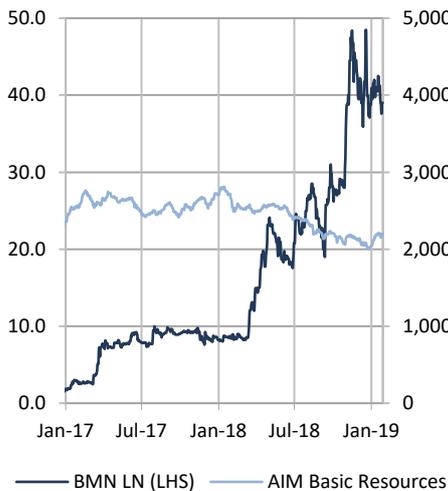


30 January 2019

#### Stock Data

Ticker	BMN LN
Share Price:	38.25p
Market Cap:	£456m

#### Price Chart



### Q4 Operating results report US\$107m EBITDA

**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.

- Bushveld report Q4 sales and EBITDA margins today.
- Sales were 167% higher in Q4 yoy at US\$60m.
- FY sales were 143% higher yoy at US\$192m.
- EBITDA rose 320% to US\$39.6m in Q4
- FY EBITDA rose 349% to US\$107m for the full year.

#### Forecasts:

- Our EBITDA forecast of US\$109m for 2018 is remarkably close to the company's actual US\$107.5m indicating that our financial model works relatively well.
- Our sales forecast US\$204m is also relatively close to the US\$193m (ZAR2,545m) reported by the company.
- Our forecasts are remarkably close to reality considering the volatility of vanadium prices, the lag in sales vs production and the disruption caused by stoppages, holidays and plant maintenance.
- Vametco produced 657mtV of Nitrovan and ferro-vanadium in Q4 to bring full year production to 2,560mtV for the year. While Q4 production was 22% higher than Q3, the year was 3.4% down on CY 2017.

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100% Vametco		2017	2018	2019	2020	2021	2022	2023
Price V205	\$/lb	6.4	19.2	17.7	17.7	12.8	10.3	10.3
Ferro Vanadium	US\$/kg	32.6	81.2	75.0	75.0	55.0	45.0	45.0
Vanadium sales	kg	2721	2573	3400	4370	5000	7500	10000
Sales	US\$m	75.6	178.0	235.6	302.8	254.1	311.9	415.8
Operating costs	US\$m	57.9	70.5	81.5	98.1	103.2	143.5	187.6
Operating costs	US\$/kg	21.3	27.4	24.0	22.4	20.6	19.1	18.8
Operating profit	US\$m	17.7	107.5	154.1	204.8	150.9	168.3	228.2
Pre-tax profit	US\$m	17.5	106.5	152.8	202.8	145.1	158.8	218.6
tax	US\$m	5.0	30.4	43.5	57.8	41.3	45.2	62.3
Post-tax profit	US\$m	12.5	76.2	109.2	145.0	103.7	113.5	156.3
EPS	US\$/s	1.1	6.9	9.8	13.1	9.3	10.2	14.1
PE	x	44.7	7.3	5.1	3.9	5.4	4.9	3.6
EV/EBITDA	x	31.5	5.2	3.6	2.7	3.7	3.3	2.4
EBITDA	US\$m	17.7	107.5	154.1	204.8	150.9	168.3	228.2
Free Cash Flow	US\$m	17.5	94.5	144.5	191.6	87.7	105.1	215.0
Attrib. Cash Flow 74% BMN	US\$m	12.9	69.9	106.9	141.7	64.9	77.8	159.1

SP Angel forecasts: Figures based on 100% of Vametco plant. Bushveld now hold an effective 59.1% of the Vametco plant

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

**Bushveld Minerals Cont....**

- Ferro-vanadium sales fared slightly worse down 8% yoy at 586kgV in Q4 and down 3.4% yoy to 2,573mtV which was just 27mtV lower than the 2,600mtV used in our forecast.
- Vametco lost an estimated 230mtV from 37.5 days of stoppages. Community unrest accounted for 22.5 days of this.
- We hope these issues are now resolved and there should be no more stoppages this year due to labour grievances.
- **2019 production forecast:** we await news on the company forecast but we expect Vametco to produce substantially more vanadium through 2019 than was produced last year.
- Phase 2 of the expansion was completed in June taking Vametco capacity to 3,750mtV pa but the plant is not likely to run over 3,400mtV for the year due to grade, kiln availability and silica liberation issues.
- Costs: examination of the full year results indicates a significant improvement on our assumed costs which compensates for slightly lower than anticipated sales.
- While costs rose by 19% yoy due to inflation and higher raw material costs the result was still better than we had anticipated.
- Vametco has embarked on a transformation programme to sustainably increase production cost efficiencies reduce costs though unit costs should improve due to the expansion in capacity going forward.
- **Exploration** at the Vametco mine shows a variety of grades above and below 2% V2O5. We have cautiously reduced our assumed grade for the year to 1.82% V2O5 from 2.01% previously assumed.
- Ultimately we see Nitrovan and ferro-vanadium production rising to around 10,000mtVpa as Bushveld continue to expand their current and potential new facilities.
- **Price forecasts:** we see ferro-vanadium prices remaining relatively high at US\$75/mtV this year and next before falling back to US\$45/mtV thereafter
- Ferro-vanadium prices have picked up since the new year rising to \$77-78.75/kgV for 78% material in Western Europe and to \$70-72/kgV in China (Fastmarkets MB).
- We expect the Chinese authorities to determinedly crackdown on non-compliance for strengthening steel rebar.
- The effect should be for steel producers to move to buy more vanadium in, what looks like, a relatively tight market environment.
- Chinese rebar prices hit a 12-month high last week but have since settled back at \$545-551/t.

**Conclusion:** Vametco has produced a solid set of figures despite some challenges through the year. The Vametco and Bushveld management team has learnt much since Bushveld acquired control of the Vametco plant and we expect a smoother ride from now on. The Phase 2 expansion is already in place indicating a very significant increase in cash flow to come.

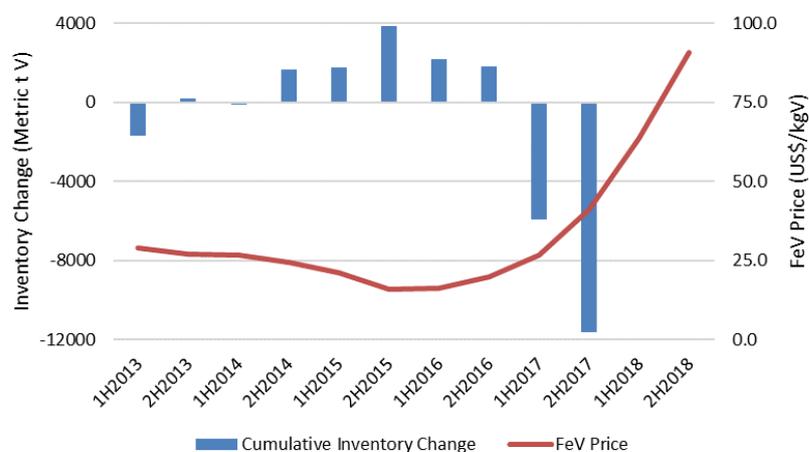
**We retain our Buy recommendation and 87 pence per share target price**

### Vanadium market.

- **Historically vanadium prices have been** held back by high levels of by-product vanadium in China from slag production as a by-product of titanomagnetite 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:**

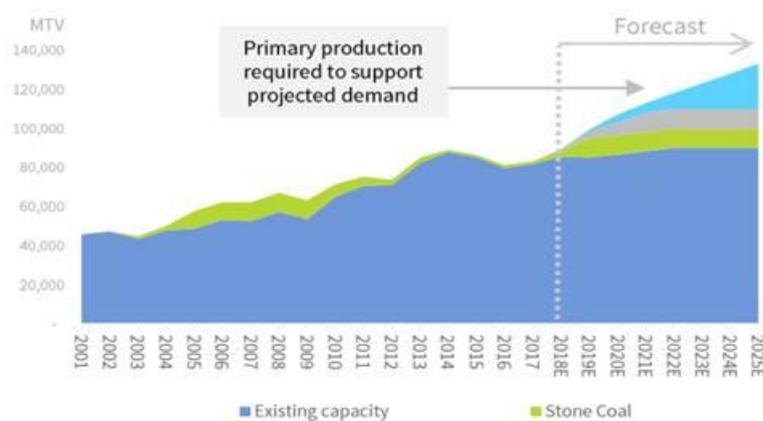
<b>Co-product steel slag</b>	US\$3.23-9.47/lb V2O5
<b>Primary vanadium ore</b>	US\$4.15-4.50/lb V2O5
<b>Chinese stone coal</b>	US\$6.22-12.0/lb V2O5
<b>Secondary</b>	US\$8.22-11.88/lb V2O5

- 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.
- 

### Global Vanadium Production Forecast (2)

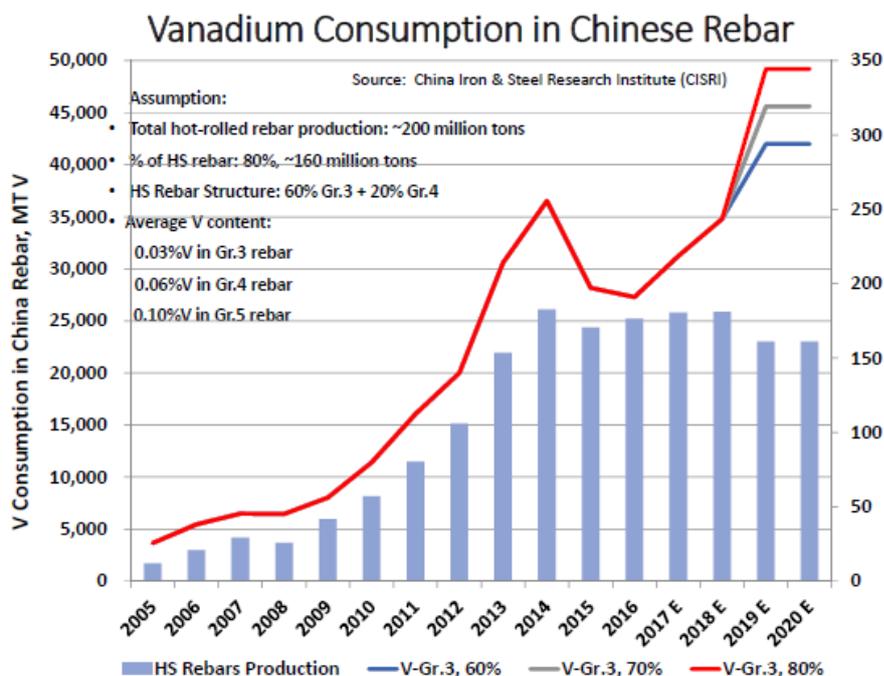


- Production from existing sources (including all idle capacity and expansion of existing primary mines) is forecast to grow at 3.7% CAGR, reaching 111,000t in 2025 according to TTP Squared, a vanadium market consultancy.
- The vanadium deficit is therefore expected to widen significantly by 2025.

#### 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):**

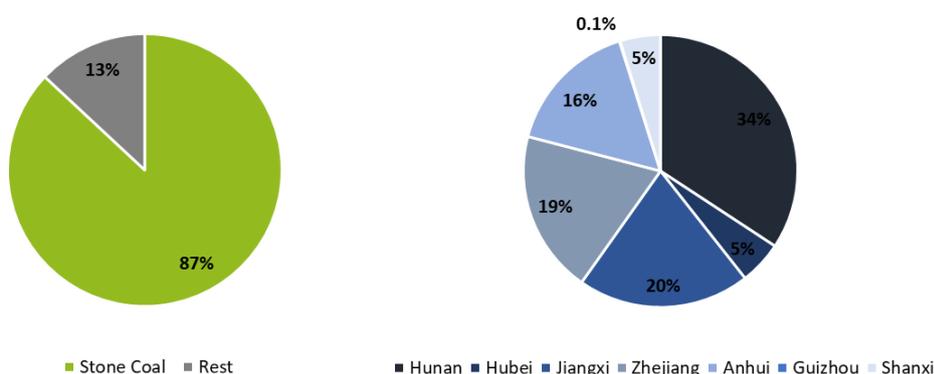
- Removal of all four categories of vanadium scrap imports as “forbidden” by the Ministry of Environmental Protection under new regulations came into effect after December 31, 2017. This is creating serious tightening in the scrap market limiting the availability of raw material.

**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 V<sub>2</sub>O<sub>5</sub> 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 Cl<sub>2</sub>, HCl and SO<sub>2</sub>, 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):

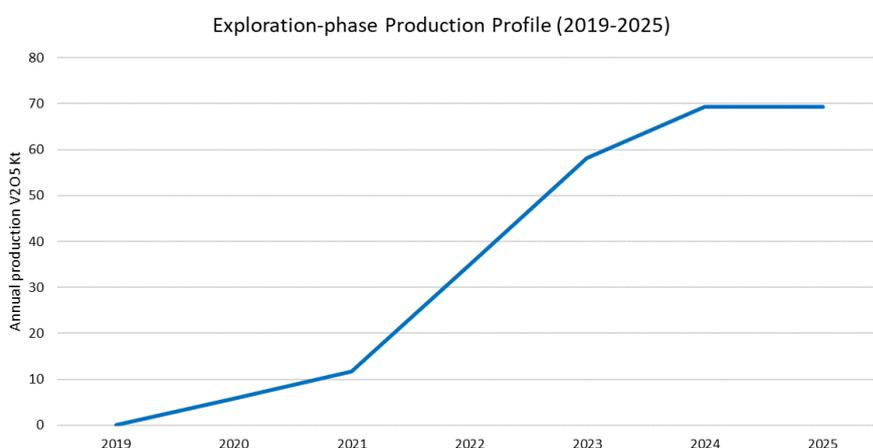
- **Niobium** can be used as a substitute for vanadium but only for certain grades of steel and under specific conditions. Elevated price above ~US\$20/kgV create an economic motivation to replace V with Nb or Nb+Ti, however the result is an inferior quality product with higher rejection levels.
- Given 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 V<sub>2</sub>O<sub>5</sub> 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 V<sub>2</sub>O<sub>5</sub> per month, subject to V<sub>2</sub>O<sub>5</sub> 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 V<sub>2</sub>O<sub>5</sub> in Stage 1.

**Developers and explorers with high grade projects are:**

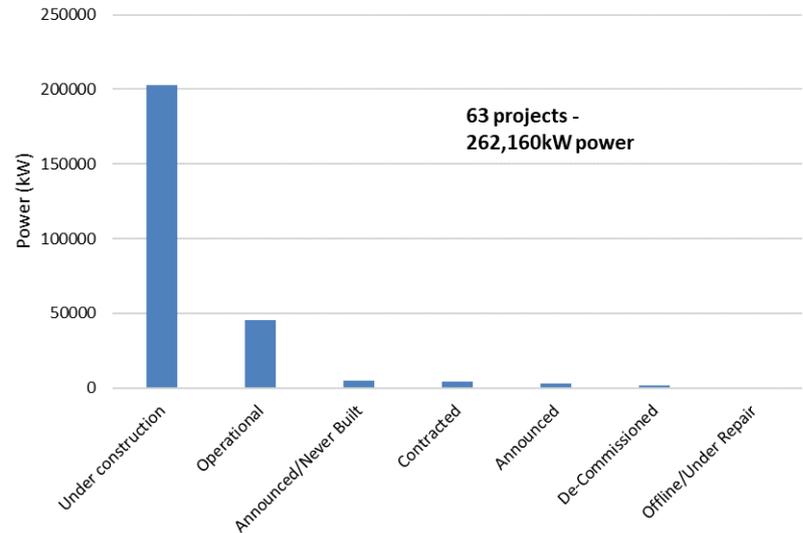
- **Australian Vanadium:** Gabanintha (Australia) – 175.5Mt Resources @ 0.77% V<sub>2</sub>O<sub>5</sub>
- **Atlantic Ltd:** Windimurra (Australia) – 235Mt
- **TMT Ltd:** Gabanintha (Australia) – 16.7Mt Reserve @ 0.96% V<sub>2</sub>O<sub>5</sub>
- **VanadiumCorp:** Lac Doré (Canada) – 99.1Mt @ 0.43% V<sub>2</sub>O<sub>5</sub>
- **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 remain at high levels till new material enters the market. We are therefore raising our ferro-vanadium assumption to US\$75/kgV in 2019 and 2020.**

**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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