Understanding and Managing Power Consumption

An article by marine electrician Barry Clark

Let's begin by looking at some principals of electrical systems

- *Current*, measured in amps, is the speed at which electricity flows. Just like in a river, or a tidal flow.

- *Voltage*, is the pressure that causes the current to flow. Similar to the pressure exerted on water by the pump that produces a flow of water, or by the 'head pressure' of water in a tank.

- *Power* (watts, kilowatts, etc.) is equal to volts multiplied by amps. This is the electrical 'Energy' produced or consumed by something.

- For accurate calculations using the formula above, we must use the actual voltage at the time, rather than the nominal voltage of the electrical system. For example, the 'nominal' voltage of our DC electrical system might be 12 volts, but the 'actual' voltage will almost never be 12 volts. A fully charged battery will have a voltage somewhere in the region of 12.6 to 12.8 volts depending on the type, age and condition of the battery.

- Nothing is 100% efficient. The energy going into a battery charger, inverter, or any other electrical device will always be more than what is available at the output of that device.

Let's put those principals into practice.

Based on the principals described above, we will now look at why using a lower power, or lower rated, appliance to do a job (such as boiling water) will not save any energy.

If we prefer to power our 230 volt electric kettle from an inverter rather than a genset or shore power, are we going to use less battery power by using a 1000 watt kettle than we would using a 2000 watt kettle? The answer is no. Let's look at boiling some water that has a 'cold' temperature of 15° Celsius. Given a common ambient temperature for all cases. To raise the temperature of our water from 15° Celsius to boiling point requires an amount of energy that is determined primarily by the volume of water we want to heat. A low power kettle and high power kettle will use the same amount of power to do the same job. This is a basic principal of physics. Therefore, the only difference that using a lower power kettle will make is to extend the time taken to boil that particular volume of water. In an extremely cold climate, that could actually use more power rather than less, because of the heat that would be lost to the cold atmosphere.

If we wanted to reduce the power consumed, we would need to reduce the volume of water. For this reason, you will take less power from your batteries by boiling no more water than you absolutely have to.

Now let's look at what happens when we start to drain our batteries and reduce their voltage.

Let's assume we need a given amount of power to do a particular job.

Electrical power is equal to volts times amps. Therefore, to get a given amount of power, if either volts or amps is reduced, the other must increase.

As we draw power from our batteries, their voltage will reduce. This means that the current (amps) **must increase** if the same amount of power is to be produced. Current is the **speed** at which we are drawing power. So, as we reduce the battery voltage we begin to draw power form the batteries at an ever increasing rate. This reduces the voltage further, the current draw (amps) increases further to provide the required power, and so, and so on.

Some types of electrical load won't follow this principal. They will simply produce less power, but it is useful to understand the principal. It is also useful to understand that some devices can be damaged by low voltage. A reference to recommended maximum battery discharge levels (minimum voltages) is available in a separate document.

What conclusions can we draw from the things we have learned?

- Given the choice, it is more efficient to use an appliance that operates directly from the power source. For example, if you are going to use a 12 volt battery as a power source, it is more efficient to use a 12 volt appliance than to convert the power to a different voltage via an AC inverter, or DC voltage converter.

- Drawing high rates of power from batteries that are not being maintained by a charger that can meet the power demand, could possibly result in an 'avalanching' battery discharge that will very likely be harmful to the batteries.

- It is better to supply higher 230/240 volt loads from a generator or shore power supply.

What equipment draws the most power?

If you have an ammeter (yes, that is the correct spelling) to show the current drawn from your batteries, or from your 230/240 volt power system, this will help you to see which equipment draws the most current (multiply this by the supply voltage to get power in watts). The power ratings marked on the equipment will also help you to determine this.

But there's more! We need to look a 'watt hours'. Electricity meters for buildings measure kilowatt hours. Watt hours is the amount of energy in watts multiplied by the number of hours the energy is delivered for. Therefore, we need to do more than look at which devices draw the most current (amps) or consume the most power (watts). We also need to consider how many hours per day that amount of power is drawn for. 'Refrigeration systems' is a good example. These are cycling on and off all day and all night. The amount of time they spend 'on' compared to the amount of time they spend 'off' is referred to as their 'duty cycle', usually expressed as a percentage to indicate the percentage of time they are 'on'. To determine the power a 'cycling' appliance is drawing in a 24 hour period, we must multiply 'watts x duty cycle x 24'. This will show us the 'watt hours' consumed in a 24 hour period. For example, a 2000 watt appliance with a 40% duty cycle will consume 19,200 watt hours per day.

In summary, devices that 'cycle' can account for greater power consumption than you might have thought.

Automatic generator starting

If you prefer to draw 230/240 volt power from a quiet inverter rather than a noisy generator, I recommend that you use automatic generator starting. This will monitor battery voltage and when the voltage falls to a pre-set value, start a generator to provide power for 230/240 volt equipment while recharging the batteries.