Solar power calculator

Solar power system components

Let's start with a brief revision of the major components found in a basic **solar power system**. This should help you to understand then correctly identify and select the correct size components for your **solar power system**.

The following diagram shows the major components in a typical basic **solar power system**.
A basic solar powered system:

The **solar panel** converts sunlight into DC power or electricity to charge the **battery**. This DC electricity/(charge) is controlled via a **solar regulator** which ensures the battery is charged properly and not damaged and that power is not lost/(discharged). DC appliances can then be powered directly from the battery, but AC appliances need a **power inverter** to convert the DC electricity into 220 Volt AC power.

Description of individual solar power system components

Solar Panels

Solar panels are classified according to their rated power output in Watts. This rating is *the amount of power the solar panel would be expected to produce at STC (standard testing conditions) of sunlight intensity 1000w/metre at 25 degrees centigrade*
Different geographical locations receive different quantities of average peak sun hours per day.
As an example, in areas of the Highveld in South Africa, the annual average is around *5.6 sun hours per day*. This means that an *80W solar panel based on the average figure of 5.6 sun hours per day, would produce a yearly average of around 450W.H per day*.

Solar panels can be *wired in series or in parallel to increase voltage or current respectively*. The rated terminal voltage of a solar panel is usually between 17-22 volts, but through the use of a regulator, this voltage is reduced to around 13 or 14 volts as required for safe battery charging.

Solar panel output is affected by the cell operating temperature. Panels are rated at a nominal temperature of 25 degrees Celsius. The output of a solar panel can be expected to vary by 0.25% for every 5 degrees variation in temperature. As the temperature increases, the output decreases.

Solar Regulators

The purpose of **solar regulators, or charge controllers** as they are also called, is to *regulate the current from the solar panels to prevent the batteries from overcharging*. Overcharging causes gassing and loss of electrolyte resulting in damage to the batteries.

A solar regulator is used to sense when the batteries are fully charged and to stop, or decrease, the amount of current flowing to the battery.

Most solar regulators also include a *Low Voltage Disconnect feature*, which will switch off the supply to the load if the battery voltage falls below the cut-off voltage. This prevents the battery from permanent damage and reduced life expectancy.

A *solar regulator also prevents the battery from back feeding or discharging into the solar panel at night and, hence, flattening the battery.*

Solar regulators are rated by the amount of current they are able to receive from the solar panel or panels.

See section below for information on correctly sizing a solar regulator.

Power inverters

The **power inverter** is the main component of any independent power system which requires AC power. The **power inverter** will convert the DC power stored in the batteries and into Ac power to run conventional appliances.



DC to AC power inverters

Just over a decade or so ago, **DC AC power inverters** were so inefficient and unreliable, many people restricted themselves to 12V lights and appliances.
If you have recently tried to shop around for 12V DC appliances, you will see that there is a very limited selection available.
Today, the efficiency and reliability of the latest **DC AC power Inverters** are a far cry from the inverters that were available 15 to 20 years ago.
There are three waveforms produced by modern solid state power inverters. The simplest, a square wave power inverter, used to be all that was available. Today, these are very rare, as many appliances will not operate on a square wave.
True Sine wave inverters provide AC power that is virtually identical to, and often cleaner than, power from the grid.

Power inverters are generally *rated by the amount of AC power they can supply continuously*. Manufacturers generally also provide 5 second and ½ hour surge figures. The surge figures give an idea of how much power can be supplied by the inverter for 5 seconds and ½ an hour before the inverter's overload protection trips and cuts the power.

For more info on solar inverters go check out our **power inverter website** - http://www.inverter.co.za/solar-power-inverter.htm

Solar Batteries

Deep cycle batteries are usually used in **solar power systems** and are designed to be discharged over a long period of time (e.g. 100 hours) and recharged hundreds or thousands of times, unlike conventional car batteries which are designed to provide a large amount of current for a short amount of time.

To maximize battery life, deep cycle batteries should not be discharged beyond 50% of their capacity. i.e. 50 % capacity remaining. Discharging beyond this level will significantly reduce the life of the batteries.

Deep cycle batteries are rated in Ampere Hours (Ah). This rating also includes a discharge rate, usually at 20 hours. This rating specifies the amount of current in Amps that the battery can supply over the specified number of hours.

As an example, a battery rated at 120A.H at the 100 hour rate can supply a total of 120A.H over a period of 100 hours. This would equate to 1.2A per hour for 100 hours. Due to internal heating at higher discharge rates, the same battery could supply 110Ah at the 20 hour rate, or 5.5A per hour for 20 hours. In practice, this battery could run a 60W 12VDC TV for over 20 hours before being completely drained.

There are many factors that can affect the performance and life of a battery or bank of batteries. It is highly recommended that you *speak with an experienced solar power system installer or solar battery provider prior to making any significant battery purchase.*

Choosing the right size solar regulator

A **solar regulator** must be able to handle the maximum current that can be produced by the solar panels. Reflected sunlight and specific temperature conditions can increase the output current of a **solar panel** by as much as 25% above it's rated output current. The solar regulator must be sized to handle the increased current.

Example: An 80W 12V solar panel has a rated output current of 4.55 Amps and a rated short circuit current of 4.8 Amps.

Minimum **solar regulator** size for a single 80W solar panel should be:
4.8 Amps x 1.20 = 5.76 Amps.

It is recommended that the regulator selected is even slightly larger than this figure to ensure that it is not constantly operating at 100% of its rating, particularly in regions with higher ambient temperatures.
A good rule of thumb is a margin of between 20 and 30%.

Sizing your solar power system

In order for you to size your **solar system** correctly, you need to note the power rating of each appliance that will be drawing power from the system.
Let us take some common household appliances like lighting, a TV, and a fridge to see how one calculates the correct size solar system:
10 x 12W globes = 120W operating 10 hours per day. = 1200W.H
2 x TV x 250W = 500W operating 6hrs per day = 3000W.H
Fridge x 250W = 250W operating 24/7 = 6000W/day

Power inverter sizing

Appliance total power draw = 120W(for the 10 lights) + 500W(for the 2 TV's) + 250W(for the fridge) = a total power draw of 870W.
To provide a small buffer or margin your minimum size inverter choice should be around 1000W.
A modified sine wave inverter with a 1500W continuous power rating will therefore be your obvious choice in this specific solar system design.

Determining the size and number of solar panels

Here we take the total power usage daily = 1200W.H + 3000W.H + 6000W.H
This = a total of 10200W.H
Divide the total daily power requirement by the number of charge hours for that geographic region eg. 10200/5.5Hrs = 1854.54W
Add 20% for inefficiencies = 2225.45 W
This total power value determines the size and number of panels eg. 2225.45/75W panels = 30 x 75W panels.
If you fancied say 125W panels , then 2225.45/125W = 18 panels.

How many batteries?

Well the 75W panels produce 4.4Amps, thus 30 x 4.4 A = 132A x 5.5 Hrs = 726Ah
105Ah batteries, should be discharged to no more than 50%, thus we divide total amps by 105A x 50% = 50A.H
726/50A = 14.5 x 105Ah batteries.
For ease of possible 24V or 48V configuration, this would mean 16 batteries.

What size regulator do we need?

Let's say we had 20A regulators at our disposal.
One 75W panel produces around 4.4Amps.
3 x 4.4A = 13.2A
So 30 solar panels would need 30/3 = 10 x 20A solar regulators.

Complete the solar power system

Well we have the following:

- 30 x 75W **solar panels**
- 10 x 20A **solar regulators**
- 16 x 105A.H **deep cycle batteries**
- 1 x 1000W **modified sine wave power inverter**

Thus we have calculated the **solar power system** components that you would need in order to cater for your current power usage