a solar PV system as they can generate power at night and on overcast rainy days when solar production is low or non-existent. It can also assist to increase energy generation in case of PV panel limitation due to lack of roof space. Wind turbines are only used to charge batteries (DC) and not to supply AC loads.

Hybrid Solar Systems



Hybrid solar systems combine the best from Grid-Tied and Off-Grid solar systems. These systems can be described either as Off-Grid solar with utility backup power, or Grid-Tied solar with extra battery storage.

Advantage of Hybrid Solar Systems

Hybrid solar systems are less expensive than Off-Grid solar systems. You do not really need a backup generator and the capacity of your battery bank can be downsized. Off-peak electricity from the utility company is cheaper than diesel.

Equipment for Hybrid Solar Systems

- Charge Controller
- Battery Bank
- DC Disconnect (additional)
- Hybrid Inverter
- Correct Power Meter to feed back into the Grid if choose to

Battery-Based Grid-Tie Inverter

Hybrid solar systems utilize battery-based grid-tie inverters. These devices can draw electrical power to and from battery banks, as well as synchronize with the utility grid.

The bottom line is: Utilising the utility grid for electricity and energy storage, providing it is reliable and not costly to connect to the grid, is significantly cheaper and more practical than using battery banks and/or backup generators.

Lithium Ion Battery Storage

We at Helderberg Solar Energy only make use of Lithium Ion batteries for various reasons. Lithium Ion Phosphate batteries might seem expensive when compared to lead acid batteries, but this is not true.

A proper scenario comparison will reveal that the purchase costs are very similar and any marginal premium for a LiFePO4 battery is more than compensated for by longer life and a very high efficiency. The high efficiency means that far less energy is wasted and that the solar array can be 30% smaller to achieve the same results.

In general: Because of the high DoD (Depth of Discharge) capability and high efficiency the ampere hour rating of a LiFePO4 battery need only be 35% of a lead acid battery to give the same useful output – this is important when comparing costs between the two technologies.

UPS systems are notorious for the short life span of the typical lead acid batteries they use, especially if the batteries are kept in a high temperature environment.

LiFeP04 cells are much less sensitive to high temperatures and can happily operate up to 45°C with negligible drop in life span or performance. Lithium Ion is regularly chosen for new installations or as a suitable replacement for lead acid batteries, which have reached the end of their life in a solar PV storage system.

Advantages of Lithium Ion Batteries:

- Much lesser space required
- Lighter weight
- No gas emissions
- Maintenance free
- Higher efficiency
- Can withstand higher temperature
- Great Depth of Discharge
- Higher cycle life
- Better maintained voltage during the discharge cycle
- Lower lifetime costs
- Lower impact on the environment
- Longer warranty available

Advantages of the Pylontech Lithium-Ion battery include:

- More than 6000 cycles with 80% DOD.
- Compact and fashionable design.
- Delivers up to 5kW for 15 seconds with single module (2.4kWh).
- Modular design gives the end customers the power of choice of capacity.
- Compatible with the Axpert and Infinisolar inverters.
- Simple buckle fixing minimizes the installation time and cost.
- Safety Cert. TÜV CE UN38.3.
- Up to 10-year warranty available, if registered on the Pylontech portal.

In most cases, it is expected that the lifetime cost of a Lithium-Ion battery would be less than half that of a lead-acid battery bank of equivalent capacity. The example below compares a 400Ah lead acid battery bank to a 250Ah Lithium bank, using pricing and specifications of products currently available:

- For lead acid: 2200 cycles @ 50% DOD (C10 rating); unit pricing = R4,500.
- For Lithium: 6000 cycles @ 80% DOD; unit pricing = R13,900.

LEAD ACID PRICE PER kWh					PYLONTECH LITHIUM-ION PRICE PER kWh				
Lead Acid Bank (48V)	Cycles @ 50% DOC	kWh Storage	Initial cost	Price per kWh	Pylon Bank	Cycles @ 80% DOC	kWh Storage	Initail cost	Price per kWh
8x200Ah (400Ah)	2200	9.6kWh	R36,000	R1.72	5 x US2000B Plus (250Ah)	6000	9.5kWh	R69,500	R1.22

From this example, it can be concluded that while the initial cost of lead acid batteries may be lower at around 50% of the cost of Pylontech, over the life cycle the price per kWh of lead acid is up to 40% more expensive.

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