

What the vanadium?

To say University of New South Wales researcher Maria Skyllas-Kazacos is ahead of her time might be an understatement.

Skyllas-Kazacos is best known for the first successful demonstration of a vanadium redox flow battery (VRFB) in the 1980s. While her work was considered a breakthrough in energy storage possibilities – ultimately leading to the patenting of the technology – the invention would surprisingly fly under the radar of the renewable energy industry for the decades that followed.

“For many years, we had quite a lot of interest from a lot of companies, especially in Japan but, unfortunately, the market for energy storage hadn’t yet developed,” Skyllas-Kazacos said in 2021. “That was even though we were seeing a lot of renewable energy coming onto the grid. At the time, the renewable energy companies were maintaining the grid is the storage medium for the renewable energy.

“But [the opposite] became quite apparent once they started putting large wind

farms onto the grid and it started destroying the stability of the grid. So, energy storage started to emerge as an important issue for expanding renewable energy.”

Today, it’s a different story with several large-scale VRFBs installed around the world. In September, China cut the ribbon on the world’s largest flow battery facility, commanding a 100MW/400MWh capacity.

The vanadium-powered Dalian Flow Battery Energy Storage Peak-shaving Power Station, situated in the country’s north-east, has a maximum capacity of 200MW/800MWh. The Chinese Academy of Sciences say the battery can meet the daily energy needs of up to 200,000 residents.

Other vanadium batteries have been deployed in Japan (60MWh, Sumitomo Electric), Canada (8.4MWh, Invinity Energy Systems) and South Australia (8MWh, Yadlamalka Energy).

VRFBs contrast greatly with the lithium-ion batteries commonly used in mobile phones and EVs. Flow batteries

are designed to indefinitely charge and discharge, preventing a degradation in capacity and lifespan which has been observed in lithium-ion batteries. A common example is the degrading battery life of a mobile phone which has been used for several years and charged hundreds of times.

“There has been a lot of investment in alternative technologies which have their niche applications but have shown they are not the answer for energy storage,” Thorion Energy Ltd general manager Jeremy Newman told **Paydirt**.

Thorion is building locally manufactured VRFBs in the southern Perth suburb of Bibra Lake, in partnership with SMEC Power & Technology.

“VRFBs provide reliable energy storage and do not have issues with loss of capacity over time, temperature constraints or the potential to catch fire,” Newman explained. “If you’re supplying a particular load with either of the standard battery technologies, you need to install twice as much battery to compensate for that loss



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The main vanadium players on the ASX

Company	ASX Code	Market Cap	52-week average at time of print
Neometals Ltd	NMT	\$320.58 million	47.5c-\$1.64
Australian Vanadium Ltd	AVL	\$144.04 million	2.4c-5.7c
Tivan Ltd	TVN	\$119.07 million	4.7c-13.5c
Richmond Vanadium Technology Ltd	RVT	\$87.62 million	20c-44.5c
Technology Metals Australia Ltd	TMT	\$73.74 million	21c-45c
Surefire Resources NL	SRN	\$24.77 million	1.1c-2.9c
Viking Mines Ltd	VKA	\$9.22 million	0.5c-1.5c

of capacity over the life. Even then, you still have potential temperature issues that may shorten that life.

“So, the VRFB technology with no limitation on cycling, ability to handle high temperatures without degradation and without loss of capacity really suits the mining applications that we see here in WA.”

Although Thorion is keen to become a strong player in energy solutions for Australian mine sites, SMEC managing director and founder Martin Law acknowledged Asia is a rapid early adopter of the technology.

“They are super proactive,” Law said. “I think it is early stages...but there’s a lot of interest.”

“Because of the amount of small islands in some Asian countries, they’re sitting on gensets and they’re all small power suppliers. So, it makes sense and they’re an ideal target for us.”

“We’re already talking to people in Vietnam and India, so it won’t just be [used] in Australia.”

Martin Law and Jeremy Newman with a Thorion Energy vanadium redox flow battery assembled in Bibra Lake



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Richmond Vanadium Technology managing director Jon Price, back row and second from right, during the signing to invest \$3 million in Thorion Energy (then called Ultra Power Systems)



Professor Maria Skyllas-Kazacos and her research team, pictured here in 1988, with the first vanadium cell laboratory prototype. Credit: University of New South Wales and Maria Skyllas-Kazacos

Vanadium, a mineral traditionally used to make steel alloys, is mostly produced in China, South Africa and Russia according to the US Geological Survey.

Steel manufacturing still remains the bread and butter for vanadium, but the commodity is seeing a strong forecast for increased battery demands.

CRU Group in January estimated global vanadium demand for VRFBs was to grow 33% by 2030 with a supply shortfall expected in the following years.

Newman said Thorion is currently sourcing its vanadium from the spot mar-

ket but is eager to take part in a fully domestic supply chain from pit to product.

"There's a number of sources but ultimately, the plan is to be utilising vanadium pentoxide from vanadium mined here in Australia and processed here in Australia," he said.

This is exactly what Richmond Vanadium Technology Ltd (RVT) is seeking to do with its Richmond-Julia Creek vanadium project in north-east Queensland.

In February, RVT entered an agreement with Thorion – then named Ultra Power Systems – to invest \$3 million, secure

them as an offtake partner and acquire a 10.94% stake in the battery manufacturer.

RVT managing director Jon Price said partnering with a domestic manufacturer was a no brainer.

"[Thorion] are actually building batteries and deploying them into regional areas at the moment," Price told **Paydirt**. "We're looking forward to that scale growing into the larger megawatt hour sort of level and we'll be able to provide them the electrolyte grade product they need to make their electrolyte.

"In turn, we'll be working with them on growing the battery manufacturing in this country and keeping it in Australia rather than being a quarry, sending it off and then buying it back at 100 times the cost."

Richmond-Julia Creek commands a 1.8bt @ 0.36% vanadium for 6.65mt contained product resource from three deposits: Lilyvale, Rothbury and Manfred. At the time of print, RVT was working towards the release of a BFS.

"That will be completed by Q3 next year, where we'll be making the investment decision," Price said.

A PFS on the asset has forecast a \$613 million NPV, a 38% IRR after 3.2 years, a \$242 million capex and a 25-year mine life. First product sales are expected from 2025.

Price attributed the project's competitive capex to its mineralogy.

"It's very unique in terms of its scale and simplicity," he said. "In ground, it is an oxide resource and one of the largest oxide resources on the planet. Nature has done a lot of the oxidation for us, which gives us a much lower capital and a much lower operating cost.

"We have an extremely large, scalable resource and we can meet the growing demand of electrolyte product. Where a lot of the producers at the moment are producing ferrovandium, we're going to be producing battery-grade vanadium straight into the energy storage market."

Of Australia's vanadium hopefuls, one of the most advanced developers is Australian Vanadium Ltd (AVL) which is working towards FID at its namesake project south-east of Meekatharra.

AVL plans to produce a concentrate on site and take the product to a processing plant east of Geraldton port, with production to start in 2025.

Last year's BFS forecast a \$833 million pre-tax NPV, 20.6% IRR, \$US435 million capex and \$US4.43/lb opex with a mine life in excess of 25 years.

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Technology Metals Australia managing director Ian Prentice, third from right, visiting the LE System Co Ltd electrolyte plant and battery lab in Japan

In May, AVL executed a \$49 million grant with the Commonwealth Government to inject more capital into the asset.

AVL chief executive Graham Arvidson said this was a signal of government interest in a domestic VRFB market to help decarbonise the Australian economy.

“The grant we’ve signed for \$49 million is a wonderful vote of confidence from a government level that’s going to allow us to push the project forward,” Arvidson told **Paydirt**. “The reason there is such strong support for the domestic vanadium industry is not the steel industry.

“Yes, steel is the bread and butter and using vanadium in steel is a good way to decarbonise in the near term because vanadium halves your CO2 emissions. But the main drawcard for us and other industry players is we can bring cost effective vanadium units into the market that can end up in batteries.”

AVL operates a wholly owned subsidiary, VSUN Energy, making its own batteries. The company has already successfully trialled a 5kW/30kWh VRFB with the Water Corporation to power a chlorinator while a 80kW/300kWh standalone power system was installed at IGO Ltd’s Nova nickel operation to power a bore pump.

For Arvidson, a high priority is to continue putting VRFBs in conversation on energy solutions and he anticipates this year’s Diggers & Dealers – where he will present on behalf of AVL – will be a great opportunity to invigorate a number of old and new relationships.

“I think Diggers & Dealers is a wonderful forum for us to combine all the good work we’ve been doing educating the market, with a forum where we can all get together and talk more seriously about vanadium,” he said. “I think it’s really good timing with the thematic around long duration stationary storage and the ongoing supply constraints in other stationary storage technologies.

“It’s the right time for people to come talk to us and learn more about vanadium because it’s in a very interesting space right now.”

Also based outside of Meekatharra is Technology Metals Australia Ltd (TMT) with its Murchison technology metals project, which hosts a 153.7mt @ 0.8% vanadium resource.

TMT recently received commitments for an \$11.5 million placement which would go towards working capital at the project. Like Law, TMT managing director Ian Prentice is bullish on Asia’s role in the VRFB space.

“For VRFBs in Australia, it’s emerging slowly. Around the globe, certain jurisdictions are well ahead and developing very strongly. China is clearly leading by a long way in deployment of the batteries at proper scale,” Prentice told **Paydirt**. “But we are seeing Europe and North America, Japan and Korea really starting to move along there as well, but the big one for me is India and the opportunities in India.”

TMT executed a MOU in April to supply vanadium from its flagship asset to Indian

VRFB manufacturer Delectrik Systems Pvt Ltd. The Indian Government also recently set aside \$US4.3 billion for the country’s energy transition.

“I travelled to India last July with the WA State Government and trade mission and the big eye opener for me there was just the amount of renewable energy generation capacity they’re putting out there,” Prentice said. “They recognise that vanadium batteries are one of the best technical solutions for long duration storage.”

A bullish outlook surrounding VRFBs has been infectious enough to even sway junior gold explorer Viking Mines Ltd to pivot its focus towards vanadium exploration. The company acquired the Canegrass vanadium project south-east of Mt Magnet in November.

Canegrass – which has an inferred resource of 79mt @ 0.64% vanadium – marked Viking’s first foray into battery minerals exploration.

“Our board is a big believer in the project and our chairman Charles Thomas certainly sees the potential to deliver an economic, mineable project,” Viking managing director Julian Woodcock told **Paydirt**.

“There was a strong desire from the board to have some commodity diversification. Michael Cox, our other director, he’s also a very strong believer that the commodity is going to do very well.

“With the battery sector growing as it is and western economies wanting to reduce their reliance on critical minerals sources from China or Russia, it just opens the door up for this commodity.”

Viking plans to begin a scoping study at Canegrass early next year. Following rigorous drilling, the company has set an exploration target of 144mt-129mt @ 0.45-0.99%.

When asked how investors have reacted to a gold explorer opening itself up to the vanadium space, Woodcock said he was confident the long-term narrative surrounding VRFBs could quickly permeate to the broader public.

“A big trigger for this is going to be the uptake in the VRFB sector,” he said. “The word vanadium will get associated with batteries and then there’ll be an understanding.

“At this stage, many people still don’t understand or even know of vanadium. I open my conversation with, ‘I’m working on a vanadium project’ and some people know what that is and some don’t.”

VRFB godmother Skyllas-Kazacos and her team may have been ahead of their time, but the wheels on the vana-

dium battery bus are now in motion many decades later, according to Arvidson.

“Until about 12 months ago, I think we have not as a society appreciated the scale of stationary long duration storage,” he said. “This transition is happening in China and in areas of the US and Australia. Large power providers are literally calling for these batteries because they see the technological benefits.

“A 2050 [net zero] target is impossible to achieve without multiple technologies. You will need pumped hydro, lithium-ion batteries and there will definitely be a multi-decade constraint on lithium-ion supply.

“Vanadium flow batteries compete on cost and are technically superior for long duration stationary applications. That’s the real world story.”

– Fraser Palamara



Canegrass was acquired with an existing inferred resource of 79mt @ 0.64% vanadium



Australian Vanadium has engaged Primero as a contractor for early works on the planned processing plant at its namesake project in WA