Battery Sizing Questions and Answers

How Long Will my Batteries Last?

Unfortunately, this question cannot be answered without knowing the size of the battery bank and the load to be supported by the inverter. Usually, this question is better phrased as "How long do you want your load to run?", then specific calculations can be made to determine the proper battery bank size.

Formulas and Estimation Rules

1. Watts = Volts x Amps
2. Battery capacity is expressed by how many Amps for how many hours a battery will last – Amp Hour (Ah) capacity
3. For a 12-Volt inverter system, each 100 Watts of the inverter load requires approximately 10 DC Amps from the battery
4. For a 24-Volt inverter system, each 100 Watts of the inverter load requires approximately 5 DC Amps from the battery

The first step is to estimate the total Watts (or Amps) of load, and how long the load needs to operate. This can be determined by looking at the input electrical nameplate for each appliance or piece of equipment and adding up the total requirement. Some loads are not constant, so estimations must be made. For example, a full-sized refrigerator (750-Watt compressor), running 1/3 of the time would be estimated at 250 Watts-per-hour.

After the load and running time is established, the battery bank size can be calculated. The first calculation is to divide the load (in Watts) by 10 for a 12-Volt system or by 20 for a 24-Volt system resulting in the number of Amps required from the battery bank.

Example of Load Calculations

Suppose you were to run a microwave oven for 10 minutes a day, which draw about 1000 Watts, despite their size. To keep it simple, think of the inverter as electrically transparent. In other words, the 1000 Watts required to run the oven come directly from the batteries as if it were a 12 VDC microwave. Taking 1000 Watts from a 12-Volt battery requires the battery to deliver approximately 84 Amps.
(1000 Watts ÷ 12 Volts = 84 Amps DC)

A full-sized refrigerator draws about 2 Amps at 240 Volts AC. By multiplying 2 Amps x 240 Volts, you find out the refrigerator uses 480 Watts. The batteries will need to deliver 40 Amps to run the refrigerator (480 Watts/12 Volts = 40 Amps). Typically, refrigerators operate about 1/3 of the time (1/3 "duty cycle"), or 8 hours a day. Therefore, the Ah drain will be 320 AH (8 hours x 40 Amps = 320Ah).

After the load and running time is established, the battery bank size can be calculated. The first calculation is to divide the load (in Watts) by 10 for a 12-Volt system or by 20 for a 24-Volt system resulting in the number of Amps required from the battery bank.

Example of Input Calculations

1. Total Watts = 1000 W
2. Amps from 12-Volt battery = 1000 ÷ 10 = 100 Amps DC
3. Amps from 24-Volt battery = 1000 ÷ 20 = 50 Amps DC

Next, the number of DC Amps must be multiplied by the time in hours that the load is to operate.

If the load is to operate for 3 hours:

For a 12-Volt battery: 100 Amps DC x 3 hours = 300 AH

For a 24-Volt battery: 50 Amps DC x 3 hours = 150 AH

Now, the proper type and amount of batteries must be selected. Traction batteries, (also called deep cycle or golf cart type), should be used in order to be able to handle the repeated discharge/charge cycles that are required.

Choosing the Correct Number of Batteries

This is a little more difficult due to the rating method used by the battery manufacturers (CCA cannot be used as a rating factor, only Ah capacity @ C_{10}, C_{20}, C_{100}). Also, because of the nature of the battery, the higher the discharge rate, the lower the capacity of the battery.

12 VOLT BATTERY CAPACITY Ah @ C_{20}	HOURS OF DISCHARGE WITH 5A LOAD
100	20
90	10
87	8
83	6
80	5
70	3
60	2
50	1

Most batteries' Ah capacity is stated for the 20-hour rate of discharge (C_{20}). This means that a battery has a 100 Ah capacity if it is discharged over 20 hours, or at about 5 Amps-per-hour (100 Ah / 20 hours = 5 Amps DC). However, this same battery would last only one hour if the discharge rate was 50 Amps-per-hour (50 Amps DC x 1 hour = 50 Ah) because of the high rate of discharge.

The chart above indicates that for 3 hours of discharge rate, the battery has only 70% capacity. Therefore, we must have 428 AH of battery capacity. (Figured by dividing the Ah capacity by the percentage of loss, or 300 Ah ÷ 0.7 (70%)). Therefore we would require 428 Ah of batteries at a stated 20-hour rate. If the standard 12-Volt battery is 105 AH, four batteries are needed.

Finally, two more items must be considered. The more deeply the battery(s) is discharged on each cycle, the shorter the battery life will remain. Therefore, using more batteries than the minimum will result in longer life for the battery bank. Keep in mind that batteries lose capacity as the ambient temperature lowers. If the air temperature near the battery bank is lower than 25°C, more batteries will be needed to maintain the required capacity. It should also be kept in mind that all lead acid batteries lose between 1% and 2% of their rated capacity through self discharge every 24 hours. This self discharge increases dramatically above 25°C ambient air temperature.