



Expanding **vanadium** producer in Kazakhstan

MARCH 2019



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Corporate snapshot

Ferro-Alloy Resources Ltd

- Guernsey registered company
- All projects 100% owned
- Already a commercial vanadium producer
- Over 140 employees
- **No debt and no warrants or options outstanding**

Listed on the Kazakhstan Stock Exchange in 2017



- KASE Ticker: GG_FERR
- Over 150 shareholders, 28% of shares held by major institutions
- Crest registered

London Main Market IPO – March 2019 

Board

- CEO - Nicholas Bridgen
- Director of Operations - Andrey Kuznetsov
- Non-Executive director - Chris Thomas
- Non-Executive director - James Turian

Advisors



Overview

Ferro-Alloy Resources Group (“FAR”)

- FAR is already a vanadium producer
- Two major projects at the same Balasausqandiq site, with combined NPV of \$2 billion (\$4.5 billion at the current price)

1. Expansion of current processing operations (NPV 10% US\$73m, or \$216m at current price):

Operational treatment plant processing secondary vanadium materials. Already profitable

Low-cost expansion project already underway

2. The Balasausqandiq project (NPV US\$2.0 billion, or \$4.2 billion at the current price):

Develop the giant Balasausqandiq vanadium deposit and construct a new standalone processing plant

Unique geology provides a host of cost and metallurgical advantages versus typical vanadium deposits

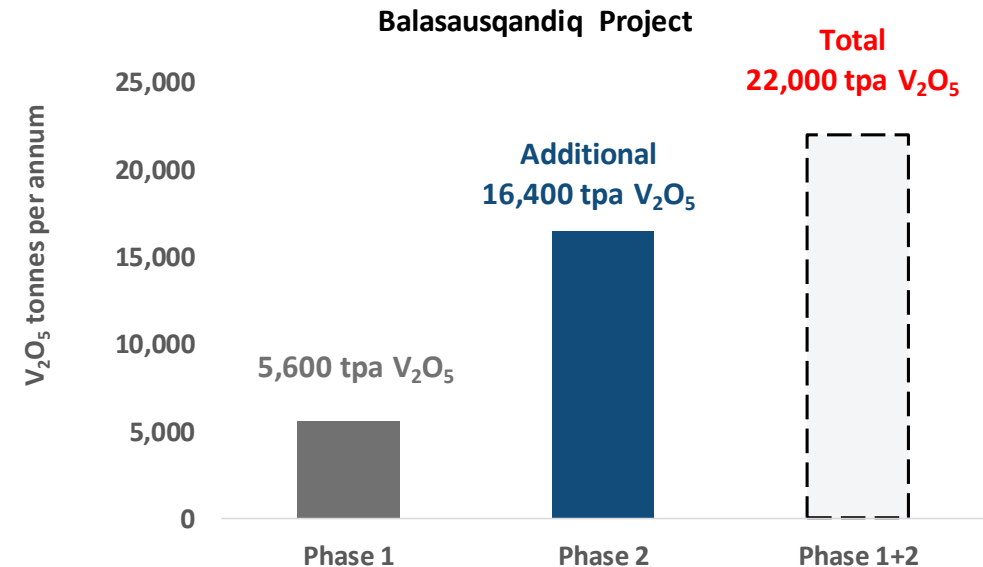
Potential to become one of the world’s lowest cost and largest vanadium producers

To be developed in parallel with the existing processing operation

Balasausqandiq project – the real prize

Development of the giant Balasausqandiq vanadium project

- NPV (10%) \$2.0 billion, IRR 89%, at forecast \$7.50/lb V_2O_5
- New standalone plant to be operated in parallel with the existing processing operation
- Phased expansion in two stages:
 - Stage 1 - Mining & Processing 1 Mtpa of ore, **capex \$100m**
 - Stage 2 - Expansion to 4 Mtpa of ore, **capex \$225m**
- Development will be phased so that each development contributes to the capex of the next phase - minimising shareholder dilution
- Balasausqandiq has the potential to one of the world's largest producers, and at the world's lowest cash cost of production



An NPV of \$2 billion for \$35m new equity

	Current processing operation US\$m	Balasausqandiq Phase 1 US\$m	Balasausqandiq Phase 2 US\$m
Equity	5	28	
Retained earnings	5	14	225
Corporate debt/bond issue		58	
Total capital required	10	100	225

Source: Competent Person's Report 12 November 2018; concept plan dependent on prices and trading conditions

Why FAR is special – in a nutshell

What's different from Largo, Bushveld and other primary vanadium producers?

- Balasausqandiq is not a titano-vanadiferous magnetite deposit – nearly all others are
- Our ore contains very low levels of iron oxide and carbonates (i.e. acid-consuming components)
- That means, unusually, the vanadium can be directly leached in sulphuric acid with low acid consumption

What impact does that have?

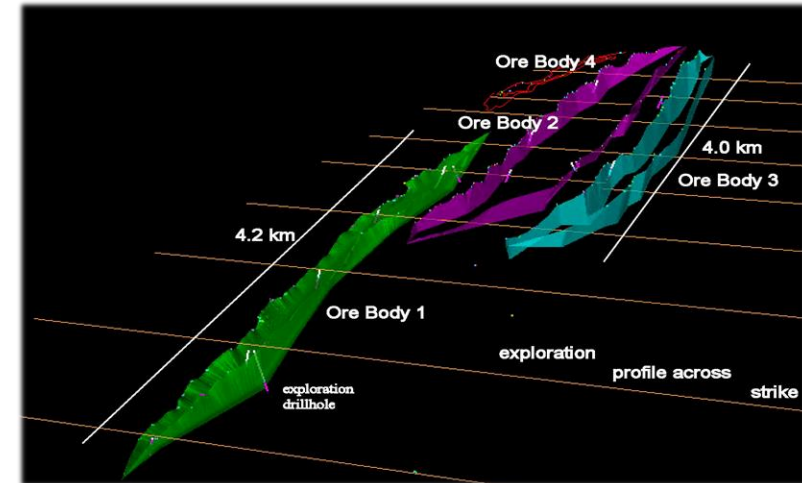
- No need to pre-concentrate the ore
- No need for high temperature roasting (typical salt-roast process requires roasting at 1,100 degrees C)
- **Reduces capital and operating costs by about 60%**
- **FAR should become the world's lowest cost producer**
- It means FAR's economic potential is in a different class from all the others – the usual metrics are not applicable

What else is good?

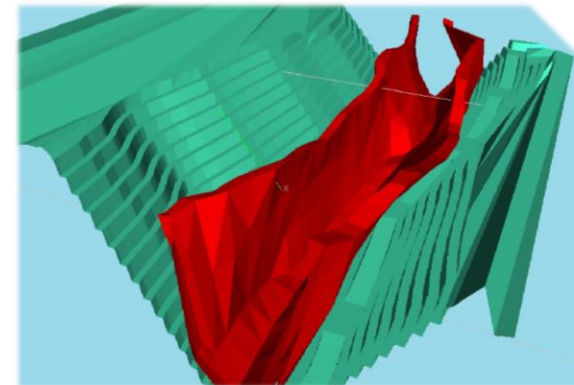
Not all vanadium deposits were created equal

- Outcrops at surface, open pit with no pre-strip required
- Very large, with huge exploration potential
- Constant grade with little tectonic alteration, visible geological cut-off makes for easy mining
- Simple, low risk flow-sheet with low capital expenditure to build
- Low acid consumption, access to cheap sulphur
- Low input costs in Kazakhstan e.g. labour, power
- Low corporate tax rates, incentives include a tax holiday for the processing operations
- Existing operations with experienced work-force
- All major infrastructure existing – excellent roads, high voltage power line

Orebodies 1-4



Typical cross-section



Vanadium – used in steel but also Energy Storage

Vanadium Redox Flow Batteries (“VFBs”) are the solution to large scale, long discharge, energy storage

- The replacement of fossil fuels with solar and wind power requires energy storage to cope with intermittency
- Typical use is for charging in the day from solar and near-full discharge in the evening and overnight
- Lithium-ion batteries are unsuitable for this purpose
- VFBs have indefinite life with no degradation over time or in use, so give the lowest levelized cost
- Being rolled out at large scale world-wide but particularly in China
- FAR is the only potential primary vanadium supplier that can meet this demand at relatively low capital cost and at a price that allows the VFB industry to develop
- Suitable for national grid use and for microgrids in remote locations

Balasausqandiq – resources and potential

- JORC Resource is based on only one orebody (OB1)
- Substantial JORC Exploration target based on additional orebodies (OB2-OB5) – all of which outcrop

Orebody	Category (JORC 2012)	Tonnes (Mt)	V ₂ O ₅ (%)	MoO ₃ (%)	U ₃ O ₈ (%)	REM (ppm)	C (%)	V ₂ O ₅ (tonnes)	V ₂ O ₅ % equiv.
OB1	Indicated primary ²	21.4	0.67	0.03	0.009	-	14.1	143,380	0.91
OB1	Inferred oxide ¹	1.3	0.89	-	-	-	-	11,570	
OB1	Inferred primary ²	1.6	0.67	0.03	0.009	335	13.4	10,720	0.91
	Total	24.3	0.68	0.03	0.009	335	13.6	165,670	
OB2-OB5	Exploration target ³	85.5	0.68	0.03	0.009	335	13.6	581,400	
	Total	109.8	0.68	0.03	0.009	335	13.6	747,070	
Locally approved (non-JORC)		15.9	1.02	-	-	-	-	162,144	
Overall Total		125.7	0.72	0.03	0.009	335	13.6	909,214	

¹ Oxide ore based on bulk density 1.7

² Primary ore based on bulk density of 2.4

³ Mean of range estimated by FAR's independent geologist. GBM CPR, 12 November 2018

⁴ If the by-product potassium alum were included, the equivalent V₂O₅ grade would rise to 0.98%

Balasausqandiq - reserves

JORC - Ore body 1 only:

Category	Reserve Tonnes (000)	Mean grade V ₂ O ₅ [%]
Probable	22,938	0.59

Note that the economic analysis contained in the Competent Person's Report by GBM of 12 November 2018 includes inferred by-product grades of carbon, uranium oxide, molybdenum oxide, together with and additional 3.1m tonnes of inferred vanadium resource contained within the designed ultimate open pit shell, giving a total expected ore tonnage from OB1 of 26m tonnes, at a stripping ratio of 4.2:1

GKZ – Kazakhstan's reserve reporting framework

Category	Reserve Tonnes (000)	Mean grade V ₂ O ₅ [%]
B	832	1.0
C1	15,649	0.75
C2	54,366	0.74
B + C1 + C2	70,847	



Valuable by-products

As well as being low in deleterious elements, Balasausqandiq's ore contains valuable by-products:

- **Carbon-silica** – carbon can be concentrated to make carbon black, used in the manufacture of rubber, \$12bn global market, selling for several thousand dollars per tonne depending on grade. Carbon-silica mix can be briquetted to make ideal feed for ferro-silicon smelting
- **Uranium / molybdenum** – bulk concentrate. Kazatomprom has a statutory first right to purchase uranium products in Kazakhstan
- **Potassium alum** - market in China in the chemicals, medicinal, culinary industries and for water purification
- **REE concentrate** – currently excluded from base-case due to depressed market, but potential for the future

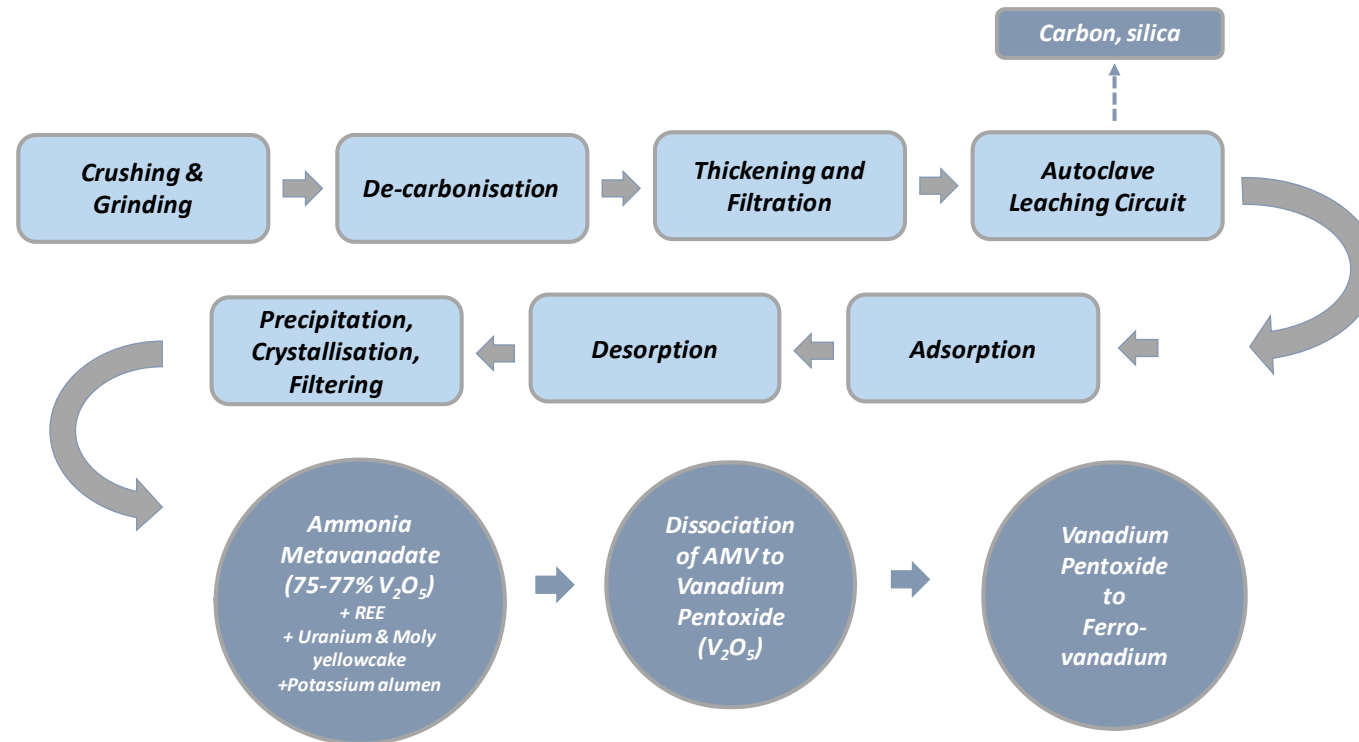
By-products at Balasausqandiq have the potential to boost revenue per tonne significantly

Product	Projected revenue per tonne of ore (\$/t)
Vanadium (V_2O_5) @\$7.50/lb	93
Carbon-silica flux	26
Uranium (UO_3)	3
Aluminium/potassium	10
Molybdenum (MoO_3)	4
Total	135

All of the ore can be utilised for saleable products – the Company aims to have no tailings from the process plant

Balasausqandiq processing

Straightforward process flowsheet, tested in a 15,000 tonnes per year pilot-plant



Leadership

Nicholas Bridgen Chief Executive

- Chartered Accountant, lives in Kazakhstan and speaks fluent Russian. Nick has led Ferro-Alloy Resources Limited since 2010
- 14 years with Rio Tinto group in various roles, finally as Group Planning Manager with the Pillar engineering and chemical companies group
- 25 years' board level experience with companies operating in the FSU including Chief Executive of Hambledon Mining plc

Andrey Kuznetsov Director of operations

- Degree in Engineering from the Moscow State Technical University and a doctorate in non-formal mathematical logic. Native Russian and English speaker
- Ex-Chief of the Scientific Department in Central Committee of Youth (Comsomol).
- Ex-General Director of Kontakt Research and Development.
- General Director of TOO Firma Balausa since 1996 and author of over ten patents in vanadium treatment technology

Chris Thomas Non-Executive Director

- Chairman of I&S BBDO in Japan
- Previously CEO of BBDO in the Americas and Chairman of I & S BBDO in Japan
- CEO of BBDO in Asia, Middle East and Africa, 2006 – 2015

James Turian Non-Executive Director

- Accounting and Trust Management Background. Chartered Fellow of the Securities Institute IAQ and a Fellow of the Institute of Directors
- Director and majority shareholder of Accounts For You Limited, a Guernsey accountancy firm, as well as several other directorships

Management

Alexander Fofanov **Technical director TOO Firma Balausa**

- Degree in Chemistry, PhD in the research and development of vanadium extraction. Expert in the technology of vanadium production
- Tenure with the Central Research Metallurgical Institute in Moscow, MD of Tula Vanadium
- Previously Director of technical support for vanadium assets at the Evraz Group

Oleg Shulepov **Production director TOO Firma Balausa**

- Mechanical engineer
- Majority of career spent at Tula Vanadium and the Evraz group, most recently as Chief Manager of the Project Management Department.

Tony Thornton **Director of Balasausqandiq project**

- Mining engineer from Camborne School of mines
- Previously Director of Iluka's Kazakhstan operations and before that, Managing Director of SRK's Kazakhstan office following an extremely varied career in the mining industry

Allan Davidson **Director of Energy Metals Limited, UK holding company of processing operations**

- PhD in theoretical physics from King's College, Cambridge. Fellow of the English Institute of Chartered Accountants.
- Career in investment banking and with US multinational companies. Over 20 years' experience with PwC

Location

Excellent regional infrastructure

- ✓ **Brownfield:** as FAR has an operating vanadium plant, significant site infrastructure is already in place
- ✓ **Logistics:** excellent links to China, Russia and Europe
- ✓ **Power:** connected to grid , now connecting to nearby HV line
- ✓ **Water:** readily available sources
- ✓ **Terrain:** unpopulated area, no agricultural use
- ✓ **Roads.:** 70km sealed road runs from near site to Shieli and motorway standard roads from Shieli into Europe, Russia and China
- ✓ **Rail:** Mainline railway station located in Shieli
- ✓ **Silk Road Economic Belt:** corridor of roads, rail, energy and telecommunications infrastructure linking China to Europe and passing through southern Kazakhstan



Attractive operating environment

Kazakhstan is an attractive jurisdiction

- Stable democratic government
- Already a major exporter of metals and minerals
- Attractive fiscal regime – 20% corporate profits tax
- No requirement for government free-carry or local ownership
- Subsoil use law updated in 2018 based on international practices

Strong government support

- Investment Incentive Agreement signed with the Government
- Main incentives given in respect of processing operations:
 - 0% tax until 2026
 - Property tax exemption until 2024



Ministerial Visit to Balasausqandiq - November 2013

79% operating margin

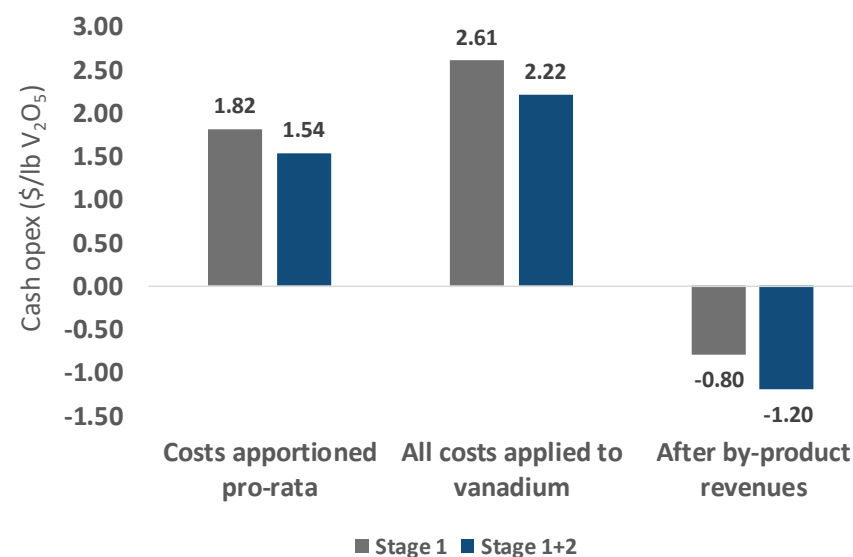
Base-case financial analysis shows that Balasausqandiq will be a highly profitable operation

Base-case uses \$7.50/lb V_2O_5 , well below the current low price of \$16.25/lb (1 February 2019)

Highly competitive cash costs

Operating margin (mining & processing own ore only, after all expansions)	\$7.50/lb V_2O_5
Revenue per tonne treated	135
Opex per tonne treated (inc. royalties)	28
Operating profit per tonne treated	107
Operating margin	79%

Balasausqandiq cash operating cost (inc. royalties and G&A)
per lb of V_2O_5



Current processing operations

FAR currently operates a vanadium processing plant which treats purchased vanadium-containing concentrates and raw materials.

Currently profitable at small scale

\$10m expansion of the current operation is underway to expand production, allow the plant to treat a wider range of higher grade vanadium-containing feedstocks and to produce higher-value products

- Production will step up incrementally with only minor shutdowns
- Requires only minor process changes

Current production	144 tpa V_2O_5
Expanded production	1,500tpa V_2O_5
V_2O_5 price assumption/lb	2019: \$13, 2020: \$10 then \$7.50
NPV (10%) of expansion project	\$73m, IRR 242%
Net annual cash flow (2021 – 2026)	\$9.7m p.a



FAR's current processing facility at Balasausqandiq

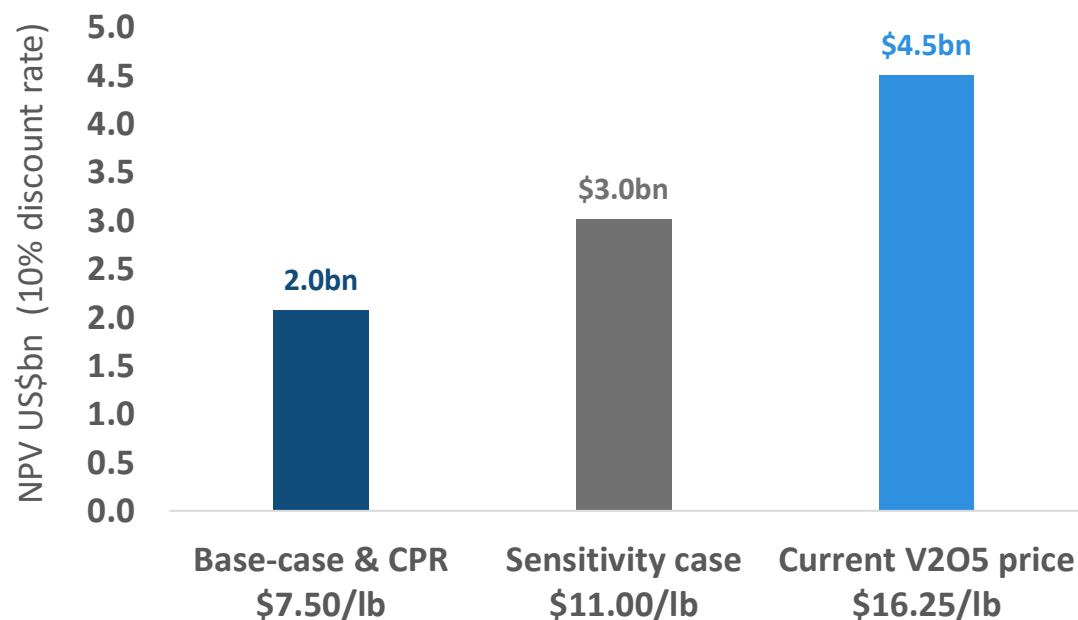


Financial analysis (combined projects)

NPV^{10%} for combined projects **\$2.0billion** (at \$7.50/lb V₂O₅ from 2021)

Overall project IRR = **96%**

NPV^{10%} **\$4.5 billion** at current low vanadium price of \$16.25/lb



Driven by
high-margins



\$1.54/lb

Balasausqandiq
Stage 2 opex
per lb V₂O₅

\$16.25/lb

Current low
V₂O₅ price

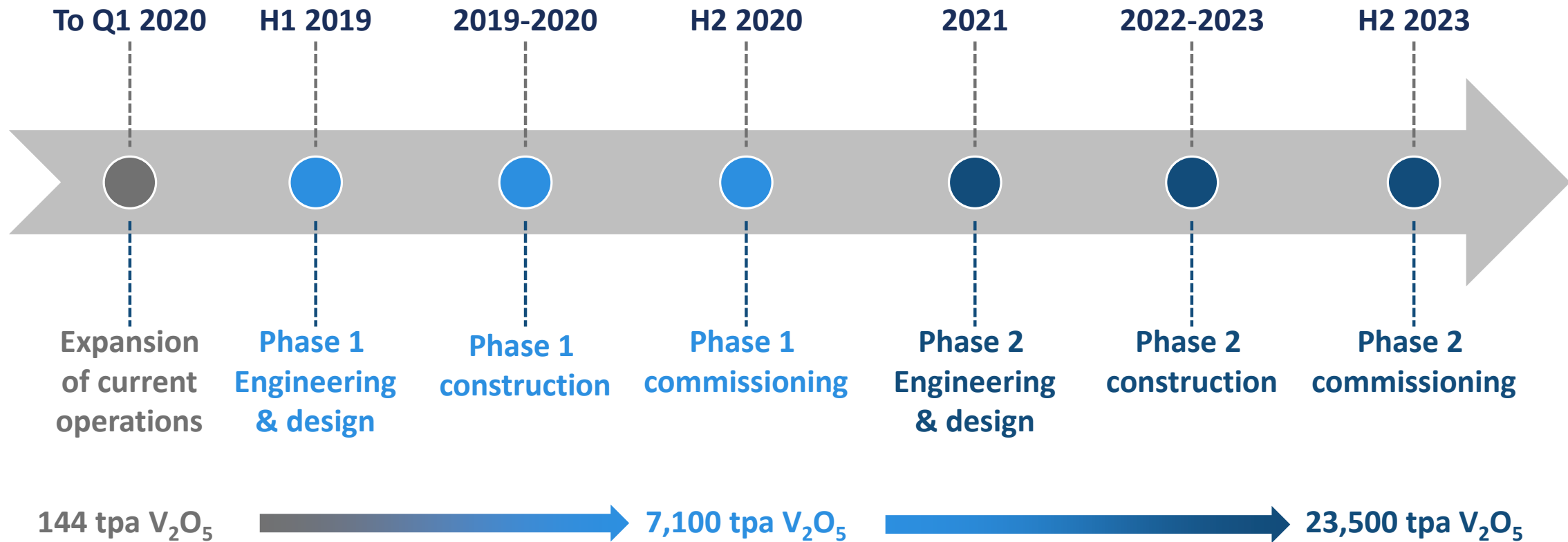
\$7.50/lb

Base-case & CPR
Price assumption
for 2021 onwards

Combined development plan

	Current	Expansion of current operation	Balasausqandiq Stage 1 1Mtpa	Balasausqandiq Stage 2 4Mtpa
Additional production:		1,356 tpa V ₂ O ₅	5,600 tpa V ₂ O ₅	16,400 tpa V ₂ O ₅
Total production:	144 tpa V ₂ O ₅	1,500 tpa V ₂ O ₅	7,100 tpa V ₂ O ₅	23,500 tpa V ₂ O ₅
Total Capex:	-	\$10m	\$100m	\$225m
Approx start date:	Operating	In stages to end of Q1 2020	2020	2023

Development timeline



Vanadium and its uses



Vanadium is a soft grey ductile transition metal

Main products Vanadium Pentoxide (V_2O_5) and Ferro-vanadium



Characteristics

One of the highest strength to weight ratios of all metals

Adds corrosion and heat resistance

Ability to exist in multiple oxidation states (+5, +4, +3, +2)

Resistant to attack from acids and salt water



Uses

90% consumed by global steel industry

Small additions (0.15%-1.5%) of vanadium can double the strength of steel alloy

Most of balance used in titanium alloys - e.g. jet engine and aircraft

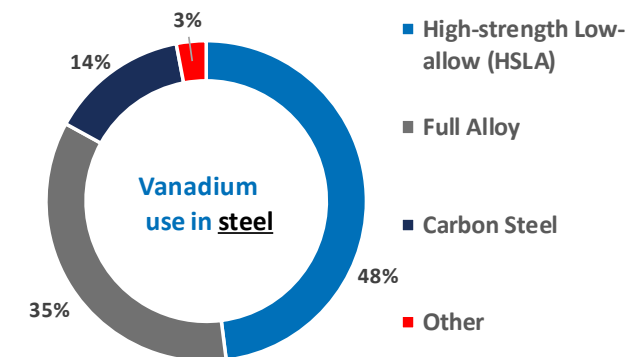
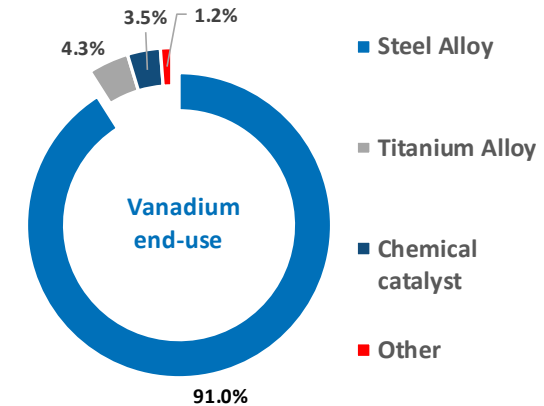
Minor use in ceramics and chemicals industry



Small but rapidly growing use in Vanadium Flow Batteries (VFB) – grid-scale energy storage

153kt
 V_2O_5
2017 demand

238kt
 V_2O_5
2025
TTP Squared
Forecast



Vanadium demand - steel

Steel demand remains robust

Demand remains robust for structural steel and speciality steels in the automotive & aerospace industries

- specifically the high-strength low-alloy (HSLA) steels which utilise vanadium.

Growth area - reinforcing bars (rebar), used in the construction industry

- high-strength rebar contains more vanadium.

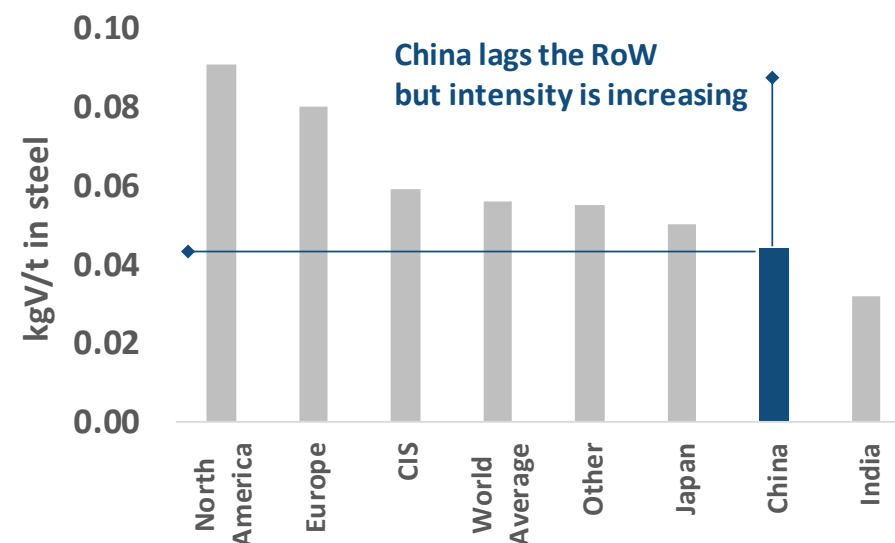
Rebar regulations driving increased application

- Tightening legislation in China
- Law enacted - requires Grade 3 rebar to be used in new building construction
- Shift from Grade 2 (no vanadium) to Grade 3 (c.0.35kg V/t) and Grade 4 (1kg V/t)
- Further revisions due – elimination of 335Mpa rebar in favour of 600Mpa – positive for vanadium

Intensity of use increasing

- Steel demand 3-4% CAGR but intensity of vanadium use in steel 8% CAGR

Intensity of vanadium demand in steel



Vanadium demand - VFBs

VFBs - increasing impact on vanadium demand

Growing application in Vanadium Flow Batteries

Primarily used for grid-scale mass energy storage

Peak-shaving and grid stability

Dovetails with the buildout of renewable energy – wind, solar

Application to microgrids - autonomous from main grid

VFB Advantages:

- Store large amount of energy, long life span, semi-infinite recharge cycles
- Discharge to 100% without capacity loss and do not degrade
- Scalable

Global build-out of VFBs underway

- Largest installation – Dalian VFB in China – 800MWh (200MW) – 5,700t V₂O₅ for this single battery
- Rongke Power building VFB giga-factory Phase 1 (300Mw), Phase 2 (1GW) and Phase 3 (3GW). Full 3GW capacity assuming 4MWh per MW, implies an annual requirement of 48,000MTV, or 85,700t of pentoxide, around 55% of current annual consumption
- UK – First VFB connected to the grid in 2017 in Cornwall

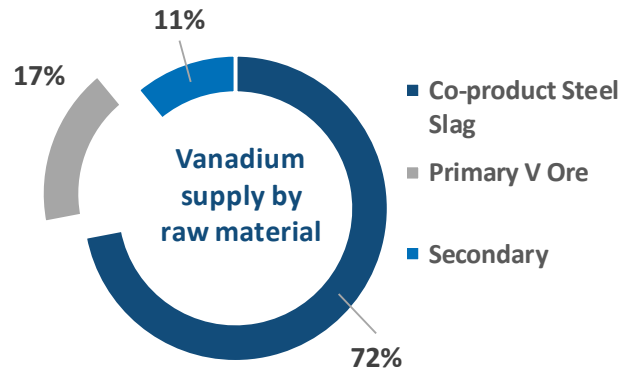
The VFB roll-out is happening



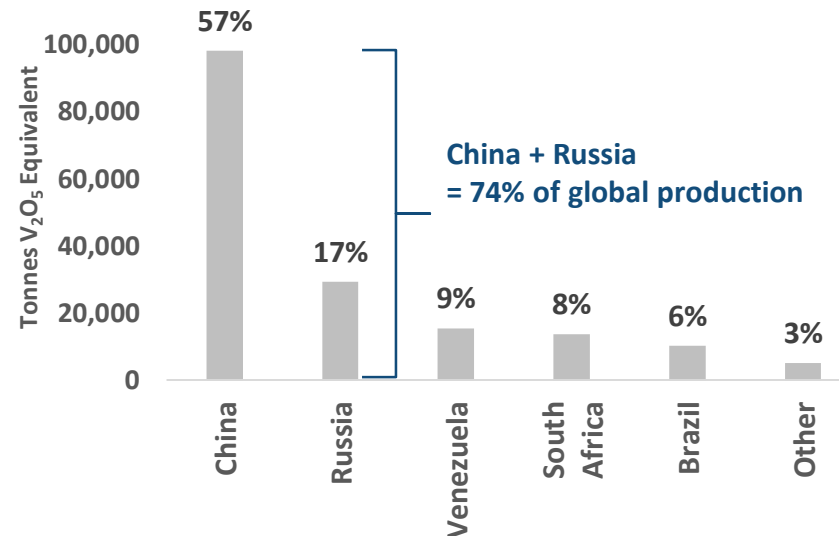
Vanadium supply issues

The vanadium “problem”...

- Supply is extremely concentrated - **72%** of global production derived as a **co-product** from steel plants using magnetite iron-ore
- Production of steel from magnetite declining compared with from higher grade haematite iron ore which does not contain vanadium
- Few economic primary vanadium mines in the pipe-line
- High capital costs and long lead time for primary producers
- VFB build-out needs security of supply



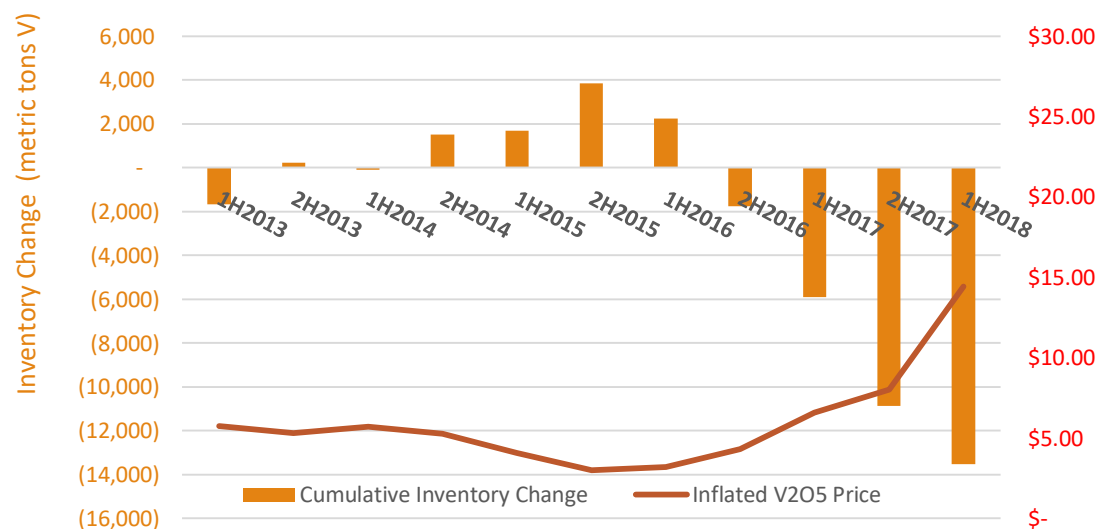
- Supply dominated by China and Russia
- Mine production from Russia & South Africa declining, partially offset by Brazil (Largo Resoruces)
- Not many “pure-play” vanadium producers - **FAR is one of few**
- Supply disruption possible** – only 10 Chinese steel mills account for 73% of vanadium supply from co-product route
- China has imposed ban on imports of vanadium-containing scrap



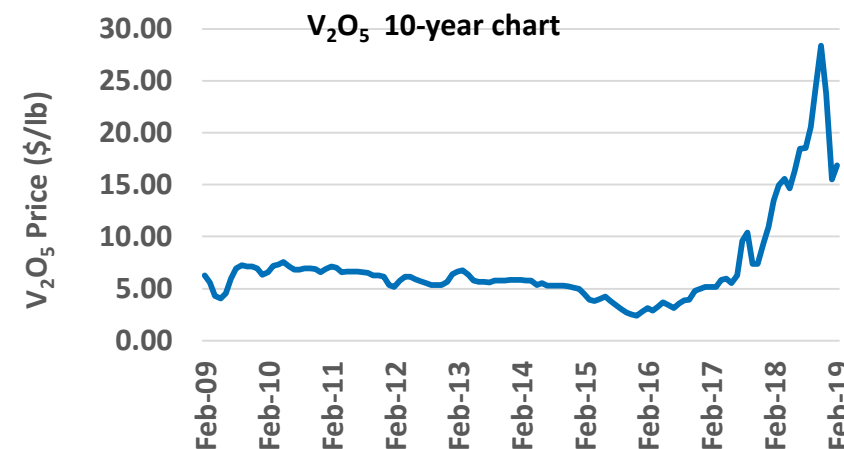
Vanadium outlook & pricing

- V_2O_5 prices have been volatile, peak \$35/lb in 2005, cyclical low in 2015 \$2.38/lb
- Currently over \$16.25/lb – nearly 7 x increase in last 2.5 years
- Structural deficit, lower production from South Africa, few new projects coming onstream
- Global stockpiles diminished – minimal buffer to soak up new demand
- Deficit in 2017 – 1st time in a decade

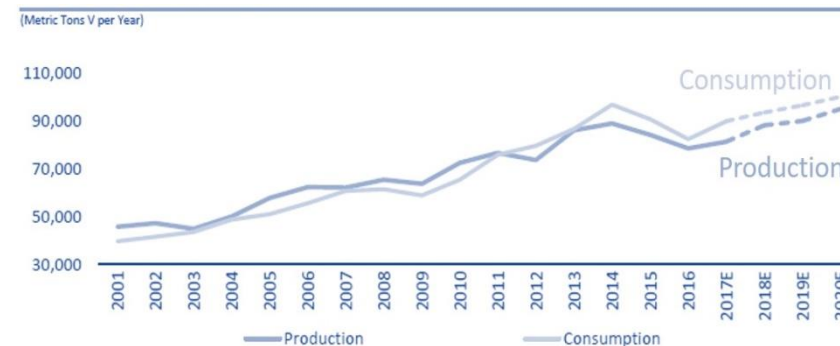
Global Vanadium Cumulative Inventory Change (TTP Squared)



Vanadium pentoxide Europe price (\$/lb) (TTP Squared)



Near-term market balance forecast (TTP Squared)



Investment summary

- Already a vanadium producer with a low-capex expansion of existing operations already underway
- Developing the huge Balasausqandiq project to be one of the biggest and lowest cost producers
- Minimal equity dilution – low capex and phased development using mostly retained earnings
- Not another magnetite deposit – no pre-concentration and no costly pyrometallurgy required
- Low technical risk, proven process, brownfield expansion
- Simple mining and processing results in peer-leading low capital intensity
- Bottom of the cost-curve
- FAR can respond to increases in market demand for Vanadium Flow Batteries with further low cost expansions

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