HALLGARTEN & COMPANY

Coverage Update

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Neometals

(ASX: NMT, NYSE:RDRUY, FSE: 9R9)

Strategy: Long

Key Metrics			
Price (AUD)	$ 0.17		
12-Month Target Price (AUD)	$ 0.45		
Upside to Target	165%		
12mth hi-low	$0.135-$0.235		
Market Cap (AUD mn)	$ 92.48		
Shares Outstanding (mns)	544.0		
Performamce Warrants	11.3		
	FY19	**FY20e**	**FY21e**
Consensus EPS		n.a	n.a
Hallgarten EPS		$0.033	$0.042
Actual EPS	$0.1400		
P/E Ratio	**1.2**	**5.2**	**4.0**
Dividend Per Share	$0.02	$0.01	$0.015

Neometals

Extracting Value from Steel By-Products

- Neometals, and its JV partner Critical Metals, are planning on exploiting substantial high-grade Vanadium stockpiles from steel by-products (slag) in Sweden and Finland to produce Vanadium Pentoxide
- Potential to become one of the largest sources of Vanadium in Europe and become vertically integrated in the Vanadium Redox Battery (VRB) push
- Averaging between 3-4% grade of V, the slag heaps are far richer than the average of Vanadium mined conventionally and comes with the benefit of having no mining cost
- Vanadium Redox batteries had a setback in 2018 when prices for V_2O_5 soared but have now come back into focus as a viable mass storage option
- Low extraction cost make the mooted operation a lower cost source than most primary mines
- Phased introduction will lower upfront construction costs
- ✗ Vanadium has been a wild ride in recent years. The price is currently quiescent, but widely fluctuating prices have been the undoing of many desiring to advance projects in this metal
- ✗ Critical Metals might be challenged to meet its share of construction cost as it is an unlisted entity (for now)

Vanadium and the Circular Economy

One of the dilemmas of those propounding that the EU should lift its game in dealing with the Chinese challenge in supply-chain dominance is the NIMBYism that has evolved in much of the continent since the predatory pricing of the Chinese undercut (and sank) most European mines in the 1980s. This also coincided with rising living standards and the phenomenon of "who wants to work in a mine" sprang up.

Now that China is perceived as a persistent threat and the EU benefits gravy train has run into a buffer there is a revival of interest in the EU becoming its own source of metals that it requires for the so-called Circular Economy. The process is, well, a process and permitting is no slam dunk with locals coming out in opposition even when national governments support a mine plan…. Or vice versa.

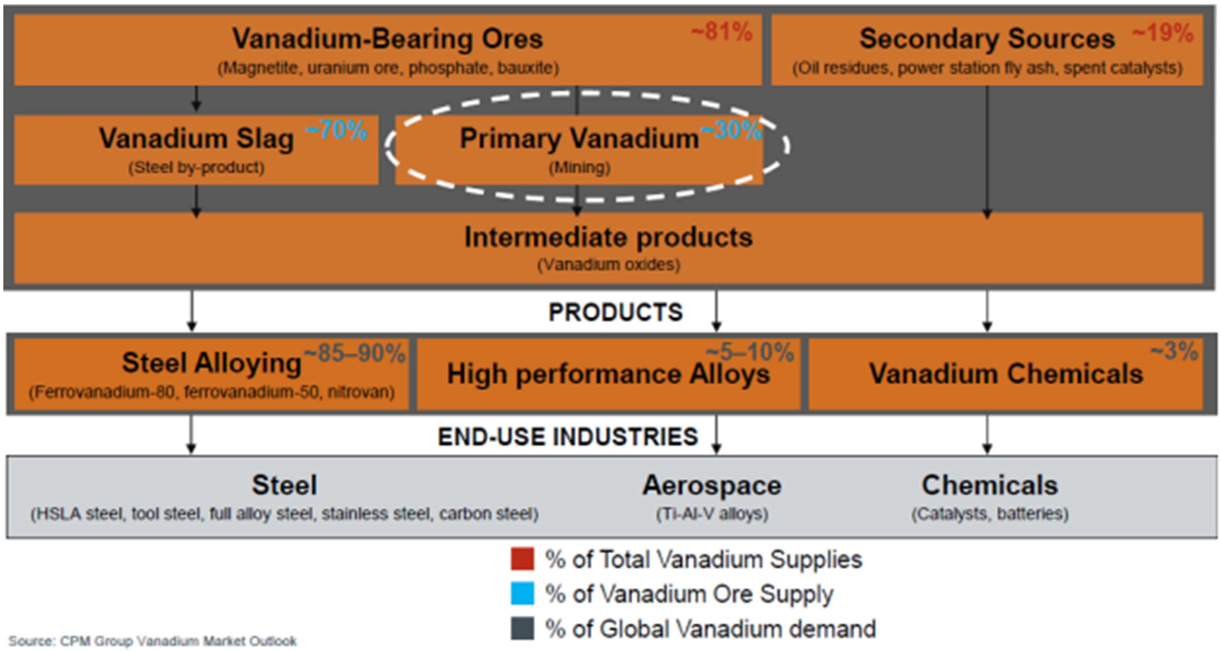
In the short-term the low-hanging fruit to feed the Circular Economy (to mix some metaphors) is recycling and in the case of Vanadium, recovery of metals from steel mill slag. This is not an unconventional practice as a large percentage of Vanadium's production has long been sourced from non-mine sources (steel mills and petroleum refineries). Surprisingly though, the vast bulk of V-rich slag reprocessing is done in Russia and China while countries like Sweden have allowed this slag to mount up and lie unused. It is important to note though that recovery of Vanadium from slag is NOT recycling, as this material has never been used *per se*. In fact, according to UN Environment Programme - UNEP (2011), in their study on the recycling rates for critical materials, the percentage of Vanadium that is recycled once applied to its final application (e.g. rebar) is less than 1%.

The worm is now turning on the resource security and environmental fronts and the entry of Neometals (and its partner Critical Metals) into this space is proving to be particularly timely. In this note we look at the nature of the venture and Neometals' partner, the "resources" at the three steel mill sites, the process for recycling, the advantages (economic and otherwise) this brings and finally the outlook for VRBs and Vanadium pricing. We shall also look at Neometals Titanium-Vanadium mining project in Western Australia that might mesh in with the other aspects of the business further down the road.

Vanadium Sourcing Dynamics

The dynamics of the Vanadium supply chain are unique. In some ways we might compare the metal's supply chain (at least up until now) to that of Lead, where the chief source is recycling.

The chart below (from the consultants CPM) shows that much of Western supply is sourced primarily from steel scrap, then mining, followed by secondary sources (which are in fact derived largely from "energy" industries whether petroleum processing or fly ash from the power generation sector).



Approximately 75% of global Vanadium supply is produced in China and Russia from steel smelter slag while other countries produce it either from the flue dust or heavy crude oil, or as a byproduct of uranium mining. It is mainly used to produce specialty steel alloys such as high-speed tool steels. The most important industrial Vanadium compound, Vanadium Pentoxide (V_2O_5), which is used (primarily) as an alloy with steel and as a catalyst for the production of sulphuric acid.

Vanadium is recovered as V_20_5 contained in an intermediate slag which is formed between iron-making and steel-making in integrated steelworks (eg Panzhihua in China, Highveld in South Africa and Nzhny Tagil in Russia). At these steel plants the Vanadium contained in the iron ore is taken into solution in the iron during the ironmaking process. The hot metal is then oxidised and a slag, which contains between 10% and 25% V_20_5, is formed and removed before the hot metal is passed on for final steelmaking. The slag containing l0-25% V_20_5 is then treated in a roast/leach process, the end product of which is Vanadates or Vanadium oxides.

Critical Metals

This company was spun out of the ASX-listed Hannans (ASX:HNR) back in 2016. Thus it is a novel entity in being an Australian registered public company (with around 1,200 shareholders) that holds a portfolio of exclusively Scandinavian assets but that does not have a listing. Neometals holds a stake of 15.4% in Critical Metals and is thus its largest shareholder.

It has a portfolio of projects across a range of metals in Sweden and Finland in metals, such as iron ore, Vanadium and copper and PGMs. It has also explored for Lithium in the region.

Critical aims to supply the European energy storage industry with metals from Scandinavia via urban mining (recovering metals from industrial by-product stockpiles) and traditional mining.

The Joint Venture

This recycling opportunity was introduced by Critical Metals to Neometals in early 2019. Neometals will fund and manage the evaluation activities up to consideration of an investment decision by 31 December 2022, which, if positive, will lead to a 50:50 incorporated joint venture. The anticipated cost of the studies to be funded by Neometals is ~AUD$5mn. Critical Metals will manage the relationship with SSAB and all activities in Sweden and Finland.

Neometals will be entitled to a gross revenue royalty on sales of vanadium products for use of its proprietary hydromet technology.

SSAB

The joint venturers aim to process the vanadium-rich slag that exists in stockpiles at three of sites of SSAB, two in Sweden and one in Finland.

The Swedish-Finnish company SSAB AB (formerly Svenskt Stål AB or Swedish Steel) was formed in 1978 and specialised in processing raw material to steel. The Finnish element to the business is the result of, in 2014, SSAB purchase of the Finnish steel manufacturer Rautaruukki for 1.1 bn euros. The largest shareholders are Aktiebolag Industrivärden and the Government of Finland. The company also has a large presence in the US.

The stockpiles have built up over 30 years and have been continually assayed by SSAB through that period. The steel operations are forecast to continue to generate slag at a rate of +180 ktpa to 2035.

The Deal with SSAB

The keystone of the venture is a feedstock supply agreement with Scandinavian steel giant SSAB. The agreement consists of:

- a 10-year slag supply agreement with SSAB
- Critical Metals will purchase steel by-products (i.e. slag) from SSAB
- provision for at least two million dry metric tonnes of slag
- conditional on Critical Metals meeting project study milestones and commencing production by December 2024

The aim of the long-term slag supply agreement is for Critical Metals/Neometals to be processing slag from the SSAB steel mills in Oxelösund and Luleå in Sweden and Raahe in Finland by 31 December 2024. The agreement provides Critical Metals with access to at least two million tonnes of existing and future slag from SSAB steel mills. This provides a secure basis for the evaluation of a slag recycling facility capable of processing 200,000 tonnes of slag per annum without the need to build a mine and concentrator like existing primary producers.

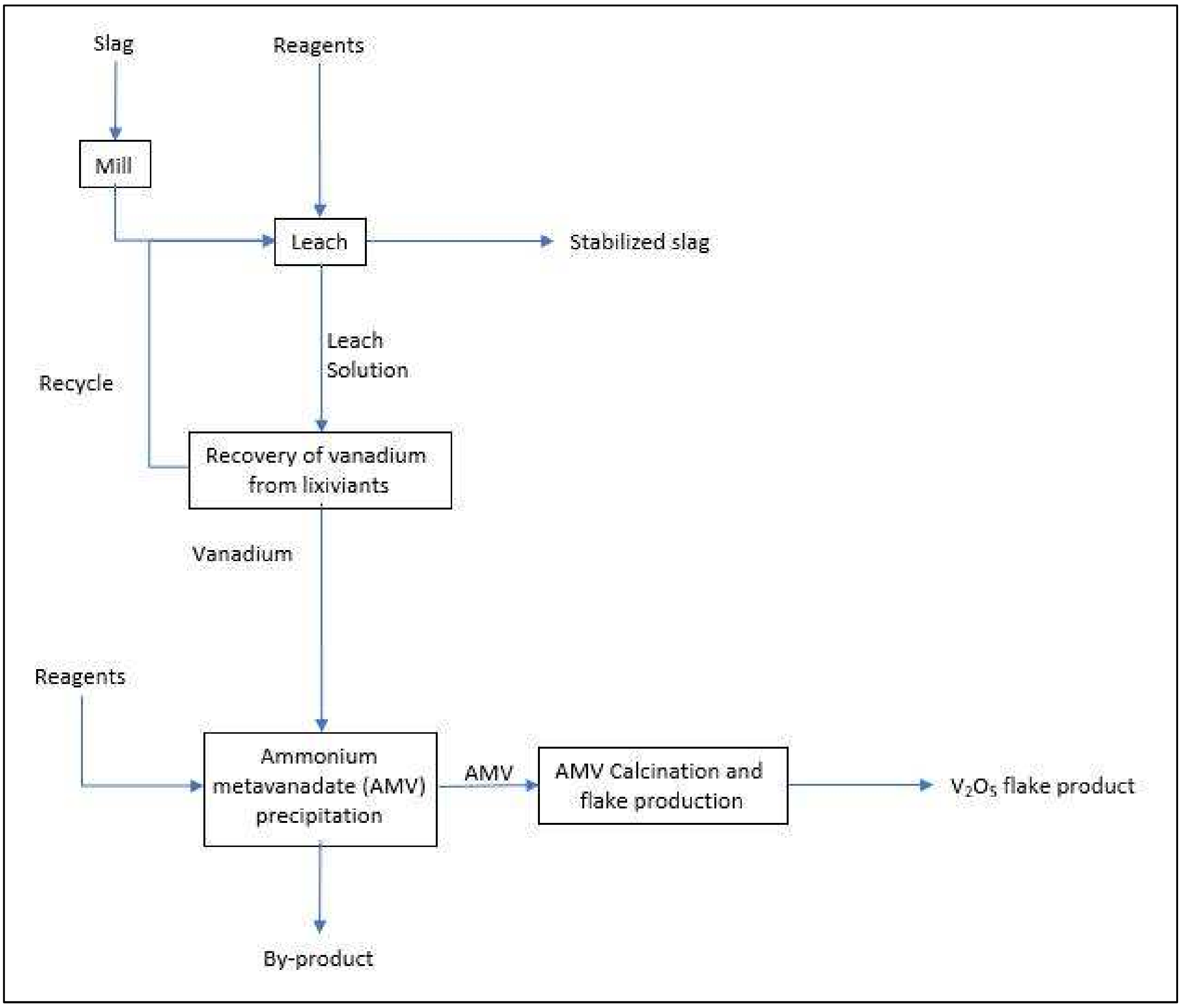
The Vanadium grade at the SSAB stockpile in Luleå is ~4% V_2O_5 and at both Oxelösund and Raahe is ~3% V_2O_5 making it one of the highest-grade Vanadium feedstock sources in the world.

The Neometal's Technology

The prime advantage that the joint venturers have lies in its resource. This consists of a 4% V_2O_5 stockpile, already crushed to <10mm, which the partners can hydromet process without needing to mine/beneficiate/salt roast. As a result this venture has the potential to place this Vanadium project within the lowest quartile of production costs globally.

Preliminary tests completed by Neometals on by-products from the SSAB steel mills during the last 12 months have confirmed up to 80% vanadium recovery from leaching under mild conditions. Neometals contends that its proprietary hydrometallurgical process has significant operational, cost and risk advantages over traditional pyrometallurgical (salt-roast) process routes.

A provisional patent has been lodged for the hydromet process developed by Neometals. It uses conventional equipment, non-exotic materials of construction, operates at atmospheric pressure and mild temperatures. Test work so far has been bench scale with ~50kgs of slag from the various slag stockpiles that are the subject of the agreement between Critical Metals and SSAB.



Source: Neometals

The venture is looking to only permit a simple start-up with flake production and a site large enough for enough by-product storage to cover the payback period of the plant. Further phases of work such as the potential for making Vanadyl sulphate will follow as potential future options.

Then there are the by-products of the process. The stabilised slag by-product is expected to be suitable for use in road construction and general construction as a fill material. In addition, test work will be carried out to ascertain if the stabilised slag can be used to supplement the supply of lime and residual iron back into the steel making process.

In summary the high-grade Vanadium feedstock is located at surface, adjacent to ports and excellent infrastructure in low sovereign risk jurisdictions, providing an opportunity to establish vanadium production in the lowest quartile position on the cost-curve, with no mining risk or beneficiation costs.

Siting

Critical Metals' initial role will be the funding of a study for the identification of the location for the operation. At the moment sites in the vicinity of the steel mills at Luleå, Oxelösund and Raahe are being considered as potential locations for the project. The potential site locations are all proximal to the following SSAB stockpiles, tonnage and grade:

- Luleå – 711,000 tonnes of slag grading +4% V_2O_5
- Oxelösund – 890,000 tonnes of slag grading +3% V_2O_5
- Raahe – 385,000 tonnes of slag grading +3% V_2O_5

Aerial view of the massive slag pile at Luleå.

In practice the operation will require a plant area of ~10 ha with a further are for stockpile storage of ~10 ha. Beyond that the by-product storage area required will be a further 30 ha. As Oxelösund is in the more densely populated part of Sweden, we would expect that the plant will end up being at one of the other sites, both of which are at the northern end of the Gulf of Bothnia that lies between Sweden and Finland. The operation's labour requirement will be around 80 full-time employees (when in operation).

There is limited room on SSAB's sites for the processing plant and storage areas as currently envisioned. Two main sites are being considered for the location of the processing facility – an industrial park close to being permitted by the local commune less than 5km north east of the SSAB Luleå facility in Sweden and also an industrial site in Raahe in Finland located near the port and the subject of extensive previous baseline environmental work.

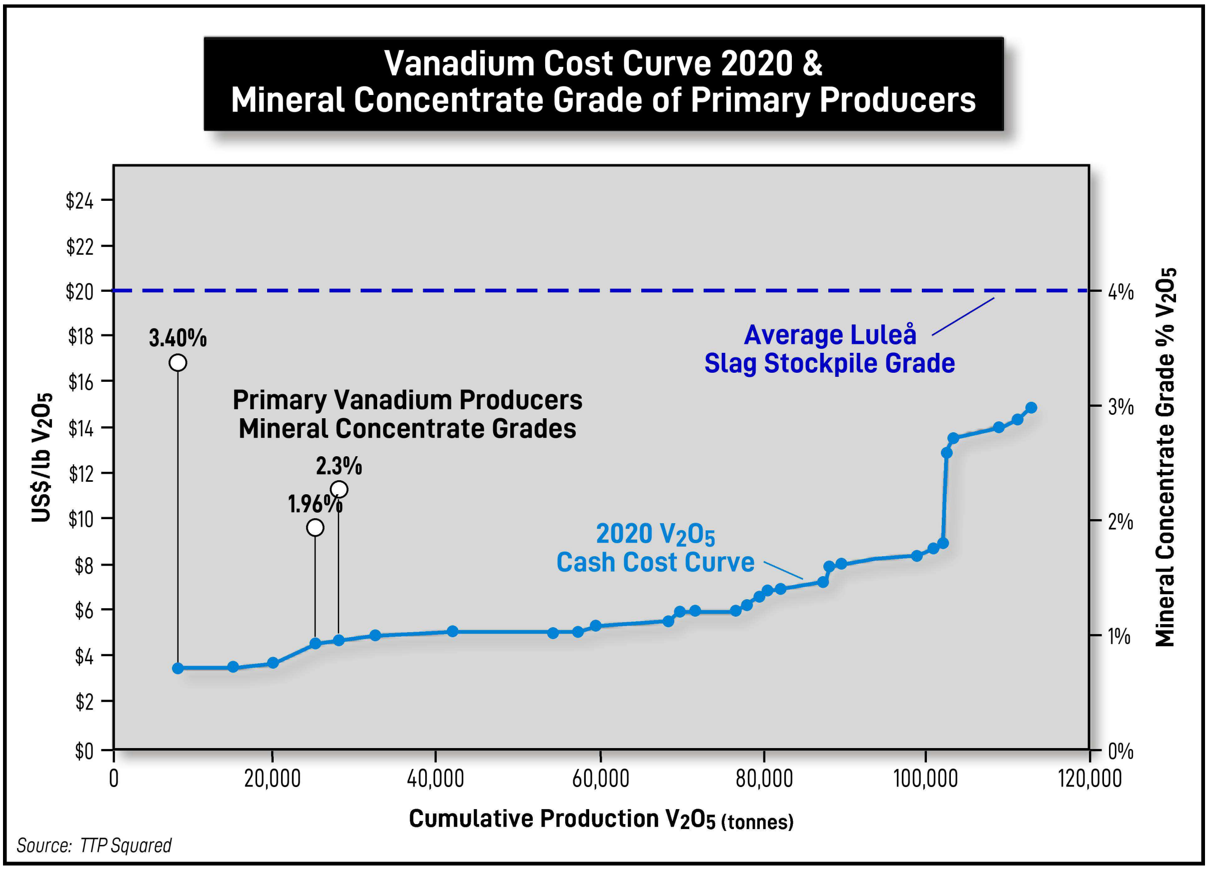
Energy is a key consideration with expected power consumption of around 26 million kWh per year. The north of Sweden has an energy surplus with 30.8 TWh produced by hydroelectric power plants, of which 16% is produced by the 15 Vattenfall hydroelectric power plants that dot the 460 kms-long Lule River in northern Sweden. Flowing southeast from the mountainous Sarek wilderness along the Norwegian border, the river meanders its way down to Luleå and discharges into the Gulf of Bothnia.

The final location for the Vanadium recovery plant will be decided after consultation with stakeholders in Sweden and Finland to ensure production by the due date.

Economics

That "grade is king" is often stated in mining circles but if that grade is achieved without any mining cost then what may we call that? The project as envisioned by the joint-venture partners involves no mining cost.

Below can be seen where Luleå stands *vis-a-vis* the rest of the primary Vanadium producers.



It might be useful to make a comparison with Largo Resources (TSX:LGO) the largest producer with a public listing. Cash operating costs, excluding royalties, were US$2.48 per lb V2O5 in 4Q19. Concentrate grade (the closest comp to the V-slag of the joint venturers) was 3.36%.

Largo in its recent filings has offered a total cash cost guidance for FY20 of US$3.45 - 3.65/lb V_2O_5.

Thinking about the Vanadium slag project one might consider that the absence of a mining cost saving alone might reduce OpEx by one third. On top of that comes a milling advantage in that the material is already crushed to <10mm. This should reduce costs further.

With 200,000 tonnes per annum of slag potentially to be processed at 3.3% (across the three slag pile sources) and presuming a 76% recovery we can create a model of potential revenues.

As entry into production is to be phased, and as Luleå has the highest grades, the most likely Phase One production would be between 100,000 to 200,000 tonnes of material of 4% grade being reprocessed per annum. Even these modest expectations would produce revenues of over US$30mn at currently subdued prices.

Scenarios on V-Slag Recovery

Mills	Tonnage p.a.	Grade	Recovery	V2O5	Revenues @ $7/lb	Revenues @ $10/lb
All	200,000	3.3%	76%	5,016	$73,735,200	$105,336,000
	150,000	3.3%	76%	3,762	$55,301,400	$79,002,000
	100,000	3.3%	76%	2,508	$36,867,600	$52,668,000
	50,000	3.3%	76%	1,254	$18,433,800	$26,334,000
	25,000	3.3%	76%	627	$9,216,900	$13,167,000
Luleå	50,000	4%	76%	1,520	$22,344,000	$31,920,000
	25,000	4%	76%	760	$11,172,000	$15,960,000

In should also not be forgotten that besides the production of V_2O_5, the by-products are potentially saleable and will add (unknowable at this stage) by-product credits to further lower unit production costs per lb or tonne.

At the upper end of production, Sweden would be vaulted from nowhere to fifth in the world in terms of tonnage produced.

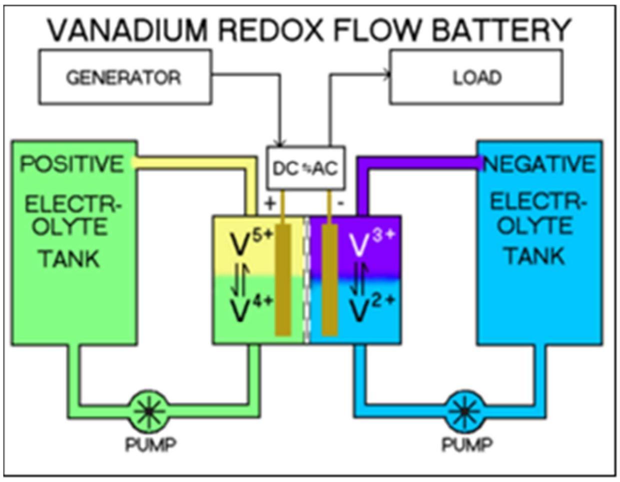
The Brave New World of Mass Storage

New uses are potential X factor for the Vanadium space. While aerospace has been growing organically and increasing its share of the usage of the metal the area with the best potential for a quantum leap is in battery applications.

Chief amongst these is the Vanadium Redox (and Redox Flow) battery (VRB), which is a type of rechargeable flow battery that employs Vanadium ions in different oxidation states to store chemical potential energy. The Vanadium Redox Battery concept is the result of over 25 years of research, development, testing and evaluation in Australia, Europe, North America and elsewhere.

The use of Vanadium in batteries had been suggested back in the 1970s by a number of scientists including some at NASA. The present form (with sulphuric acid electrolytes) was patented by the University of New South Wales in Australia in 1986 where scientists carried out the first known successful demonstration and commercial development of the all-Vanadium redox flow battery employing Vanadium in a solution of sulphuric acid in the second half of the 1980s.

A Vanadium Redox Battery consists of an assembly of power cells in which two vanadium-based electrolytes are separated by a proton exchange membrane. The battery exploits the ability of vanadium to exist in solution in four different oxidation states, and uses this property to make a battery that has just one electroactive element instead of two.



Source: Vanadiumsite.com

The main advantages of the Vanadium Redox Battery format are that it can offer almost unlimited capacity simply by using larger and larger storage tanks, it can be left completely discharged for long periods with no ill effects, it can be recharged simply by replacing the electrolyte if no power source is available to charge it, and if the electrolytes are accidentally mixed the battery suffers no permanent damage. The VRB has also been shown to have the least ecological impact of all energy storage technologies.

The main disadvantages with Vanadium Redox technology are a relatively poor energy-to-volume ratio, and the system complexity in comparison with standard storage batteries.

There are currently a number of suppliers and developers of these battery systems including Ashlawn Energy (with its VanCharg product) and Vionx in the United States, Invinity (the merger of the former Renewable Energy Dynamics (RED-T) in Ireland and Avalon Battery Systems), Cellstrom GmbH in Austria (controlled by the solar energy arm of Germany's Gildemeister group), Cellennium in Thailand, and

Prudent Energy in the United States and China.

The image that follows gives a good idea of one of the more practical applications of such batteries. In this case the solar panels collect energy during the day and store it in the battery for release during the period when the solar panels cannot access sunlight.

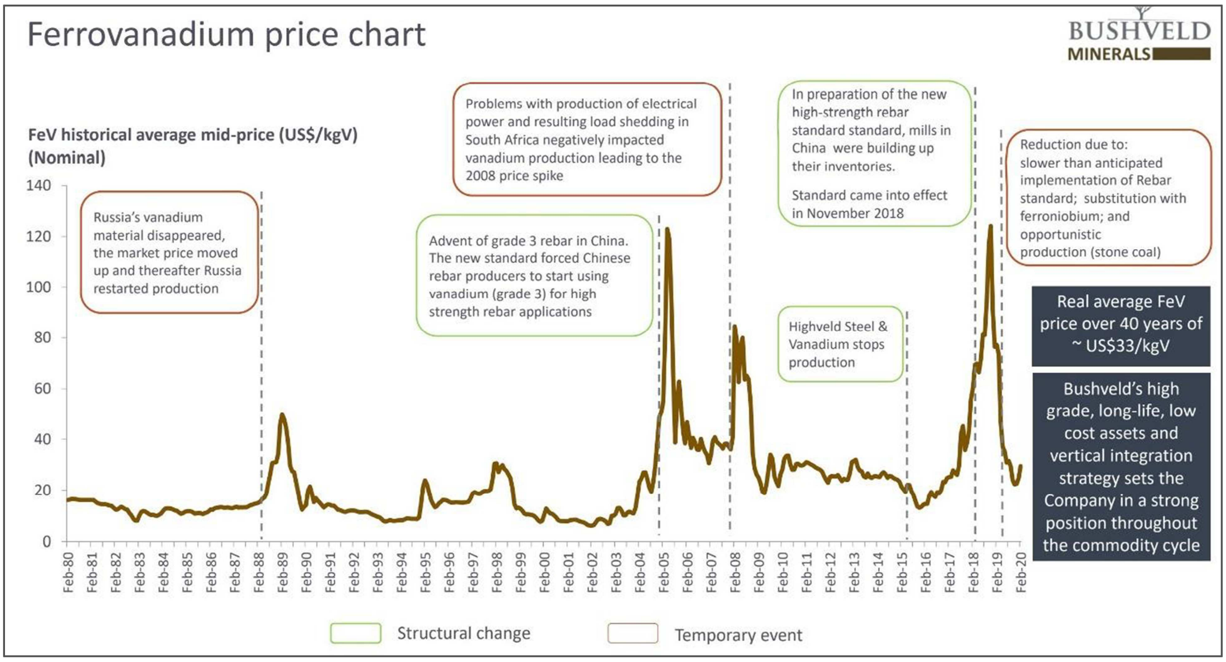
Source: Cellstrom GMBH

Vanadium Pricing

Even by the standards of specialty metals, where wild price gyrations, frequently occur, Vanadium has been exceptional in recent years. In 2017-18 in particular the vanadium price took off in a frenzied way that was partly driven by Chinese requirements for high V content in steel alloys used for rebar (as a response to a number of devastating earthquakes) combined with the general rush into battery metals that put VRBs on the radar screen of a wider audience.

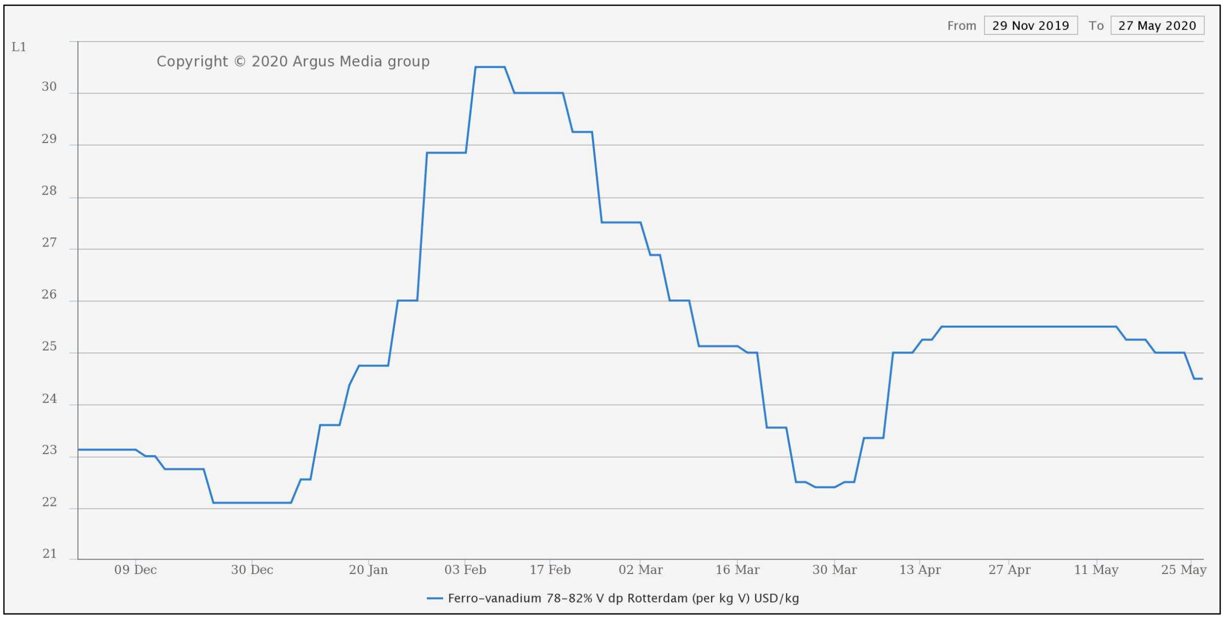
This was the third surge in 15 years whereas in the 25 years until 2005 there had only been one spike in Vanadium prices.

The most recent surge pushed the price of V_2O_5 to around \$30 per tonne and cast into doubt the viability of the VRB part of the demand equation as most developers of this technology started talking of VRBs being priced out of the market by the soaring price. As usual when this happens, the price went into steep retreat and nearly fell back to its 2016 lows. There was a suspicion that the Chinese also baulked at the high prices and instructed buyers to soft-pedal on the implementation of the higher V content rules in rebar.

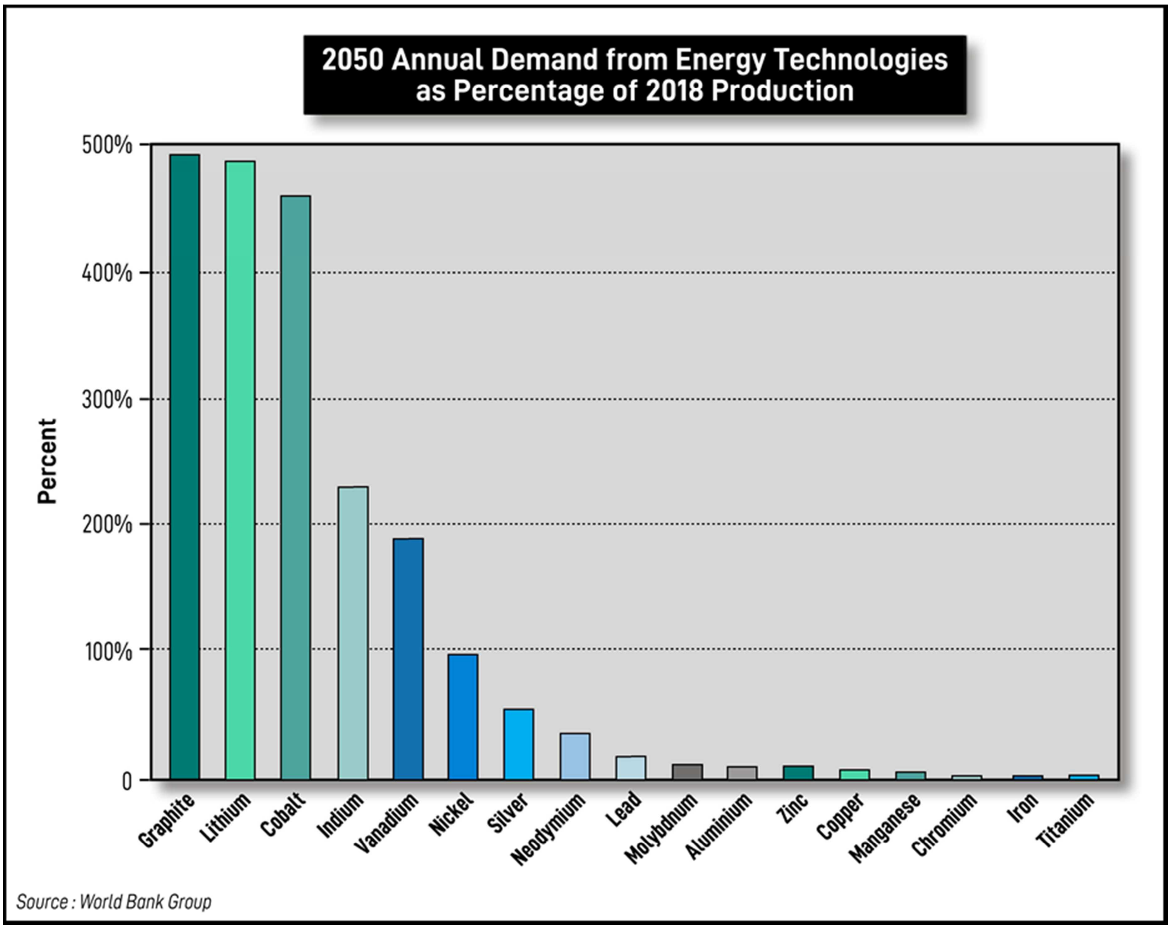


Source: Bushveld

And here is a chart over recent months for Rotterdam delivery, still showing quiet wide fluctuations in prices.



Source: Argus Media



The chart above shows that there will need to be a massive uplift the production of five metals, in particular, for the battery revolution. While the Graphite and Lithium supply situation is being dealt with by a plethora of projects, the many Vanadium projects at this time are either not advancing (largely starved of funding) or unviable because their production costs are above the metal's price (unlike the Neometals V-slag recovery project).

The Barrambie Project

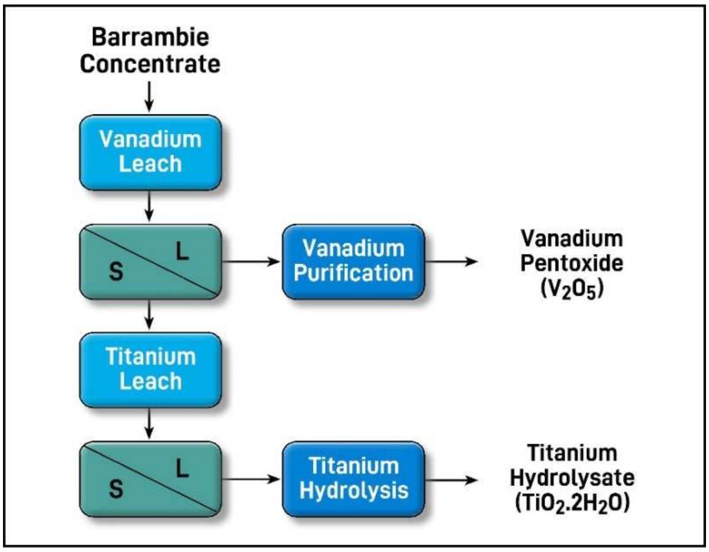
This project is located is located 80 kms north of Sandstone in Western Australia and is 100% owned by Neometals. The deposit was discovered by Hector Ward in the 1960s and was acquired by Neometals (then Reed Resources) in April 2003 from Precious Metals Australia Ltd and Magnum Properties Pty Ltd. As noted it started out as a Vanadium project, it is now being styled as a Titanium project with Vanadium (and Iron) as the by-products.

The Barrambie resource contains high-grade ilmenite intergrown with a vanadium-bearing magnetite (iron) and, as demonstrated, the Neometals process flowsheet can produce a superior intermediate feed material that is safer, cleaner and cheaper to produce titanium pigment from. In addition, the Barrambie titanium hydrolysate has very favourable morphology and chemical properties that offer numerous cost and quality advantages for the titanium pigment industry. Further upside in this flowsheet for Barrambie is the recovery of the accessory vanadium and iron in a saleable form.

Below can be seen the Barrambie high-grade vanadium Resource (from 2018) which was calculated at a V_2O_5 cut-off of 0.5%.

	Tonnes (M)	TiO_2 (%)	V_2O_5 (%)
Indicated	49.0	16.93	0.82
Inferred	15.9	16.81	0.81
Total	**64.9**	**16.90**	**0.82**

The next evaluation step is the recovery and production of a vanadium by-product from the primary leaching stage of the Titanium Pilot Plant. In parallel, Neometals is preparing approximately 10 tonnes of gravity and magnetic concentrates from the high titanium grade Eastern Band for the proposed Chinese demonstration plant trial. The Vanadium test work and concentrates shipment was expected to be completed by the end of the March Quarter 2020, but the COVID-19 crisis has delayed achieving this.



Risks

In this instance we shall not consider the company's exposure to Lithium but focus on the project in question. Amongst the risks related to the vanadium recovery project are:

- Vanadium price risk
- Excessive CapEx
- Financing is still tenuous and dependent upon sentiments towards VRBs and Vanadium
- Slow permitting

The metal price has been all over the place in recent years and must rank as one of the most volatile metals in the last ten years. This has made things extremely difficult for developers of mines or other recovery processes to have a solid market price on which to hang their economic projections.

There has been a curious dilemma of VRB manufacturers claiming the technology is not viable with V_2O_5 input prices above $10 per lb while most miners are claiming they are not profitable below that level.

The CapEx is clearly cheaper than Vanadium mining as the material is already mined. Thus the cost is only the processing cost.

Financing of battery metal projects has run into very heavy weather with the EV revolution having been delayed, challenged and questioned. However VRBs are not linked with the EV "phenomenon" and can potentially be decoupled with the right spin by the vendors of the units. It's a niche technology but a very big niche.

The permitting issue is an unknown. This is not a mining issue and wherever it is undertaken it will most likely be in close proximity to one of the source steel plants so we do not see this as a blockage but more of a (possibly) extended procedure.

Conclusion

Few would challenge that the potential of VRBs is impressive. However, Vanadium has in some ways been its own worst enemy with the 2017 to around $30 per lb for V_2O_5 being a deal-killer for many developers of VRBs. The rather rapid decline back to sub-$10 was equally unhelpful because it meant that at levels around $6-7 per lb there was no enthusiasm, and even less development capital, for Vanadium mining projects. It was a typical dilemma of the mining sector with pricing at extreme poles of too-low to too-high choking off activity.

It should be no surprise that Neometals has advanced at this point into the vanadium recovery space as it has long been cultivating ambitions in primary mining of the metal at Barrambie. That project has been advancing slowly due to the many oscillations in the Vanadium price over the last decade (and Neometals prime focus being Lithium). We specifically use the term "recovery" rather than "recycling" here as Vanadium "recovery" is in fact the conventional mode of V production with mining coming second, or at least that was the situation until recently.

It is therefore no great leap for Neometals to morph from Lithium developer to Lithium producer to

Lithium recycler and through that to Vanadium recovery. All of the company's *leitmotiven* in play.

And then it is interesting to note the circularity in Neometals' partnership with an entity that is a spin-out from an associated company. What comes around goes around. Vanadium as one of the roads to be taken in the battery is a natural extension of Neometals' journey since 2010.

With most Vanadium mining projects mired in financing woes since the price dipped below $10 per lb, the joint venture partners have the opportunity to fill the niche with material produced at a lower OpEx and with one of the few (or only) sources of the metal in Europe at a time when VRB demand is rising and there is strong pushback against Chinese domination of the alternative energy space.

We have had Neometals in our Model Mining Portfolio since 2009 as a **LONG** call and we reaffirm our twelve-month target price of $0.45.

Important disclosures

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