



The purpose of this document is to help familiarize you with some of the terminology, definitions and system types used. It helps to answer some of the questions frequently asked by customers.

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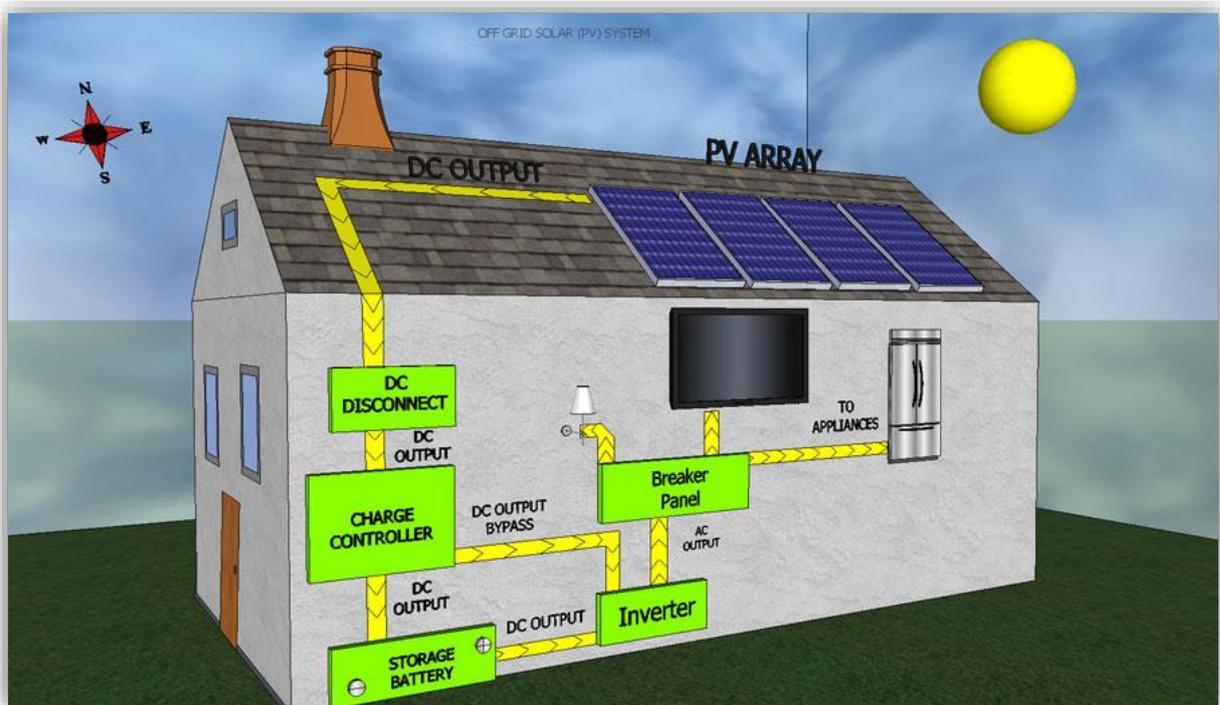
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## Introduction

Thank you for purchasing our solar system from EnergyAlt. The system was designed to provide you with years of free and reliable energy. However it is important to understand the basic workings of your system to ensure flawless operation at all times.

It is important to take some time to read through your operating manual to ensure that you understand the workings and limitations of your system – what it can do and can't.

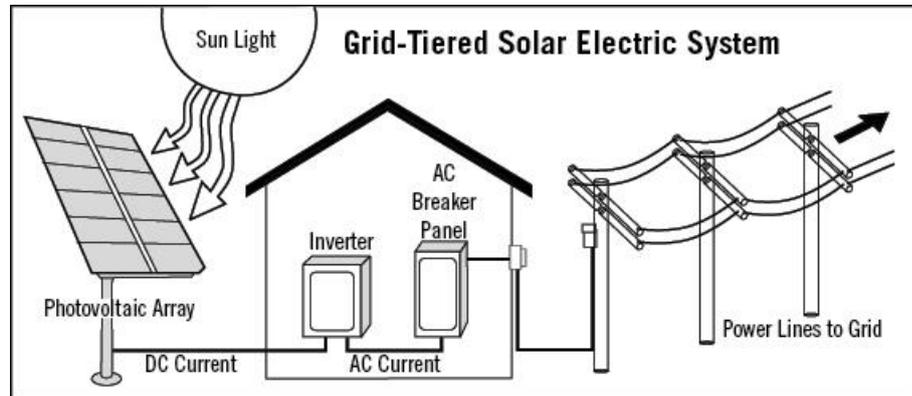
This document is added to provide you with a brief explanation of the solar system and its components installed at your home or business.



## Your Solar System Explained

In principle there are three types of solar photovoltaic (PV) systems. These systems are defined as follows:

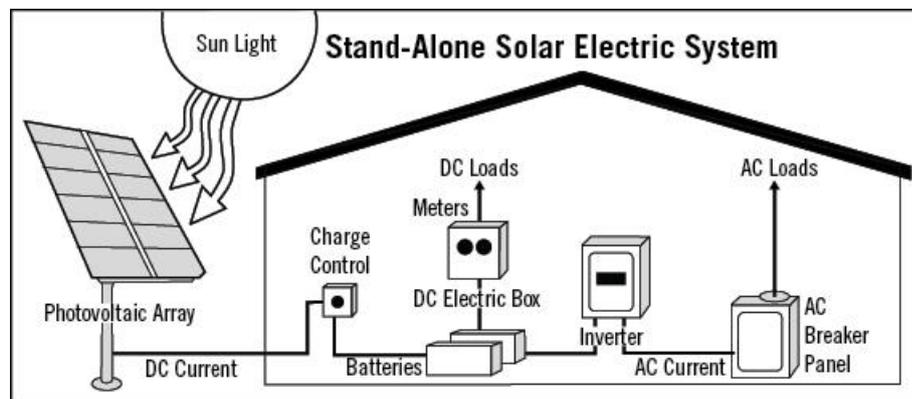
### 1. Grid Tie System:



Grid-tied systems are connected to the electrical grid, and allow residents of a building to use solar energy as well as electricity from the grid. When there is no demand for energy, the solar system can send excess electricity back out into the grid for use.

Grid-tied systems do not provide protection from power outages. When the electrical grid fails, grid tied systems will automatically shut off and will not continue to operate for safety reasons.

### 2. Off-Grid Systems



Off-grid solar-electric systems operate independently from the local utility grid to provide electricity to a home. Off-grid systems usually incorporate a battery bank to store energy produced during the day. If you have a solar battery system as well as a solar PV system, your power will continue to work.

### 3. Hybrid Systems

Hybrid systems is a combination of Grid Tie and Off Grid systems and can be configured to use grid energy, solar energy and battery backup. The backup battery is charged by both the grid and the solar panels. In the event of an outage, the backup battery will switch on automatically to provide backup power to the building.

## Basic building blocks for a solar system

A solar system consist of the following units as depicted in the Figures below.

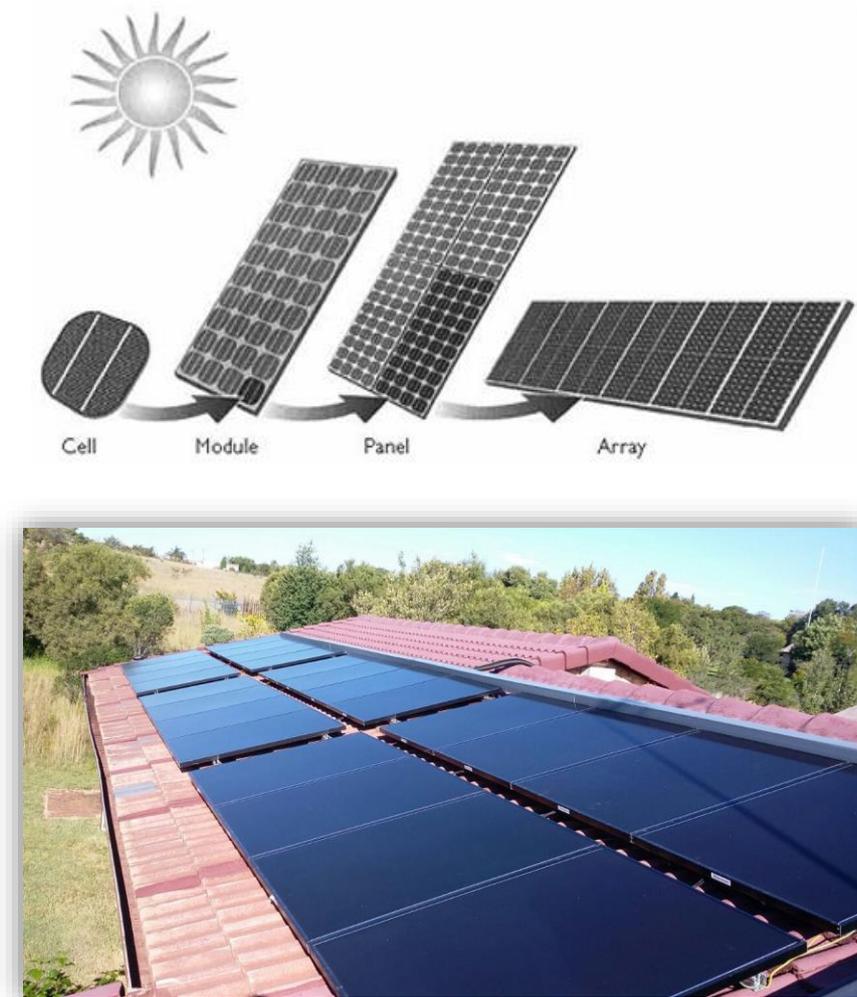


Figure 1: Solar generation

The first unit is the solar generation part. This unit is called a solar array, consisting of individual solar panels in series and parallel. Photovoltaics (PV) is a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect.

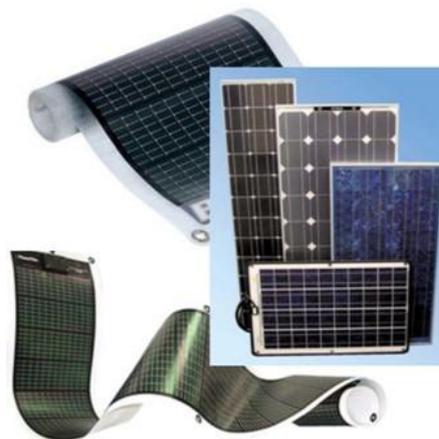




Figure 2: Inverters

The second important component is the charge regulator or controller/inverter which converts the energy generated by the sun to usable energy. An inverter, is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).



Figure 3: Battery bank with battery rack

The battery bank is used to store the energy harvested during the day for night time use. There are different technologies to use when it comes to batteries. The three main lead-acid batteries are:

- Flooded (FLA) → **unsealed** with **liquid** electrolyte
- Absorbed Glass Matt (VRLA) → **sealed** with electrolyte **held captive** by glass mat
- Gelled (VRLA) → **sealed** with **gel** electrolyte

	Lifespan*	Minimal Gassing	Spill Proof Rating	Flexibility in Mounting	Charging Voltage Sensitivity	Maintenance	Price
Flooded	3	1	1	1	3	1	3
Gelled	2	3	3	2	1	3	2
AGM	2	3	3	2	2	3	1

- \*if well cared for
- Rating: 1 - poor    2 – good    3 - excellent



Figure 4: Solar System Distribution Board with circuit breakers

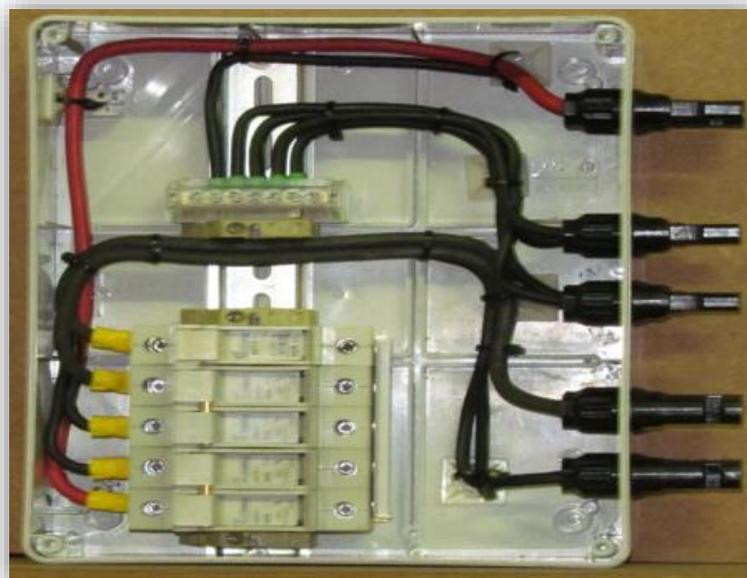


Figure 5: Solar panel combiner box

Protection mechanisms –Figure 4 & 5 are in no way less significant than the other components as they are protecting the overall system and protect your family against electrocution, short circuits, over current faults in wiring.

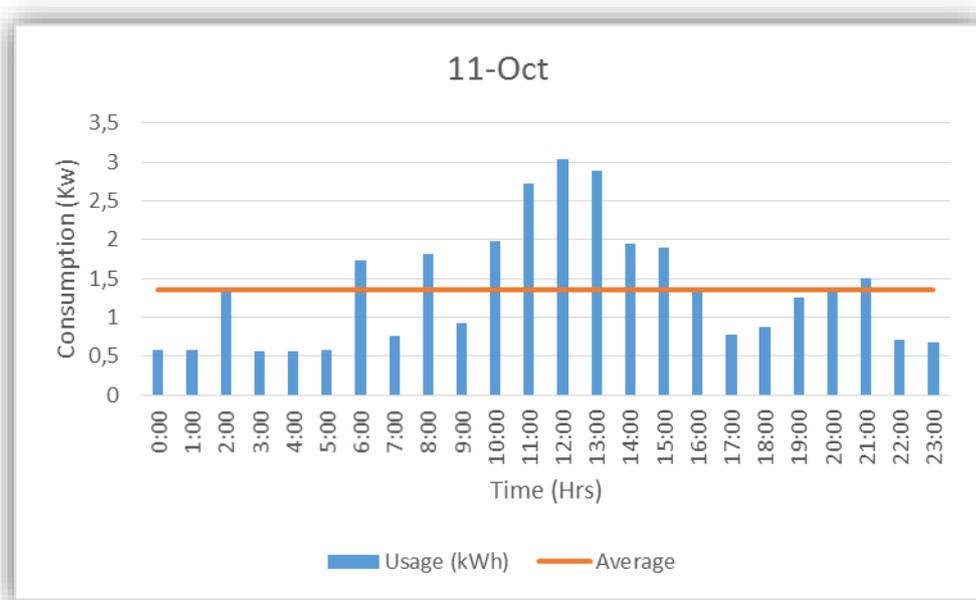
## How does my system work?

The system installed at your home is a Hybrid system as it connects to the grid but only to utilise the grid as a backup. Your system was designed to supplement utility power and appliances like your geyser, stove and air conditioners etc. might still be using utility power as before. In order to reduce the dependence of utility power you could consider installing solar geysers and gas stoves.

This system is an all-inclusive system incorporating all components like the MPPT charge controller, Pure Sine Wave inverter and battery charger in one system working together to provide efficiencies of up to 97%.

The system is configured to use solar energy as 1<sup>st</sup> priority then use the battery energy stored as 2<sup>nd</sup> priority and lastly use the utility to provide energy for your house or business.

The design of the system was based on your average consumption over a 24hour period. This information was gathered over a seven day period using an energy usage instrument or an Energy Audit by physically counting all components and appliances. The design and sizing of your system was done using the information gathered to provide power for your essential appliances on your premises which could utilise the sun as energy source without using too much battery energy. Figure 2 shows the average consumption for an average household over a 24hour period.



**Figure 6:** Example of average electricity usage over a 24 hour period before solar system installation.

The system was designed to fill the area under the average line to supplement you're existing utility supply.

During the day when the sun shines we are trying to use most of the energy produced to run appliances like your washing machine, dishwasher, pool pump and refrigerator while at the same time charging the batteries for night time usage. At night you would like to run your lights, TV or radio and refrigerators.(This all depends on the size of your system)

## Does my solar system generate power on a cloudy day?

This question is often asked and the short answer is yes. But when you look at figure 7 you can see that the effectiveness deteriorates as the radiance of the sun is limited due to clouds.

On cloudy or rainy days you need to make some adjustments with how you use the system. If it rains for example don't use the washing machine, dishwasher and switch of the pool. You want to conserve energy and use all available energy to charge the batteries.

Another point to remember is that the average solar radiation time is 5.5h per day during the year. This means out of 24hours you need to harvest enough energy to provide power for the other 18.5 hours.

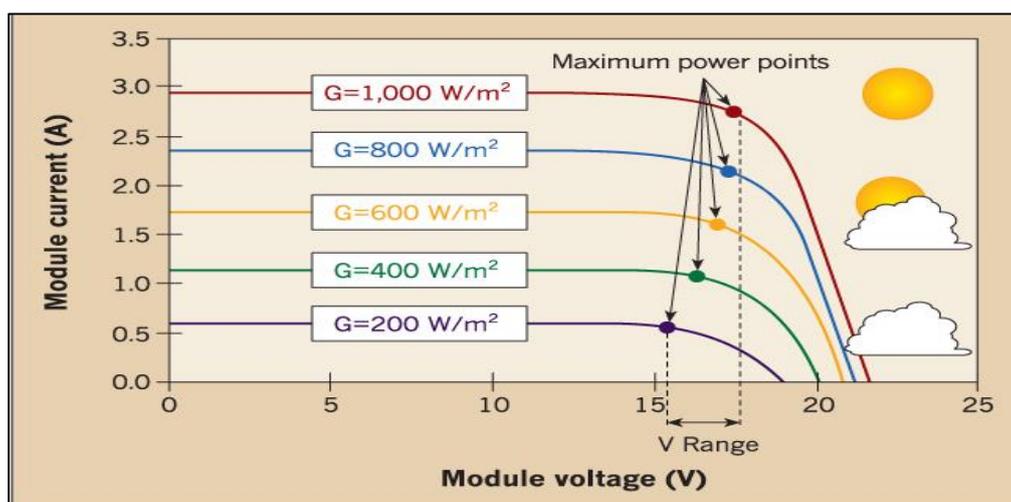


Figure 7: Graph indicating effectiveness of solar panels depending on cloud coverage

## What will happen if it rains for days on end?

Your system is designed to prioritise the energy source it needs to use. If it is constantly raining the system will go to bypass mode and use utility power while it charges the batteries. Once the batteries are charged it will go back to using the batteries.

You can also manually set your unit to use the utility first to provide power – see instruction manual. This is recommended when the weather forecast predicts rain for a couple of days to rather change to this mode, because when the system charges your batteries and repeat the cycle – using battery power it uses more energy to power your appliances.

## How long will my batteries last?

The basic system consist of four 12V 100Ah / 200Ah batteries configured in series to generate 48V for the system to operate. Batteries used in UPS systems are typically rated by "Design Life" which is normally from 10 years to 15 years. This can be achieved because in a UPS system the batteries are only used when there is a power outage.

In the case of a Solar PV System we use the "Cycle Life" instead because in a solar system the batteries are cycled much more frequently. Typical AGM / Gel batteries will give up to 1500 cycles or close to 5 years if the system is well designed (50% Depth Of Discharge (DOD)).

We do get batteries with an even higher cycle-life like Lead Crystal batteries that can give up to 3000 cycles for a Depth of Discharge of 50% (7-10 years).

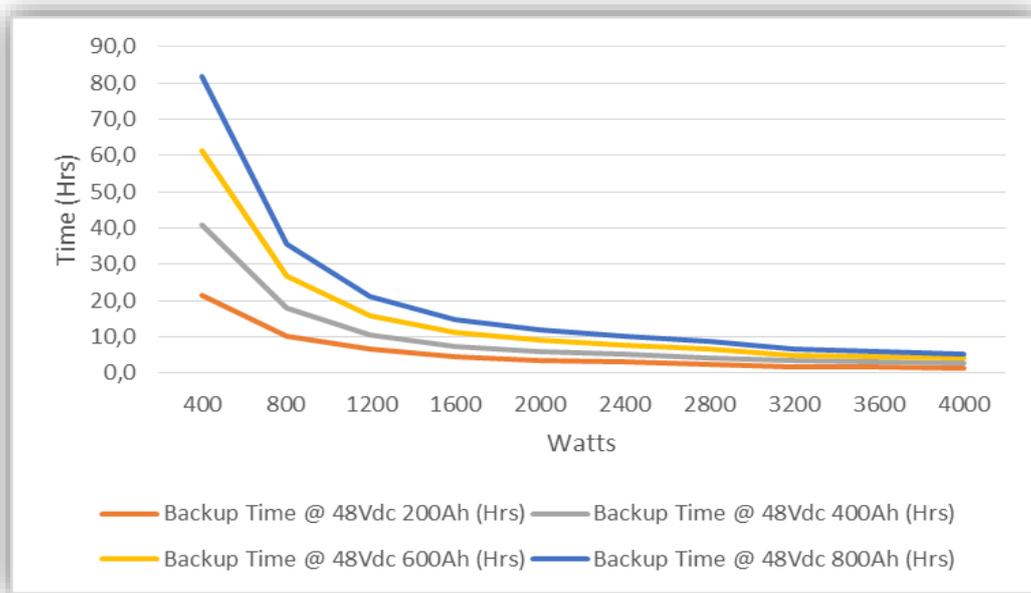


Figure 8: Approximate back-up time

As can be seen from the graph as the load increases the consumption rises and the available backup time decrease. The capacity of your batteries is determined by the size of the batteries – not the voltage but amp hour capacity. For example the basic size of your system is 200Ah, but if you upgrade and install additional batteries the capacity will double as the batteries are put in parallel.

**Note:** Backup time depends on the quality of the battery, age of battery and type of battery used. Specifications of batteries may vary depending on different manufacturers.

### Why am I limited on using appliances at the same time?

Your house is supplied by your utility provider with ±15KVA of power. The power generated from your solar system is about a 2 x 3<sup>rd</sup> of the utility capacity. The number of solar panels required to match the supply from the utility would be ±88 x 170Watt vs the 18/36/60 currently installed. Space and cost would thus be the limiting factors.

The following table gives a comparison of power generated by your local utility and your solar system.

Utility power for Home				Solar power for Home 5KVA system			
Single phase				Single Phase Solar			
Volts	Amps	KVA	KW	Volts	Amps	KVA	KW
230	60	15	14	230	22	5	4

Table 1

As can be seen from table 1 the reserves available from the utility is significantly more than the power generated by the PV System. Because you only have this amount of power available you need to apply “load shedding” to ensure that you don’t overload your system.

As an example a hairdryer rated at 2000Watt and kettle rated at 2000Watt used simultaneously could already use more energy than the rated limit of the system. The system can however manage surge power of up to 10KVA. To increase the capacity the system can handle at any one time we can add extra inverters in parallel (up to 30KVA (24KW)) to the existing one for increased power.

**Typical Household Appliance wattages:**

APPLIANCE	Appliance watts
Clothes Washer (does not incl. warm/hot water)	300
Dishwasher - Heat dry	815
Freezer - upright, auto defrost - New	80
Refrigerator - side-by-side - New	77
Computer – Laptop	120
Television - 42 inch, Plasma	327
Fan - Ceiling (does not incl. lights)	80
Microwave Oven	1375
Computer - Desktop with LCD Monitor	135

Table 2

### What appliances should I avoid using with my solar system?

It all depends on the size of your solar system. As a rule of thumb appliances with a heating element should be avoided. The exception is for your kettle, and microwave oven which could be used as it is normally used for a short period of time and then switch of. An iron could also be used during day time as normal wattage range between 250W/h and 300W/h.

If you use only one inverter with your system, other heating appliances like heaters, under-floor heating and clothes dryers should never be used with your solar system. Heavy machinery, like electrical saws, welding machine etc. should not be used. These machines draw a huge starting current which could damage your inverter. The fact that we can use up to 6 inverters in parallel can solve this scenario so you can use all the appliances and tools if needed.

### Is my system safe?

Your system was designed with safety first. Electricity can kill and your inverter generates electricity as your utility. The safety mechanisms protect your family against electrocution, overload, and short-circuits. They comply with safety regulations. The Inverter system also have built in safety mechanisms and will shut down in the event of failures. The earth leakage protection is built in for your protection and outages due to tripping is normally an indication of faulty power lines. Rain often causes tripping indicating a damaged cable. The system is also designed with surge protection to protect your investment against power surges.

### What will happen to my solar panels when it hails?

The solar panels are designed to withstand normal forces of nature and in most instances the hail will bounce off with no damage. It is still a good idea to insure your investment against unforeseen

acts of nature. The CIS (Thin Film) modules are better protected against hail as the glass sheeting is double the thickness of normal Polycrystalline solar panels.

### How long will my PV system last?

The design life for the solar panels is between 25 to 30 years, with batteries between 3 to 10 years depending how they are cycled. Battery life can be more depending on the type of batteries used. The inverter is rated for ± 15years but as with other technology products like your TV could be replaced with better technology.

### Can I upgrade my system?

Yes your system was designed with growth in mind and as your demand grows, additional inverters, batteries and solar panels can be added. However the maximum number of PV panels per inverter is 3000W (18 CIS modules). IF you exceed the 3000W you need to add another Inverter. Typically when you need more power you will add additional inverters. These inverter’s can be configured in parallel to provide between 5KVA and 30KVA depending on the number of inverters.

### What is the State of Charge (SOC)?

State of charge is the equivalent of a fuel gauge for the battery bank at your home. The units of SOC are percentage points (0% = empty; 100% = full).

Battery Condition at 25 degree Celsius	Nominal battery Voltage	
	12V	48V
Battery near full charge while charging	14.4 to 15.0	57.6 to 60.0
Battery near full discharge while charging	12,3 to 13.2	49.2 to 52.8
Battery fully charged with light load	12.4 to 12.7	49.6 to 52.8
Battery fully charged with heavy load	11.5 to 12.5	46.0 to 50.0
SOC - No charge of discharge for 6 hours - 100% charged	12,7	50,8
SOC - No charge of discharge for 6 hours - 80% charged	12,5	50
SOC - No charge of discharge for 6 hours - 60% charged	12,2	48,8
SOC - No Charge of discharge for 6 hours - 40% charged	11,9	47,6
SOC - No Charge of discharge for 6 hours - 20% charged	11,6	46,4
SOC -No Charge of discharge for 6 hours - Fully discharged	11,4	45,6

Table 3

### What is the Depth of Discharge (DOD)?

Depth of discharge (DOD) is an alternate method to indicate a battery's state of charge (SOC). The DOD is the complement of SOC: as one increases, the other decreases. While the SOC units are percent points (0% = empty; 100% = full), the units for DOD can be Ah (e.g.: 0 = full, 50 Ah = empty) or percent points (100% = empty; 0% = full)

### What are the maintenance procedures?

Solar PV systems are solid state technology, have no moving parts, and require no maintenance beyond cleaning, which can typically be done with a garden hose. Most systems should be cleaned 2-4 times a year, concentrated in the drier seasons.

Batteries - battery terminals should be tightened once a year as natural degradation of the terminals occur. All connecting cables should be checked for integrity.

Inverter – The inverter fans need to be checked every 6months for dust built-up and should be cleaned by an approved service agent.

## If I overload my system how do I reset the system?

In the event of an overload the inverter will go into fault mode either giving a constant beep or showing an error code 7. Normally the inverter will reset itself.

If the inverter does not restart please follow the following steps to restart your system in the ACDC DB.

1. Switch off the Earth leakage switch
2. Switch of the Eskom circuit breaker
3. Switch of the PV disconnect switch
4. Turn of the Inverter switch at the bottom of the inverter
5. Switch of the main battery switch or pull the main fuse holders.

### ***The inverter should now be off.***

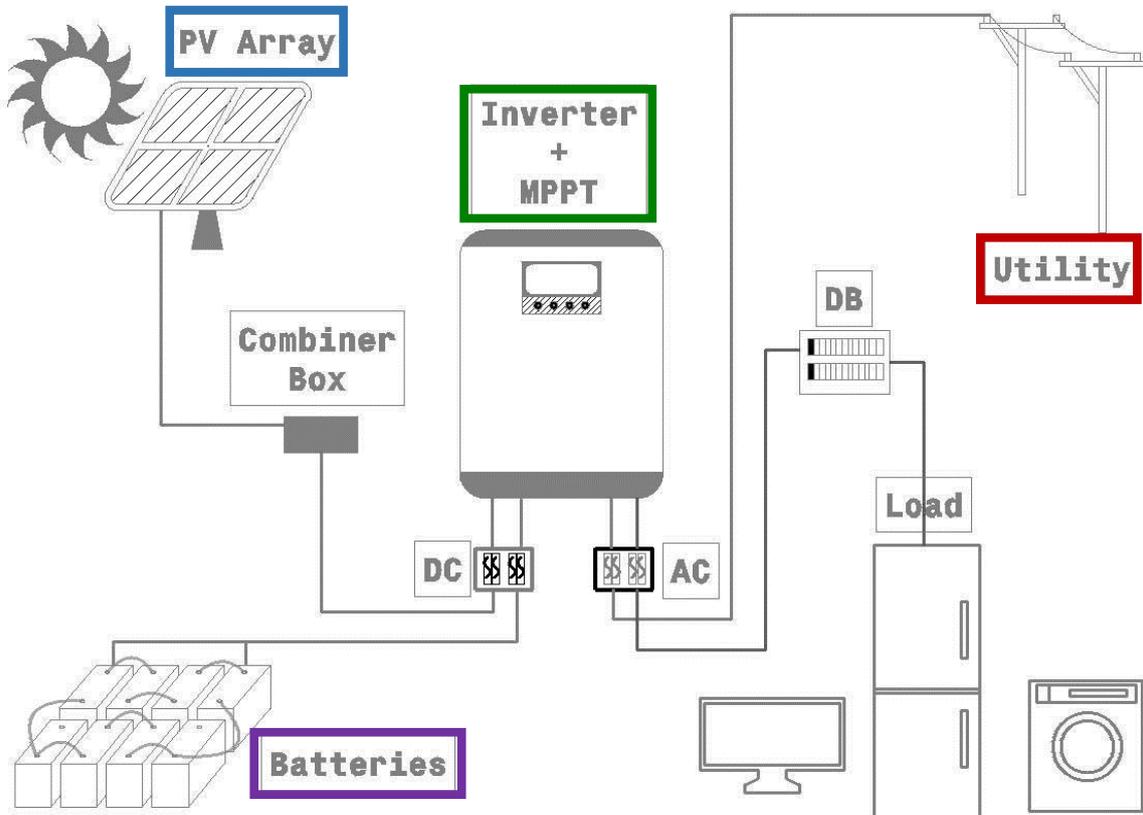
Please disconnect or switch off applications from your circuits which caused the overload.

1. Switch on the main battery switch and close the main fuses
2. Turn on the PV disconnect switch or close the disconnect fuses. A Battery and solar panel should appear on the screen.
3. Switch on the switch under the inverter. The inverter will now start and should show 230V
4. Turn on the Eskom circuit breaker
5. Lastly switch on the Earth leakage switch.

The system should now be functioning normally.

For additional information around solar energy please visit: <http://energy.gov/eere/sunshot/solar-energy-glossary>

## System Installation Diagram



- Pv Array - Combiner Box - DC Disconnect - Solar Input - MPPT/Inverter
- Inverter / MPPT - DC Disconnect - Batteries
- Utility - AC Breaker - AC Input - Inverter / MPPT
- Inverter / MPPT - AC Breaker - DB - LOAD