Ingenious Brain

Future-Proofing Businesses

Are **Sodium-ion Batteries** the Game-Changer We've Been Looking For?

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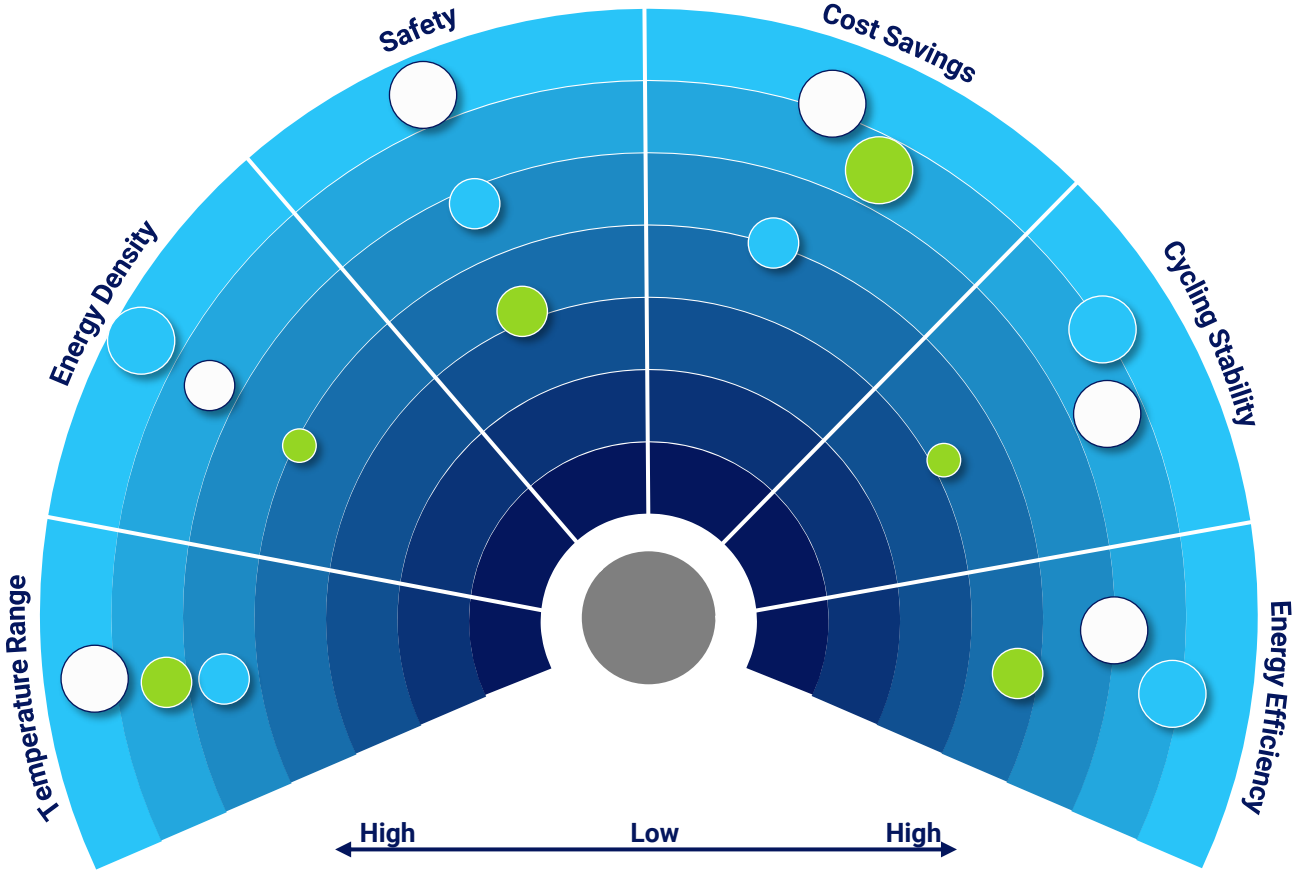
Comparative Outlook – Sodium-ion Batteries

Sodium-ion batteries offer an economical & versatile energy solution, utilizing abundant sodium with low production costs, fast charging, stability in extreme temperatures, and enhanced safety while being less toxic due to the absence of lithium, cobalt, copper, and nickel.

Opportunity Radar – Sodium-ion Batteries



Notation | Lead Acid Batteries | Lithium-ion Batteries | Sodium-ion Batteries

Sustainability Matrix – Sodium-ion Batteries

Sustainability Matrix \ Type of Batteries	Sodium-ion Batteries	Lithium-ion Batteries	Lead Acid Batteries
Materials	○ Abundant and widely available ○ Non-toxic	○ Expensive ○ Geographic dependency ○ Supply pressure	○ Use toxic materials such as lead and sulfuric acid
Recycling	○ Limited potential for improvement as technology mature	○ Complex & limited recycling infrastructure	○ High recycling rates ○ Well-established processes
Impact on human & environment	○ Minimal	○ Significant social and environmental issues in cobalt mining	○ High impact on human health
Safety	○ Safe to ship and store in a zero-energy state ○ Low risk of overheating or explosion	○ Must be partially charged when shipped ○ Risk of thermal runaway	○ Risk of explosion due to hydrogen evolution ○ Strongly acidic electrolyte

Impact | Low | Medium | High

Source: IeB analysis

Note: *The bubble size represents the range of the respective attributes*

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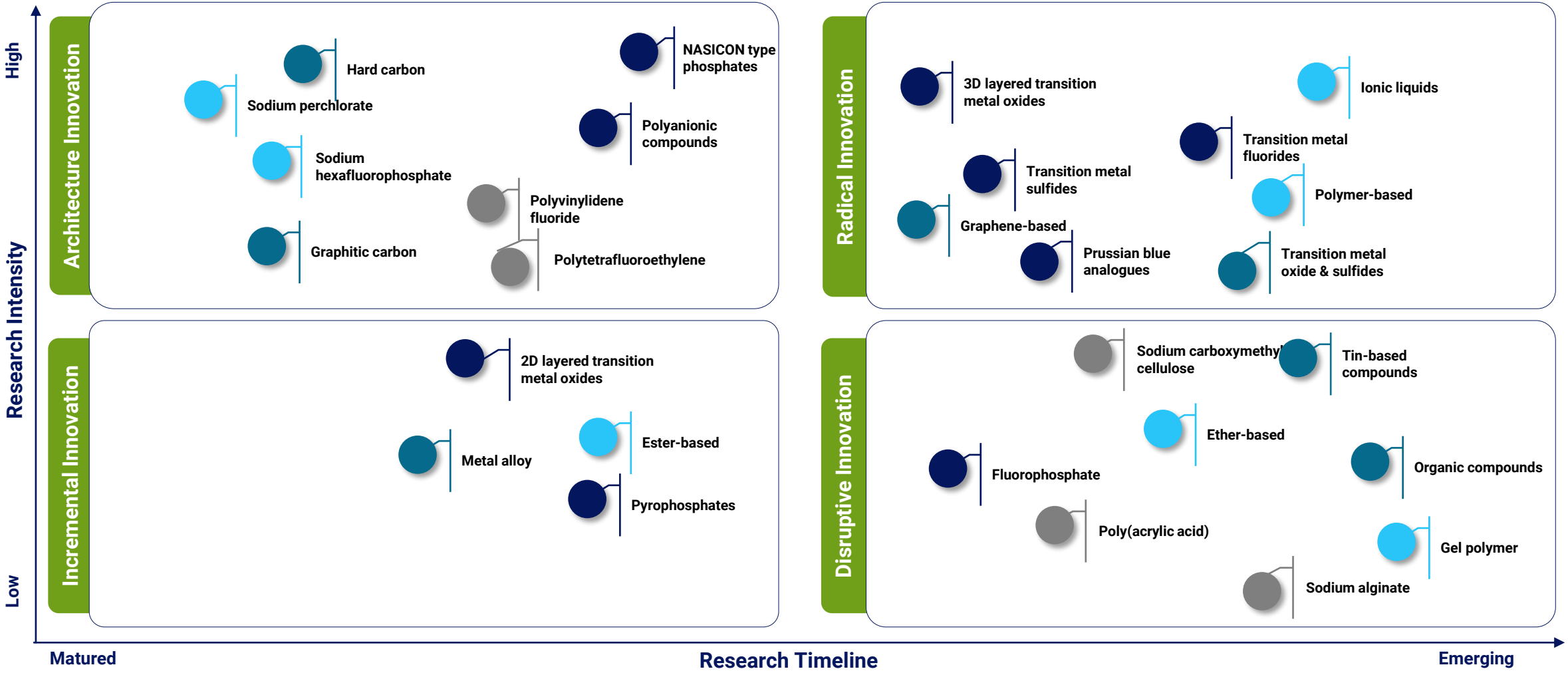
Key Materials – Sodium-ion Batteries

Sodium-ion batteries have an inherently lower energy density than lithium-ion batteries due to sodium's higher atomic weight and lower redox potential. Ongoing research efforts emphasize advancing energy density by developing high-capacity cathode and anode materials, including layered transition metal oxides, Prussian blue analogs, and tin-based anodes.



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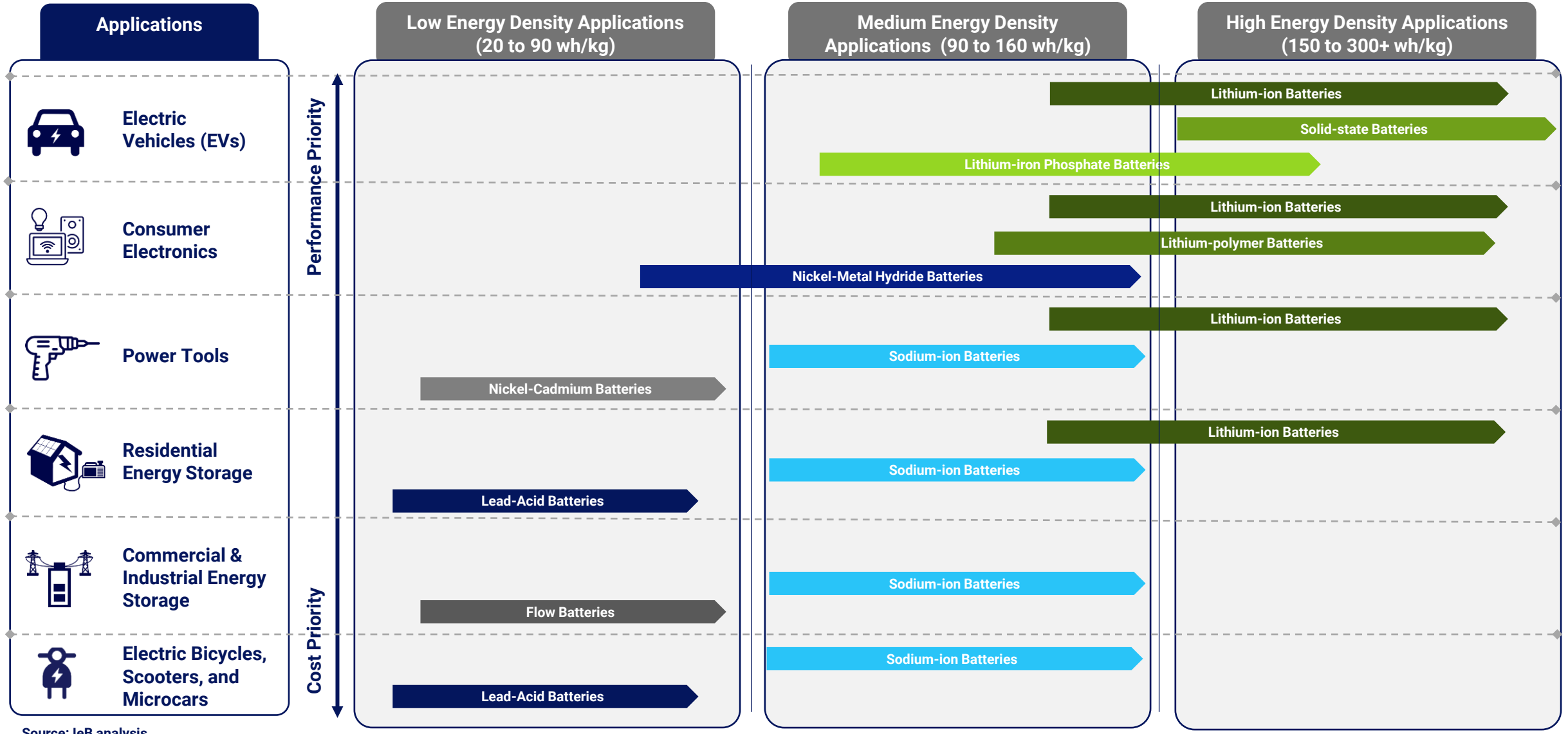
Best-fit Applications – Sodium-ion Batteries

With relatively lower energy density, sodium-ion batteries are ideal for applications where high energy density is not crucial, such as stationary energy storage, electric two-wheelers, and electric microcars, making them a widely adopted solution in the evolving energy landscape.



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Market Dynamics – Drivers, Restraints, and Opportunities

Sodium-ion batteries could be ideal for winter power storage due to their excellent capacity retention, efficient operation below -20°C, faster charging, superior cold-start performance, longer lifespan, and enhanced safety compared to lithium-ion batteries

Drivers

- **Sustainable Choice | Abundant Resource | Low-cost:** Sodium is cheaper than lithium because it is more abundant and readily available; Sodium-ion batteries use materials that are less toxic and more environmentally friendly compared to those in lithium-ion batteries.
- **Market Demand | Technological Advancements:** Ongoing research to find alternatives to current battery materials, combined with the ever-growing demand for large-scale energy storage solutions and electric vehicle applications.

Restraints

- **Lower Energy Density | Poor initial performance | Lower Conductivity:** Lower energy density compared to lithium-ion batteries, making them less suitable for applications requiring high energy density, like high-performance electric vehicles; These batteries often exhibit lower initial performance and suffer from lower ionic conductivity, which can lead to reduced power output.
- **Infrastructure and Investment | Market Acceptance:** High initial research and development costs for optimizing sodium-ion battery technology, while significant investments in lithium-ion battery production and infrastructure can be a barrier to the adoption of sodium-ion technology.

Opportunities

- **Low-cost Alternative | Emerging Market:** Sodium-ion batteries can utilize aluminum for the anode current collector instead of the copper used in lithium-ion batteries, further reducing material costs and mitigating supply chain risks; Developing countries could become an emerging market where cost is a critical factor, and sodium-ion batteries can offer a more affordable energy storage solution.
- **Technological Innovations | Grid Storage Solutions:** Extensive research on solid-state sodium-ion batteries and the development of new anode, cathode, and electrolyte materials to enhance performance metrics such as energy density, cycle life, and efficiency; Sodium-ion batteries can be used for large-scale energy storage systems, aiding in the integration of renewable energy sources like solar and wind.

Source: IeB analysis

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Key Players – Strategic Activities

Key industry players are making significant strides in sodium-ion battery technology through strategic investments & collaborations. It leads to advancements in energy density, rapid charging capabilities, and industrial-scale production, catering to diverse applications, from energy storage to low-speed electric vehicles.

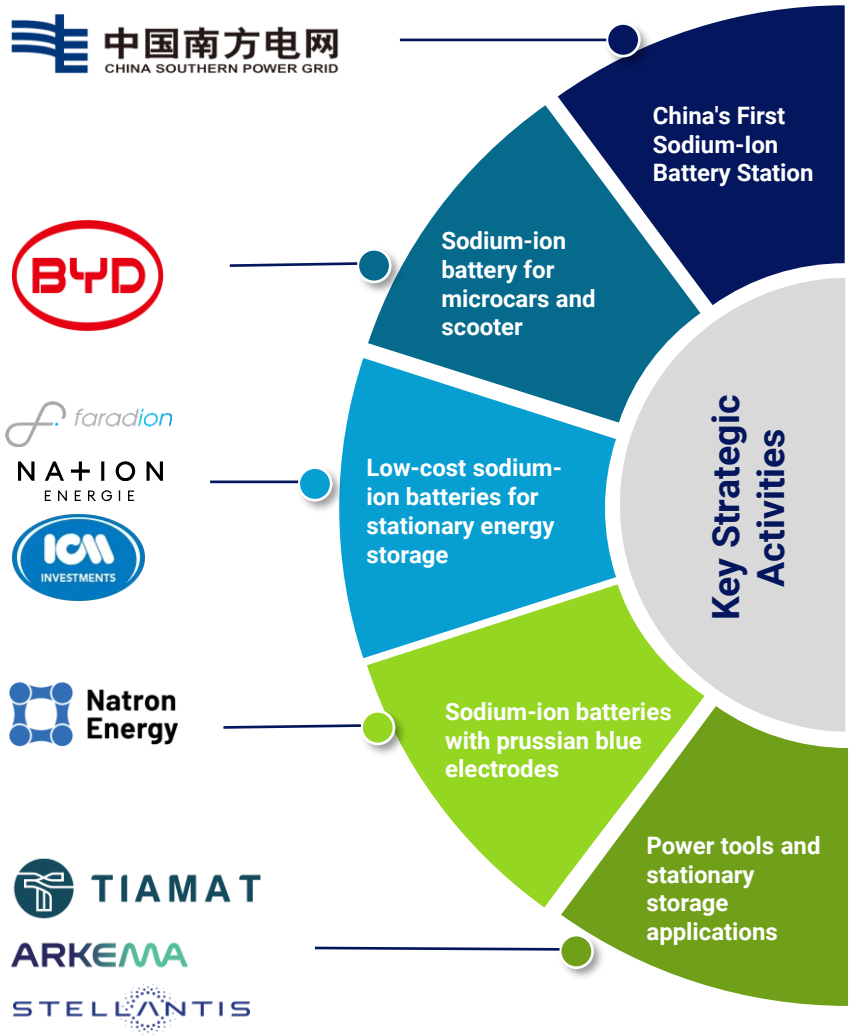
2024 | China has launched its **first large-scale sodium-ion battery energy storage station in Nanning, Guangxi**, operated by China Southern Power Grid; This pioneering facility, developed by China Southern Power Grid, has an initial capacity of 10 MWh and aims to expand to 100 MWh; The station is designed to enhance peak energy management and support clean energy initiatives by generating 73 million kWh of renewable electricity annually, enough to power 35,000 households and reduce CO2 emissions by 50,000 tons.

2024 | BYD has commenced construction on its first **sodium-ion battery plant** in Xuzhou, China, with an **investment of $1.4 billion;** The facility, which aims to produce 30 GWh annually, will primarily manufacture sodium-ion battery cells and packs for electric vehicles, particularly microcars and scooters; This initiative is part of BYD's strategy to diversify its energy storage solutions and reduce reliance on lithium-ion batteries.

2022 | The **first Faradion sodium-ion battery** has been installed at a trial site in Australia by Nation Energie, **a joint venture between ICM Investments and Faradion, a subsidiary of Reliance Industries.** This breakthrough marks a significant advancement in Na-ion battery technology for commercial, residential, and industrial sectors, moving beyond conventional lithium-based solutions.

2024 | Natron Energy has achieved the **first U.S. commercial-scale production of sodium-ion batteries in Holland, Michigan,** with an annual capacity of 600 MW, catering to the energy storage demands of data centers driven by the surge in Artificial Intelligence; Natron's high-performance sodium-ion batteries surpass lithium-ion counterparts in power density and recharging speed, while requiring no lithium, cobalt, copper, or nickel, and are non-flammable.

2024 | Tiamat has secured $24 million in funding from investors including **Arkema and Stellantis** to advance the commercialization of sodium-ion batteries while initially aiming to produce 0.7 GWh of batteries by 2025, scaling up to 5 GWh at their facility in France; Their initial focus is on power tools and stationary storage applications, with plans to expand into electric vehicles in the future.



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