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BLOG

Sodium-ion batteries – a potential replacement for lithium-ion batteries?

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Despite the dominance of lithium-ion batteries (LIBs) in the energy storage industry over the past two decades, we believe sodium-ion batteries (SIBs) could replace them in the future, driven by their promising characteristics: (1) sodium is cheaper than lithium, (2) its chemical behaviour is similar to lithium's, (3) the irreversible capacity of carbon anodes in SIBs is less than in LIBs, (4) sodium is abundant in the earth's crust and in seawater, and (5) it can be transported safely and at lower cost. SIB start-ups have been attracting venture capital (VC) funding in recent years. Given the potential of SIBs, coupled with the problems in the LIB supply chain, the opportunity for VC firms and other investors to be part of this sustainable and affordable energy source is substantial.

Why discuss alternatives to LIBs?

While LIBs will likely continue to drive the energy storage industry for at least the next 10 years, there are some concerns regarding them: (1) safety hazards, as they contain flammable electrolytes and explode if damaged or overcharged, (2) there is a shortage of key inputs, and (3) they are expensive.

Importantly, more than the shortage of key inputs – lithium (c.5% of LIB volume) and cobalt (c.20% of LIB volume) – mining constraints put supply-side pressure on the pricing of LIBs due to environmental concerns and domestic instability. For instance, South American countries, particularly Argentina, Bolivia and Chile, hold over 50% of the world's lithium supply, but due to water scarcity in the region, mining activity is limited. The Democratic Republic of Congo (DRC) holds over 50% of the world's cobalt supply, followed by China (<10%), but this dependence on a single country rife with local disputes makes investment in the DRC difficult.

LIB prices fell 87% from 2010 to 2019, primarily due to the introduction of new chemistries and advanced manufacturing techniques. However, with lithium and cobalt being the key inputs, LIB prices will likely remain far higher than those of potential alternatives.

The abovementioned concerns have forced scientists to explore alternatives such as lead-acid batteries, zinc-air batteries and aluminium-ion batteries. However, SIBs have emerged as one of the most viable alternatives in recent years. The following is a comparative analysis of SIBs, LIBs and lead-acid batteries.

	SIBs	LIBs	Lead-acid batteries
Cost	Low	High	Low
Energy density	Moderate/High	High	Low
Safety	High	Low	Moderate
Materials	Abundant	Scarce	Toxic
Cycling stability	High (negligible self-discharge)	High (negligible self-discharge)	Moderate (high self-discharge)
Efficiency	High (>90%)	High (>90%)	Low (<75%)
Remarks	Less mature technology; easy transportation	Transportation restriction at discharged state	Mature technology; fast charging not possible

Source: Wikipedia

What does research on SIBs indicate?

A number of start-ups, such as Aquion Energy and Natron Energy, are already manufacturing SIBs, but these are used primarily for large-scale electricity storage, for example, for storing solar power for lighting, air conditioning and powering small electronics systems, and for other industrial uses. However, research is ongoing to assess the viability of using SIBs to provide portable electricity for mobile phones, laptops, electronic gadgets and electric vehicles.

At present, SIBs do not last as long as LIBs, primarily because of an unintended presence of hydrogen, which degrades the battery, making the life of SIBs shorter. Hydrogen is usually absorbed from the environment during the fabrication of cathode material, which affects the properties of electronic materials. Scientists are, therefore, exploring new materials that can be used as components of SIBs. Many start-ups and institutions such as the University of Texas, the University of Birmingham and the Nagoya Institute of Technology are conducting research on how to improve battery life, charging speed, and energy density.

SIB start-ups attract VC funding

While start-ups have already incurred significant amounts of debt, they have also been able to attract millions of dollars from VC firms across the globe given the promising characteristics of SIBs. The following table lists some recent deals:

	Company	Country	VC investor/s	Deal size (USDm)
Sep-20	Natron Energy	US	ABB Technology Ventures, NanoDimension Capital, Chevron Tech. Ventures, Khosla Ventures, etc.	35
Jul-20	Natron Energy	US	US Dept. of Energy's Advanced Research Projects Agency-Energy	19
Apr-20	HiNa Battery	China	Phoenix Tree Capital Partners, and Star Technology Incubator	–
Jun-18	HiNa Battery	China	Cash Capital	–
Jan-17	Faradion	UK	Mercia Technologies, and Finance Yorkshire Seedcorn	4
From 2014 to 2016	Aquion Energy	US	Bill Gates, Gentry Venture Partners, Foundation Capital, Bright Cap., Trinity Cap. Investment, CapX Partners, etc.	190

Source: Company data

We understand that it may take a few years for SIBs to be commercially ready for widespread use and that LIBs will likely dominate the energy storage industry for at least the next 10 years. However, SIBs and LIBs could co-exist, with SIBs gaining an upper hand if the current challenges are resolved in the next few years. PR Newswire expects SIB demand to grow at a 24% CAGR to c.USD3.5bn by 2027, surpassing the estimated growth rate of 16% for LIBs. We believe, therefore, that given the potential of SIBs and the concerns regarding LIBs, VC firms and other investors have a significant opportunity to be part of this sustainable and affordable energy source.

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