How to Guide

Power Budget

ROADTREK

Power Budget

FAQ: Power Budget

Quite often we get asked "How long can I run my [fill in the blank] on my batteries?" This guide will attempt to help you answer that question.

This brief manual is a general guide. Due to nearly endless different conditions or situations there's no way to provide specific timelines.

The numbers and times in this guide are very, very simplified approximations and will vary from the brochures and specific model manuals. Your actual run times will vary quite a bit from the very simple calculations shown here. Your experience is your best guide.

Run times and energy consumption depend on many factors. For example, your Air Conditioning (A/C) will work much harder in a hot parking lot in 104 degree weather in 99% humidity with a filter full of cat hair than it would under a shade tree in 85 degree weather with 50% humidity with a new filter.
Think of your batteries as a bank. When you charge, you are saving a certain amount of energy units. When you discharge, you're spending those units. It's much like balancing a checkbook or keeping track of expenses.

What affects battery life

All sorts of things affect battery life. Temperature extremes, both hot and cold, the age and condition of the battery, the state of charge, even humidity can affect the life of the battery.

What affects charging

As with battery life, many things affect charging. Temperature, both hot and cold, will reduce the performance of chargers and alternators. Condition of the wiring, humidity, and so on. Heat is very hard on electronics, so make sure your inverter/charger has at least 2" all around it for ventilation. Keep that area clear and do not interfere with any factory installed shroud if so equipped. If you live in an area where roads are salted in the winter, you may experience lower performance due to salt corrosion on the terminals and cables.

AGM batteries

A pair of 6V AGM batteries holds about 2000 watts. That means that you can take out one watt every hour for 2000 hours before the battery is dead. You really don't want to do that with AGMs; they have a "minimum balance requirement" of 50%, or 1000 watt-hours. That means you can only take out 1000 watt-hours before the bank gets very nasty with you. Therefore, you can take out a watt every hour for 1000 hours, or 100 watts for 10 hours.

If you have four pairs of AGM batteries, you have a bank of 4 x 1000 usable watt-hours = 4000 usable watt-hours.

Read the label on your A/C; it probably uses somewhere around 1200 - 1800 watts; let's assume 1500 watts. With our new knowledge, we can say that our bank of 4 AGM batteries will run the AC for 4000 watt-hours / 1500 watts = two and a half hours or so. Close enough. In the real world, that number will vary widely and will probably be less, but you get the idea.

Your microwave uses about 1400 watts, so 4000 watt-hours / 1400 watts = 3 hours, give or take.

Since you probably use your microwave for a minute or two, it will barely make a dent in the battery storage, while the air conditioning will be the largest consumer of power. You can go around and figure out some of the other appliances from the table on page 5.

Lithium Power Modules

A single Lithium 200 Power Module holds about 2500 watt-hours. The Lithium bank is a lot more generous than the AGM bank; it lets you take out 80% of the power. That means that the Lithium battery has about 2000 watt-hours of usable power, a good bit more than the AGMs.

With four Lithium batteries you have a usable bank of about 8000 watt-hours, so you can run your air conditioner for about 8000W / 1500W = 5 hours, give or take. Again, quite approximate, and if you have other appliances running it will be less. (we are omitting system losses, which can be as high as 15%, and would reduce your runtime by an hour or so.)

Battery Management System

The battery management system monitors the following functions of the system; total voltage, independent cell voltage, battery temperature and amperage draw. There are no serviceable parts and a tester is required to read the battery management system.

How many batteries do I need?

It is recommended to use lithium modules in sets of two, however for most household functions like watching TV or turning on the lights you only need to have one module turned on. If you plan to use your air conditioner, microwave, or induction stove, you should turn on at least two if not four Lithium Power Modules.

 One battery will provide the power for an air conditioner, but it will not last long.

With one Lithium Power Module, you have 2000 watt-hours of usable power; if your air conditioner uses 1500 watts, you can see that a single Lithium Power Module will last an hour, give, or take. In the real world, it will be less; batteries lose a lot of power to "friction" when you impose high demands on them. For this reason, it is best to turn on several Lithium Power Modules when running big appliances.

 Because of potential cycling and recovery times, we recommend that you always use at least two Lithium Power Modules when running the air conditioner.

Charging

It is recommended to always charge in sets of two. The underhood generator can bring a single Lithium battery to full charge in as little as a half-hour of highway driving. Let's look at the math:
Lithium battery is down 1600 watt-hours at 20% charge. The underhood generator generates 3000 watts at highway speeds. At that rate it will charge the battery in 1600 watt-hours / 3000 watts = about half an hour. Note that this is ideal conditions, when the underhood generator can generate maximum power, and nothing else is on. Any power draws, such as leaving the inverter on, and especially running the air conditioner, will increase charge times significantly.

 High charge rates heat up the underhood generator. It will produce less power to keep itself cool if needed; expect longer charge times on very hot days.

Let's look at charging multiple batteries. With four Lithium Power Modules at 20% charge, you're down 8000 watt-hours. At 3000 watts of charging, that's just over 2 hours of driving: 8000 watt-hours / 3000 watts = just over 2 hours. Again, this is ideal conditions and in the real world that charge rate would be reduced by heat and power demands.
You get the idea. Charging one module at a time gives you the chance to have full power quickly in that module, and then charge the rest of the modules.

Solar charging

Every 100 watts of solar generates 100-watts. Keep in mind this is under ideal conditions; in the real world, latitude, cloud cover, daylight hours, and so on reduce that power significantly. As a rule of thumb expect about 4 hours of peak production a day; less on cloudy days. Thus a 100-watt panel would generate 400 watt-hours a day, and 400 watts of panels would generate about 1600 watt-hours in each day.

 Solar panels produce less power when hot, so expect lower solar output during hot days.

The Inverter/Charger

The inverter/charger serves 2 functions:

- Charge your batteries when plugged into shore power
- Provide household current (120VAC) when not plugged into shore power.

Only turn on your inverter/charger when you want to charge your batteries when plugged in, or when you need to use an appliance that plugs into a wall outlet, such as a microwave, hair dryer, or blender.

At all other times keep the inverter off as it also consumes power when on.

 The switch on top of the inverter should always be OFF. Turning it ON disables the remote switch.

How many watts do my appliances use?

These are very rough numbers to help you start.

- TV - 150 watts
- Blender - 1000 watts
- Inverter - 100 watts (Yes, the inverter uses power. Turn it off when not needed.)
- Lights (LEDs) - 50 watts (old incandescent lights use about 10 times that)
- Roof fan - 60 watts
- Compressor fridge - 60 watts
- 3-way fridge on electric - 300 watts
- Air conditioner - 1200-1800 watts
- Microwave - 1400 watts
- Propane furnace - 60 watts
- Alde - 30 watts
- Insta-Hot water dispenser - 750 watts
- Hair dryer - 1500 watts

 Check and make sure that your fridge is unplugged from the 120VAC outlet. The fridge is more efficient on 12VDC when boondocking.