

Cumulus Energy Storage Ltd

Copper/Zinc super-storage batteries for energy storage

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Cumulus[®]
Energy Storage

Cumulus believes its Copper/Zinc battery system can achieve the Lowest Cost of Energy (LCOE) for grid scale storage at £120/MWh, or the equivalent of pumped hydro.

Key facts/data:

Cumulus Energy Storage Ltd

Technology: Electrical energy battery storage

Established: 2012

Type: Startup

Location: Rotherham, AMP Technology Centre

Employees: 12 (4 UK; 8 USA)

CEO: Nick Kitchin

After graduating in 1981 with a degree in Acoustical Engineering from Southampton University Nick Kitchin gained operational and management experience at companies like Shell Chemicals, Amalgamated Plastics and as General Manager at polyurethane foam manufacturer, Carpenter. Latterly, as a private consultant providing strategy, leadership and culture change advice, he has worked with over 250 SME's in the UK, focusing especially on high growth companies.

Manufacturing

Nick Kitchin, founder and CEO, studied engineering at university, then spent a large part of his latter career working as a consultant with process industry companies. Having provided consulting advice to others for many years he became keen to establish a manufacturing and exporting business drawing on his experience as a consultant and focusing on the opportunities for energy storage globally.

North Sea

The idea to focus on the energy storage business came about during a visit to the San Francisco area on a 'Learning Journey' with 15 other UK companies, designed to understand the 'secret source' of Silicon Valley. Around the same time, Kitchin had attended a conference in Yorkshire about the offshore wind power market. The scale of investment, about £50bn between then and 2020, made it clear there would be a significant opportunity to enter the supply chain as a manufacturer. The question he carried with him on the Silicon Valley visit was what part of the supply chain to enter.

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San Francisco journey

In San Francisco he visited a fellow MBA alumnus from London Business School, Darron Brackenbury, who had moved to California a number of years before. Brackenbury had founded Applied Intellectual Capital (AIC), which listed on the London AIM in 2007. At AIC they had developed considerable expertise in battery technologies.

Supply chain opportunity

Regular conversations between Kitchin and Brackenbury distilled the offshore wind power supply chain opportunity into three possibilities: turbine blades, foundations, and storage. Additionally, they believed that to enter these markets successfully would be helped by the transfer of an existing technology from another industry which would have a disruptive impact on the market. They decided energy storage offered the best opportunity since it is the missing link for all types of variable renewable electricity, not just wind.

Electrowinning insight

Brackenbury believed Cumulus could de-risk and shorten its development programme by adapting the chemistries and architectures used routinely in 'electrowinning' metals, including Copper and Zinc, from ores in the metal refining industry. These plants regularly operate for decades at 100s of MW scale. This would make it relatively low risk compared with developing a new battery chemistry.



Volta

The existing copper/zinc battery chemistry was based on a battery that the Italian physicist and chemist, Alessandro Volta, first invented approximately two hundred years

ago using discs of Copper and Zinc separated by cardboard soaked in brine. The adjustment

Brackenbury proposed was to insert a membrane between the Copper and Zinc to prevent the Copper and Zinc ions from travelling to the opposite electrode, which would potentially enable this single use battery to become a rechargeable one.

New opportunity

The required membrane technology did not exist in Volta's day. And, the need for low-cost grid-scale rechargeable batteries had not existed until the emergence of grid storage for the renewables power industry; as a result there had been less focus on innovation in this area of battery storage technology. Most battery development instead has focused on the automotive and mobile markets, which require smaller, lighter, higher energy density chemistries, all of which are less important for the stationary energy storage market. This presented an opportunity to apply a new approach based on Volta's Copper/Zinc chemistry.

Membrane methodology

The link with electrowinning is that every time the battery is charged, the Copper electrode releases Copper ions into the electrolyte and Zinc ions electro-win onto the Zinc electrode. On discharge the reverse happens. Providing the Zinc and Copper ions are prevented from migrating to the opposite electrode, the battery can be electrically charged and discharged for thousands of cycles. The membrane material has low ionic leakage which the company says will ensure the maintenance of the battery through a 30-year lifetime, which is optimal for the supply chain in which it operates.

Start up period

Cumulus Energy Storage was established after Kitchin returned to the UK. Founders' funds, helped considerably by an £800k grant award from the UK government's Department of Energy and Climate Change (DECC) in 2014, together with investment from business angels, have enabled the development of a full-scale prototype, grid-connected rechargeable Copper / Zinc battery.

Battery chemistry

The battery development has been led by Chief Technology Officer, Michael Hurwitz, whom Brackenbury had initially recruited in San Francisco (where he is based) to work for Applied Intellectual Capital as Director of Chemistry. Hurwitz specialises in synthetic and analytical chemistry with a focus on electrochemistry. Together they developed and patented a method for making a rechargeable Copper/Zinc battery, using an ionically permeable separator.



Key Benefits

- Scalability – the bipolar design means individual cells can be added in series to meet the desired voltage requirement
- Low cost – the target LCOE is £120/MWh, making it comparable to pumped-hydro
- Low stress, low energy density, low voltage couple – enabling use of low-cost materials, scaled-manufacturing processes, and greater reliability
- Long life, low maintenance – the target lifecycle for the battery is 30 years
- Operational at all voltages – from high voltages - 320kV and potentially up to 800kV - to low voltages - 800-1,000V
- Reliable – Cu/Zn chemistry is well understood and electrowinning plants have operated at GWh scale for decades
- Availability – unstressed operation and ease of maintenance provides 98% up-time
- Efficient – with an anticipated round trip efficiency of ~80%
- Sustainable – the electrolyte can be easily replenished and each cell can be refreshed by draining and filtering. There is no electrolyte consumption or waste and all materials can be recovered and reused at end of life
- Maintainable – flooded tank-cell configuration allows individual cells to be swapped out with minimal downtime whilst battery is operating

The battery system

The battery comprises multiple cells, each with a cross-sectional area ~ 1m x 1m. The membrane keeps the copper and zinc electrolyte solutions separate. Each cell is capable of delivering approximately 1kWh of electrical energy. A 1MWh scale battery (~1000 cells) is designed to fit into a 40ft container. The goal is to deliver 1-100MWh energy storage installations. Connection to the grid will be through a bi-directional inverter with transformers for specific grid voltages.

LCOE

The key measure for grid-scale energy storage is the levelised cost of energy (LCOE) in £/MWh, which measures the cost of energy delivered over the lifetime of the installation. Cumulus forecasts it will be positioned at £120/MWh, which is in the middle of the pumped hydro range ~£100-£140/MWh. If achieved this would put it well ahead of other battery rivals.

Other approaches

There are a number of other approaches to deliver intermittent grid battery storage, some of which have been reviewed previously in 'inside:technology' [for example, Highview Power (Liquid Air Energy Storage) and PowerOasis (a cloud-based distributed energy management system based on small scale battery systems)]. What differentiates Cumulus, Kitchin says, is that the technology is relatively straightforward (tried and tested) and potentially (much) better value than other solutions.

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Status

A 20kWh operational prototype is being developed in the company's labs in San Francisco. Grid-connection is the equivalent of TRL7 in terms of 'technology readiness levels' says Kitchin. The battery is UK patent granted with a "thicket of other international patent applications pending". Kitchin says this will mean Cumulus is the only company in the world that can make and sell a bipolar rechargeable Copper/Zinc battery.

The company intends to offer stationary bulk electricity energy storage, charging the Copper/Zinc super-storage battery in 4-6 hours and discharging in a similar timeframe.

The target markets are:

- Electricity intensive industries
- Infrastructure
- Commercial renewables

Customers

In the UK, Cumulus has established a 'customer interest group' with E.ON, National Grid, Siemens, S&C Electric Europe, Costain, Evalu8, Sheffield Forgemasters, Solar South West and Sheffield University.

Manufacturing

The plan is to manufacture the super-storage battery units in the Sheffield area, on or near the Advanced Manufacturing Park where Cumulus is based. It is targeting 500MWh to 1GWh production capacity in 2017. Outside investment to fund development is now being sought. ■

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