LITHIUM VS. LEAD-ACID BATTERIES:
COMPARING TOTAL COST OF OWNERSHIP

Compared to lead-acid batteries, RELiON's lithium iron phosphate (LiFePO4) batteries offer users practical advantages such as lighter weight and hands-off operation. These batteries also have longer lifetimes which makes for far less frequent battery replacements and service calls. But many first-time buyers of LiFePO4 batteries wonder if their higher purchase price compared to lead-acid batteries makes sense in terms of total cost of ownership.

Do LiFePO4 batteries cost more, or less, than lead-acid batteries over their operation lifetime? In this article, we present the results of a simple calculation that compares the total cost of ownership of a LiFePO4 battery compared to three competing lead-acid technologies.

ELEMENTS OF TOTAL COST OF OWNERSHIP

To estimate of the total cost of ownership of several battery technologies, we performed a simple cost calculation of RELiON's RB100 lithium iron phosphate battery and three equivalent size (BCI Group 31) off-the-shelf lead-acid battery technologies: flooded lead-acid (FLA), Absorbent Glass Mat (AGM), and Gel. We took into account the most important factors such as:

Initial cost of the battery. The up-front retail cost of the battery, the largest cost of initial installation.

Labor cost of installation. A nominal cost of installing a battery, often performed by a skilled technician who in some cases must be scheduled and dispatched to the customer's site. This cost is approximately the same for each battery type, however, the process must be repeated multiple times with lead-acid batteries over the life of a single LiFePO4 battery.

Labor cost of maintenance. In the case of flooded lead-acid batteries, for example, this includes checking and topping off water levels and cleaning acid residue off the battery, and often the surrounding area, as well as cleaning and/or replacing nuts and bolts and cables that have become badly corroded. Lithium-ion batteries require no maintenance during their lifetime.

Battery replacement costs. Includes a new replacement battery plus the cost of removal and installation by a qualified technician.

Cost of charging. The nominal cost of electricity for charging the battery. It includes the need for overcharging lead-acid batteries to avoid stratification (the accumulation of lead sulfate on the battery's plates). In our calculations, we assumed a DOD (depth-of-discharge) of 80% on all batteries before recharging was necessary.

Along with the initial cost of the battery, perhaps the most critical factor in estimating the total cost of ownership is the specified lifetime of the battery in terms of the number of cycles until end of life.

For our calculations, we took end of life to be when each battery fails to deliver 50% of its initial capacity for lead-acid batteries and 70% for LiFePO4 batteries.

The table below shows the retail price and expected number of cycles until end of life, taken from retail websites and the manufacturer's published data sheets, of the four batteries used in this analysis.

ESTIMATED CYCLE LIFE

BATTERY	RETAIL COST PER BATTERY (USD)	ESTIMATED LIFE (TOTAL CYCLES)
Flooded Lead-Acid	$185	500
AGM Lead-Acid	$270	400
Gel Lead-Acid	$400	1,000
RELiON RB100 $LiFePO_4$	$1,050	7,100

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RELiON LiFePO4 BATTERY:
RB100

Lead-Acid Technologies in Comparison:

- Lead-Acid
- AGM
- Gel

Calculation Parameters:

- Electricity cost for charging of $0.12/kWh
- Battery maintenance costs of $10/hour
- Installation and replacement costs of $25/hour

Results Over Lifetime:

- TCO Cost = $1,925
- 51% less than competing technologies
- Average cost per charge was $0.27

THE RESULTS

The total cost of ownership of each battery was calculated over a single lifecycle of the RELiON RB100 since it has the longest life of all four batteries. Each of the three lead-acid batteries requires multiple replacements over the life of the RB100.

For this calculation, we assumed:

- Electricity cost for charging of $0.12/kWh
- Battery maintenance costs of $10/hour
- Installation and replacement costs of $25/hour

The table below shows each factor in the overall total cost of ownership for each battery as well as the total cost of each battery per cycle. Based on the specified lifetime of each battery and their retail prices, it's clear the total cost of the RELiON RB100 battery is far less in terms of each cycle and in terms of the overall cost of ownership.

TOTAL COST OVER LIFE COMPARISON

COST FACTOR	FLA	AGM	GEL	RELION RB100
Purchase Cost	$185	$270	$400	$1,050
Installation Cost	$25	$25	$25	$25
Maintenance Cost	$525	$40	$40	$0
Charging Cost	$970	$970	$970	$850
Replacement Cost	$2,600	$5,450	$3,000	$0
Replacement Labor	$700	$1,000	$375	$0
# of Replacements	(14)	(20)	(7)	(0)
# of Cycles Over Life	(500)	(400)	(1,000)	(7,100)
TOTAL COST OVER LIFE	**$5,005**	**$7,755**	**$4,435**	**$1,925**
Cost Per Cycle	$0.67	$0.92	$0.55	$0.27

While the lead acid batteries have a far lower up-front cost, they require frequent replacement. The FLA batteries required 14 replacements, the AGM required 20 replacements, and the more cost-effective Gel batteries still required 7 replacements over the life of a single RB100.

The total cost of ownership, including charging costs, of the RB100 was $1,925. **That's 51% less than the Gel battery, the most economical of the three lead-acid batteries.** The total average cost per charge of the RB100 was just $0.27 over life.

SUMMARY

RELiON's long-lived LiFePO4 batteries reduce the inconvenience and expense of replacement and service calls, and they lend peace of mind to many users when it comes to demanding applications. As this article shows, LiFePO4 batteries are also beneficial to the bottom line. Our calculation compares the total cost of ownership of RELiON's RB100, a 12V 100 Ah LiFePO4 battery, to three equivalent size (BCI Group 31) off-the-shelf lead-acid battery technologies.

Using measured lifetimes taken from the manufacturer's published specifications of each battery, our analysis shows that the RB100 costs at least 51% less over life than even the most cost-effective lead-acid battery.

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