

performance, power handling and energy storage capacity. See all these trends and opportunities graphed in Zhar Research report, "[Supercapacitor, Pseudocapacitor, CSH and BSH Hybrid Market Forecasts in 26 Lines, 110 Manufacturers Appraised, Deep Technology Analysis, Roadmaps, Next Successes 2024-2044](#)". For instance, it explains why carbon nanotubes, MXenes metal organic frameworks MOF have become part of this story, some just entering production.

Trend to everyday elements

Every year, a smaller percentage of RFB manufacturers use expensive vanadium in RFB though vanadium versions may still enjoy 20 years more growth. They favour aqueous and other electrolytes that need no expensive electrodes to work well with them. See Zhar Research report, "[Redox Flow Batteries: 26 Market Forecasts, Roadmaps, Technologies, 48 Manufacturers, Latest Research Pipeline 2024-2044](#)".

Battery-free storage

Grid and off-grid storage are partly trending to battery-free for much longer life and storage time. That is just part of the megatrend examined in Zhar Research report, "[Battery-Free Electrical Energy Storage and Storage Elimination MilliWh-GWh: Markets, Technologies 2024-2044](#)".

Solid state cooling

Solid state cooling takes many forms but it mostly involves multifunctional smart materials providing thermal insulation, reflection and radiation together. This increasingly avoids expensive materials, the cost being now in the manufacturing complexity you must tackle. Contrast vapour compression cooling progressing from liquids that damage the ozone layer to ones that cause global warming and now, all-too-often, ones that have toxic breakdown products with cost and life issues remaining.

New electronics materials

In electronics, several trends take us to battery-free devices that are fit-and-forget. Firstly, on-board energy harvesting becomes more powerful due to improved efficiency and multi-mode operation. Secondly, we use loads that need less electricity such as new ultra-low-power integrated circuits and LEDs. Thirdly, we await planned 6G Communications with simultaneous wireless information and power transfer SWIPT that enables user devices to have just fit-and-forget supercapacitors or no storage at all.

New optical materials

New optical materials are increasing in need and supply, not least because telecommunications is moving into THz far infrared, near infrared and visible frequencies. See Zhar Research report, "[6G Communications: Terahertz and Optical Materials, Components 2024-2044 with 32 Forecast Lines, Technology Roadmaps](#)".

In support, electronics and electrics are progressing to new semiconductors and active materials such as plasmonic graphene and chalcogenides for THz frequencies, perovskite-on-silicon for more efficient photovoltaics everywhere and metamaterials. For instance see, the overview Zhar Research report, "[6G Communications: Materials and Hardware Markets and Technology 2024-2044](#)".

Structural electronics

Structural electronics cuts across much of this with researchers progressing such things as supercapacitor aerogel carbon/ carbon fibre fuselages for aircraft down to supercapacitor cases for smartphones.

Sensors

Call them wireless sensor networks LPWAN, IOT or something else but self-powered wireless sensors with drive circuits and transceivers are popping up everywhere. Increasingly that is where they cannot be accessed for maintenance or replacement. Can they become solid smart materials, some even stretchable? See Zhar Research report, "[Sensor Markets, Technologies, Companies 2024-2044: By Inputs, Modes, Applications, Patents, Manufacturers, Research, Roadmaps, Forecasts](#)".

Report availability

The reports can be obtained from www.zharresearch.com and www.Giiresearch.com.

Company Contact:

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Zhar Research

E. anastasiams@zharresearch.com

W. <https://www.zharresearch.com/>

Additional Contact(s):

Dr Peter Harrop

peterharrop@zharresearch.com

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