

9 May 2019

Stock Data

Ticker	BMN LN
Share Price:	26.5p
Market Cap:	£294m

Price Chart



Vanchem acquisition adds value to Mokopane

Bushveld Minerals holds 74% of Vametco, an integrated vanadium mining, processing and technology business. 26% of Vametco held by a BEE group.

Bushveld Energy (84%) is developing vanadium redox batteries for grid use in South Africa.

Lemur Holdings (100%) is developing a thermal coal mining & power project in Madagascar.

AfriTin separately listed on AIM in London. Bushveld retain a minority stake in the company

- Vanchem acquisition for \$68m cash adds real value due to its combination with Bushveld's nearby Mokopane project which can supply much-needed fresh ore to Vanchem.
- Vanchem technically has capacity of 5,000mtVpa but currently produces just ~960mtVpa.
- **Capex est. \$45m** to restore capacity plus \$20m for new Mokopane mine construction.
- Our new Mokopane/Vanchem NPV looks good at US\$461m, IRR strong at 63% due to low capital outlay and faster production growth on 10% discount rate.
- Vanchem currently in business administration due to lack of own resources and feedstock from closure of Highveld steel in 2016.
- Production running off just one of three kilns at Vanchem.
- Low-risk expansion using existing kilns, and equipment, simply replaces lost production.
- Vanchem's vanadium chemicals business helps diversify sales while the increase in production still leave scope for further expansion at Vametco.
- **Valuation:** We have reduced our assumed vanadium price to \$60/kgV for 2019 and 2020 due to lesser compliance with the new Chinese regulations than expected, though we do expect punishment of Chinese officials to create better compliance this year. Vanchem acquisition offsets our assumed lower vanadium prices. Our revised target price valuation rises to 90p/s from 87p/s previously.
- **Energy Tech: Bushveld Energy** initial valuation as sales of Vanadium Redox Flow Batteries 'VFRBs' to Eskom and others draw closer. Higher vanadium production give potential to significantly expand VFRB electrolyte sales. We value Bushveld Energy at 3.6/s as an initial starter valuation though the business should develop significantly greater value in time.

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Vametco & Vanchem		2017	2018	2019	2020	2021	2022	2023
Price V205	\$/lb	6.4	19.2	14.0	14.0	12.8	10.3	10.3
Ferro Vanadium	US\$/kg	32.6	81.2	60.0	60.0	55.0	45.0	45.0
Vanadium sales	kg	2586	2573	3096	4370	5432	6422	7911
Sales	US\$m	71.8	178.0	171.6	242.3	276.1	267.0	328.9
Operating costs	US\$m	57.7	70.5	74.9	94.5	113.5	127.3	152.6
Operating costs	US\$/kg	22.3	27.4	24.2	21.6	20.9	19.8	19.3
Operating profit	US\$m	14.2	107.5	97.1	149.2	164.8	142.1	180.2
Pre-tax profit	US\$m	13.9	106.8	91.9	142.3	157.4	134.5	172.8
tax	US\$m	4.0	30.4	26.2	40.5	44.9	38.3	49.2
Post-tax profit	US\$m	9.9	76.3	65.7	101.7	112.6	96.2	123.5
EPS	US\$/s	0.9	6.9	5.9	9.2	10.1	8.7	11.1
PE	x	38.5	5.0	5.8	3.8	3.4	4.0	3.1
EV/EBITDA	x	29.8	3.9	4.3	2.8	2.6	3.0	2.3
EBITDA	US\$m	14.2	107.5	97.1	149.2	164.8	142.1	180.2
Free Cash Flow	US\$m	-	11.8	74.0	5.5	87.1	103.7	148.3
Vametco Cash Flow	US\$m	74.00%	11.8	74.0	59.9	78.8	68.0	71.6
Vanchem Cash Flow	US\$m	100.00%	-	-54.5	8.3	36.7	35.6	76.7

SP Angel forecasts: Figures based on 100% of Vametco plant. Bushveld now hold an effective 74% of the Vametco plant. Bushveld hold 100% of Vanchem

*An SP Angel mining analyst and nomad have visited the Vametco in South Africa.

Bushveld Minerals Cont....

- Bushveld management have been looking over the fence at Vanchem in South Africa as combining the assets appears to be the best and most cost-effective way of developing their Mokopane vanadium project.
- The deal to acquire Vanchem out of Business Administration for \$68m in cash is subject to regulatory approvals and gives Bushveld immediate access to an additional 960tpa of vanadium production capacity plus infrastructure to expand to 4,200tpa.
- Payment: US\$6.8m is to be paid in cash on 30 April 2019 plus US\$61.2m settled no sooner than 31 July 2019 and no later than 31 October 2019.
- Vanchem is currently operating one out of three furnaces with production currently reduced to just 960mtVpa due to a lack of suitable feedstock and constrained resources, though this should more than double in 2021 as the Mokopane mine comes on stream.
- Capital expenditure of \$45m is planned to restore the plant to 5,000mtVpa of capacity in the form of various vanadium chemical products.
- Mokopane: Developing the new open cast mine and infrastructure at Mokopane will cost just \$20m which added to the \$68m acquisition cost and \$45m of capital is just \$133m vs the previously estimated development cost at Mokopane of \$298m.
- Mokopane ore is a very high 70% magnetite which serves to offset transport and logistics costs when compared with Vametco.
- The acquisition adds immediately to Bushveld vanadium production without adding any new vanadium to the market enabling management to take advantages of current vanadium prices.
- Vanchem is a cheap deal for Bushveld as the business was starved of feedstock and was forced into business rescue by the closure of Highveld which formerly supplied slag and Mapochs mine feedstock to the Vanchem plant. We note some modification will be done to adjust to feedstock from Mokopane.
- Comparing the Vanchem acquisition with the original Mokopane PFS shows the Vanchem deal to work better on virtually every metric and critically the deal serves to simply take over and replace Vanchem production which was lost to the market last year.
- Our new Mokopane/Vanchem NPV is better at US\$487m vs US\$418m in the 2016 Mokopane PFS assuming a 10% discount rate and our IRR is at 66% vs 24% in the 2016 PFS.
- Chemicals: Vanchem is a large chemicals business focussed on vanadium chemicals and products. It has multiple product streams and lots of big kit for spare capacity. It is also well connected to Vametco and Mokopane by rail and road which gives increased flexibility in its operations and potential for create for more value-added products.
- Cheaper acquisition: Vanchem is a significantly cheaper acquisition on a per tonne of capacity basis than the Vametco deal due to its distressed state, need for feedstock and capex requirements.
- The capital intensity of the Vanchem deal is around \$17,000/t of V2O5 on our figures vs around \$31,000/t in the Mokopane 2016 PFS.
- Production is currently running off just one of three existing kilns at Vanchem and the new \$45m capital program to restore production over the next five years is seen by management as relatively cautious.
- The plan allows for existing production to continue while refurbishing capacity which was recently mothballed for lack of feed. Hopefully reality will be faster given the presence of so much infrastructure at site.

- Replacing lost capacity: The strategy simply replaces vanadium production which was lost to the market after Highveld closed and should have little impact on vanadium prices.
- Highveld Steel closed in 2016 left for dead by Evraz, its Russian owner which cut around 1,800 jobs in the process. We have seen reports suggesting the plant may reopen sometime though this may require higher steel prices, a weaker South African rand or both.
- Vanadium deficit: Vanadium remains in structural deficit in the market according to Bushveld supported by 2.5% compound demand growth from steel and chemicals and potential for CAGR growth of up to 8.4% driven by vanadium redox batteries.
- Vanadium prices have fallen this year due to China's failure to fully implement its new standards on vanadium content in steel rebar. The result is that many smaller steel mills are still making brittle steel by quenching and tempering which is not good if corroded or unexpected strain is put on its reinforced structure.
- Chinese officials are being punished for failure to implement government policies and we expect more officials to move to impose standards rather than risk several years in a correctional facility.
- We have adjusted our model to replace our forecast \$150m expansion at Vametco with new and less capital-intensive production from Vanchem.
- While we suspect management will be busy restoring production at Vanchem it is possible that Vametco could also expand further in time if the supply deficit widens and prices continue to support additional supply.
- This is good news for consumers as it offers the prospect for an additional vanadium supply into a market which could potentially see longer term constraint as banks may struggle to finance many other vanadium projects.
- Assumptions: We have reduced our ferro-vanadium price assumption to \$60/kgV from US\$75/kgV for 2019 and 2020 based on the assumption that ferro-vanadium prices average current price levels through the rest of the year.
- Our price assumptions of US\$55/kgV for 2021 and US\$45/kgV for 2022 onwards remain the same.
- We suspect ferro-vanadium prices may dip further before recovery later in the year as Chinese officials better implement government regulations introduced last year.
- Production: We have combined our production assumptions for the Vametco and Vanchem plants. Our new production figures reflect our best guess for the combined output of the two plants. We see an acceleration in the increase in vanadium production but are more cautious as we assume production is around 80% of capacity going forward.
- Bushveld Energy: We have modelled some basic assumptions for Bushveld Energy for incorporation into our valuation. We assume relatively modest margins for the business on project management of Vanadium Flow Redox Batteries 'VFRBs' into the South African grid. We also assume a more modest margin on the production of electrolyte based on the value of the vanadium pentoxide contained.

Conclusion: The combination of Mokopane with Vanchem is a great way forward for Bushveld Minerals. The deal given immediate access to production and near-term expansion at relatively low capital cost and technical risk.

It broadens the range of value-added vanadium products and enables greater operational flexibility with vanadium pentoxide to feed Bushveld Energy's planned electrolyte plant.

This should give the team greater confidence to take on contracts for vanadium electrolyte for the next generation of VFRB batteries to be built in South Africa for energy storage and grid balancing.

A worrying number of fires in Li-ion storage facilities suggests that VFRB may not only be a more economic way forward but may also be the only relatively fire-safe way forward for Megawatt-scale grid storage.

We retain our Strong Buy recommendation

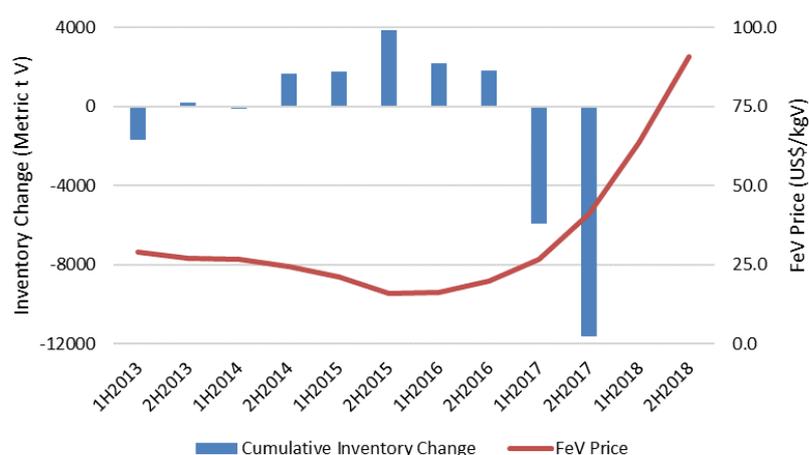
Our valuation rises to 90 pence per share from 87p/s previously

Vanadium prices

- Vanadium prices were historically held back by high levels of by-product vanadium in China from slag production as a by-product of titano-magnetite and other iron ore feedstock processing.
- **Demand strength** is now driven by volume growth in infrastructure and higher rebar standards in China starting in November and potentially some stockpiling by consumers and traders. China also banned imports of vanadium in slag.
- **Virtually no exports** – China export traders reported to be offering very little in Europe and elsewhere as local demand absorbs almost all supply.
- **Demand expected to significantly outstrip supply:** ~10% market deficit in 2017.
- It looks as if European steel producers and other consumers may struggle to buy vanadium with so much Chinese production now being directed back into the Chinese market.
- China may need a further 17,000t of vanadium to meet demand if much of its hardened steel production moves to the new Grade 3 standard. This represents an increase of 21% of total 2017 global vanadium production.

Reducing global vanadium availability:

- Global inventories of vanadium continue to tumble, becoming extremely tight on the back of supply side rationalisation and strengthening environmental legislation across China. Global cumulative inventories are contracting to levels around 12,000t deficit in H2 2017 according to Vanitec and Metal Bulletin data, which is supporting rapid price appreciation.



- The availability of vanadium remains extremely low in China, with diminishing numbers of exporters offering deliveries into international markets due to favourable domestic demand. Traders are reported to be filling domestic orders in preference to export demand.
- Supply has been impacted since the liquidation of Evraz Highveld, removing ~11,000tpa following the closure of the major Mapochs mine in South Africa in February 2016.

Sustained low commodity prices and subsidised steel imports impacted on the viability of the operation. Subsequently Vanchem, a major producer of high-purity V2O5, also closed due to a lack of feedstock from Highveld.

- The global vanadium market fell into an 8,000t deficit during 2017, with demand forecast to continue exceeding supply through 2020, creating sustained market tightness and an elevated price environment in the near-term. The commonly traded 98% pure vanadium pentoxide has risen more than 800% since the start of 2017 to approximately \$34/lb in October.
- While some market participants are calling a peak to prices, topping its previous 2005-06 high of \$25/lb, structural changes in the market could sustain further price appreciation. Analysts at Roskill are forecasting sustained growth in demand with 2025 consumption reaching 133,000t, growing 51% from current levels.
- The market is forecasting a shortfall of approximately two new significant operations with output the size of Bushveld Minerals' Vametco asset to come online each year for the next seven years to sustain projected market consumption.
- Significant investment is therefore required across the sector to develop global reserves given the lack of near-term primary ore projects. Consequently, some investors are forecasting prices to top \$40/lb.

Environmental legislation impacting traditional Chinese supply:

- With rising prices, the entire cost curve has positive margins encouraging potential for expansion across the entire supply spectrum.



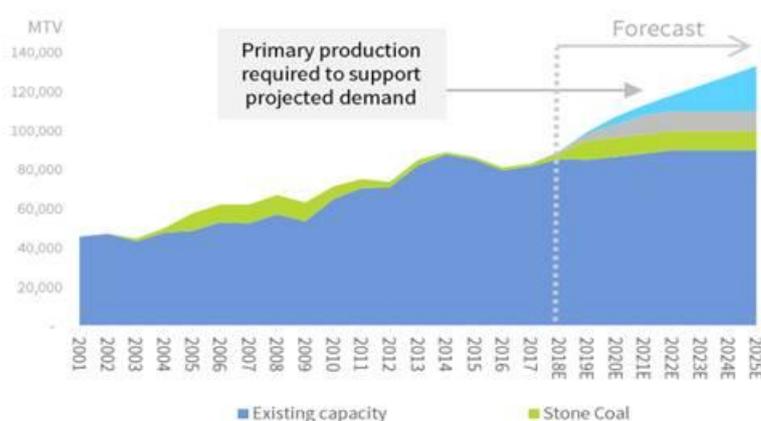
2018 projected cash costs:

Co-product steel slag	US\$3.23-9.47/lb V2O5
Primary vanadium ore	US\$4.15-4.50/lb V2O5
Chinese stone coal	US\$6.22-12.0/lb V2O5
Secondary	US\$8.22-11.88/lb V2O5

- The market is principally driven by co-production from the steel industry, reprocessing waste slag to extract vanadium. However, recently China moved to ban imports of waste material, removing significant Russian supply to reduce the feedstock to Chinese slag producers.

- We suspect Russian steel slag traders will either move to upgrade this material to get around the new Chinese rules or look to process the slag in Russia as is done by Evraz. Evraz produced some 15,672t of vanadium last year.
- Following an announcement by the Chinese Ministry of Environmental Protection all four categories of vanadium scrap are 'forbidden' to be imported into China under new regulations coming into effect at the beginning of 2018.
- Additionally Chinese rationalisation has shuttered numerous high-cost, low quality domestic iron ore mines which supply vanadium-titanium magnetite ore, while 'Blue Sky' environmental campaigns are creating sustained demand for high-purity iron ore which contains no vanadium.
- The raw material supply base is largely not responsive to changes in the vanadium market price, and environmental legislation changes are only expected to hamper the ramp-up in production.
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Global Vanadium Production Forecast ⁽²⁾



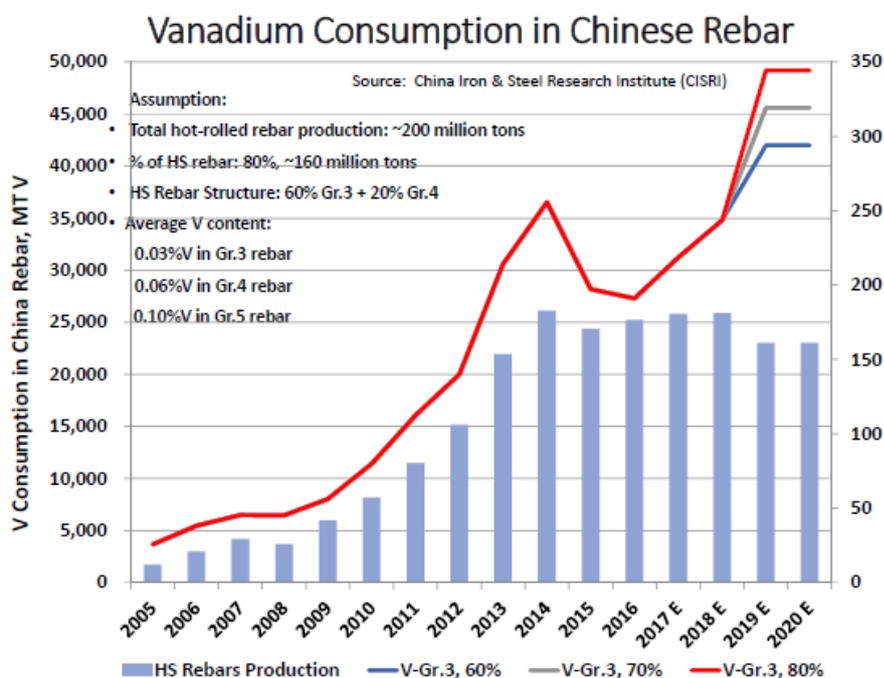
- Production from existing sources (including all idle capacity and expansion of existing primary mines) is forecast to grow at 3.7% CAGR, reaching 111,000t in 2025 according to TTP Squared, a vanadium market consultancy.
- The vanadium deficit is therefore expected to widen significantly by 2025.

Rebar standards:

<https://roskill.com/news/vanadium-new-chinese-rebar-standards-positive-ferrovanadium-demand/>

- In 2016 some 27,000t of vanadium was consumed in high strength rebar in China down significantly from 37,000t in 2014. In fact vanadium consumption fell an estimated 27% in high strength rebar and 5% overall causing prices to drop to unusually low levels as Chinese melt-shops introduced induction 'Q&T' Quench & Tempered steel which they sold as grade 3 high-strength rebar despite its lack of vanadium, poor ductility and substandard strength.
- Small steel mills sold this Q&T steel till the authorities tightened the regulations and also introduced a new test which measures the true strength of the steel throughout the metal and not just at its surface. This means that Q&T steel should not now pass the strength test.
- Some 70mt of induction melt-shop capacity has now been shut, saving power, improving overall productivity, cutting pollution and improving steel quality.
- A further 40mt of Grade 2 rebar has also been eliminated by the regulations as it is not suitable for use in seismic areas indicating that a further 40mt of Grade 3 rebar with the higher vanadium content should be produced to replace the lost capacity.

- The net result is that vanadium demand should be around 54,000tpa assuming the manufacture of 180mt of Grade 3 steel, with no niobium substitution.
- Vanadium demand is expected to grow to 42,000t if only 60% of the high strength rebar is produced with vanadium. See chart below from the China Iron & Steel Research Group:



- Collectively global consumption of vanadium is expected to rise significantly, with China fronting the climb in demand. While global vanadium demand could rise by 55% to 133,205t by 2025.
- Chinese consumption is forecast to rise a massive 89% from 2017 levels.

Scrap (Secondary 10% of market):

- Removal of all four categories of vanadium scrap imports as “forbidden” by the Ministry of Environmental Protection under new regulations came into effect after December 31, 2017. This is creating serious tightening in the scrap market limiting the availability of raw material.

Steel Slag production (72% of total vanadium supply):

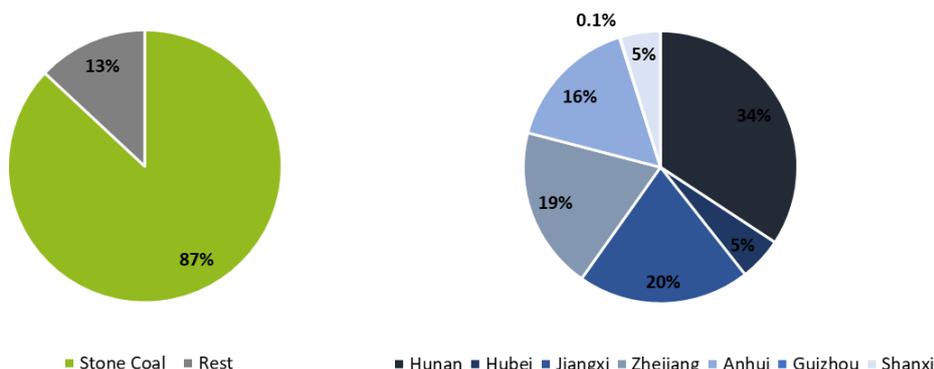
- China’s new **Green Shield environmental policies** combined with high power costs have caused many steel producers to shift to higher-grade Australian iron ore which does not contain much vanadium. Eg they have cut back on the use of iron ore concentrates which more often contain vanadium.
- Using higher grade iron ore in steelmaking reduces energy consumption, cuts process times, increases capacity and cuts emissions. Rio Tinto and BHP are also reliable shippers delivering their high-grade product on time and according to specification reducing the need for high port stock levels and so much inventory financing.
- Details regarding the scale of environmental inspections and restrictions across China are thin at best, but the trends are still observable with Chinese vanadium production falling

35% in August 2017 as environmental inspections restricted production in Sichuan province.

- The removal of Russian slag feedstock is expected to impact around 50,000tpa of vanadium-bearing slag with 10-20% V₂O₅, equivalent to 4,500-5,500tpa.

Stone coal environmental restrictions:

- Domestic supply has historically also been supported by output from stone coal. The Asian nation hosts significant gross reserves totalling 61.88bn tonnes, equating to ~118Mt V₂O₅ and accounts for around 87% domestic reserves (source: Hydrometallurgy).



- The number of producers is limited as the vanadium content low, extraction costly (US\$6.22 12.0/lb) and the roasting process generates significant quantities of caustic gasses, such as Cl₂, HCl and SO₂, which cause severe environmental harm.
- Australian Vanadium managing director and Vanitec committee member, Vincent Algar notes *“it’s a very dirty process that’s done by various small corporations throughout China. It’s extremely environmentally damaging. It introduces toxins and acid into the environment”*.
- As a consequence, Chinese environmental regulators have refused to issue permits to existing stone coal operators, thereby eliminating a sizable domestic source of vanadium. *“It’s outlawed by the Chinese authorities and they have been very clear...it is a matter of record that they will not accept that environmental degradation under any circumstances. No market conditions will allow corporations in China to pollute both the air and the land”*.
- The introduction of washing plants may enable stone coal mines to regain permits if the coal can be sufficiently upgraded and cleaned, though they create their own environmental issues.
- Early reports by FerroAlloyNet suggest factories extracting vanadium from stone coal are undergoing major upgrading to transform the process into cleaner operations, however commercial potential will remain limited and highly constrained. Facilities, principally located in Hunan and Shaanxi, may adopt more competitive low salt roasting-cyclic oxidation or biohydrometallurgical routes to minimise environmental controls.
- Alternative experimental, cleaner leaching methods may or may not restore some production from this source though the cost is also likely to be high.
- The removal (potentially temporary) of stone coal production, increased pressure falls on primary mine supply to match the growing global shortfall.

Substitution (Niobium):

- **Niobium** can be used as a substitute for vanadium but only for certain grades of steel and under specific conditions. Elevated price above ~US\$20/kgV create an economic motivation to replace V with Nb or Nb+Ti, however the result is an inferior quality product with higher rejection levels.

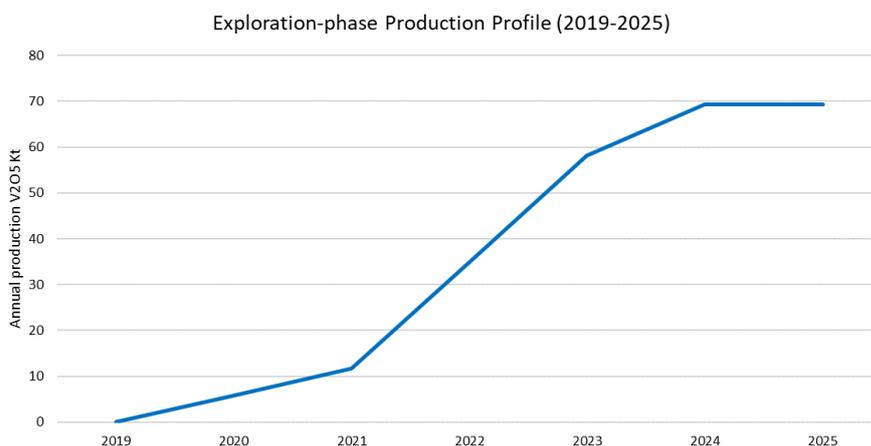
- Given the relatively small scale of the Niobium market, the few companies with niobium metal stocks and a total market of just 64,000tpa with just one mine producing some 89% of the global market we do not expect many users to turn to niobium in place of vanadium.
- Given that prices of vanadium have risen about the level necessary for substitution it is believed the vast majority of any substitutional loss of market has already occurred.



Primary (Mine) production (18% of market):

- There is limited primary production entering the market with a number of projects with primary JORC resources undergoing scoping studies to meet the growing requirement for vanadium pentoxide.
- Many projects will require time for further resource definition, feasibility study work and significant capital before commissioning and eventual production.
- Production may also be supported from a number of proposed **poly-metallic projects** in future years, although project viability will also be tied to the production of associated metals including iron, graphite, titanium and uranium. The fastest of these new co-product supplies is likely to be from smaller graphite mines but will still take time to build co-product process lines.
- A number of projects are proposing primary vanadium production, with a larger number indicating potential for vanadium as a by-product of iron ore, titanium, uranium and graphite.
- Project development time scales are generally in the region of 3 to 10 years for primary vanadium and often similarly for by-product output though some are sooner indicating the market for vanadium could see significant deficit for some years.
- Due to the long lead times in developing advanced-stage exploration assets, the forecast new supply is not expected until at least 2021. This delay period is expected to only exacerbate the tightening market and continue to drive prices higher. The supply gap is therefore expected to become more heavily reliant on existing operators who are required to expand capacity to match the booming demand.

Vanadium market production profile:



Largo Resources (Brazil):

- Largo Resources runs Maracas Menchen, one of the world's highest-grade vanadium mines in Brazil has a market capitalisation on the TSX in Canada of around C\$2.88bn fully diluted inc.16m warrants.
- Largo are expanding the mine to 12,000tpa and could take this to 13,200tpa with certain other upgrades. The mine recently achieved a daily run rate of 10.7tpa of V₂O₅ at a cost of around \$4.11/lb

Glencore (South Africa):

- Swiss-based Glencore, produced 20.9Mlbs (equivalent 9,300t) vanadium pentoxide in 2017 from the Rhovan open-pit vanadium mine and smelter complex near Brits in South Africa.

Energy Fuels (US):

- Vanadium production starting Q4 with 91-102kgV per month or 1,092-1,224kgVpa.
- The uranium producer, are the only North American company near-term vanadium production. The company's vice president Curtis Moore adds "*we believe we are the best-positioned vanadium company in North America, because we think we will beat everyone else to production, and we are building our longer-term vanadium production profile. Over the past several months, we have been working on refurbishing and upgrading the vanadium circuit at the White Mesa mill, and we plan to resume vanadium production from our ponds beginning in November 2018 at a rate we estimate at 200,000-225,000lbs of V₂O₅ per month, subject to V₂O₅ prices remaining strong and technical success.*"

Ferro-Alloy Resources (Kazakhstan):

- Ferro-Alloy Resources Group in Kazakhstan have plans to rapidly ramp up production currently in the form of ammonium metavanadate to 22,400tpa vanadium pentoxide in a multi-stage development.
- Balasausqandiq vanadium deposit initially targets a proposed 5,600tpa V₂O₅ in Stage 1.

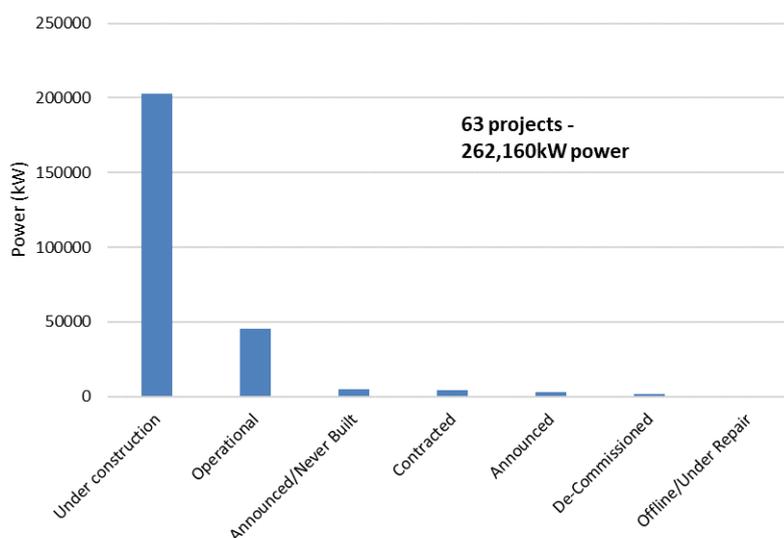
Developers and explorers with high grade projects are:

- **Australian Vanadium:** Gabanintha (Australia) – 175.5Mt Resources @ 0.77% V₂O₅
- **Atlantic Ltd:** Windimurra (Australia) – 235Mt
- **TMT Ltd:** Gabanintha (Australia) – 16.7Mt Reserve @ 0.96% V₂O₅
- **VanadiumCorp:** Lac Doré (Canada) – 99.1Mt @ 0.43% V₂O₅
- **Tando Resources** (South Africa) – 513Mt Inferred (SAMREC) @ 0.78%

- **Golden Deep** (Namibia) – 1.12Mt Inferred @ 1.28%

Redox flow battery demand:

- Vanadium in electrolyte may be leased as part of the financing for ‘Vanadium Redox Flow Batteries’. The leasing of the vanadium units should enable the financing of large-scale units for high speed grid back up, grid balancing and general grid storage.
- VFRBs could replace large numbers of standby diesel and gas generators and more efficiently balance renewable energy power supply from solar and wind power. Flow batteries are ideally suited for long-duration peak shifting or demand-shifting and may be combined with short-duration services where high cycle life is required. The round-trip AC-to-AC efficiency for flow batteries is typically 65-75% which is not bad for a battery.
- Lithium-ion battery installation round trip losses are difficult to find but *“the round-trip efficiencies for the EES systems have been calculated as between 83 percent and 86 percent, falling to between 41-69% where parasitic loads are included,”* according to one study.
- It is therefore difficult to judge but the market for VFRBs but Li-ion battery installations over the next five years could grow by 55%pa from 2GWh last year to 18GWh in 2022 according to GTM Research. VFRBs could replace or support Li-ion battery installations in time, especially give there are 63 current grid-level VRB projects globally according to the DOE global energy storage database.



Risk to supply forecasts:

- While we are struggling to understand how the market will feed the apparent increase in vanadium demand created by the removal of Q&T steel and the increase in vanadium content in strengthened steels we are wary of the potential for innovation in the vanadium supply chain.
- Chinese producers of stone coal may work out how to wash the coal to meet new environmental standards, though we suspect the cost is prohibitively high.
- Former Chinese vanadium slag processors might also come up with a cleaner hydrometallurgical solution to the production of vanadium from steel slag.
- Other by-product and primary vanadium might come to the market faster than we are anticipate.
- Innovation might enable the strengthening of steel through substitution using other metal alloys.



In conclusion:

If China maintains its Green Shield environmental policies and steel producers continue to use Australian iron ore in preference to other, less clean, sources of iron feedstock then the vanadium market should see a very substantial deficit and prices could remain at relatively high levels for the next few years.

The risk is that the market situation may become so severe so quickly that that consumers will have to either slow production or find ways to either substitute vanadium or to produce vanadium from other feedstock or to increase the tensile strength of steel in other ways.

Vanadium prices indicate the market may be desperately short of material with few new sources of production in the short term.

Short term:

It is difficult to see much new production coming through till 2020 indicating the potential for ferro-vanadium prices to average significantly higher price levels than previously seen in past cycles.

We can see good potential for ferro-vanadium prices to return to high levels till new material enters the market. However we are pulling back our ferro-vanadium assumption to US\$60/kgV from US\$75/kgV in 2019 and 2020 in reaction to slower than expected compliance with new Chinese vanadium content specifications.

Longer term: Much of the new primary production is also likely to carry higher operating costs when it comes in requiring further cost analysis. We therefore expect new vanadium supply to return to the market from a higher cost base needed to repay new capital and higher operating costs.

**SP Angel act as Nomad and broker to Bushveld Minerals.*

Note: Bushveld Minerals controls and holds an effective 84% of Vametco

**An SP Angel mining analyst and nomad have visited the Vametco vanadium mine and processing facilities in South Africa.*

**SP Angel act as Nomad and broker to Bushveld Minerals*

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