SOLAR STATUS
GIVING POWER BACK TO YOU & YOUR HOME

A guide to understanding the basics of how a Solar PV system works.

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Introduction

When starting out in solar, all the names, figures, and components can be overwhelming and difficult to compute. This is a simple guide to help you along the way.

Solar Panels

The Solar panels are what generate the electricity using the irradiation from the sun. The rating of the panel (e.g. 360W panel) is the amount of power a panel will give you in one hour under standard test conditions (STC: 25°C, 1000W/m^2 of irradiation and no wind).

Therefore, the amount of power your panels produce will be dependant on two main factors, the ambient temperature of the panels in situ and secondly the amount of irradiation they are getting. Note the use of the term irradiation, and not direct sunlight as there is still irradiation even if there is cloud cover.

The total amount of power your PV system (Photo Voltaic system specifically refers to solar panels) will produce, can therefore be calculated as the sum of panels multiplied by the rated Wattage i.e. 2 x 360W panels will give you +/- 720W per hour depending on the ambient temperature and irradiation.

How many do I need?

In order to work out how many panels you require, you first need to calculate how much electricity you use on average per day (amount per month x 12/365). Once you know this you can then divide it by 5 hours, which is the amount of peak irradiation on the shortest day of the year, this will then give you the amount of Watts you require per hour.

Example: A house using 110 kW (110'000W) per month can be worked out as follows:

= 110 kW x 12 Months / 365 days
= 3.6 kW (3600W) per day
= 3600 W / 5 hours of peak irradiation on the shortest day
= 720 W of power required per hour divided by the size/ Wattage of the panel (This differs per model and manufacturer, we are using a 360W panel for this example)
= 720 W / 360
= 2 Panels

Or to look at it another way:

= 2 x 360 W panels
= 720 W per hour X 5 hours

= 3.6 kW (3600W) Per Day X 365 days of the year
= 1314 kW per annum / 12 months
= An average yield 110 kW

The above calculations are a general rule of thumb, and differ from sight to sight, depending on orientation, irradiation in the specific geo location as well as storage capacity of the batteries. Ideally you want enough panels to be able to fully charge the batteries during the day, as well as supply the load to the house on the shortest day of the year.

Over the course of the year, we receive on average 7.5 hours of peak irradiation, so for instance you can base your calculation on that, but you will more than likely need to supplement with Eskom during days of low irradiation. This again is all dependant on the amount of battery storage capacity on hand.

Inverter

The inverter is the main control unit for power in and power out. Therefore, a 5kW inverter for instance, means that it is rated to accept a maximum input of 5000W from the solar PV (photo voltaic) system as well supply a maximum output (usable power) of 5000W. See what does it all mean, for a better explanation.

The PV inverter is the main component of the system and depending on the make or model serves four purposes:

The main purpose of an inverter is to convert DC (Direct Current), such as the power coming from the solar panels, into AC (Alternating Current) which is the same as the power from Eskom and required for your electrical needs.

There are three other important functions that the inverter performs (depending on make and model)

- Firstly, it regulates the amount of power coming into the system whether it be from Eskom or from the Solar panels.
    - On the DC side, the solar panels are plugged into the inverter via a MPPT (Maximum Power Point Tracker). This balances and maximizes the cells of your solar panels (approximately 72 cells per panel) to give you optimum power.
- Secondly, it functions as a charge controller for the battery:
    - The charge controller regulates the charging and discharging of the battery, making sure it is always at optimum levels and doesn't discharge too low or overcharge.

  - The inverter will charge the batteries using either the DC power directly from the solar panels or convert the AC power from Eskom to DC, depending on what is readily available. Batteries are DC power and therefore can only receive and distribute DC power.
- And Lastly your inverter distributes and balances the whole system. It will use whatever power is available to maintain a stable flow of electricity. It first uses the power from your solar panels and then if there is not enough power or no power from the panels such as at night, it will balance the load using either power from Eskom or your batteries, depending on your system requirement set up and storge capacity.

Battery Storage

In places like America, storage is not as major of a concern as it is in South Africa due to the fact that they have a more stable grid and essentially use the grid/ electricity provider for storage. Meaning any excess electricity from the solar panels, feeds back into the main utility grid and is then utilised at a latter stage when there isn't sufficient energy from the solar panels such as at night.

Unfortunately, this is not practical in South Africa due to the fact that if the grid is down, your property will also be down and will have no electricity even if there is sufficient sunlight to power your panels. Therefore, batteries are used to alleviate this problem.

What does the battery rating mean?

The battery size is basically the amount of amps it can store, at a certain voltage, and is rated in Watt hours. For example, a 48V 100A/h battery will give you 4.8 kW/h or 4800W/h (48 x 100) or storage power.

Take water for an example, the battery size would be the size of the bottle, and the amount of water the bottle will be able to store, 5L in this example, would be the amps.

Another aspect to remember is if the battery is 1C or 2C rated. 1C batteries are able to discharge their full amount in an hour, whereas 2C batteries can only discharge over two hours. i.e., 1C = 100% discharge in an hour, 2C = 50% discharge in an hour. Most Lithium-ion batteries for home or small business use are 2C batteries, this is because they do not need to deplete as rapidly as they do for large commercial use.

What does it all mean?

With a basic understanding of what the different components of your system do, we can look at what it means in practicality?

For this example, let's use the following system size:

Solar Panel output to inverter:	2kW
Inverter size:	3kW
Battery Storage using a 2C battery:	5kW/h

Every appliance has a rating in W for the amount of power it requires whilst in operation as well as a peak rating (the amount of watts it requires to start).

For this example, if you are drawing 2800W as per the above inverter size you are almost on the cusp. You still have 200W to use, so if the appliance is rated at 180W's but the peak rating of 400W, your system will trip. i.e., 2800W + 400W of peak power to start up exceeds the maximum power output the inverter can handle, and it will shut down. Therefore, no matter how much electricity is available, this is the maximum amount of power that can be used at any one time.

The amount of power available for use is dependent on three factors, available power from the solar panels, battery storage capacity, and power from the grid. Using the system information above, the solar panels will produce approximately 2000W per hour, meaning you could run a maximum of 250 8W light bulbs per hour. Anything over that would have to be supplemented by either Eskom or your batteries.

Remembering that your inverter size is your input amount and output rating, as per the system in this example, you are only able to use a maximum of 3kW at any one time, i.e., 375 8W light bulbs, anything more than that and your system will trip.

The battery or stored energy is similar to the panel input in as much as the rating is the amount of usable power. As per the above figures, a 5kW/h battery will give you 5000W of stored energy. However even if it is a 1C battery, Due to the fact that we are using a 3kW inverter, we can only draw a maximum of 3kW/h from the battery. If it is a 2C battery you will only be able to draw a maximum of 2.5kW (5kW / 2) per hour. Anything more that that and the system will trip, even though the inverter is of a higher rating.

Let's use water in a swimming pool as an example to tie it all together.

- Panel wattage: the amount of water available to full up the pool
- Inverter size:
  - Input: The maximum amount of water that can flow through the pipe into the swimming pool
  - Output: The maximum amount the water can flow out of the pool at any one time
  - I.e., a bigger pipe will allow more water to flow.
- Battery capacity:
  - The total amount of water the swimming pool can hold.
  - 1C vs 2C: The amount of water that can flow back through the pipe at any one time.

I hope after reading this guide you come away with a better understanding of how a solar PV system works. If there is anything that you are still a little uncertain about, please don't hesitate to give us a call or send an email and we will happily endeavour to answer your questions no matter how trivial they might seem. We all had to start at the beginning at some point.

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