



Australian  
**VANADIUM**  
LIMITED

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# Investing in the energy storage future with Australian Vanadium

Low Emission and Technology Minerals November 2016

Vincent Algar

**Managing Director**

# Disclaimer

The views expressed in this presentation contain information derived from publicly available sources that have not been independently verified. No representation or warranty is made as to the accuracy, completeness or reliability of the information.

## Comment

It is common practice for a company to comment on and discuss its exploration in terms of target size and type. In addition surface sampling assays and drill sample results may also be discussed in the context of information describing the presence of anomalous metal content. The information relating to an Exploration Target should not be misunderstood or misconstrued as an estimate of Mineral Resources or Mineral Reserves. Hence the terms Resource(s) or Reserve(s) have not been used in this context. The potential quantity and grade is conceptual in nature, since there has been insufficient exploration to define a Mineral Resource. It is uncertain if further exploration will result in the determination of a Mineral Resource.

## COMPETENT PERSON REFERENCES

### Competent Person Statement – Metallurgical Results

The information in this statement that relates to Metallurgical Results is based on information compiled by independent consulting metallurgist David Pass B.Sc (Hons), Mr Pass is a Member of The Australian Institute of Mining and Metallurgy. David Pass is employed by Battery Limits Pty Ltd Mr Pass has sufficient experience which is relevant to the style of mineralisation and type of deposit under consideration and to the activity which is undertaken to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'.

Mr. Pass consents to the inclusion in the report of the matters based on the information made available to him, in the form and context in which it appears".

### Competent Person Statement – Mineral Resource Estimation

The information relating to the Gabanintha Project 2015 Mineral Resource estimate reported in this announcement is based on information compiled by Mr John Tyrrell. Mr Tyrrell is a Member of The Australian Institute of Mining and Metallurgy (AusIMM) and a full time employee of AMC (AMC Consultants Pty Ltd). Mr Tyrrell has more than 25 years' experience in the field of Mineral Resource Estimation. He has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and in resource model development to qualify as a Competent Person as defined in the 2012 Edition of the 'Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves'.

Mr. Tyrrell consents to the inclusion in the report of the matters based on the information made available to him, in the form and context in which it appears.

The information is extracted from the report entitled "Substantial high-grade vanadium resource highlights Gabanintha's world-class potential" released to ASX on 10 November 2015 and is available on the company website at [www.australianvanadium.com.au](http://www.australianvanadium.com.au). The company confirms that it is not aware of any new information or data that materially affects the information included in the original market announcement and, in the case of estimates of Mineral Resource or Ore Reserves, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcement continue to apply and have not materially changed. The company confirms that the form and context in which the competent person's findings are presented has not been materially modified from the original market announcement.

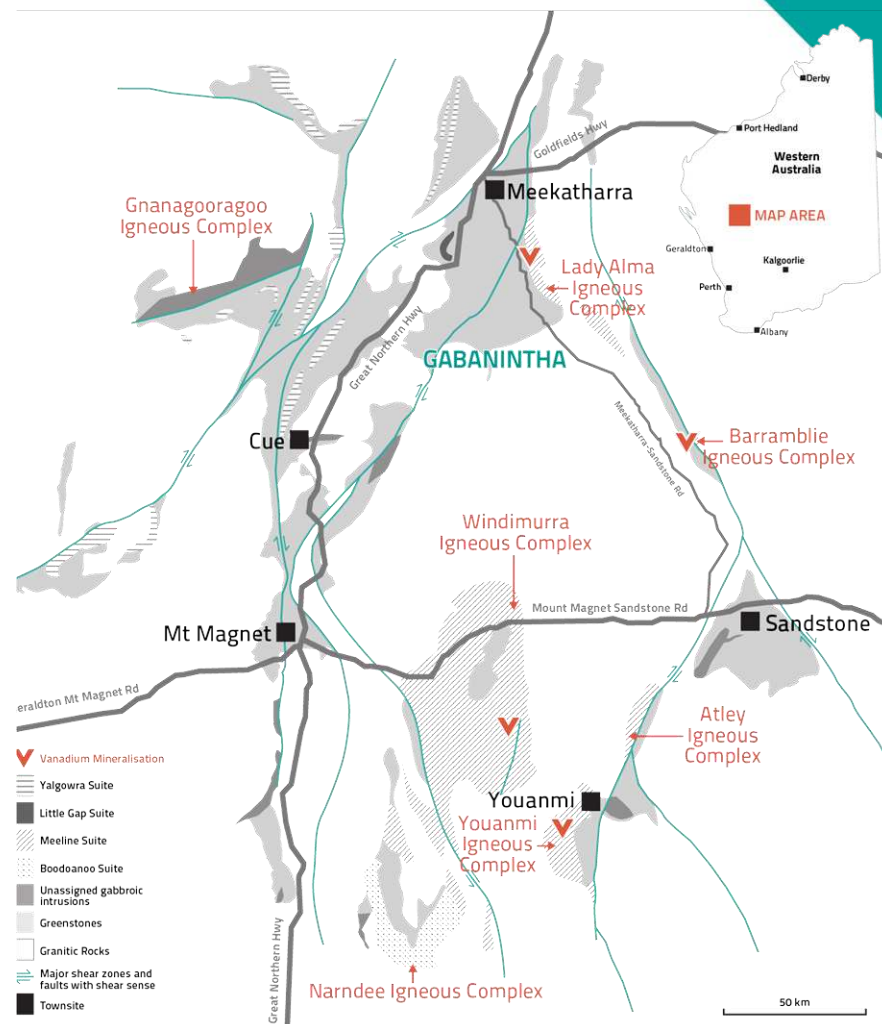
## Forward Looking Statements

This announcement may contain certain "forward-looking statements" which may not have been based solely on historical facts, but rather may be based on the Company's current expectations about future events and results. Where the Company expresses or implies an expectation or belief as to future events or results, such expectation or belief is expressed in good faith and believed to have a reasonable basis. However, forward looking statements are subject to risks, uncertainties, assumptions and other factors which could cause actual results to differ materially from future results expressed, projected or implied by such forward-looking statements. Such risks include, but are not limited to Resource risk, metal price volatility, currency fluctuations, increased production costs and variances in ore grade or recovery rates from those assumed in mining plans, as well as political and operational risks in the countries and states in which we sell our product to, and government regulation and judicial outcomes. For more detailed discussion of such risks and other factors, see the Company's Annual Reports, as well as the Companies other filings. Readers should not place undue reliance on forward looking information. The Company does not undertake any obligation to release publicly any revisions to any "forward looking statement" to reflect events or circumstances after the date of this announcement, or to reflect the occurrence of unanticipated events, except as may be required under applicable securities laws.



# AVL is an integrated Battery Metals Company

- Battery metals focused ASX listed company
- Active evaluation of a new, long-life vanadium project (Gabanintha) in Western Australia
- Significant project with large, high-grade Measured, Indicated and Inferred resources
- Vanadium energy storage market will disrupt traditional global vanadium supply
- Key agreements with battery suppliers and renewable energy installers to develop local market
- AVL offers investors exposure to entire vanadium energy storage value chain
- Focus offers leverage to rising vanadium prices and new applications in energy storage
- New Lithium project option offers further leverage to energy storage strategy

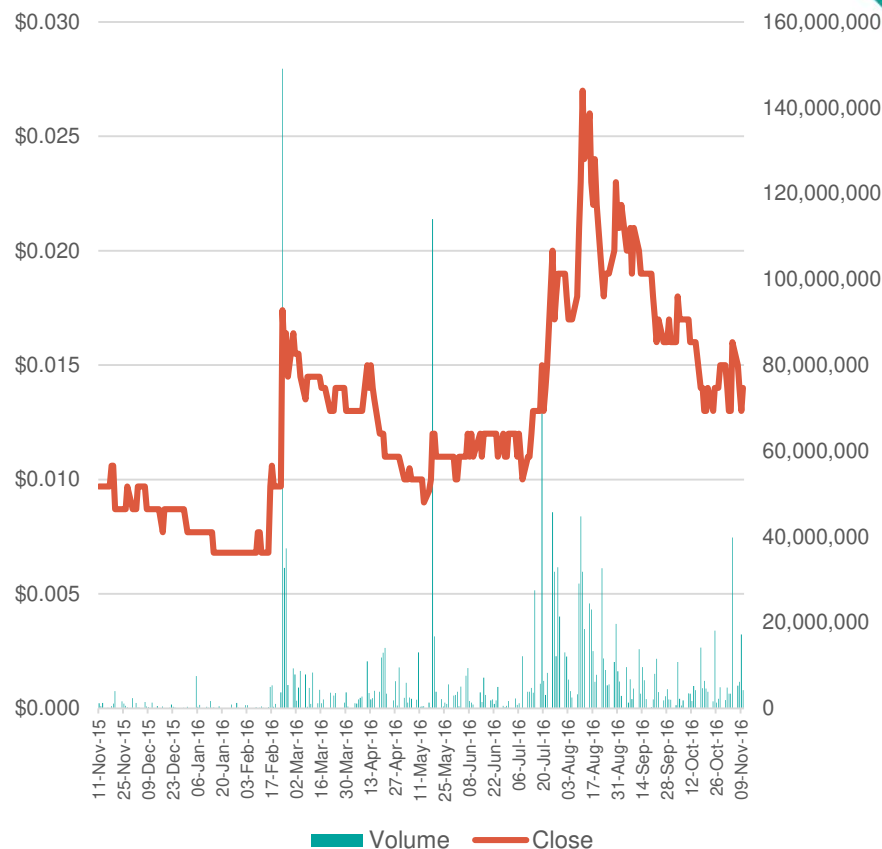


# Corporate Snapshot (ASX:AVL)

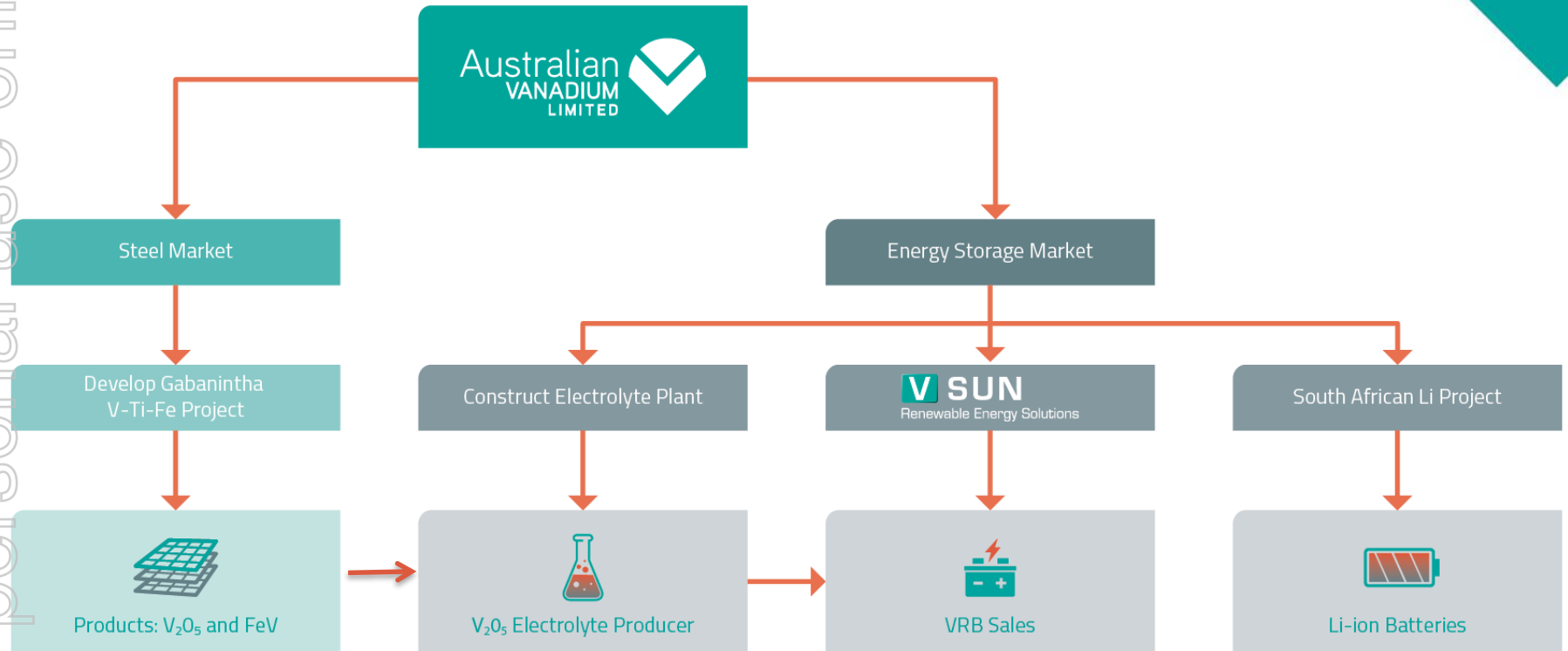
Capital structure and major shareholders

Key Statistics (as at 9/10/16)	
Ordinary shares on issue	1,100m
Options on issue (ex at 1.47c expire Dec 2017)	176.1m
Listed Options (ex at 2.c exp Dec 2018) AVLO	235.8m
Share price	AUD \$0.014
Market capitalisation (undiluted)	A\$15.4m (Cash ~A\$3.5m)
Shareholders	2,165
Substantial Shareholders	
Mr Neale Parsons	4 %
Management	7 %
Board of Directors	
<b>Vincent Algar</b> Bsc(Hons) Geol, MAusImm	Managing Director
<b>Leslie Ingraham</b>	Executive Director
<b>Brenton Lewis</b> MBSc., BBSec.(Hons)	Non Executive Chairman

AVL Share Price History

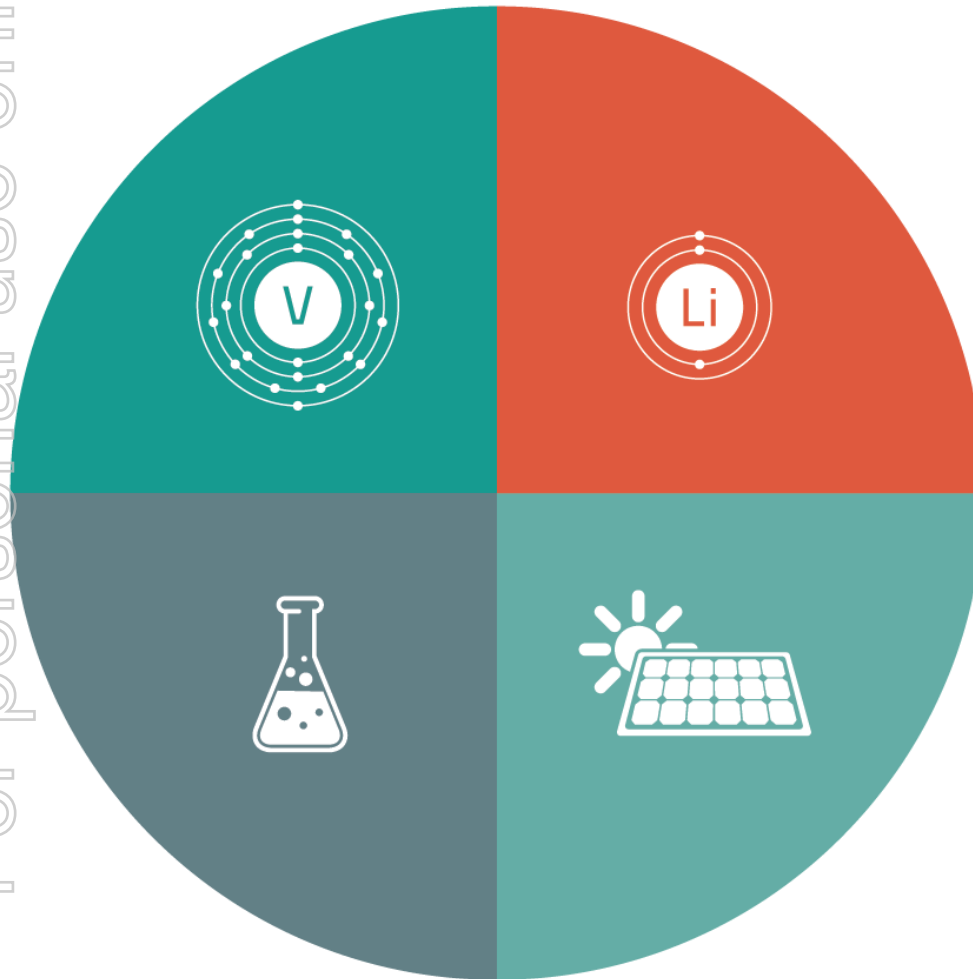


# AVL Vertical Integration Strategy



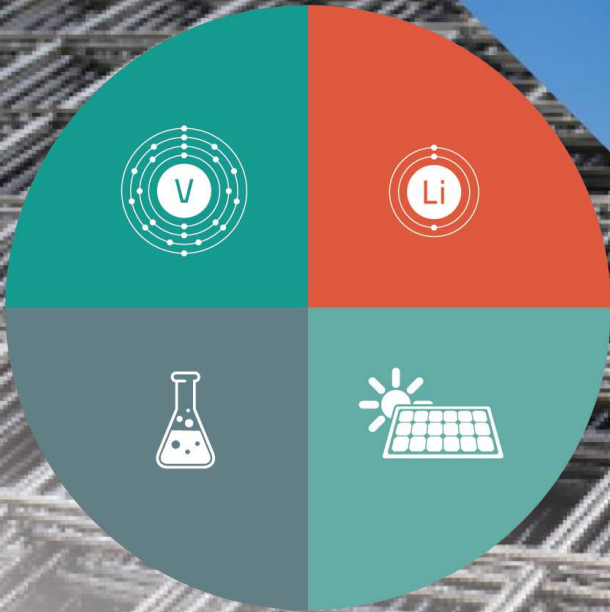
# Integrated Strategy

Diversified Action to Maximise Opportunity



-  Gabanintha Vanadium Project – Australia
-  Electrolyte Plant Development
-  VSUN Flow Battery Sales and Market Development
-  Lithium Project Development – Africa





# Vanadium Markets

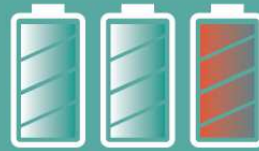
## Steel and Energy Storage

# Vanadium in Energy Storage

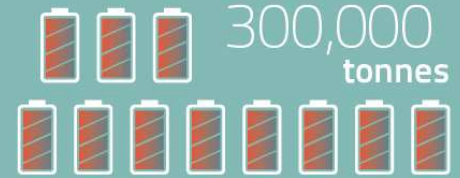
***“Energy storage has the potential to transform our entire energy system.” - Clean Energy Australia***



Battery storage capacity expected to grow to 185 Gwh in the next few years



62 Gwh (30%) of this market demand expected to be taken up by Vanadium Redox Batteries



Results in 300,000 tonnes of new demand for vanadium



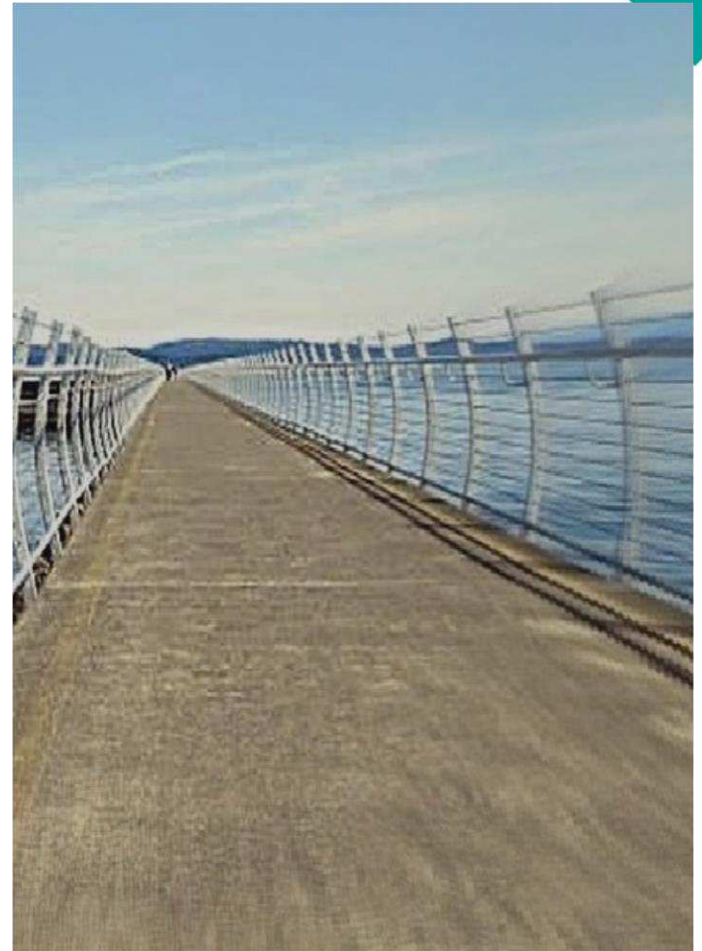
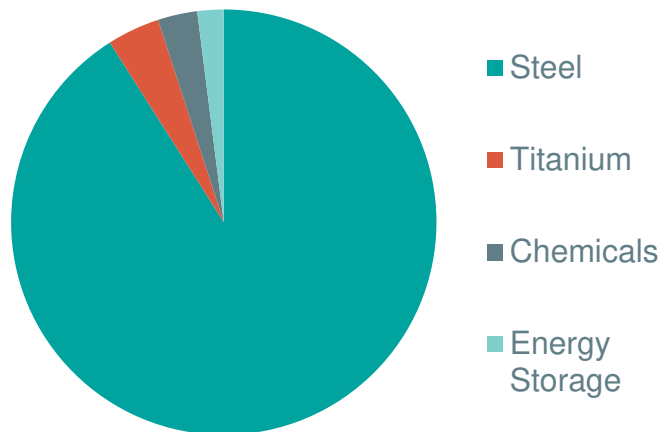
Renewable Energy Solutions



# Vanadium Markets - Steel

Despite reduced rate of steel production, demand for vanadium continues to grow. Steel remains a price driver for vanadium

- » Steel is primary market (92% of vanadium consumption)
- » Addition of 0.2% vanadium increases steel strength up to 100% and reduces weight up to 30%
- » Demand for use in rebar continues to increase at 6% annually (TTP Squared)
- » New markets in steel will increase demand such as;
  - › Materials for automotive, aviation and aerospace
  - › Power lines and power pylons
  - › High-strength steel structures



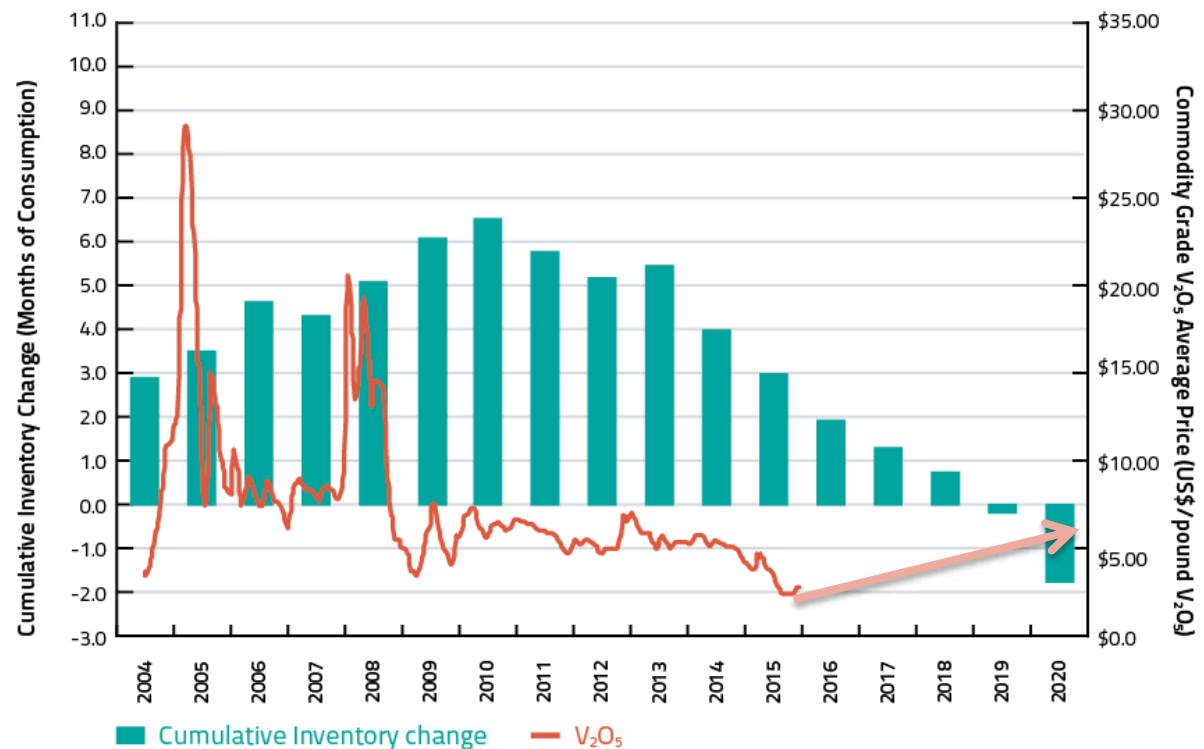
# Vanadium Markets - Overview

Supply and demand outlook offers compelling opportunity for early involvement – particularly with interest from Energy Storage

- » Upward price signals are clear from very recent data
- » FeV prices up between 36% and 41% in early 2016
- »  $V_2O_5$  prices up 18% in early 2016 with indications of deals up to 55% higher.
- » Supply under pressure with Highveld Steel (RSA) closed
- » Chinese FeV capacity constrained at present due to low demand in 2014/5
- » Rising prices give immediate improvement to Gabanintha Project economics due to its higher resource grades

(RN and MB via TTP Squared analysis)

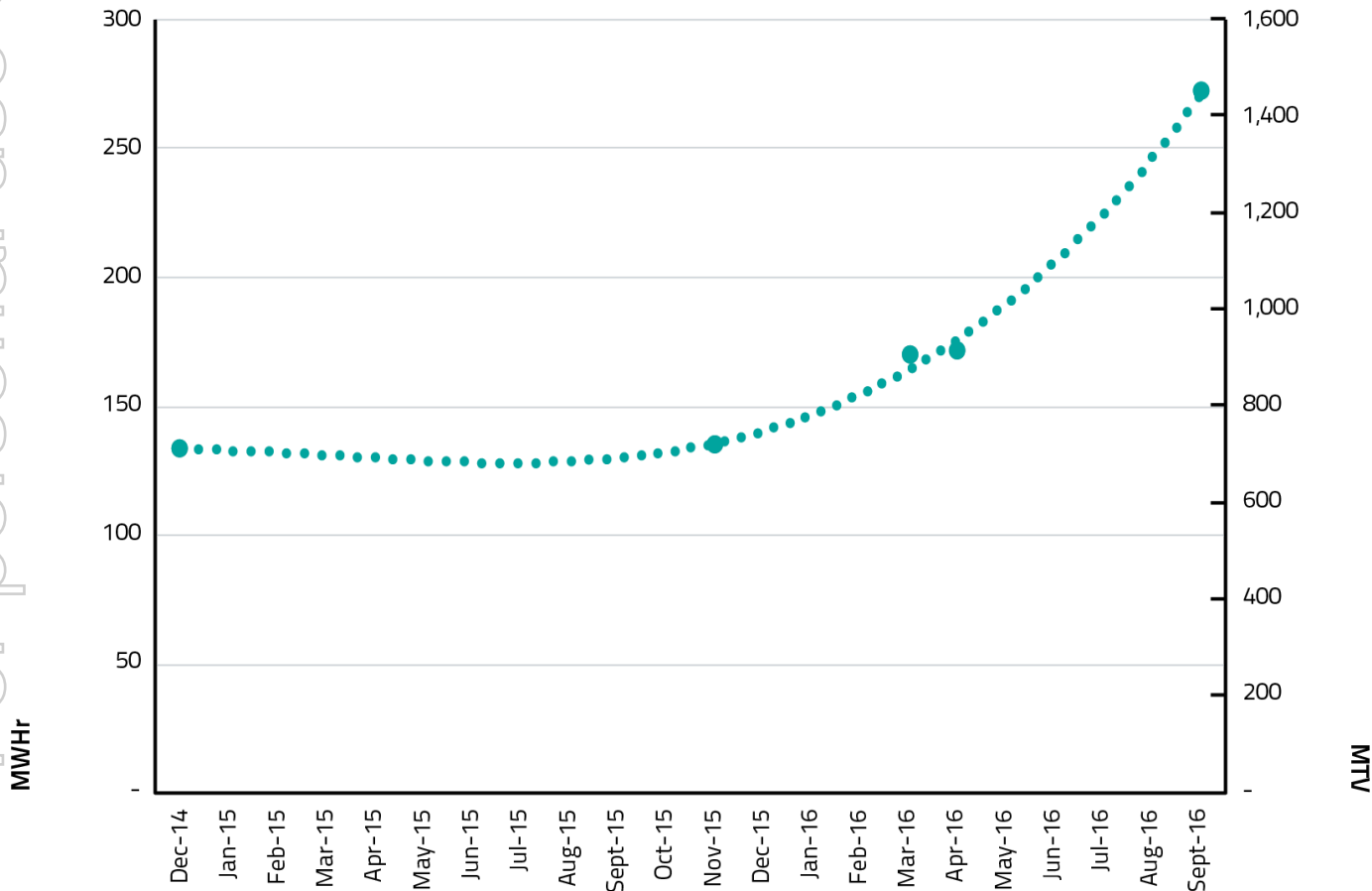
Global Vanadium Inventory Change vs  $V_2O_5$  Price



# Vanadium Markets - Overview

Impact of Energy Storage Demand (VRB and V cathode in Li-Ion) already significant

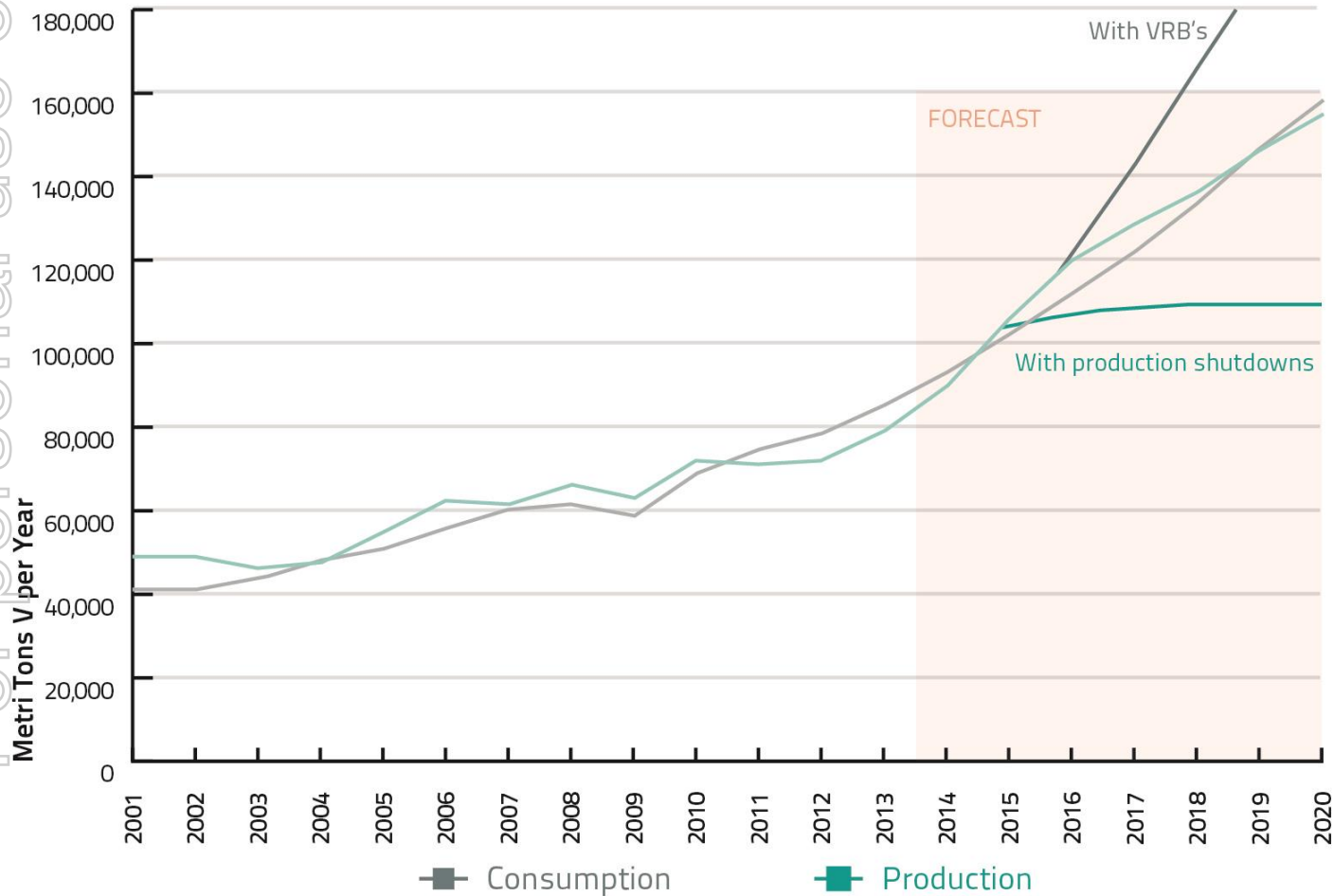
Source: DOE Energy Storage Database



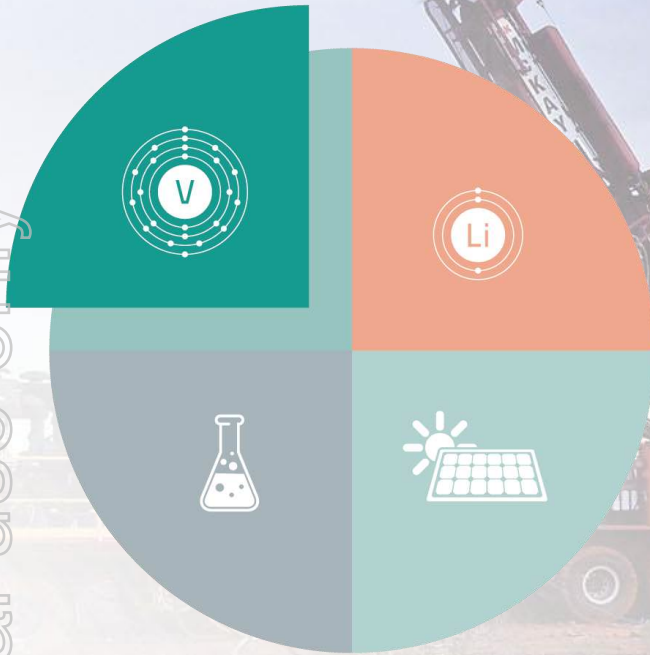
# Vanadium Markets - Overview

Impact of Energy storage demand on V-demand significant and disruptive

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# Globally Significant Project

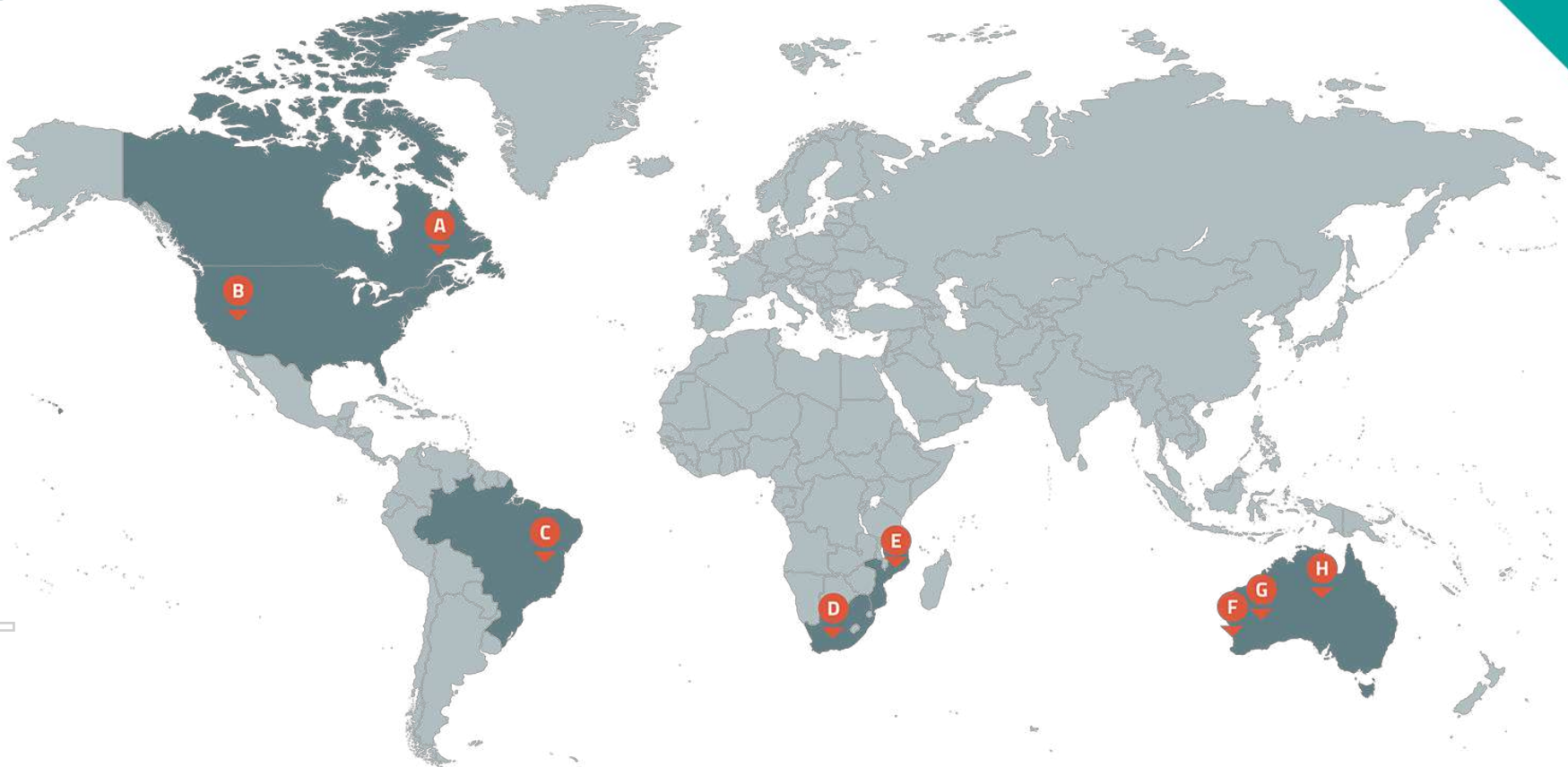
Gabanintha Vanadium Project in Western Australia



# Global Player

Gabanintha Project is significant development project on a global scale in grade and size

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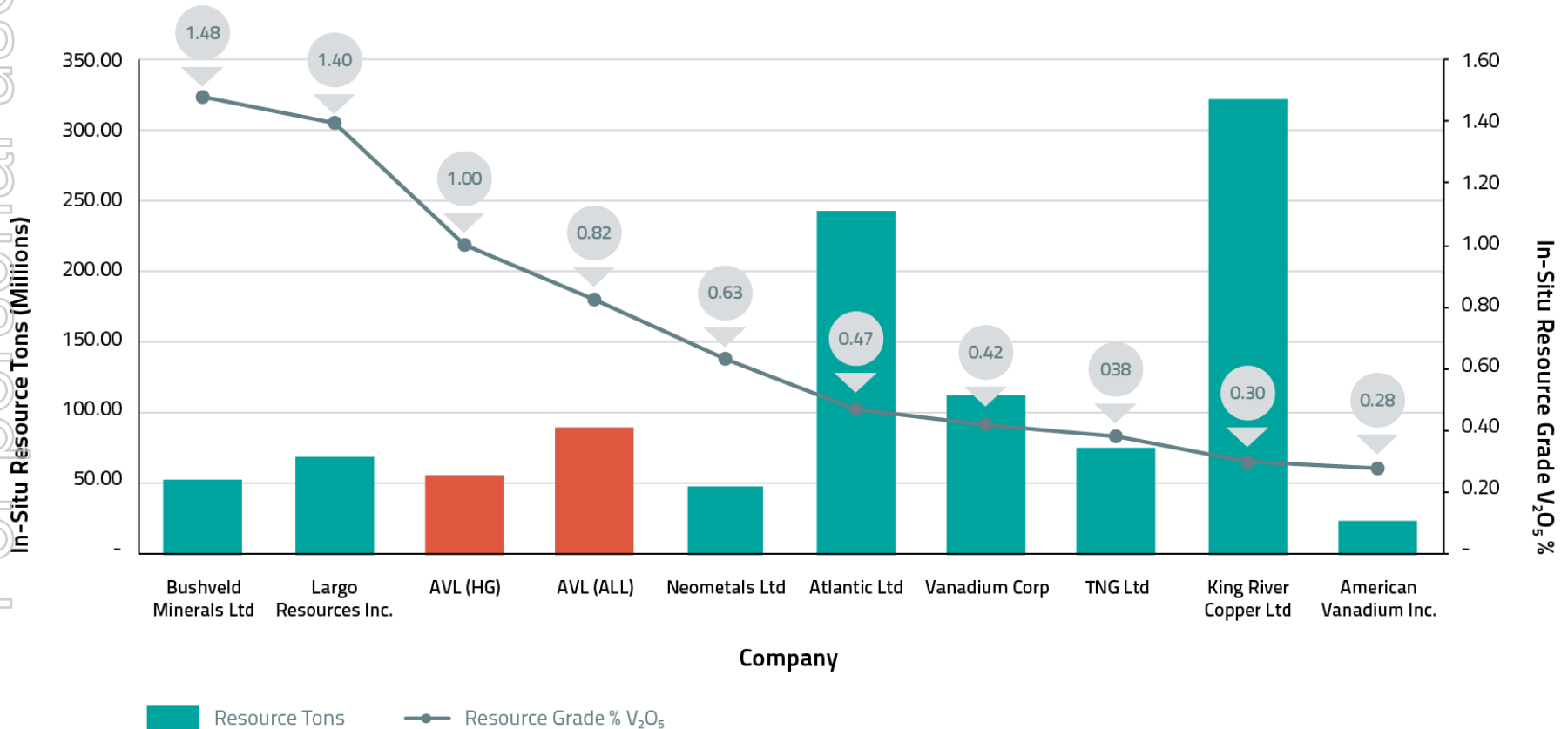


- |                          |                              |                          |                            |
|--------------------------|------------------------------|--------------------------|----------------------------|
| <b>A</b> Vanadium Corp   | <b>B</b> American Vanadium   | <b>C</b> Largo Resources | <b>D</b> Bushveld Minerals |
| <b>E</b> Syrah Resources | <b>F</b> Australian Vanadium | <b>G</b> Neometals       | <b>H</b> TNG Limited       |

# Vanadium Peer Comparison

Gabanimtha a globally significant deposit on grade and tonnage basis.

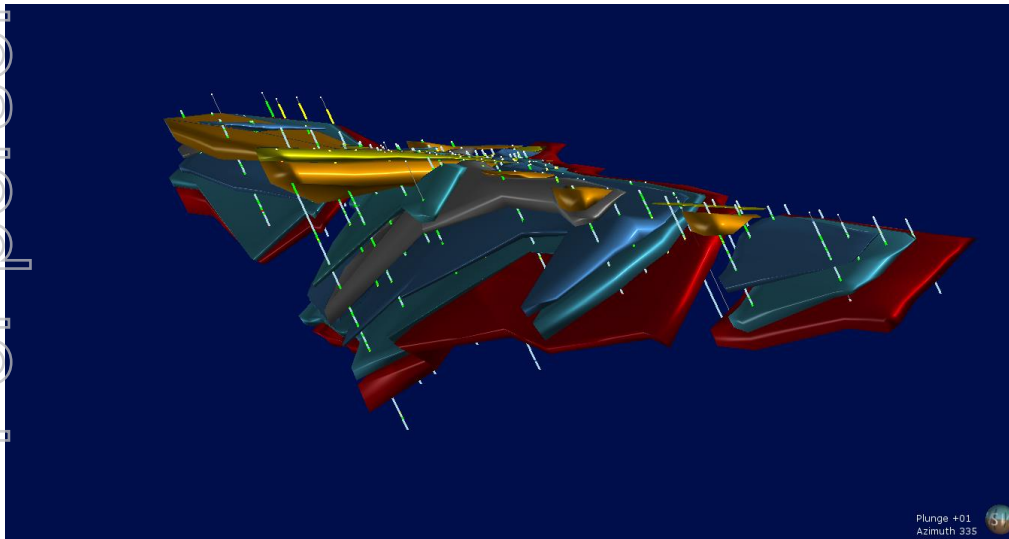
AVL Market Cap of \$15m compares to TNG Market Cap of \$110M and BMN \$17M.



# Gabanintha Vanadium Project

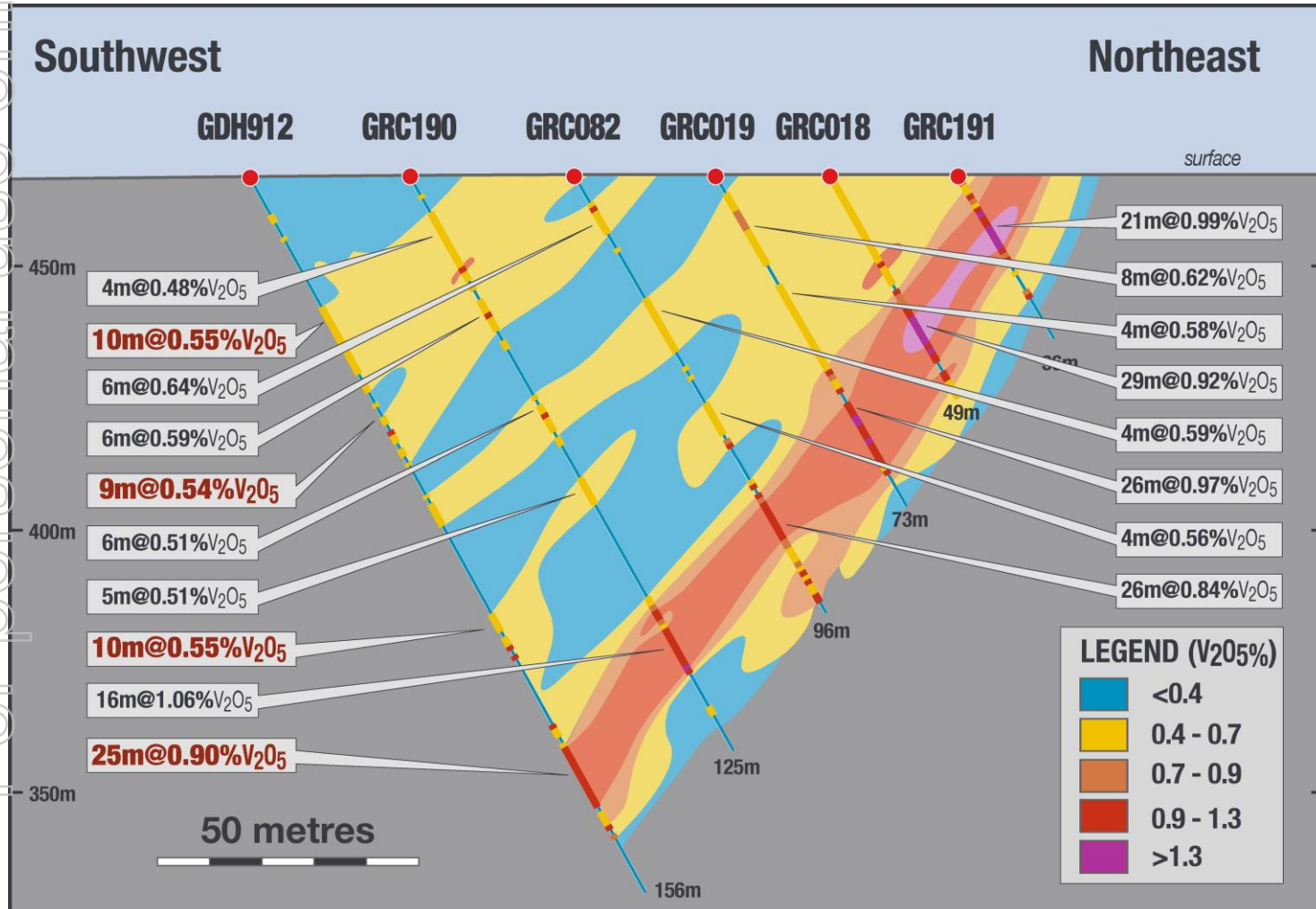
High grade resource in favourable mining jurisdiction in Murchison of WA

- » One of the highest-grade vanadium deposits currently being advanced globally;
  - › JORC 2012 compliant Total Resource of 91.4Mt @ 0.82%  $V_2O_5$ , 10%  $TiO_2$  and 35% Fe
  - › Separate high-grade Measured Indicated & Inferred Resource of 56.8Mt @ 1.0%  $V_2O_5$ , 11%  $TiO_2$  and 42% Fe
- » Deposit is at surface suitable for open pit operation and open at depth



# Gabanintha Vanadium Project

Discrete high-grade zone, simple geometry, suitable for open pit mining





# Vanadium Resource

## Large high-grade resource

Material	JORC Resource Class	Million Tonnes	In situ bulk density	V <sub>2</sub> O <sub>5</sub> %	Fe%	TiO <sub>2</sub> %	SiO <sub>2</sub> %	Al <sub>2</sub> O <sub>3</sub> %	LOI%
High grade	Measured	7.0	3.73	1.09	43	12	10	8	3.4
	Indicated	4.3	3.29	1.07	41	12	12	9	4.6
	Inferred	45.5	3.67	0.97	42	11	12	8	2.8
<b>Subtotal High Grade</b>		<b>56.8</b>	<b>3.65</b>	<b>1.0</b>	<b>42</b>	<b>11</b>	<b>12</b>	<b>8</b>	<b>3.0</b>
Low grade	Indicated	13.4	2.39	0.55	24	7	27	19	8.7
	Inferred	21.1	2.48	0.53	25	7	27	17	7
<b>Subtotal Low grade</b>		<b>34.6</b>	<b>2.45</b>	<b>0.53</b>	<b>25</b>	<b>7</b>	<b>27</b>	<b>18</b>	<b>7.6</b>
Subtotal Measured	Measured	7.0	3.73	1.09	43	12	10	8	3.4
Subtotal Indicated	Indicated	17.8	2.61	0.68	28	8	23	16	7.7
Subtotal inferred	Inferred	66.7	3.29	0.83	37	10	17	11	4.1
	<b>TOTAL</b>	<b>91.4</b>	<b>3.19</b>	<b>0.82</b>	<b>35</b>	<b>10</b>	<b>18</b>	<b>11</b>	<b>4.8</b>

Note: density values quoted here are weighted average values. The Mineral Resource was estimated as a block model within constraining wireframes based upon logged geological boundaries and grade cut-offs of 0.30% V<sub>2</sub>O<sub>5</sub> for Low Grade (LG) and 0.70% V<sub>2</sub>O<sub>5</sub> for High Grade (HG). Tonnages have been rounded to reflect that this is an estimate.

### Comment

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### Competent Person Statement – Mineral Resource Estimation

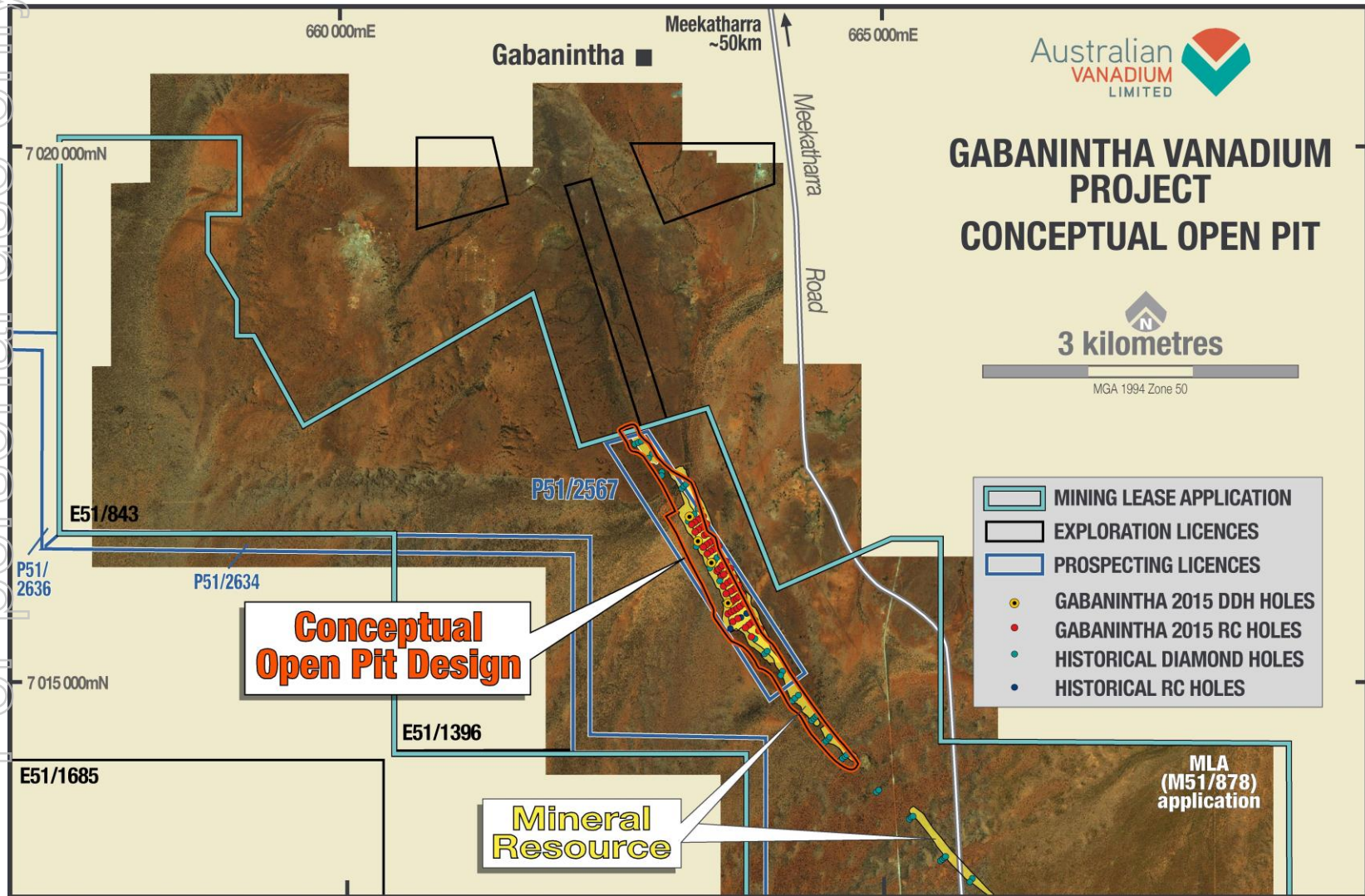
“The information relating to the Gabanintha Mineral Resource estimate was compiled by Mr John Tyrrell. Mr Tyrrell is a Member of the Australian Institute of Mining and Metallurgy (AusIMM) and a full time employee of AMC (AMC Consultants Pty Ltd). Mr Tyrrell has more than 25 years’ experience in the field of Mineral Resource Estimation. He has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and in resource model development to qualify as a Competent Person as defined in the 2012 JORC Code.

Mr. Tyrrell consents to the inclusion in the report of the matters based on the information made available to him, in the form and context in which it appears”.



# Gabanintha Vanadium Project

First pass internal optimisation shows significant potential



# Gabanintha Vanadium Project

## Updated Concept Engineering Study

### CONCEPT STUDY PARAMETERS – CAUTIONARY STATEMENT

The Concept Study in this presentation (nominal +/- 50% accuracy) is based on low-level technical and economic assessments, and is insufficient to support estimation of Ore Reserves or to provide assurance of an economic development case at this stage, or to provide certainty that the current conclusions of the Concept Study will be realised. While there is a high level of geological confidence associated with Measured and Indicated Mineral Resources, there is no certainty that further exploration and development work will result in the estimation of Ore Reserves.

The Company advises the Concept Study results reflected in this presentation are highly preliminary in nature as conclusions are drawn from the average grade of Measured, Indicated and Inferred Resources. A generic mining cost per tonne of material moved and an average resource grade has been used to determine overall mining and processing costs as opposed to a detailed mining block model evaluation to produce a detailed mining schedule.

### Forward Looking Statements

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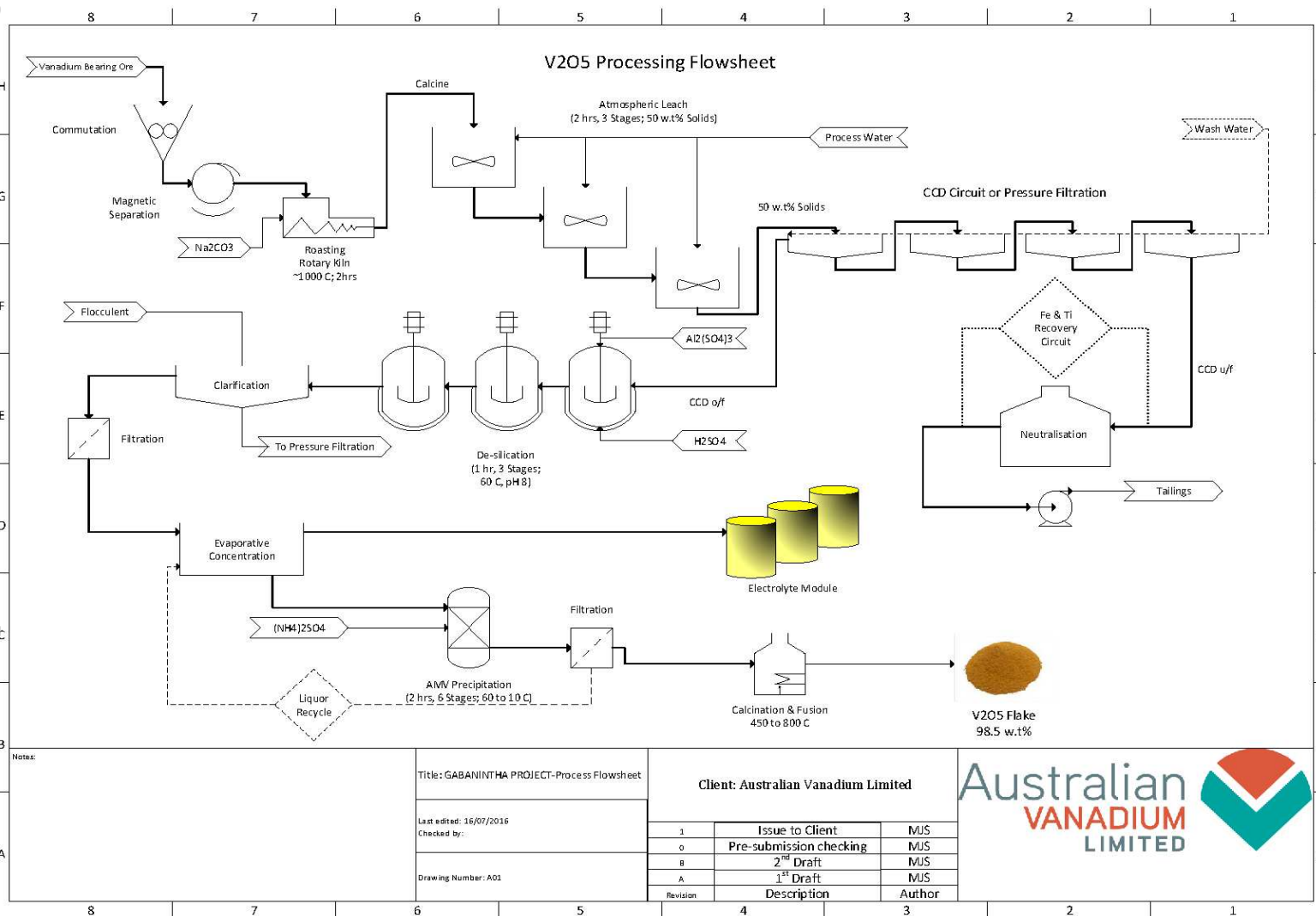
# Gabanintha Concept Study

Updated Concept Engineering Study supports move forward

- » **Results of study have satisfied the Board to advance the Project with further key studies.**
- » Studies to include roast-leach metallurgical work, resource update, detailed mining study, hydrology study, environmental studies and permitting work.
- » A detailed review of the commercial production of vanadium electrolyte will be undertaken.
- » Pit optimisation modelling undertaken for management purposes using internally generated inputs. Modelling recorded very positive results
  - › Contains 45.3 Mt mineralised material for processing and 86.8 Mt of waste material.
  - › Shell contains 45.3Mt @ 0.80%  $V_2O_5$  representing 49.6% of the total 2015 Mineral Resource Estimate (100% of the Measured and 99% of the Indicated)
  - › Represent 54% of the total Mineral Resource material within the pit shell
- » Production cases considered were potentially economically viable while treating feed material containing up to 50% oxide and low grades (0.5%  $V_2O_5$ ) with beneficiation pre-treatment.
- » Tailings residue contains high Ti and Fe values and has the potential to be reprocessed to produce saleable titanium oxide and iron oxide products.

# Gabanintha Concept Study

## Proposed Process Flowsheet



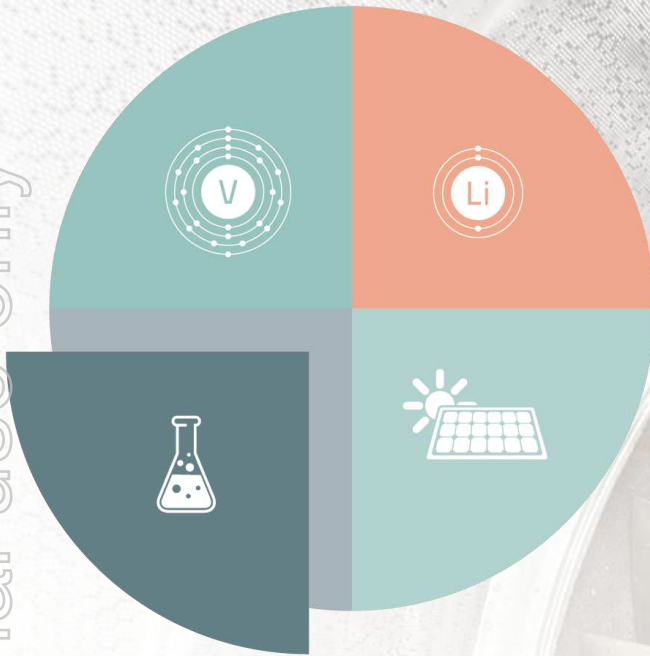
# Gabanintha Concept Study

Updated Concept Engineering Study supports move forward

PROJECT DESCRIPTION	MONTH									
	Oct 16	Nov 16	Dec 16	Jan 17	Feb 17	Mar 17	Apr 17	May 17	Jun 17	Jul 17
Resource Upgrade										
Mine Design										
Metallurgical Test Program										
Water Supply & Hydrology Studies										
Environmental Studies										
Environmental & Permitting Review										
Marketing and Offtake negotiations										

“The body of work that support’s AVL’s positive view on the Gabanintha vanadium/iron/titanium deposit continues to grow. The Company will now concentrate on key studies that reduce the risks for the project ahead of detailed feasibility studies. Water and environment are such areas. Along with the positive metallurgical test outcomes, the mining studies will assist us in marketing and offtake discussions which are essential for project development.”





# Vanadium Electrolyte

Integration from vanadium resources directly to  
energy storage products

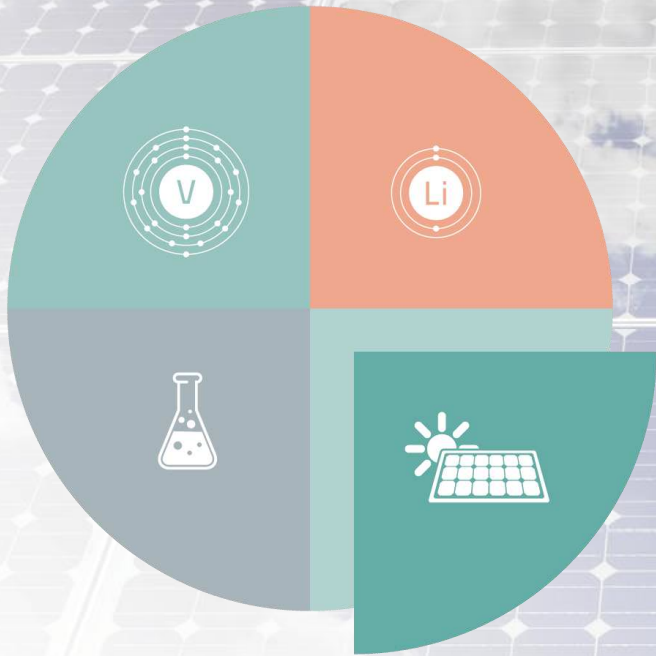
# Value Addition in V-electrolyte

Vanadium electrolyte production at the source de-risks and adds options

- » Vanadium electrolyte is battery “fuel”
- » Mild acid solution of  $V_2O_5$  with all oxidation states available for electron transfer.
- » Can be produced in stand-alone plant or as part of mine process.
- » Offers unique opportunity to value-add at source location for low cost
- » Local production leads to all-important reduction of battery TCO
- » Benefits target market by having local “supply” for imported battery units.
- » High re-cycle potential for vanadium units
- » Company advancing to stand alone commercial plant specification and development in 2017
- » Pilot plant due for commissioning in Perth in November 2016







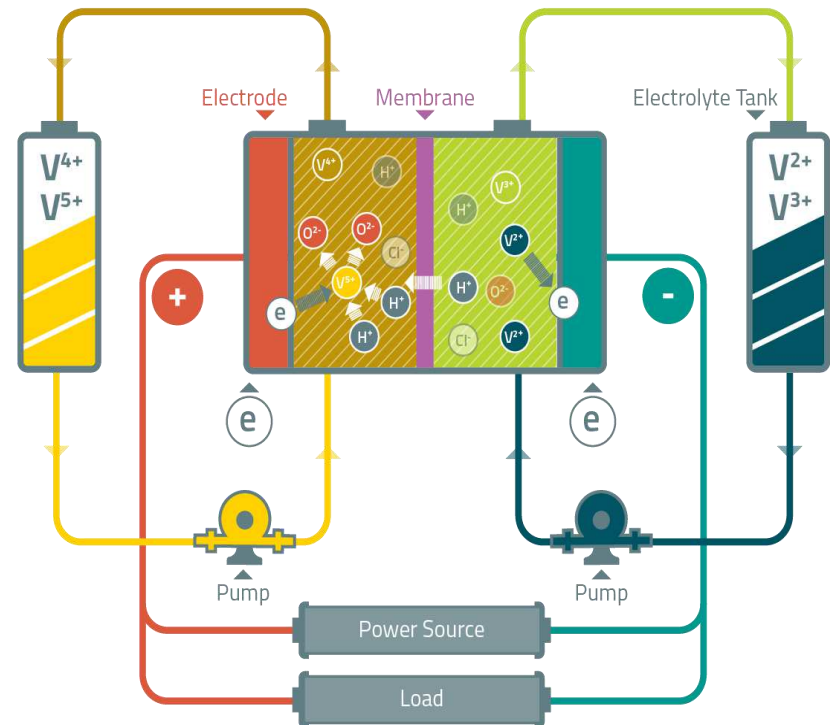
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# Vanadium in Energy Storage

# Vanadium in Energy Storage

## Unique characteristics of Vanadium Redox Batteries (VRBs)

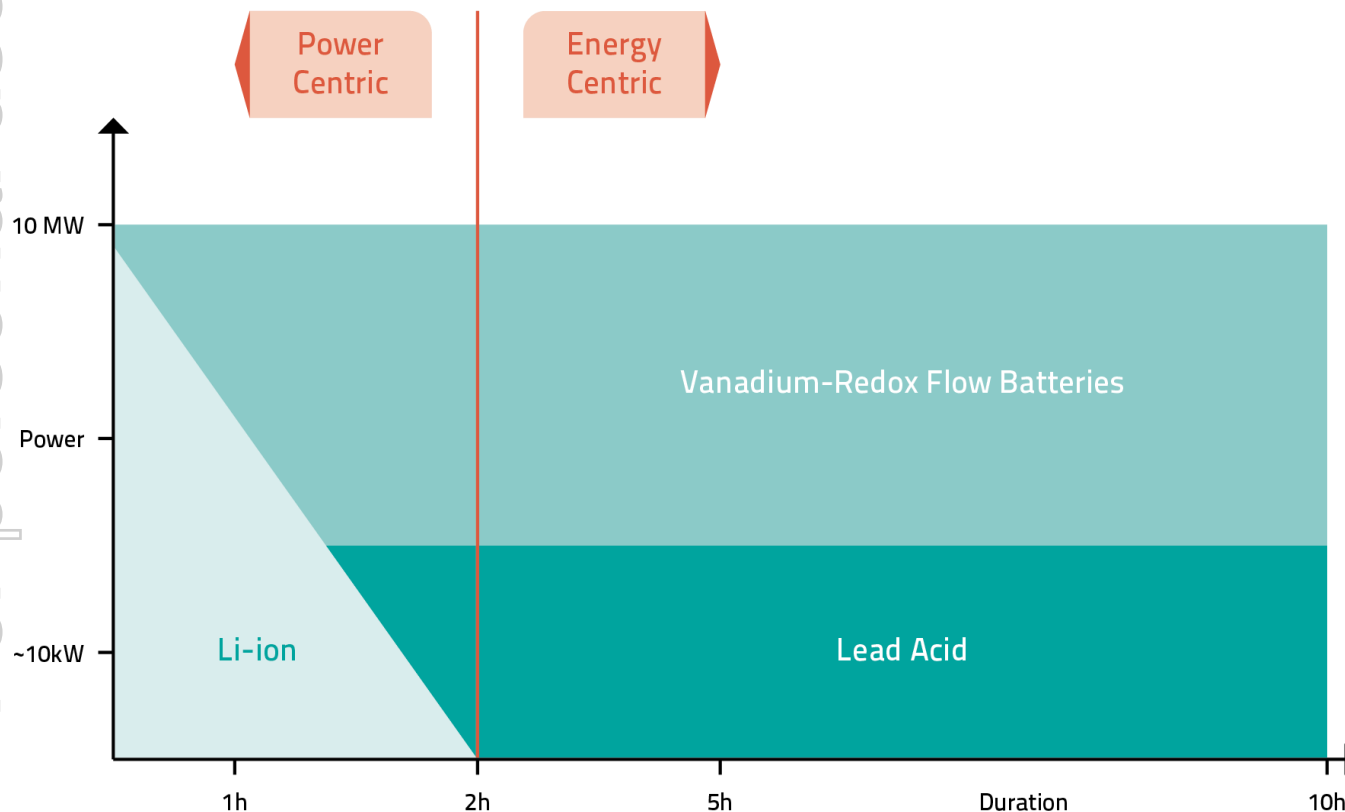
- » Flow battery technology well established and at commercial deployment status
- » VRBs provide a way to store and re-supply renewable energy. Their very high capacity is ideal for large-scale energy storage applications, unlocking the full potential of renewables while maintaining grid security.
- » VRBs have unique advantages over other batteries;
  - › Easily scaled into large MW scale solutions
  - › Lifespan of 20 years with very high cycle life and no capacity loss over time
  - › A key feature of using only one element in electrolyte,  $V_2O_5$  which can be re-cycled
  - › Immediate and rapid energy release
  - › Excellent charge retention (up to 1 year)
  - › Suitable for grid connection
  - › Can discharge 100% with no damage
  - › Improved safety and low replacement rate compared to Li-ion (lower lifetime LCOE)



# Vanadium in Energy Storage

Defining the space for flow battery technology

- » Vanadium Flow Batteries are Energy Batteries that provide a unique ability to significantly time-shift very large amounts of previously generated energy.



Source: GILDEMEISTER Energy Storage



# Vanadium vs Lithium : Key Comparisons

Vanadium Flow Battery	Lithium (Li-ion)
Energy Battery – Store large amounts of energy for later use	Power Battery – ideal for shorter term high power application
Energy stored in electrolyte tanks	All energy stored in cell
Stable – non-flammable	Flammable (prone to thermal runaway)
Long lifespan (20 years) due to very high cycle life. No degradation during cycling. (20,000 cycles)	Short lifespan (5-10 years) due to physical changes induced in charge discharge cycle (6000 cycles)
Vanadium electrolyte can be re-used, does not degrade (30% residual value)	Recycling difficult due to multiple components (no residual value)
Scalability – as modules or by introduction of larger tanks – fewer control systems	Multiple small batteries required – Complexity of control increases
100% depth of discharge with no lifetime capacity loss	Limited to 80% depth but with increasing capacity loss in high cycle environment

# Redox Battery Market Beckons in Australia

Can the VRB be the ultimate grid energy storage solution for Australia?

- » Rising power costs: VRB can reduce power bills by peak off-peak shifting and demand management
- » Australia has world's most extended networks: Many fringe-of-grid and off-grid opportunities exist
- » Battery storage strongly on political agenda: Efforts to reduce power price rises and carbon dependency
- » VRB rollout can assist with Australian networks primary goal – capital cost deferment
- » Australian storage market expected to grow to 3000MWh by 2030 (CEC Report 2012).
- » VSUN Energy actively identifying multiple large (+10kW to 250kW power, 100kWh to 2MWh and multiples) commercial storage opportunities being and in qualifying stages.







**V SUN**

Renewable Energy Solutions

## First CellCube Installation Completed

Rural site to benefit from Solar PV plus CellCube to shift to 90% renewable energy self consumption. First opening into large Australian market.

# Key Partnerships in Place to Grow Strategy

AVL is on track to achieving vanadium storage market objectives with excellent market and technology companies



- GILDEMEISTER energy storage GmbH developed the CellCube, the world's most commercially advanced Vanadium Flow Battery, based on 15 years of development with over 100 installations worldwide.
- MOU is in place for future co-operation in developing the Australian vanadium flow battery market .
- Signed Distribution Agreement for distribution of CellCube energy storage systems.



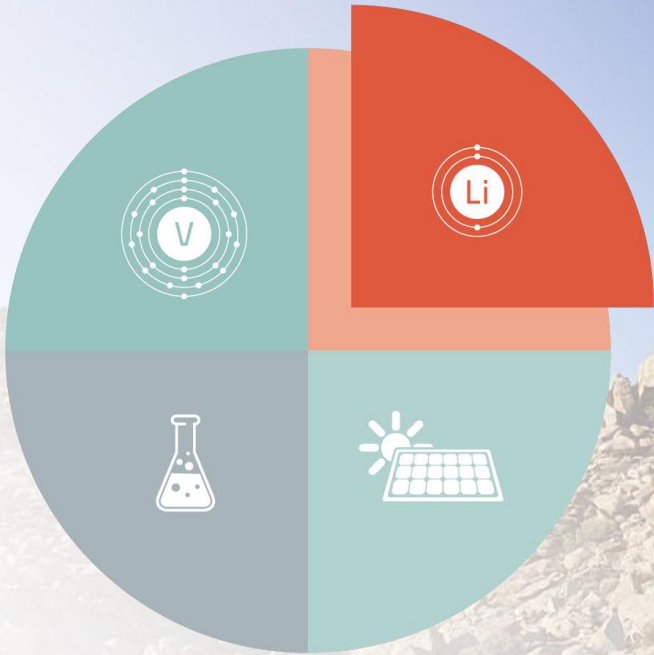
- Sun Connect is an Australia-wide commercial solar solution company, an appropriate partner for AVL in the installation of integrated solar and VRB solutions.
- Collaboration on VRB opportunities with installations throughout Australia.
- AVL and Sun Connect are actively evaluating several potential integrated solar and VRB installations throughout Australia.



- C-Tech Innovation is a UK research and technology company supply technology for electrochemical applications
- MOU is in place to collaborate on VRB opportunities installations throughout Australia.
- AVL and C-Tech will collaborate on building Vanadium Electrolyte plant capacity in Australia
- C-Tech will assist in the integration of electrolyte production capacity into the Gabanintha Project design.







# Lithium-Tantalum Project

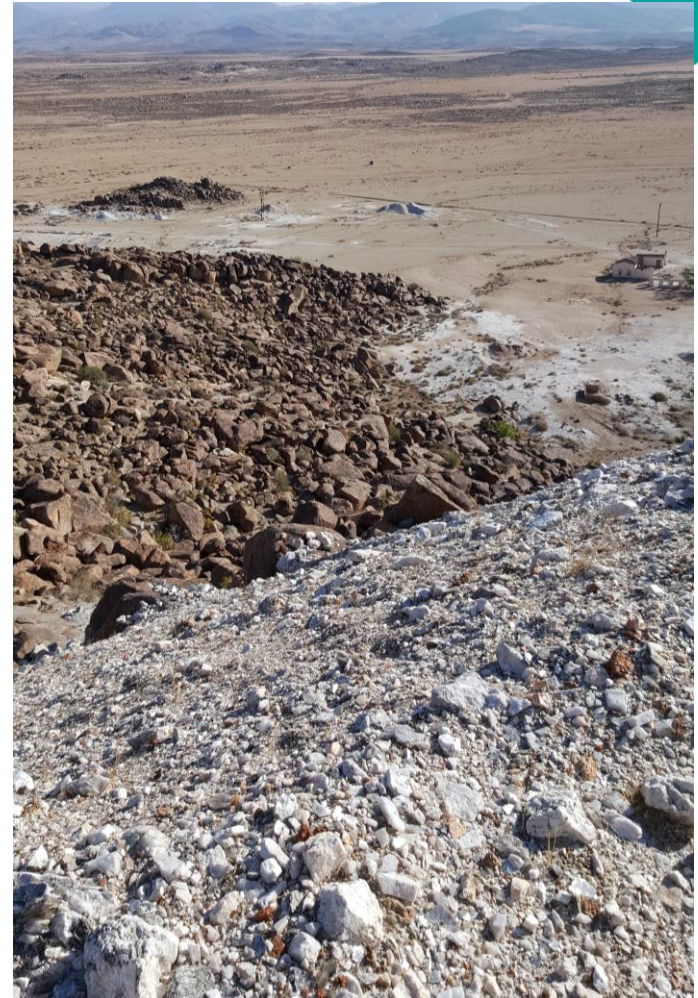
New project to add diversity to AVL and extend  
battery metal focus



# Blesberg Lithium-Tantalum Project Acquisition

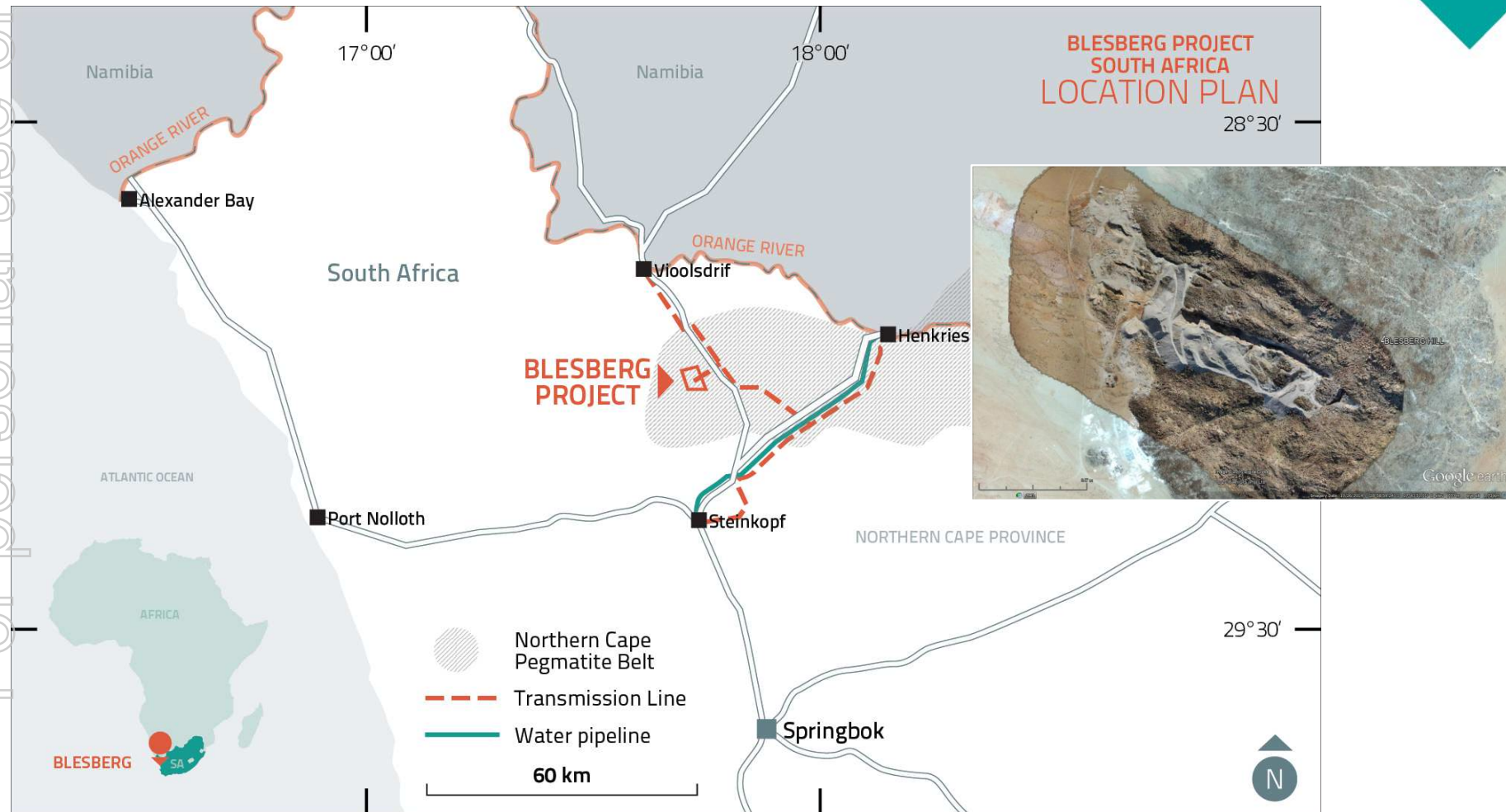
AVL broadens its focus on energy storage minerals

- » AVL secures option to acquire a minimum 50.03% interest in the Blesberg Lithium-Tantalum Project in South Africa.
- » AVL interest in the project may be increased to 74%.
- » Project acquisition includes the historic Blesberg Mine.
- » Blesberg Mine is one of the largest known mineralised pegmatite deposits in the Northern Cape pegmatite belt.
- » Historic production from Blesberg Mine includes spodumene concentrate (containing lithium), tantalite, feldspar, bismuth, beryl and mica.
- » Limited production information available however a 1960's feldspar shipment of 150 tons assayed 1.74%  $\text{Li}_2\text{O}$ .
- » Historical samples collected from Blesberg Mine open cut in 2013 assayed between 2.19% and 6.51%  $\text{Li}_2\text{O}$ .
- » Mine is located close to sealed highway access & is connected on-site to grid power.
- » First drilling programme at Blesberg Mine to be undertaken upon exercise of option.
- » Due diligence review well advanced



# The Blesberg Project

AVL broadens its focus on energy storage minerals



# Blesberg Lithium-Tantalum Project Acquisition

AVL broadens its focus on energy storage minerals

- » Consideration on exercise of option consists of:
  - › 70 Million AVL Shares;
  - › 80 Million Performance Rights over 2 milestones, and
  - › a conditional 1.0% net smelter return royalty.
- » Staged exploration earn-in phase consists of:
  - › payments split over 3 tranches totaling US\$1.0M, and
  - › exploration expenditure of US\$2.0M.
- » Shares and Performance Rights to be issued under AVL's existing placement capacity.

**AVL is expanding its focus on energy storage minerals, leveraging off its existing experience and ongoing activities in vanadium, a rapidly emerging energy storage metal.**

**Other AVL vanadium focused activities on Gabanintha Project advancement, pilot vanadium electrolyte plant commissioning and vanadium redox flow battery sales to continue unabated.**



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## Blesberg Lithium Project



# Australian Vanadium:

An active company advancing a unique integration strategy focused on energy storage

## Highlights

- » Quality, grade and tonnage of Gabanintha resource moving towards project development.
- » Detailed concept engineering study shows outstanding results to support project advancement. Key studies underway
- » Targeting vanadium steel producers and battery manufacturers for offtake and project involvement.
- » A commercial scale vanadium electrolyte plant is being considered for 2017 construction. Pilot plant to be commissioned in November 2016.
- » Sales agreement executed with global leader in Vanadium Battery Manufacture – GILDEMEISTER Energy Storage GmbH.
- » Collaboration with a leading Australian commercial solar installer.
- » 1:3 Rights Issue successfully completed, raising A\$3m for project and battery market activities. Over A\$1.2m raised from unlisted option exercise since raising.
- » Significant interest and demand identified for commercial scale solar and vanadium battery storage solutions in Australian urban and rural environments.
- » Planned acquisition of Li project an extension of energy storage strategy



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