Deep Cycle Battery Discussion*

Below is a discussion of the specs listed in **Chart 1** (flooded, AGM, Gel, and LFP batteries), with specific information related to **Chart 2** (Lithium Iron Phosphate batteries only) near the bottom.

Chart 1: Comparison of 4 Types of Deep Cycle Batteries

Battery Type (12V)	Lead Acid (Flooded)	AGM (SLA)	Gel (SLA)	Lithium Iron Phosphate (LFP)
Company & Model Name	EverStart	Renogy	Renogy	Renogy
Model Name	Marine/RV Deep Cycle	Absorbent Glass Mat	Hybrid Gel	Smart LiFePO4
Price Tag (as of 2/2024)	$94	$207	$200	$599
Nominal Voltage	12V	12V	12V	12.8V
Amp Hour Capacity	109	100	100	100
Watt Hour Capacity (Ah x Nominal Voltage)	1308WH	1200WH	1200WH	1280WH
Depth of Discharge % = usable WH capacity	50% = 654WH	50% = 600WH	50% = 600WH	80% = 1024WH
Cycles (based on DoD)	200 - 300	400 - 500	750	4000
Expected Lifespan (yrs) – 1 full cycle per day	0.68	1.23	2.1	10.9
Dimensions (inches)	12.65 x 6.85 x 9.25	13.1 x 6.9 x 8.6	12.9 x 6.8 x 8.7	11.4 x 6.8 x 7.4
Weight (lbs)	50	64	64	26
Storage Temperature (°F)	~ 50°F	5°F - 104°F	-4°F - 140°F	-13°F - 149°F
Temperature Range (discharge °F)	0°F - 115°F	5°F - 122°F	-4°F - 140°F	-4°F - 140°F
Temperature Range (charge °F)	40°F - 113°F	5°F - 104°F	32°F - 122°F	32°F - 131°F
Self-Heating?	No	No	No	Yes!
Max Continuous Charging / Discharging Current	27A / 750 (MCA)	30A / 1000A (@ 5s)	30A / 1000A (@ 5s)	50A / 100A
Warranty (yrs)	1	2	3	5

Notes about the comparison chart: *Performance and battery lifespan depend on many factors, including: temperature, depth of discharge, frequency of use, availability of charging source, months in storage, etc.*

Assumptions on data*: Operating temperature of 25°C (77°F), Depth of Discharge (DoD) 50% for Lead Acid, AGM and Gel (12.0V) and 80% for Lithium Iron Phosphate (12.8V).*

Chart data collected from the following sources:
northeastbattery.com/battery-101-three-things-need-know-lead-acid-batteries/,
simpliphipower.com/company/news/blog/temperature-effects-on-phi-batteries-vs-lead-acid/
as well as Renogy product specifications at renogy.com.

Price Tag

When looking at a side-by-side comparison of price tags, it's pretty easy to see which battery will make the smallest dent in your pocketbook. Keep in mind, this is just the upfront cost and not the whole financial picture. For instance, while LiFePO4 batteries are definitely more expensive upfront, let's understand *why*. Looking at the "Usable Watt Hour Capacity" line in the chart, LFP batteries offer 80-100% of the stated battery capacity. To achieve the same usable watt hour capacity from any type of lead acid battery, you will need 2 batteries – doubling the price (and space needed for your battery bank). See below for more information.

Nominal Voltage

In the world of energy, voltage is pressure, while amperage refers to current -- like water flowing through a hose or pipe. Nominal voltage is a value assigned to designate a battery's voltage "class" (i.e., 12V, 24V, 48V or 120V). It is equal to the supply circuit system voltage to which the

unit may be connected. You may consider it an “approximate” voltage and all systems have a “safe” range.

You’ll note that all 12V-100Ah lead acid batteries have a nominal voltage of 12.0V while 12V-100Ah LFP batteries are in the 12.8V range. This means that you get more bang for your buck because LFP are a higher capacity battery at the same amp hours (V x Ah = WH).

Amp / Watt Hour Capacity & Depth of Discharge

Deep cycle batteries are rated in amp hours (Ah). While this number is important, where the rubber hits the road is the amount of energy / work the battery can specifically deliver in each cycle. This number is expressed in watt hours (WH), which is equivalent to amp hours x volts (e.g. 100Ah x 12V = 1200WH). While this seems simple and straightforward, what most people don’t realize is that different battery chemistries have different ***safe*** Depths of Discharge (DoD), which is the percentage of charge that you can safely use without damaging the battery. For instance, you can ***only*** use 50% of a lead acid battery’s total capacity in a given cycle. In other words, if the battery has a capacity of 1200WH, you can only use up to 600WH per cycle without damaging the battery. With LFP, the battery can be discharged by up to 80%, and occasionally up to 100%, without significantly shortening the lifespan of the battery. If the battery capacity is 1280WH, you can routinely use 1042WH and sometimes use all 1280WH. So, LFP batteries are nearly a 2-for-1 deal when you consider the energy they can store.

Cycles & Lifespan

Cycles are the number of times a battery can go through a discharge and recharge state; in other words, it’s the lifespan -- like dog years for a battery! By following the recommended depth of discharge (DoD), your battery will live longer and give you back more cycles. As we just discussed above, the recommended DoD for any lead acid battery is 50%, for LFP 80%. With 4000 available cycles over its lifespan, *this* LFP battery offers up to 16 times more cycles than flooded lead acid (250 cycles). This means that the potential lifespan watt hours (or total energy/work) is far greater for LFP!

To compare apples to apples, we’ve estimated the lifespan of all 4 batteries using 1 full cycle per day (average cycles / 365 days = expected lifespan). With simple math, you’ll notice that you will need to replace both AGM batteries 8.9 times and both Gel batteries 5.2 times during the normal lifespan of just one Smart LFP battery (nearly 11 years). That means that at today’s prices, you’ll spend **$3,685** on the purchase of AGM batteries OR **$2,080** on Gel batteries during this same 11 year period. Instead, you can spend just $600 on a Smart Lithium Iron Phosphate Self-Heating battery which is smaller, nearly ⅓ the weight of AGM or gel, and charges significantly faster, etc. 11 years later, you’ll still have the same LFP battery!

Dimensions & Weight

Another consideration on saving money is size and weight. Since LFP has nearly double the WH capacity of lead acid, you can install a smaller battery for roughly the same energy storage at a fraction of the weight. Weight contributes to the overall fuel economy of your vehicle, which is something to keep in mind when thinking about the investment.

Storage Temperature

Since deep cycle batteries have different chemistries, they can handle different temperatures. In order to keep a battery healthy while not in use, it is important to note the optimal storage

temperature for that specific battery. Storage temperature comes into play if you only use your deep cycle batteries for a portion of the year, and of course, in what type of climate your RV or boat will be stored. Consider removing batteries and storing them in a temperature controlled environment.

Temperature Range for Discharging & Charging (During Normal Use)

Discharging a battery means that you are using it to run and/or charge your household appliances. Charging a battery means that energy is coming in from your solar panels or other charging power source.

Charging has a smaller temperature range than discharging across all battery types. So most batteries will continue to provide energy to your off-grid set up well beyond the charging temperature range. AGM has the greatest performance in the cold of any lead acid battery. However many new LFP batteries offer a self-heating function which overcomes this challenge. When the BMS detects a charging current, it will turn on a small heating element in the battery to bring the core temperature up to an acceptable charging range. Then the battery will charge and discharge normally.

Maximum Continuous Charging / Discharging Current

Lead acid batteries typically charge more slowly than LFP batteries because their maximum continuous charging currents are much lower. Typical AGM/gel batteries have a maximum charging current of 30A while Renogy's LFP batteries are all rated at 50A. So if the sun is shining brightly on your panels, LFP batteries will charge nearly twice as fast as their lead acid cousins.

Discharging current refers to how much energy your batteries can deliver *in one hour* to power your appliances. Again, there is a significant difference between lead acid and LFP batteries, as noted in Chart 1. If your system requires a large draw of power at any given time (i.e., you typically run many appliances at once), it is better to purchase a battery bank with a higher rate of discharge to meet your energy needs.

Connection Configuration

If you are using more than one battery to power your life, you may want to set them up in series (to increase voltage) or parallel (to increase amperage). With all types of lead acid batteries (flooded, AGM, and gel), you can configure them in either series or parallel, but with many LFP's, you are limited to parallel only. This is because the BMS in these batteries is designed to work on 12V, such as the one listed in Chart 1. Some newer LFP batteries can be set-up in series (see Chart 2), just like many traditional lead acid batteries. Always check all the specs.

Battery Orientation & Installation Location

All *flooded* lead acid batteries need to be mounted upright because of the potential for spilling the liquid solution inside. They also must be vented to the outside, most in fact are stored in a special compartment or box on the tongue of the trailer, because of the potential off-gassing which occurs during charging.

AGM and gel batteries have minimal off-gassing because they are sealed, and just need to be in a vented area (no sealed boxes). They can be installed in a variety of orientations (e.g., on their side) which increases installation options.

LiFePO4 batteries do not need to be vented, can be stored inside or outside, and offer the same installation flexibility as AGM and gel.

Chart 2: Comparison of 4 Different LiFePO4 Batteries by the Same Company

Lithium Iron Phosphate (LiFeP04) Renogy 12V-100Ah Batteries	12V-100Ah	12V-100Ah	12V-100Ah	12V-100Ah
Style	Basic	Self-Heating	Core	Pro
Price Tag (as of 2/2024)	$540	$599	$430	$650
Nominal Voltage (V)	12.8	12.8	12.8	12.8
Amp Hour Capacity (Ah)	100	100	100	100
Watt Hour Capacity (Ah x Nominal Voltage)	1280WH	1280WH	1280WH	1280WH
Depth of Discharge 80% = usable WH capacity per cycle	80% = 1024WH	80% = 1024WH	80% = 1024WH	80% = 1024WH
Cycles (based on DoD)	4000	4000	5000	5000
Expected Lifespan (years) – w/ full cycle per day	10.9	10.9	13.7	13.7
Max Continuous Charging / Discharging Current	50A / 100A	50A / 100A	100A / 100A	100A / 100A
Dimensions (inches)	11.4 x 6.8 x 7.4	11.4 x 6.8 x 7.4	10.6 x 6.9 x 8.6	10.6 x 7.6 x 8.1
Weight (pounds)	26	26	23	27
Self-Heating Battery -OR- Low Temp Shut Off?	Low Temp Shut Off	Self-Heats (<41°F)	Low Temp Shut Off	Self-Heats (<41°F)
Bluetooth (Built-In vs Capable)	Capable (w/BT Module)	Capable (w/BT Module)	Capable (w/Shunt 300)	Built-In
BMS (Battery Management System)	Yes	Yes	Yes	Yes
Storage Temperature (°F)	-13°F - 149°F	-13°F - 149°F	-13°F - 149°F	-13°F - 149°F
Temperature Range (discharge °F)	-4°F - 140°F	-4°F - 140°F	-4°F - 140°F	-4°F - 140°F
Temperature Range (charge °F)	32°F - 131°F	32°F - 131°F	32°F - 131°F	32°F to 131°F
Warranty (years)	5	5	5	7
Connection Configuration	Parallel	Parallel	Parallel and/or Series	Parallel

Notes about the comparison chart: *Performance and battery lifespan depend on many factors, including: temperature, depth of discharge, frequency of use, availability of charging source, months in storage, etc.*

Assumptions on data*: Operating temperature of 25°C (77°F), Depth of Discharge (DoD) 80% for Lithium Iron Phosphate (12.8V).*

Chart data collected from the following sources: *Renogy product specifications at renogy.com.*

*Additional Discussion for LiFePO4 Battery Specs Only

Self-Heating -OR- Low Temperature Shut Off

One of the greatest leaps in battery technology over the past couple of years have been these added features, and they are complete game changers for many of us who rely on solar energy year-round. To compensate for colder temperatures, many newer LFP batteries have a self-heating feature which keeps the battery core temperature above 41°F, so it will work throughout the year no matter how cold it gets outside! This self-heating feature will turn on when: 1. The core battery temperature falls below 32°F **AND** 2. When the BMS detects a charging current of at least 4A. For batteries without a self-heating function, the low temperature shut off included in the BMS will protect the battery from potential damage due to cold temperature exposures. *Please note that none of the lead acid batteries feature this protection.*

Bluetooth: Capable OR Built-In

Bluetooth has changed the way solar users can monitor their equipment. Previously, a shunt connected to the battery's negative terminal then hard wired to a battery monitor was the most reliable method to monitor a battery. With Bluetooth, users can monitor batteries, a charge

controller, inverter, etc. from afar with the Renogy DC Home app and/or the Renogy ONE monitor. Built-in Bluetooth means that this feature is part of the battery itself. Bluetooth capable refers to a port which allows the user to add a BT-Module, or to connect wirelessly through the Battery Shunt 300 (for all other deep cycle battery models). *Note: Other solar companies also offer Bluetooth capable batteries.*

Battery Management System (BMS)

BMS refers to a computer chip in the battery which runs a health check on the battery and prevents it from overcharging or over discharging – two things which can shorten the lifespan of a battery significantly. The BMS helps you get the most of your battery purchase in the long run.

We hope these charts and discussion assist you in finding a battery that is best for your lifestyle, energy needs, climate, budget, and more. If you need further explanation or help with troubleshooting your solar installation, give us a shout! We are Solar Coaches and love to help people get started. Please contact us via our website at Freedom in a Can.

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