Hybrid Storage - Looking into Lithium-Ion Capacitors

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This new commercially oriented 470-page report finds that lithium-ion capacitors LIC and other battery supercapacitor hybrid BSH energy storage will now become mainstream, headed to being a $10 billion business. It is the most up-to-date, comprehensive report on the subject and it concentrates on the opportunities for value-added materials and device suppliers with much for investors, product and system integrators and others. There is a glossary at the start and terms are explained throughout. Dollars, gaps in the market and benefitting society and lessons from success and failure have precedence over nostalgia and academic obscurity. Nonetheless, a large amount of research and experience from 2023 and 2024 is referenced and interpreted too, so you can dig deeper where you wish.

Pivoting to success

Dr Peter Harrop, CEO of Zhar Research advises,

> “After a false start with lead and nickel versions and concentration on tiny versions for electronics with limited demand at the time, the industry has pivoted to add larger lithium-ion ones for electrical engineering. Incoming technologies particularly need these such as fusion power stations, electric trains, in unmanned mining vehicles, heavy vehicle fast chargers and electromagnetic weapons.”

He adds,

> “Latest versions are better than a simple compromise between supercapacitors and lithium-ion batteries. For example, they can last longer than the equipment to which they are fitted and provide more than enough power handling yet minimal end-of-life issues – like supercapacitors. Many can now hold electricity almost as long as a lithium-ion battery can achieve yet have ten times the power density and pulse capability. Versions approaching lithium-ion battery levels of energy density are not flammable and need little or no battery management system or temperature control – huge advantages. The flood of new research covered in the report gives assurance of even better to come such as lower cost and no valuable materials needed for most of them.”

The report layout

The Executive Summary and Conclusions is sufficient for those in a hurry. It has all the 30 key conclusions, SWOT appraisals, 42 forecast lines (sub types, by region, by power level, by application and for equipment to which they are fitted 2024-2044. There is a market and technology milestone roadmap 2024-2044, and many new infograms pull it all together, including graphics of the supercapacitor-like and battery-like versions with rationale and pictured examples of success.

The 23-page Introduction starts with the place of battery supercapacitor hybrids in the energy storage toolkit, including BSH replacing batteries in a 2023 e-bike. Learn how energy harvesting and beyond-grid power production create BSH markets and how they are evolving beyond standard formats to widen appeal. The technology is then introduced by comparing BSH internal design to others, how hot topics now include LIB and graphene. Understand BSH voltage, charge retention and ageing issues compared to competition. See BSH competitive position on energy density vs power density and days storage vs rated power return. A table then compared 34 parameters for LIC, Li-ion battery and supercapacitors then you see LIC formats compared with adjacent technologies and further reading.

Covering the technology in depth for each type of emerging BSH begins with Chapter 3. “Future lithium-ion capacitor design and competitive position” (10 pages). Then comes Chapter 4. “Lead-ion, nickel-ion, potassium-ion, sodium-ion, zinc-ion capacitors: design and competitive position” (15 pages) followed by Chapter 5. “Other emerging chemistries for battery-supercapacitor hybrid storage (15 pages)”. Here are BSH using Zeolite Ionic Frameworks ZIF, Metal Organic Frameworks MOF, MXenes and other exotica such as metal alloys and manganese complexes. Where will that all lead? Primarily, these chapters are an appraisal of latest research, including much in 2024. Toxic, flammable, temperature intolerant or short-lived materials, even with good other parameters, will not be acceptable anymore.

Do you want more detail of specifics of the anatomy of a BSH – electrodes, electrolytes and membranes? That requires us to cast the net wider to look at research that is relevant to BSH but not specific to it. That

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analysis is in Chapter 6. “Emerging materials employed with 2024, 2023 research pipeline analysis” (50 pages) is a much deeper look at the matched active-electrode/ electrolyte and membrane opportunities emerging. The battery electrode is not the emphasis here. There is depth on the many reasons why more adopt graphene yet research in MXenes and metal organics frameworks MOF and actual use of carbon nanotubes is happening. We identify your best opportunities to supply value added materials in future and to create and sell the most successful devices. See the limited research on reducing self-discharge despite the fact that the commercial impact of that would be considerable.

Now come the markets that will earn the big money 2024-2044. Chapter 7 introduces them with “Emerging markets : basic trends and best prospects compared between energy, vehicles, aerospace, military, electronics, other”. It takes only 11 pages because it consists mainly of new infograms, tables and pie charts covering such things as “Market analysis for the six most important applicational sectors” in 6 columns, 5 lines and “Market propositions of the most-promising supercapacitor families 2024-2044” in 6 columns, 3 lines. Another describes largest lithium-ion capacitors offered by 7 manufacturers with 4 parameters and comment.

The market detail then starts with Chapter 8. “Energy sector emerging markets for supercapacitors and their variants” (49 pages), starting with “Overview: poor, modest and strong prospects 2024-2044” and mostly detailing the opportunities in “thermonuclear power”, “less-intermittent grid electricity generation: wave, tidal stream, elevated wind”, beyond-grid power and fast chargers for electric vehicles land and air because all read to the strengths of supercapacitors. See both examples and intentions.

Chapter 9 is 48 pages on “Emerging land vehicle and marine applications: automotive, bus, truck train, off-road construction, agriculture, mining, forestry, material handling, boats, ships”. Chapter 10 at 29 pages is “Emerging applications in 6G Communications, electronics and small electrics” again with compact comparisons and infograms. Chapter 11, “Emerging military and aerospace applications” in 19 pages analysing and comparing key aspects of this rapidly emerging sector demanding all three – CSH, supercapacitor and BSH. For example, electrodynamic and electromagnetic weapons including force field all use supercapacitors and also military hybrid and diesel vehicles because they are not replaced by battery electric as seen on-road because their duty cycles are too demanding. Chapter 12 is 110 pages comparing 116 companies in detail in ten columns plus colour coding and pie charts. The ones making or saying they will make are identified, including which BSH type, and the others are supercapacitor cell and stack makers considering the BSH option.

That is why we suggest that the report, “Lithium-Ion Capacitors & Other Battery Supercapacitor Hybrid Storage: Detailed Markets, Roadmaps, Deep Technology Analysis, Manufacturer Appraisal, Next Successes 2024-2044” is essential reading for investors, value-added materials suppliers, device manufacturers, product and system integrators with much to interest legislators, researchers, users and other interested parties as well.

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