Here Comes a $5 billion Redox Flow Battery Company

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The market for redox flow batteries RFB will rise to over $22 billion as they are radically improved and repositioned. You can create the market leader at $5 billion if you lead the pivoting to new technology and market priorities. So says the unique 284-page Zhar Research report, "Redox Flow Batteries: 28 Market Forecasts, Roadmaps, Technologies, 48 Manufacturers, Research Pipeline 2024-2044" has the detail. Many market reports look at a few players and mainly the obvious grid opportunity, but this report takes a much closer look. Hundreds of latest research papers to the end of 2023 have been examined and interviews carried out. The activities of 58 companies dominating the value chain are assessed, including 48 companies making, or about to make RFB. The basics of the physics and chemistry are considered including hybrid RFB taking market share. Trends are carefully established.

Drivers of change

The vital importance to RFB of three emerging trends are established and detailed in specific chapters. They are radically different designs and how the largest emerging opportunities will now involve long duration energy storage and beyond-grid, which embraces far more than microgrids. The major opportunity in grids is also closely appraised.

Dr Peter Harrop, CEO of Zhar Research, advises,

> "RFB costs will tumble with new technologies and volume sales. Specifications will radically improve, such as halving size, cost down 60%, wider temperature range, removing toxigens and expensive metals. However, there are reasons why RFB retaining some of this will still sell. A $1 billion vanadium RFB company will appear."

Many technologies will succeed as the market fragments. Emerging competition, best partners and acquisitions? Detailed roadmaps of technology and market milestones, forecasts, technology issues, gaps in the market? They are here based on latest inputs. Older reports are useless for this fast-moving subject. See data to the end of 2023 that is continuously updated.

28 forecast lines

The Executive Summary and Conclusions at 41 pages gives the whole picture in 1-2 hours of reading. Bullet conclusions, new infograms, SWOT appraisals, 28 forecast lines and graphs 2024-2044, two roadmaps 2024-2044 showing milestones ahead. 48 manufacturers and putative manufacturers are tabulated and prioritised with their essential features. Learn how to make a billion-dollar company in vanadium RFB and named alternatives and hybrids can get you to $5 billion. Who to buy or partner? Understand why you should participate in the extremes of the house and the grid market but your leadership opportunity lies primarily in-between.

The Introduction at 24 pages explains why the world is electrifying and off-grid is trending. See how it is possible that the stationary storage market may overtake the mobile storage market including electric vehicles. Understand intermittency issues with solar and wind power, creating Long Duration Energy Storage LDES needs, many of which can be addressed by RFB. This is a balanced assessment so it reveals options for reducing the need for storage and their potential. Many new graphics make the megatrends of electrification, solar, LDES and beyond-grid easy to grasp. The chapter closes with RFB design basics and latest examples of RFB competing both on- and off-grid.

Chapter 3 (58 pages) covers RFB design principles and research pipeline with new graphics, pictures and SWOT appraisals. Absorb the detailed look at cost issues that move markets - how liquids and membranes mostly dominate cost but evaluating the rest as well. Learn how footprint matters in most of the major RFB markets emerging and that is as much a matter of making them safely stackable as just increasing energy density. Some RFB can work without aircon, space between units or major firefighting infrastructure. Enjoy the deluge of materials opportunities and how they are changing. Here are the

vanadium and alternative designs, iron-based options, metal-chelates, hydrogen bromine and more. Cutting across all that is organic, aqueous and mixed liquids appraisal, detail on membrane improvement, including no membrane at all.

Elephant in the room

The elephant in the room with RFB is toxigens and this chapter addresses them. See highly corrosive acids, cyanide radicals, toxigen intermediates where the precursors and breakdown products are carcinogenic, including fluoropolymers the European Union may ban. Understand the 11 escape routes needed and the companies behind them, as uses proliferate. Controlled disposal of materials and recycling of valuable metals become problematic. Here again are many research references to end 2023, constantly updated.

Chapter 4 (132 pages) examines 48 RFB manufacturers and putative manufacturers and ten support companies that may enter manufacture later. A table compares them in 8 columns: name, brand, technology, technology readiness, beyond grid focus, LDES focus and comment with the most promising companies highlighted. 130 pages then give profiles with indicators of future success - sales achievements, technology, progress to beyond-grid and long duration energy storage, size and cost reduction. This explains why vanadium RFB will grow sales for another 20 years but certain alternatives will grow faster.

Chapter 5 uses 24 pages, mostly infograms, to explain how LDES will soon be involved in most RFB sales. Here are the principles, parameters, technologies, new needs 2024-2044. Here are different needs for grid vs beyond-grid is followed by the 12 LDES technology choices compared in 7 columns, nine primary LDES technology families, including RFB, vs 17 other criteria then the place of RFB in this. See how RFB is competing for increasing LDES duration, leaders in the trends to beyond-grid and LDES RFB. Then comes equivalent efficiency vs storage hours for RFB and other options, available sites vs space efficiency for LDES technologies, LCOS $/kWh trend vs storage and discharge time, LDES power GW trend vs storage and discharge time, days storage vs rated power return MW for LDES technologies, potential by technology to supply LDES at peak power after various delays. All this compares RFB with many alternatives including how they will evolve 2024-2044.

Chapter 6 takes that forward to “Redox flow batteries for LDES beyond grids” with overview of how this is much more than microgrids Then it fully addresses beyond-grid: buildings, industrial processes, microgrids, other. Next is beyond-grid electricity production and management and the trend to needing longer duration storage for these. That is balanced by how strategies for reducing LDES need can limit escalation of LDES but not stop it. The LDES toolkit for grid and beyond-grid, including RFB, is presented and market drivers of beyond-grid electricity generation notably providing LDES. Here is the multifunctional nature of beyond-grid storage and the LDES cost challenge. For example, long delay of electricity means greater amount stored not just minimising self-leakage. It gives the big picture of LDES technology potential for grid and beyond-grid, all of this being mostly new infograms. They continue with why beyond-grid LDES will become the largest number and value market for RFB 2024-2044 and technologies for largest number of LDES sold 2024-2044. After all, some will seek to sell millions and others will prioritise larger versions. Successful RFB from 1kWh to 1GWh is coming. Only this Zhar Research report, “Redox Flow Batteries: 28 Market Forecasts, Roadmaps, Technologies, 48 Manufacturers, Research Pipeline 2024-2044”. has the latest information and thorough analysis, lucidly presented, for you to find your place in all that. Access at www.zharresearch.com and www.giiresearch.com.

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