Ionic Rare Earths Limited

IXR.AX

A research platform of MST Financial

13 February 2024

Momentum Building; Mining Licence Granted

NEED TO KNOW

- Mining Licence approved
- New Executive Chair appointed
- Momentum on drilling, magnet recycling, demo plant

Mining Licence approved; major step towards development: The Large-Scale Mining Licence was officially signed on 17 January 2024 by the Ugandan Minister of Energy and Mineral Development, representing the first such licence to be issued in Uganda under the Mining Act of 2022. This is a major step for IXR towards the development of the Makuutu Project.

New Executive Chair appointed, adds strong skill set to board: Brett Lynch has been appointed to the board as Executive Chairman. Mr Lynch has a strong background in mining and mining-related businesses with over 30 years' experience in international business development and management. Mr Lynch has also subscribed to A$1.5m of IXR shares.

Momentum continues in executing 3-pillar strategy: IXR has maintained momentum, with the magnet recycling plant moving to 24-hour operations, encouraging drilling results received, and the on-site demonstration plant working towards 1QCY24 completion and delivery of product to customers.

Investment Thesis

Essential elements for the modern economy: IXR is progressing toward becoming an integrated and significant producer of critical and strategic rare earths (REEs), which are essential to green energy and modern technologies. IXR's flagship Makuutu Rare Earths Project in Uganda is well positioned to produce high-value heavy rare earths (HREEs) as a long-life, low-cost asset.

Downstream magnet recycling: IXR's Ionic Technologies subsidiary (100%) has developed processes for separating and recovering REEs from mining ore concentrates and recycled permanent magnets (NdFeB). The proprietary technology efficiently recovers high-grade magnet rare earth elements from diverse magnet grades, contributing to the production of high-performance magnets vital for sectors such as EVs and wind turbines.

Long-term supply chain partnership opportunities: IXR is poised to develop new Western supply chains, integrating mining, refining, and recycling. It has two opportunities in the emerging Western REE supply chain to become a circular producer: it is studying a US refining plant and developing a magnet recycling program in the UK, positioning IXR as a leader in magnet REE recycling.

Valuation: $0.10/share (unchanged)

Our IXR valuation is unchanged at A$0.10/share, fully diluted. Our valuation is based on IXR's Makuutu Project, using a discount rate of 12%. We have applied a 75% risk weighting. Our valuation incorporates the increase in ownership of Makuutu from 60% to 94% and the related issuance of shares to pay for this increased ownership as well as recent share issues to the Executive Chairman.

Risks

Key risks include an increase in development capital costs, technological risks with processing REEs, and country risks with operating in Uganda.

Equities Research Australia

Mining and Energy

Michael Bentley, Senior Analyst
michael.bentley@mstaccess.com.au

Ionic Rare Earths Limited (ASX: IXR) is focused on developing its flagship Makuutu Rare Earths Project in Uganda into a significant long-life, low-cost supplier of high-value critical and heavy rare earths. It also plans to become a refiner and recycler of sustainable and traceable magnet and heavy rare earths.

https://ionicre.com.au/

Valuation	A$0.10 *(unchanged)*
Current price	A$0.017
Market cap	A$81m
Cash on hand	A$4.54m *(31 December 2023)*

Upcoming Catalysts/Newsflow

1Q2024	First product from Makuutu Demonstration Plant
1Q2024	Secure project funding for Makuutu
CY2024	Commence construction of Makuutu

Share Price (A$)

Source: FactSet, MST Access.

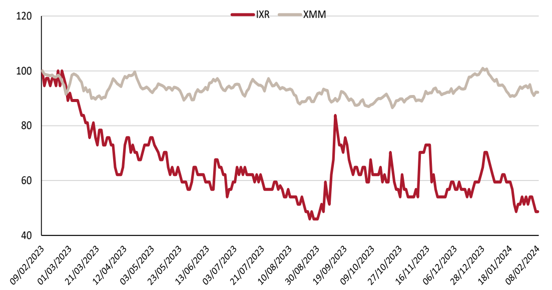
Financial Summary: Ionic Rare Earths Limited

IONIC RARE EARTHS LIMITED — **IXR.AX**

Year end June 30

MARKET DATA		
Share Price	A$/sh	0.017
52 Week Low	A$/sh	0.016
52 Week High	A$/sh	0.037
Market Cap (A$m)	A$m	73
Net Debt / (Cash) (A$m)	A$m	(5)
Enterprise Value (A$m)	A$m	68
Shares on Issue	m	4,308
Options/Performance shares	m	1,002
Other Equity	m	4,228
Potential Diluted Shares on Issue	m	9,538

12-Month Relative Performance vs S&P/ASX Metals & Mining



INVESTMENT FUNDAMENTALS		Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Reported NPAT	A$m	(5)	(1)	(4)	(9)	21
Underlying NPAT	A$m	(5)	(1)	(4)	(9)	21
EPS Reported (undiluted)	¢ps	(0.1¢)	(0.2¢)	(0.1¢)	(0.1¢)	0.2¢
EPS Underlying (undiluted)	¢ps	(0.1¢)	(0.0¢)	(0.0¢)	(0.1¢)	0.2¢
P/E Reported (undiluted)	x	n/m	n/m	n/m	n/m	n/m
P/E Underlying (undiluted)	x	n/m	n/m	n/m	n/m	n/m
Operating Cash Flow / Share	A$	(0.00)	(0.00)	(0.00)	(0.00)	0.00
Price / Operating Cash Flow	x	(18.4)	(5.8)	(28.2)	(12.6)	6.5
Free Cash Flow / Share	A$	(0.00)	(0.00)	(0.00)	(0.02)	0.00
Price / Free Cash Flow	x	(4.6)	(5.8)	(28.2)	(1.0)	6.5
Book Value / Share	A$	0.01	0.01	0.02	0.01	0.02
Price / Book	x	1.36	1.54	1.08	1.17	1.03
NTA / Share	A$	0.01	0.01	0.02	0.01	0.02
Price / NTA	x	1.36	1.54	1.08	1.17	1.03
Year End Shares	m	3,873	3,946	8,536	8,536	8,536
Market Cap (spot)	A$m	66	67	145	145	145
Net Cash / (Debt)	A$m	27	11	100	(46)	(23)
Enterprise Value	A$m	39	56	45	191	168
EV / EBITDA	x	n/m	n/m	n/m	n/m	1.6x
Net Debt / Enterprise Value		(0.4)	(0.2)	(1.5)	0.7	0.3

PRODUCTION AND PRICING		Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
CAPEX	$AUD	(0)	-	-	(134)	-
IXR REO Basket Price (excl. payability)	$US/kg	77	88	96	101	100
AUDUSD	:	0.73	0.70	0.67	0.67	-

Profit & Loss (A$m)	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Revenue	-	-	-	-	129
Expenses	(5)	-	(6)	(6)	171
EBITDA	**(5)**	**-**	**(6)**	**(6)**	**43**
D&A	(0)	(1)	(0)	(0)	(0)
EBIT	**(5)**	**(1)**	**(6)**	**(6)**	**42**
Interest	0	-	1	(8)	(13)
Tax	-	-	2	4	(9)
Underlying NPAT	**(5)**	**(1)**	**(4)**	**(9)**	**21**
Exceptionals					
Reported Profit	**(5)**	**(1)**	**(4)**	**(9)**	**21**

Balance Sheet (A$m)	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Cash	27	11	226	91	113
Receivables	1	1	1	1	9
Inventory	-	1	1	1	14
PP&E	0	2	2	136	130
Exploration	12	2	2	2	2
Other	9	28	28	28	28
Assets	**49**	**45**	**260**	**258**	**295**
Creditors	1	1	1	1	15
Debt	-	-	126	136	136
Other	0	0	(2)	(4)	2
Liabilities	**1**	**1**	**125**	**133**	**154**
Shareholder's Equity	**48**	**44**	**134**	**125**	**142**

Cashflow (A$m)	Jun-22	Jun-23	Jun-24e	Jun-25e	Jun-26e
Net Cash From Operations	**(4)**	**(12)**	**(5)**	**(11)**	**22**
Capex	(0)	-	-	(134)	-
Exploration	(9)	-	-	-	-
Other	(2)	-	-	-	-
Net Cash From Investing	**(11)**	**-**	**-**	**(134)**	**-**
Equity	30	1	94	-	-
Borrowings	-	-	126	10	-
Dividend					
Net Cash From Financing	**30**	**1**	**220**	**10**	**-**
Effects of FX	(0)	0	-	-	-
Net Increase / (Decrease) in Cash	**16**	**(10)**	**215**	**(136)**	**22**

Source: Company data, MST Access.

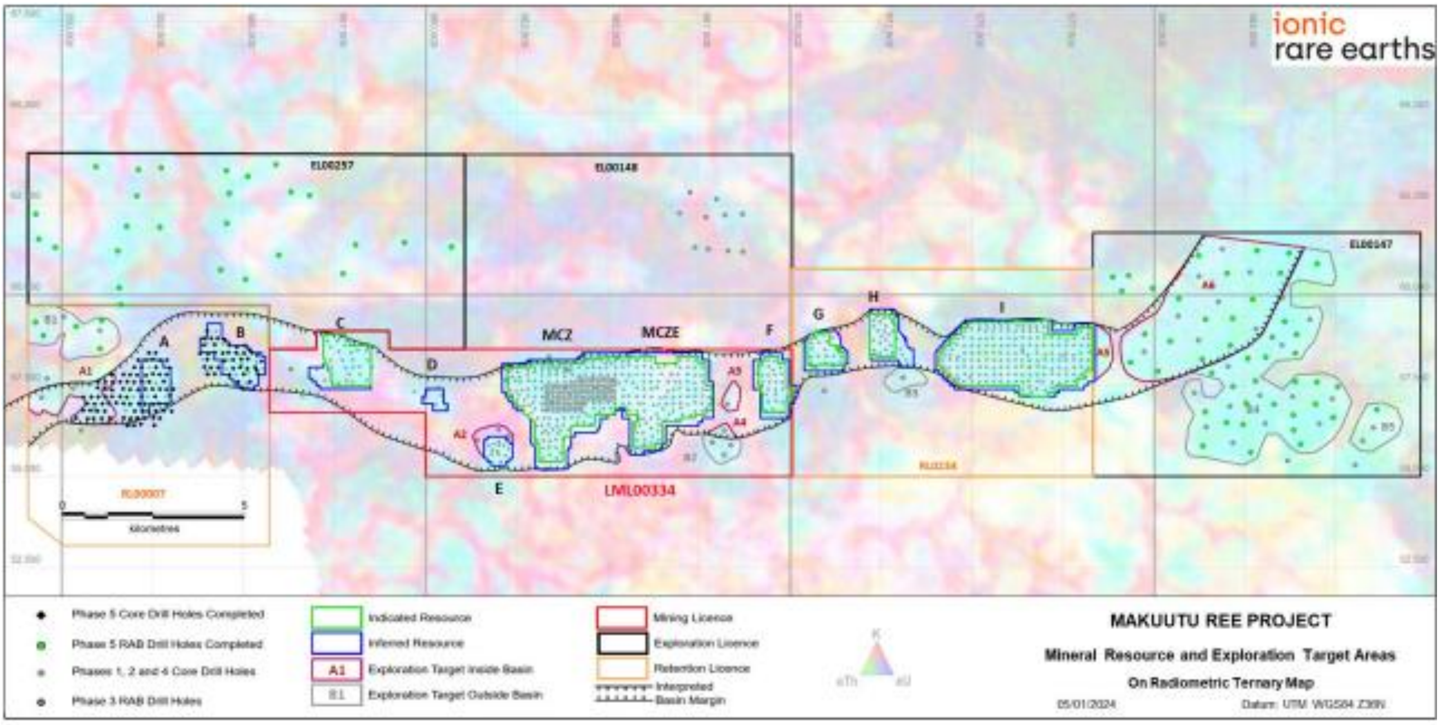
Mining Licence Approved – Major Step Towards Development; FID in CY24

In a major milestone for the company, the Large-Scale Mining Licence for the Makuutu Project was approved by the Ugandan Government on 17 January 2024. The award, which represents the first large-scale mining licence to be issued in Uganda under the Mining Act of 2022, adds to the flagship project status awarded to Makuutu in 2022 and reflects the strong support received from the government.

IXR has been working with the Ugandan authorities for some time to obtain the approval of the Mining Licence, with the process taking longer than both the company and the market had expected. However, the finalisation of the mining licence now enables discussions with potential strategic and supply chain partners to progress to the next stage to bring Makuutu and a new supply of magnet and heavy rare earths to market.

The project is aiming for final investment decision (FID) later this year, and first product to customers in early 2026.

Figure 1: Makuutu Project area showing Stage 1 Mining Licence area awarded (centre, red boundary LML00334)



Source: IXR.

Executive Chair Appointed – Adds Strong Skill Set; Invests A$1.5m into IXR

Brett Lynch has been appointed Executive Chairman of IXR, effective immediately. Mr Lynch will work closely with IXR's board and management to oversee the strategic direction of the company. The board had been searching for a new Chair since mid-2023 when previous Chair Trevor Benson resigned for personal reasons.

We believe that Mr Lynch has strong qualifications and experience for the job and will be of great assistance to Managing Director Tim Harrison in delivering IXR's strategy, working towards its objective to be a leading miner, refiner, and recycler of heavy rare earths.

Strong and relevant experience

Mr Lynch is a qualified mining engineer and has over 30 years' experience in international business development and management.

From 2019 until August 2023, Mr Lynch was Managing Director of Sayona Mining Limited (ASX: SYA), where the company grew a low-carbon-footprint lithium supply chain into the North American market. During this time, Mr Lynch oversaw Sayona's growth from a junior explorer to an ASX 200 company.

Significant investment into IXR by the new Executive Chairman

Mr Lynch has made a A$1.5m investment in IXR at $0.018 per share (the closing price on 23 January 2024). We believe that this investment reflects Mr Lynch's confidence in the company's asset base and strategy as well as his commitment to his new role.

Details of the Executive Chairman package

- Base salary: $35,000 per month ($420,000 per annum) inclusive of superannuation.
- Purchase 83,333,333 shares at $0.018 per share
- Sign-on incentives, subject to the receipt of shareholder approval:
  - issued 10,000,000 shares on commencement.
- Long-term incentives, subject to the receipt of shareholder approval: 30,000,000 Director Performance Rights, each of which entitle the holder to subscribe for one share upon satisfaction of the vesting condition, as shown in Figure 2.

Figure 2: Long-term incentives (Director Performance Rights) in the Executive Chairman package

Number of Director Performance Rights	Conditions
10,000,000	To vest on the 12-month anniversary of commencement
3,000,000	To vest upon successfully securing any offtake for the Makuutu product
3,000,000	To vest upon the company's Board making a FID on the Makuutu Project to construction
3,000,000	To vest upon the Makuutu Demonstration Plant producing more than 30 tonnes of Mixed Rare Earth Carbonate (MREC) at the target product specification
5,000,000	To vest upon successfully securing a strategic partnering investment within the company or Makuutu
3,000,000	To vest upon successfully securing offtake, or a strategic partnering investment within Ionic Technologies
3,000,000	To vest upon FID to progress a commercial magnet recycling plant with Ionic Technologies

Source: IXR.

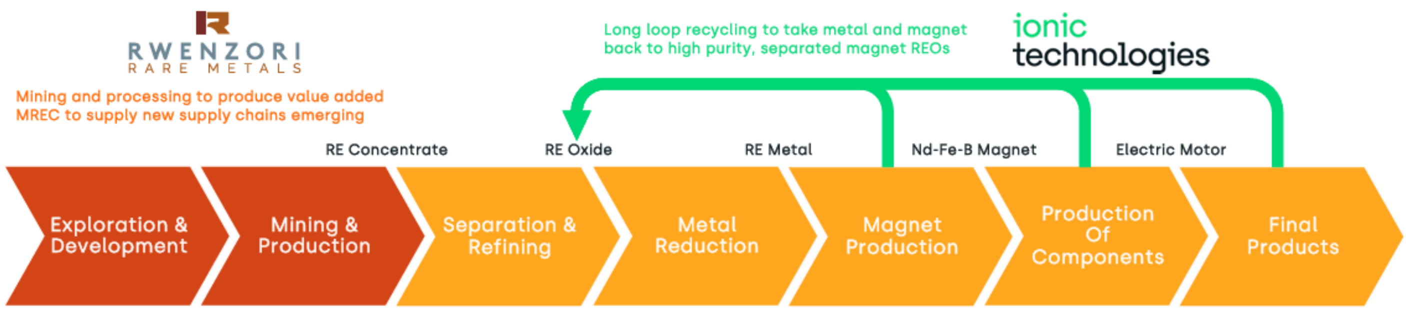
Momentum Continues – Makuutu Most Advanced IAC[1] Project, Drilling Update and Recycling

IXR's 3-pillar strategy

Momentum is building for IXR to deliver its 3-pillar strategy (see Figure 3), which aims to supply a circular economy of sustainable and traceable magnet and heavy rare earth element (REE) products for EVs, offshore wind turbines, communication, and key defence initiatives. The company has defined the key elements of its strategy as follows:

- **Pillar 1: to develop its existing flagship project**, the Makuutu Rare Earths Project in Uganda, to be a long-term, low-capital supplier of high-value magnet and heavy REOs
- **Pillar 2: to develop a potential US-based heavy rare earth refinery** to produce value-added, separated REOs and compounds and cement the company's place in new, ex-China rare earths supply chains
- **Pillar 3: to develop a downstream magnet recycling business.**

Figure 3: IXR's 3-pillar strategy and role in establishing a new western supply chain



Source: IXR.

Makuutu the most advanced IAC project in the world

Makuutu is the most advanced new IAC project globally which has product available for western customers. Figure 4 shows the advanced status of Makuutu compared to the other global IAC projects.

Figure 4: Status of the Makuutu Project compared with comparable IAC projects globally

Project (Owner) (Ticker)	Location	Market Cap	Mineral Resource Estimate	Scoping Studying / PEA	Pre-Feasibility Study	Ore Reserve Estimate	Definitive Feasibility Study	Demo Plan	Env Permits	Mining License	Offtake	Final Investment Decision	Target First Production
Pela Ema Mineracao Serra Verde (Private)	Brazil	N/A	✓	-	✓	✓	✓	✓	✓	✓	China		✓
Makuutu Ionic Rare Earths Ltd (ASX: IXR)	Uganda	A$94m	✓	✓	-	✓	✓	Q1 2024	✓	✓		H2 2024	2026
Penco Module Aclara Resources Inc (TSX: ARA)	Chile	C$82m	✓	-	✓	✓	-	✓	✗				
Carina Module Aclara Resources Inc (TSX: ARA)	Brazil	C$82m	✓	✓									
Koppamurra Australian Rare Earths (ASX:AR3)	Australia	A$22m	✓										
Caldeira Meteoric Resources Ltd (ASX: MEI)	Brazil	A$470m	✓							✓			
Colossus Viridis Mining & Minerals Ltd (ASX: VMM)	Brazil	A$63m											
Bluebush Alvo Minerals Ltd (ASX: ALV)	Brazil	A$16m											
Brazilian Rare Earths Ltd (ASX:BRE)	Brazil	A$318m	✓										
Harena Resources Pty LtdCitius Resources Plc (Private)	Madagascar	N/A	✓										

Source: IXR.

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[1] IAC – Ionic Absorption Clay

Phase 5 infill drilling continues to be encouraging

IXR has been conducting an expansive drilling campaign with 3 distinct pathways:

- infill drilling the current Makuutu western resource Retention Licence (RL) 00007 to move the resource category to Indicated to support the next mining licence application (MLA);
- drilling on EL00147, located at the eastern end of the extensive licence holding at Makuutu and
- drilling on previously unexplored EL00257 to the north-west of the licence holding.

Latest results from infill drilling

While the area was previously tested with 400m-spaced holes in 2021, the 2023 Phase 5 program decreased the hole spacing to approximately 200m (see Figure 5). The program is intended to increase resource estimation confidence from Inferred to Indicated status on resource areas A and B, and to test extensions of those areas to expand the mineral resource area. The updated Mineral Resource Estimate (MRE) is expected in 1Q2024.

Assay results for 76 holes of the 128-hole Phase 5 resource infill and extension drilling program completed on RL00007 have now been received.

Assays from the latest 20 holes (11 of which are extensions to the MRE and 9 of which are MRE Area A infill holes) have been received, with mineralisation intersections in all holes.

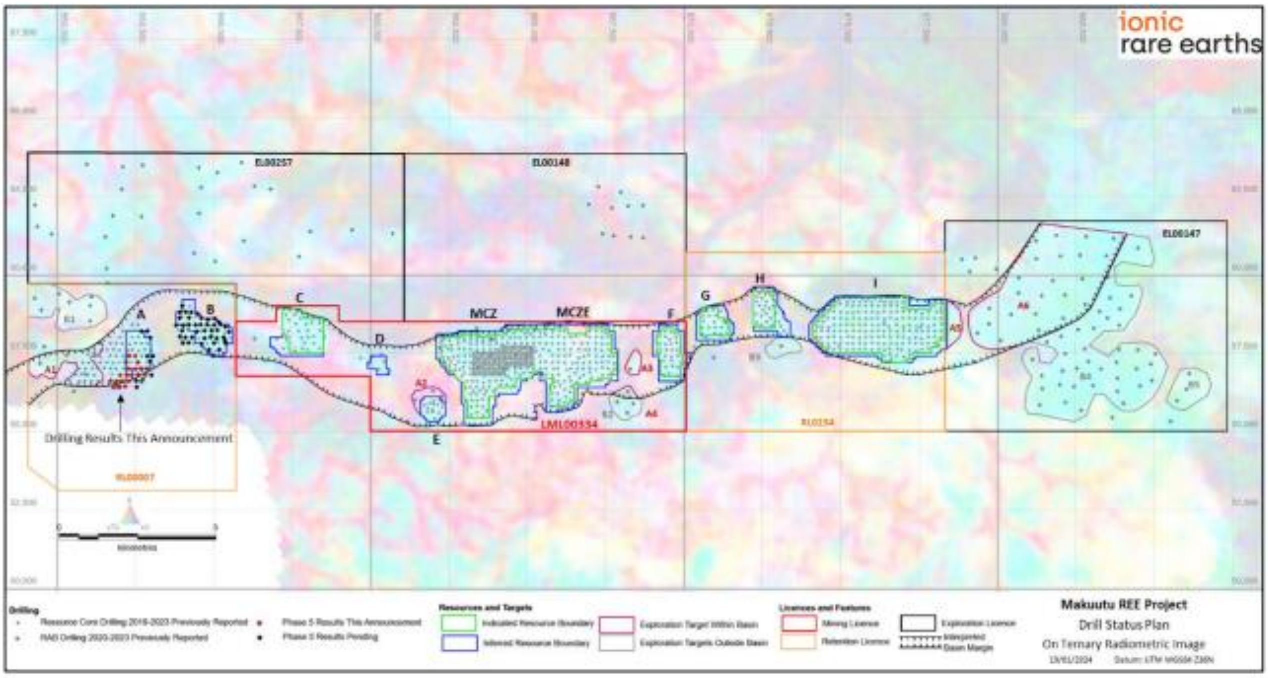
Key results:

- 5.3 metres at 1,044 ppm TREO from 2.7 metres
- 17.1 metres at 1,003 ppm TREO from 4.8 metres
- 16.2 metres at 713 ppm TREO from 4.0 metres
- 11.0 metres at 691 ppm TREO from 4.0 metres
- 14.6 metres at 684 ppm TREO from 6.1 metres.

The infill holes to date continued zones of thicker and often higher-grade intervals than the original 400m-spaced drill holes used to estimate the Inferred Resource.

The remaining 52 drill holes are currently being analysed at the laboratory in Perth.

Figure 5: Makuutu project phase 5 drill status plan



Source: MST Access.

Makuutu Demonstration Plant progresses towards 1QCY24 start

The Makuutu Demonstration Plant technical facility aims to further optimise metallurgical test work and provide further technical validation basis for grade control, mine design, material handling, metallurgical reconciliation, and construction activity, whilst also supporting project financing and strategic partner activity.

Construction of the technical facility is nearing completion (see Figure 6), with off-site testing of metallurgical equipment underway prior to installation.

The demonstration plant is essential to validating the mine development plan and generating mixed rare earth carbonate (MREC) samples for offtake to potential partners in 1Q2024. The plant will also demonstrate IXR's position as a strategic resource for near-term development and long-term supply of magnet and heavy rare earth oxide.

Figure 6: Makuutu Demonstration Plant nearing completion on site in Uganda

Source: IXR.

Recycling plant moves to 24-hour production

Ionic Technologies (IXR's 100%-owned magnet recycling subsidiary in the UK) has developed separation and refining technology that can be applied to the recycling and refining of individual magnet rare earths from used permanent (NdFeB) magnets. The hydrometallurgical process is able to deliver high-purity separated magnet rare earth oxides, independent of variability in composition of magnet feedstock, enabling the creation of sustainable, traceable, and sovereign rare earth supply chains.

24/7 operation has commenced at the Ionic Technologies Magnet Recycling Demonstration Plant in Belfast with the intention to produce high-purity separated rare earth oxides at the design production capacity of 10 tonnes per annum (tpa) from 30 tpa of end-of-life permanent magnets or production swarf.

This production will flow immediately into the UK Government–supported CLIMATES collaboration with Ford Technologies and Less Common Metals (LCM). The continuous operation allows IXR to deepen supply chain relationships and provided additional data to support the completion of the feasibility study, (targeted for mid CY2024) on a commercial plant, and is de-risking the technology and the flowsheet.

See Appendix 1 for a refresher on the landmark recycling agreement with Ford, Less Common Metals and the UK Government.

Refresher on IXR moving to 94% ownership of the Makuutu Project

An important move – opens up funding, offtake, strategic partners

IXR has signed a conditional Share Purchase Agreement (SPA) to acquire a further 34% in local Ugandan operating entity Rwenzori Rare Metals Limited (RRM) which owns the Makuutu Rare Earths Project, taking IXR's ownership to 94% on completion.

This increased ownership of its flagship project is crucial for IXR as it positions the company strongly to further discussions on project funding and offtake agreements, as well as key discussions with potential strategic partners in the project.

Terms of the deal

For acquiring the shares held by RRM in the project, IXR will issue consideration on completion as follows.

Ordinary shares: 425,000,000 fully paid ordinary shares in IXR.

Consideration Rights: *Tranche 1 performance rights* – 350,000,000 performance rights vesting on satisfaction of **both** of the following milestones, on or before 3 years after completion:

- issue of the Mining Licence for the Stage 1 development of Makuutu over RL1693 (MLA TN03834) **– COMPLETED LML00334**
- the volume weighted average price (VWAP) of IXR shares for a period of 30 consecutive trading days exceeding $0.05 (the VWAP Condition).

Tranche 2 performance rights – 350,000,000 performance rights vesting on satisfaction of **both** of the following milestones, on or before 5 years after completion:

- IXR obtaining binding funding commitments (debt and/or equity) to fully fund construction at Makuutu, and any conditions precedent to drawdown being satisfied or waived
- the VWAP Condition being satisfied.

Bonus Consideration: Additionally, if the Consideration Rights vest in accordance with their terms, IXR has also agreed to pay Bonus Consideration as **one** of the following:

- 135,000,000 IXR shares (the Bonus Consideration Shares); **or**
- the cash equivalent of the Bonus Consideration Shares based on the 5-day VWAP at the time; **or**
- a combination of cash and shares (capped at the cash equivalent of 135,000,000 IXR shares).

Voluntary escrow: The parties have agreed to put into voluntary escrow the ordinary IXR consideration shares (for a period of 12 months), as well as the IXR shares that vest in relation to the Tranche 1 performance rights (for 12 months) and Tranche 2 performance rights (for 6 months).

Shareholder approval required

Shareholder approval is required for the SPA to proceed. IXR expects to request this approval Q12024.

Valuation Stays at A$0.10/Share, Fully Diluted; Higher Ownership Offsets More Share Capital

After a review on the back of IXR's increased Makuutu ownership and increased share capital, our valuation remains unchanged at A$0.10/share, fully diluted. Our valuation is derived from our discounted cash flow (DCF) analysis of IXR's flagship Makuutu Project and a 75% probability risk weighting.

Valuation summary and key changes

We have updated our valuation to include the shares issued to the new Executive Chairman and his purchase of A$1.5m of shares at A$0.018 each, as well as an additional placement of A$0.5m at A$0.018.

Figure 7 summarises our valuation, using a discount rate of 12%. Our valuation assumes a A$84m capital raise (60/40 debt to equity for IXR's share of capex) at A$0.027/share (a 35% premium to the current share price – see Figure 8).

Our fully diluted share count is 8.988 bn.

Figure 7: Base-case valuation summary for IXR

Ionic Rare Earths Valuation				
	Discount rate	**Risk weighting**	**AUD$mn**	**AUD$/sh**
Makuutu (94%)	12.0%	75.0%	843	0.09
Total operating assets			**843**	**0.09**
Corporate/SG&A	12.0%		(30)	(0.00)
Net cash/(debt) ($AUD)			99	0.01
Net Asset Value			**912**	**0.10**
Current Share Price				0.020
Upside				407%

Source: MST Access.

Figure 8: Summary of debt and equity financing

Financing - 60/40 Debt to Equity	
Capex IXR 94% Ownership - First Module ($Am)	**210.4**
Debt Arrangement (60%)	
Debt ($Am)	126.3
Interest Rate	12%
Equity Raise (40%)	
Equity Raised ($Am)	84.2
Issued Price (35% premium to current price) A$ cps	0.027
Shares Issued (m)	3,118
Options/Performance Rights (m) (including Makuutu Consideration and Bonus Rights)	1002

Source: MST Access.

Our key valuation assumptions

Our critical valuation assumptions are shown in Figure 9.

We believe our pricing assumptions are conservative, given the critical status of the Makuutu product basket. We also assume a conservative head grade in the later years of the project.

Our base-case NPV valuation is based on a mine plan consistent with Stage 1 DFS, but it assumes a final plant capacity of 15 mtpa ROM throughput instead of the DFS's 5 mtpa. We consider this a reasonable assumption given the resource size (currently: 532 mt @ 640ppm) and anticipated demand.

IXR must fund its 94% share of the project, requiring US$84m. We assume a 60/40 debt-to-equity split (per company guidance) and an equity raising at a price of A$0.027/share. The remaining three modules (2.5 mtpa of additional processing capacity) will be self-funded through Makuutu's free cash flow.

Figure 9: Our Stage 1 DFS assumptions underpinning our base-case valuation

Assumptions (LOM)	MSTe
PROJECT ASSUMPTIONS (Real FY23)	
Project Ownership (%)	94%
Strip Ratio (waste : ore)	0.57
Mixed Rare Earth Carbonate (% REO)	>90%
TREO Average Recovery (%)	35.0%
Average REO Produced - ex. Scandium (tpa)	3,263
Mine Life (years)	35
Pre-development Capex - first module (US$m) - for 100% (Real)	144
Major project capital - Incl. pre-development (US$m)	303
Sustaining Capex (US$m)	19
COST & FINANCING ASSUMPTIONS	
Discount Rate - Nominal (%)	12%
Inflation Rate (%)	2%
Capital Raised - IXR 94% Share (A$M)	84
Debt to Equity Split of Capital Raised (%)	60:40
Debt interest rate	12%
Issued Price for Equity raising (A$/share)	0.027
PRICING & EXCHANGE RATE ASSUMPTIONS	
USD/AUD	0.67
Average REO Price LOM (Real) (US$/kg) - incl. Payability factor	86
Royalty Rate (%)	5%
Corporate Tax Rate (%)	30%

Source: MST Access.

Appendix 1: A Refresher on the Landmark Recycling Agreement

Recycling business and strategy – closing the loop

Ionic Technologies (IXR's 100%-owned magnet recycling subsidiary in the UK) has developed IP and processes for separating and recovering REEs from mining ore concentrates, swarf (cuttings and shavings) and recycled permanent magnets. This proprietary technology provides a flexible solution for extracting high-grade REEs from varying magnet grades. It has the potential to provide magnet rare earth oxides (REOs) for the production of modern high-performance magnets, which are integral to sectors such as electric vehicles (EVs) and wind turbines. The recycling business is the third pillar of IXR's three-pillar strategy, and potentially the first to generate revenue.

Demonstration recycling plant in Belfast – grant received September 2022

In September 2022, Ionic Technologies received a £1.72m (~A$2.9m) grant from the UK Government to build a demonstration-scale magnet recycling plant in Belfast, UK. The facility will recycle waste magnets and scrap to produce high-purity REOs, suitable for use in rare earth permanent magnets employed in EVs and offshore wind turbines. IXR expects to produce ~10t of magnet REOs across CY2024 as part of the demonstration plant program.

Latest production progress from the demonstration plant

Ionic Technologies has made substantial progress, initiating commissioning and generating its first magnet REOs at the Belfast demonstration plant. The first batch (from process commissioning) of high-grade magnet REOs included:

- 4.2 kg of Nd_2O_3, grading at 99.7% and ~0.3% Dy_2O_3 (cumulative REO content of 99.99%)
- 0.6 kg of Dy_2O_3, graded at 99.8% (total REO content of 99.9%).

Landmark agreement – Ford gets involved; UK Government chips in

Ionic Technologies has secured a collaboration partnership with Ford and Less Common Metals (LCM) to develop a UK supply chain for recycled magnet rare earths to magnets.

IXR's recycling technologies will be used to produce high-purity REOs from spent magnets and swarf which will then be sent to LCM to produce alloys which are suitable for use in permanent magnets. LCM will then send the alloys to a permanent magnet manufacturer (ex-China) who will produce permanent magnets for testing in Ford's EV-producing plants.

Final aim of agreement – IXR's recycling technology to contribute to magnets that satisfy Ford's standards

The majority of Ford's European Union (EU) production will come from its UK-based Halewood facility, which Ford plans will produce close to half a million units per annum by 2026.

The aim of the agreement is to ensure that IXR's rare earths recycling technology, once implemented into the rare earths production chain, will lead to a sufficiently high-quality permanent magnet product to satisfy Ford's needs for its EV-producing plants in Europe.

Each stage of the process from magnet recycling to EV testing will generate waste (magnets and swarf), including the magnets used in Ford's EV motors. IXR will recycle this material, thus completing a totally circular rare earth supply chain within the UK.

The verification by Ford of the quality of the magnets produced from IXR's recycled materials would be a significant validation of IXR's recycling strategy.

UK Government grants accelerate the process

IXR will receive approximately £750k in direct cash funding as a result of the grants from the UK Government. The grants represent a strong commitment by the UK Government to IXR's recycling facility and, along with the agreement signed with LCM and Ford, will accelerate the development path of the company's recycling strategy.

£1m towards the IXR–LCM–Ford partnership: The UK Government will support the partnership between Ionic Technologies, Ford and LCM via a £1m grant, with Ionic Technologies announced as the major beneficiary and lead collaborator in the focus on delivering the UK's first domestic sourcing of separated high-purity magnet REOs.

A further £1m for recycling feasibility study: The UK Government is providing an additional £1m grant in funding a feasibility study into the construction and supply-side dynamics of a magnet rare earth recycling plant in the UK in collaboration with the British Geological Survey (BGS).

Appendix 2: Understanding Rare Earths – the Metals and the Market

The rare earth elements (REEs) might colloquially be referred to as 'industrial vitamins' because, despite being used in small amounts, they play an important role in various industrial processes and are essential to enabling many modern industrial materials and technologies. The sources of the most valuable rare earths, heavy rare earths, are concentrated in China, which is driving efforts to diversify the supply chain for these essential elements.

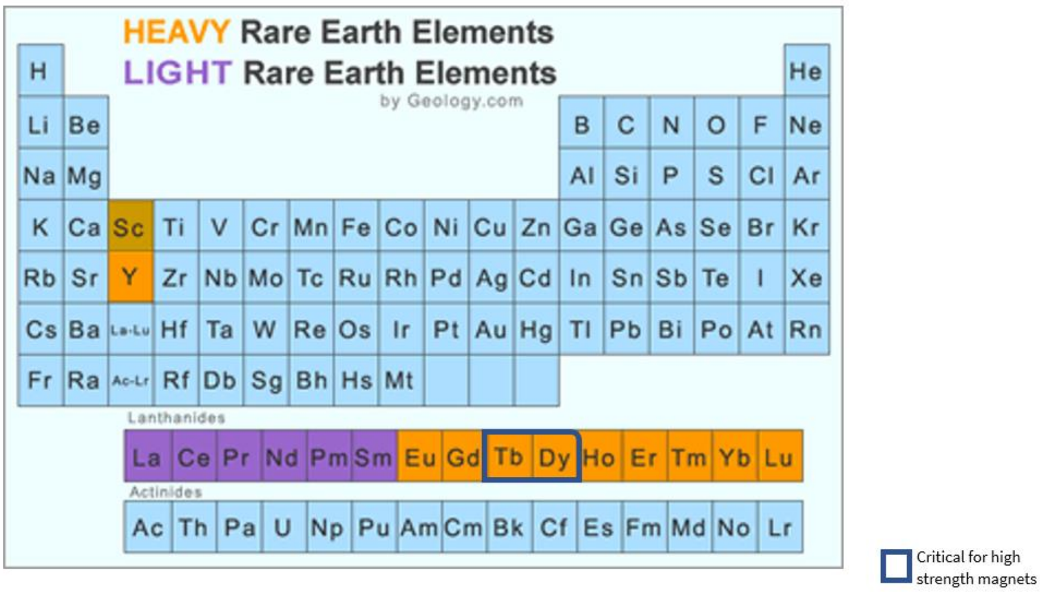
Definition of rare earths: what are they?

The REEs are a group of 15–17 metallic elements composed of the lanthanides on the periodic table, and sometimes also including scandium and yttrium (non-lanthanides) – see Figure 10. These elements, while sharing similar chemical properties, possess distinct physical and magnetic characteristics.

REEs are typically divided into two categories, light and heavy, based on their atomic weight and electron configurations. Heavy rare earth elements (HREEs) have a higher atomic weight compared to light rare earth elements (LREEs).

The REEs are typically abundant in the earth's crust; cerium (Ce) is as abundant as copper, for example. However, because of their geochemical properties, the elements are rarely found in concentrated economic clusters (ore deposits). Typically, economically viable ore deposits will contain concentrations of many or all of the individual REEs.

Figure 10: Rare earth elements (REEs)



Source: Geology.com.

Light rare earths (LREEs) – key to the clean energy transition

LREEs are more commonly found in nature than HREEs and are also more abundant in the earth's crust. They are widely used in a variety of industrial and technological applications, such as catalysts, polishing powders, and glass additives. Of the LREEs, praseodymium (Pr) and neodymium (Nd) are of the most economic interest due to their critical role in rare earth permanent magnets (PMs). Lanthanum (La) and cerium (Ce) are typically the most abundant in economic LREE deposits but are very low value in comparison and are often discarded.

Heavy rare earths (HREEs) – driving value and strategic importance for Makuutu

HREEs typically have higher melting/boiling points and tend to be more magnetically and electrically active. They are also generally more costly than LREEs as they are rarer and harder to extract. Some HREEs are facing shortages, especially dysprosium (Dy) and terbium (Tb), due to high demand.

Ionic adsorption clay (IAC) deposits in southern China and Myanmar are the world's primary source of HREEs today, producing over 95% of global products – some estimates are as high as 98%. This deposit type is informally referred to as 'south China clays.' Thick clay accumulations that host low concentrations of REEs – about 0.04%–0.25% (or 400–2,500ppm) total rare earth oxides (TREO) – form in tropical regions with moderate to high rainfall when REEs are leached by groundwater from granite bedrock.

Thick zones of clay-rich soils develop above the granites, and then mobilised REEs become weakly fixed (by ion adsorption) onto clays in the soils.

Despite their low concentrations of REEs, the clay deposits of south China are economic because the REEs can be easily extracted at low capital costs from the clays with weak salts and acids, and labour costs are low. The IAC deposits are often enriched in high-value HREEs and, given chemical precipitate form, have a higher payability than mineral concentrates, providing a superior return.

Global rare earths market: demand, production, supply and pricing

Permanent magnet use is the most important and highest-growth end use for REEs.

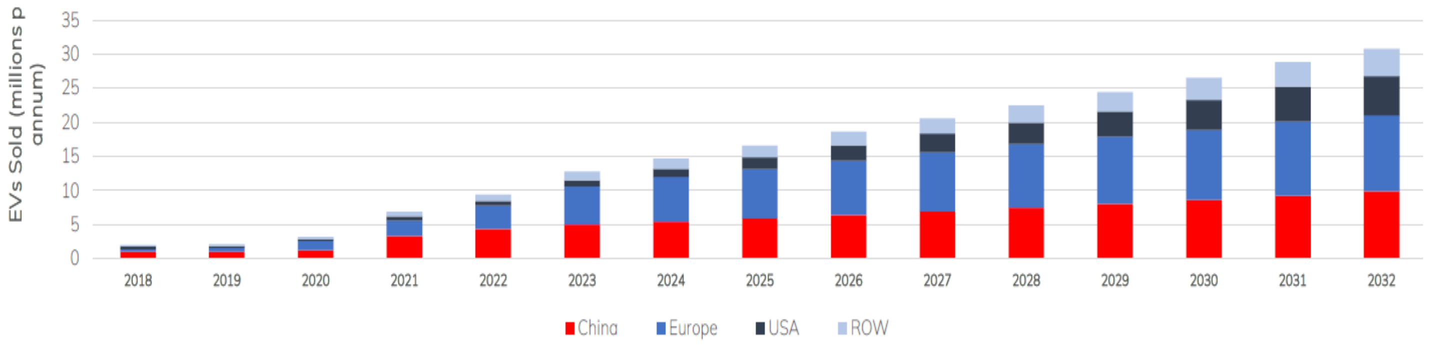
REEs have a wide range of industrial applications, including in rare earth PMs (e.g. NdFeB magnets), catalysts, glass and ceramics, metal alloys, and electronics.

By volume, most rare earth consumption is driven by low-value end uses that consume La and Ce; catalysts, polishing powders, and metallurgical applications. This represents >40% of the end-use categories by volume for rare earths.

However, by market value, PM use is the most important and highest-growth end use for REEs. In 2019, approximately 5,000 tonnes of rare earth PMs were used worldwide in electric vehicles (EVs). This figure is expected to increase significantly by 2030, with estimates ranging from 40,000t to 70,000t of rare earth PMs on a global scale. This is due to growing EV penetration, with the global EV fleet forecast to grow 27% from 2020 (13m EVs) to 2030 (140m), and then 15% per annum to 2040 (565m) – see Figure 11.

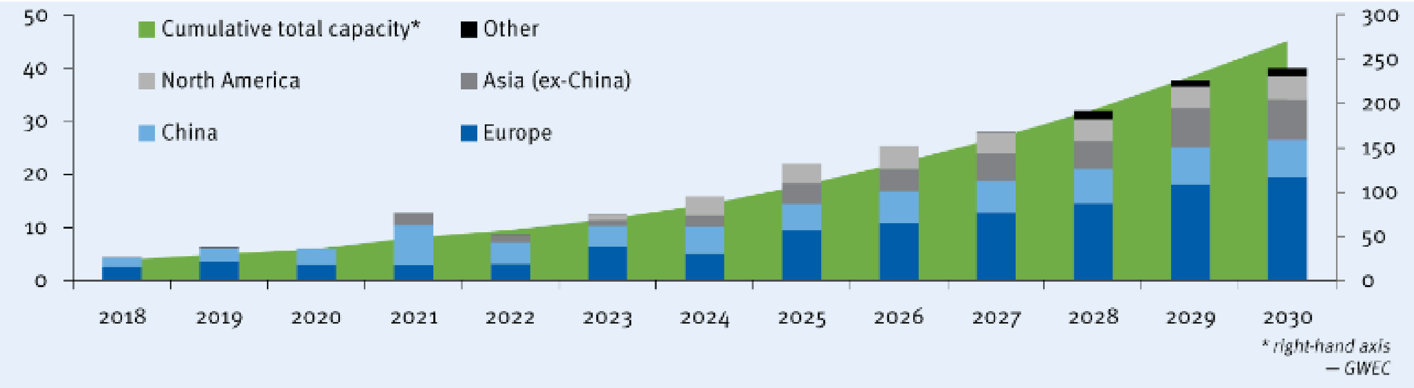
Demand for rare earth PMs is further driven by the use of such magnets in wind turbine generators, with an expected addition of 235GW (25% CAGR) by 2030 (Figure 12).

Figure 11: Global EV sales



Source: IXR, Argus Analytics.

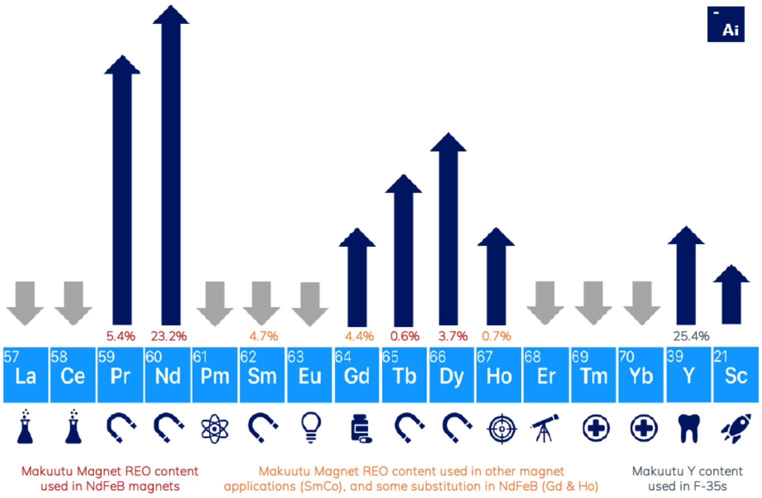
Figure 12: Global offshore wind power additions, 2018–2030 (GW)



Source: IXR.

Forecast demand drives long-term price appreciation for the Makuutu basket, with forecasts shown in Figure 13.

Figure 13: Pricing forecast for the Makuutu basket



Source: IXR.

Uses in rare earth permanent magnets (which underpin key modern technologies)

The use of magnet REEs and boron (B) is crucial for the design of 'neodymium' (NdFeB) PMs, commonly present in wind turbines and EVs.

NdFeB magnets consist of about 28–32% NdPr and 4–8% DyTb, which improves high-temperature performance.

HREEs (especially Dy/Tb) play a critical role in rare earth PMs. NdFeB PMs are crucial for developing efficient, lightweight, and compact traction motors. These magnets are composed of approximately 28–32% NdPr, with minor additions of DyTb (4–8%) to enhance performance under high-temperature conditions.

Dysprosium (Dy) and terbium (Tb) are essential ingredients for high-performing modern PMs. Dy improves the temperature stability of NdFeB magnets, and Tb increases their energy for stronger magnets in high-temperature applications such as EVs and wind turbines.

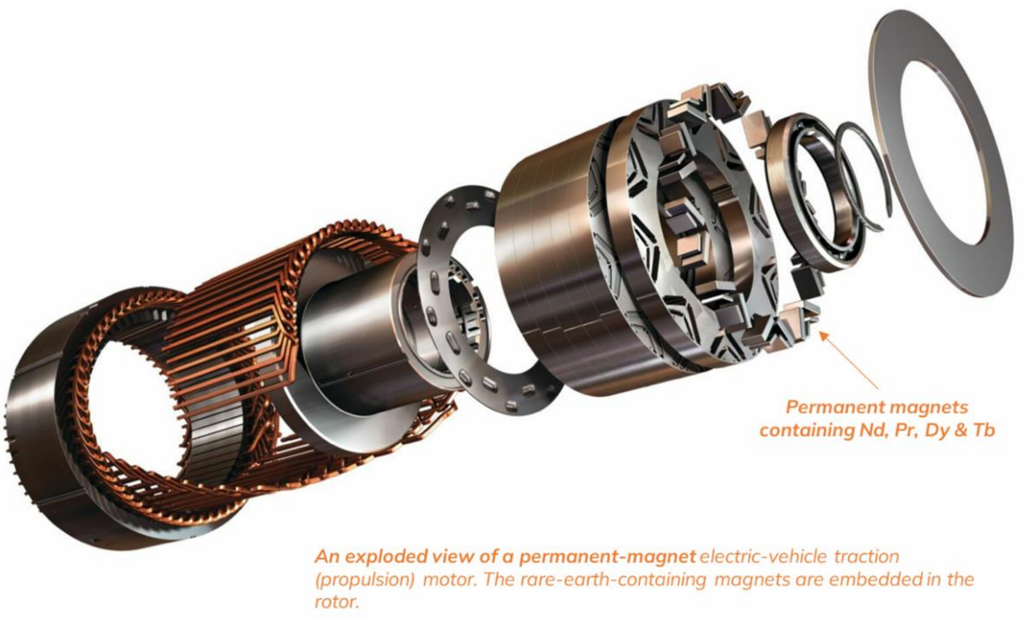
Terbium, or Tb (65), is a silvery rare earth metal that is so soft it can be cut with a knife. It is used in compact fluorescent lighting, colour displays, and as an additive to permanent rare earth magnets so they can function better under higher temperatures. Other uses include fuel cells designed to operate at elevated temperatures, some electronic devices, and naval sonar systems. In its alloy form, Tb has the highest magnetostriction[2] of any such substance. Moreover, because of its magnetisation, its shape is easily changed in its alloy form, making it a vital component of Terfenol-D which is used in many defence and commercial technologies.

Dysprosium, or Dy (66), is a soft, silver metal with one of the highest magnetic strengths of all of the rare earths, matched only by holmium (Ho) (IXR has this too!). Dy is often added to rare earth PMs to help them operate more efficiently at higher temperatures. Other uses include lasers, commercial lighting, hard computer disks and other electronics, nuclear reactors, energy-efficient vehicles, and Terfenol-D.

The use of DyTb is essential for producing magnets that can withstand high temperatures. Adding DyTb to the magnet increases the coercivity of the motor, enabling it to operate at much higher temperatures (150–240ºC), and more efficiently, than motors with only NdPr (maximum temperature: 80ºC) which start to demagnetise at lower temperatures. Therefore, either Dy or Tb must constitute 10–15% of the rare earth elemental content in offshore wind turbines and EV magnets.

[2] Magnetostriction is a property of magnetic materials that causes them to change their shape or dimensions during the process of magnetisation. This effect causes energy loss due to frictional heating in susceptible ferromagnetic cores.

Figure 14: Electric vehicles are driven by NdFeB magnets



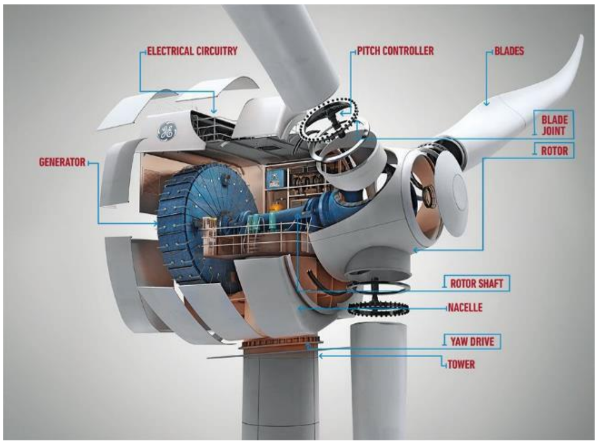
Source: IXR.

Without Dy and Tb, the performance and structure of offshore turbines would be significantly impaired.

A closer look at applications in wind turbines

Offshore wind turbines are equipped with PM generators containing NdPr and smaller quantities of DyTb. On average, the PM used in this application contains approximately 28.5% NdPr, 4.4% DyTb, 1% B and 66% Fe; DyTb is essential for the operation. Historically, a 6MW offshore direct drive wind turbine would consume PMs weighing up to 4 tonnes. Currently, wind turbines up to 16MW in capacity are in development, driven by economies of scale and maximum efficiency in offshore wind production (Figure 15). The development of larger turbines requires a greater role for such NdFeB magnets, driving significant forecast demand (Figure 16). Without Dy and Tb, the capacity (and structural integrity) of these turbines operating out at sea would be significantly compromised.

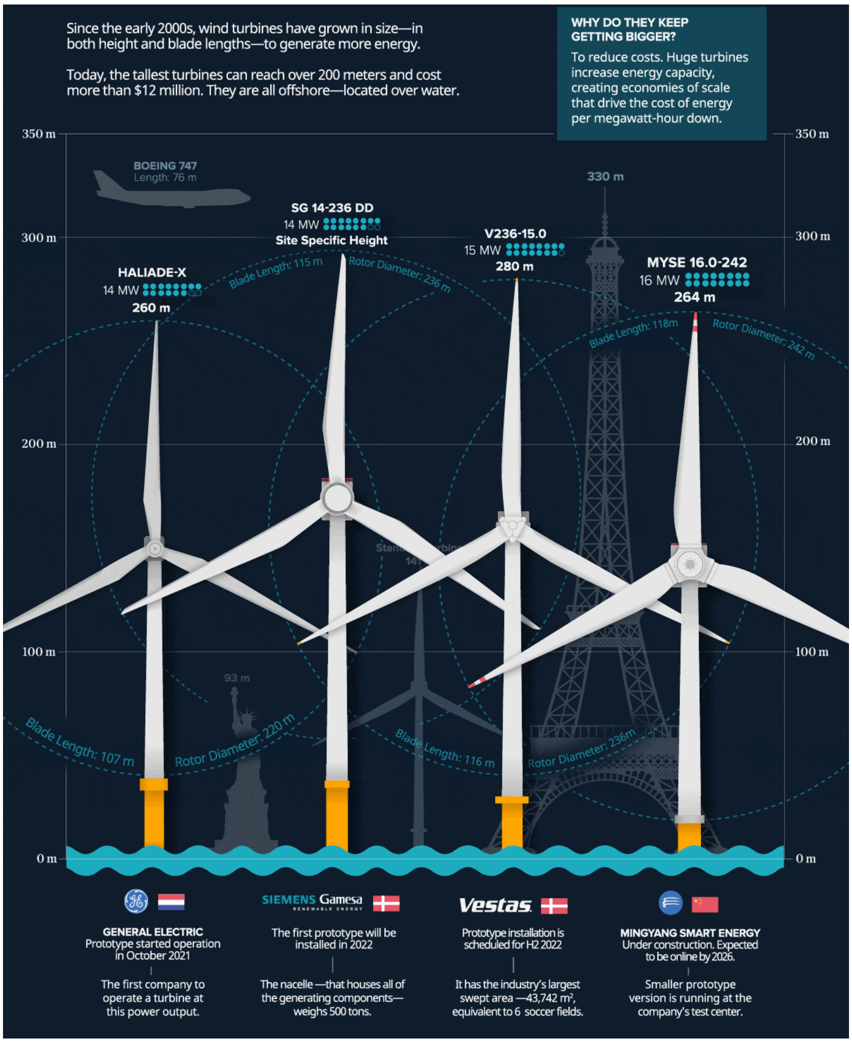
Figure 15: DyTb is critical for offshore wind turbine capacity



Rare Earth Element	Quantity kg per MW	Total Quantity for 6 MW (kg)	Total Quantity for 16 MW (kg)
Nd_2O_3	~210	1,260	20,160
Pr_6O_{11}	~42	254	4,032
Dy_2O_3	~20	117	1,920
Tb_4O_7	~8	49	768
Total	**~280**	**1,680**	**26,880**

Source: IXR.

Figure 16: Wind turbines keep getting bigger for increased economies of scale



Source: IXR.

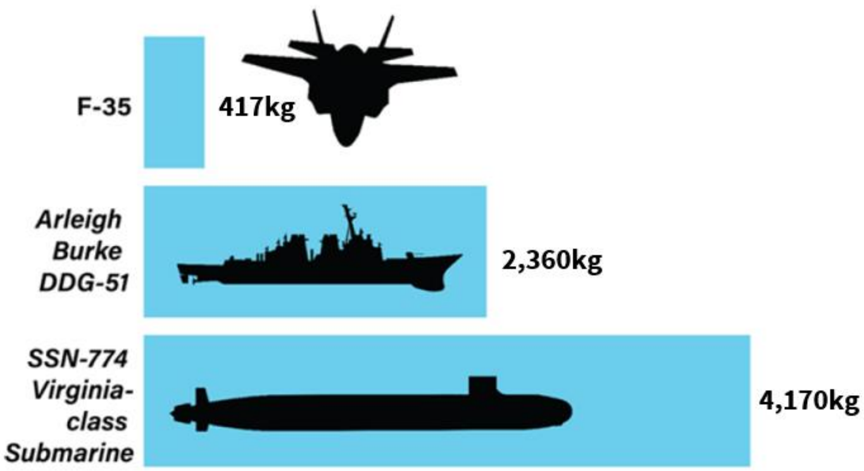
HREEs are strategically important for their unique properties and crucial role in various high-tech applications.

Uses in critical national security systems

Rare earths are used in a wide range of military equipment, communications systems, intelligence-gathering systems, nuclear weapons, and other strategic defence systems, which are essential for national security.

HREEs are considered to be of strategic military importance due to their unique properties and essential role in a wide range of high-tech applications (see Figure 17).

Figure 17: REEs crucial in defence applications



Source: IXR (Congressional Research Services).

LREEs are primarily obtained from monazite and bastnaesite concentrates.

Supply: HREE market faces growing supply constraints

Typical deposit sources for light and heavy REEs – the geology

The commercial extraction of REEs is dominated by a few mineralogies, including hard rock minerals bastnaesite, monazite and xenotime, and IACs. These sources account for >95% of economic production.

LREEs are mainly recovered from concentrates of monazite and bastnaesite in China, the US, Australia, India, and Madagascar, but also loparite in Russia (Figure 18).

Figure 18: Major LREE minerals

Ore type	TREO%	Advantages	Disadvantages
Bastnaesite	1-8%	High REO content Established economic deposits	Uncommon in economic concentrations Chemical- and energy-intensive processing and refining
Monazite (primary and placer deposits)	0.5-10% (0.5-2.5%)	Weathered monazite particularly high REO contents and reduced Th & U Developed processing method	Typically occurs in carbonates which can increase reagent consumption during processing Mainly contains LREEs (La & Ce)
Loparite	2-3%	Developed processing method Titanium content	Often occurs along with U and Th minerals

Source: Roskill.

Most **HREEs** are sourced from IAC deposits in Myanmar and China, with minor volumes of xenotime mineralisation from Australia (Figure 19).

Figure 19: Major HREE minerals

Ore type	TREO%	Advantages	Disadvantages
Ion adsorption clays	<0.5%	Well established main source Easy to process Low cost	Lower TREO content Potentially environmentally damaging mining techniques
Eudialyte (RE silicates)	~0.5-1.5%	Contains higher-value HREEs	Hard rock deposits requiring more processing stages, high reagent consumption No widely established metallurgical process
Xenotime	1-2%	High yttrium content Established process	Deposits of "pure" xenotime are quite unusual and are often small Some deposits have significant levels of Th and U
Uranium tailings	~5%	Material already mined reducing overall mining costs	Composition variable; Y levels may be low Capacity limited by amount of tailings generated

Source: Roskill.

Geographical distribution of light and heavy REEs – China has most HREEs by far

Southern China has almost all of the world's IAC deposits, the primary source of HREEs. Geological settings where REEs are found can be grouped into two main categories: **placer deposits**[3], which include IAC deposits, and **lode deposits[4]**, which can be considered as hard rock mines.

IAC deposits are considered highly desirable due to their balanced composition of REEs, with both light and heavy REOs, giving them higher product value and broader appeal. The key benefits of IAC deposits over hard rock (LREE) deposits are shown in Figure 20.

[3] Placer deposits are a type of mineral deposit that forms as a result of weathering and erosion of primary mineral deposits. They are characterised by the secondary concentration of minerals.

[4] Lode deposits are formed by the primary concentration of minerals in the host rock and are characterised by the presence of mineral-rich veins. They are often found in hard rock, such as granite or quartz, and typically mined using underground or open-pit mining methods.

Figure 20: Comparison of IAC REE deposits (typically containing HREEs) vs hard rock–hosted REE deposits (typically containing LREEs)

Stage	Ionic Adsorption Clay	Hard Rock
Mineralisation	Soft material, high HREO content	Hard rock, bastnaesite and monazite (LREO dominant), Xenotime (HREO dominant)
Mining	Low cost, surface mining, progressive rehabilitation	High cost, blasting, high strip ratios
Processing	Simple process, potential for in-situ leaching	Comminution, beneficiation with expensive reagents
Mine product	Mixed high-grade rare earth oxide/carbonate	Mixed REE mineral concentrate, high LaCe content
Payability	60–70% as mixed rare earth oxide/carbonate	30–35% as mineral concentrate
Environmental	Non-radioactive tailings, solution treatment and reagent recovery	Radioactive tailings, complex and costly disposal, legacy tailing management
Refinery	Simple acid solubilisation, lower capex	High temperature mineral "cracking", complex capital-intensive plant, complex recycling of reagents and water

Source: IXR.

The availability of magnetic HREEs, the most valuable subset, is heavily concentrated in China.

Magnetic HREE deposits: strategically important to the West

The availability of magnetic HREEs, the most valuable sub-set of HREEs, is heavily skewed towards China, which dominates the global production of these elements. This is due to the unique geological conditions in China, which favour the formation of IAC deposits – the primary source of HREEs.

The West (i.e., regions of Australasia, Europe, and the Americas), on the other hand, has a plethora of hard rock rare earth mines, rich in LREEs, but very few IAC deposits. This creates a supply imbalance, with Western countries heavily dependent on imports of HREEs from China.

Makuutu boasts a significant presence of magnet REOs, with 43% of its basket made up of these vital elements. Additionally, the deposit holds valuable dysprosium (Dy) and terbium (Tb) oxides, which are scarce outside of China and Myanmar. This strategic positioning places Makuutu in a prime position to supply these in-demand oxides to the Western market.

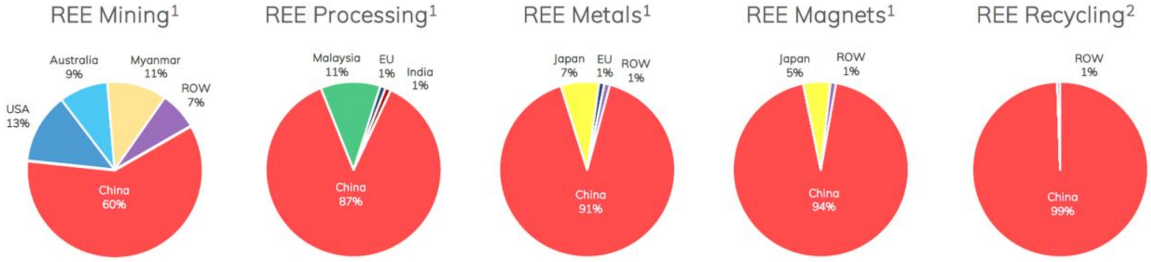
Refining and production – China the dominant player

Most refined rare earths go through China

Rare earth minerals are processed into refined products, either as mixed or semi-separated compounds or individual rare earth compounds. Further refinement, or metallisation into rare earth metals and alloys, is necessary for magnetic applications. Most refining occurs in China (~91%), comprised of both domestically mined product and imported ores and mineral concentrates for separation and refining.

As shown in Figure 21, China currently dominates processing (87%), metal making (91%), magnet making (94%), and REE recycling (99%).

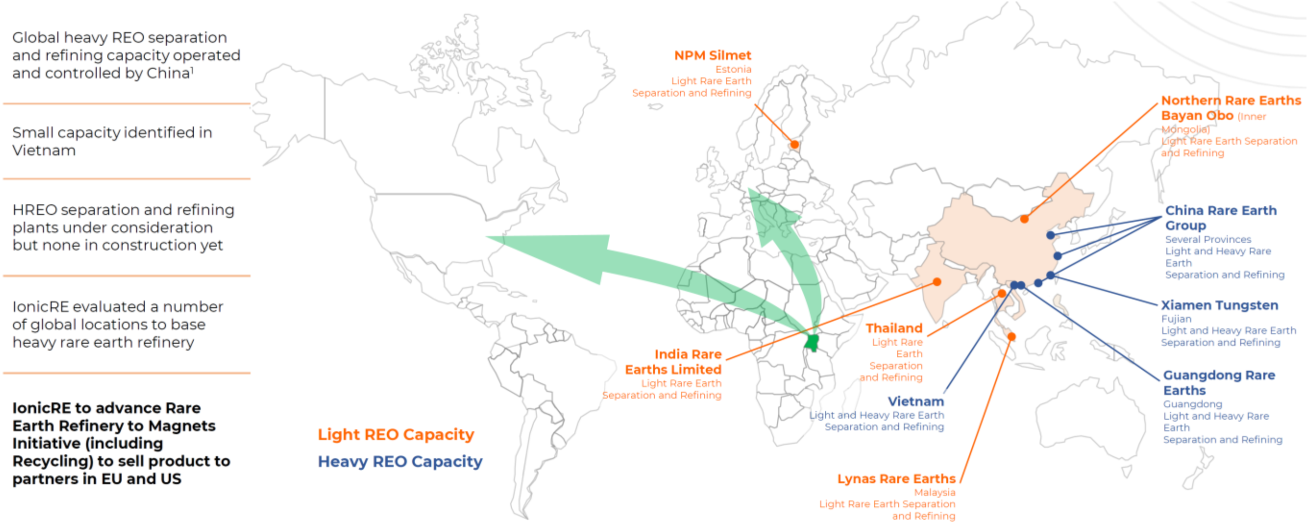
Figure 21: China is dominant at all stages of the rare earth supply chain



Source: [1]Rare Earth Magnets and Motors: A European Call for Action – A report by the Rare Earth Magnets and Motors Cluster of the European Raw Materials Alliances, Oct 2021. Argus Analytics Oct 2021. [2]Wood Mackenzie Global rare earths short-term outlook August 2022.

Global refining capability is dominated by China – see Figure 22.

Figure 22: The global landscape of refining capability



Source: IXR.

As the global demand for REEs increases and the West seeks to establish alternative supply chains outside of China, it is crucial to develop the necessary assets and cultivate the essential expertise and capability to extract and process REEs effectively. This includes the knowledge and resources to separate and refine the various REE compounds and convert them into value-added components.

China has boosted LREE capacity but not HREE production from IACs in recent years due to resource depletion and tighter regulations.

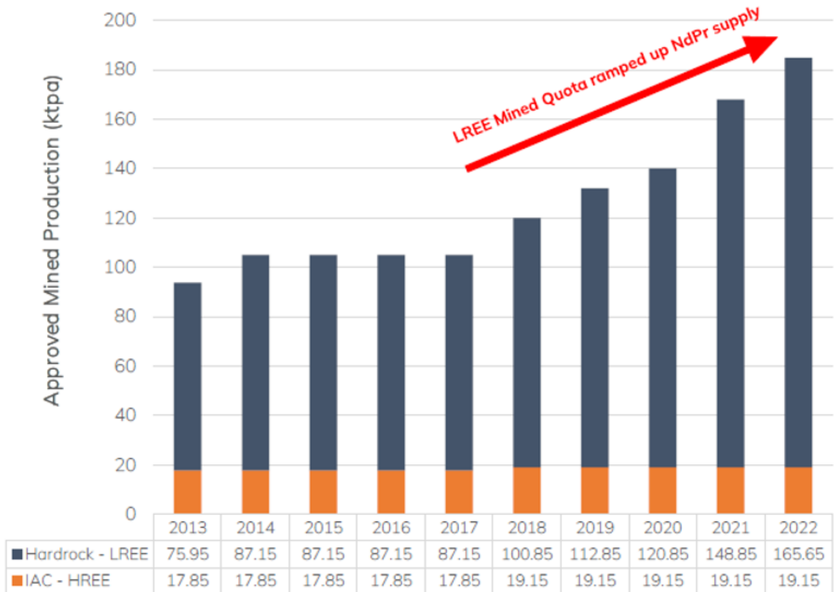
China's HREE production is declining

Over the last five years, China has ramped up its capacity of LREE mineral concentrates (see Figure 23), but it has not been able to increase production of HREEs from the IACs to the same extent. This is due to the depletion of economic IAC deposits and a tightening of industrial and environmental controls.

A 2012 White Paper by the Ministry of Industry and Information Technology (MIIT) which oversees China's REE industry states that 'the reserve-extraction ratio of ion-absorption-rare-earth mines in China's southern provinces has declined from 50 two decades ago to the present 15.'

China has been a significant investor in Myanmar's REE mining industry to replace this declining domestic production and is currently ramping up production in Myanmar to such an extent that the HREEs coming out of Myanmar now surpass what is being mined in China. As a result, Chinese HREE-focused refineries are operating well below capacity, diminishing strategic stockpiles and driving higher prices for key HREEs such as Dy and Tb.

Figure 23: Chinese REO mining production quota



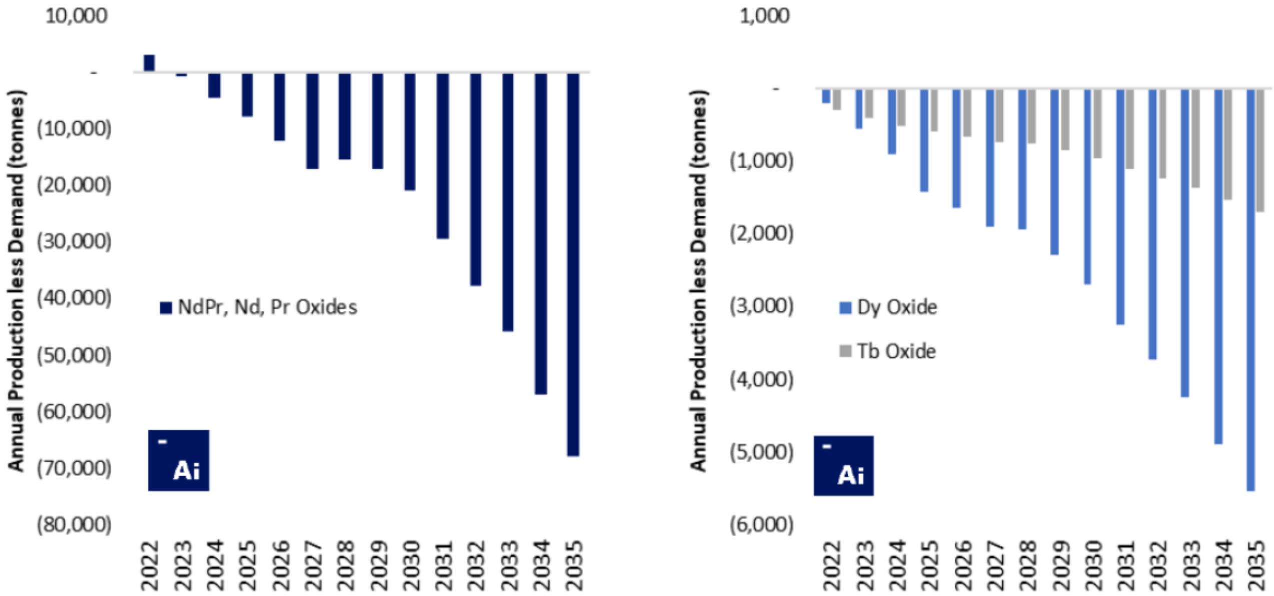
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hardrock - LREE	75.95	87.15	87.15	87.15	87.15	100.85	112.85	120.85	148.85	165.65
IAC - HREE	17.85	17.85	17.85	17.85	17.85	19.15	19.15	19.15	19.15	19.15

Source: IXR, Ministry of Industry and Information Technology, China, 2022.

The result: a supply shortage of HREEs

The global rare earth market is expected to face a shortage of HREEs, such as DyTb, due to limited global production and uncertain supply from Myanmar, a major producer of these elements. According to Adamas Intelligence, by 2035, the market could be short more than 5X the amount of DyTb oxide supply currently produced by China, unless production increases significantly (Figure 24).

Figure 24: Forecast deficit in magnet REOs from 2023 accelerating over the next decade: DyTb deficit escalating now



Source IXR, Adamas Intelligence.

Pricing – IXR basket pricing looks set to rise

How are REEs sold?

Most ex-China production is sold as ore concentrate or moderately beneficiated products, e.g., mixed rare earth carbonate (MREC). Lynas produces a range of refined REOs in Malaysia (mostly LREEs), sold to customers in other end markets including Japan. Lynas also produces small quantities of mixed SEG (samarium, europium and gadolinium) and HREEs (holmium to yttrium), sold as mixed products to Chinese refiners.

Some REEs are also sold in other forms (such as metals, alloys, or salts), depending on the specific application and the processing requirements of the end user. For example, dysprosium, terbium and ytterbium are used in the form of metals, while cerium and lanthanum are used in the form of salts.

How are REEs priced?

REEs, being niche commodities with specific uses, have their prices and sales terms negotiated between producers and consumers.

Since REEs are largely a niche commodity with bespoke products and end uses, most commercial terms for pricing and sale are negotiated between producers and downstream consumers. In China, the price is more tightly controlled by the few large SOE producers, with the annual mining quotas used as a tool to increase or constrain supply in the market (where possible).

Many pricing references exist for the variety of REOs and metals. REE prices are typically referenced in US dollars per metric tonne. They can also be quoted in other currencies or as a price per unit of weight. Prices can be obtained through various sources, such as industry publications, commodity exchanges, and consulting firms.

Examples of industry publications that provide rare earth prices include Asian Metal, Metal-Pages, Shanghai Metals Market and Industrial Minerals.

Consulting firms such as Adamas Intelligence, Argus Metals, Project Blue, CRU, and Wood Mackenzie also provide REE prices as part of their research and consulting services. However, REE prices can fluctuate widely due to a variety of factors, such as supply and demand, production costs, and government policies.

Upward trend for IXR basket pricing: industry experts predict strong growth

The 'basket price' refers to the blended average received across all of the various REEs sold or contained in the intermediate products (rare earth concentrate, mixed rare earth carbonate). Since each element will have a different price and a different composition by weight within the final product, the basket price represents the weighted average price of each of the 15 constituent REEs.

Forecasts from top analysts predict significant price increases for the Makuutu basket in the coming years.

Consensus pricing forecasts from leading industry analysts, including Adamas Intelligence (through 2035), Argus Metals (through 2031), and Wood Mackenzie (through 2050), predict significant increases in the price of the Makuutu basket. These forecasts (consensus) indicated an approximate 40% increase by 2030 to that used in the 2021 scoping study.

Scandium: what is it and pricing models for sales

The Makuutu Project has the potential to create a low-cost scandium co-product with minimal additional processing, making it an attractive opportunity. Makuutu presently boasts the second-largest reported global scandium resource.

Scandium oxide (Sc_2O_3) is usually found in the same ores as other rare earth elements such as yttrium and lanthanum, as well as in nickel laterite deposits. Its major applications are varied, including high-strength–low-weight aluminium-scandium alloys, solid state energy storage, 3D printing, and high-intensity lighting.

For modelling purposes, we have assumed the price for scandium oxide (Sc_2O_3) sold product is US$700/kg (<25tpa), with a long-term pricing basis of US$800/kg (>30tpa). A payability of 70% has been applied to the Sc_2O_3.

Methodology & Disclosures

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