

# **Building Secure Long Life Critical and Heavy Rare Earths Capacity**

2021 Annual General Meeting

# Cautionary Statement

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Information in this report that relates to previously reported Exploration Targets and Exploration Results has been cross-referenced in this report to the date that it was originally reported to ASX. Ionic Rare Earths Limited confirms that it is not aware of any new information or data that materially affects information included in the relevant market announcements.

The information in this report that relates to Mineral Resources for the Makuutu Rare Earths deposit was first released to the ASX on 3 March 2021 and is available to view on [www.asx.com.au](http://www.asx.com.au). Ionic Rare Earths Limited confirms that it is not aware of any new information or data that materially affects information included in the relevant market announcement, and that all material assumptions and technical parameters underpinning the estimates in the announcement continue to apply and have not materially changed.

The information in this report that relates to Scoping Study results and production targets was first released to the ASX on 29 April 2021 and is available to view on [www.asx.com.au](http://www.asx.com.au). Ionic Rare Earths Limited confirms that it is not aware of any new information or data that materially affects information included in the relevant market announcement, and that all material assumptions and technical parameters underpinning the estimates in the announcement continue to apply and have not materially changed.

# The Time is Now

## DEVELOPING A SECURE, TRACEABLE, CRITICAL AND HEAVY RARE EARTH SUPPLY CHAIN TO FACILITATE CARBON NEUTRALITY



### The Mine – Makuutu

Makuutu is one of **very few global ionic adsorption clay (IAC) deposits** with scale to move the needle on HREO supply

Defined potential to supply **27+ year life of Mine**, with **significant exploration upside**

**Simple mining and low capex processing to produce Mixed Rare Earth Carbonate (MREC)**

**No radionuclides**



### The Refinery – Secure Supply

Opportunity to **maximise revenue** from the Makuutu Mixed Rare Earth Carbonate (MREC) product

**Alternative HREO refiner** targeting western markets

Collaborate with Western end users on **development of secure and traceable REO supply chain**

**Expandable in future**



### The Basket – High Margin

One of the **highest value REO baskets of all projects** in evaluation today

**43% magnet REOs (Nd, Pr, Dy, Tb, plus Sm, Gd, Ho)**

**44% Heavy REOs (Sm to Y)**

**93% of forecast value derived from magnet REOs plus Y**

Major future source of **Scandium** production



### Increasing Demand, Reducing Supply – Becoming Urgent

**World accelerating to carbon neutrality**, with 8-fold demand increase in both EVs and offshore wind turbine forecast by 2030

ESG drive globally to **source sustainable critical raw materials**

**Limited future HREO supply from declining reserves of IACs in southern China**



# ESG initiatives 'front and centre' at Makuutu

## ENVIRONMENT, SOCIAL AND GOVERNANCE (ESG) FRAMEWORK IN DEVELOPMENT TO BUILD LASTING LEGACY



Environmental and Social Impact Assessment (ESIA) in progress

Baseline environmental surveys completed

Focus on carbon footprint reduction using renewable power

Rehabilitation plans aim to ensure net positive climate legacy

Water treatment for reagent recovery and rehabilitation strategy



Rehabilitation to consider development of longer term industrial programs for employment

Aligned with Uganda's 3rd National Development Plan (NDP III)

Agricultural Programs to increase productivity

Aquaculture and fish farming

Agroforestry



Community Support Programs identified

Working together to build a future where everyone has a pathway to health and opportunity

Establishment of an Advisory Committee to coordinate community development investment priorities

Key focus being community health and education



Community socio-economic baseline surveys across initial project area underway

Establishing Ugandan team to drive Project activity in country

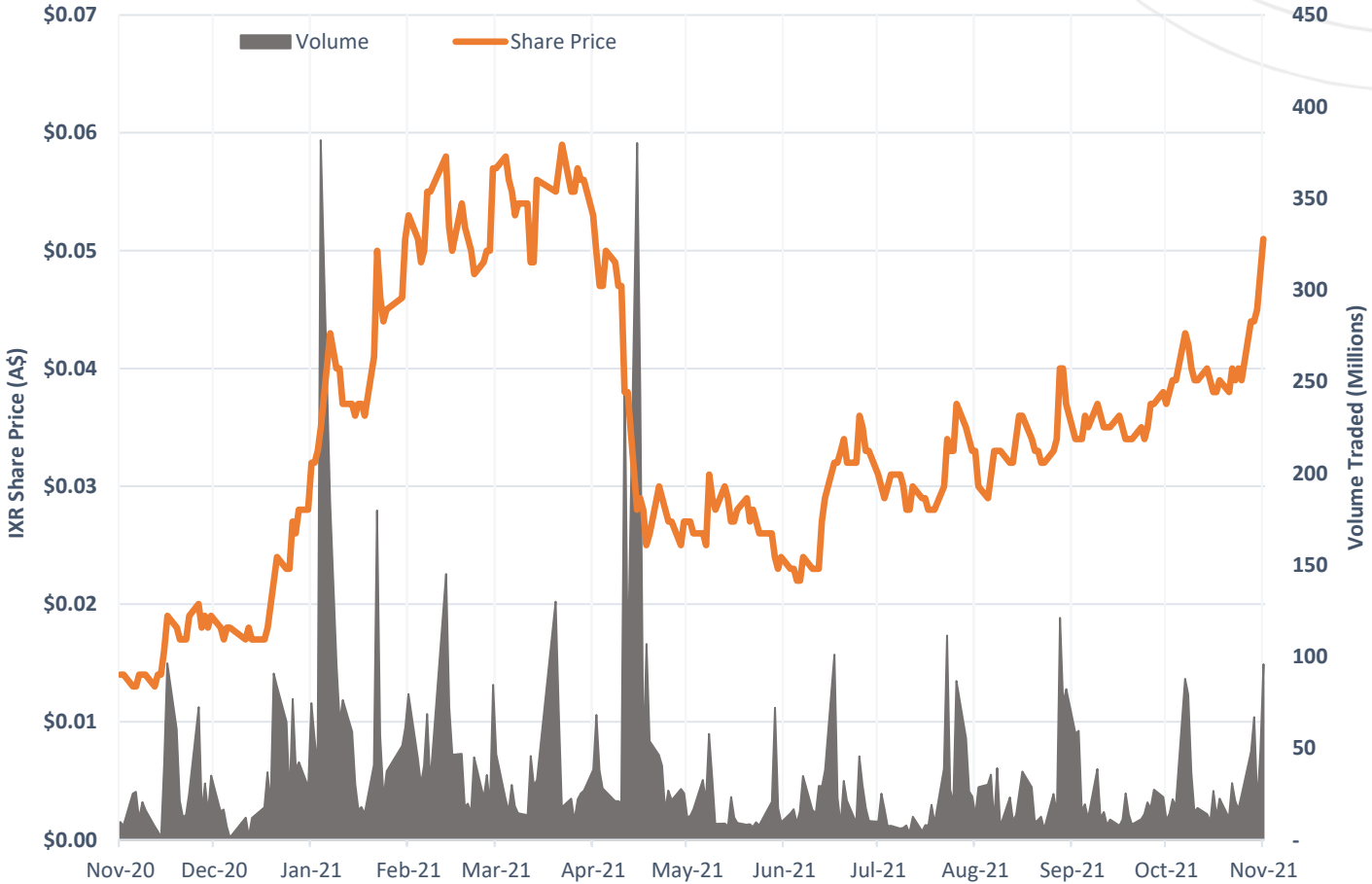
Community and Stakeholder engagement ramping up

Local support for sub-district health clinics during Covid-19

# IonicRE Corporate Snapshot

## STRATEGIC VALUE DRIVEN BY THE UNIQUE CREO/HREO BASKET

CAPITAL STRUCTURE (as @ 19/11/2021)	
Shares Outstanding	3,392,399,514
Total Options Outstanding	175,000,000 (exercisable at 1.8 to 6.0 cents)
Share Price	A\$0.051
Market Capitalisation	A\$173 million
52 week share price range	A\$0.013 – A\$0.065
Cash Balance (30/09/2021)	A\$9.5 million
IXR MAJOR SHAREHOLDERS	
Major Shareholders (Top 20)	32.7%
Board, Executives, & Key Advisors	11%
BOARD AND MANAGEMENT	
Trevor Benson	Chairman
Tim Harrison	Managing Director
Jill Kelley	Executive Director
Max McGarvie	Non Executive Director
Brett Dickson	Company Secretary & CFO



## Makuutu Rare Earths Project

Developing a Secure, Sustainable,  
Long-Life, CREO/HREO Supply



# Harnessing the wide appeal of the Makuutu Basket

MAKUUTU PROVIDES A UNIQUELY BALANCED BASKET WITH 73% CRITICAL AND HEAVY RARE EARTHS



Scoping Study confirms **robust economics** for Base Case CREO and HREO production with **potential to extend beyond 27 + years Life of Mine (LOM)**

**Strategic importance of Makuutu** (51% IonicRE ownership moves to 60% on completion of FS ~ Oct 2022)

IonicRE has **pre-emptive right** on remaining 40% of the Project



**Makuutu is unique and receiving global interest** due to **high quality balanced** (CREO + HREO) basket

Non-binding MOU signed with Chinalco subsidiary **China Rare Earths Jiangsu** to accelerate Makuutu mine development to production

**Discussions continue with other groups** looking to secure long-term CREO/HREO supply, and **potential feed to standalone IonicRE Rare Earth Refinery**



## Existing Infrastructure at Makuutu

- Highway and road access to site plus rail
- Nearby 132 kV power infrastructure with readily available low-cost hydropower
- Cell phone communications available across site
- Water available



## Significant Exploration upside at Makuutu still to be realised

Already one of **worlds largest Ionic Adsorption Clay (IAC) deposits**

Highly prospective licence EL00147 recently tested via RAB drilling with **assays confirming clay hosted REE mineralisation present**

**Phase 4 drilling program completed** to increase Indicated and Measured resource base

# 315 Mt Ionic Adsorption Clay (IAC) Mineral Resource Estimate with Upside

## FURTHER IAC TARGETS IDENTIFIED AT MAKUUTU

279 drill holes (4,754 metres) completed between October 2019 and October 2020 defining **JORC MRE<sup>1</sup> of 315 Mt @ 650 ppm** Total Rare Earths Oxide (TREO), at a cut-off grade of 200 ppm TREO-CeO<sub>2</sub>

67 RAB drill holes (Phase 3) announced in July **confirmed extension of mineralisation east to EL00147, between previous identified radiometric anomalies, and to northwest (EL00257)**

**Phase 4 infill drilling program completed** (8,200 m, 432 holes) with **assays pending** (2 of 6 Tranches) to feed into next **MRE update planned for Q1/Q2 2022**

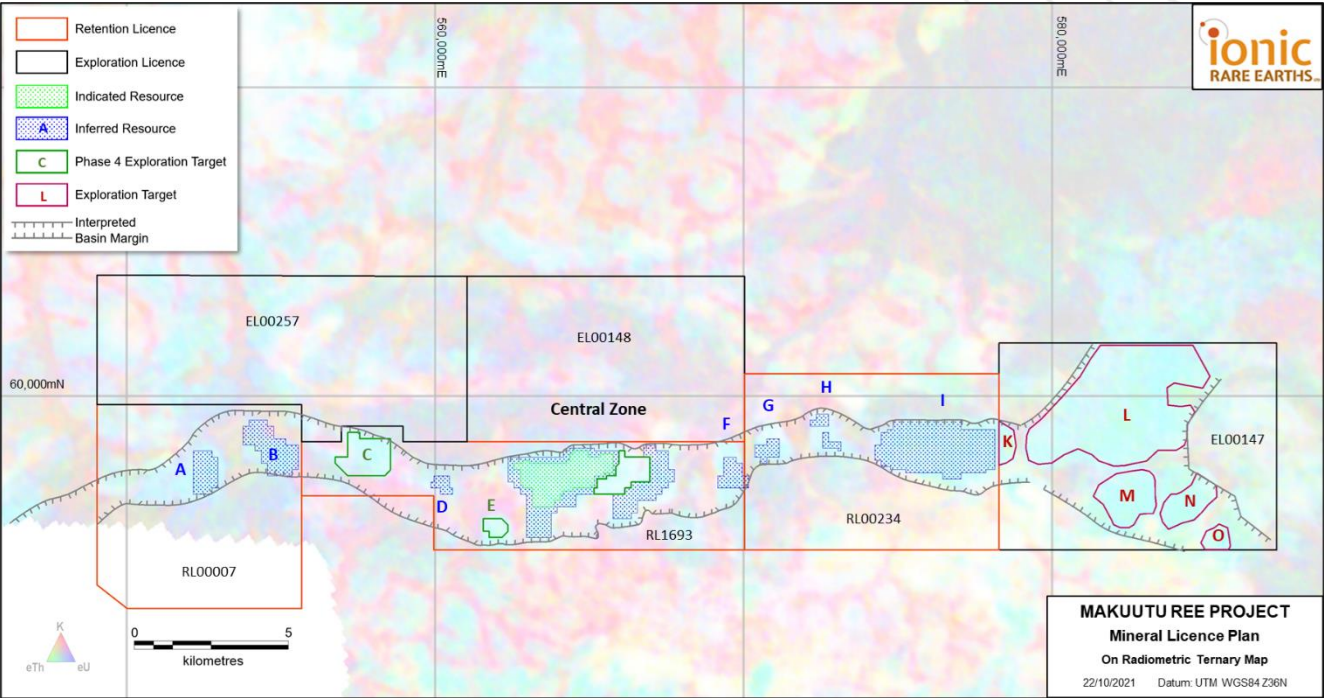
Objective to **increase Indicated and Mineral Resource classifications to greater than 250Mt** to support Feasibility Study in 2022

**Near term exploration extension** from areas that haven't yet converted (Areas C, E, Central Eastern Zone) so expecting total MRE will increase

**Shallow, near surface IAC mineralisation**, with clay layer averaging 5 to 12m thick under cover approximately 3m deep. Average hole depth ~17m

Longer term, **numerous exploration targets identified** for drilling in 2022

Scandium currently not included in cut-off grade determination



Category	Estimation Domain	Tonnes (Mt)	TREO (ppm)	TREO no CeO <sub>2</sub> (ppm)	LREO (ppm)	HREO (ppm)	CREO (ppm)	Sc <sub>2</sub> O <sub>3</sub> (ppm)
Indicated	Clay	66	820	570	590	230	300	30
Inferred	Clay	248	610	410	450	160	210	30
<b>Total Resource</b>	<b>Clay</b>	<b>315</b>	<b>650</b>	<b>440</b>	<b>480</b>	<b>170</b>	<b>230</b>	<b>30</b>



# Makuutu Rare Earth Project Highlights

## STRATEGIC VALUE DERIVED BY THE UNIQUE CREO/HREO DOMINANT BASKET

**Ionic Adsorption Clay (IAC)** deposit mineralisation is highly desirable given it produces a balanced **REO** basket dominant in **CREO & HREO**

**Globally one of the largest IAC deposits** discovered outside of southern China and SE Asia & one of less than a handful of economic size and scale

High margin basket potential, approx. **73% of basket is CREO+HREO**, magnet REOs make up **43% of basket**

Scoping Study<sup>1</sup> completed in April 2021 defined a **very robust base case** with highly attractive 11-year Base Case economic parameters

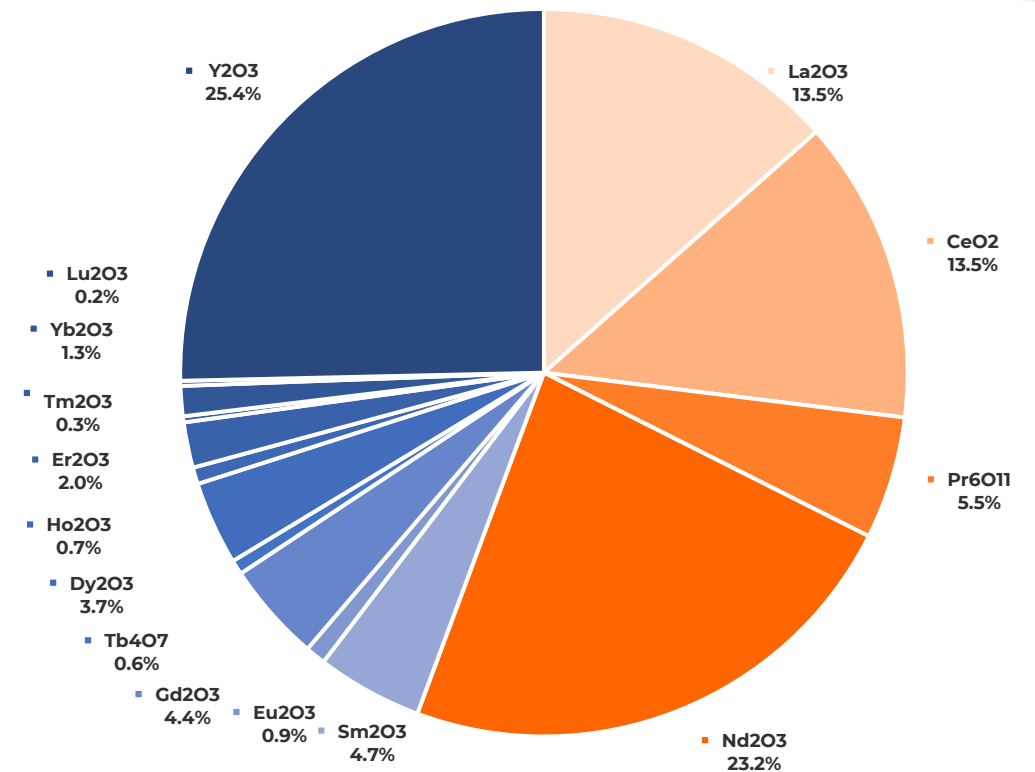
- Post-tax long term free cash flow **US\$766 million** over 11 years
- EBITDA of **US\$1.28 billion**
- Post-tax Net Present Value (8) of **US\$321 million**
- Internal Rate of Return of **38%**
- Pre-production CAPEX requirement of **US\$89 million**
- Expansion CAPEX of \$212 million funded by Project free cash flow
- Potential upside out to 27 years with inclusion of Inferred resource
- **10% increase in basket REO price leads to 30% increase in post tax NPV(8)**

315 Mt Mineral Resource Estimate<sup>2</sup> with **significant exploration upside** confirmed with mineralisation stretching across 37 km trend

**Global Appeal** – Strategic importance of Makuutu product basket seen as critical for governments to deliver carbon neutral policy objectives & major appeal to **key defence applications**

**Scandium upside is significant** with MRE containing ~9,450 tonne Sc<sub>2</sub>O<sub>3</sub>, potential annual production from 25 to ~100 tonnes per annum

## MAKUUTU BASKET HIGH VALUE CREO / HREO PRODUCT



# Makuutu Basket is Balanced, CREO+HREO Dominant and High Value

Company		Ionic Rare Earths	Lynas Rare Earths <sup>1</sup>	MP Materials <sup>2</sup>	Arafura Resources <sup>3</sup>	Australian Strategic Materials <sup>4</sup>	Hastings Technology Metals <sup>5</sup>	Peak Resources <sup>6</sup>	Pensana Rare Earths <sup>7</sup>	Northern Minerals <sup>8</sup>	USA Rare Earths <sup>9</sup>	REO Pricing Argus Metals 22-NOV-21 US\$/kg
Mineralisation		Ionic Adsorption Clay	Monazite	Bastnasite	Monazite	Eudialyte / Bastnasite	Monazite	Bastnasite	Monazite	Xenotime	Rhyolite	
Project		Makuutu	Mt Weld / LAMP	Mountain Pass	Nolans Bore	Dubbo	Yangibana	Ngualla	Longonjo	Browns Range	Round Top	
Development Stage		FS	Operations	Operations	DFS	DFS	DFS	DFS	DFS	PFS	PFS	
La <sub>2</sub> O <sub>3</sub>	%	13.5%	25.5%	34.0%	19.3%	22.1%	10.0%	27.6%	23.9%	1.9%	3.3%	1.52
CeO <sub>2</sub>	%	13.5%	46.7%	48.8%	48.7%	36.3%	39.6%	48.2%	45.9%	4.8%	12.2%	1.58
Pr <sub>6</sub> O <sub>11</sub>	%	5.5%	5.3%	4.2%	5.9%	3.6%	8.0%	4.8%	4.9%	0.7%	1.9%	133.50
Nd <sub>2</sub> O <sub>3</sub>	%	23.2%	18.5%	11.7%	20.5%	14.1%	33.8%	16.5%	17.2%	3.2%	5.1%	132.00
Sm <sub>2</sub> O <sub>3</sub>	%	4.7%	2.3%	0.8%	2.3%	1.7%	3.9%	1.6%	2.5%	2.1%	1.8%	5.00
Eu <sub>2</sub> O <sub>3</sub>	%	0.9%	0.4%	0.1%	0.4%	0.0%	0.8%	0.3%	0.6%	0.4%	0.0%	32.00
Gd <sub>2</sub> O <sub>3</sub>	%	4.4%	0.1%	0.2%	1.0%	1.6%	1.8%	0.6%	1.2%	5.7%	2.0%	68.50
Tb <sub>4</sub> O <sub>7</sub>	%	0.6%	0.1%	0.0%	0.1%	0.2%	0.2%	0.1%	0.1%	1.3%	0.6%	1,695.00
Dy <sub>2</sub> O <sub>3</sub>	%	3.7%	0.1%	0.0%	0.3%	1.9%	0.5%	0.1%	0.6%	8.8%	5.7%	461.00
Ho <sub>2</sub> O <sub>3</sub>	%	0.7%	0.1%	0.0%	0.0%	0.4%	0.1%	0.0%	0.1%	1.8%	1.5%	194.50
Er <sub>2</sub> O <sub>3</sub>	%	2.0%	0.1%	0.0%	0.1%	1.1%	0.1%	0.0%	0.2%	5.3%	6.1%	60.00
Tm <sub>2</sub> O <sub>3</sub>	%	0.3%	0.1%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.7%	1.2%	850.00
Yb <sub>2</sub> O <sub>3</sub>	%	1.3%	0.1%	0.0%	0.1%	0.9%	0.1%	0.0%	0.1%	4.4%	9.4%	16.30
Lu <sub>2</sub> O <sub>3</sub>	%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	1.3%	850.00
Y <sub>2</sub> O <sub>3</sub>	%	25.4%	0.4%	0.1%	1.4%	15.8%	1.1%	0.2%	2.6%	58.2%	47.7%	10.50
Sum Total		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	
Magnet REO	%	43%	26%	17%	30%	24%	48%	24%	27%	24%	19%	
LREO	%	56%	96%	99%	94%	76%	91%	97%	92%	11%	22%	
HREO	%	44%	4%	1%	6%	24%	9%	3%	8%	89%	77%	
CREO	%	54%	20%	12%	23%	32%	36%	17%	21%	72%	59%	
CREO+HREO	%	73%	28%	17%	32%	42%	50%	24%	30%	93%	84%	
Basket Value	REO/kg	\$ 81.80	\$ 36.86	\$ 22.56	\$ 40.17	\$ 43.50	\$ 63.93	\$ 31.19	\$ 37.54	\$ 103.22	\$ 95.46	

Note. Rounding Applied to nearest 0.1%.

# Makuutu Timeline to Production

## ACCELERATING MAKUUTU TOWARDS PRODUCTION IN 2024

ACTIVITY	2021	2022				2023				2024	
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Resource Drilling (Phase 4)											
Metallurgy Testwork											
MRE Update											
ESIA											
Feasibility Study											
Landowner Agreements											
Demonstration Plant											
Funding Agreements											
Mining Licence Application											
Final Investment Decision											
Site Early Works											
Construction											
Mining Commences											
Commissioning											
Plant Production											



# Tier-One In-Country Infrastructure already there – supports low CAPEX development

## EXCELLENT LOCAL INFRASTRUCTURE SUPPORTS LOW CAPEX DEVELOPMENT

### LOGISTICS

Approximately 10 km from Highway 109, connecting Makuutu to both capital city Kampala and Port of Mombasa, Kenya

Approximately 20 km from rail line connecting to Port of Mombasa

### POWER

Large hydroelectric generation capacity (+810MW) within 65 km of Makuutu Project area will deliver very low-cost (US\$0.05/kWh), plus further capacity being developed

Existing electrical grid infrastructure immediately adjacent to site to provide stable power

### WATER

Plentiful fresh water within and near project area (water harvesting)

### WORKFORCE

No camp required – low-cost professional local workforce available



# Investment in Uganda – The Pearl of Africa

## MAJOR INTERNATIONAL INVESTMENT INTO UGANDA IS UNDERWAY

- Ugandan law allows for 100% foreign-owned businesses, and foreign businesses are allowed to partner with Ugandans without restrictions.
- The US\$10B Lake Albert Oil Project (Total (56.67%), CNOOC (28.33%) and UNOC (15%)) development encompasses Tilenga (operated by Total) and Kingfisher (operated by CNOOC) upstream oil projects in Uganda, delivering a combined production of 230,000 barrels per day, and the construction of the East African Crude Oil Pipeline (EACOP) transporting from the oilfields in Uganda 1440km to the port of Tanga in Tanzania.
- Uganda is rich in natural resources. Foreign Direct Investment (FDI) mainly goes to the coffee and mining sectors. Kenya, Germany and Belgium are the country's main investors.
- Good support from government agencies including the Directorate of Geological Survey and Mines (DGSM)
- Transparent Mining Cadastral system implemented in Uganda for tenement management
- Ugandan Mining Act 2003 outlines royalties for base metals at 5% and Corporate Tax Rate = 30%
- Asset depreciation given Project is > 50km from Kampala is 50% initial depreciation allowance, and 100% of the assets in a 3-year period.

Foreign Direct Investment <sup>1</sup>	2017	2018	2019
FDI Inward Flow (million US\$)	803	1,055	1,266
FDI Stock (million US\$)	11,996	13,051	14,317
Number of Greenfield Investments	8	17	29
Value of Greenfield Investments (million US\$)	290	366	960



# China Dominates Global REE Separation & Refining Capacity

## ALL HEAVY RARE EARTH ROADS LEAD TO ..... CHINA

Global HREO separation and refining capacity operated and controlled by China<sup>1</sup>

Small capacity identified in Vietnam

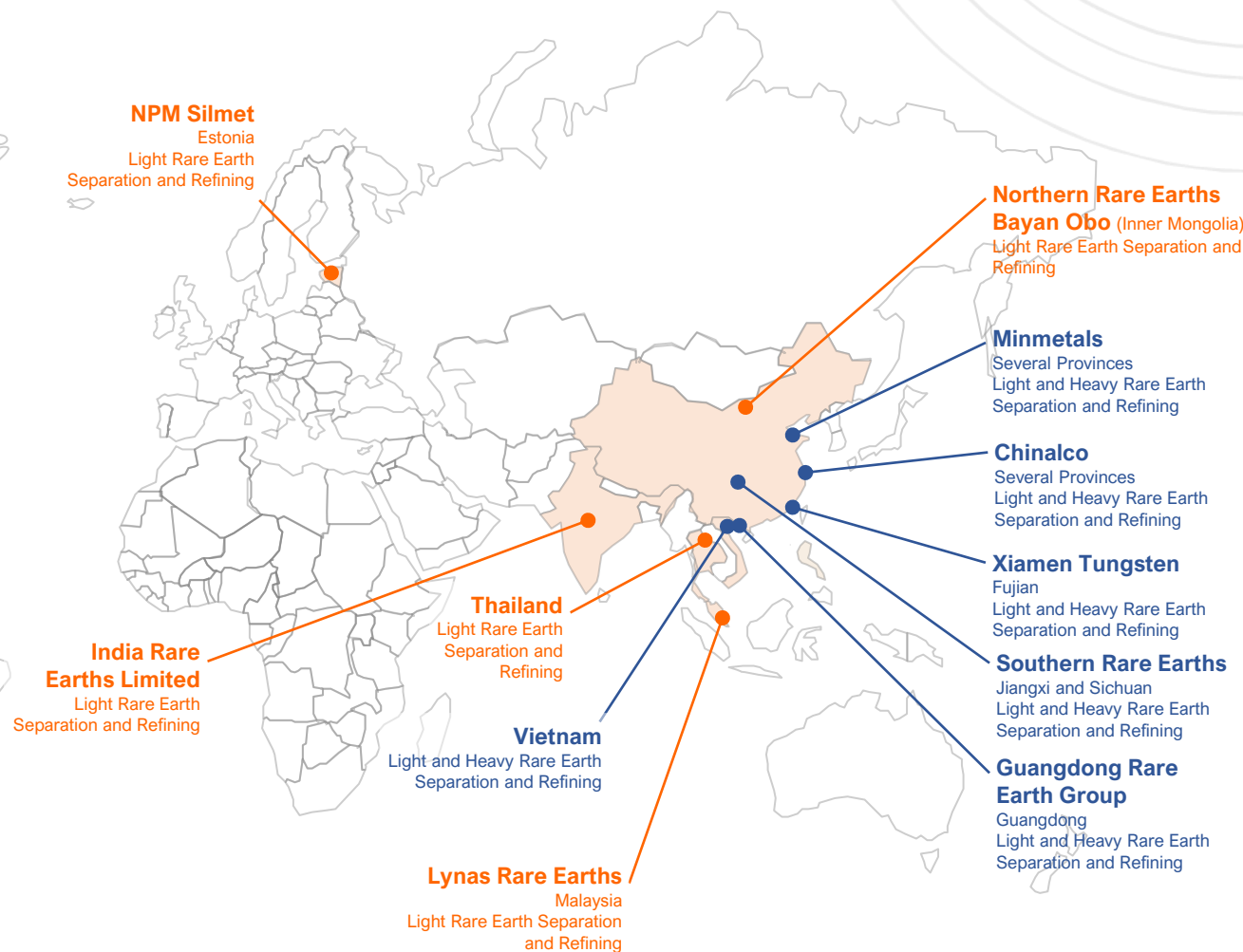
China Rare Earths Jiangsu operate 4 REO Refineries

- Chinalco (Changzhou)
- Chinalco (Funing)
- Chinalco (Yixing)
- Chinalco (Changshu)

HREO refining plants in US under consideration but no committed timelines as yet

IonicRE to consider best global Refinery location with direct access to sell product to partners in US, UK, Europe, and Asia

**LREO Capacity**  
**HREO Capacity**





# Strategic Partnership Activity – Exploring Optionality

## A RARE EARTH BASKET WITH 'BALANCED' APPEAL

- IAC balanced basket appeal as one of only two global IACs of scale in development
- IonicRE in April signed a non-binding MOU<sup>1</sup> with China Rare Earths Jiangsu, a subsidiary of Chinalco
- IonicRE continues parallel discussions with numerous global groups regarding the development of the Project, and ultimately access to the Makuutu basket
- Growing understanding of importance of IACs to provide balance to REO production capacity
- **Standalone Rare Earth refinery and integration into new supply chains becoming clearer and demand will become stronger**
  - **Electrical Vehicle market**
  - **Offshore wind farms**

# IonicRE Value Proposition

## MAKUUTU'S STRATEGIC IMPORTANCE WILL INCREASE LONG TERM LONG-LIFE, LOW-COST, HIGH-VALUE BASKET ASSET



### Large, Long-Life Potential

- Massive Ionic Adsorption Clay deposit with exploration upside
- 37km long mineralisation trend, 26 km in MRE with prospective ground to east and northwest
- 95% of current world supply of HREO supplied from Chinese/Myanmar IAC deposits which are being depleted – declining HREO supply on horizon
- Scandium upside yet to be fully demonstrated



### High Value Product

- REO demand increasing at rates that exceed forecast driven by Government Stimulus spending on electric vehicles (EVs), renewable energy, communications, defence
- Makuutu's basket ~ 43% magnet REOs (Nd, Pr, Dy, Tb, Sm, Gd, Ho)
- 73% critical plus heavy REOs makes it a standout



### Growing Demand

- EVs and Offshore wind turbines need DyTb plus NdPr – Makuutu basket has the right ratio
- Governments have pledged +230 GW of offshore wind turbine by 2030, 20% GAGR forecast by end of the decade
- Banning Internal Combustion Engines (ICE) in several countries from 2025, with significant changes in Europe where demand driven by government incentives will see it overtake China by 2030 as the largest market for EVs



### Strategic Asset

- Makuutu one of less than a handful of 'real' IACs with scale for development
- One of the largest future sources globally of heavy rare earths
- Huge importance to key military applications for the future

*“When peering into the outlook for the next decade to come, it becomes quickly apparent that the rapid demand growth of the 2020s will soon be dwarfed by the astronomical demand growth of the 2030s – and therein lies the real defining challenge and opportunity facing the global rare earth industry today.*

*If the global industry continues to operate myopically – preparing, anticipating and investing only for a three to five-year outlook – the rate of demand growth for magnet rare earths will soon reach ‘escape velocity’; a point at which annual demand growth becomes so great (i.e. >6,000 tonnes per annum) that it is simply implausible for the already-lagging supply-side to catch up and keep up.”*

**Adamas Intelligence, Sept 28, 2020**

# Looking Forward to 2022

## KEY ACTIVITIES OVER NEXT 6 TO 12 MONTH THAT UNLOCK SUBSTANTIAL VALUE AT IONIC RARE EARTHS

- Drill assays from remaining Phase 4 infill program (next 3-4 months)
- Submission of ESIA in Uganda (Q4 2021)
- Mineral Resource Estimate update (Q1/Q2 2022)
- Phase 2 Metallurgical variability and testwork (Q2 2022)
- Ongoing Exploration Activity – RAB Phase 3 metallurgical testwork to inform exploration drilling at EL00147 and EL0257
- Finalise Makuutu Project Approvals (Q2/Q3 2022)
- Makuutu Feasibility Study (Oct 2022)
- Makuutu Mining Licence Application target submission (Oct 2022)
- Refinery Scoping Study (Q3 2022)
  - Downstream Opportunity and how IonicRE can play a larger role in development of alternative, secure and traceable rare earth supply chains and alliances





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**ADDITIONAL SLIDES**



# REE Hard Rock Mining/Processing vs IAC Mining/Processing

## IONIC CLAY RARE EARTH ELEMENTS VS HARD ROCK RARE EARTH ELEMENTS PROJECTS

Significant project and cost advantages associated with ionic clay projects like Makutuu

MINING/PROCESSING STAGES	IONIC ADSORPTION CLAY-HOSTED REE	HARD ROCK-HOSTED REE
Mineralisation	Soft material, negligible (if any) blasting Elevated HREO/CREO product content	Hard rock; Bastnaesite and Monazite (LREO dominant); Xenotime (HREO dominant)
Mining	Low relative operating costs: Surface mining (0-20 m) Minimal stripping of waste material Progressive rehabilitation of mined areas	High relative operating costs: Blasting required Could have high strip ratios
Processing Mining Site	No crushing or milling Simple process plant Potential for static or in-situ leaching with low reagent consumption at ambient temperature	Comminution, followed by beneficiation that often requires expensive (flotation) reagents to produce mineral concentrate
Mine Product	Mixed high-grade rare earths precipitate, either oxide or carbonate (+90% TREO grade) for feedstock directly into Rare Earth separation plant, low LaCe content	Mixed REE mineral concentrate (typically 20-40% TREO grade), high LeCe content, requires substantial processing before suitable for feed to rare earth separation plant
Product Payability	70-80% payability as mixed Rare Earth oxide/ carbonate/chloride	35-40% payability as a mineral concentrate
Processing - Environmental	Non-radioactive tailings Solution treatment and reagent recovery requirements (somewhat off-set by advantageous supporting infrastructure)	Tailings often radioactive (complex and costly disposal) Legacy tailing management
Processing - Refinery (Typically not on Mining site)	Simple acid solubilisation followed by conventional REE separation Complex recycling of reagents and water	High temperature mineral "cracking" using strong reagents to solubilise the refractory REE minerals Complex capital-intensive plant required Radionuclide issues follow REE mineral concentrates

**Ionic Adsorption Clay (IAC)** deposit mineralisation is highly desirable given it produces a balanced **REO basket** **dominant in CREO & HREO with higher value and broader appeal**

Near surface IAC mineralisation translates to **lower strip ratios** with lower cost mining methods

IAC ores require much **lower CAPEX intensity to produce refined REOs**

IACs produce **value added Mixed Rare Earth Carbonate** product from IAC deposits, **higher grade and basket value**

IAC product achieves **nearly double the payability**

IACs experience **none of the radionuclide issues the plague hard rock LREO Projects**

**IAC separation and refining much lower CAPEX requirement**



# The REE Basket Problem – the Solution requires ‘Balance’



**Ionic Adsorption Clay (IAC)** deposit mineralisation is highly desirable given it produces a balanced **REO basket** dominant in **CREO & HREO** with higher value and broader appeal

**Hard rock rare earth mines typically >90-95% LREE**, i.e. very low in HREE content

**Very few true IAC deposits (<5) identified** of scale outside of southern China, Myanmar and south east Asia

**Increased LREE production to facilitate oversupply, and potentially suppress LREE prices, specifically NdPr**

**IAC HREE mines complement hard rock LREE mines in China**, providing ‘balance’ to REE supply quotas

IAC HREE mines typically **much lower production capacity** than hard rock LREE mines

**The rare earth solution for the future requires a balance; LREE readily sourced but HREE is truly rare**

# Makuutu and Critical Raw Materials 2020

## MAKUUTU BASKET CONTAINS HIGH RANKED CRMs IDENTIFIED IN 2020 EU STUDY REQUIRED TO ACHIEVE CARBON NEUTRALITY

**Secure and sustainable supply** of both primary and secondary raw materials, specifically of critical raw materials (CRM)

Targeting key technologies and strategic sectors as renewable energy, e-mobility, digital, space and defence is one of the **pre-requisites to achieve climate neutrality**

European Commission report identified Global **competition for resources will become fierce in the coming decade**

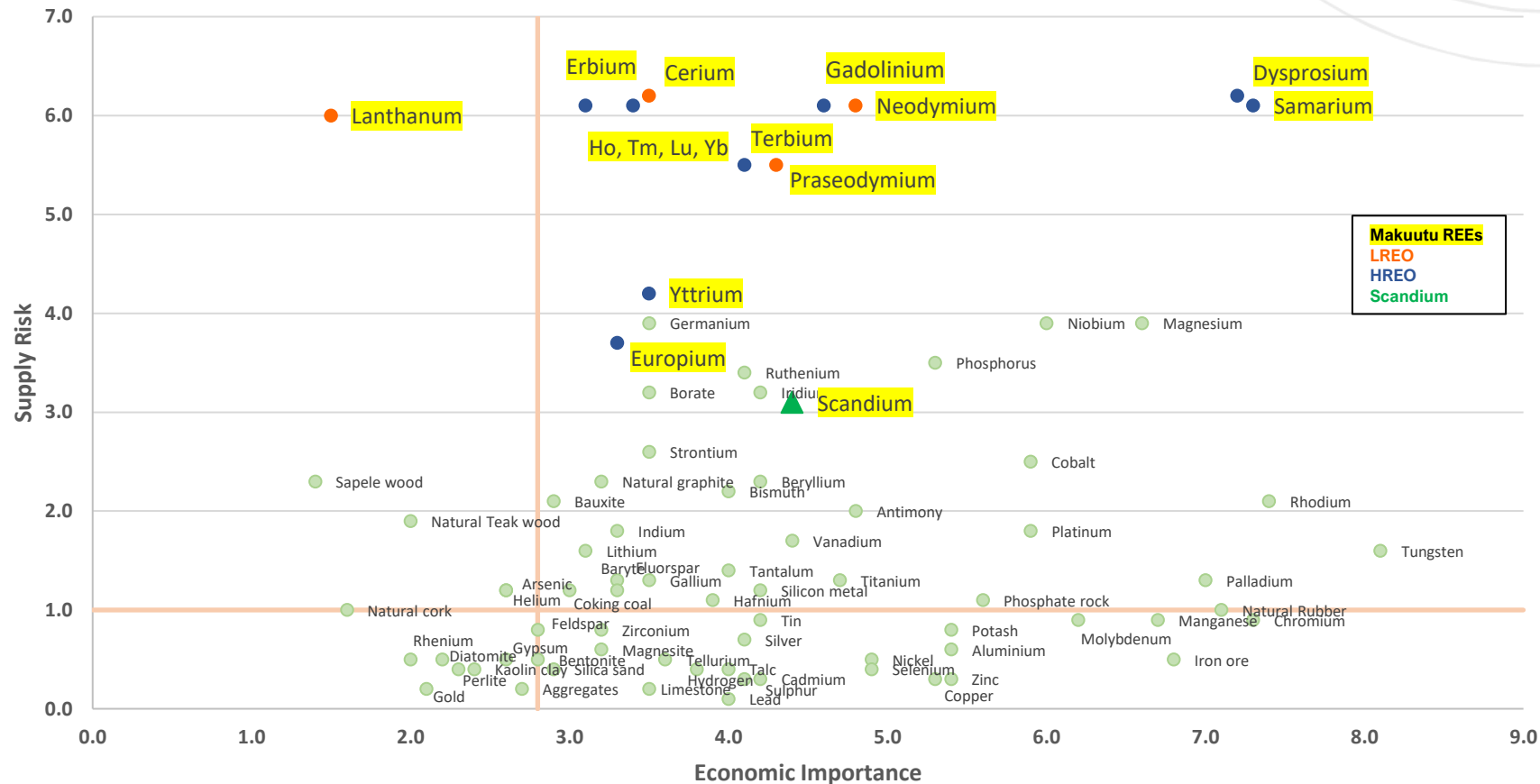
**Dependence of critical raw materials may soon replace today's dependence on oil**

**Makuutu has all the REO requirements in appreciable quantities**

**Scandium** potential at Makuutu to **facilitate light weighting transportation**

Long term stable supply is not a given – will **require investment further up the supply chain**

Economic Importance vs Supply Risk results for 2020 criticality assessment<sup>1</sup>



# Makuutu is one of the largest global Scandium resources... and growing

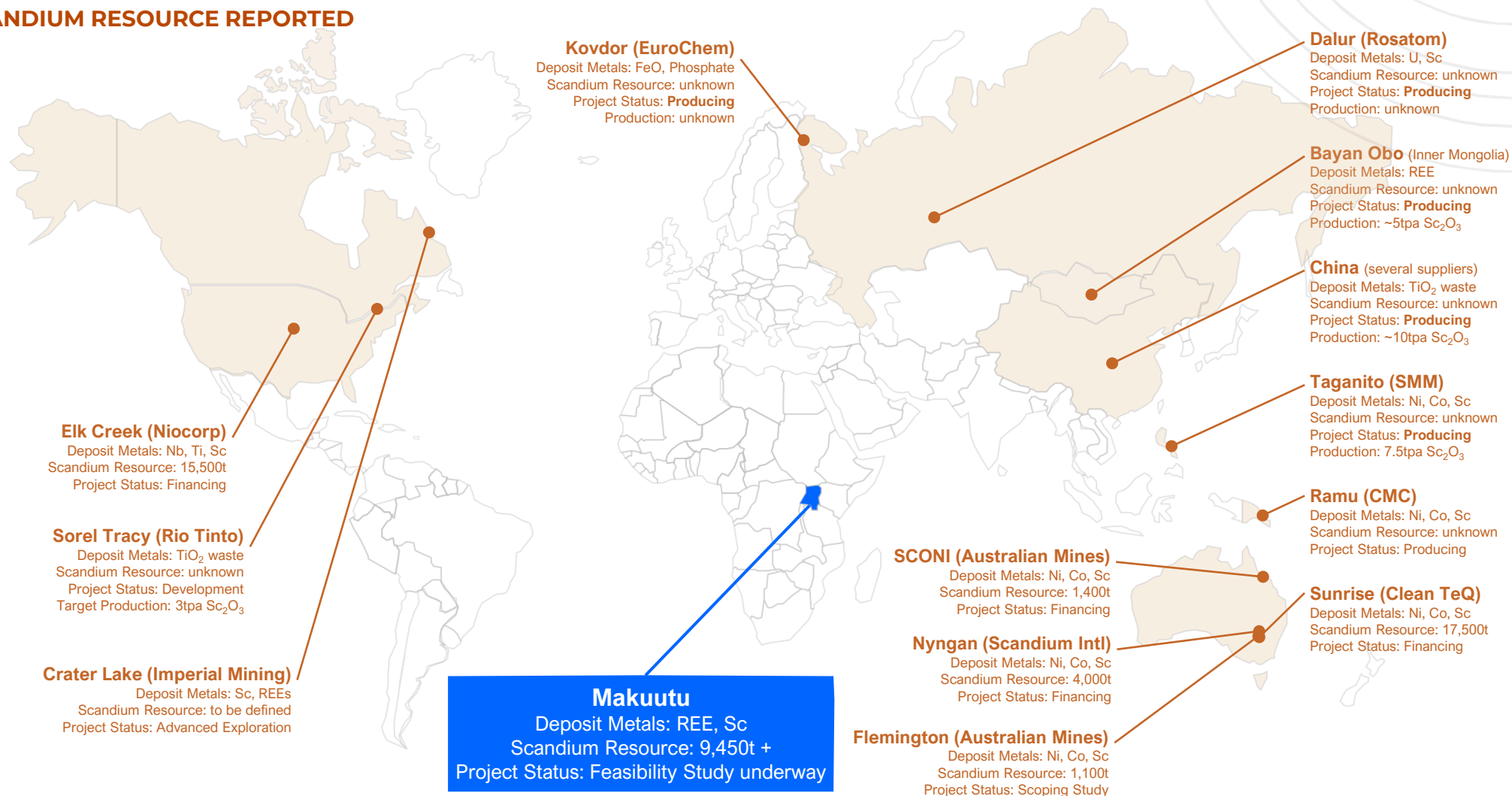
## 3<sup>RD</sup> LARGEST GLOBAL SCANDIUM RESOURCE REPORTED

Key to the success of the scandium industry is a diverse and reliable supply chain

While historically the scandium market has been dominated by Chinese supply, there are companies producing scandium or actively developing scandium supply

The Makuutu Rare Earths Project's scandium endowment and time to market make it a key future global player in the scandium market

Scandium market expected to grow very quickly once stable supply is demonstrated



# Applications with Aluminium in Light-weighting Transportation

The need for light-weighting solutions has dramatically increased the adoption of aluminium alloys in transportation. Stricter efficiency standards, the advent of the electric vehicle and the emergence of new sectors are accelerating uptake, generating new opportunities for aluminium alloys, like Al-Sc alloys, to strengthen its position as a key material for the future



## AUTOMOTIVE

Aluminium content in vehicles has been steadily increasing, driven by stricter efficiency and emissions requirements

Aluminium is displacing high-strength steel (HSS), a lower cost and heavier competitor, in several components

The electric vehicle (EV) revolution is dramatically accelerating aluminium's market share through new parts (e.g. battery boxes) and the need to increase vehicle range. EVs have 35-50% more aluminium than internal combustion engine vehicles<sup>1</sup>



## AEROSPACE

Aluminium is well-established in aerospace, with most airplanes constructed of aluminium alloys. While carbon fibre materials are lighter, they are more expensive, have a higher maintenance cost and require costly metals (such as titanium) to be used in concert. More advanced aluminium alloys can provide comparable low-cost alternative to composites

The next aerospace aluminium alloys will be strong and weldable, removing the need for rivets, providing enormous weight saving.



## SPACE

While historically niche sub-sector of aerospace, the commercial space industry represents a fast-growing sector where aluminium has a long, deep-rooted history

Rockets use a range of aluminium alloys in propellant tanks, providing a strong, lightweight material which can operate over large temperature ranges

Advanced aluminium alloys, combined with 3D printing, provide the space industry a unique opportunity to mass produce reusable rockets and satellites



## MARINE

Due to its high strength and high corrosion resistance, aluminium alloys are a growing material of choice for shipbuilding

'Marine grade' aluminium is 100 times less prone to corrosion than its steel counterpart<sup>2</sup>

'Marine-grade' aluminium alloys are both strong and weldable, which mean large sections of ships can be constructed with no joints or bolts, which reduce corrosion and the risk of water ingress



## RAIL

Like aerospace, aluminium has had a long history with rail, widely used in both freight and passenger cars

Aluminium provides ~30-35% weight reduction over steel and does not corrode, leading to a much longer service life

High-speed trains realise the greatest benefit from aluminium, which require low weight and high-strength to minimise friction loss

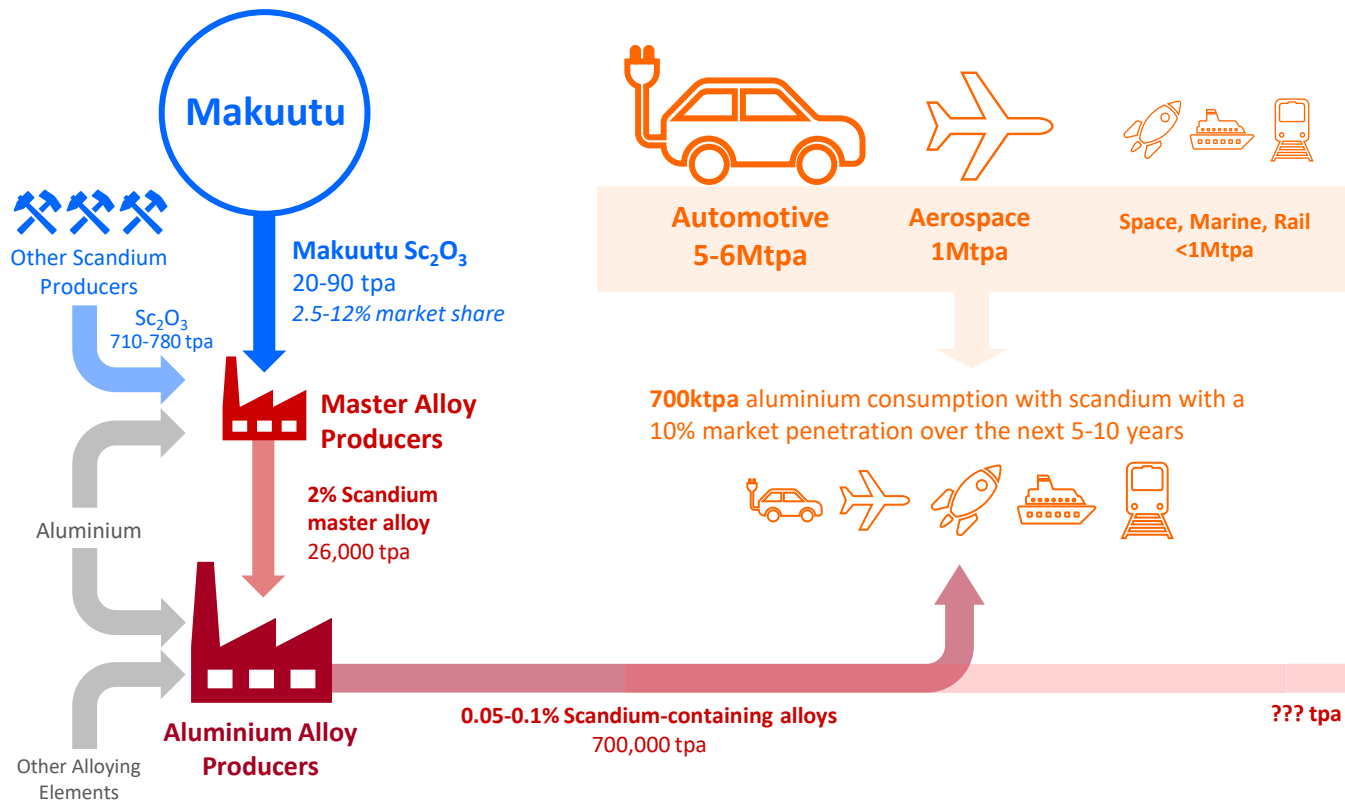


# Scandium Market Potential

## SIGNIFICANT POTENTIAL FOR SCANDIUM MARET TO GROW RAPIDLY IN GLOBAL TRANSPORT SECTORS

While the current scandium (Sc) market is 15-20 tonnes per annum scandium oxide (Sc<sub>2</sub>O<sub>3</sub>), the global transportation industry has the potential to turn scandium into a billion-dollar market

### Scandium supply chain:



### 7Mtpa aluminium consumption in global transport:



700ktpa aluminium consumption with scandium with a 10% market penetration over the next 5-10 years



### Contestable Scandium Market

The adoption of scandium will be heavily dependent on its price-point. As the market grows, the scandium price will decrease as economies of scale for production can occur. This will allow aluminium-scandium to be used in an increasing number of applications. While the initial price of scandium could be US\$1,000/kg Sc<sub>2</sub>O<sub>3</sub> at low tonnages, this will likely drop to ~US\$700/kg with increased volumes

### Scandium Market Value

- Avg Sc content: 0.075%
- Required Scandium: 525tpa (800tpa Sc<sub>2</sub>O<sub>3</sub>)
- Sc price range: US\$700-1,000/kg Sc<sub>2</sub>O<sub>3</sub>
- Market: US\$560-800M p.a.

### Makuutu Scandium

20-90+ tpa Sc<sub>2</sub>O<sub>3</sub>  
(2.5-12% total market share)  
US\$20-63M+ p.a. Revenue

### Future Markets / Applications:

