



## Engerbø Rutile and Garnet Project – Prefeasibility Study

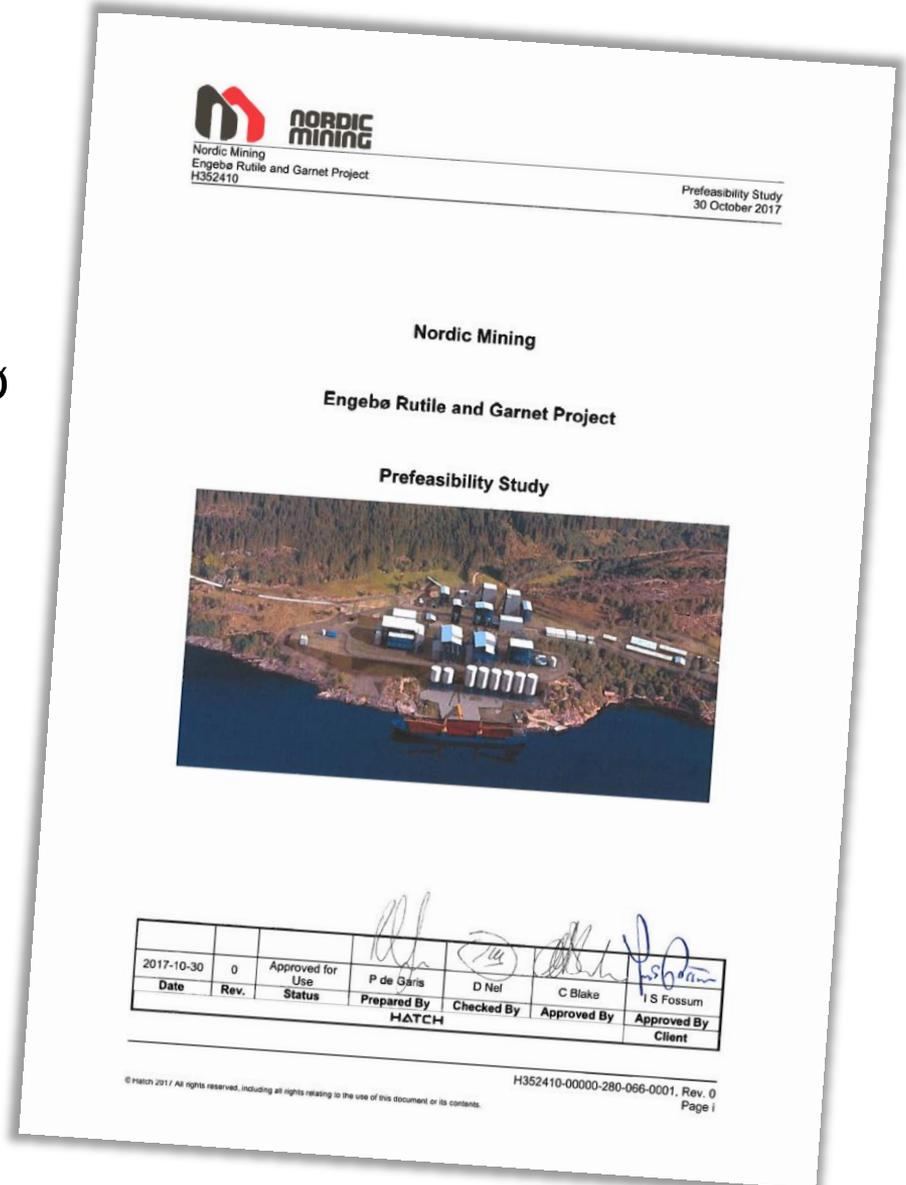
30 October 2017



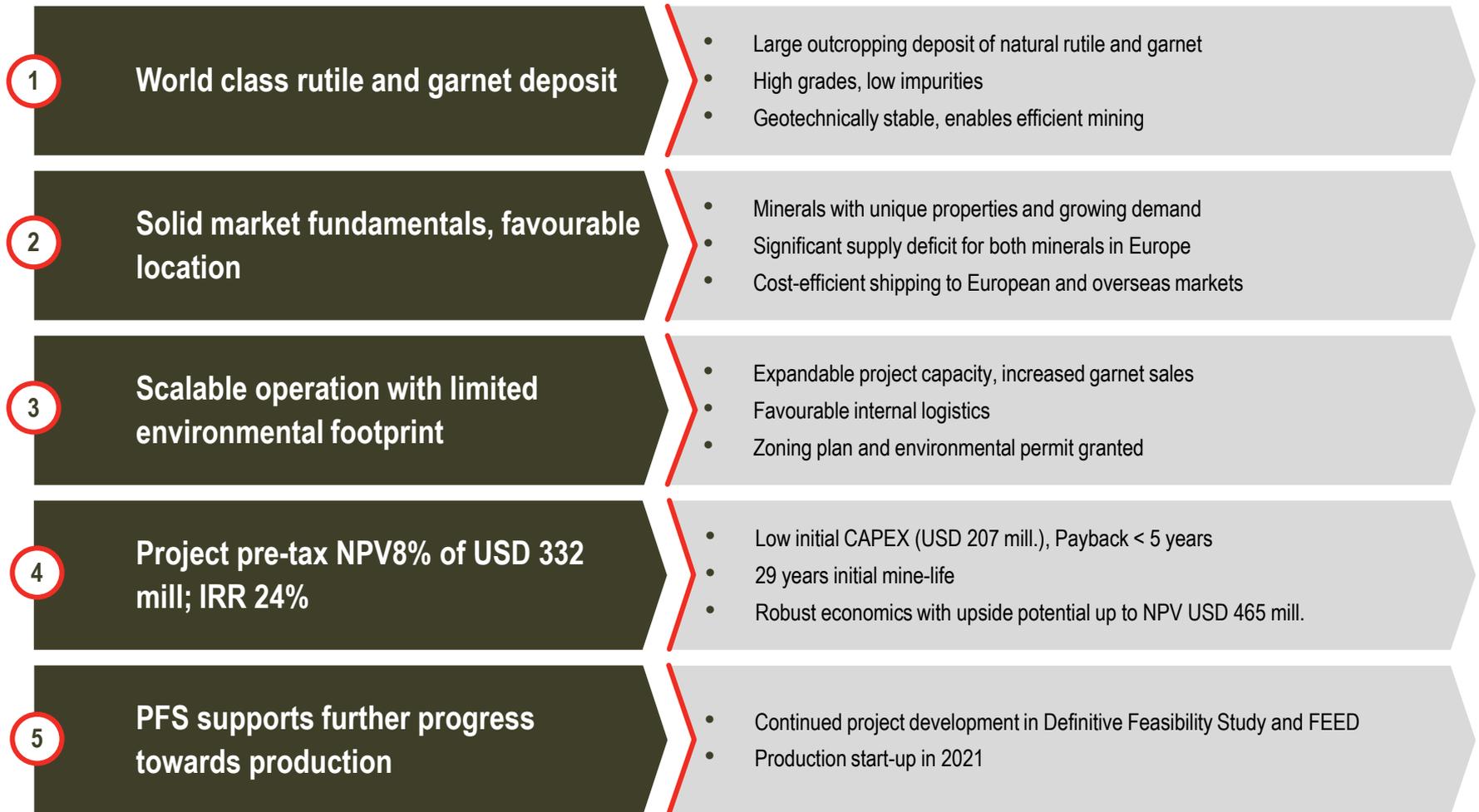
*Exploration and production of high-end minerals and metals*

# AGENDA

- ✓ Presentation of the Engebø Prefeasibility Study
  - CEO Ivar S. Fossum
  - CFO Lars K. Grøndahl
- ✓ Q&A session



# Summary of the Engebø Prefeasibility Study (PFS)



1

World class rutile and garnet deposit

2

Solid market fundamentals, favourable location

3

Scalable operation with limited environmental footprint

4

Project pre-tax NPV8% of USD 332 mill; IRR 24%

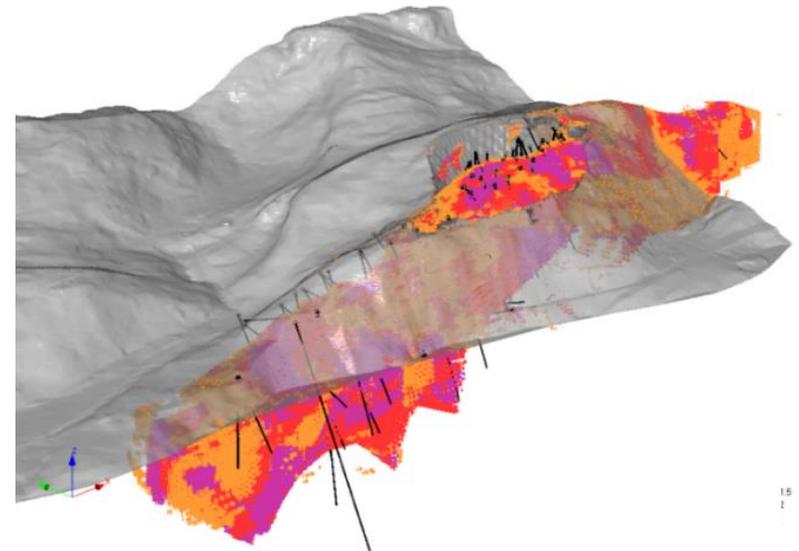
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PFS supports further progress towards production



# Large eclogite deposit located at tidal waters

- ✓ Outcropping deposit with unknown extension to depth
- ✓ Geotechnically stable orebody allows for effective mining
- ✓ Low impurities, negligible content of heavy metals and radioactive elements
- ✓ Easy transition from open pit to underground mining



15



# High grade rutile and garnet mineralisation

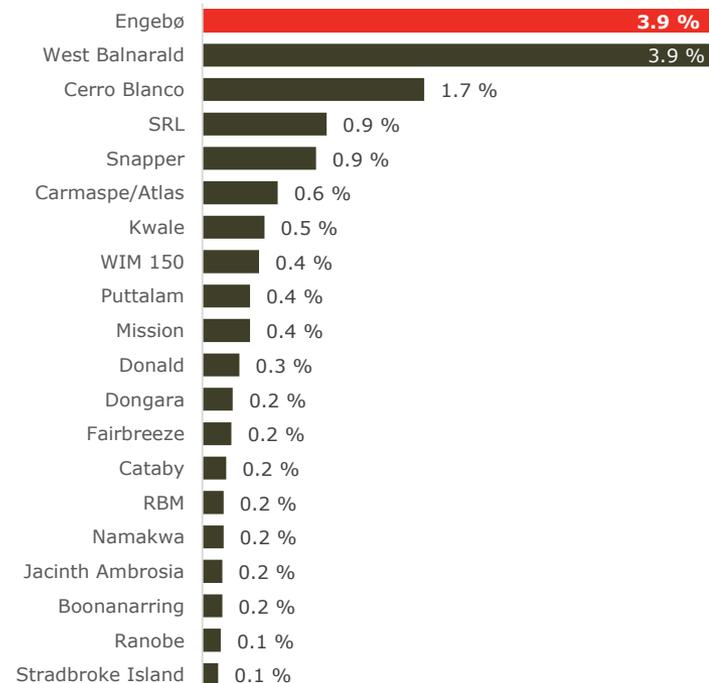
## Mineral resource classification\*

- ✓ The mineral resource is defined with 3% cut-off
- ✓ Increased cut-off implies stronger financial performance in early mining years
- ✓ Large potential in inferred resources

	3% cut-off grade		
	Tonnage Mt	TiO <sub>2</sub> %	Garnet %
Measured	15	3.97%	44.6%
Indicated	78	3.87%	43.6%
<b>Measured &amp; indicated</b>	<b>93</b>	<b>3.89%</b>	<b>43.7%</b>
Inferred	138	3.86%	43.5%

## Among the highest rutile grades

- ✓ Rutile grade for current producers and planned projects



\* Resource estimates completed by Competent Person Adam Wheeler, corresponding to the guidelines of the JORC Code (2012 edition).



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# Rutile and Garnet - unique mineral properties, increasing demand

## Garnet

Current world production: ~ 1.4 million tonnes



WATERJET CUTTING



SAND BLASTING



ABRASIVES



Tests have demonstrated that Engebø can produce coarse and fine garnet suitable for a broad range of applications

## Rutile

Current world production: ~ 0.8 million tonnes



PIGMENT



WELDING RODS



TITANIUM

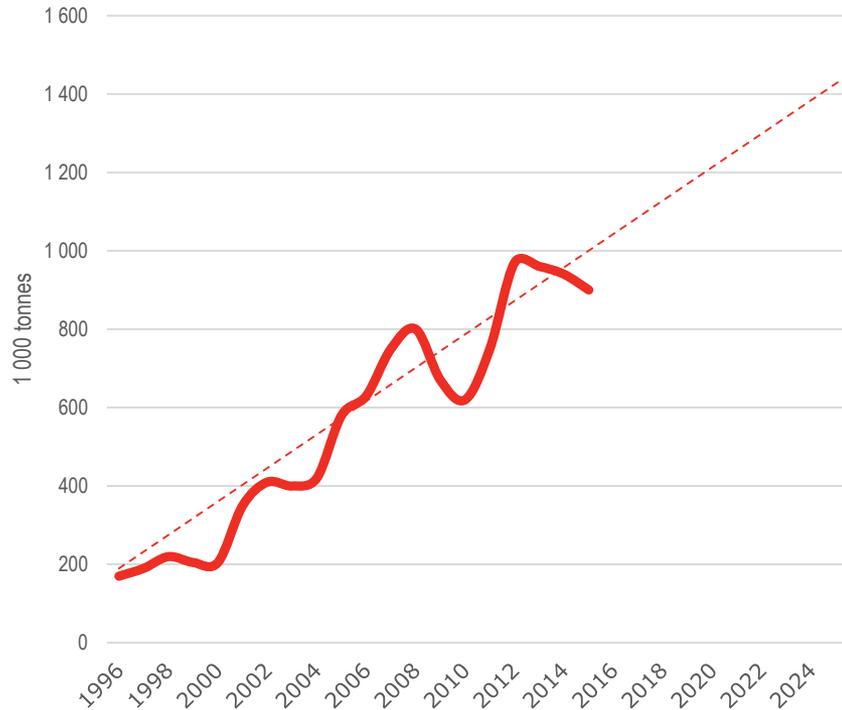


Tests have demonstrated that Engebø can produce 95% TiO<sub>2</sub> rutile suitable for pigment and titanium metal

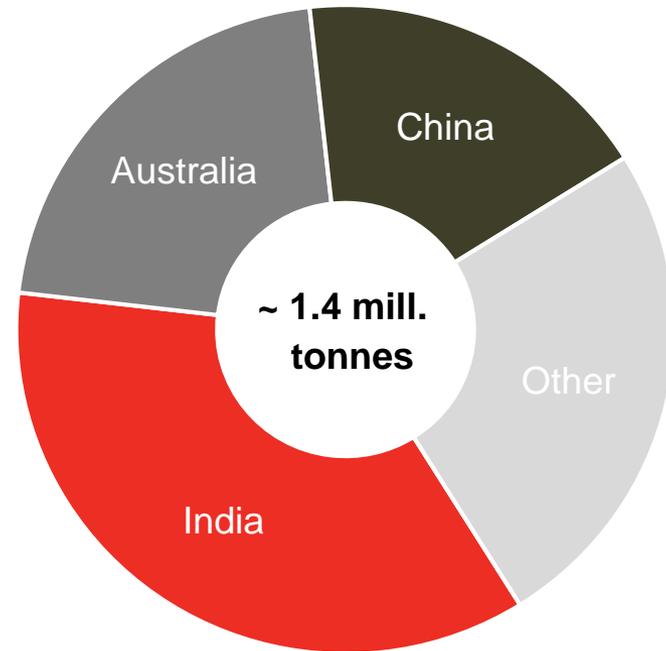


# Garnet - young mineral with strong growth

Apparent consumption of garnet (excl. China)\*



Current world production\*

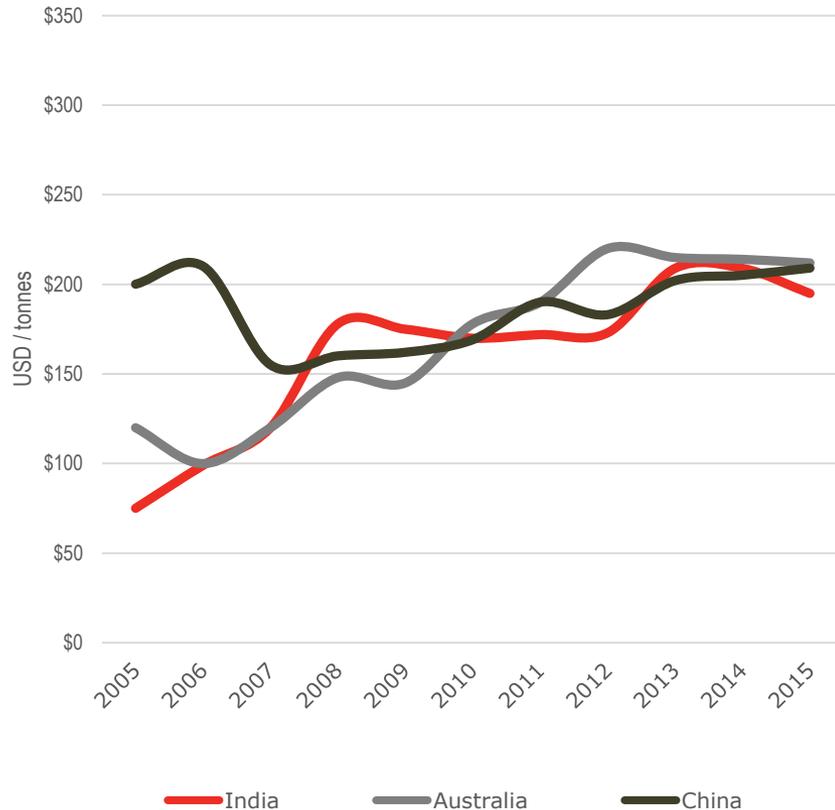


\* Source: TAK Industrial Mineral Consultancy



# Garnet market and price forecast

Average garnet export prices (FOB)\*



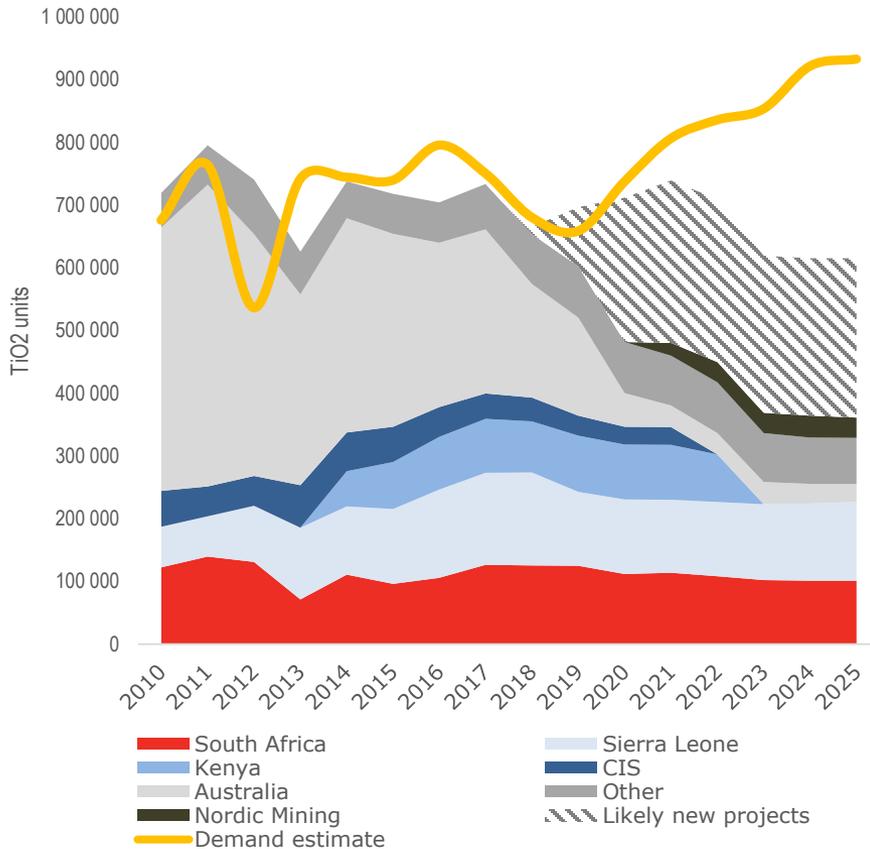
- ✓ Emerging mineral with strong growth in the waterjet cutting markets
- ✓ Currently no European production
- ✓ Engebø is one of few hard rock deposits of almandine garnet
- ✓ Engebø will produce commercial end-products:
  - 80 mesh waterjet
  - 100 mesh waterjet
  - 30/60 mesh blast market
- ✓ PFS garnet price assumption of USD 250/tonne in real terms based on a basket of the three products

\* Source: TAK Industrial Mineral Consultancy

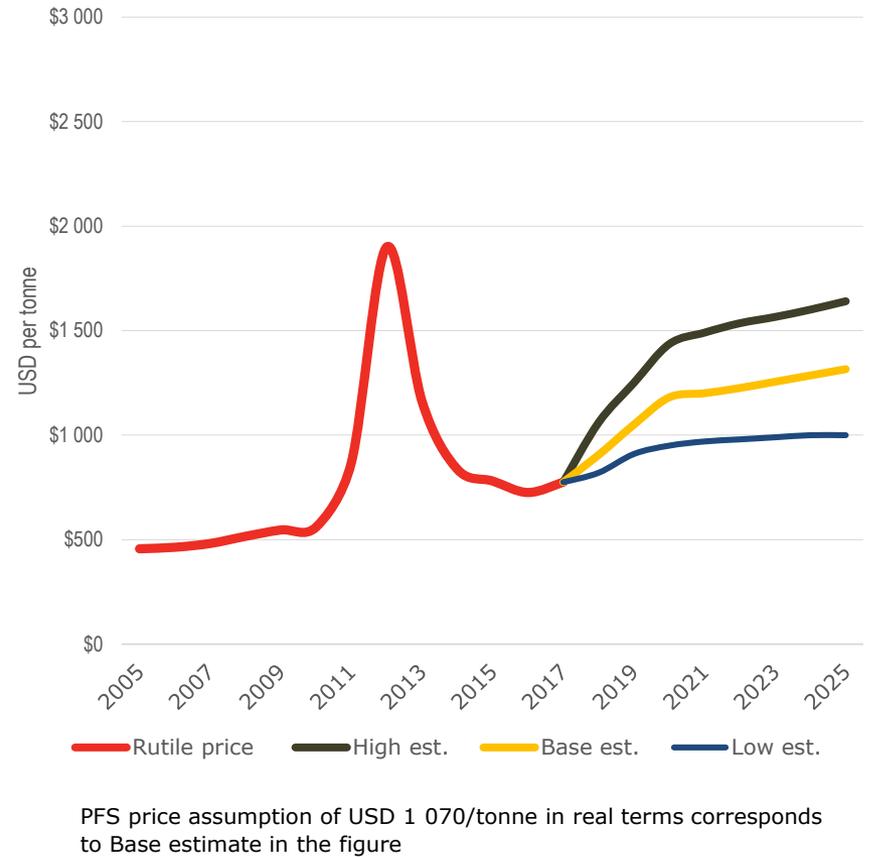


# Rutile market and price forecast

## Global rutile supply/demand balance\*



## Rutile price forecast\*



\* Source: TZMI

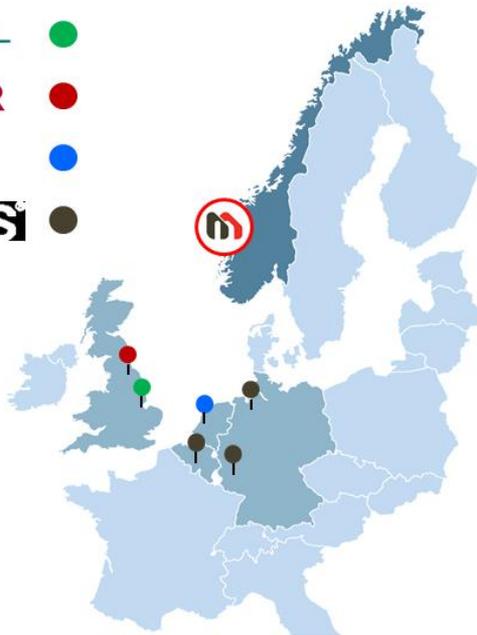


# Export sales from Engebø

## Rutile off-take

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- ✓ The largest pigment manufacturers in Europe with chloride technology have a total production capacity above 500,000 tonnes per annum
- ✓ Several can consume Engebø's annual volume
- ✓ Plant-to-plant shipment
- ✓ Logistical and freight cost advantages



## Garnet off-take

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- ✓ Nordic Mining has signed a MoU with a leading, international producer of industrial minerals
- ✓ The parties intend to establish long-term cooperation within development, production, sales, marketing and distribution of garnet products from Engebø



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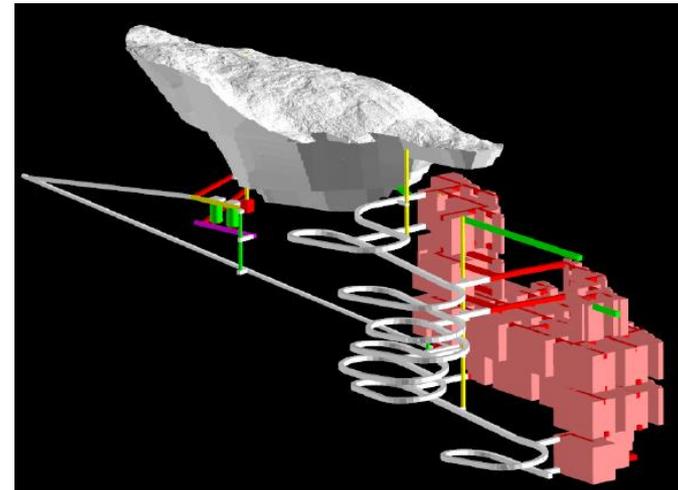
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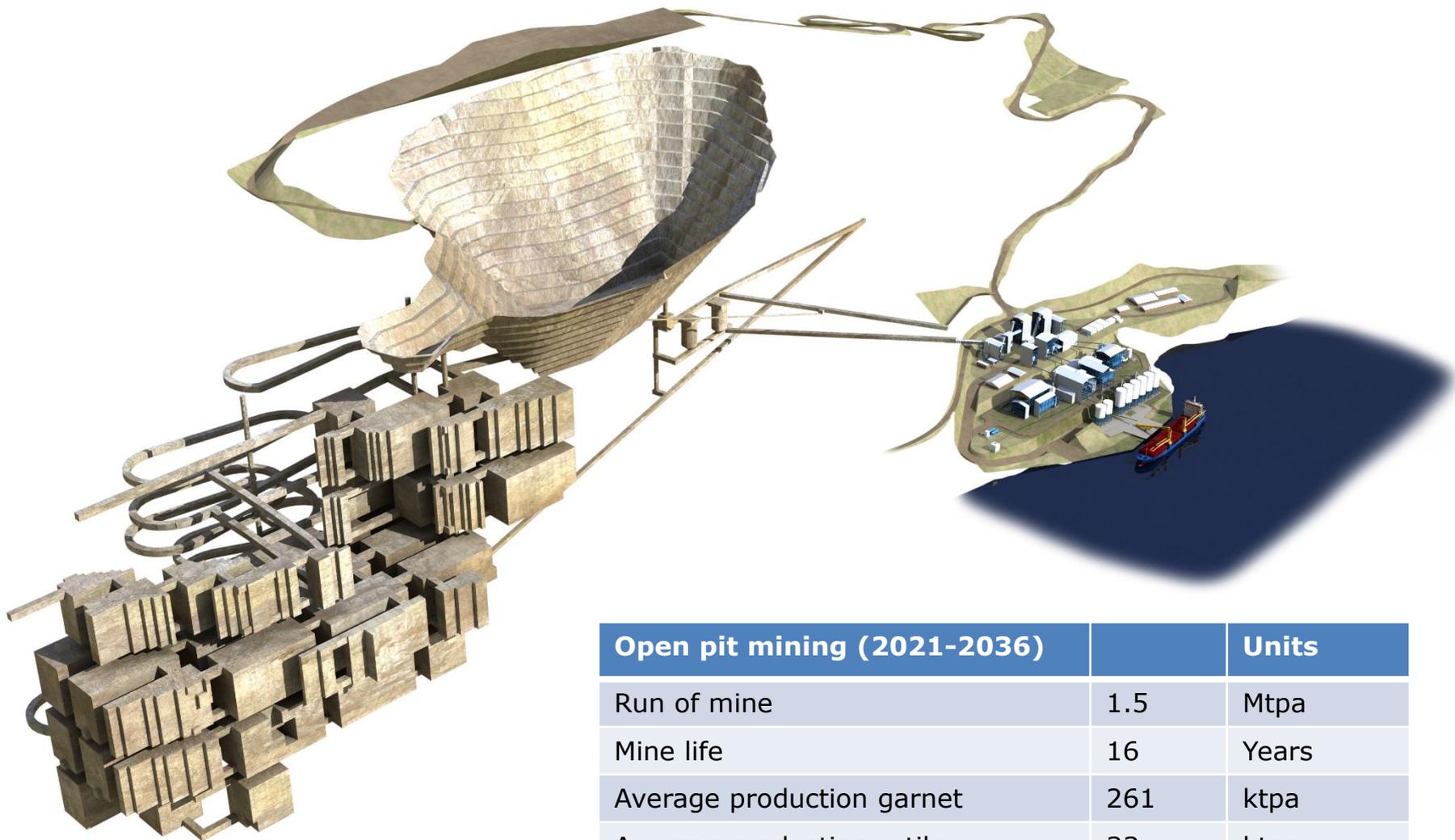
PFS supports further progress towards production



# Favourable internal logistics, short haulage distance

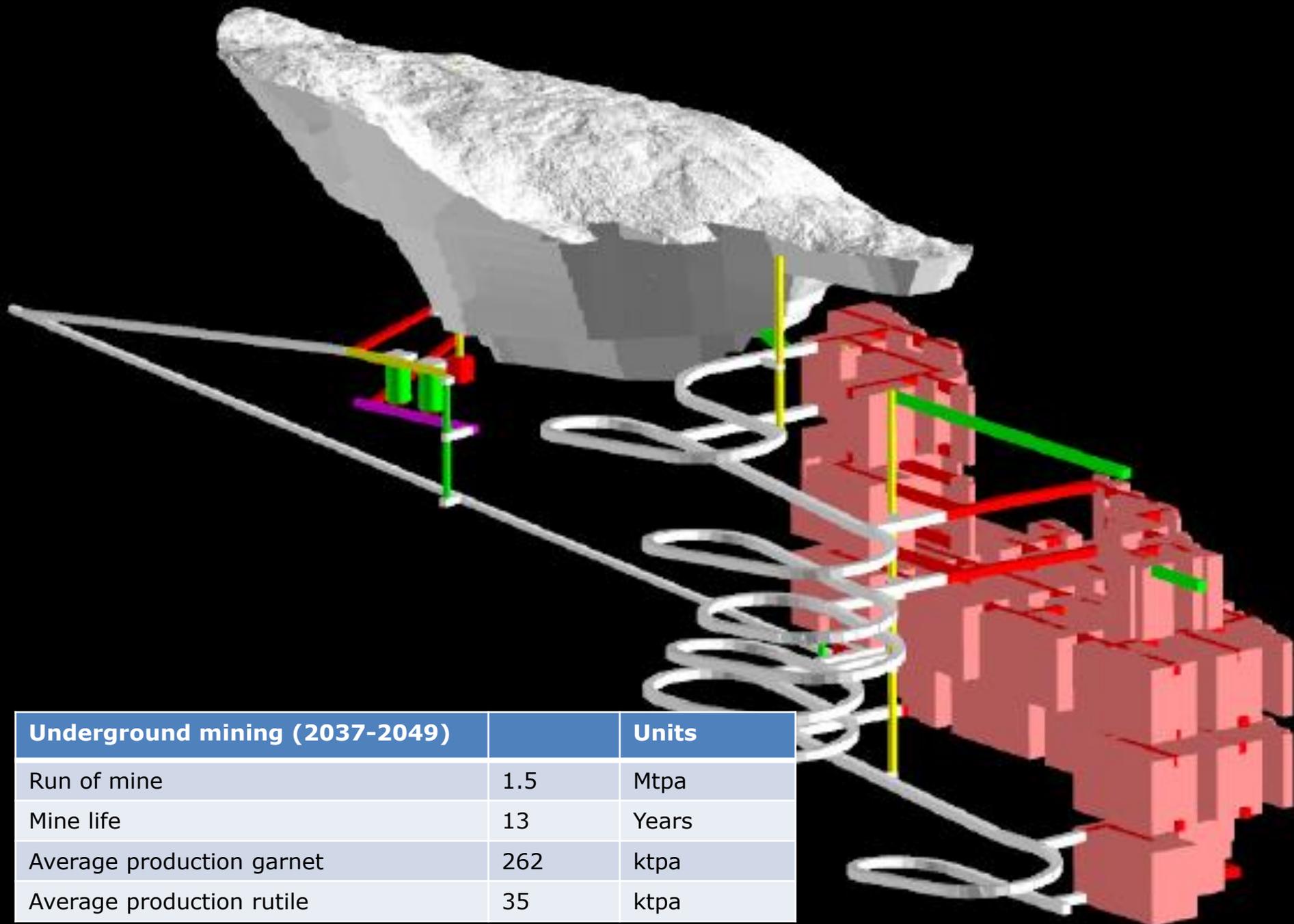
- ✓ 16 years open pit mining
- ✓ Rich ore in the early years
- ✓ Low stripping ratio
- ✓ Glory hole concept with underground crushing facility
- ✓ Underground ore silos enable ore blending and operational flexibility
- ✓ Minimum haulage distance
- ✓ Limited visual impact
- ✓ Open pit gives easy access to underground ore
- ✓ Permit allows for future expansion





Open pit mining (2021-2036)		Units
Run of mine	1.5	Mtpa
Mine life	16	Years
Average production garnet	261	ktpa
Average production rutile	33	ktpa
Strip ratio	1.34	Waste/ore





<b>Underground mining (2037-2049)</b>		<b>Units</b>
Run of mine	1.5	Mtpa
Mine life	13	Years
Average production garnet	262	ktpa
Average production rutile	35	ktpa

# PFS process testwork; industrial scale equipment

- ✓ Comprehensive testwork has documented commercial products from rutile and garnet according to market specifications
- ✓ Testwork has demonstrated rutile recovery of approximately 60%



**HATCH**

**ihc** ROBBINS

**JKtech**  
SMI  
Technology Transfer

**SGS**

  
**MINTEK**

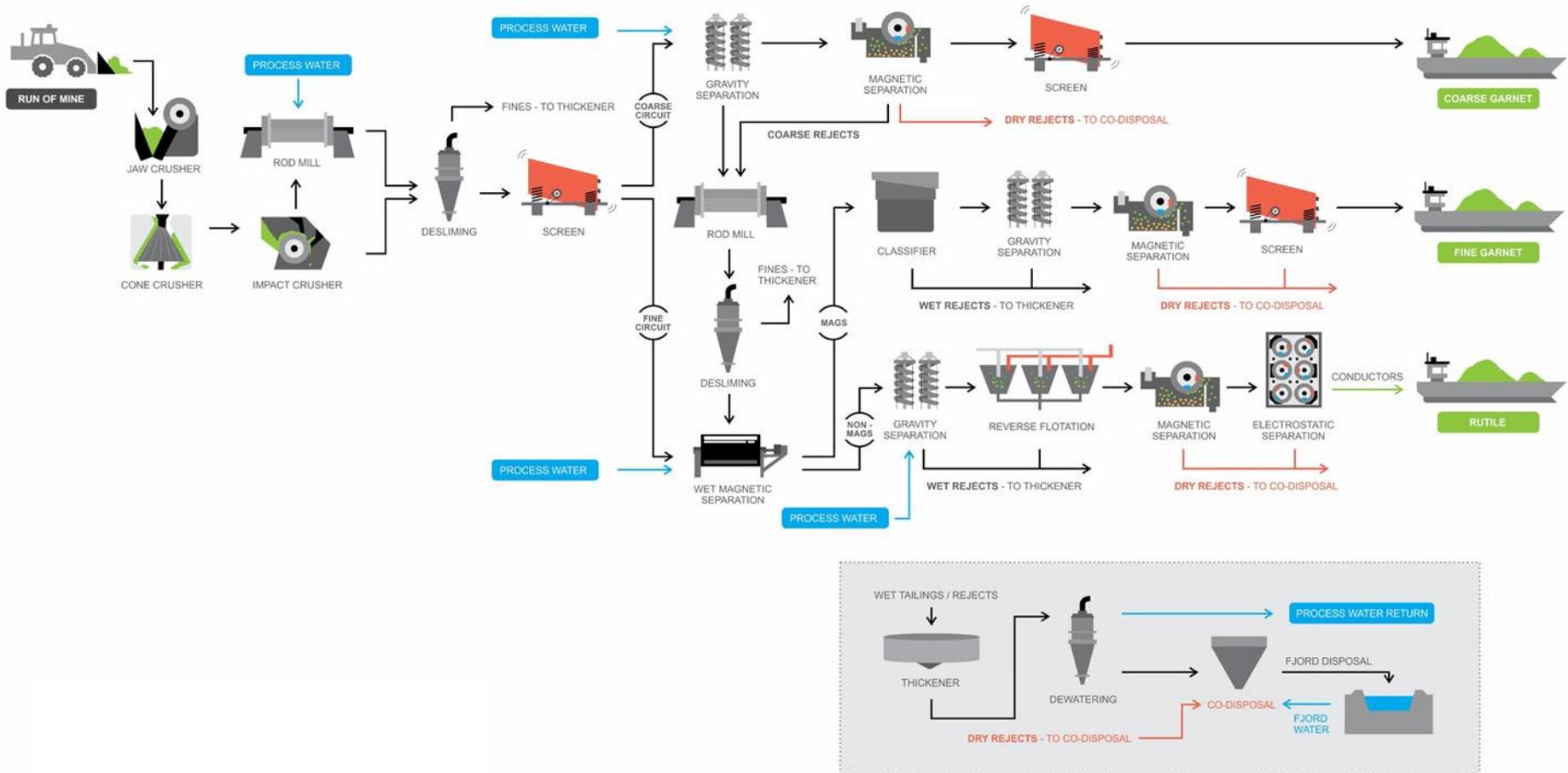
**IMSV**  
ENGINEERING

**CORE** 

 **Mineral  
Technologies**  
A Downer Company

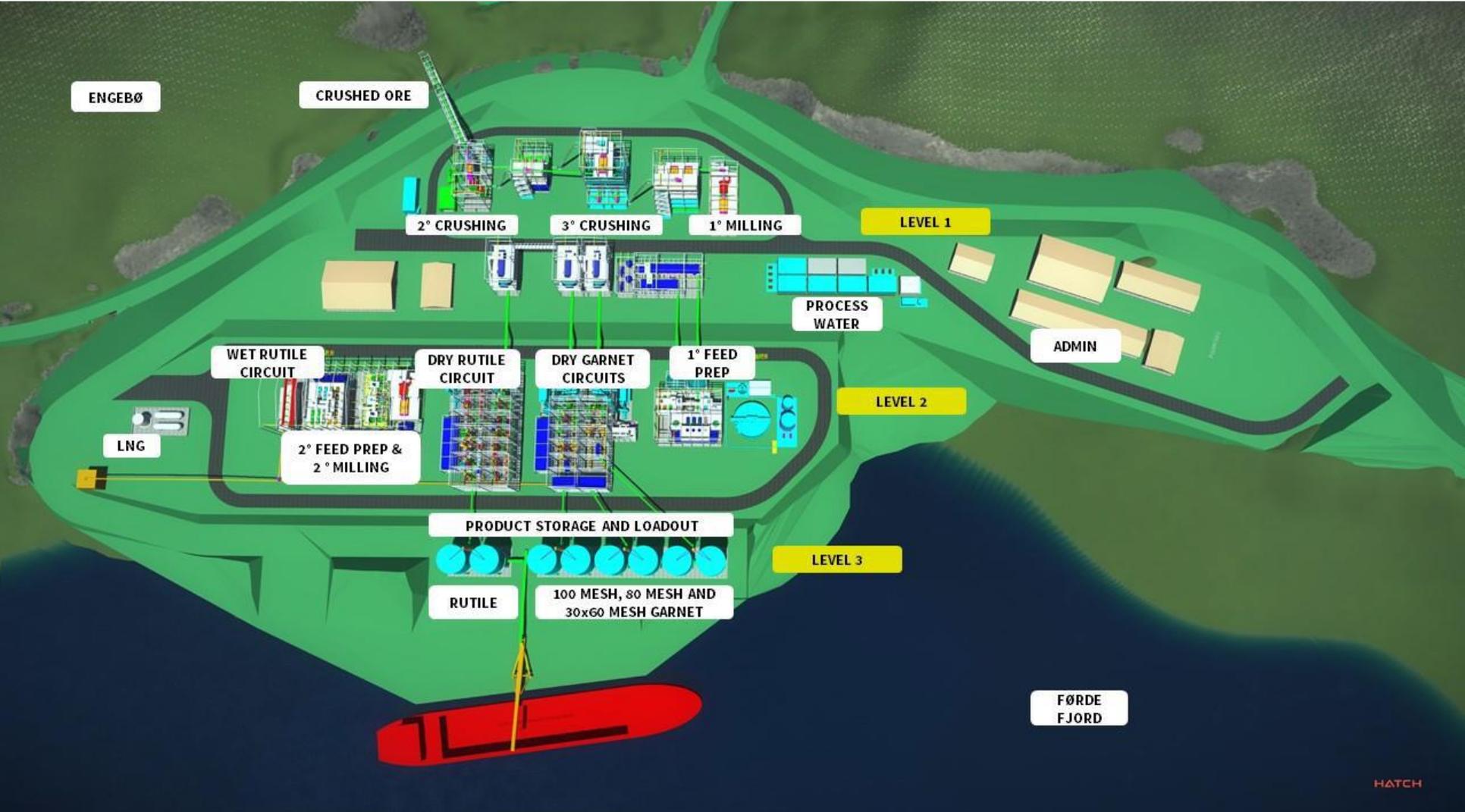


# Flowsheet of rutile and garnet process





# Compact process plant, including ship-loading facilities



HATCH



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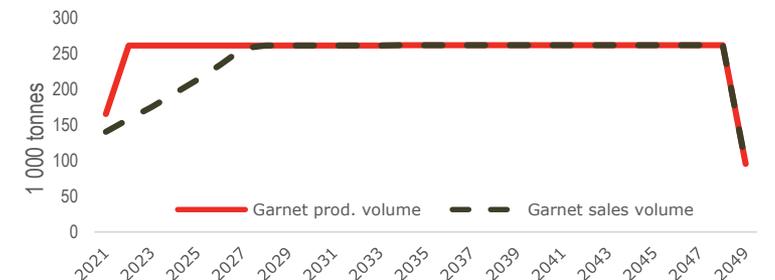
# Key project assumptions

Assumptions	Value
Garnet price	USD 250/tonne
Rutile price	USD 1 070/tonne
Garnet sales (from ~2027)	261 000 tpa
Rutile sales (average)	32 500 tpa
Opex per sales tonne <sup>1)</sup>	USD 87 per tonne
<b>Capex 2019-2021</b>	<b>USD 207 mill.</b>
Open pit mining and comminution	26.8
Mineral processing and tailings handling	68.6
Infrastructure, storage and loadout	35.7
Indirects	41.8
20% contingency	34.2
<b>Deferred capex 2033</b>	<b>USD 17 mill.</b>
Underground mining and comminution	10.8
Indirects	2.7
25% contingency	3.4

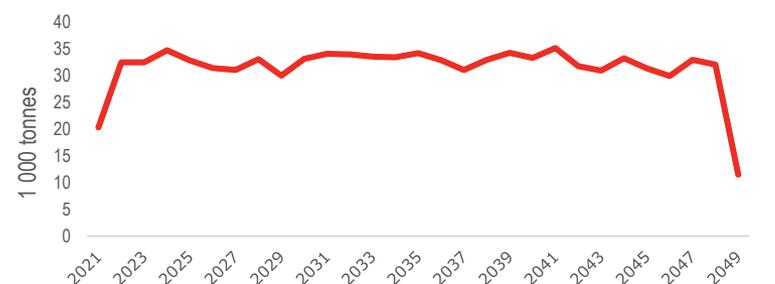
## Mining production



## Garnet sales and production volume



## Rutile sales and production volume

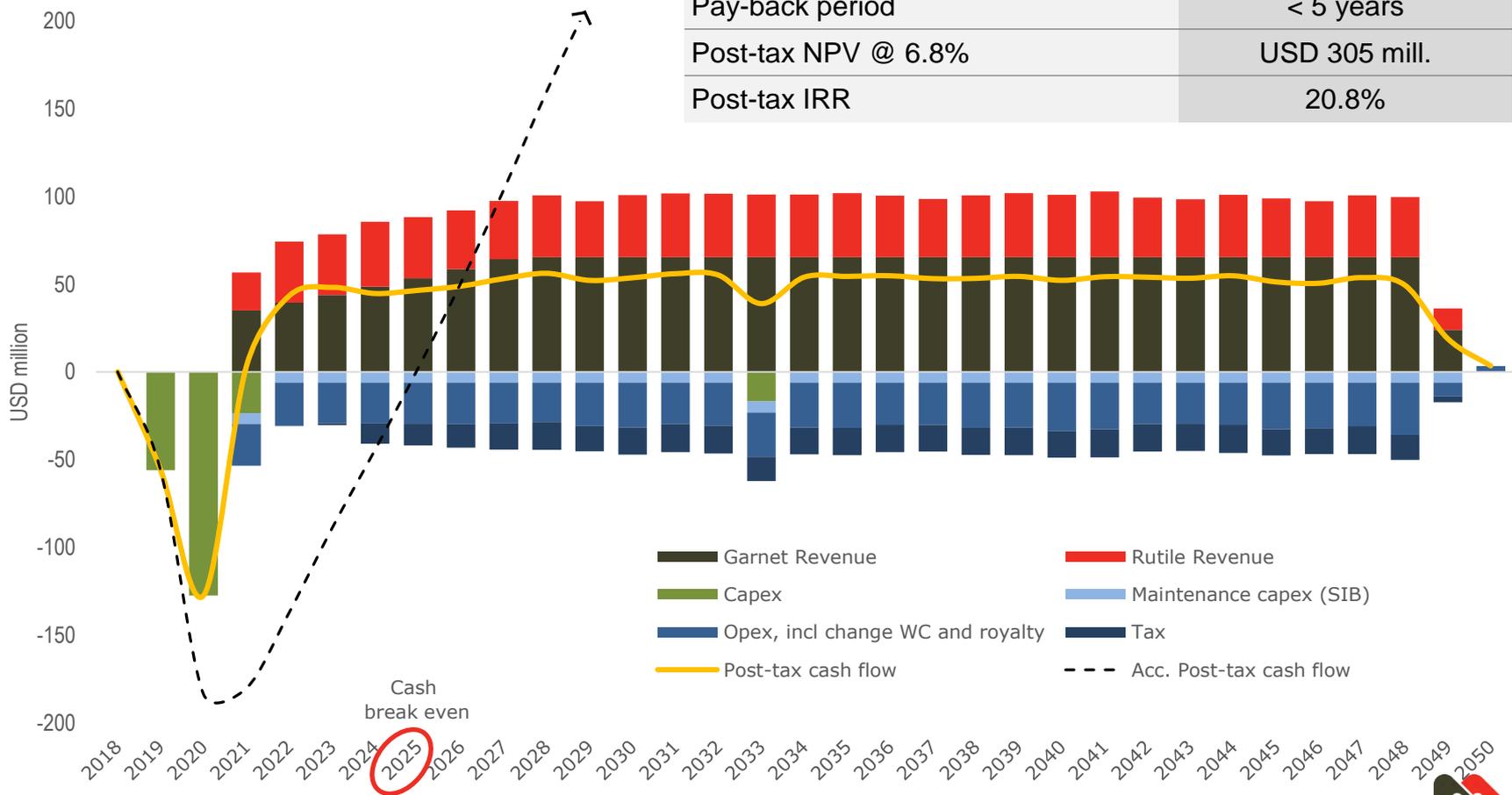


1) Based on total sales volume for rutile and garnet



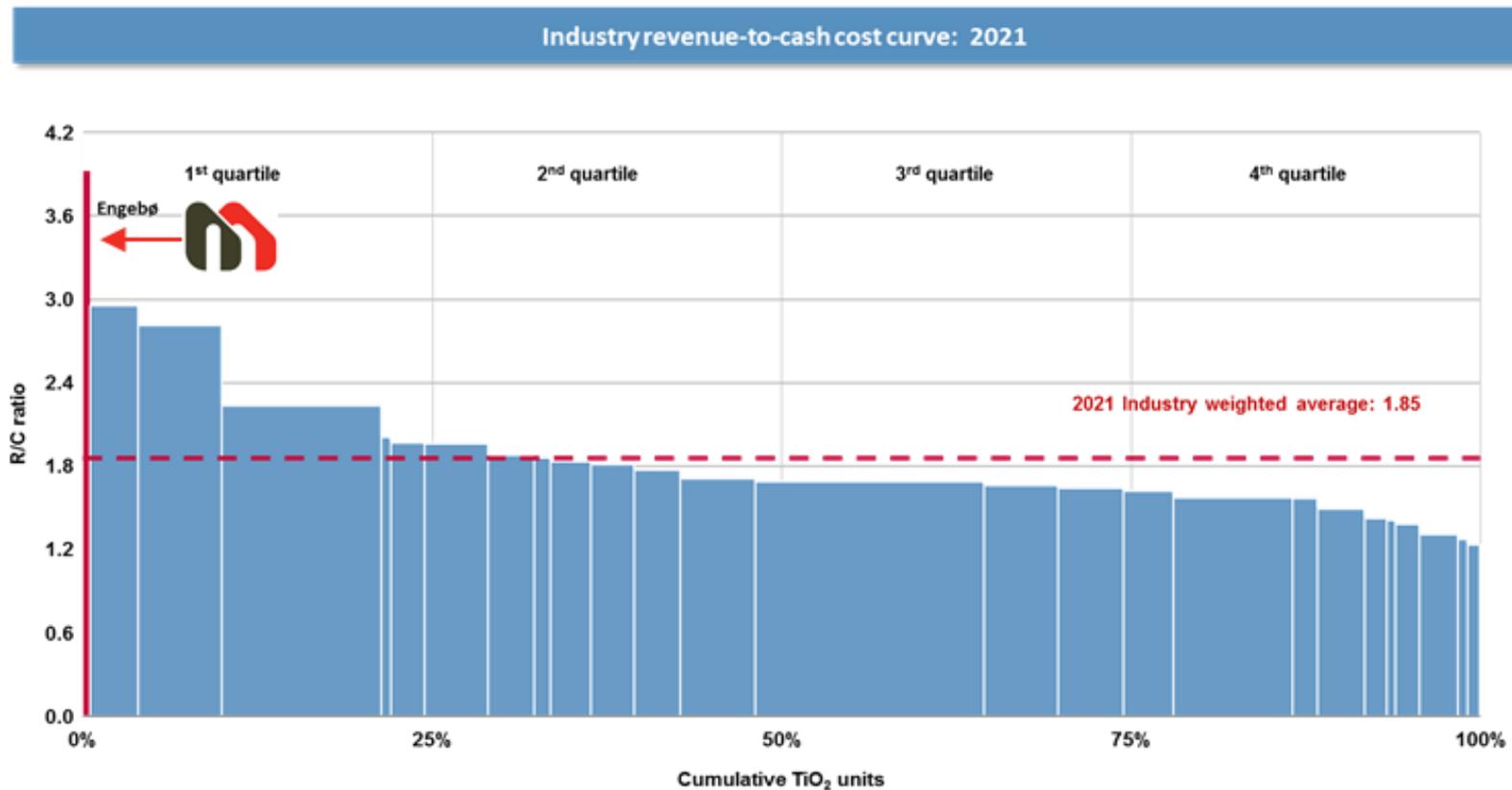
# Attractive project economics

Metric	Value
Pre-tax NPV @ 8%	USD 332 mill.
Pre-tax IRR	23.8%
Life of mine	29 years
Pay-back period	< 5 years
Post-tax NPV @ 6.8%	USD 305 mill.
Post-tax IRR	20.8%



# Competitive rutile revenue-to-cash cost position

- ✓ The revenue-to-cash cost ratio is based on the first ten years of operations
- ✓ Engebø benefits from producing high value products with low mining and processing costs

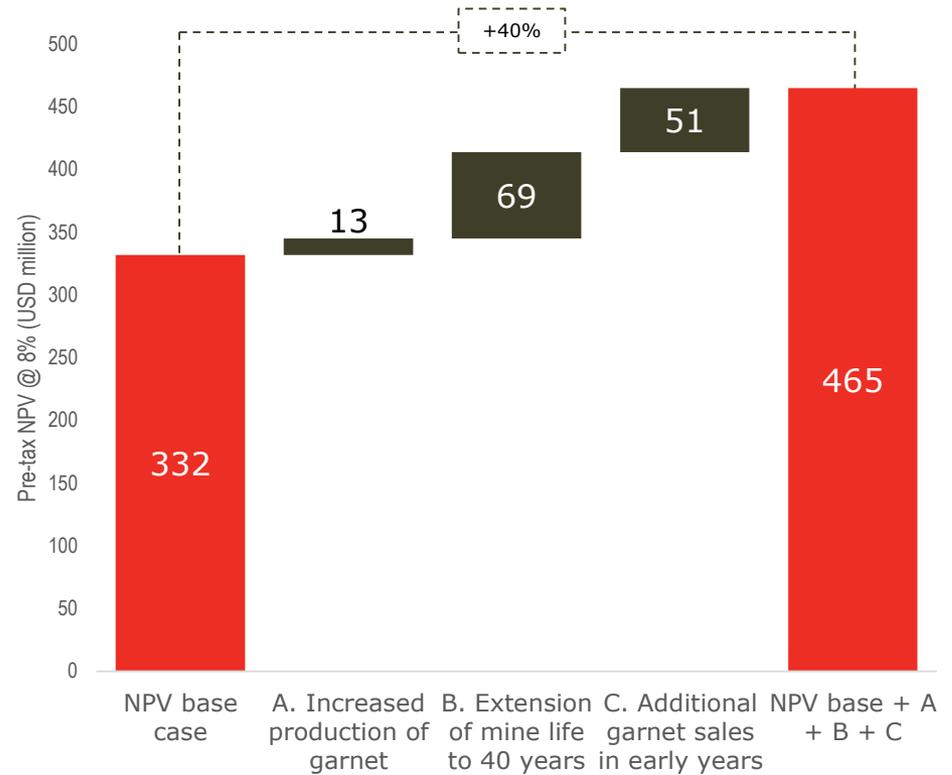


Source: TZMI



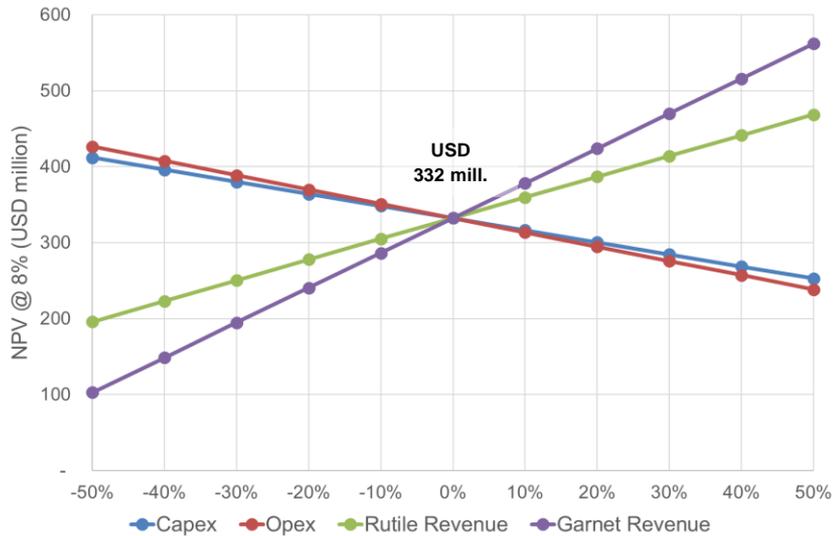
# Large upside potential

- A. Increased production of garnet to meet garnet sales at 300 000 tonnes/year
- B. Extension of mine life to 40 years by including Inferred Resources
- C. Additional garnet sales in early years in line with production

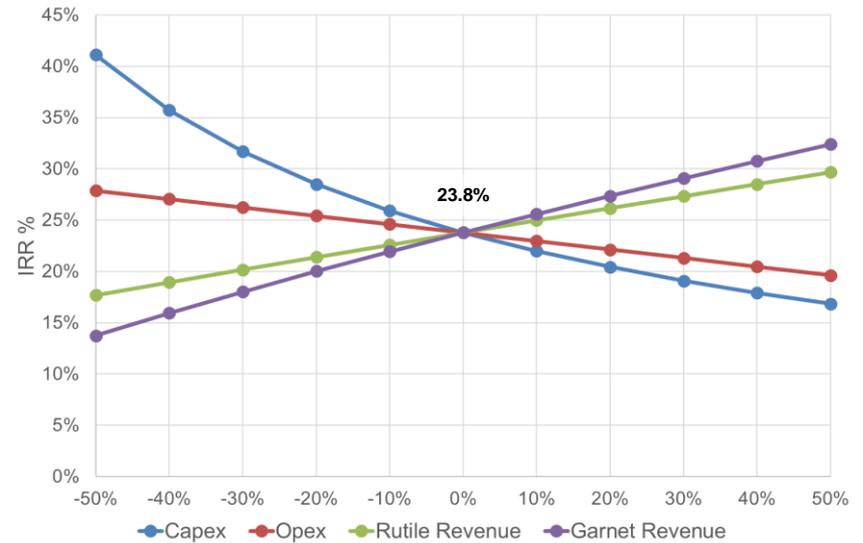


# Sensitivity calculations confirm robust economics

Pre-tax NPV sensitivity



Pre-tax IRR sensitivity



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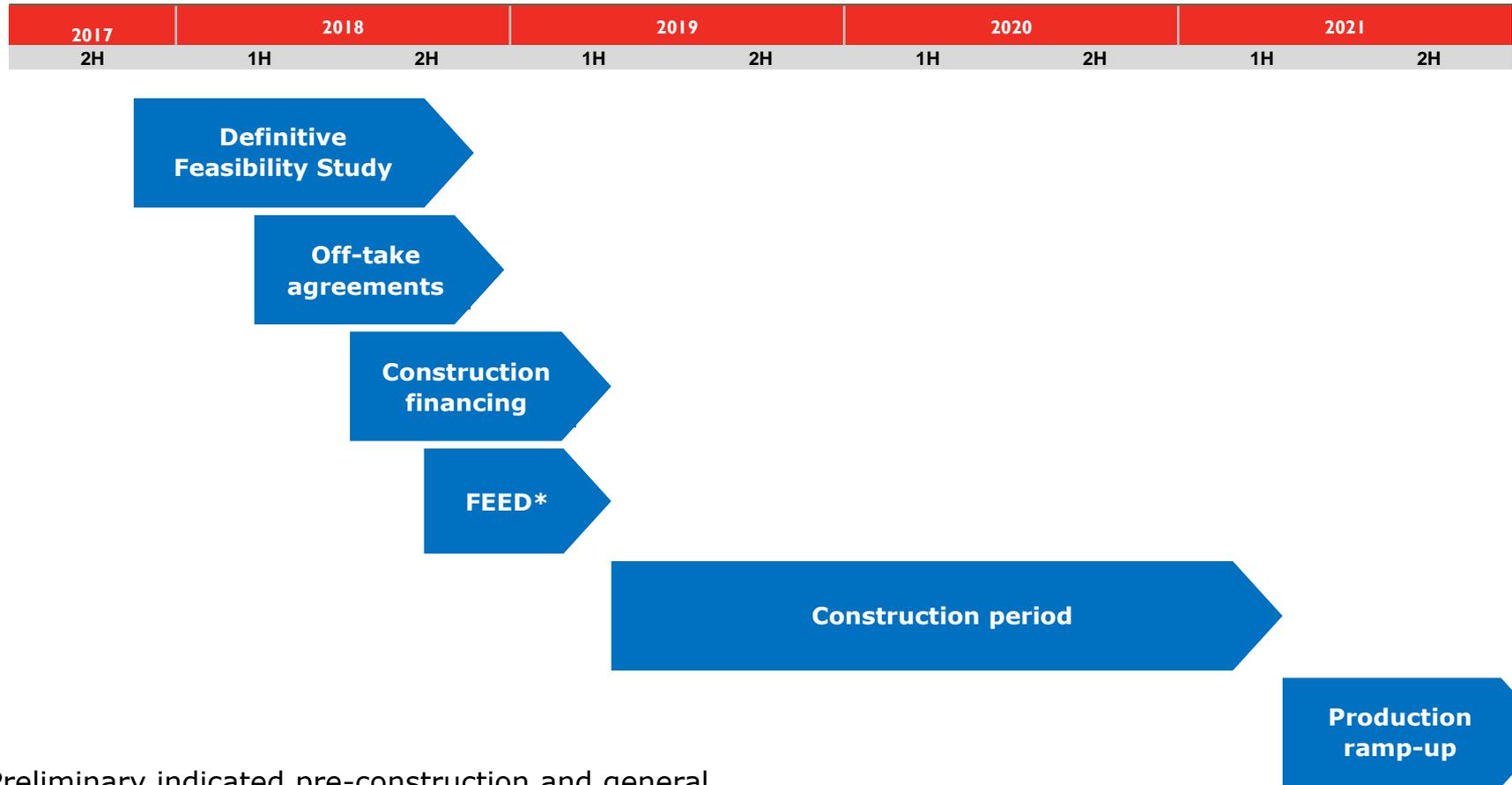
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# The way forward



Preliminary indicated pre-construction and general corporate expenditures of approx. USD 20 million

\* FEED: Front End Engineering & Design



# Definitive Feasibility Study targets project bankability

## Scope of Work

The high-level activities envisaged for the two study phases include:

- Phase 1 – Project set-up, key studies and trade-offs, including:
  - ♦ Update resource model
  - ♦ Mining geotechnical studies, including open pit, underground and seismic risk
  - ♦ Mining trade-off studies, including mine design and schedule, and mine planning
  - ♦ Mineral processing testwork to provide input to the process design criteria and process flow sheets. The phase 1 testwork will be used to develop the flow sheets for the DFS. Additional testwork will run in parallel and will be considered confirmatory
  - ♦ Project set-up for Phase 2, including development of key documentation for the DFS, finalisation of project design standards and criteria
  - ♦ Modularisation and logistics studies – the strategy for the process plant fabrication, assembly and construction will be evaluated and approved before commencement of Phase 2 design development work. This study will encompass engineering, logistics and construction
  - ♦ Determination of a procurement strategy and a procurement operating plan for the DFS
  - ♦ Jetty assessment.
- Phase 2 – FEL-3 Design Development
  - ♦ Multi-disciplinary engineering design development
  - ♦ Procurement engagement with the market to support development of capital cost estimate
  - ♦ To protect the schedule, the construction enquiries will be issued to the market with indicative bills. Once the tenders have been received, the proposals will be updated with the latest bills from the engineering team
  - ♦ Development of DFS CAPEX and OPEX
  - ♦ Other studies and support for external consultants
  - ♦ Development of the Project Execution Plan (PEP) and Construction Schedule
  - ♦ QRA.



# Summing up - Promising results from the Prefeasibility study

- ✓ Robust dual-mine operation with high-quality garnet and rutile
- ✓ Low investments
- ✓ Attractive project economics
- ✓ Definitive Feasibility Study targeted in Q4 2018



# APPENDIX



# Key figures (1/2)

Project Financials	Unit	Value
Pre-tax NPV @ 8.0%	US\$ M	332
Pre-tax IRR	%	23.8
Payback Period	years	4.1
Net Project Pre-tax Cashflow (Undiscounted)	US\$ M	1,613
Post-tax NPV @ 6.8%	US\$ M	305
Post-tax IRR	%	20.8
Pre-tax Opportunity NPV @ 8.0%	US\$ M	465
<b>Production Capacity</b>		
Initial Production Capacity ROM	Mtpa	1.5
<b>Capital Expenditure</b>		
Initial Capital Expenditure for Open Pit and Processing Plant	US\$ M	207.2
Deferred Capital Expenditure for Underground Mine (Year 13)	US\$ M	16.9
<b>Operating Cost</b>		
Total Operating Cost	US\$/ROM tonne	16.28
Total Operating Cost	US\$/Sales tonne	86.92

Mining and Processing		
Open Pit Life	years	16
Total Open Pit Ferro-eclogite Ore Production	Mt	22.6
Underground Life	years	13
Total Underground Ferro-eclogite Ore Production	Mt	19.4
Total Project Mine Life	years	29
Total Project Ferro-eclogite Ore Production (LOM)	Mt	41.9
Ferro Ore Grade – Rutile *	%	3.46
Rutile Recovery*	%	58.5
Ferro Ore Yield – Garnet *	%	17.47
<b>Rutile and Garnet Sales (Average for First 5 Years of Operation)</b>		
Rutile Sales	Tonnes per annum	30,525
Rutile Sales Revenue	US\$ M per annum	32.7
Garnet Sales	Tonnes per annum	176,000
Garnet Sales Revenue	US\$ M per annum	44.0
Garnet basket price	US\$ per tonne	250
Rutile price	US\$ per tonne	1,070



## Key figures (2/2)

Activity	Units	Life of Mine
<b>Open Pit Mining</b>		
Production start		2021
Capacity	Mtpa	1.5
Life	years	16
Waste Mined	kt	30,446
Ferro Ore Mined	kt	22,616
Strip Ratio	tonne waste: tonne ore	1.34
<b>Underground Mining</b>		
Production start		2034
Capacity	Mtpa	1.5
Life	years	13
Waste Mined	kt	10,020
Ferro Ore Mined	kt	19,432
<b>Feed to Plant *</b>		
Ferro Ore Feed to Plant	kt	41,896
Ferro Ore Grade – Rutile	%	3.46
Ferro Ore Grade – Garnet	%	40.45

\* Diluted by waste rock: 4% for open pit and 6% for underground

Upfront Capital Estimate	US\$ M
Open Pit Mining	10.027
Comminution	16.802
Mineral Processing	61.573
Tailings Handling and Disposal	7.045
Product Storage and Loadout Facilities	13.108
Infrastructure	22.565
Indirects (excluding contingency)	41.834
Contingency	34.222
<b>Total</b>	<b>207.176</b>

Table 21-2: Deferred Capital Estimate for Underground Mining

Deferred Capital Estimate – Underground Mining	US\$ M
Underground Mining	7.833
Comminution	2.970
Indirects (excluding contingency)	2.747
Contingency	3.381
<b>Total</b>	<b>16.931</b>



# Mine plan key production statistics

Activity	Units	Total – Life of Mine	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
<b>Open Pit Mining</b>																
Waste Mined	kt	30,446	2,139	1,866	1,377	1,202	1,670	1,787	1,151	893	3,238	3,608	1,895	3,090	3,512	1,599
Ferro Ore Mined (before losses and dilution)	kt	22,616	1,000	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,410
<b>Underground Mining</b>																
Waste Mined	kt	10,020	-	-	-	-	-	-	-	-	-	-	-	-	-	226
Ferro Ore Mined (before losses and dilution)	kt	19,432	-	-	-	-	-	-	-	-	-	-	-	-	-	90
<b>All Mining</b>																
Total Waste Mined	kt	40,466	2,139	1,866	1,377	1,202	1,670	1,787	1,151	893	3,238	3,608	1,895	3,090	3,512	1,826
Total Ferro Ore Mined (before losses and dilution)	kt	42,048	1,000	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Total Ferro Ore Mined Rutile Grade (before losses and dilution)	%	3.72	3.98	3.69	3.69	3.95	3.73	3.57	3.53	3.76	3.41	3.77	3.87	3.86	3.81	3.80
Total Ferro Ore Mined Garnet Grade (before losses and dilution)	%	40.3	39.6	39.7	39.9	41.6	40.1	39.7	40.6	41.2	35.4	35.2	35.0	35.8	36.6	40.7
<b>Feed to Plant</b>																
Ferro Ore Feed to Plant	kt	41,896	988	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482	1,482
Ferro Ore Grade - Rutile	%	3.46	3.83	3.55	3.55	3.80	3.59	3.43	3.39	3.61	3.27	3.62	3.72	3.71	3.66	3.65
Ferro Ore Yield - Garnet	%	17.47	16.72	17.63	17.63	17.63	17.63	17.63	17.63	17.63	17.63	17.63	17.63	17.63	17.63	17.63
<b>Plant Production and Sales</b>																
Rutile Produced	kt	910.4	20.2	32.4	32.3	34.6	32.7	31.3	30.9	32.9	29.9	33.0	34.0	33.8	33.4	33.3
Rutile Sales	kt	910.4	20.2	32.4	32.3	34.6	32.7	31.3	30.9	32.9	29.9	33.0	34.0	33.8	33.4	33.3
Garnet Produced	kt	7,318.1	165.2	261.3	261.3	261.3	261.3	261.3	261.3	261.3	261.3	261.3	261.3	261.3	261.3	261.3
Garnet Sales	kt	6,956.2	140.0	158.0	175.0	194.0	213.0	234.0	257.0	261.3	261.3	261.3	261.3	261.3	261.3	261.3

Activity	Units	Total – Life of Mine	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
<b>Open Pit Mining</b>																	
Waste Mined	kt	30,446	862	556	-	-	-	-	-	-	-	-	-	-	-	-	-
Ferro Ore Mined	kt	22,616	1,004	1,201	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Underground Mining</b>																	
Waste Mined	kt	10,020	180	131	498	603	880	781	1,312	163	78	265	1,188	548	405	1,962	802
Ferro Ore Mined	kt	19,432	496	299	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	548
<b>All Mining</b>																	
Total Waste Mined	kt	40,466	1,042	687	498	603	880	781	1,312	163	78	265	1,188	548	405	1,962	802
Total Ferro Ore Mined (before losses and dilution)	kt	42,048	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	548
Total Ferro Ore Mined Rutile Grade (before losses and dilution)	%	3.72	3.89	3.73	3.52	3.74	3.89	3.78	3.99	3.61	3.51	3.78	3.56	3.40	3.74	3.64	3.57
Total Ferro Ore Mined Garnet Grade (before losses and dilution)	%	40.30	41.0	41.4	42.2	41.8	41.1	41.0	43.6	42.4	44.5	43.9	41.4	39.7	44.3	37.3	41.9
<b>Feed to Plant</b>																	
Ferro Ore Feed to Plant	kt	41,896	1,482	1,482	1,511	1,511	1,511	1,511	1,511	1,511	1,511	1,511	1,511	1,511	1,511	1,511	552
Ferro Ore Grade – Rutile	%	3.46	3.74	3.59	3.32	3.53	3.67	3.57	3.76	3.40	3.31	3.56	3.36	3.20	3.53	3.43	3.37
Ferro Ore Yield – Garnet	%	17.47	17.63	17.63	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31	17.31
<b>Plant Production and Sales</b>																	
Rutile Produced	kt	910.4	34.1	32.7	30.9	32.8	34.1	33.2	35.0	31.6	30.8	33.1	31.2	29.8	32.8	31.9	11.4
Rutile Sales	kt	910.4	34.1	32.7	30.9	32.8	34.1	33.2	35.0	31.6	30.8	33.1	31.2	29.8	32.8	31.9	11.4
Garnet Produced	kt	7,318.1	261.3	261.3	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	95.5
Garnet Sales	kt	6,956.2	261.3	261.3	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	261.5	95.5

