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FLOW BATTERIES: VANADIUM SUPPLY

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A new vanadium energy storage committee has been set up to address issues such as supply and how costs of the technology can be reduced.

Vanadium industry gathers to focus on storage and shortages

The world's largest battery announced to date — a 200MW/800MWh beast to be installed by 2020 in northern China — is not being made of lithium ion but from industrial sized 20MW/80MWh flow battery systems, developed out of a US-Sino collaboration.

Off the back of growing demand for stationary storage all around the world, interest in flow batteries is increasing, especially for applications in remote areas and for enhancing grid stabilization when too much renewable energy starts to affect the smooth running of the electricity grid.

To bring together up and downstream supply chain partners and end-users, to share knowledge across R&D, production statistics, market demand as well as best practice in health, safety and environment, global vanadium industry association Vanitec has set up a new committee dedicated to energy storage, which held its inaugural meeting near London's Heathrow airport in October.

Unlike other minerals the vanadium commodities industry is relatively small. For the past 40 years Vanitec has brought together the various players in the vanadium supply chain.

Until now the focus has been on steel, which accounts for 92% of vanadium production. A major market for vanadium is for the production of rebar (short for reinforcing) steel, which are the thin bars, or meshes of bars, used to reinforce concrete in construction.

The vanadium redox flow battery market size is fractional compared with steel. But with VRFB developers gaining commercial traction in global markets, including Europe, North America, China, Africa and Australia, scaling of the industry demands attention — especially if VRFB is to compete with lithium ion, which is benefitting from cost reductions, due largely to scaling in manufacturing capacity as well as improvements to the chemistry itself.

In a VRFB system, electrolytes in different oxidation states make up the positive and the negative halves of a cell. The flow of the electrolyte is separated by an ion exchange membrane. A reversible electrochemical reaction simply allows electrical energy to be stored and subsequently returned.

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The setup of the electrolyte and the membrane stack is comparable to an engine and fuel tanks. The membrane stack — the engine — delivers power rated in kilowatts, whilst the fuel — the vanadium electrolyte — delivers energy rated in kilowatt hours.

In steel processing just adding a fractional amount of vanadium, around 0.2%, can increase steel's strength by 100% and reduce the alloy's weight by up to 30%. But the slowdown in China, and flat demand in established construction markets such as the US, mean that the rebar steel market is seeing steady if unspectacular growth at an annual rate of about 6%.

By comparison, to make the electrolyte solution for a VRFB about 145 grams of vanadium pentoxide per litre is needed. For a 1.6MWh flow battery that's equivalent to 15 tonnes.

Gildemeister has installed its CellCube VRFB systems, mainly in commercial and industrial applications

Shortage worries

Global growth prospects for energy storage could, therefore, open up a significant new source of demand for vanadium and new opportunities for Vanitec's members, which include vanadium producers and electrolyte suppliers as well as downstream developers of VRFB systems.

Developers of energy storage systems based on vanadium redox flow chemistry, such as Austrian company Gildemeister, are already starting to look at locking in prices of vanadium in anticipation of demand growth over the next two years.

"There is a shortage risk. We're already seeing a shortage on the steel side, so if the price, due to steel, goes up it could risk killing off the energy storage market for vanadium," says Vincent Algar, whose company Australian Vanadium, which is a Vanitec member, is starting to develop energy storage projects through its subsidiary VSUN. Gildemeister is a distribution partner of VSUN's in Australia.

Scott McGregor, CEO of REDT, a US developer of energy storage systems based on vanadium redox flow chemistry, is not unduly concerned.

"There is enough vanadium in the ground to supply terawatts of demand for energy storage," he says, referring to deposits around the world, including Brazil, Australia and Africa. "But we are locking in prices a little bit, to flatten against any rise," he says.

What makes vanadium flow batteries compelling is their ability to store energy for hours and days if necessary and an operational lifetime that is double that of lithium ion.

In September VSUN completed installation of a 100kWh Cellcube, supplied by Gildemeister, at a tree nursery farm in Western Australia. The battery stores solar energy from a 15kW solar PV array on site, so the farm can maximise its use of solar generation. The battery is big enough to store solar energy over several days.

VSUN is talking to other farms and also mining operations. And with more projects under its belt over the coming months, the developer will be in position to bid for tenders put out by utilities and distribution network operators in Australia.

In the meantime parent company Australian Vanadium is pushing on with plans to become a vertically integrated player in energy storage, with mining at the top of the upstream end and

VSUN's energy storage project development business at the downstream end.

"Production of the electrolyte has to be very clean so to reach a high level of purity you need to minimize the process of refinement, because it adds cost," says Algar.

Australian Vanadium is developing a site in Western Australia with the potential to mine the metal. The mine will not begin production until 2019.

The Gabanintha project, measuring 91.4 million tonnes at 0.82% vanadium, has the potential to produce high-grade vanadium, which is needed for low cost production.

Today Largo Resources, through its Maracás Menchen mine in Brazil, produces the highest grade, lowest cost vanadium, producing a record 800 tonnes of vanadium pentoxide in September 2016, much of its output supplying the steel industry. Even though rebar steel production is seeing little growth, new steel applications continue to drive demand.

Australian Vanadium has also acquired a pilot line for making electrolyte from British company C-Tech Innovation. "We aim to be producing commercial quantities of electrolyte by mid-2017, buying in vanadium from third party sources until our own mine comes on-stream," says Algar.

Controlling costs

By having total control over key stages of the vanadium battery supply chain, Australian Vanadium will be able to reduce the cost of VRFB production.

Bringing together the different supply chain partners via the new energy storage committee within Vanitec enables end-users — flow battery makers — to feed back in terms of the performance levels they are seeking from their batteries.

Enhancements to vanadium processing across the supply chain, starting with the mineral itself, to electrolyte synthesis, to stack design, will all lead to reductions in production costs.

One of the sessions at the first energy storage committee meeting included a panel discussion about the standards and quality of electrolyte. The meeting also included a presentation on research opportunity ideas.

Attendees included VRFB developers, including REDT, Gildemeister and Rongke New Power, mining companies, such as Evraz Stratcor, as well as electrolyte producers, including Chinese firm Dalian Bolong New Materials, which processes electrolyte from vanadium that has been recycled from steel, which is probably the largest source of the mineral today outside of mining it.

"There is opportunity for the mining sector to find sites with high purity sources of vanadium because this industry cannot risk any shortage," says Algar.

Unique characteristics

VRFBs have performance characteristics that are under appreciated in the current energy storage market. Unlike lithium ion, lead acid and other types of batteries, VRFBs can be cycled many thousands of times with little signs of degradation, thus resulting in potentially long operational lifetimes.

There have even been discussions within the vanadium storage industry in terms of renting vanadium pentoxide electrolytes, rather than selling them.

"Because the electrolyte degrades so little. It is potentially one way of reducing the cost of vanadium redox flow energy storage," says McGregor.

It would also be a first, since no commodity metal or mineral to date has been leased in such a way.

The commercial operational lifetime of a VRFB asset is in the region of 20 years, matching that of wind and solar farms. Twenty years is the equivalent of 10,000 cycles, and the point at which

minimal degradation starts to occur.

“Most big grid-connected batteries are for short-term applications, as opposed to long-term or where the battery is not required to cycle multiple times a day. Utility investors are comfortable investing in assets that can operate for many years. But because energy storage is a new sector it is seen as a more risky technology,” says McGregor.

His company recently started shipping VRFB containers to Gigha, a Scottish island with ambitions to become more reliant on renewable power. The alternative would be to install a new transmission cable between Gigha and the mainland.

The project has received over $3 million in funding from the UK government toward the demonstration and pre-commercialization of a utility-scale VRFB technology. Should the island’s cable go down, the battery can provide power for at least 16 hours, or double that if it is only discharged at half power.

However, the 1.68MWh VRFB system will earn money by providing grid support services. The system is configured to remove generation and export constraints from the addition of an extra 330kW community-owned wind turbine on the island. In addition, the machines will also eventually provide voltage and frequency support services as well as back-up for the remote community.

Commercial opportunities

McGregor sees a market emerging in Germany for co-locating VRFB systems with wind farms, to firm up the resource so enhancing the wind farm’s output for trading and enabling the operator to provide grid services.

Gildemeister has notched up dozens of installations of its Cellcube battery, mainly among commercial and industrial end-users. VRFB is non-flammable, making it safe to install in buildings, or densely populated urban areas, an advantage over lithium ion.

VRFB along with lead acid is the only battery chemistry to receive a letter of no objection from the New York Fire Department. The Cellcube technology was chosen for an energy storage pilot by the city’s Mass Transit Authority, announced in 2014, to show how commercial buildings can time-shift energy to save money.

This year Gildemeister beat several other companies to win a tender by Italian grid operator Terna, which is piloting a flow battery on the grid. Two of the company’s Cellcubes were recently installed in Codrongianos, on Sardinia, with a total storage capacity of 1.1MWh. The system will be evaluated for its ability to enhance grid stabilization and provide some services.

The giant battery that Chinese VRFB company Rongke Power announced it will deploy is the result of collaboration with its US affiliate Uni Energy Technologies to scale up VRFB batteries to reduce costs.

The battery arrays approved by the China National Energy Administration will be made up of ten 20MW/80MWh VRFB systems. After full commissioning in 2020, the system will be able to peak-shave 8% of Dalian’s expected load. The battery will also provide black-start capabilities in the event of emergency.

With lithium ion batteries in the news again over flammability risks and concerns, the seemingly unstoppable ascent of lithium ion as the mainstream choice for energy storage is under question, with energy storage players reporting renewed interest in safer alternatives. However, the fledgling VRFB industry needs to rally and take full advantage if this promising energy storage technology is to have any real hope of industrializing successfully.

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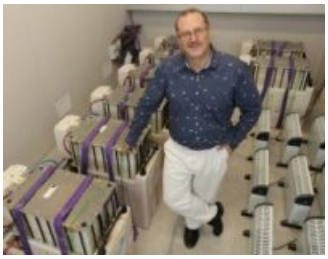

INDUSTRY ***December 16, 2016 6:46 am*** *by ESJ*

Redflow, the Australian zinc-bromine flow battery maker, announced on December 5 it had approved a further seven installers for its ZCell storage system, meaning the company now has installers in every state and territory in Australia. The batteries, which Redflow claims are the smallest flow batteries in the world, appear to be flying out | READ MORE

Britain's largest Grid-Scale Battery is Approved after Two-Year Trial

INDUSTRY ***December 16, 2016 6:38 am*** *by ESJ*

UK energy utility UK Power Networks on December 2 announced the success of a two-year trial of the largest grid-scale battery in Britain, 6MW, which it says could transform the energy grid and play a major role in the transition to a low-carbon economy. The Smarter Network Storage facility at Leighton Buzzard, Bedfordshire, was designed | READ MORE

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INDUSTRY ***December 14, 2016 5:01 am*** *by ESJ*

ESSinc are excited to share their new white paper on the rapidly emerging market for flexible longer-duration energy storage. The document is based on a recent combination of online questionnaires and in-depth discussions with energy storage procurement decision makers including project developers, utility representatives, and consultants. This white paper captures the growing need and | READ MORE

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FEATURE ***December 2, 2016 8:27 am*** *by ESJ*

Dr. Alex Mardapittas, Managing Director of Powerstar and inventor of the Virtue energy storage system, discusses how using battery storage technology can help users realise significant savings on energy bills. In addition, how storage solutions have the potential to change the way in which energy is distributed in Smart City infrastructures. In the UK | READ MORE

Nidec ASI joins German utility to install one of world's largest BESS

INDUSTRY ***December 2, 2016 8:14 am*** *by ESJ*

Italian generating firm Nidec ASI and German utility STEAG have installed one of the world's largest battery energy storage systems with a total capacity of 90MW across six different sites in Germany. LG Chem, the Korean electronics giant, supplied the batteries for the BESS, which was installed at three sites in North Rhine Westphalia, in | READ MORE

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