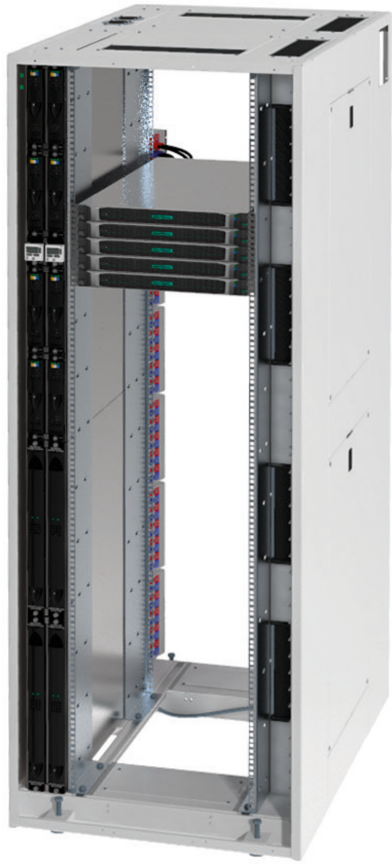
DATA CENTERS

Sodium-ion batteries: Re-shaping design and operation

A new sodium-ion battery is set to free up space and enhance design flexibility in data centers and other mission-critical facilities. Such batteries can reliably and safely provide tens of thousands of cycles at very high peak-power discharges with no potential risk of combustion, explosion, or outgassing, thus allowing them to be deployed in locations unthinkable for lead and lithium battery types.



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Lead acid batteries have been a mission-critical element for decades in electrical system applications ranging from healthcare and communications to manufacturing and data centers. However, despite significant efforts to improve them, these workhorses present shortcomings in terms of electrical life, power density and peak power. In view of these limitations, essential facilities are designed and operated with high levels of redundancy in mind.

But things are changing. Recent advancements in battery chemistry are opening new horizons in terms of the design and operation of data centers and other critical facilities. It is therefore worth looking at which technologies offer the best mix of performance, availability, life cycle and cycle-rate capabilities, energy and power density (two different characteristics), not to mention reliability, safety, sustainability and efficiency.

Three battery types

There are three battery chemistries that align well with mission-critical electrical systems: lead acid, lithium-ion, and sodium-ion.

Lead acid batteries are well known and, despite drawbacks, are the standard when it comes to short- and medium-duration energy storage for essential operations.

Some infrastructure operators are experimenting with a combination of lithium-ion batteries and battery energy storage systems (BESS). Their results have varied. The relatively quick acceptance of this battery type has led to emerging safety codes, electrical standards and guidelines that have difficulties keeping up with the specific characteristics of these batteries. Furthermore, it is not currently feasible to recycle lithium ion batteries and their use in industries such as EVs and mobile phones is constraining supply.

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01 The unique peak-power capacity of sodium-ion batteries can be utilized to enable new solutions, such as ABB's Edge distributed data center power architecture.

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02 Thanks to their high power-to-energy ratio, sodium-ion batteries enable data centers to use less space and cooling than with lead or lithium batteries.

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03 Capable of tens of thousands of cycles, sodium-ion batteries significantly surpass lead and lithium batteries.

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04 Thanks to their superior safety characteristics, sodium-ion batteries can be deployed in areas where lithium batteries are not allowed and where lead batteries offer insufficient life expectancy to carry the load.

Recently, however, a new battery chemistry has emerged: sodium-ion →01. This battery utilizes Prussian Blue analogs for cathode and anode. These offer extremely low internal resistance, a high cycle-rate, high peak-power capacity, are nonflammable, and exhibit no thermal runaway characteristics by design. This chemistry is not only safe – passing UL9540A and NFPA855 requirements – but checks the sustainability box as it is comprised primarily of aluminum, manganese, iron, Prussian Blue (a commodity dye), and sodium-ions. Such batteries are not compromised by dependence on rare earth metals, conflict minerals or questionable supply chain implications.

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Sodium-ion batteries surpass lead and lithium in peak power, cycle rate, cycle count, charge/discharge times, and more.

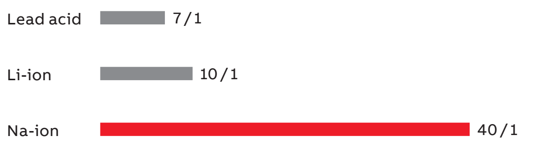
From a performance point of view, the new sodium-ion battery surpasses both lead and lithium in peak power →02, cycle rate, cycle count, charge/discharge times, →03 round-trip efficiency, safety, and operates over a much wider temperature range. These characteristics, particularly with regard to peak-power capacity, enable data centers and other space-constrained mission-critical facilities to free up power and floorspace since peak-power and reserve starting/bridging capacity can be realized in a much smaller volume and do not add any cooling load.

The sodium-ion battery's ability to repeatedly, reliably and safely provide very high peak-power discharges with no potential risk of combustion, explosion, or outgassing under frequent, repetitive use means that it can be deployed in locations and architectures unthinkable for other battery types →04.

Sodium-ion batteries can and are being deployed in data and communication centers within the "white space" inside IT/Telecom equipment racks – an area where lithium batteries are often not allowed, and lead batteries don't have the performance required to carry the load.

Reducing space, power and cooling demands
The unique peak-power capacity of sodium-ion batteries can be utilized to enable new power architectures. One example of where this is possible is in ABB's Edge distributed data center power architecture →01.

4x higher max power-to-energy ratio



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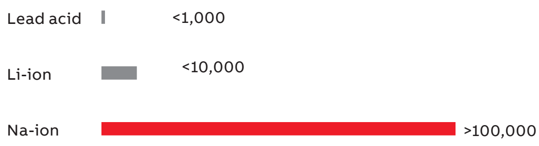
10x longer deep discharge cycle life



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Nonflammable during failure and abuse

	Lead acid	Li-ion	Na-ion
Heating	✓	✗	✓
Overcharge	✗	✗	✓
Short circuit	✗	✗	✓
Nail penetration	✓	✓	✓

04

When using sodium-ion batteries, peak-power capacity can provide over twice the total system power of either lead or lithium batteries. In addition, should any battery fail, there is enough peak power capacity within the remaining battery (n=2) or batteries (n=3+) that they can carry the entire load in the event of an outage without the need for a back-up battery.

These innovative 4-kW rack-mounted-batteries could be suitable for data center, telecom, and industrial applications. In the near future, larger form-factor sodium-ion batteries will become available from Natron in 300-kW battery cabinets designed for data center applications. Sharing the same inherent characteristics as current rack-mounted batteries, these cabinets will open new perspectives in terms of designing mission-critical facilities in ways that reduce space, power and cooling requirements.

With their rapid recharge capabilities and tens of thousands of cycles, sodium-ion batteries create a framework for data centers, telecom/network systems, and edge compute nodes to deploy software-defined-power-creating revenue opportunities from what are traditionally considered to be fixed costs and stranded assets. •