# Lithium-ion Battery Pride Before the Fall

**Thursday 30 May, 2024**

The lithium-ion battery market will peak then fall well within the next twenty years. Lithium-ion batteries are facing slow but inexorable replacement by other ion-batteries, starting with sodium-ion then perhaps aqueous zinc-ion batteries subject to a flood of research in 2024. The alternatives promise 40% lower cost, superior safety and better performance in certain respects. In addition, new needs are arriving that lithium-ion cannot possibly satisfy. They vary from laser guns (mostly battery-supercapacitor hybrids) to months-or-more grid storage (mostly gravity and underground compressed air storage, some redox flow battery). After lithium-ion, even sales of all ion-batteries taken together may decline within 20 years as the market shifts to what they can never provide. Let us look more closely.

**Electric cars cease to be the largest segment, electronics needs less storage**

The overall market will saturate because electric cars, the largest lithium-ion market, are becoming commoditised and increasingly punished or banned in cities. Electronics and some electric vehicles will even become batteryless Zero Energy Devices ZED thanks to on-board energy harvesting providing the whisper of electricity needed by new ultra-low-power circuits. Beyond that, Second Generation 6G Communications, around 2035, may involve strongly-powered Reconfigurable Intelligent Surfaces RIS in the propagation path. They could activate client devices such as smartphones and IOT nodes by Simultaneous Wireless Information and Power Transfer SWIPT so they need little or no on-board energy storage. Like RFID and anti-theft tags on steroids. They are all “backscatter”. Meanwhile, smartphone sales drop as does the percentage of their cost that is battery.

**New market for pulse and high power-density**

A new market is opening up for pulse and very high power-density storage for electromagnetic weapons, ultra high-speed train regeneration and acceleration and thermonuclear power generation where lithium-ion is useless. These need such things as cycle life 10,000 with 200Wh/kg and 2kW/kg power-density. In 2024, sodium-ion capacitor research in *“Low-crystallinity conductive multivalence iron sulfide-embedded S-doped anode and high-surface area O-doped cathode of 3D porous N-rich graphitic carbon frameworks for high-performance sodium-ion hybrid energy storages” Energy Storage Materials Volume 68, April 2024, 103368* claimed something near. An emerging $20 billion sector awaits.

Much bigger, the largest energy storage market segment becomes Long Duration Energy Storage LDES. It is becoming mostly duration (Wh divided by W rating) of 12 hours to one month, covering wind and solar dead for longer and implying up to 10GWh sizes. Although GWh deployments of lithium-ion batteries do occur for under eight hours duration, they are merely a stopgap in the face of scalable, non-flammable, non-toxic alternatives coming in with one tenth of the levelised cost of storage and 20 times the life at that duration (very little recycling). For example, heavily solar Queensland Australia will install the largest pumped hydro storage, storing electricity “for up to months”. There is other gravity storage with many plants lifting blocks being erected in China (zero self-leakage) and the British RheEnergise High-Density Hydro up mere hills being trialled. There is also a full orderbook for proven compressed air in underground caverns such as old salt mines, with 84 days the current record. Already plenty of orders for 12 hours duration of subsequent discharge or more are being placed with lithium-ion batteries not even considered. LDES will be at least 30% of the total market in 2044 and another no-go area for lithium-ion.

**The goalposts have moved**

New realities are that energy storage is required to be non-flammable, minimally toxic, with almost no ancillary equipment such as firefighting, thermal or battery management, no scarce, expensive material or spacing requirements for the large ones and very long life. Lithium-ion is making poor or no progress in most of these directions.

Even for solar houses a few battery-supercapacitor hybrids and redox flow batteries have already been installed for those keen for longer life, greater reliability and safety and sodium-ion is being lined up for lower cost, having first appeared in cars in 2023.

**Here come lower cost, better ion-batteries**

Sodium-ion batteries are being delivered and much lower price is certain, with substantial production capacity now being installed – 40 plants planning 320GWh capacity according to Benchmark. Such

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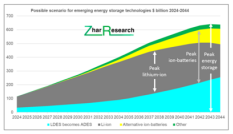

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batteries use abundant sodium, iron and manganese. Their avoidance of copper anodes also saves cost. Theoretically, Na-ion batteries can have high energy and power density combined so statements that the technology will only minimally usurp lithium-ion on price and low temperature performance and have far inferior energy density are only describing the initial situation.

A flood of research on zinc-ion alternatives also now takes place. This is also a lower cost system than lithium-ion but clear advantages over sodium-ion are, as yet, unclear, but from theory we have the prospect of excellent safety, energy density/ power density and other benefits. The latest preference for vanadium cathode compounds in zinc-ion battery research seeking high energy density does not necessarily reduce cost but now a surge in hydrogel electrolyte work for them promises low self-leakage, minimal packaging, use in structural electronics and other benefits.

**No sudden death of lithium**

As we have shown, multiple factors now make it inevitable that lithium-ion batteries will peak in value sales within 20 years with their use in grid storage and basic cars and smaller electric vehicles being the most immediately vulnerable. All the same, lithium-ion will ride high for some time because of familiarity, production capacity and some advantages retained. Major advances continue such as the recent announcement by CATL of a large increase in energy density, valuable in vehicles and mobile electronics.

**Possible scenario**

One of our scenarios is shown in the picture. We show peak lithium in 2037. If the disruptors prove to be stronger, that could be 2030. We suggest you use this as a thought provoker and modify using your own insights but above all, disbelieve those many analysts that simply extrapolate.

Many of the aspects covered in this article can be deeply understood from Zhar Research reports at www.zharresearch.com
such as:

“Long Duration Energy Storage LDES Reality: Materials, Equipment Markets in 35 Lines, Technology Roadmaps, Manufacturers, Winners, Losers, Alternatives 2024-2044”

“Long Duration Energy Storage LDES beyond grids: markets, technologies for microgrids, minigrids, buildings, industrial processes 0.1-500MWh 2024-2044”

“Redox Flow Batteries: 26 Market Forecasts, Roadmaps, Technologies, 48 Manufacturers, Latest Research Pipeline 2024-2044”

“Zinc-based storage: Zn-ion batteries, Zn redox flow batteries, Zn-ion supercapacitors, Zn-air rechargeable batteries: technologies, markets 2024-2044”.

“Lithium-ion capacitors and other battery supercapacitor hybrid storage: market forecasts, roadmaps, deep technology analysis, manufacturer appraisal, next successes 2024-2044”

“Supercapacitor, pseudocapacitor, CSH and BSH hybrid market forecasts in 30 lines, 95 manufacturers appraised, technology roadmaps, next successes 2024-2044”

“Zero Energy Devices ZED: Self-Powered and Backscatter-Powered Electronics and Electrics Markets, Technology 2024-2044” and a drill down report on the 6G ZED."

"6G Communications: Reconfigurable Intelligent Surface Materials and Hardware Markets 2024-2044".

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