- Background general, battery and solar experience

- Solar short story - Email

- Solar Panel specifications and how to interpret for 12 volt battery charging
  - Some local solar radiation numbers, moisture, altitude
  - Truly Green - 25 year warranty

- Solar controller and/or battery charger - what to look for

- Deep Cycle Lead Acid battery graphs - all require a little Kentucky Windage
  - SOC - state of charge
  - Float service life
  - Cycle service life
  - Discharge rates and impact on capacity
  - Charge voltages (3)
  - Capacity versus Temperature

- General battery discussion - off the cuff (CCA, MCA, RC, capacity testing, etc.)
  - No mixing - same type, lot, and capacity
  - Other than lead acid , Ni-cad, NiMH, Li

- Worksheets
  - Shack and radio loads + time = how many AH needed
  - Battery sizing - don’t forget cloudy days and DOD for full service life
  - Solar panel selection

- Q and A

Email 12/16/2006

Hi Steve (AE6NX)

Yes, solar is not cheap! You have to look at the panels 'ampere' output - as manufactures typically rate them in watts. Usually panels built for 12 volts systems have their wattage rating based on about 17 volts.

The root of solar design is ampere-hours and one must look past a panels "watts" rating and find its useable ampere output.

A typical panel manufactured for 12 volt systems actually puts out its rated amperes at about 17 volts. To fully charge a 12 volt battery we need to get the voltage of the battery up to around 14.2 to 14.4 volts (depending on its acid content). Add to the 14.x volts battery charge voltage we need some head room, or if you will some working voltage for the charge controller - we end up needing around 17 volts out of the panel.

Now the hooker, the manufacture figures his "advertised" panel wattage using the 17 volts - however the user needs to figure AH (ampere-hours) for a 12 volt system. If the panel is rated at say 55 watts we must divide that by (about) 17 volts to find the panels actual ampere output, in this case 55/17 = 3.2 amps. When looking at a 12 volts system we are now only working with about 39 watts, or about 70% of the panels rating.

Now you look at how many hours the panel is going to produce some amps for you to charge a battery. For a "fixed" panel or one that doesn't track the sun - summer output is equivalent of around 7 hours of full output, and winter output is equivalent to around five hours. The net, using the above 55 watt panel in the summer is 7 hours times the 3.2 amps, or a daily output of 22.5 AH (ampere-hours). And, in the winter about 16 AH.

Then one needs to look at the charge efficiency for lead acid 'batts is around 80% - you need to put in about 125% to fully charge a battery to 100% of its rated capacity. Again using the example 55w panel, in the summer we only stuff about 18 AH of useable energy back into our battery system, and in the winter about 13 AH. And so on ....

Regards, Hugh AE6YC

Shack Load Worksheet

Amperes x Time (in hours) = AH (ampere hours)

Load	Name	Amps	Time in hours	Amp Hours
Rx - Standby *Transmit*	*TM-742*	*.75 amps* *5.2 amps*	*4* *.5*	*3.0* *2.6*
Radio 1 Rx Xmitt				
Radio 2 Rx Xmitt				
Radio 3 Rx Xmitt				
Packet Rx Xmitt				
APRS Rx Xmitt				
Scanner				
Lighting				
Other (inverter for 115vac)				
				Total daily AH usage

For APRS and Packet operation estimate the number of transmit burst for the time the system is powered. If the average APRS burst is one second and you have 400 transmissions, then; (400 x 1 = 400seconds, 400/60 = 6.67minutes, 6.67/60 = .11hours). For packet assume 3 seconds per, 500 burst = 1500 seconds, 1500/60 = 25 minutes, 25/60 = .42 hours.

Battery Sizing - - - Panel Selection

Deep cycle and golf cart batteries available at the large retailers should yield around 3 years of service. Properly maintained their AH capacity after 3 years of service will be in the range of 40 to 60%. The 12 volt '27' case size deep cycle/marine batteries range in capacity from 110 to 120 ampere hours. The 6 volt golf cart type are around 200 AH, the Trojan T105 is advertised at 220 AH.

To achieve a three year service life with some reserve, the initial battery capacity should be 6 times your expected daily usage. Remember, after three years of service the capacity has decayed to around 50%. Power outages and inclement weather go hand in hand, don't be caught short.

Daily AH usage	120 AH 12 volt deep cycle	220 AH 6 volt golf cart	Float service standby - New	Float service standby after 3 yr
10 to 20	One	Two in series	6/11 days	3/5 days
30	Two in parallel - 240	Two in series -220	8/7 days	4/3 days
40	Two in parallel - 240	Two in series - 220	6 days	3 days
50	Three in parallel - 360	Four in series/parallel - 440	7/8 days	3/4 days

Lead acid battery charge efficiency is between 80 and 85%. If we use 10 amp-hours from our battery, the charge/solar system must apply 12 AH to bring the battery back to its 100% charge state. For our location a fixed panel solar array will provide the equivalent of 7 hours full output in the summer and a mere 5 hours in the winter.

Daily AH used	AH replacement for 100% charge	50 watt panel at 3 amps for 5 hours = 15 AH	120 watt panel at 7 amps for 5 hours = 35 AH	Total AH
10	12	One panel = 15 AH		15
20	24	Two = 30 AH	One panel = 35 AH	30/35
30	36	Three = 45 AH		45
40	48	One = 15 AH	One = 35 AH	50
50	60	Four = 60 AH	Two = 70 AH	60/70