Special Report

# Revolutionizing Energy Storage: The Untapped Potential of Sodium and Zinc


aranca

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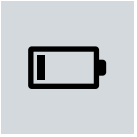
# Executive Summary

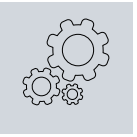
## Challenges with Lithium Ion (Li-ion)

- Lithium batteries are made of scarce metals such as lithium and cobalt.
- The scarcity and rising demand for batteries mean higher cost. Lithium costs around USD 20,000 per metric ton (MT).
- Lithium batteries are unsafe; they are known for overheating and causing explosions.
- Lithium batteries are not as environment-friendly as previously thought and contain toxic metals.



## Potential Limitations of Sodium and Zinc Batteries and Niches

- They are comparatively less dense and have less storage capacity. Their battery life cycle is also significantly low compared to lithium-based batteries.
- Since the technology is still in its infancy, very few companies operate in this segment, leading to higher cost of batteries.
- However, they could find uses in low capacity EVs and grid energy storage.



## Can Sodium or Zinc Replace Lithium?

- Sodium and zinc resources are much more abundant than lithium, and their global distribution is even.
- Sodium- and zinc-ion batteries cost 30–40% lower than lithium-ion batteries.
- Apart from the obvious cost advantages, sodium-ion batteries are safer, and dendrites are not easily produced in these batteries.

## Investment Opportunities

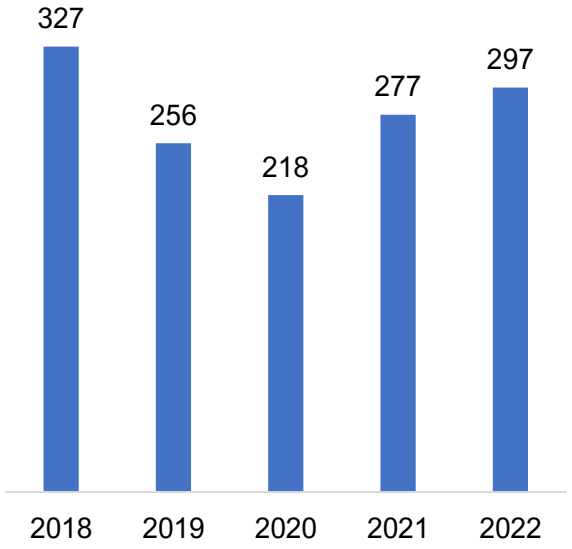
- Several companies are researching or have already started producing sodium and zinc batteries.
- For example, CATL and Natron Energy are making sodium batteries.
- Others such as e-Zinc and ZAF Energy Systems are manufacturing zinc-based batteries.

# Why We Need to Look Beyond Lithium?

## Limitations include safety concerns, high cost, scarce supply, and environmental harm

### Concerning Lithium Battery Incidents

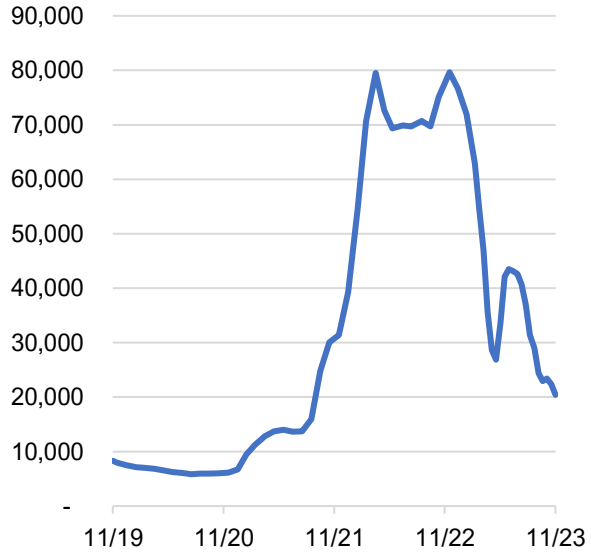
By year in which incidents were reported




- Lithium batteries are prone to overheating, which can result in fires or explosions.
- They contain toxic substances such as lithium, electrolyte, and cobalt that are detrimental to the environment.

### Lithium Carbonate Prices

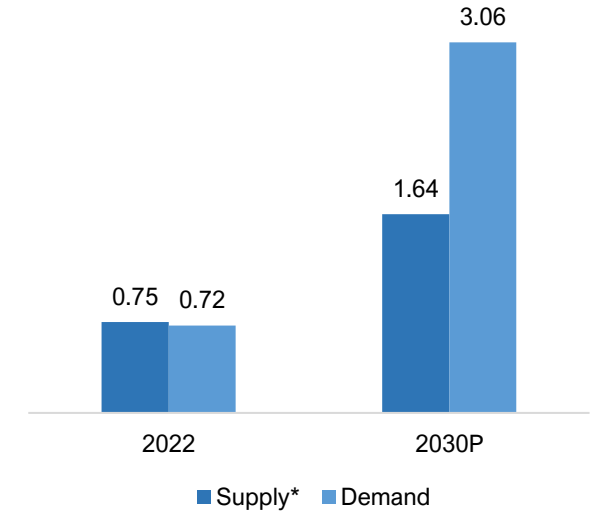
Price in USD / metric ton (Battery Grade)




- Lithium carbonate costs around USD 20,000 and prices reached the USD 80,000 level in 2021 and 2022.
- The high price of lithium greatly increases the battery cost.

### Demand to Outgrow Supply

In Million Tons of Lithium Carbonate Equivalent (LCE)



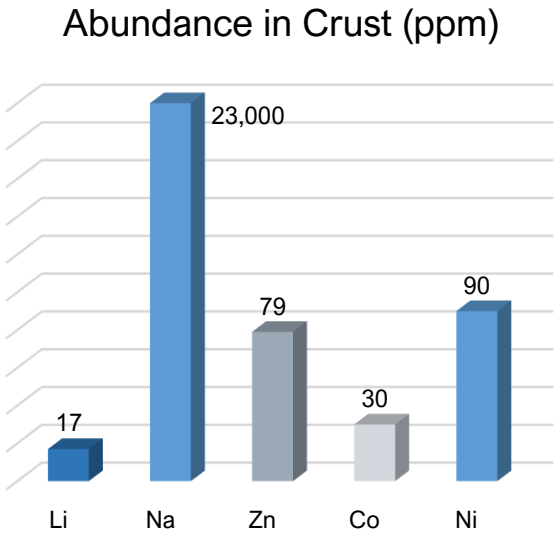

- Lithium is a scarcely available resource. Demand is expected to outstrip supply in 2030. Additionally, supply is concentrated in a few countries, especially China.
- Nickel and cobalt, used in layered-oxide cathodes of Li-ion batteries, are also scarce.

***Source:*** *Consumer Product Safety Commission, McKinsey & Company. *Confirmed Supply*

# Can Sodium / Zinc Replace Lithium?

## Advantages include lower cost, availability and distribution channels, and environment-friendly

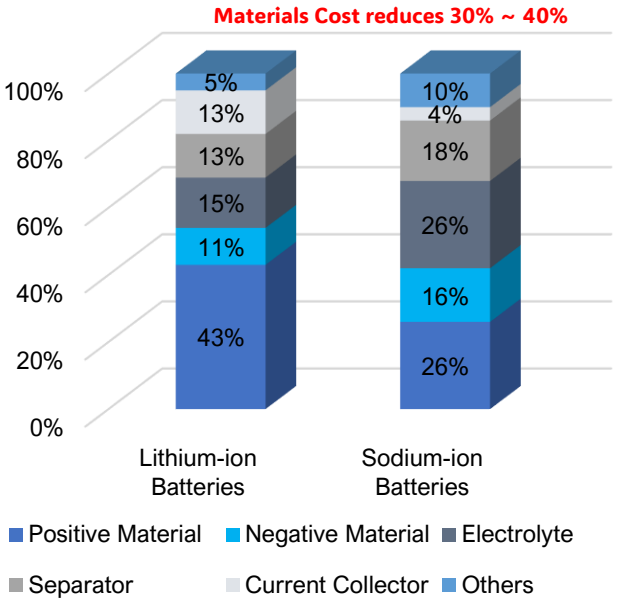
### Availability of Sodium and Zinc v/s Lithium




- Metals such as sodium and zinc are abundantly available on earth.
- Their extraction is comparatively less expensive than lithium.

*Li- Lithium; Na- Sodium; Zn- Zinc; Co- Cobalt; Ni- Nickel*

### Substantially Lower Battery Cost




- The cost of sodium and zinc batteries is considerably low relative to lithium.
- Lithium-ion batteries cost in the range of USD 200–250 per KWh, while zinc-air batteries roughly cost USD 150 per KWh and could fall below USD 100 with more widespread adoption.

### Environmentally friendly

- Sodium batteries typically do not require the use of toxic and scarce elements, such as cobalt, which can mitigate environmental and ethical issues associated with Li-ion battery production.
- Zinc-based batteries are non-toxic and non-flammable, which reduces safety concerns.
- Sodium- and zinc-based batteries generally have lower risk of thermal runaway than lithium-ion batteries, reducing the likelihood of fires or explosions, which can pose environmental hazards.

***Source:*** *Ecolithiumbattery, GEP, SIAM*

# Navigating Challenges and Exploring Niches

## Challenges include lower energy density, shorter battery life, and other material constraints

### Energy Density

- Sodium and zinc batteries typically have lower energy densities than lithium-ion batteries.
- This means they may store less energy per unit mass or volume, which could limit their application in devices requiring high energy density such as EVs.

### Cycle Life and Performance

- Sodium batteries might have a shorter cycle life and lower performance compared to their lithium-ion counterparts.
- They may experience a higher rate of degradation over charge-discharge cycles, reducing their longevity and overall efficiency.
- Zinc-based batteries might experience performance degradation over repeated charge-discharge cycles.
- This degradation could limit their lifespan and overall efficiency.

### Material Constraints

- While sodium is more abundant than lithium, finding suitable materials for the electrodes that can perform well and maintain stability over numerous charge-discharge cycles can be challenging.
- This might hinder the development of high-performance sodium-based battery technology.
- Some types of zinc-based batteries face challenges related to rechargeability and reversibility of chemical reactions, impacting their efficiency and recyclability.

### Niche Applications for Sodium- and Zinc-based batteries

- **Energy Storage (Grid Level and Individual Units):** Sodium and Zinc based batteries can be suitable for stationary energy storage applications, such as storing renewable energy generated from solar or wind sources as well as in residential or commercial settings to store excess energy and provide power during periods of low generation.
- **Certain Automotive Segments:** While lithium-ion batteries dominate the electric vehicle market, sodium and zinc-based batteries might find niches in specific automotive segments like low-speed vehicles, electric bicycles, or scooters where energy density is less critical but safety, cost-effectiveness, and longer cycle life are more important.

# Companies Likely to Benefit from Sodium / Zinc Transition

## Companies such as CATL, Natron, and Faradion are revolutionizing the market

| Company Name | Listed / Unlisted | Current Production* | 2030E Additional Capacity* | Description |
|---|---|---|---|---|
| CATL | Listed | >10 GWh | 20 GWh | Contemporary Amperex Technology Co. Limited (CATL) is a battery manufacturer and technology company based in China. The company is a market leader in producing lithium-ion batteries and already ranks first in EV battery consumption volume.<br>It unveiled its first-generation sodium-ion battery in 2021, which can integrate sodium- and lithium-ion cells. Sodium batteries can thus be complimentary to the traditional lithium batteries. |
| Natron Energy | Unlisted | 0.6 GWh | 5 GWh | Natron manufacturers sodium-ion batteries using Prussian blue electrode materials. Its batteries exclude toxic, conflict or rare earth materials.<br>The company is based in California, US, and was started in 2012 by a Stanford University PhD student. Its batteries are safer than Li-ion and lead acid batteries. |
| Faradion | Listed (Acquired) | > 10 GWh | 5 GWh | Recently acquired by Reliance Industries, Faradion was founded by Dr. Jerry Barker, Dr. Chris Wright, and Ashwin Kumaraswamy in 2011 to develop and commercialize sodium-ion technology. It has built a strategic, broad-reaching, and substantial IP portfolio that includes 21 patent families covering sodium-ion technology. |
| E-Zinc | Unlisted | – | – | e-Zinc is a Canadian company founded in 2012 to store energy in zinc metal. Its batteries are recyclable, flexible, and uses a water-based electrolyte that reduces the risk of inflammation. The company recently appointed several executives in an effort to move toward commercialization |

***Source:*** *Company Websites, source: Wood Mackenzie, "Sodium-ion update: A make-or-break year for the battery market disruptor". * Sodium-ion battery capacity*

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