LITHIUM-ION POWER FOR DATA STORAGE AND SERVERS

Data is one of the most important things to protect, whether personal or corporate, and more and more data is produced and stored than ever before. Very large amounts of data residing in cloud-based storage require backup power to prevent loss if AC mains fail. Battery backup power is the critical to maintaining data integrity, but what is the best approach to battery power?

What to Choose

For many years, the dominant battery chemistry has been lead acid in a variety of formats including vented or flooded cells, gelled and AGM (absorbed glass mat) sealed maintenance-free batteries. Sealed lead-acid batteries (SLAs) are a mature chemistry offering good performance and value but at the price of weight, size and low energy density. As a comparison, the chemistry chart (Figure 1) shows SLA on the bottom left with a volumetric energy-density value of approximately 130Wh/L and a gravimetric energy density of approximately 50Wh/Kg, (maximum values). Today's lithium-ion chemistry provides approximately 700Wh/L, 5.3 times that of SLA, and approximately 250Wh/Kg, 5 times that of SLA (maximum values).

Lithium-iron-phosphate (LFP) technology, a less conventional variant of lithium ion, provides an increase over SLAs at approximately 350Wh/L and 120Wh/Kg. LFP may yield less energy, but it has other characteristics that are very positive in relation to life and performance.

As a result of the increased energy density, several important considerations can be made. How much floor space is really necessary for additional backup power? Can floor space be greatly reduced if upgrading from SLA to lithium ion for equivalent power? Storage energy can be increased by approximately a factor of three in the same amount of space depending on the lithium chemistry. Additionally, battery racks and cabinets can be designed to support only one-third of the weight of SLA batteries, saving cost on racks and easing system installation. A higher level of distributed power close to or in the server racks is possible. Secondary benefits of less rack space include lower air-conditioning costs.

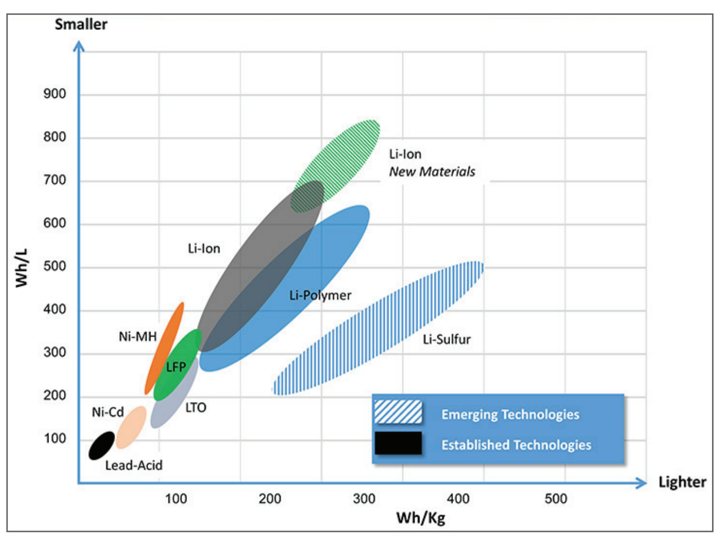

Figure 1

In a lithium-ion battery, lithium-ion chemistry comes in two physical configurations, cylindrical and prismatic, and can be housed in either a metal can or a soft-pack polymer format. Lithium-ion cells are also available in a variety of chemistry blends such as LCO (lithium cobalt oxide), NMC (nickel manganese cobalt), NCA (nickel cobalt aluminum) or LFP (iron phosphate), each offering characteristics unique to its makeup and enabling various performance classes. The classes divide into four major categories:

- **High energy density:** This class provides the most energy in a given battery size and is ideal for lower-drain long-duration backup applications. Its high energy density, however, limits its output-current capability and recharge time.
- **High power density:** This class provides high levels of discharge current output for high pulse or sustained high discharge rates. Batteries in this class can typically be charged quicker than high-energy batteries but have less overall capacity.
- **Mid power density:** This class offers a compromise between high energy and high power, providing good capacity and power output, and additionally offering great life at elevated temperature environments.
- **Iron phosphate:** This class has the lowest energy density but offers excellent rate capability, fast recharge and excellent cycle life. It is very good for backup applications owing to stability at elevated temperature at 100% state of charge, making it ideal for central backup power.

SLA and lithium ion not only differ in the amount of energy they can hold in a given size or weight, but they also differ in many other characteristics. The following table (Figure 2) provides a side-by-side comparison of several chemistry-cell characteristics. Cycle life and recharge time are two major benefits. The ability to recharge a backup battery after an outage in a short time is critical to supporting the next power failure; in countries where power is less stable, this is a critical feature. Cycle life is self-explanatory: a battery that lasts 4 to 10 times as long eliminates the costs involved in replacing spent batteries and increases reliability. Initial savings with lower-price batteries are soon lost when the replacement costs are included over a longer term.

	Lead Acid	LFP	Li-Ion
Cell Voltage	2V	3.2V ~ 3.3V	3.6V ~ 3.7V
Cycle Life	250	>2,000	500 - 1,000
End-of-Life Capacity	60%	80%	80%
Capacity Rating Method	C/20	C/5	C/5
Charging Time	6 ~ 8 hrs	1+ hrs	2+ hrs
Weight	5X	2.5X	1.1X
Size	3X	1.75X	1X
High Temp Survivability	1X	3X	2X
Long Term Storage Recovery	1X	2X	2X

Figure 2

More Than Just a Battery

Lithium-ion battery packs incorporate battery-management electronics that enable a host of functions to provide information such as accurate state-of-charge and end-of-life indications to the user. Backup battery packs embedded in data servers, rack-mounted battery systems and larger battery cabinets can all use communication protocols (such as SMBus, I²C and CAN bus) and others from the battery pack for a variety of functions. Battery management enables enhanced performance, such as smart charging algorithms to maximize cycle life, temperature monitoring for charge enable/inhibit to increase safety and life, cell balancing, state of charge, state of health, various types of visual and audio indications, and power-management functions for fan control.

Unlike SLA batteries that use a common case housing (typically three or six 2V cells in a plastic case), lithium-ion batteries comprise singular cells that are assembled into strings designed to meet the required voltage for the system it is powering. This structure enables flexibility in developing custom battery systems at voltages that make for optimum designs both electrically and mechanically. Lithium-ion battery packs used as backup power for data-storage systems range in size from as small as 8Wh packs embedded in servers to 1,000Wh packs mounted in racks and central megawatt-hour backup systems. Whatever your data-storage requirements, you have options for your backup power, and lithium-ion battery systems can offer you solid features and power per square foot.

By: C. Gonzalez

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