

Following the rising cost of electricity, most people have been thinking of going the solar route. Two questions arise. One, what is the right system for my needs, and two, is it worth it? Most people have installed systems which may either be too big (and therefore expensive) for them, or too small (and therefore ineffective). They are often left frustrated.

In this lesson, I will take you through the steps needed to determine the right system for you. But basics first.

Components

At a minimum, a solar system comprises of the following components:

1) Solar Panels

These are the components that convert solar energy to electrical energy. Normally mounted on roofs. They require sunlight to operate. They should be mounted in a way that ensures maximum exposure to sunlight. Their size is measured by how much electricity they generate (power) in Watts. Typically, they give the power at 12 volts, though some exist for 24/48v. We will limit our discussion to 12V panels.

2) Batteries

These store the energy generated by the solar panels for later use. The key parameter is capacity, measured in Ampere Hours (AH). This is a measure of how much energy the battery can store. Whereas different voltage specifications exist, we will limit our discussion to the most common, a 12 V battery.

3) Inverter

This converts energy stored in the battery into a form usable by your home components, ie from DC to AC. The size is rated in Watts, an indicator of how much power the inverter can give out.

4) Charge Controller

This device protects your batteries from being overcharged by the solar panels, or being drained excessively by the inverter. It also protects your solar panels in the event of a short circuit in the subsequent wiring. A key parameter is the current rating, which is a measure of how much current (in Amperes) they can allow to pass through.

The objective of this lesson is to design a system that meets the following conditions:

- 1) Solar panels are sized to generate adequate energy for the required purpose within a given duration
- 2) The batteries are sized in such a way that they store sufficient energy to run your electrical/electronic components over the required period of time without running out
- 3) The inverter is powerful enough to supply power to the required components (we will call it the load henceforth).
- 4) The charge controller is sized to allow the generated current from the solar panels to pass through to the batteries.

Step 1. Determine your energy requirements

This step requires you to determine how much energy you use both at any given instant (Watts) and over a period of 24 hrs (KWH).

For example, a bulb's power, expressed in Watts, is a measure of how much instantaneous power it uses. If you put the bulb on for 2 hours (hrs), the product of watts and hours gives you an indication of how much energy the bulb has consumed over the two hours. To determine your daily energy need, check all the devices in your setting (those you wish to put on solar) and their power rating. Estimate as accurately as possible how long each device is put on. Tabulate as follows.

Work out the Gross Power column by multiplying Watts by How many.

Compute the daily need by multiplying Gross Power and Hrs/day. Finally, obtain the totals for the Gross Power and the Daily Need columns.

Note that every system has some losses. Common practice is to assume that 20% of the energy will be lost or consumed by the system. So, we will add 20% to 6560. We get 7872WH.

We will therefore design a system capable of delivering 7872 WH per 24 Hrs.

Table: Energy Requirements.

Step2: Determine the size of solar panel

From the basics, we now know that all the energy we will use will come from the sun through

the solar panels.

So, whatever size we get, it must be able to generate 7872WH every day. Note that the sun isn't at optimum angles to the solar panels at all times. For practical purposes, take it that the sun will be available for 6 Hrs only. This is a good average considering morning and late afternoon hours when the sun is at an angle.

So, our panels must give 6560 WH in six hours. To get the rating needed, divide 7872 by 6.

$$7872 \div 6 = 1312W.$$

Solar panels are available in different rating, like 100W, 200W, etc. You can chose any combination that gives you a total of 1312, but try not to pick very few big panels, or very many small panels. In our case, we an pick 6*250W panels, which gives us 1500W.

Step3: Determine size of Inverter

We assume a worst case scenario where all appliances are switched on. We will need an inverter which will be able to handle a load on 1065 watts.

Note however that an inverter is only approximately 50% efficient. So, as a rule, take a size that is double (or almost double) your instantaneous power requirement. In our case, we will pick one rated at 2000 watts.

Step 4: Determine Battery Size

The battery is what keeps your badgers on,so it is very important to get it right.

To do so, we need the following parameters:

a) Battery voltage (BV). This is a specification of the battery. The most common are 12V batteries,though there exist 24 and 48 V batteries. We will work with 12V.

b) Depth of Discharge (DD). To make our batts last longer, we will avoid a situation where we drain our batteries to zero before charging them again. A higher figure means shorter life. A lower figure means a higher life. A safe figure to use for batteries rated as "Deep Cycle" is 75%, or 0.75.

c) Battery Efficiency (BE): Again, the battery isn't 100% efficient. It will only give you a certain percentage of the energy in store. A typical figure is 85%, or 0.85.

d) Daily Usage (DU): This is the figure we obtained from the audit of our daily needs in step 1.

To get the right battery size, use the following formula.

$$DU/(BV*BE*DD)$$

In our case

$$=7872/(12*0.85*0.75)$$

=1029AH.

So, we need to get a combination of batteries with a total rating of around 1029 AH.

Typical ratings are 100, 200, 250, etc.

Just like with the panels, we will get a combination that is not too many of small batteries or too few of large batteries. We will go with 4*250AH batteries, which gives us 1000, almost equal to our computed figure.

Step5: Charge Controller Sizing

We determine the rating of the controller by getting the total power output from the panels and dividing this by the battery voltage.

There are some systems designed on 12v, 24v, 48v, etc depending on whether the components are connected in series or parallel. That is beyond the scope of this lesson. Let us start simple and assume a 12v system.

The rating will be $1500/12=125A$.

We notice this current is too much, and charge controllers of that rating will be very expensive. Therefore we will go with a 24v design which will put our charge controller rating at 62.5 amps.

A 24V-60-amp controller will therefore suffice.

Note that this rating (24V) dictates that our inverter should also be rated at 24V. Subsequently, the panels and batteries will need to be connected in the right way to achieve a 24V system. Any electrician worth his salt should be able to figure this out. I won't dwell on it since it is beyond the scope of our lesson.

Putting it all together

We have designed a system that will use the following components. I have put approximate costs of the items.

6*250W solar panels @12k =72k

4*250Ah batteries @28k =112K

1*2KW inverter @40k =40k

1*60amps Controller @25k =25K

Misc accessories 30K

Total 279K.

Is it worth?

The most expensive and short lived component is the battery. Good ones should serve you for 5 years. So, will there be any saving by having such a system to replace Kenya Powerless? Let's see.

At a daily usage of 6560 WH, your monthly need is $6560 \times 30 / 1000 = 197$ units per month.

At the current price of 24 per unit, that means a monthly bill of 4,752, say 5k

It will take you $279,000 / 5000 = 56$ months to break even if you opt this route, and if power costs remain the same. That is roughly 5 years, the same time you will be replacing the batteries.

Whereas there may not be any significant saving, the joy is that you have power 24/7, not at the mercy of Kenya powerless.