



Australian Government

Australian Trade and Investment Commission

Australian Critical Minerals Prospectus



Acknowledgements

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Acknowledgement of Country

In delivering the Australian Critical Minerals Prospectus, we pay respect to our First Nations peoples, their Elders, and their ancestors who have always cared and continue to care for our lands, water, and communities.

First Nations people are the Traditional Owners and custodians of the lands and waters on which critical minerals mining and processing takes place. Their voices and knowledge are critical to the success and sustainability of the critical minerals sector.

Austrade recognises First Nations people's continuing contribution towards creating a strong and prosperous nation, and we thank them for their custodianship of the Country that we live and work on today.





Introduction

The Australian Government is committed to fast-tracking the exploration, extraction, processing, and value-adding of critical minerals, and is actively supporting the development of projects across Australia. Critical minerals and strategic materials are essential components of transformative technologies such as electric vehicles, hydrogen electrolyzers, solar panels, wind turbines, greener buildings, and batteries that will drive Australia's ambitions to become a renewable energy superpower, and global energy partner of choice. They are also crucial to the defence, technology, and medical sectors.

The Australian Government's Critical Minerals Strategy 2023-2030 outlines Australia's vision, objectives and focus areas to ensure we can seize the opportunities of the clean energy transition. Implementation of the strategy includes increasing support to finance mining and processing projects, and investing in our international partnerships.

The International Energy Agency's World Energy Outlook 2023 underscores the exponential growth of the critical minerals market, which has doubled in size over the past five years. Projections indicate that demand is set to grow between two and fourfold by 2030¹.

At the same time, there is a need to diversify our trade to avoid vulnerabilities arising from volatile prices or highly concentrated supply chains. Industry end users are increasingly investing upstream to secure stable supply of responsibly produced critical minerals and strategic materials with Australia well positioned to meet this growing demand and become a globally significant producer of both raw and processed minerals.

In October 2023, the Government announced a A\$2 billion expansion of the Critical Minerals Facility, bringing the total financing available under the Facility to A\$4 billion. Further, in December 2023, the Australian Government updated its Critical Minerals List and introduced a new Strategic Materials List, recognising the importance of certain materials in the global transition to net zero and in broader strategic applications.

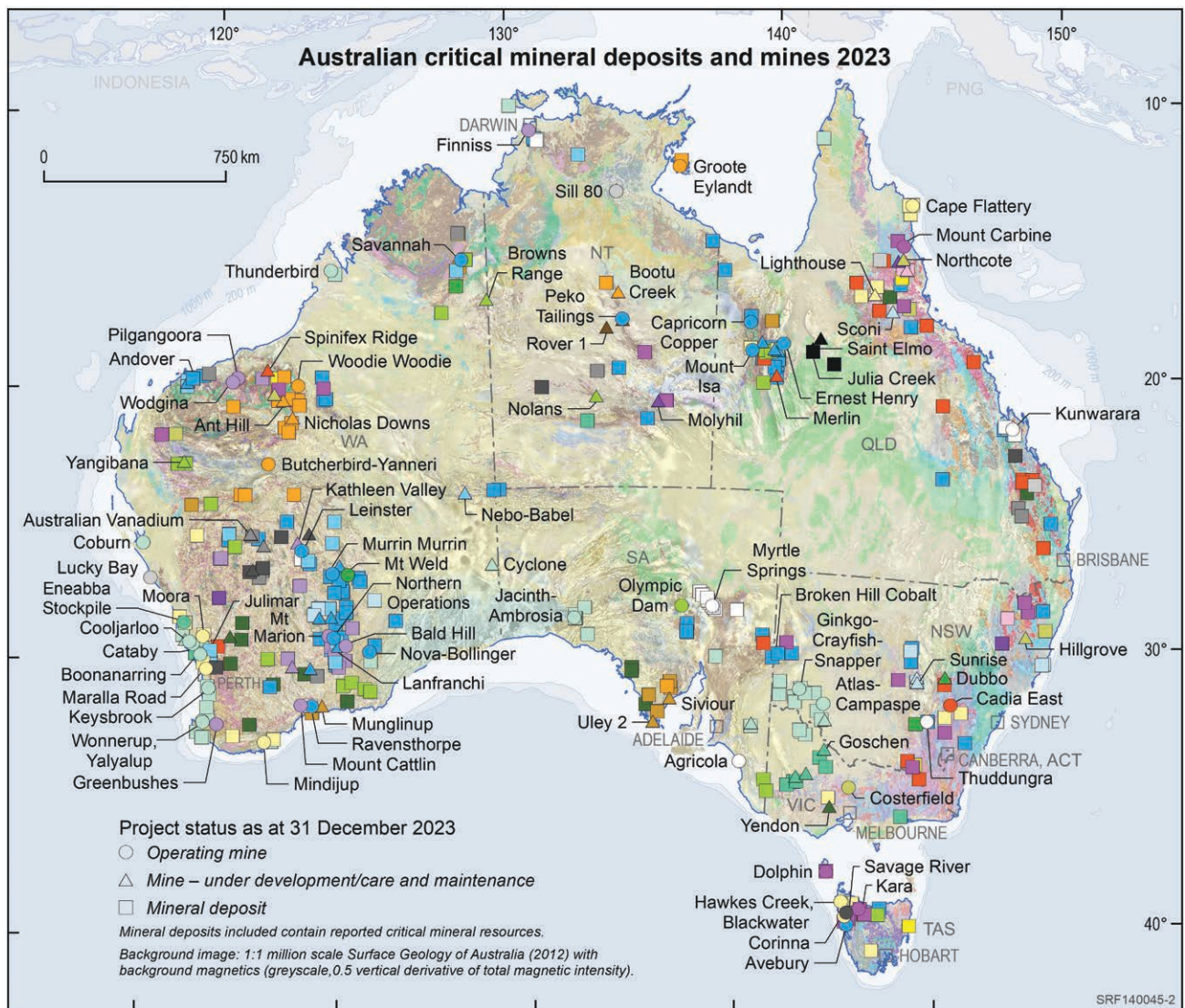
The *Australian Critical Minerals Prospectus* showcases investment-ready projects that have significant potential to address anticipated production shortfalls, build supply chain security, and deliver progress on a net zero future.

The Prospectus provides a snapshot of investment opportunities in Australia-based projects and additional information on the critical minerals and strategic materials sector reflective of the dynamic nature of the market, including:

- Updated mineral endowment figures from Geoscience Australia.
- Information on the additions to the Critical Minerals List and the new Strategic Materials List.
- 52 investment-ready project summaries.
- An updated *Developing the midstream* section, which reflects recent advancements.
- A *Spotlight on lithium*, which includes a snapshot of the project pipeline.

High-value critical mineral exports not only fuel economic growth, but also catalyse the development of new local processing capabilities. With its history as a global leader in resource project development, Australia boasts a highly skilled workforce, robust environmental, social and governance (ESG) practices, and a transparent regulatory environment. These advantages put Australia at the forefront of the exploration, extraction, production, and processing of critical minerals.

1. IEA (2023) World Energy 2023, IEA Paris



Commodity type

- | | |
|---|--|
| ● Antimony | ● Molybdenum, +/- Rhenium |
| ● Bismuth, +/- Cobalt, +/- Indium | ● Heavy Mineral Sands (HMS) – Titanium, Zirconium |
| ● Chromium, +/- Cobalt, +/- PGE | ● HMS – Titanium, Zirconium, REE |
| ● Cobalt | ● Rare Earth Elements (REE) |
| ● Platinum Group Elements (PGE), +/- Cobalt | ● REE, Zirconium, Niobium, +/- Hafnium, Lithium, Tantalum, Gallium |
| ● Scandium, +/- Cobalt, +/- PGE | ● Silicon (High Purity Silica/Quartz) |
| ● Fluorine | ● Tungsten |
| ● Graphite | ● Tungsten, Molybdenum |
| ● High Purity Alumina | ● Titanium |
| ● Indium | ● Titanium, Vanadium |
| ● Lithium, +/- Tantalum, +/- Niobium | ● Vanadium |
| ○ Magnesium | ● Vanadium, Molybdenum |
| ● Manganese ore | |

Map courtesy of Geoscience Australia, 31 December 2023



World leading critical mineral endowment

Australia is a leading mining jurisdiction and the most successful exploration destination in the world².

The Australian Government publishes a Critical Minerals List consisting of metallic or non-metallic materials that are essential to our modern technologies, economies and national security, and whose supply chains are vulnerable to disruption. The list was first identified in 2019 with 24 critical minerals, expanded in 2022 to 26 minerals, and in line with the Critical Minerals Strategy revised in December 2023 to 30 minerals.

Recent global events have emphasised Australia's important role in supplying the minerals needed for diverse, resilient, and sustainable global supply chains. These supply chains are crucial to the industries and technologies that support:

- The global transition to net zero
- Domestic and regional energy security
- Australia's defence and economic security

Mineral	Antimony	Arsenic	Beryllium	Bismuth	Chromium
Australian resources (EDR 2022)	139.4 kt Sb	n/a	n/a	n/a	n/a
World ranking for resources	6	n/a	n/a	n/a	0
Share of world production	2%	n/a	n/a	n/a	0%

Mineral	Cobalt	Fluorine	Gallium	Germanium	Graphite
Australian resources (EDR 2022)	1,742 kt Co	343 Kt F	n/a	n/a	8.5 Mt
World ranking for resources	2	9	n/a	n/a	8
Share of world production	3%	0%	n/a	n/a	0%

Mineral	Hafnium	High purity Alumina	Indium	Lithium	Magnesium
Australian resources (EDR 2022)	14.5 kt	16.7 Mt (ore)	n/a	7,046 kt Li	294 Mt MgCO ₃
World ranking for resources	n/a	n/a	n/a	2	5
Share of world production	n/a	n/a	n/a	52%	2%

2. MinEx Consulting, 2023. Exploration: Australia vs The World <https://minexconsulting.com/exploration-australia-vs-the-world/> accessed 24/11/2023.

Mineral	Manganese	Molybdenum	Niobium	Platinum group elements	Rare earth elements
Australian resources (EDR 2022)	496 Mt (Mn ore)	687 Kt Mo	216 kt Nb	359.3 t PGE metal	5.70 Mt oxide
World ranking for resources	4	5	unknown	minor	6
Share of world production	5%	10%	minor	unknown	minor

Mineral	Rhenium	Selenium	Scandium	Silicon	Tantalum
Australian resources (EDR 2022)	n/a	n/a	36.65 kt Sc	n/a	110 kt Ta
World ranking for resources	n/a	n/a	unknown	n/a	unknown
Share of world production	n/a	n/a	0%	n/a	4%

Mineral	Titanium	Tellurium	Tungsten	Vanadium	Zirconium
Australian resources (EDR 2022)	Ilmenite 303.3 Mt Rutile 39.0 Mt	n/a	568 kt W	8,510 kt V	Zircon 88.3 Mt
World ranking for resources	Ilmenite 2 Rutile 1	n/a	2	2	1
Share of world production	Ilmenite 5% Rutile 27%	n/a	minor	0%	25%

Table Notes:

Rare Earth Elements (REE) include yttrium (Y), lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu). Platinum Group Elements (PGE) include ruthenium (Ru), rhodium (Rh), palladium (Pd), osmium (Os), iridium (Ir), and platinum (Pt).

n/a not available

EDR = Economic Demonstrated Resources

Units: t = tonnes; kt = kilotonnes; Mt = million tonnes. Where an element symbol follows the unit it refers to contained metal content.

Minor: Less than 1% of global economic resources and/or production, therefore Australia's ranking unable to be determined.

Unknown: Global economic resources are too opaque for comparisons or Australian production is likely to have occurred during the year but quantities are not publicly available.

Sources: Australia's Identified Mineral Resources 2023, preliminary data tables, Geoscience Australia. Mineral Commodity Summaries 2023, United States Geological Survey.

Recent updates to Australia's Critical Minerals List

On 16 December 2023, the Australian Government updated the Critical Minerals List, which enacted the following changes:

Added: Arsenic

Arsenic is used as an alloying agent in many industrial processes. It also has some defence applications. Importantly, high-purity arsenic metal is used to manufacture semiconductors for solar cells, space research, telecommunications, and specialty optical materials.

While there is currently no production in Australia, there is resource potential for arsenic, with many known deposits and potential for recovery as a by-product from existing deposits and commercial operations. In 2022, world arsenic production was approximately 61,000 tonnes.

Added: Fluorine

Fluorine is sourced from fluorite (also called fluorspar), which can be used in batteries and for manufacturing semiconductors and solar photovoltaic cells. Its main use is as a fluxing material for manufacturing steel and aluminium.

There is no known production of fluorine in Australia, however Mineral Resources have been reported in Tasmania, New South Wales, Queensland and in Western Australia.

Australia ranks ninth globally for economic fluorine resources despite representing less than 1% of the world's resource total. Overall, the global fluorine market is expected to experience better market opportunities in coming years, driven by the increasing demand for fluorine-based products in various industries, and the development of new and innovative applications for fluorine compounds. The reliance on a small number of individual countries for fluorine production reinforces its susceptibility to supply chain disruptions.

Added: Molybdenum

Molybdenum is primarily used to increase the strength, hardness, and corrosion resistance of alloys. Molybdenum alloys are widely used as a refractory metal in chemical applications and in structural steel, aircraft, and automobile parts. Molybdenum is also used in green energy applications such as wind turbines, solar panels, and geothermal plants.

Production of molybdenum resumed in Australia in 2022 for the first time since 1978, when Newcrest's Cadia operations in New South Wales commissioned its processing plant to extract molybdenum from copper concentrates. Cadia is currently Australia's only mining operation reporting molybdenum production.

In addition to Cadia, there are several deposits/projects that have the potential to produce molybdenum as a by-product alongside gold, copper, tungsten, uranium, and iron ore. Caravel, Molyhil, and Kalkaroo represent such projects within this Prospectus.

In 2022, global molybdenum production was approximately 252kt, and the world's identified resources of molybdenum have been estimated to be more than 12,000kt. Australia ranks fifth globally for molybdenum resources, accounting for 6% of the global total. While production is currently small, there is potential for it to grow from new and existing projects.

Added: Selenium

Selenium is used in copper and steel alloys, manganese metal production, and solar cells and photocells.

Australia may have potential sources of selenium by recovering by-products from the production of other minerals, such as copper, lead, nickel, and zinc sulphide ores, which are abundant in Australia. In 2022, global production of refined selenium was approximately 3,200 tonnes.

Added: Tellurium

Tellurium is used to produce thin-film solar cells and thermoelectric devices for cooling and energy generation. It can also be used as an alloy for steel, copper, and lead.

Tellurium is commonly enriched in copper deposits, from which the majority of the world's tellurium is produced as a by-product during the refining process.

In 2022, global tellurium production was 640 tonnes, while the world's identified resources of tellurium have been estimated to be more than 32,000 tonnes.

Removed: Helium

Helium was removed from the Critical Minerals List. This more closely aligns Australia's List with those of our international strategic partners.

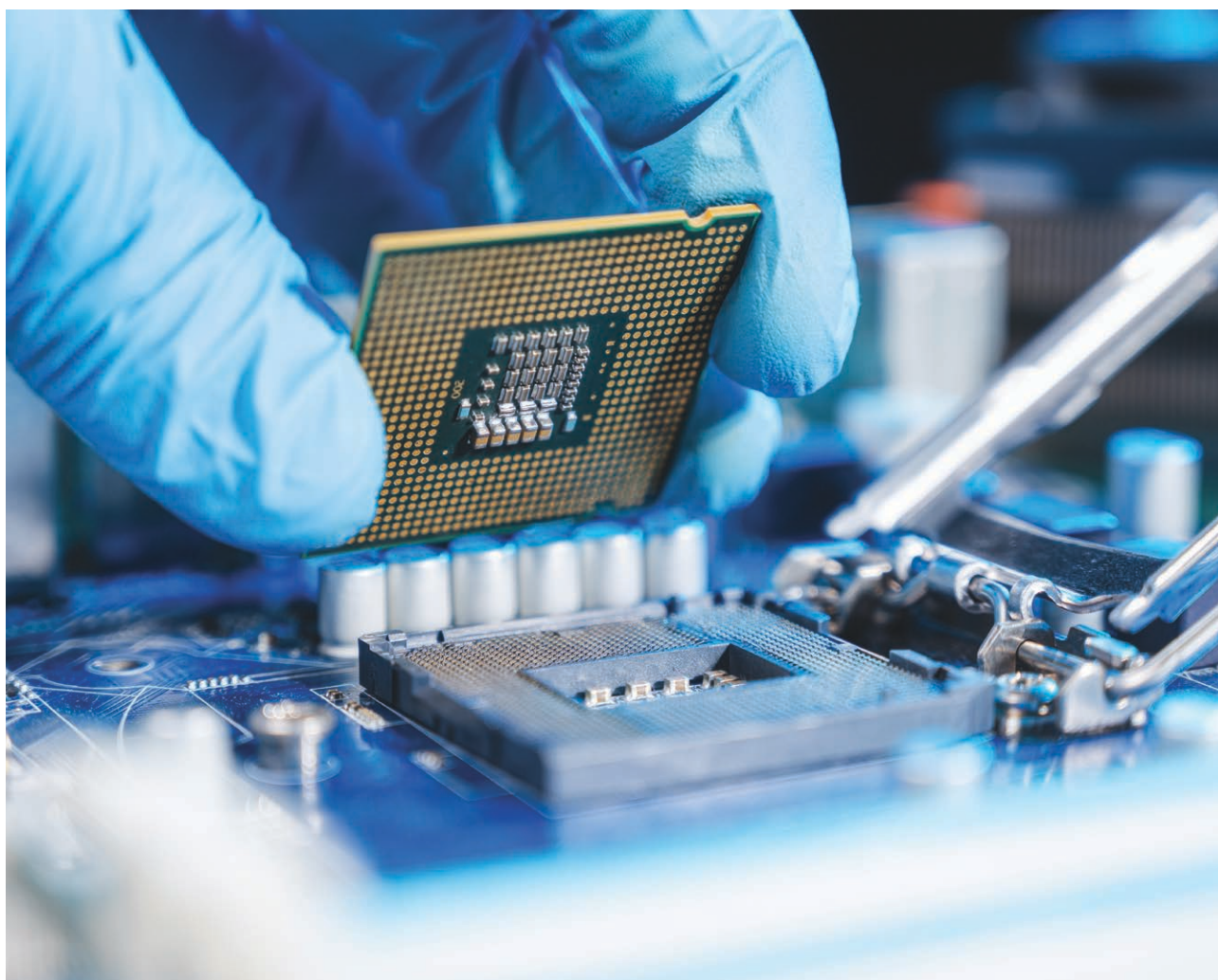
Strategic Materials List

In December 2023, alongside the Critical Minerals List revision the Australian Government also released a Strategic Materials List, consisting of minerals important for the global transition to net zero and broader strategic applications, which are in demand for our international partners, but whose supply chains are not currently vulnerable enough to be considered critical minerals.

The Strategic Materials List includes **aluminium, copper, nickel, phosphorous, tin, and zinc**.

While these minerals are not eligible for the Australian Government's dedicated critical minerals support and finance, the Government will continue supporting the extraction and processing of these minerals and monitoring their market developments. This signals the Government's support for their continued development.

Source: Department of Industry, Science and Resources, and Geoscience Australia





Why Australia for critical minerals?



Australia continues to be the **most attractive region globally** for mining investment*



Australia is ranked first in the world for **financial freedom** and third for **trade freedom****



Australia is ranked fourth worldwide for **regulatory quality and efficiency*****



Australia is the **most successful exploration destination** in the world****

* Mejia, J. & Aliakbari, E. 2022. Fraser Institute Annual Survey of Mining Companies 2022. Fraser Institute, Vancouver)

** The Heritage Foundation. 2023. Index of Economic Freedom. The Heritage Foundation, Washington D.C.)

*** Kaufmann, D., Kraay, A. 2023 Worldwide Governance Indicators. World Bank, Washington, D.C.)

**** MinEx Consulting, 2023. Exploration: Australia vs The World <https://minexconsulting.com/exploration-australia-vs-the-world/> accessed 24/11/2023.

A secure economy backed by strong exports, services, and a stable geopolitical environment

Amid ongoing global uncertainty, Australia continues to be one of the most attractive places to do business, scoring significantly higher than other OECD countries for government effectiveness, regulatory quality, and rule of law.³ Despite challenges posed by global inflation and the persistent impacts of the COVID-19 pandemic, Australian GDP growth projections for 2024 exceed forecasts for other advanced economies.⁴ Although home to only 0.3% of the world's population, Australia is a centre of economic dynamism as the 12th largest economy in the world. Australia's strong economy is reinforced by a strategic geography and stable geopolitical environment, both of which support the long-term viability of mining investment. As a result, Australia's resources sector continues to set records for production and exports of high-quality minerals that satisfy increasing global demand as the world transitions to net zero.

Robust and thorough ESG practices

Consumers are increasingly conscious of the origins of traded goods and the social impact of their choices. A secure supply of minerals for industrial end users requires the effective management of all environmental, social and governance (ESG) considerations related to mining and minerals processing.

Australia is well positioned to meet the growing demand for responsibly produced minerals. The Australian resources sector has a global reputation for extracting minerals safely, responsibly, and with robust environmental, social, and labour protections. Increasingly, Australian companies are investing in renewable energy to decarbonise their operations and processes along the supply chain. As an active participant in the International Organization for Standardization, Australia is constantly working to ensure that production standards are equitable and environmentally sustainable.

3. Kaufmann, D., Kraay, A. (2022). Worldwide Governance Indicators. World Bank, Washington.

4. International Monetary Fund, (2023). World Economic Outlook: Navigating Global Divergences. IMF, Washington D.C.

The *Environment Protection and Biodiversity Conservation Act 1999* is Australia's primary piece of national environmental and heritage protection legislation, providing a framework for the protection of the environment, in particular those aspects of the environment that are nationally 'protected matters'. It includes statutory obligations on respectful and effective engagement with Australia's First Nations people.

Australian critical minerals companies increasingly view ESG reporting as an opportunity to create value for customers and investors, and are recognised for their focus on workplace, community, and labour relations in sustainability reports, in addition to management of water and greenhouse gas emissions⁵.

Australia's unique mineral endowment and explorational endeavour

Australia is a geological powerhouse with a unique mineral endowment. As seen in our *World leading mineral endowment* section, Australia is ranked in the global top ten for ten individual minerals, and Australia's geology presents unique investment opportunities for investment.

Australia spent over A\$4 billion on mineral exploration in 2022 and has an extensive and freely available precompetitive geoscience program that underpins exploration and mineral discoveries across the country.

More information is available on our sections entitled *World leading mineral endowment* and *Australia's geological surveys: the gateway to Australia's untapped resources*.

Comprehensive financial incentives

The Australian Government supports advanced critical minerals projects through several Commonwealth financing bodies.

Australia's export credit agency, Export Finance Australia, provides finance to critical minerals projects and related infrastructure.

Export Finance Australia recently approved a USD loan for the equivalent of A\$125 million for the expansion of Pilbara Minerals' P680 lithium expansion, and a A\$220 million loan to support Lontown's Kathleen Valley lithium project.

Export Finance Australia also administers the Australian Government's Critical Minerals Facility. In October 2023, the Facility was expanded from A\$2 billion to A\$4 billion.

To date, the Australian Government has approved three loans under the Facility. The loan recipients are:

- **Iluka Resources:** A\$1.25 billion loan for the development of its Eneabba Rare Earths Refinery Project.
- **Renascor Resources:** A\$185 million loan for its Siviour Graphite Project.
- **EcoGraf:** US\$40 million loan for its Battery Anode Material Facility.

Eligible projects are also able to access finance from other Commonwealth financing bodies, including the **Northern Australia Infrastructure Facility** (NAIF) and the **Clean Energy Finance Corporation** (CEFC). NAIF recently approved loans for critical minerals projects, including A\$125 million for the expansion of Pilbara Minerals' P680 lithium expansion project and A\$160 million for the development of the Thunderbird Mineral Sands Project. CEFC has invested directly in critical minerals projects such as Pilbara Minerals' Pilgangoora Project, as well as in the development of Novalith Technologies' LiCAL Technology.

As part of the **Critical Minerals Strategy 2023-2030**, the Australian Government has also allocated A\$500 million to NAIF to support proponents and end-users by investing in the reliable supply of critical minerals through project development and encouraging upstream investment.

Eligible projects may be able to obtain finance from multiple Commonwealth agencies.

The Australian Government supports the critical minerals sector through a A\$4 billion finance facility



5. Smith, D., Upcorft, M., Claassen, M. Reynolds, C., O'Donoghue, J., McKenna, S., Meadows, R., Pope, C., McKinley, S., Haynes, L., Mulherin, C., Vangou, D., Harris, C., Jamieson, M., Frayre, F., Whittaker, L., Torres, J.D., Sharma, M., Mehta, J., Robb, K., Loughridge, J. 2022. Aussie Mine 2022 Mission Critical. PricewaterhouseCoopers, Melbourne.

6. Austrade. (2023). Why Australia: Benchmark Report 2023, Austrade, Canberra, pg. 17

A highly skilled workforce and a globally recognised METS sector

The Australian resources sector benefits from a talented and highly skilled workforce. Australia's top-ranking education system, coupled with a national focus on growing in-demand skills, supports the longevity of a work-ready local talent pool. With research institutions that rank in the world's top 1% across 15 different fields, Australia's workforce includes a variety of skills needed in the resources industry.⁶

The international competitiveness of Australia's resources sector is underpinned by an advanced mining equipment, technology, and services (METS) industry, which directly employs more than 300,000 people.⁷ Australia is also an established services hub, with professional and technical services growing at an average rate of 7%.⁸ Our equipment and technology producers have long embraced robotics, automation and big data, meaning that Australia resources projects are efficient and productive.

*Australia ranks in the top five worldwide for tertiary education quality*****



**** Lanvin B., Monteiro, F. 2023 Global Talent Competitiveness Index. INSEAD, Fontainebleau)

Supportive government frameworks at all levels

The Australian Government supports the development of the Australian critical minerals sector. Government initiatives are complemented by a range of other strategic and policy initiatives at the state and territory level. Australian Government policies and programs are designed to:

- 1. foster sector-wide development** through trade and investment facilitation, research and development, standards and accreditation, and hubs and precincts.
- 2. forge strategic partnerships** with major trading partners such as the United Kingdom, the United States of America (US), the EU and its member countries, Japan, South Korea, and India.

7. METS Ignited. (2023). METS in Australia, Brisbane.

8. Austrade. (2023). Why Australia: Benchmark Report 2023, Austrade, Canberra, pg. 17



- 3. drive the development of critical minerals projects through supportive debt finance and other funding mechanisms.**
- 4. unlock the midstream** through industry development, research and development, science, technology, and infrastructure support.

In June 2023, the Australian Government released its **Critical Minerals Strategy 2023-2030**, which sets out a vision to grow Australia's critical minerals wealth, create Australian jobs in mining and manufacturing, strengthen global clean energy supply chains, and support the path to net zero.

The Strategy has four objectives:

- 1. Create diverse, resilient and sustainable supply chains** through strong and secure international partnerships.
- 2. Build sovereign capability in critical minerals processing.**
- 3. Use our critical minerals to help become a renewable energy. superpower.**
- 4. Extract more value onshore from our resources** – creating jobs and economic opportunity, including for regional and First Nations communities.

The Strategy is intended to be an enduring framework which will guide the Government's future policy decisions to maximise the national benefits of Australia's internationally significant critical minerals endowments.

Australian Government support of the critical minerals sector

Critical Minerals Office

The Department of Industry, Science and Resources: Critical Minerals Office (CMO) provides national policy and strategic advice to grow Australia's critical minerals industry, delivering the Australian Government's Critical Minerals Strategy in partnership with Austrade, and the Department of Foreign Affairs and Trade (DFAT).

The CMO works with Austrade and DFAT to:

- develop policy and regulatory settings that enable investment.
- unlock downstream opportunities
- promoting investment and building diverse and secure global supply chains.
- improve access to regulatory approvals and funding and investment information
- supporting research and development.

Australian Trade and Investment Commission

Austrade is the Australian Government's trade and investment facilitation agency. It contributes to the growth of the Australian critical minerals industry by developing commercial partnerships that connect Australian companies with targeted sources of offtake and investment. In doing so, Austrade works closely with the CMO, DFAT, state and territory investment agencies, as well as counterpart trade and investment facilitation agencies in other jurisdictions.

In critical minerals, Austrade's three principal areas of focus are:

- offtake agreements for (and investment and potential equity in) Australian critical minerals projects to accelerate their development;
- foreign investment in downstream processing and value chain creation;
- foreign investment in greenfield critical minerals opportunities.

Austrade delivers this capability through specialised services to Australian critical minerals companies, including bespoke client engagement programs and targeted trade missions. These initiatives build on the Austrade's understanding of the specific needs of global critical mineral end users and their tiered suppliers. Austrade also facilitates commercial partnerships with targeted global partners. Interested investors, project proponents and offtake partners can contact Austrade via austrade.gov.au or criticalminerals@austrade.gov.au.

Department of Foreign Affairs and Trade

DFAT provides international government-to-government engagement that advances the goals of the Critical Minerals Strategy to create diverse and secure global supply chains for critical minerals, and to attract international investment. In particular, DFAT works closely with the CMO and Austrade to build bilateral and multilateral partnerships that enable commercial linkages and support the sector's development. Australia's diplomatic missions overseas are working to showcase Australia's critical mineral industry to international partners.

Financing bodies

Clean Energy Finance Corporation

The Clean Energy Finance Corporation (CEFC) is a specialist investor at the centre of efforts to help deliver on Australia's ambitions for a net zero future. CEFC investments in the resources sector seek to capitalise on Australia's world-leading access to many of the minerals critical to the low emissions economy of the future, including those that are essential to the development of renewable energy, energy storage and electrification. With a strong investment track record, the CEFC invests to fill market gaps by collaborating with investors, innovators, and industry leaders to spur substantial new investment where it will have the greatest impact. The CEFC invests on behalf of the Australian Government, with a strong commitment to deliver a positive return for taxpayers across its portfolio.

Northern Australia Infrastructure Facility

The Northern Australia Infrastructure Facility (NAIF) is a A\$5 billion lending facility providing loans to infrastructure projects in northern Australia. An extra A\$2 billion was allocated to the lending facility in the 2022-23 Australian Budget. NAIF investments can be used to develop new or materially enhance existing infrastructure. NAIF can lend up to 100% of the debt, provided there is appropriate risk sharing. Loans can be on concessional terms, relative to private sector financing arrangements, if the infrastructure generates public benefit and there is an ability to repay or refinance. The Australian Government has also allocated A\$500 million to NAIF to support proponents and end users by investing in the reliable supply of critical minerals.

Export Finance Australia

Export Finance Australia supports Australia's trade and infrastructure agenda by providing commercial finance for exporting businesses and Indo-Pacific infrastructure development. Export Finance Australia supports critical minerals projects and related infrastructure, and Australian businesses involved with the critical minerals export supply chain.

Export Finance Australia administers the Australian Government's National Interest Account. This includes the A\$4 billion Critical Minerals Facility, the Defence Export Facility, and lending for the Australian Infrastructure Financing Facility for the Pacific.

National Reconstruction Fund

The Australian Government established the A\$15 billion National Reconstruction Fund (NRF) to facilitate increased flows of finance into the Australian economy through targeted investment to diversify and transform Australian industry, create secure, well-paid jobs, and boost sovereign capability. Key for this sector is the A\$1 billion for value-adding resources. On 30 November 2023, the Australian Government published the NRF Corporation's Investment Mandate. Funding is expected to become available in 2024. Finance is expected to be provided in the form of loans and equity investment. To keep up to date with developments, please refer to nrf.gov.au.

Scientific & research institutions

Geoscience Australia

Geoscience Australia is Australia's pre-eminent public geoscience organisation and a trusted source of information on Australia's geology and geography. It provides technical capability,

geoscience information, innovation, and advice on critical minerals. The organisation, working with its state and territory partners, delivers programs of continental-scale data acquisition, and develops tools for mapping, prediction, and decision making.

Geoscience Australia's critical minerals activities aim to underpin new exploration technologies, stimulate mineral exploration investment, drive new discoveries, and open up new, producing critical minerals provinces.

To find out more about Geoscience Australia's critical minerals activities, publications and data, visit: ga.gov.au/scientific-topics/minerals/critical-minerals

Future Battery Industries Cooperative Research Centre

The Future Battery Industries Cooperative Research Centre (FBI-CRC) is jointly funded by a variety of participants across industry, government, and the research community. FBI-CRC has a six-year research and development program targeting each stage of the battery value chain. It has a mandate to enable the growth of battery industries that will power Australia's future.

Australian Nuclear Science and Technology Organisation

The Australian Nuclear Science and Technology Organisation (ANSTO) is contributing to the development of sustainable alternative supply chains for the Australian critical minerals industry. ANSTO's minerals business unit has world-leading expertise in critical minerals, particularly rare earth processing (including scandium), lithium processing (brines and hard rock), zirconium/niobium/hafnium processing and other speciality metal processing. The minerals group also has expertise in uranium and base metals processing, and radioactivity control and management in the mining and minerals processing industries.

Commonwealth Scientific and Industrial Research Organisation

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) has considerable strengths in critical minerals processing. It generates ideas for innovation and process improvements that help Australian mining companies to operate competitively and sustainably. It is developing technologies to help Australian critical minerals companies to improve extraction from difficult and low-grade ores. CSIRO is also developing practical technologies that will help Australian companies upgrade and refine critical minerals to speciality grades, and to manufacture the minerals into intermediate components.



Australia's geological surveys: the gateway to Australia's untapped resources

Until recently, most Australian mineral discoveries were either exposed at the surface or had some form of surface expression that could be easily detected by geological, geochemical or geophysical exploration methods. There is no reason to suppose that resources will only be found near the surface. **With most of the Australian continent underexplored, many potential resources remain undiscovered.**

Australia's federal, state, and territory geological surveys provide world-leading precompetitive geoscience to accelerate new mineral discovery and development.

Geoscience Australia's A\$225 million Exploring for the Future program is Australia's premier investment in precompetitive geoscience aimed

at progressing world-class, Australia-wide, geological, geochemical and geophysical data coverages. From these coverages, a national inventory of resource potential is emerging and informing regional projects, where government geoscience is further reducing risks for explorers.

Freely available precompetitive geoscience information underpins much of the success of explorers in Australia. Since 2015, Australia's share of global exploration expenditure has risen from 8 to 18% and, over the same period, generated the greatest return on investment in the world⁹. Precompetitive geoscience has been vital to supporting this value creation, underpinning three quarters of the eight world class discoveries made in Australia since 2017¹⁰.



9. MinEx Consulting, 2023. Exploration: Australia vs the World, <https://minexconsulting.com/exploration-australia-vs-the-world/> access on 24/11/2023.

10. Czarnota, K., Shodde, R. & Upton, D., 2023. Precompetitive Geoscience for Discovery. Brisbane: World Mining Congress Keynote [DOI: <https://dx.doi.org/10.26186/148668>].

Australia Minerals

Australia's eight geological surveys collaborate as Australia Minerals to support the development of Australia's minerals sector. The Australia Minerals team provides coordinated and strategic actions to:

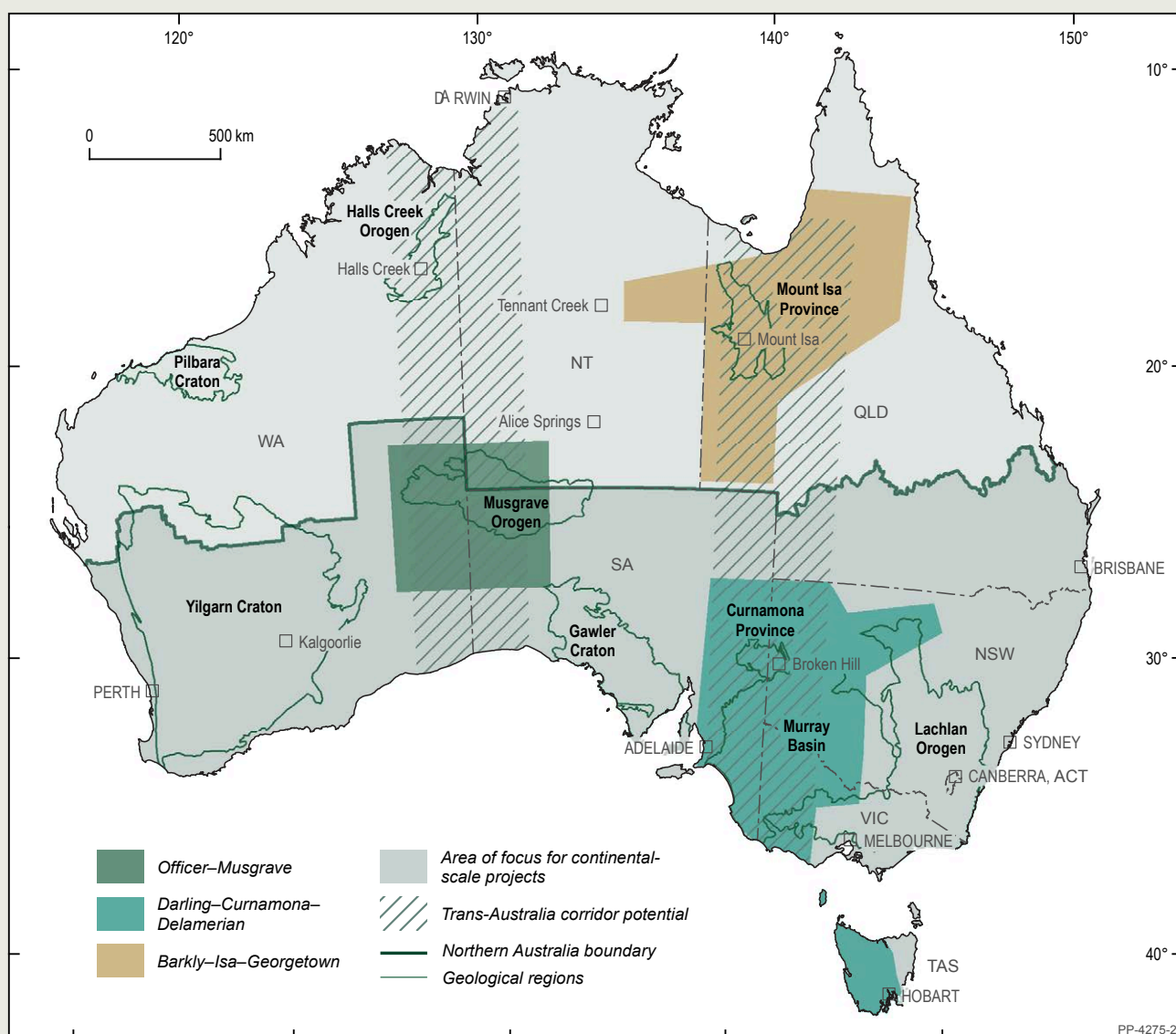
- highlight investment opportunities in Australia's minerals sector
- explain Australia's competitive advantages, including Australia's leading ESG
- promote Australia's precompetitive data, information and tools for de-risking mineral exploration

- provide unrivalled expertise about Australia's geology, resource potential, mining regulations, industry activities, and exploration and development initiatives in Australia.

For further information online:

- Exploring for the Future, including a wealth of data via the data discovery portal – eftf.ga.gov.au

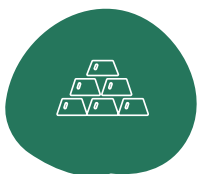
Figure 1. Australian resource provinces



Map courtesy of Geoscience Australia, 2023

Critical minerals mapping initiative

Geoscience Australia, the Geological Survey of Canada, and the United States Geological Survey have created the Critical Minerals Mapping Initiative to support a diversified critical minerals industry through precompetitive geoscience collaboration. The collaboration has released a range of precompetitive data and interpretations, including the world's largest dataset of critical minerals in ores. For more information visit criticalminerals.org



Australia has

22 commodities ranked in the top five

for world economic resources, including cobalt, lithium, manganese, tungsten, and vanadium.



In 2022, Australia spent **A\$4,054.9 million on mineral exploration**, an increase of 13% from 2021. Included in the total spend was exploration for minor metals (including critical metals such as lithium and rare earth elements) which increased by 66% to A\$482.6 million¹¹.

11. Australian Bureau of Statistics (September 2023), Mineral and Petroleum Exploration, Australia. ABS Website, Canberra.

Australian mineral systems with critical mineral discovery potential

Critical mineral deposits are the consequence of earth processes that concentrate elements, termed mineral systems. A mineral of interest can be concentrated in a number of different mineral systems and accompanied by other commodities. Here, we highlight some of the particularly notable mineral systems across Australia with the potential to supply critical minerals.

Felsic igneous-related **rare earth elements, lithium, tungsten, niobium, tantalum, beryllium, and bismuth** occur in known deposits and have potential for additional discovery across Australia.

Mafic-ultramafic-related **platinum group elements, chromium, and cobalt** resources often occur together with nickel and copper in mafic-ultramafic igneous complexes. Precompetitive geoscience contributed to large discoveries such as the Julimar PGE-Ni-Cu-Au-Co deposit near Perth, WA.

Australian sedimentary basins host critical and strategic minerals such as **magnesium, manganese, nickel, and vanadium**. Of these, manganese, magnesium, and nickel are currently mined in Australia, and advanced exploration projects have identified significant resources of magnesite (source of magnesium) and vanadium (plus nickel and molybdenum). Moreover, metamorphosed basins are also known to contain significant **graphite** resources. **Scandium** and rhenium resources are known in other geological environments.

Australia's near surface is emerging as an important search space for critical minerals. New discoveries of heavy mineral sand provinces in Australia, such as the Murray Basin, attest to the potential of the continent for further delineation of major resources, which host **zirconium, titanium, and rare-earth elements**. Australian salt lakes have low potential for **magnesium** and **lithium**, but they have high potential for potash, which is now being produced in WA. Clay-hosted **rare earth element** deposits are also an emerging deposit style in Australia, with the potential to host large volumes of heavy rare earth elements.

High purity alumina (HPA) is aluminium oxide with very low levels of impurities, which can be produced primarily from kaolin clay or processed bauxite. **Silicon** for high-tech applications is produced from high-purity quartz (HPQ) with a purity greater than 99% silica. HPQ occurs through a variety of natural processes and a broad range of geological mineral systems, such as hydrothermal veins, gravels and quartz-rich granites.

Antimony, indium, gallium and germanium are primarily by-products of the refining of major commodities, including gold, zinc, lead, copper, aluminium and nickel. Australia holds significant resources of these major commodities and there is potential for new or increased production of these minerals.

Investment summaries

The Prospectus is a non-exhaustive list of advanced Australian critical minerals projects. There are more projects than those listed here. Austrade is able to facilitate introductions to other projects according to your specific needs. **For further information, please contact your local Austrade representative or email criticalminerals@austrade.gov.au**

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Antimony

Projects

Blue Spec

24





Blue Spec

Calidus Resources Ltd

ASX:CAI • calidus.com.au

Investment summary

The Blue Spec Mineral Resource contains 190,000 ounces of gold at a grade of 24.4g/t Au and 242kt of antimony at a grade of 1.6% Sb. The Blue Spec Project is now fully permitted to commence development when Calidus decides is the appropriate time. Calidus will soon commence offtake and financing discussions with interested parties.

Project description

Blue Spec is located 20km east of Nullaine in the Pilbara, WA. It is a steeply dipping vertical/sub-vertical narrow vein deposit. There are two separate mining areas located ~1.2km apart along strike, named Blue Spec and Gold Spec. Ore will be mined via mechanised underground cut and fill techniques and trucked to a flotation plant to be constructed at the main gold processing plant located 75km away at Warrawoona. The Warrawoona site provides access to low cost power along with access to existing maintenance and support functions. The floatation plant at Warrawoona will produce a high-grade gold/stibnite concentrate for sale to an offtaker.

Commodity(ies):	Gold, Antimony			
Mineral Resources as at 29 September 2022 (2.5g/t AuEq cut-off)	Resource Category	Tonnes (Mt)	Au (g/t)	Sb (%)
	Indicated	0.094	31.1	1.8
	Inferred	0.148	20.1	1.3
	Total	0.242	24.3	1.6
	Contained		190koz	3.872kt
Ore Reserves as at 29 September 2022	Reserve Category	Tonnes (Mt)	Au (g/t)	Sb (%)
	Probable	0.2	11.4	0.75
	Total	0.2	11.4	0.75
	Contained		83koz	1.500kt



Project Status
Feasibility Study
(Sep 2022)



Offtake Available
100%



Min Mine Life (Yrs)
5



Pre-tax IRR:
30% (Sep 2022)



Capital Cost:
A\$34m (Sep 2022)



Pre-tax NPV_{5%}:
A\$49m (Sep 2022)



Product & Annual Production Rate:
• Stibnite Concentrate
(36–39% Antimony and 250–300g/t Gold):
4,500tpa

Cobalt

Projects

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Broken Hill Cobalt Project & Kwinana Cobalt Refinery

Cobalt Blue Holdings Ltd

ASX:COB • cobaltblueholdings.com

Investment summary

Cobalt Blue (COB) is developing the Broken Hill Cobalt Project and Cobalt Refinery in Kwinana. Environmental field work has been completed and the EIS will be submitted in the first half of 2024. All required regulatory and First Nations approvals are in progress. COB has developed and patented a metallurgical process that liberates cobalt from pyrite at low pressure and temperature. It produces high-quality cobalt sulphate and high-purity elemental sulphur, with no sulphur dioxide emissions and at relatively low capital and operational costs compared to other processing methods. COB is evaluating equity and offtake partnerships. Detailed discussions are expected in 2024, following completion of the DFS.

Project description

The Broken Hill Cobalt Project includes the development of an open-cut mine and ore processing to produce an intermediate mixed cobalt-nickel hydroxide and elemental sulphur. The Refinery in Kwinana will process intermediate feedstock from both third-party sources and the mine in Broken Hill to produce high-purity cobalt sulphate. It is expected that the life of the mine and processing operations will be >20 years. A pilot plant was commissioned in March 2021, and a larger scale demonstration plant commenced operations in 2022 continuing with test work. In 2023, a series of geotechnical investigations and a comprehensive drilling program were completed to support the DFS. In 2022, the Australian Government granted Major Project Status to the Project and a A\$15m grant has been awarded through the Critical Minerals Accelerator Initiative. COB's ESG credentials have been assessed in accordance with the Cobalt Institute's Responsible Assessment Framework.

Commodity(ies):	Cobalt, Sulphur, Iron				
Mineral Resources as at Sept 2021 (275 ppm CoEq cut-off)	Resource Category	Tonnes (Mt)	Co (ppm)	S (%)	CoEq (ppm)
	Measured	18	1,030	10.9	1,276
	Indicated	59	631	6.9	788
	Inferred	41	619	7.2	781
	Total	118	687	7.6	859
	Contained (kt)	81.1			
Ore Reserves as at Jul 2020	Reserve Category	Tonnes (Mt)	Co (ppm)	S (%)	
	Probable	71.8	710	7.6	
	Total	71.8	710	7.6	
	Contained (kt)	51			



Project Status

Pre Feasibility Study (July 2020)



Offtake Available

Yes



Min Mine Life (Yrs)

20



Post-tax IRR:

18.9% (July 2020)



Capital Cost:

A\$560m (July 2020)



Post-tax NPV^{7.5%}:

A\$554m (July 2020)



Product & Annual Production Rate:

- Cobalt sulphate heptahydrate: ~16,700tpa (containing ~3,500tpa Cobalt metal)
- Sulphur: ~300,000tpa



Kalgoorlie Nickel Project – Goongarrie Hub

Ardea Resources Ltd

ASX:ARL • ardearesources.com.au

Investment summary

In 2023, Ardea Resources (ARL) completed its Goongarrie Hub Project PFS confirming the Project's status as one of the world's largest, lowest-cost sources of battery materials. Mining Leases granted and expanded environmental baseline surveys expected to be finalised by early 2024 for EPA referral. ARL's ESG policies and governance structure ensures the Project will be undertaken to the highest ESG standards with the Company enjoying strong local stakeholder support. ARL is undertaking a Strategic Partner process to select a development partner wanting to secure offtake.

Project description

The Goongarrie Hub is the developed world's premier nickel-cobalt project with world-class supporting infrastructure in the well-established, community supportive Kalgoorlie mining district, WA. Open-pit mine with low strip ratio and +40 year operation feeding 3.5Mtpa goethite dominated ore into two high-pressure acid leach autoclaves and 0.5Mtpa into an atmospheric leach circuit. The Project utilises proven hydrometallurgical technology to produce a mixed hydroxide precipitate (MHP) at 39.9% Ni and 2.9% Co containing 2,100tpa cobalt metal and 29,000tpa nickel metal. Power will be generated off-grid using excess steam from the on-site acid plant, which favourably contributes to climate change impact with a Life Cycle Assessment of 11.9kg CO₂ eq. per kg nickel in MHP. The Project DFS will examine the potential to produce precursor cathode-active material and recovery of scandium. Goongarrie is part of ARL's Kalgoorlie Nickel Project (KNP), the largest nickel-cobalt project in the developed world providing optionality to develop multiple processing hubs and substantially expand production.

Commodity(ies):	Nickel, Cobalt . Potential for Scandium and Rare Earth Elements.			
Mineral Resources as at 30 June 2023 (0.5% Ni cut-off)	Resource Category	Tonnes (Mt)	Co (%)	Ni (%)
	Measured	18	0.085	0.94
	Indicated	277	0.046	0.70
	Inferred	289	0.037	0.67
	Total	584	0.043	0.69
	Contained (kt)		250	4,044
Ore Reserves as at 6 July 2023	Reserve Category	Tonnes (Mt)	Co (%)	Ni (%)
	Proved	16.7	0.09	0.96
	Probable	177.4	0.05	0.68
	Total	194.1	0.05	0.70
	Contained (kt)		99	1,365



Project Status

Pre Feasibility Study (July 2023)



Offtake Available

100%



Min Mine Life (Yrs)

40



Post-tax IRR:

23% (July 2023)



Capital Cost:

A\$3.117b (July 2023)



Post-tax NPV ^{7%}:

A\$4.980b (July 2023)



Product & Annual Production Rate:*

• **Mixed hydroxide precipitate @39.9% Ni and 2.9% Co:** 145.4ktpa (containing: 29.0ktpa nickel metal and 2.1ktpa cobalt metal)

**LOM averages, higher in initial years with Year 1 to 5 (post ramp up) production >34ktpa nickel and >3ktpa cobalt.*



Kalkaroo

Havilah Resources Ltd

ASX:HAV • havilah-resources.com.au

Investment summary

Kalkaroo is one of the largest undeveloped open-pit copper-gold-critical minerals deposits in Australia on a CuEq Ore Reserve basis, containing approximately 1.1m tonnes of copper, 3.1m ounces of gold and 23,000 tonnes of cobalt in JORC resources. The orebody is open at depth and along strike and has excellent potential for resource expansion with further drilling. Mining leases have been granted over Kalkaroo, encompassing a Native Title Agreement and comprehensive environmental studies. Havilah owns the surrounding pastoral property.

Project description

Kalkaroo is favoured by its proximity to the regional mining centre of Broken Hill with its skilled workforce and the transcontinental railway line and Barrier highway. It is an area that is endowed with abundant solar and wind energy opportunities and substantial groundwater suitable for ore processing purposes. Regional exploration during the past 12 months has advanced several nearby multicommodity copper-critical minerals prospects that could potentially provide additional ore feed for Kalkaroo. Mining is likely to be by conventional open-pit methods. The ore is amenable to standard flotation that produces a high-grade, low impurity copper concentrate and also a by-product cobalt-rich pyrite concentrate. Production of a by-product bastnasite concentrate, high in the more valuable REE's (Nd, Pr, Tb, Yb), is also under study.

Commodity(ies):	Copper, Gold, Cobalt , Rare Earth Elements, Molybdenum				
Mineral Resources first stated March 2018 (0.4% CuEq cut-off):	Resource Category	Tonnes (Mt)	Copper (%)	Gold (oz)	Cobalt (%)
	Measured	97.6	0.50	0.47	–
	Indicated	34.9	0.39	0.41	–
	Inferred	113.0	0.42	0.33	–
	Inferred (cobalt only)	193.3	–	–	0.012
	Total	245.5	0.45	0.40	
	Contained (kt Cu, Co & koz Au)		1,097	3,105	23.2
Ore Reserves first stated June 2018:	Reserve Category	Tonnes (Mt)	Copper (%)	Gold (oz)	
	Proved	90.2	0.48	0.44	
	Probable	9.9	0.45	0.39	
	Total	100.1	0.47	0.44	
	Contained (kt Cu & koz Au)		474	1,407	



Project Status

2019 Pre Feasibility Study being updated by recent BHP studies



Offtake Available

Potentially available



Min Mine Life (Yrs)

15 years open-pit.
May be a longer life if more resources are converted to Ore Reserves by the present study outcomes



IRR:

Being updated



Capital Cost:

Being updated



NPV:

Being updated



Product & Annual Production Rate:*

- **Copper (metal and in concentrate):** 30,000tpa
- **Gold (metal and in concentrate):** 72,000 oz pa
- **Cobalt (in pyrite concentrates):** ~500tpa
- **REE (in bastnasite concentrate):** under study

*estimates only based on the 2019 PFS. Current study outcomes may alter these numbers



Mt Thirsty

Greenstone Resources Ltd, Conico Ltd

ASX:GSR;CNJ (JV – 50/50)

Investment summary

The Mt Thirsty Project is seeking to become Australia's first fully-integrated cathode precursor project, with a single deposit containing all the necessary elements required to produce cathode precursor, high-purity manganese sulphate, cobalt sulphate, and nickel sulphate, all of which have a direct application in the manufacturing of batteries. Leveraging off the previously completed PFS, an updated Scoping Study including a fully integrated cathode precursor and sulphate plant is expected to be completed in late 2023. Previous environmental and heritage surveys have found no issues that would prevent moving to a mining stage, and the JV maintains a strong relationship with the local Njadju people.

Project description

The Mt Thirsty Project is focused on open-pit mining and extraction of cobalt, nickel, and manganese from a large, flat-lying, shallow, and soft orebody. The Project is located in the heart of the WA mining industry, 150km south of Kalgoorlie and 180km north of the Port of Esperance, and is supported by extensive existing infrastructure (road, rail, and power). Following a 145% increase in the Mt Thirsty resource in April 2023, the JV commenced a Scoping Study. The Scoping Study is evaluating high-pressure acid leaching (HPAL) as the ore processing method, followed by solvent extraction for the production of cathode precursor and sulphate products. This is favoured over atmospheric leaching used in previous studies due to significantly higher metal recovery rates associated with HPAL. HPAL also allows for the recovery of additional metals like scandium and manganese, not previously recovered by atmospheric leaching.

Commodity(ies):	Nickel, Cobalt , Manganese				
Mineral Resources as at 26 April 2023 (0.25% NiEq cut-off)	Resource Category	Tonnes (Mt)	Ni (%)	Co (%)	Mn (%)
	Measured	–	–	–	–
	Indicated	30.2	0.51	0.1	0.69
	Inferred (North)	4.2	0.43	0.05	0.29
	Inferred (Main)	31.9	0.35	0.03	0.24
	Total	66.3	0.43	0.06	0.45
	Contained (Kt)		283.7	40.5	297.1



Project Status

Pre Feasibility Study (March 2020)
(completed on production of MSP Product)



Offtake Available

Yes



Min Mine Life (Yrs)

Pending scoping study update



IRR:

Pending scoping study update



Capital Cost:

Pending scoping study update



NPV:

Pending scoping study update



Product & Annual Production Rate:

Pending scoping study update



NiWest

Alliance Nickel Ltd

ASX:AXN • alliancenicel.au

Investment summary

DFS underway with target completion expected end Q2 2024. Environmental approvals processes have started, with the EPA referral submitted September 2023 and approval expected following full review of submission. All Mining Tenure required for the project is approved and in good standing. The Nyalpa Pirniku people are the Native Title Claimant Group over the NiWest tenure. Alliance have committed to honouring agreements signed with previous iterations of the Nyalpa Pirniku group. Alliance is undertaking a formal process to secure investment and offtake partners for the Project. These discussions are expected to advance as offtake samples are produced through the completion of further metallurgical testwork during the DFS.

Project description

The NiWest Project is located adjacent to Glencore's Murrin Murrin Nickel operations. The Project is well serviced with existing infrastructure including rail, established mining towns, arterial bitumen roads, and communications. NiWest will be a low strip (2.0:1) shallow conventional open-pit mine, with approximately 2.4Mtpa run-of-mine ore mined at average grades of 1.05% Ni and 0.07% Co for the first 15 years. There is an opportunity to extend high-grade profile through potential conversion of Inferred Resources. ROM ore will be heap leached with pregnant leach solution recovered from leaching and neutralised prior to recovery of nickel and cobalt via highly efficient direct solvent extraction (DSX) and crystallisation to produce high-purity (+99.95%) nickel and cobalt sulphate products for the battery market. Process recoveries of 75% for nickel and 80% for cobalt are expected. The Project has a construction period of around 18 months from FID.

Commodity(ies):	Nickel, Cobalt				
Mineral Resources as at 2018 (0.8% Ni cut-off):	Resource Category	Tonnes (Mt)	Ni (%)	Co (%)	
	Measured	15.2	1.08	0.064	
	Indicated	50.4	1.04	0.078	
	Inferred	19.5	0.96	0.057	
	Total	85.2	1.03	0.065	
	Contained (kt)		878	55	
Ore Reserves as at 2018 (0.5% Ni cut-off):	Reserve Category	Orebody	Tonnes (Mt)	Ni (%)	Co (%)
	Probable	Eucalyptus	32.2	0.87	0.05
	Probable	Hepi	4.7	0.91	0.06
	Probable	Mt Kilkeny	27.9	0.96	0.06
	Total	Total	64.9	0.91	0.06
	Contained (kt)			592	38



Project Status

Pre Feasibility Study (July 2022)



Offtake Available

Yes



Min Mine Life (Yrs)

Mining: 20
Processing: 27

Post-tax IRR:

19.9% (July 2022)



Capital Cost:

A\$1,261m (July 2022)

Post-tax ungeared real NPV_{8%}:

A\$1,587m (July 2022)



Product & Annual Production Rate:

- **Nickel sulphate:** 90ktpa (hexahydrate 99.95% purity) containing 20ktpa nickel metal
- **Cobalt sulphate:** 6.8ktpa (heptahydrate >99.9% purity) containing 1.4ktpa cobalt metal



Rover 1

Castile Resources Ltd

ASX:CST • castile.com.au

Investment summary

Castile is developing the Rover 1 Project in the prolific gold copper mining province of Tennant Creek in the NT. Rover 1 is a polymetallic, high-grade iron oxide copper gold (IOCG) deposit that will produce downstream end-user critical minerals. The Project will also produce gold and a high-grade (96.5%) magnetite. The downstream processing plant means the 99% copper and 99% cobalt will be available for direct sale to EV and battery manufacturers. The gold doré and 96.5% magnetite product (used for coal washing) provide further diversity and revenue streams. Since completing the Rover 1 PFS in December 2022, Castile has now lodged its EIS referral for Rover 1 with the NT EPA and completed final metallurgical analysis for pilot plant testing to begin. The development framework for First Nations approvals has been agreed with the Central Land Council. Castile is open to development funding proposals at either project and corporate level in addition to debt and offtake financing agreements.

Project description

Rover 1 will be an high-grade underground mine utilising long hole open stoping with battery electric load and haul vehicles. The magnetite product will be separated and sulphides floated and oxidised with the solids treated using conventional carbon-in-leach. The pregnant liquor will be treated using EMEW technology to extract copper then cobalt, with all processing carried out on-site in accordance with Castile's strategy of extracting "every dollar of value from every tonne that we mine". The Rover 1 deposit remains open at depth and there are similar underexplored prospects nearby on Castile's ground.

Commodity(ies):	Gold, Copper, Cobalt , Magnetite					
Mineral Resources as at September 2022 (2g/t AuEq cut-off):	Resource Category	Tonnes (Mt)	Gold g/t	Copper (%)	Cobalt (%)	Magnetite (%)
	Indicated	3.97	1.83	1.59	0.07	23.6
	Inferred	1.61	1.57	1.25	0.07	22.1
	Total	5.58	1.76	1.49	0.07	23.2
	Contained		315.2koz	83.2kt	4.0kt	1,295kt
Ore Reserves as at November 2022:	Reserve Category	Tonnes (Mt)	Gold g/t	Copper (%)	Cobalt (%)	Magnetite (%)
	Probable	3.11	2.02	1.52	0.07	22.92
	Total	3.11	2.02	1.52	0.07	22.92
	Contained		201.8koz	47.4kt	2.2 kt	713.3kt



Project Status

Pre Feasibility Study (Nov 2022)



Offtake Available

Available in 2025



Min Mine Life (Yrs)

8



Post-tax IRR:

34.5% (Nov 2022)



Capital Cost:

A\$280.2m (Nov 2022)



Pre-tax NPV_{6.5%}:

A\$451.7m

Post-tax NPV_{6.5%}:

A\$302.6m (Nov 2022)



Product & Annual Production Rate:

- Cu metal (99%): 6.9ktpa
- Au doré: 28.7kozpa
- Co metal (99%): 0.3ktpa
- Fe₃O₄ (96.5% magnetite): 75.3ktpa (steady state annual production rates)



Sconi

Australian Mines Ltd

ASX:AUZ • sconi.com.au • australianmines.com.au

Investment summary

The Sconi Nickel-Cobalt-Scandium Project, 100% owned by Australian Mines, has the potential to produce on average, over a 30-year period, 46,800 tonnes of nickel sulphate and 7,000 tonnes cobalt sulphate per annum. The Project has been granted Mining Licenses (“MLs”) and additional extensions to these MLs have been submitted. Australian Mines is actively de-risking the Project by completing the required environmental and heritage studies including applicable land access agreements, the key elements to secure project financing (including both debt and equity capital), for a positive FID. Australian Mines welcomes discussions regarding project financing and/or offtake arrangements.

Project description

The Project is a world-class, Tier 1 project, producing ethically sourced battery minerals, as well as high-purity scandium oxide. According to an independent study in 2019 by CRU International, the Project is expected to be one of the lowest-cost nickel/cobalt projects in the world. The existing ore reserves are forecast to support a project life in excess of 30 years, with further mineral exploration upside. The Feasibility Study envisages a high-pressure acid leach processing facility to produce a mixed nickel-cobalt hydroxide precipitate (MHP), a proven process used by various MHP operations globally. Subsequently the production of sulphates of nickel and cobalt has been targeted to improve the Project economics. Australian Mines is the only mineral resources company certified Carbon Neutral under the Australian Government’s Climate Active program and the Sconi Project will follow the internationally recognised ISO 14001 Standard for an effective Environmental Management System.

Commodity(ies):	Nickel, Cobalt, Scandium				
Mineral Resources as of 30 Sept 2021 (0.40-0.55% NiEq cut-off):	Resource Category	Tonnes (Mt)	Nickel (%)	Cobalt (%)	
	Measured	8.3	0.75	0.09	
	Indicated	49.2	0.60	0.08	
	Inferred	18.2	0.54	0.05	
	Total	75.7	0.60	0.08	
	Contained (Kt)		456	57	
Ore Reserves as at 30 Sept 2021 (0.45% NiEq cut-off):	Reserve Category	Tonnes (Mt)	Nickel (%)	Cobalt (%)	Scandium (ppm)
	Proved	8.1	0.72	0.09	44
	Probable	49.2	0.55	0.08	33
	Total	57.3	0.58	0.08	35
	Contained (kt)		332	46	2



Project Status

Feasibility Study
(Nov 2018, updated in Feb 2019)



Offtake Available

Yes – Option to provide nickel-cobalt MHP offtake to LG Energy Solution for the first 6 years, otherwise potential offtake is available for purchase.



Min Mine Life (Yrs)

30



Post-tax IRR:

15%
(Feb 2019)



Capital Cost:

US\$974m
(Nov 2018)

Post-tax NPV_{8%}:

A\$817m
(Feb 2019)



Product & Annual Production Rate:

Feb 2019 Feasibility Study:

- Mixed nickel-cobalt hydroxide precipitate (MHP) @ >38% Ni and >3.8% Co containing: 11,833tpa nickel metal and 1,167tpa cobalt metal
- Scandium oxide: 48tpa

Updated Production Targets (Nov 2022):

- Nickel sulphate: 47ktpa
- Cobalt sulphate: 7ktpa
- Scandium oxide: 74ktpa



Sunrise

Sunrise Energy Metals Ltd

ASX:SRL • sunriseem.com

Investment summary

Sunrise Energy Metals completed a DFS (“Project Execution Plan”) for the Sunrise Project in late 2020. The Project Execution Plan confirmed the Project’s status as one of the world’s largest and lowest-cost new sources of critical battery materials. The Project is development ready with all technical studies completed and all key permits secured. The Company is in discussions for both investment and long-term offtake with a view to securing a funding package which will facilitate a FID. The Company also holds an extensive portfolio of mineral exploration licences within the Macquarie Arc.

Project description

Located in central west NSW, the Sunrise Project will be a fully integrated supplier of high-purity nickel and cobalt sulphate for the EV battery supply chain, as well as one of the world’s largest producers of scandium oxide. The Project consists of a shallow open-cut mine, a hydrometallurgical processing plant to leach and separate metals and a refinery for production of battery-grade nickel and cobalt sulphate and scandium oxide. Ore reserves support up to 50 years of operations. With approximately A\$250m invested to date, the Project is development-ready, with all key permits secured, lowest-quartile operating costs and industry-leading emissions performance. An energy supply study has confirmed the Project’s electricity requirement can be fully supplied by renewable power. Technical studies have also demonstrated the Project’s suitability for incorporation of additional equipment for on-site production of precursor cathode active material and battery black mass recycling.

Commodity(ies):	Nickel, Cobalt , Scandium				
Mineral Resources as at 28 September 2020 (0.35% nickel-equivalent cut-off):	Resource Category	Tonnes (Mt)	Ni (%)	Co (%)	Sc (ppm)
	Measured	69	0.65	0.11	61
	Indicated	89	0.49	0.09	79
	Inferred	17	0.26	0.10	289
	Total	177	0.53	0.10	92
	Contained (Kt)		935	168	16
Ore Reserves as at 28 September 2020:	Reserve Category	Tonnes (Mt)	Ni (%)	Co (%)	Sc (ppm)
	Proved	65.4	0.67	0.11	55
	Probable	77.9	0.52	0.09	41
	Total	143.2	0.59	0.10	47
	Contained (kt)		845	143	7



Project Status

Feasibility Study
(Project Execution Plan)
completed September 2020



Offtake Available

100%



Min Mine Life (Yrs)

50



Post-tax IRR:

15.4% (September 2020)



Capital Cost:

US\$1,826m (September 2020)



Post-tax NPV_{10%}:

US\$1,207m (September 2020)



Product & Annual Production Rate:

Annual average production years 2-11:

- **Nickel sulphate:** 96,800tpa (contained Ni metal: 21,300tpa)
- **Cobalt sulphate:** 21,000tpa (contained Co metal: 4,400tpa)
- **Scandium oxide:** 18tpa



Wingellina Nickel-Cobalt Project

Nico Resources Ltd

ASX:NC1 • nicoresources.com.au

Investment summary

Wingellina, Australia's largest undeveloped nickel-cobalt oxide deposit by reserves, stands as a development-ready, long-life project. In December 2022, a PFS was completed, demonstrating attractive economics for the Project with an NPV_{8%} of A\$3.34b, an 18% IRR and a payback period of under five years. The Project is development ready with EPA approval granted in 2016 and a Native Title Project Development Agreement with the Ng Council registered in 2011. The Company is currently seeking a five-year extension of its EPA approval. Wingellina offers a number of development options and the Company welcomes discussions with strategic investors and offtake partners alike.

Project description

The Wingellina Nickel-Cobalt Project is a world-class, nickel-cobalt oxide deposit and part of NiCo Resources' Central Musgrave Project (CMP), spanning WA, SA, and NT. Notably, the Project benefits from the A\$1.2b in government funding allocated to develop the Outback Way—an essential infrastructure corridor for project access. Low-cost open-pit mining operations with a low strip ratio (1.1:1 LOM average) will produce an average of 4.3Mtpa ROM. Wingellina is one of the world's largest 'pure oxide' limonite nickel deposits, ideal for high-pressure acid leaching (HPAL) due to its high iron content and low magnesium grades. Ore will be processed on site to produce a mixed hydroxide precipitate (MHP) at 33% Ni and 3% Co containing ~40,000tpa nickel metal and ~3,000tpa cobalt metal. The Project will use over 90% renewable energy at steady-state operation, aligning with Nico's project design commitment to reducing CO₂ emissions for the life of the operation.

Commodity(ies):	Nickel, Cobalt				
Wingellina Mineral Resources as at 30-Jun-16:	Resource Category	Tonnes (Mt)	Ni (%)	Co (%)	Fe ₂ O ₃ (%)
	Measured	37.6	0.98	0.07	45.94
	Indicated	130.9	0.91	0.07	45.55
	Inferred	14.1	0.87	0.06	41.25
	Total	182.6	0.92	0.07	45.30
	Contained (kt)		1,684	132	
The Wingellina mineral resource is part of the larger CMP which has a mineral resource inventory containing approximately 2 mt of nickel and 154,000 tonnes of cobalt.					
Wingellina Ore Reserves as at 2016:	Reserve Category	Tonnes (Mt)	Ni (%)	Co (%)	
	Probable	168.4	0.93	0.07	
	Total	168.4	0.93	0.07	
	Contained (kt)		1,561	122.6	

Financial analysis completed with macro-economic assumptions stated in 22 Dec 2022 PFS announcement – “Base Case” assumptions.



Project Status

Pre Feasibility Study
(Dec 2022)



Offtake Available

100%



Min Mine Life (Yrs)

42



Post-tax IRR:

18.0% (Dec 2022)



Capital Cost:

A\$2.9b (Dec 2022)



Post-tax NPV_{8%}:

A\$3.34b (Dec 2022)



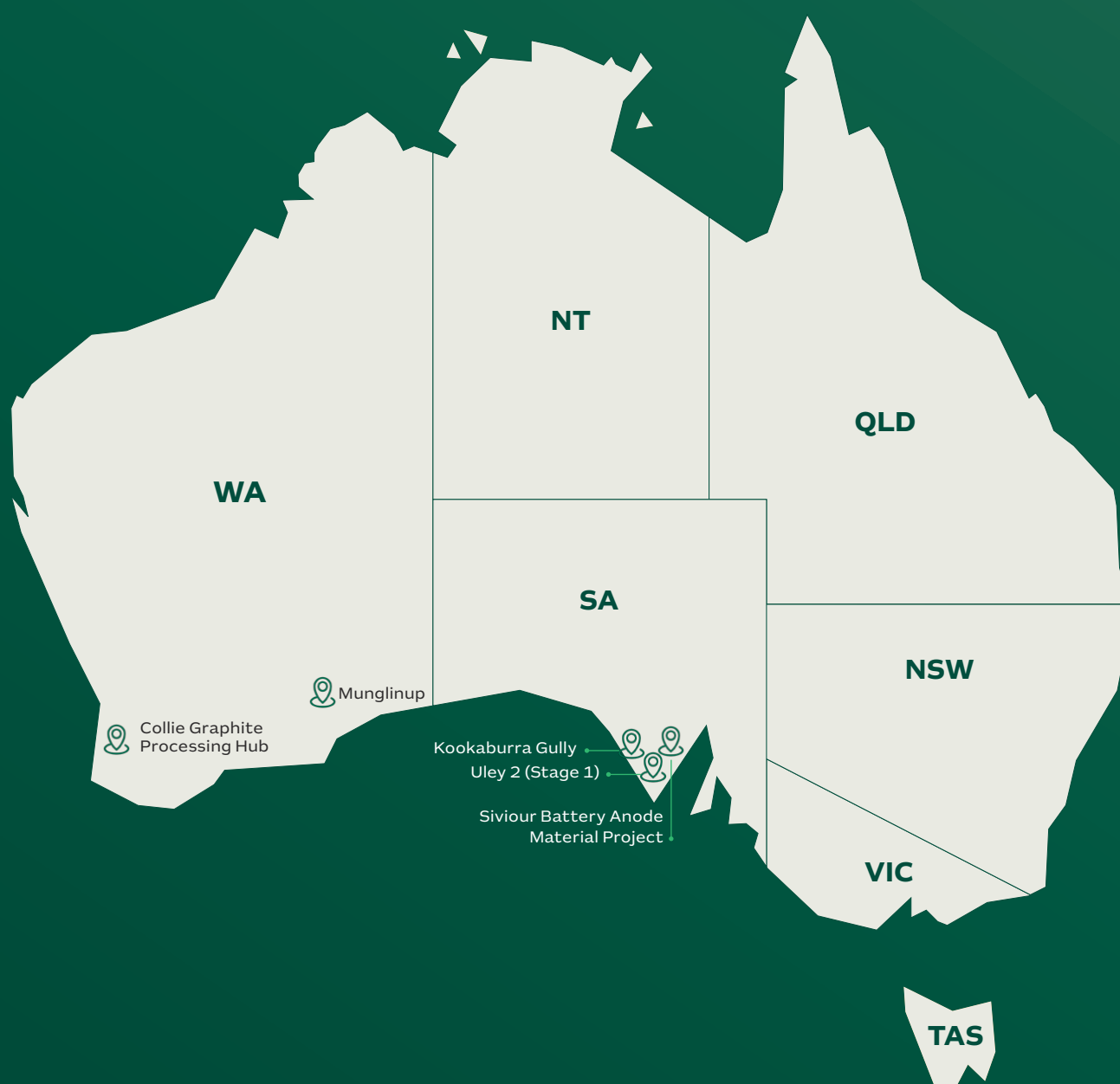
Product & Annual Production Rate:

• Nickel-cobalt mixed hydroxide precipitate (33% Ni, 3% Co):
123ktpa (dmt)

Graphite

Projects

Collie Graphite Processing Hub	36
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Siviour Battery Anode Material Project	39
Uley 2 (Stage 1)	40





Collie Graphite Processing Hub

International Graphite Ltd

ASX:IG6; FRA:H99 • internationalgraphite.com.au

Investment summary

International Graphite is developing a mine to market supply of processed graphite in WA to support the global battery industry. The Company has two flagship developments – a multi-faceted downstream graphite processing hub at Collie and a world-class graphite deposit at Springdale. Commissioned in 2022, the Collie pilot plant has successfully produced micronised and spheroidised graphite. A Feasibility Study was completed in 2023 for a 4,000tpa commercial micronising facility which is expected to be operational in 2024, when the Company anticipates seeking non-diluting construction funding. The plant is located on freehold land in an established industrial estate. Licence approvals will be finalised in 2024.

Project description

International Graphite's Collie pilot plant was a first in Australia and has been expanded to supply micronised graphite product for market testing. Commercial micronising is expected to begin in 2024. In April 2023, a Scoping Study was completed on a battery anode material (BAM) Facility at Collie which will process 40ktpa graphite concentrate via graphite micronising, spheroidising, purification by non-HF chemical leaching to produce uncoated spheroidised purified graphite (USPG), then carbon coating (roasting) to produce coated spheroidised purified graphite (CSPG) for use in lithium-ion batteries and a micronised by-product. In the future, graphite feed for Collie is expected to be supplied by International Graphite's planned mine and concentrator at Springdale. The Springdale fine flake graphite is ideally suited for battery materials. International Graphite has received A\$6.7m in support from Australian federal and state governments. We will deliver complete product stewardship from mine to market backed by the highest ESG standards.

Commodity(ies):	Graphite		
12 September 2023 (2% TGC cut-off): Springdale Project	Resource Category	Tonnes (Mt)	TGC (%)
	Indicated	11.5	7.5
	Inferred	37.8	6.1
	Total	49.3	6.5
	Contained Graphite (Kt)		3,200



Project Status

Stage 1 – 4ktpa micronising plant: Feasibility Study (March 2023)
Stage 2 – 40ktpa BAM facility: Scoping Study (April 2023)



Offtake Available

Yes



Min Mine Life (Yrs)

Subject to feasibility



Pre-tax IRR:

Stage 2: 41%^{*1}



Capital Cost:

Stage 2: US\$222m



Pre-tax NPV_{10%}:

Stage 2: \$US626m^{*1}



Product & Annual Production Rate:

- **Stage 1:** Micronised graphite: 4ktpa
- **Stage 2:** CSPG (99.95%C): 18.6ktpa
Micronised graphite by-product: 17ktpa

^{*1} Economics assume graphite concentrate purchased from third parties at market price delivered to Collie.

Refer to ASX Announcements of 15 March, 26 April and 12 September 2023 available at www.internationalgraphite.com.au.



Kookaburra Gully

Lincoln Minerals Ltd

ASX:LML • lincolnminerals.com.au

Investment summary

Lincoln Minerals is a recently re-listed emerging graphite developer with assets on the Eyre Peninsula, SA. The Company's flagship Kookaburra Gully Graphite Project is 35km north of Port Lincoln and consists of the Kookaburra Gully Deposit, the Koppio Deposit, and the Kookaburra Gully Extended Prospect. It is an advanced-stage, long-life project with demonstrated ability to produce high-grade graphite concentrates across various flake sizes and has been granted a Mining Lease. Lincoln welcomes discussions with strategic investors and offtake partners.

Project description

A Feasibility Study on the Kookaburra Gully Project was completed in 2017 based on shallow, open-pit mining of high-grade graphite with on-site processing via conventional floatation to produce 35,000tpa targeting >10% coarse flake (+100#) at >90% TGC. The Project has easy access to water, power, workforce, and transport infrastructure. Lincoln is targeting an update of the Feasibility Study in 2024, aiming to significantly increase graphite concentrate production and investigation of further downstream processing. Electromagnetic (EM) surveys, completed 2023, indicated the potential for extension of graphite mineralisation around the current deposits. An updated Mineral Resource Estimate (MRE) for Koppio was completed in October 2023 based on drilling completed this year. The current Total MRE for Kookaburra Gully and Koppio is 6.6Mt at 9.2% TGC, including a high-grade core starting from surface at Kookaburra Gully of 2.0Mt at 15.2% TGC. Resource infill and extension drilling testing the EM targets at Kookaburra Gully will be completed in 2024 Q1. Metallurgical testwork and MRE Update will be completed in 2024, prior to updating the Feasibility Study.

Commodity(ies):	Graphite					
Mineral Resources as at 10, October 2023 (2% TGC cut-off):	Kookaburra Gully			Koppio		
	Resource Category	Tonnes (Mt)	TGC (%)	Resource Category	Tonnes (Mt)	TGC (%)
	Measured	0.50	12.28	Measured		
	Indicated	1.66	10.78	Indicated	2.85	7.53
	Inferred	0.78	12.33	Inferred	0.79	6.72
	Total	2.94	11.45	Total	3.64	7.36
	Contained (kt)		336	Contained (kt)		267
	The Kookaburra Gully Mineral Resource includes a High-grade Core Total Mineral Resource of 2.03Mt @ 15.20% TGC commencing from surface (5% TGC cut-off).					
Kookaburra Gully Ore Reserves as at Nov 2017:	Reserve Category			Tonnes (Mt)		
	Probable			14.6		
	Total			14.6		
	Contained (kt)			196		



Project Status

Feasibility Study (Nov 2017)
(*1 Feasibility Study update planned in 2024)



Offtake Available

Yes



Min Mine Life (Yrs)

10



Pre-tax IRR:

33%*1 (Nov 2017)



Capital Cost:

A\$44m*1 (Nov 2017)



Pre-tax NPV_{10%}:

A\$81m*1 (Nov 2017)



Product & Annual Production Rate:

• **Graphite concentrate (>90% TGC):** 35,000tpa¹
(2024 Updated FS targeting 75,000 – 100,000tpa graphite concentrate)



Munglinup

Mineral Commodities Ltd

ASX:MRC; JV – MRC (51%) & Gold Terrace Pty Ltd (49%)

Investment summary

Mineral Commodities is a global mining and development company focused on the development of high-grade industrial and critical minerals deposits. The Company owns and operates the Skaland Graphite Operation in Norway, the world's highest-grade flake graphite operation and the largest producer in Europe. The Munglinup Graphite Project environmental permits are the only remaining approvals required before commissioning and it is anticipated that the EPA approvals for the project will be completed by mid 2024. Mineral Commodities welcomes discussion regarding financing or offtake and seeks a strategic partner for project equity, JV, or offtake arrangements in both the concentrate and downstream businesses.

Project description

The Munglinup Graphite Project is free-dig, open-pit mining of high-grade graphite mineralisation, located within a granted Mining Lease in WA. ROM ore is processed through a relatively conventional, multi-stage milling and flotation process to produce high-grade graphite concentrates across a range of flake sizes. The resource is open at depth and along strike. The recent EM survey identified 12 new targets with 3,000m resource drilling planned for 2024 to update resource and reserve. MRC is working with partners, including CSIRO and Doral Fused Materials, and has completed a Cooperative Research Centres Project to develop a non-hydrofluoric acid purification process to produce high-purity value-added products from Munglinup concentrate, targeting production of battery anode materials. The Project achieved battery grades (99.95% purity) for spherical graphite with typical recoveries to product of 90%. Pilot plant operations and optimised integrated ore-anode DFS program underway, which will be 50% funded through Australian Government Critical Minerals grant funding.

Commodity(ies):	Graphite		
Mineral Resources as at 8 Jan 2020 (5% TGC cut-off):	Resource Category	Tonnes (Mt)	TGC (%)
	Measured		
	Indicated	4.5	13.1
	Inferred	3.5	11.0
	Total	8.0	12.2
	Contained (Kt)		975
Ore Reserves as at 8 Jan 2020:	Reserve Category	Tonnes (Mt)	TGC (%)
	Probable	4.2	12.8
	Total	4.2	12.8
	Contained (kt)		543



Project Status

Feasibility Study
(January 2020)



Offtake Available

Yes



Min Mine Life (Yrs)

14



Post-tax IRR:

30% (Jan 2020)



Capital Cost:

US\$61m (Jan 2020)



Post-tax NPV_{7%}:

US\$111m (Jan 2020)



Product & Annual Production Rate:

• Flake graphite concentrate:
(>95% TGC): 52ktpa



Siviour Battery Anode Material Project

Renascor Resources Ltd

ASX:RNU • renascor.com.au

Investment summary

Renascor is committed to powering the clean energy transition through the development of its Battery Anode Material (BAM) Project in SA, a vertically integrated graphite mine and manufacturing operation to produce sustainable and ethically-sourced battery anode material for the lithium-ion battery market. The Project is in the advanced stages of development with a DFS completed in August 2023. Primary mining approvals have been obtained from the SA Government with the award of the Program for Environment Protection and Rehabilitation approval. Renascor is considering both additional offtake and investment in the project.

Project description

The Project will combine:

- Shallow open-pit mining of the Siviour graphite deposit on Eyre Peninsula, SA, the largest graphite Reserve outside of Africa and second largest Proven Reserve globally;
- Nearby processing via crushing, grinding, floatation, filering, and drying to produce graphite concentrate at 94% to 95% total graphitic carbon (TGC);
- Processing facility in Bolivar, SA to manufacture purified spherical graphite (PSG) from Siviour concentrate through Renascor's eco-friendly purification process.

Stage 1 will produce ~75,000tpa graphite concentrate initially for export then, commencing in Year 2, for processing into PSG. Stage 2 expansion, commencing in Year 4, will increase graphite concentrate production to ~150,000tpa and PSG production to ~100,000tpa. The BAM Project has received conditional approval for a A\$185m Loan Facility from the Australian Government's A\$4b Critical Minerals Facility. The Project has also has been granted Major Project Status by the Australian Government.

Commodity(ies):	Graphite		
Mineral Resources as at Sep-23 (2.3% TGC cut-off):	Resource Category	Tonnes (Mt)	TGC (%)
	Measured	16.9	8.6%
	Indicated	56.2	6.7%
	Inferred	50.5	6.5%
	Total	123.6	6.9%
	Contained (kt)	8,500	
Ore Reserve as at Aug-23:	Reserve Category	Tonnes (Mt)	TGC (%)
	Proved	16.8	8.2
	Probable	45.0	6.6
	Total	61.8	7.0
	Contained (kt)	4,300	



Project Status

Feasibility Study (August 2023) (Battery Anode Material Study including Stage 1 and Stage 2 phased development).



Offtake Available

100%



Min Mine Life (Yrs)

40



Post-tax IRR:

26% (August 2023)



Capital Cost:

Stage 1:

Mine and Processing Plant: A\$214.5m
PSG Facility: A\$394.6m

Stage 2:

Mine and Processing Plant: A\$173.3m
PSG Facility: A\$377.2m (August 2023)



Post-tax NPV_{10%}:

A\$1.5b (August 2023)



Product & Annual Production Rate:

- **Graphite concentrate:** (94 to 96% TGC): 75,000tpa to 150,000 tpa
- **Purified spherical graphite:** 50,000tpa to 100,000tpa



Uley 2 (Stage 1)

Quantum Graphite Ltd

ASX:QGL • quantumgraphite.com

Investment summary

Quantum Graphite's (QGL) century-old Uley graphite mine is part of the broader Mikkira Deposit located in SA's Eyre Peninsula, one of the world's largest natural coarse flake graphite deposits. Uley 2 (Stage 1) is the only coarse graphite project which:

- is fully permitted and development ready;
- has decades long history of supplying global manufacturers and historical prequalification of its products;
- has an exclusive arrangement with Sunlands Energy Co. (Sunlands), a leading thermal energy storage technology company, for the refining of Flake Graphite to produce high-purity graphite (HPG 99.99% gC) and the manufacture of thermal energy storage media for the Sunlands long-duration energy storage cells; and
- has a binding offtake agreement with Swiss global metals and minerals trading group MRI Trading AG (MRI) for 100% of the first five years Uley 2 production.

Project description

Quantum's 2019 Uley 2, Stage 1 DFS reconfirmed superior returns achievable from production of high-purity large to extra-large coarse flake products from the historical Uley mines. The Project will process run-of-mine ore via floatation and proprietary sequential polishing sections. QGL's proprietary mechanical process enhances flake graphite recoveries, maximises coarse flake size and achieves very high purities. Subsequently, testwork has demonstrated HPG (99.99% gC) can be produced from Uley flake using the Sunlands proprietary thermal purification process. An updated DFS is underway targeting completion in late 2023 incorporating HPG production which is not included in the 2019 Mining Study economics. The updated DFS will also examine the potential for manufacture of energy storage media.

Commodity(ies):	Graphite		
Mineral Resources as at 18 November 2021 (3.5% TGC cut-off):	Resource Category	Tonnes (Mt)	TGC (%)
	Measured	0.8	15.6
	Indicated	4.2	10.4
	Inferred	2.2	8.9
	Total	7.2	10.5
	Contained (Kt)		757
Ore Reserves as at December 2019 (3.5% TGC cut-off):	Reserve Category	Tonnes (Mt)	TGC (%)
	Proved	0.81	11.66
	Probable	3.19	11.95
	Total	4.00	11.89
	Contained (kt)		476



Project Status

Feasibility Study: Stage 1 – graphite flake production (Dec 2019)



Offtake Available

100% offtake committed to Swiss Global and MRI for first 5 years. Thereafter offtake is available.



Min Mine Life (Yrs)

12 (Uley 2, Stage 1 only)



IRR:

Not available



Capital Cost:

A\$79m (Dec 2019)



NPV:

Not available

Subsequent testwork has demonstrated potential to produce HPG 99.99% gC (not reflected in economics)



Product & Annual Production Rate:

- **Flake graphite (extra large flake):** +300um, 97.8% gC
- **Large flake:** 300+150um, 97.2% gC
- **Medium flake:** 150+75um, 96.6% gC): 55ktpa

High Purity Alumina

Projects

HPA First Project (Gladstone)	42
Premium HPA	43





HPA First Project (Gladstone)

Alpha HPA Ltd

ASX:A4N • alphaHPA.com.au

Investment summary

With growing global demand for high-purity aluminium products for application in LED lighting, synthetic sapphire, semiconductors, and lithium-ion battery industries, Alpha HPA is committed to supplying the world's most pure and sustainable ultra-high purity aluminium materials to market. Stage 1 of the HPA First Project, located in Gladstone, entered commercial production of Al-nitrates in November 2022, and will enter production of high purity alumina powders, and pellets; high-purity boehmite (alumina-hydroxide); high-purity aluminium precursors (Al-sulphates) in November 2023. From February 2024, Alpha HPA will produce synthetic sapphire from its high-purity alumina pellets. Stage 2 production is planned for 2026, representing a large-scale production centre of the products above. The Company has been awarded up to A\$112.2m in grants from the Commonwealth and Queensland Government to date and anticipates additional government financing in the near future. All key approvals in place. Now accepting individual offtake contracts.

Project description

Alpha HPA's premium products are based on its unique Smart SX purification process, which represents the world's first application of solvent extraction purification technology for aluminium. The process is disruptive at a number of levels, including:

Low carbon: By using a common industrial feedstock, recycling all reagents and using 100% renewable energy, the carbon footprint of high purity alumina production is reduced by ~70% compared to other processes.

Low cost: The front end of the purification process is 100% wet-chemical and operates at atmospheric temperatures and pressures with a 100% reagent recycle.

Flexibility: Able to produce a full range of high-purity aluminium materials from a single process.

Commodity(ies):	High Purity Alumina
------------------------	---------------------

Feedstock

Alpha HPA's unique Smart SX purification process can deliver high-purity, low-cost, low-carbon materials by leveraging the existing industrial infrastructure in the Gladstone region:

- **Feedstock:** Common industrial feedstock sourced directly from Rio Tinto's alumina refinery in Yarwun (2.5km away).
 - **Reagents:** Sourced directly from Orica Yarwun (adjacent) with binding 10 + 10-year agreements in place.
 - **By-products:** Reagents are recycled on a 100% basis and returned to Orica for further processing.
- Alpha HPA's process can match or exceed best-in-class purity across its entire product range.



Project Status

Stage 1:

Phase 1: Operating since Nov 22.
Phase 2: Construction – final stages of commissioning.
Alpha sapphire: first production anticipated from Feb 2024.

Stage 2 (Full scale commercial plant):

Feasibility Study (March 2020)
(FID expected late 2023 calendar year)



Offtake Available

Now accepting individual offtake contracts



Min Mine Life (Yrs)

N/A



IRR:

N/A (refer to investor page of the company website for currently disclosed financial metrics)



Capital Cost:

Stage 1: A\$50m (fully funded)
Stage 2: est A\$400m (March 2020)



NPV:

N/A



Product & Annual Production Rate:

Stage 1:

- **Al-nitrates+ Al-sulphate:** +300tpa high purity alumina + boehmites: 10-15tpa

- **Alpha sapphire:** ultra sapphire (Al₂O₃) TM: 7tpa low carbon synthetic sapphire

Stage 2:

- **Combination of Al-nitrates, Al-sulphate, high purity alumina and high purity boehmites:** ~13,000tpa.



Premium HPA

Cadoux Ltd

ASX:CCM • cadoux.com.au

Investment summary

Cadoux aspires to be a prominent global supplier of premium critical minerals, initially prioritising high purity alumina (HPA) for the burgeoning EV industry and other advanced applications. The first-phase small-scale production plant, underpinned by established technology, is near the finalisation of its preliminary design. In Q1 2024, we will initiate the permitting process for production facilities in the Kwinana-Rockingham Strategic Industrial Area. The Mining Lease, environmental and heritage approvals have been granted over the Cadoux mine site. Cadoux's Customer Centre of Excellence will ensure product customisation, facilitating product qualification and sales. Cadoux is open to engaging with interested parties to explore development endeavours further.

Project description

Cadoux has developed a groundbreaking, cost-effective, and environmentally-sensitive method for manufacturing premium HPA. The Company's vision is to revolutionise HPA production by leveraging its high-grade free-dig open-pit Cadoux Resource in a hydrochloric acid leach and precipitation process. Through a comprehensive end-to-end business model, encompassing the entire supply chain from mining to market, Cadoux ensures complete traceability and origin authenticity of the HPA we produce. This commitment guarantees the highest product quality and ESG certification for customers. Building upon the latest technological advancements and industry insights, in May 2023, Cadoux unveiled an updated development plan, that redefines and streamlines the Company's journey to bring a small-scale production plant (1,000tpa) to life. This strategic pivot serves to further mitigate risks and optimise the path to commercialisation. The revised plan melds the advantages of a high-volume commercial plant by adopting a staged and scalable development approach that leads Cadoux towards full-scale production.

Commodity(ies):	High Purity Alumina		
Cadoux Kaolin Mineral Resources as at April 2022 (20% Al₂O₃ cut-off grade):	Resource Category	Tonnes (Mt)	Al ₂ O ₃ (ppm)
	Measured	0.481	23.56
	Indicated	5.743	23.56
	Inferred	5.046	21.45
	Total	11.269	22.51
	Contained (kt)		2,537.0
Cadoux Kaolin Ore Reserves as at April 2022:	Reserve Category	Tonnes (Mt)	Al ₂ O ₃ (ppm)
	Proved	0.290	24.9
	Probable	2.914	24.8
	Total	3.205	24.8
	Contained (kt)		795.0



Project Status

Feasibility Study
(completed in April 2021)



Offtake Available

No – currently finalising
offtake commitments



Min Mine Life (Yrs)

50



Post-tax IRR:

55% (April 2021)



Capital Cost:

US\$202m (April 2021)



Post-tax NPV_{8%}:

US\$1.014b (April 2021)



Product & Annual Production Rate:

- Premium quality high purity alumina (>99.995% Al₂O₃): 10,000tpa

Lithium

Projects

BP33	45
Kathleen Valley	46





BP33

Core Lithium Ltd

ASX:CXO • corelithium.com.au

Investment summary

Core Lithium is Australia's newest lithium producer having commenced spodumene concentrate production at its Finniss operation in early 2023 from the Grants open-pit mine and dense media separation plant. The BP33 underground project is the proposed second mine to be developed at Finniss. The BP33 underground mine is currently the subject of an updated Feasibility Study ahead of FID in Q1 2024. A A\$45-50m early works program is underway to preserve the BP33 project critical path including; development of a covered box cut, improved access, and water management infrastructure. In May 2023, the NT Government granted mining authorisation and approved the Mine Management Plan for BP33, representing a key step in the approvals process.

Project description

BP33 is located approximately 5km from the Grants open-pit mine and DMS plant. The BP33 Mineral Resource more than doubled to 10.5Mt @1.53% Li₂O in 2023 and its confidence increased to 89% Measured and Indicated. A Feasibility Study update is currently underway for an underground mine at BP33, leveraging current infrastructure at Finniss, based on this updated Mineral Resource. This includes:

- Expanded geotechnical and hydrogeological studies
- Updated ventilation and power studies
- Expanded metallurgical test work and backfill study
- Updated mine design to incorporate significantly larger ore body
- Updated mining schedule with bias toward early production
- Updated surface infrastructure design (materials handling tailings storage facility, power)
- Execution planning and critical operational readiness activities, including early contractor engagement for key contracts

Commodity(ies):	Lithium (in spodumene concentrate)					
Total Finniss Project¹ Mineral Resources as at 16 October 2023 (0.5% Li₂O cut-off):	Resource Category	Tonnes (Mt)	Li ₂ O (%)			
	Measured	6.98	1.44			
	Indicated	14.8	1.37			
	Inferred	9.20	1.18			
	Total	31.10	1.33			
	Contained (Kt)		412.1			
Total Finniss Project Ore Reserves as at 30 June 2023²:	Open Pit ³		Underground ^{4, 2}		Total (OP + UG)	
	Reserve Category	Tonnes (Mt)	Li ₂ O (%)	Tonnes (%)	Li ₂ O (%)	Tonnes (Mt)
	Proved	1.7	1.4	3.7	1.3	5.4
	Probable	1.4	1.3	3.8	1.2	5.2
	Total	3.1	1.3	7.5	1.3	10.6
	Contained (kt)		42.0		99.8	141.8

¹ Includes Grants, BP33, Carlton, Hang Gong, Lees, Booths, An Hoy, Sandras, Penfolds and Bilatos deposits.

² BP33 Resources as at 16 October 2023 have not yet been incorporated into the Ore Reserves.

³ Open Pit Ore Reserves include Grants and Hang Gong deposits.

⁴ Underground Ore Reserves include Grants, BP33 and Carlton deposits.



Project Status

Feasibility Study (Apr 2019)
(Updated Feasibility Study underway)



Offtake Available

To be determined⁵



Min Mine Life (Yrs)

To be determined⁵



IRR:

Not available⁵



Capital Cost:

Not available⁵



NPV:

Not available⁵



Product & Annual Production Rate:

- Spodumene concentrate:
Tonnage not available⁵

⁵ To be determined by updated Feasibility Study currently underway to incorporate increased BP33 resource base)



Kathleen Valley

Liontown Resources Ltd

ASX:LTR • lresources.com.au

Investment summary

Kathleen Valley is a hard-rock lithium project with world-class scale and economics, located in a Tier 1 mining district. First production of approximately 500,000tpa of 6% lithium bearing spodumene concentrate is expected from mid 2024, with planned expansion to approximately 700,000tpa. As an independent, Australian-owned company, Liontown is fully funded (with some support from Australian Government lenders Clean Energy Finance Corporation and Export Finance Australia) to deliver Kathleen Valley to full production and will deliver US Inflation Reduction Act-compliant material to Tier 1 customers. Liontown is progressing studies into downstream processing options to convert spodumene concentrate into higher grade outputs. The Company is ideally positioned to be a fully integrated lithium producer to capture long-term value from mine to end-use in the EV market. Kathleen Valley will also produce tantalum pentoxide, a valuable critical mineral used in electronic components, high-strength alloys, and optics manufacturing.

Project description

Mining occurs predominately underground, before undergoing on-site crushing, grinding, and flotation to produce a 6% spodumene concentrate over a 23-year mine life. The deposit is open at depth. The Project will be powered by more than 60% renewable energy generation from start-up and is expected to have the largest off-grid wind-solar-battery storage capacity of any mining project in Australia. The underground mining approach, allowing direct access to higher grade mineralisation, while minimising waste rock movement and environmental footprint, is a further example of the real action being taken by Liontown to deliver on its ESG objectives. The Project is also being delivered in meaningful partnership with the Tjiwarl Traditional Owners.

Commodity(ies):	Lithium, Tantalum			
Mineral Resources as at 30 June 2023 (0.55% Li ₂ O cut-off):	Resource Category	Tonnes (Mt)	Li ₂ O (%)	Ta ₂ O ₅ (%)
	Measured	20	1.3	145
	Indicated	109	1.4	130
	Inferred	27	1.3	113
	Total	156	1.4	130
Ore Reserves as at November 2021 (Open Pit: 0.5% Li ₂ O cut-off, Underground: 0.7 – 1.2% cut-off):	Reserve Category	Tonnes (Mt)	Li ₂ O (%)	Ta ₂ O ₅ (%)
	Probable (Underground)	65.4	1.3	119
	Total (Underground)	65.4	1.3	119
	Proved (Open Pit)	2.7	1.3	141
	Probable (Open Pit)	0.5	0.9	148
	Total (Open Pit)	3.2	1.2	142
	Total	68.5	1.3	120



Project Status

Construction



Offtake Available

Majority contracted, ~10% spodumene available for spot sale.



Min Mine Life (Yrs)

23



Post-tax IRR:

57% (Nov 2021)^{*1}



Capital Cost:

A\$951m (29 September 2023 Kathleen Valley Project Update)



Post-tax NPV_{8%}:

A\$4.2b (Nov 2021)^{*1}



Product & Annual

Production Rate:

Initial production from mid 2024

- Spodumene concentrate (6% Li₂O): 500,000tpa

Planned expansion

- Spodumene concentrate (6% Li₂O): 700,000tpa

^{*1} 11 November 2021 DFS

Manganese

Projects

Butcherbird High Purity Manganese

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Butcherbird High Purity Manganese

Element 25 Ltd

ASX:E25 • element25.com.au

Investment summary

Element 25 (E25) Butcherbird Manganese Mine in WA hosts Australia's largest onshore manganese resource with >260Mt in JORC Resources. E25 is also developing the first EV lithium-ion battery grade high-purity manganese sulfate monohydrate (HPMSM) facility in the US in partnership with Stellantis and General Motors. Further capacity is expected with processing facilities planned for Asia, the EU and other battery manufacturing hotspots. The US facility is expected to complete permitting in late 2023 with construction commencing in 2024 and commissioning in 2025. All facilities will be supplied with secure, ethical manganese from E25's Butcherbird mine. E25 is seeking offtake for HPMSM supply and project financing for the US facility and subsequent plants as capacity is expanded.

Project description

E25's Butcherbird mine currently produces ~250ktpa high-quality manganese concentrate for use in manganese alloy production. Mine expansion is underway to increase concentrate production to ~1.0Mtpa, which is sufficient to produce approximately 850ktpa of HPMSM, a critical raw material for EV battery cathodes. The E25 concentrate is ideally suited for conversion into HPMSM using the E25 processing technology with industry leading carbon intensity, reagent consumption and waste levels. E25's large Butcherbird Mineral Resource will ensure a long-term secure supply of manganese to E25's HPMSM processing facilities. E25 is developing a first-of-its-kind processing facility in Louisiana, US to produce 130ktpa of HPMSM for USA EV supply chains. E25 published a Feasibility Study in April 2023, with advanced engineering, site works, and final approvals underway for construction in 2024, subject to completion of financing.

Commodity(ies):	Manganese, Silicon, Iron, Aluminum						
Mineral Resources as at 30 June 2023 (7% Mn cut-off (Measured and Indicated), 8% Mn cut-off (Inferred)):	Resource Category	Tonnes (Mt)	Mn (%)	Si (%)	Fe (%)	Al (%)	Contained Mn (Mn)
	Measured	14.1	11.4	20.6	11.7	5.7	1.6
	Indicated	40.8	10.0	20.9	11.0	5.8	4.1
	Inferred	206.0	9.8	20.8	11.4	5.9	20.2
	Total	260.9	9.9	20.8	11.4	5.9	25.8
	Contained (Kt)		25.9	54.3	29.6	15.3	
Ore Reserves as at 30 June 2023:	Reserve Category	Tonnes (Mt)	Grade (Mn) (%)				
	Proved	13.0	11.1				
	Probable	36.2	10.1				
	Total	49.2	10.2				
	Contained (kt)		5.0				



Project Status

Pre Construction



Offtake Available

20ktpa HPMSM (sulfate basis) available from train 1 commencing 2026.65ktpa HPMSM (sulfate basis) available for train 2 from 2027.



Min Mine Life (Yrs)

42 (manganese concentrate)
Note: based on only 20% of global resource



Pre-tax IRR:

29%¹ (full production – both trains) (April 2023)



Capital Cost:

US\$289m for HPMSM train 1¹
Additional US\$187m for HPMSM train 2¹ (April 2023)



Pre-tax NPV^{8%}:

US\$1,662m¹ (April 2023)



Product & Annual Production Rate:

- **NHPMSM (battery grade 99.99% purity):** 65,000tpa expanding to 130,000tpa with the addition of a second train.
- **Manganese concentrate (30-33% Mn):** Currently: ~250,000tpa. Future production and sales dependent on; (a) rate of mine and concentrator expansion, and (b) demand from additional HPMSM facilities.

¹ HPMSM Feasibility Study completed April 2023 based on 130,000tpa HPMSM production from 2 trains and Manganese Concentrate supplied at arm's length market price. Economic results exclude mine and concentrator operations.

Magnesium

Projects

Latrobe Magnesium Project	50
Winchester	51





Latrobe Magnesium Project

Latrobe Magnesium Ltd

ASX:LMG • latrobemagnesium.com

Investment summary

Latrobe Magnesium (LMG) is constructing its 1,000tpa magnesium Demonstration Plant in the Latrobe Valley, VIC which should be completed and commissioned by 31 March 2024. Following successful commissioning, LMG plans to build its 10,000tpa plus magnesium Australian Commercial Plant. Both the 1,000tpa and 10,000tpa plants are located on freehold land. The 1,000tpa is fully permitted and EPA and council approvals for the 10,000tpa plant are expected by September 2024. During 2023, LMG commenced a PFS on development of a 100,000tpa magnesium International Mega-Plant in Sarawak, Malaysia. LMG welcomes discussions on investment and offtake for the commercial plants.

Project description

LMG has developed a unique hydrometallurgical process to process fly ash and ferro nickel slag into magnesium and other valuable products. The process will recycle 100% of these wastes. LMG owns its own 11 hectare site in the Latrobe Valley where it will build both the 1,000tpa magnesium Demonstration Plant and the 10,000tpa magnesium Australian Commercial Plant which will process Yallourn power station brown coal fly ash. The power station will produce enough fly ash before it closes in 2028 to supply a 10,000tpa plant for 20 years. During 2023, LMG commenced a PFS on development of a 100,000tpa magnesium International Mega-Plant in Sarawak, Malaysia which will process ferro nickel slag to be supplied from New Caledonia using a hydro power. The LMG project is at the forefront of environmental benefit – by recycling plant waste, avoiding landfill, and producing 60% lower CO₂ emissions than the industry average.

Commodity(ies):	Magnesium
------------------------	-----------

1,000tpa Demonstration Plant and 10,000tpa Australian Commercial Plant: Based upon initial estimates from Yallourn of both the fly ash in landfill and the fly ash to be produced before closure, there is approximately 7m tonnes of fly ash at a 10% magnesium content. This resource would allow LMG to produce up to 700,000 tonnes of magnesium and operate a plant with a capacity of 10,000tpa magnesium for 70 years. For its 100,000tpa plant LMG has secured a supply agreement for 600,000tpa for 20 years (total of 12m tonnes) of ferro nickel slag (33% MgO, 9% Fe₂O₃ and 55% SiO₂) to be supplied from New Caledonia on an FOB basis by Societe Le Nickel, one of the world's largest ferro nickel producers. There is in excess of 28m tonnes of ferro nickel slag on the island and in excess of 20 smelters in the South East Asian region that produce similar slag.



Project Status

1,000tpa Demonstration Plant:
Construction (Feasibility Study completed in 2019)

10,000tpa Australian Commercial Plant: Feasibility Study planned to be undertaken based on Demonstration Plant data

100,000tpa International Mega Plant: Pre Feasibility Study commenced in 2023



IRR:

Not available



Capital Cost:

Not available



NPV:

Not available



Product & Annual Production Rate:

- **Demonstration Plant – Magnesium metal (99.9% purity):** 1,000tpa
- **Australian Commercial Plant – Magnesium metal (99.9% purity):** 10,000tpa
- **International Mega Plant – Magnesium metal (99.9% purity):** 100,000tpa



Offtake Available

Yes (for the 100,000tpa plant)



Min Mine Life (Yrs)

20



Winchester

Korab Resources Ltd

ASX:KOR • korabresources.com.au

Investment summary

In March 2022, Korab announced results of its Scoping Study into production of 50,000tpa magnesium metal from magnesium carbonate ore mined at Winchester which showed a pre-tax NPV_{12%} of approximately A\$1b. No environmental approvals have yet been secured for the Winchester Project which is located wholly within freehold land. Korab will protect any heritage, anthropological, and sacred sites. In May 2022, Korab received a Letter of Intent from Speira GmbH for purchase of magnesium metal, with commercial terms yet to be agreed. Other offtake and financing discussions are also underway. Korab welcomes discussions on additional offtake, partnerships or financing.

Project description

As per its 2018 Feasibility Study, in the initial stage of development, Korab plans to develop the Winchester project as a quarry producing DSO magnesium carbonate rock to be crushed, screened, and sorted on-site, prior to transport to the Darwin Port for export. As Stage 2 of development, part of the production is planned to be sold as unprocessed DSO magnesium carbonate rock, and part is planned be processed off-site into magnesium oxide in the form of caustic calcined magnesite (CCM), and dead burned magnesite (DBM). Off-site processing is expected to be undertaken by means of toll-treatment in kilns owned by third parties, which would not require additional capital investment. As Stage 3, Korab plans to build a magnesium metal production plant to produce 50,000tpa of high-purity magnesium metal. Most of the energy needs can be supplied by two solar farms (10MW and 12.5MW) located within 1km of the project.

Commodity(ies):	Magnesium		
Mineral Resources as at 16 July 2007 (40% MgO cut-off):	Resource Category	Tonnes (Mt)	MgO (%)
	Measured	0.0	0.00
	Indicated	12.2	43.1
	Inferred	4.4	43.6
	Total	16.6	43.2
	Contained Magnesium metal (Kt)		4,329

Project Status Stage 1: Feasibility Study – Production of Magnesium carbonate DSO (Mar 2018) Stage 2: Feasibility Study – Production of Magnesium oxides (Sept 2018) Stage 3 Scoping Study – Production of magnesium metal (Mar 2022)	Post-tax IRR: Stage 1: Magnesium carbonate DSO only – 160% (Mar 2018) Stage 2: CCM, DBM & magnesium carbonate DSO – N/A Stage 3: Magnesium metal – ~55% (Mar 2022)	Product & Annual Production Rate: Stage 1: • Magnesium carbonate DSO: 600,000-1,000,000tpa Stage 2: • Magnesium oxides DBM: 75,000-150,000 tpa, CCM: 150,000-300,000tpa, Magnesium carbonate DSO: 300,000-600,000tpa. Stage 3: • Magnesium metal: 50,000 tpa, DBM: 75,000-100,000 tpa, CCM: 50,000-75,000tpa, Magnesium carbonate DSO: 150,000-300,000tpa.
Offtake Available Yes	Capital Cost: Stage 1: Magnesium carbonate DSO only – A\$2.4m-A\$2.5m (Mar 2018) Stage 2: CCM, DBM & magnesium carbonate DSO – NIL (processing by third party) Stage 3: Magnesium metal – A\$410m (Mar 2022)	
Min Mine Life (Yrs) 15	NPV: Stage 1: Magnesium carbonate DSO only – Post-tax NPV _{12%} – A\$184m (Mar 2018) Stage 2: CCM, DBM & magnesium carbonate DSO – N/A Stage 3: Magnesium metal – Pre-tax NPV _{12%} : A\$1,000m (Mar 2022)	

Molybdenum

Projects

Caravel Copper Project

53





Caravel Copper Project

Caravel Minerals Ltd

ASX:CVV • caravelminerals.com.au

Investment summary

The Caravel Project is Australia's largest undeveloped copper project with a Mineral Resource of >3m tonnes of contained copper plus >60,000 tonnes of molybdenum, and significant gold and silver content. The Project is progressing a Feasibility Study in CY2024 ahead of a development decision mid 2025. Key workstreams required to finalise the Feasibility Study include access to groundwater and grid power, land option agreements, and state approvals. The Project is based on proven, simple open-pit bulk mining, and processing techniques that create strong financial margins via low operating costs and large-scale production. The Company is focused on de-risking the Project ahead of FID and welcomes discussion with interested parties regarding investment and offtake.

Project description

Located within 150km of Perth, WA, the Project will produce ~65,000tpa of copper and significant precious metals as a high-quality bulk concentrate, plus ~800tpa of molybdenum metal as a by-product bulk concentrate. The Project has relatively simple mining and metallurgical process, which along with access to excellent infrastructure and a world-class mining workforce, attractive social-economic-political environment and sound ESG credentials all contribute to a low-risk operation for 25+ years. A large amount of study work has been completed since 2019, including two Scoping Studies and a PFS. Geological resource estimation and mine planning, metallurgical processing test work and design, environmental and heritage surveys, and community and Traditional Owners consultation are all well advanced. Engineering and infrastructure studies are underway for the Feasibility Study completion in 2024. The Company is negotiating several strategic partnering agreements with world-class equipment suppliers, technology developers, and service providers to further de-risk the Project.

Commodity(ies):	Copper, Molybdenum, Gold, Silver		
Mineral Resource (November 2023 for Cu and Mo):			
Resource Category	Tonnes (Mt)	Copper (%)	Molybdenum (g/t)
Measured	155	0.26	64
Indicated	544	0.24	46
Inferred	578	0.23	44
Total	1,277	0.24	47
Contained metal (kt)		3,032.5	60.6
Note: 0.10% Cu cut-off, appropriate rounding applied			
Mineral Resource (November 2023 for Au and Ag):			
Resource Category	Tonnes (Mt)	Gold (g/t)	Silver (g/t)
Measured		0	0
Indicated	681	0.023	1.2
Inferred	574	0.021	1.0
Total	1,255	0.022	1.1
Contained metal (koz)		895	46,300
Note: 0.10% Cu cut-off, appropriate rounding applied			

Ore Reserves (July 2022 based on November 2021 Mineral Resource Estimate):

Reserve Category	Tonnes (Mt)	Copper (%)
Proved	105.4	0.27
Probable	478.0	0.24
Total	583.4	0.24
Contained (kt)		1,420



Project Status

Pre Feasibility Study (July 2022)



Offtake Available

Precious Metals – 100% (Year 1)
Copper – 30% (Year 1)
Molybdenum – 30% (Year 1)



Min Mine Life (Yrs)

25



Pre-tax IRR:

21% (April 2023)



Capital Cost:

A\$1.676m (April 2023)



Pre-tax NPV^{7%}:

A\$2.0b (April 2023)

*disc & USD 4.00lb Cu, 0.72 USD/AUD



Product & Annual Production Rate:

- **Copper:** ~65,000tpa (as 25% Cu in sulphide concentrate + precious metals)
- **Molybdenum:** ~800tpa (as 50% Mo in ferro-molybdenum concentrate)

Platinum Group Elements

Projects

Panton

55





Panton

Future Metals NL

ASX:FME; AIM:FME • future-metals.com.au

Investment summary

Panton is the highest-grade platinum group element (PGE) deposit in Australia and will support a long-life, expandable project on granted mining leases. The deposit hosts a resource mix that supports the growing demand for catalytic converters, hydrogen electrolyzers and fuel cells, batteries and ferrochrome. Located in the top-tier jurisdiction of WA, the Project offers a significant opportunity for diversification of PGM supply away from Russia and South Africa. Future Metals has a heritage protection agreement in place and permitting is advanced for the Project stage given prior environmental approvals. Future Metals is open to discussions with funding & offtake partners who can assist in the financing and development of the project.

Project description

Panton is located in close proximity to a sealed highway, airstrips, and deep-water port. The Project has been substantially de-risked with 20+ years of drilling and test work programs. A BFS was completed on the Project in 2003 and updated in 2011 based on a high-grade, low capital and long mine life operation. Future Metals acquired the project in 2021 and is expeditiously progressing Panton towards production. Future Metals is finalising a new Scoping Study focused on an initial high-grade predominantly underground mine and on-site processing of over 1Mtpa of ore via flotation to produce saleable PGM & chromite concentrates. Further on-site hydrometallurgical processing options are being explored. The Company plans to progress towards a BFS following delivery of the Scoping Study.

Commodity(ies):	Platinum, Palladium, Chromite, Gold, Nickel						
Mineral Resources as at October 2023 (Reef: No cut-off, High Grade Dunite: 1.4g/t PdEq cut-off, Bulk Dunite: 0.90 g/t PdEq cut-off):	Resource Category	Tonnes (Mt)	Palladium (g/t)	Platinum (g/t)	Gold (g/t)	Chromite (%)	Nickel (%)
	Reef						
	Indicated	4.5	2.6	2.4	0.4	14.0	0.25
	Inferred	6.3	2.9	2.6	0.3	15.0	0.28
	Total – Reef	10.8	2.8	2.5	0.4	14.6	0.27
	Total – High Grade Dunite						
	Dunite	26.4	0.6	0.6	0.1	2.3	0.21
	Total – Bulk Dunite	55.7	0.4	0.3	0.1	1.2	0.18
	Grand Total	92.9	0.7	0.7	0.1	3.1	0.20
Contained Total		2,158koz	1,951koz	403koz	2.8Mt	185kt	

Note: The Total High Grade Dunite and Total Bulk Dunite Resources above comprise of a mix of Indicated and Inferred Mineral Resources.



Project Status
Pre Construction^{*1}



IRR:
Not available^{*1}



Product & Annual Production Rate:

- Bulk PGE-Ni concentrate: (50-150g/t Pd, 50-150g/t Pt, 3-5% Ni): ~40ktpa (containing over 100koz pa PGE and 1,500t Ni pa for initial underground only project^{*2})
- Chromite concentrate (40-42% Cr₂O₃): 100-150ktpa^{*2}



Offtake Available
Yes



Capital Cost:
Not available^{*1}



Min Mine Life (Yrs)
~10



NPV:
Not available^{*1}

^{*1} New Scoping Study underway targeting completion 2023 H2 updating previous 2011 Feasibility Study. Previous 2011 Feasibility Study results are no longer representative of the expected project results).

^{*2} Preliminary estimates

Rare Earth Elements

Projects

Browns Range Heavy Rare Earths (HRE)	57
Donald Rare Earth & Mineral Sands Project	58
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Yangibana Rare Earths Project	63





Browns Range Heavy Rare Earths (HRE)

Northern Minerals Ltd

ASX:NTU • northernminerals.com.au

Investment summary

Northern Minerals is focused on becoming a principal supplier of ethically produced dysprosium and terbium. All primary approvals required to progress through to FID are in place along with a co-existence agreement with the Jaru Traditional Owners. Northern Minerals has entered into a supply agreement with Iluka Resources covering 100% of planned production over the initial 8+ year mine life. Iluka is also providing a conditional funding package through a series of proposed investments in Northern Minerals. The Company is progressing towards FID and welcomes discussions regarding further financing for project construction.

Project description

The Browns Range HRE Project is set to be the first significant producer of dysprosium and terbium-containing REE concentrate outside of China and is understood to be the highest grade dysprosium and terbium orebody in Australia. The Project is located ~160 km southeast of Halls Creek in the east Kimberley region of WA. A DFS is underway based on open-pit and underground mining of the Wolverine deposit, delivering ore to a beneficiation plant at Browns Range to produce a dysprosium and terbium rich concentrate containing ~25% TREO for supply to Iluka. The processing flowsheet is well-understood based on three years of pilot plant operations. DFS completion targeted in Q1 2024 prior to a FID anticipated in H1 CY 2024, and project commissioning targeted in 2026. Drilling is currently underway to increase Wolverine Indicated Mineral Resource targeting a Probable Ore Reserve. Significant exploration scope exists to develop adjacent deposits also abundant in heavy REE.

Commodity(ies):	Rare Earth Elements – Dysprosium and Terbium						
Wolverine Deposit Mineral Resources as at 10 October 2022 (0.15% TREO cut-off):	Resource Category	Tonnes (Mt)	TREO (%)	Dy ₂ O ₃ (kg/t)	Y ₂ O ₃ (kg/t)	Tb ₄ O ₇ (kg/t)	HREO (%)
	Measured	0.14	0.70	0.61	3.99	0.09	88
	Indicated	3.24	0.95	0.83	5.53	0.12	89
	Inferred	3.05	0.98	0.84	5.68	0.13	89
	Total	6.44	0.96	0.83	5.57	0.12	89
	Contained (Kt)		61	5	36	1	55
Browns Range Total Mineral Resources as at 10 October 2022 (0.15% TREO cut-off):	Resource Category	Tonnes (Mt)	TREO (%)	Dy ₂ O ₃ (kg/t)	Y ₂ O ₃ (kg/t)	Tb ₄ O ₇ (kg/t)	HREO (%)
	Measured	0.14	0.7	0.61	3.99	0.09	89
	Indicated	4.9	0.78	0.67	4.46	0.1	87
	Inferred	5.76	0.73	0.62	4.22	0.09	89
	Total	10.81	0.76	0.64	4.33	0.09	88
	Contained (Kt)		82	7	47	1	72

Note: The Wolverine Deposit Mineral Resource is a sub-set of the Browns Range Total Mineral Resource stated above. These figures are not additive.



Project Status

Feasibility Study (March 2015)
(Updated DFS targeting completion in Q1 2024. Previous March 2015 Feasibility Study based on production of RE carbonate)



Offtake Available

Supply agreement in place with Iluka covering the initial 8+ year mine life up to 5,500tpa TREO in xenotime concentrate and 30,500t TREO in total



Min Mine Life (Yrs)

8



IRR:

Not available until completion of DFS



Capital Cost:

A\$500m order of magnitude estimate (as at August 2023) (excluding financing costs)



NPV:

Not available until completion of DFS



Product & Annual Production Rate:

• REE concentrate (~25% TREO):
18,800tpa (containing 4,700tpa TREO and 400tpa Dy₂O₃)
(Approximate average life of mine production)



Donald Rare Earth & Mineral Sands Project

Astron Corporation Ltd

ASX:ATR • astronlimited.com.au

Investment summary

The Donald Rare Earth and Mineral Sands Project (Donald) is a Tier 1 critical mineral resource comprising the world's largest zircon resource and the fourth largest rare earth resource outside of China. Donald is significantly advanced with a Phase 1 DFS completed in 2023 and is the only Victorian critical minerals project with a positively assessed EES, mining license, and a Federal EPBC license. Phase 1 of the Project accesses only 17% of resource and generates a post-tax real NPV_{8%} of A\$852m (25.8% IRR) over a 41-year mine life. Phase 2 PFS demonstrates additional upside, driving a post-tax real NPV_{8%} of A\$2.2b (30.3% IRR) over a 58-year mine life. Donald's FID is expected in the first half of 2024. Astron is presently engaging in offtake and strategic partnership discussions.

Project description

Mining operations will consist of conventional open-pit dry-mining methods. Phase 1 will produce 228.7ktpa of heavy mineral concentrate (HMC) containing zircon and titania, and 7.2ktpa of rare earth element concentrate (REEC) bearing rare earth minerals of monazite and xenotime. Phase 2 will double mining throughput and add on-site processing of HMC to final zircon and titania products. Extensive metallurgical test work has produced a flowsheet with high recoveries, proven at a pilot-plant scale. Donald has an attractive mineral assemblage; a large proportion of the zircon resource is premium grade, and there is a significant heavy rare earth component crucial for permanent magnets, with a monazite to xenotime ratio less than 3:1.

Commodity(ies):	Rare Earth Elements, Zirconium, Titanium							
Mineral Resources as at 1 December 2022 (1% cut-off):	Resource Category	Tonnes (Mt)	THM (%)	Zircon (%)	Rutile/ Anatase (%)	Ilmenite (%)	Leucoxene (%)	Monazite (%)
	Measured	579	4.6	18	8	25	22	1.9
	Indicated	1,232	4.5	17	8	31	18	2
	Inferred	822	4.7	18	9	33	17	2
	Total	2,634	4.6	18	8	31	18	2
	Contained (Kt)		121,164	21,810	9,693	37,561	21,810	2,423
Ore Reserves as at 1 December 2022:	Reserve Category	Tonnes (Mt)	THM (%)	Zircon (%)	Rutile/ Anatase (%)	Ilmenite (%)	Leucoxene (%)	Monazite (%)
	Proved	415	4.8	18.6	7.2	25.7	22.6	1.8
	Probable	410	4.1	16.9	7.3	31.5	19.4	1.6
	Total	825	4.5	17.8	7.2	28.4	21.2	1.7
	Contained (kt)		37,125	6,608	2,673	10,544	7,871	631

Note: Valuable Heavy Mineral grades are reported as a percentage of THM.

Project Status Phase 1: Feasibility Study (April 2023) Phase 2: Pre Feasibility Study (June 2023)	Post-tax real IRR: 30.3%* (June 2023) * Note Phases 1 and 2	Product & Annual Production Rate: Phase 1: <ul style="list-style-type: none"> Heavy mineral concentrate (HMC) (95% THM, 37% TiO₂, 20% ZrO₂): 228.7ktpa Rare earth element concentrate (REEC) (>60% TREO, Nd/Pr 20%, Dy/Tb 2%): 7.2ktpa Phase 2: <ul style="list-style-type: none"> REEC: 13.0ktpa Premium zircon (>66% Zr(Hf)O₂): 84.6ktpa Standard zircon (<66%): 8.9ktpa Titania (>66%): 260.2ktpa
Offtake Available Yes – discussions underway and production expected to commence in 2025	Capital Cost: Phase 1: A\$364m (April 2023) Phase 2: A\$566m (June 2023)	
Min Mine Life (Yrs) 58	Post-tax real NPV_{8%}: A\$2.2b (June 2023) * Note Phases 1 and 2	



Dubbo Project

Australian Strategic Materials Ltd

ASX:ASM • asm-au.com

Investment summary

The Dubbo Project has all major approvals in place and is construction ready. ASM is targeting a project financing funding strategy based on a mix of equity and debt, supported by export credit finance and secure bankable offtakes. In 2021, ASM received a non-binding letter of support from Export Finance Australia, an Australian Government-owned agency, to secure A\$200m of debt funding. ASM intends to continue discussions with potential strategic investors, offtake partners and financial institutions, targeting FID for the Dubbo Project by December 2024.

Project description

ASM is a rare earths and critical minerals company, whose 'mine to metals' strategy is to extract, refine and manufacture high-purity metals and alloys, supplying direct to global customers. The Dubbo Project is located 25km from Dubbo, NSW. This rare earths and critical minerals project resource includes neodymium, praseodymium, dysprosium, terbium, zirconium, niobium, and hafnium. In 2023, Hyundai Engineering Co. completed Stage 1 engineering, procurement and construction definition (EPCD) work. ASM has now engaged Bechtel to undertake work to progress the design of key non-process infrastructure areas and will evaluate when to commence Stage 2 of the EPCD as the non-process infrastructure work progresses. ASM intends to develop the Dubbo Project to produce a range of metal oxides and mixed chlorides. In partnership with the Australian Nuclear Science and Technology Organisation (ANSTO), ASM has completed significant successful test work to maximise recoveries.

Commodity(ies):	Rare Earth Elements (Neodymium, Praseodymium, Dysprosium, Terbium), Zirconium, Niobium, and Hafnium					
Mineral Resources as at 19 September 2017	Resource Category	Tonnes (Mt)	ZrO ₂ (%)	HfO ₂ (%)	Nb ₂ O ₅ (%)	Ta ₂ O ₅ (%)
	Measured	42.8	1.89	0.04	0.45	0.03
	Indicated					
	Inferred	32.4	1.90	0.04	0.44	0.03
	Total	75.2	1.89	0.04	0.44	0.03
	Contained (Kt)		1,421	30	331	23
Ore Reserves as at 19 September 2017	Reserve Category	Tonnes (Mt)	ZrO ₂ (%)	HfO ₂ (%)	Nb ₂ O ₅ (%)	Ta ₂ O ₅ (%)
	Proved	18.9	1.85	0.04	0.44	0.03
	Total	18.9	1.85	0.04	0.44	0.03
	Contained (kt)		350	8	83	5



Project Status

Feasibility Study
(December 2021)



Offtake Available

Yes



Min Mine Life (Yrs)

20 with potential
for a further 50



Pre-tax IRR:

23.5% (Dec 2021)



Capital Cost:

A\$1,678m including
contingency (Dec 2021)



Pre-tax NPV_{8%}: A\$2,361m

Post-tax NPV_{8%}: A\$1,581m (Dec 2021)
(assumes 0.75 AUD:USD exchange rate,
30% tax rate, real basis)



Product & Annual Production Rate:

- **Rare earth oxides:**
1,506 tpa (including:
NdPr Oxide – 1,342tpa,
Tb Oxide – 22tpa,
Dy Oxide – 142tpa)
- **Zirconia:** 16,000tpa
- **Ferroniobium:** 2,650tpa
- **Hafnium oxide:** 30tpa



Eneabba Refinery

Iluka Resources Ltd

ASX:ILU • iluka.com.au

Investment summary

Iluka is building Australia's first fully integrated rare earths refinery at Eneabba in WA. Once commissioned in late 2025, the refinery will produce both light and heavy separated rare earth oxides. Iluka believes this represents a game changing development for the diversification of global supply chains and for domestic value addition to Australia's rare earth resources. Iluka has secured primary environmental approvals and earthworks commenced on site in November 2022. Front End Engineering Design is expected to conclude in late 2023. The refinery receives funding via a loan under the Australian Government's Critical Minerals Facility.

Project description

Iluka's Eneabba refinery has been designed with the capacity and capability to process a broad range of feedstocks from Iluka's portfolio and from a range of third parties. The refinery will utilise roasting, leaching, purification, solvent extraction and product finishing to produce 17.5-23ktpa of rare earth oxides, subject to the feedstock used. The refinery will be fed initially from concentrate produced from Iluka's unique 1Mt rare earths stockpile, located at Eneabba. Thereafter, it will be fed by rare earths from Iluka's Australian operations and from third parties. In October 2022, Iluka concluded an agreement with Northern Minerals for future supply of rare earth concentrate from its Browns Range project. Iluka continues to progress other sources of feed including its Balranald mine in NSW (in Construction) and its Wimmera Project in Victoria (DFS underway). In August 2023, Iluka announced the commencement of a PFS into rare earth metallisation – the next step in the value chain.

Commodity(ies):	Rare Earth Elements, Zirconium (Zircon) and Titanium (Ilmenite)						
Eneabba MSP By-Product Stockpile Mineral Resources as at 31 Dec-2022:	Percentage of Total Heavy Metals						
	Resource Category	Tonnes (Mt)	In Situ HMTonnes (Mt)	Total HM Grade (%)	Ilmenite Grade (%)	Zircon Grade (%)	Monazite + Xenotime Grade (%)
	Measured	0.68	0.57	84.0	32	26	21.4
	Indicated	0.29	0.24	82.5	37	31	13.2
	Inferred	0.06	0.04	69.4	38	29	13.2
	Total	1.04	0.86	82.8	34	28	18.7
	Contained (kt)			857	292	237	160
Eneabba MSP By-Product Stockpile Ore Reserves as at 31 Dec-2022:	Percentage of Total Heavy Metals						
	Resource Category	Tonnes (Mt)	In Situ HMTonnes (Mt)	Total HM Grade (%)	Ilmenite Grade (%)	Zircon Grade (%)	Monazite + Xenotime Grade (%)
	Proved	0.69	0.58	84.7	32	27	21.6
	Probable	0.28	0.23	82.5	37	31	12.9
	Total	0.96	0.81	84.1	34	28	19.2
	Contained (kt)			810	254	210	145



Project Status

Pre Construction
(FID announced April 2022; EPCM contract awarded June 2022; groundworks commenced Q4 2022; FEED completion expected Q4 2023)



Offtake Available

Yes – detailed discussions are ongoing



Min Mine Life (Yrs)

Initial ~9 year life from Eneabba stockpile



IRR:

Refer to Iluka's FID announcement on 4 April 2022



Capital Cost:

~A\$1,200m



NPV:

Refer to Iluka's FID announcement on 4 April 2022



Product & Annual Production Rate:

• 17.5 – 23 ktpa rare earth oxides subject to feedstock used: Product range will include neodymium (Nd) oxide; praseodymium (Pr) oxide; didymium (NdPr) oxide; dysprosium (Dy) oxide; terbium (Tb) oxide



Goschen

VHM Ltd

ASX:VHM • vhmld.com.au

Investment summary

VHM is developing the Tier 1, advanced development stage Goschen Rare Earths and Minerals Sands Project, in north west Victoria. The Goschen deposit is globally significant containing critical minerals rare earths elements (neodymium, praseodymium, dysprosium, and terbium), zircon, and titania which are crucial for the manufacturing of technologies required for the global energy transition. Adequacy review for the Goschen Environmental Effects Statement has been completed to meet bilateral Government approvals requirements, with Environmental and Mining Licence approvals targeted in 2024. No Native Title or Aboriginal Cultural Heritage values have been identified for the mine footprint. Goschen has the potential to provide downstream manufacturers with supply of rare earths and heavy mineral sands products required to meet decarbonisation targets. VHM welcomes further discussion on offtake, financing, and strategic partnerships to accelerate the Project into production in 2025.

Project description

The Goschen DFS completed in March 2023 defines a 5Mtpa nameplate shallow open-pit mine production rate for a 21-year mine life. The rare earths and heavy mineral sands bearing ore will be processed on site via a mining unit plant and wet concentrator to produce a heavy mineral concentrate (HMC). The HMC will undergo further processing to produce a rare earth mineral concentrate (REMC) and a zircon-titania HMC. A hydromet circuit will be constructed in Phase 1A to further process the REMC into a mixed rare earth carbonate (MREC). There is future potential to refine the HMC into premium zircon, zircon concentrate, HiTi rutile and leucoxene and low-chromium ilmenite mineral products.

Commodity(ies):	Rare Earth Elements, Zircon and Titanium								
Goschen Mineral Resource as at 5 January 2023 (cut-off grade of 1.0% Total Heavy Mineral):	Resource Category	Tonnes (Mt)	THM (%)	Zircon (%)	Rutile (%)	Leucoxene (%)	Ilmenite (%)	Monazite (%)	Xenotime (%)
	Measured	30.7	5.72	29.9	10.8	9.0	24.7	4.3	0.8
	Indicated	310.3	3.19	20.5	10.1	8.6	24.9	3.4	0.7
	Inferred	287.7	2.32	17.2	8.7	7.5	22.7	2.9	0.5
	Total	628.7	2.92	20.2	9.6	8.2	24.1	3.3	0.6
	Contained (Kt)		18,329	3,698	1,765	1,509	4,418	601	118
Global Ore Reserve as at 18 September 2023	Reserve Category	Tonnes (Mt)	THM (%)	Zircon (%)	Rutile (%)	Leucoxene (%)	Ilmenite (%)	Monazite (%)	Xenotime (%)
	Proved	24.5	5.4	29.9	10.8	9.0	24.7	4.3	0.8
	Probable	185.7	3.6	20.9	9.8	8.4	25.7	3.4	0.6
	Total	210.2	3.8	22.4	10.0	8.5	25.5	3.6	0.7
	Contained (Kt)		8,039	1,797	803	682	2,050	288	53

Note: Valuable Heavy Mineral grades are reported as a percentage of THM.



Project Status

Feasibility Study (March 2023)
Front End Engineer
Design complete



Offtake Available

Yes



Min Mine Life (Yrs)

21



Pre-tax IRR:

44% (March 2023)



Capital Cost:

Phase 1: A\$483m

Phase 1A: A\$124m (March 2023)

Pre-tax NPV_{10%}:

A\$1.5b (March 2023)



Product & Annual Production Rate:

• **Phase 1:** Rare earth mineral concentrate (REMC): 9,400tpa
Zircon-titania heavy mineral concentrate (HMC): 134,500tpa

• **Phase 2:**
Mixed rare earth carbonate (MREC): 8,500tpa
Zircon-titania heavy mineral concentrate (HMC): 134,500tpa



Nolans

Arafura Rare Earths Ltd

ASX:ARU • arultd.com

Investment summary

The Nolans Project is particularly endowed in the ‘magnet feed’ rare earths neodymium and praseodymium (NdPr), critical to the production of EVs, wind turbines and other renewable energy technologies required for global decarbonisation. Nolans will significantly contribute to the growth of Australia’s critical minerals sector, deliver industry development opportunities, add value through downstream processing, and help to meet global NdPr demand. Nolans has all NT environmental and mining approvals and permitting in place, in addition to Mining Authorisation and Native Title Agreement. Arafura has binding offtake agreements in place with Hyundai and Kia, Siemens, and Gamesa Renewable Energy. Offtake negotiations with other international OEMs and Tier 1 producers are well advanced. Project funding activities are ongoing and include opportunities for strategic equity investment.

Project description

Nolans is 135km north of Alice Springs, NT, with excellent proximity to existing infrastructure. The Project’s single-site ore-to-oxide operating model will see all mining, processing and waste management on-site – a solution strongly aligned with a rapidly escalating global focus on responsible mining and ESG performance. The metallurgical process developed by Arafura for Nolans leverages natural characteristics of the orebody to deliver low operating costs, and has been de-risked via a four-year pilot plant program to refine the flowsheet. Enabling and early construction works commenced on-site in the first half of CY2023. Nolans’ minimum 38-year mine life will see the Project deliver inter-generational benefits to local communities and the broader region through job creation, training initiatives, new industry development, capability building and business opportunities.

Commodity(ies):	Rare Earth Elements (Neodymium and Praseodymium (NdPr))				
Mineral Resources as at 7 June 2017 (1% TREO cut-off grade):	Resource Category	Tonnes (Mt)	TREO (%)	P ₂ O ₅ (%)	NdPr Enrichment (%)
	Measured	4.9	3.2	13	26.1
	Indicated	30	2.7	12	26.4
	Inferred	21	2.3	10	26.5
	Total	56	2.6	11	26.4
	Contained (Kt)		1,456	6,160	384
Ore Reserves as at 16 March 2020:	Reserve Category	Tonnes (Mt)	TREO (%)	P ₂ O ₅ (%)	NdPr Enrichment (%)
	Proved	5.0	3.0	13	26.2
	Probable	24.6	2.8	13	26.5
	Total	29.5	2.9	13	26.4
	Contained (kt)		856	3,835	226



Project Status

Pre Construction



Offtake Available

46.5% (1,754tpa)¹ of NdPr oxide currently available (Oct 2023)



Min Mine Life (Yrs)

38



Post-tax IRR:

19.3% (Nov 2022)



Capital Cost:

A\$1,590m (Nov 2022)



Post-tax NPV_{8%}:

A\$2,358m (Nov 2022)



Product & Annual Production Rate:

- NdPr oxide: 4,440tpa
- SEG/HRE carbonate: 474tpa
- Phosphoric acid (fertilizer-grade, 54% P₂O₅): 144,393tpa

¹ Remainder of Binding Offtake Target (85% (3,774tpa) of 4,440tpa Planned Production from Nolans.



Yangibana Rare Earths Project

Hastings Technology Metals Ltd

ASX:HAS • hastingstechmetals.com

Investment summary

Located 250km north-east of Carnarvon in WA's Gascoyne region, the Yangibana Project is underpinned by one of the world's most highly-valued deposits of neodymium and praseodymium (NdPr), with an average life of mine NdPr to total rare earth oxides (TREO) ratio of 37%. With an initial mine life of 17 years, Yangibana will become a globally significant source of NdPr, a critical component in permanent magnets used in advanced technology products, including EVs and wind turbines. Stage 1 of the Project is fully permitted and Hastings has an agreement in place with the TMWTJ people for development of the Project. Hastings is committed to developing and operating in a sustainable manner, with its strong ESG credentials subject to independent third-party ratings including by Sustainalytics and EcoVadis. Hastings has a strategic 20% shareholding TSX-listed Neo Performance Materials – a leading global rare earth processing and advanced permanent magnets producer – providing the Company with the opportunity to explore the creation of a mine-to-magnet supply chain.

Project description

The Yangibana Project will be developed in two stages with Stage 1 including the construction of the mine and beneficiation plant to produce up to 37,000tpa of rare earth concentrate, followed by the construction of a hydrometallurgical plant in Onslow to produce up to 15,000tpa of mixed rare earth carbonate in Stage 2. At 30 September 2023, A\$126m has been invested in Stage 1 early works including construction of an airstrip, 294-bed village, access roads and water infrastructure. First concentrate production is expected in the first half of 2025.

Commodity(ies):	Rare Earth Elements (Neodymium and Praseodymium (NdPr))			
Mineral Resources as at 11 Oct 22 (0.24% TREO cut-off (6 deposits), 0.2% Nd ₂ O ₃ +Pr ₆ O ₁₁ cut off (4 deposits)):	Resource Category	Tonnes (Mt)	SiO ₂ (%)	Nd ₂ O ₃ + Pr ₆ O ₁₁ (%)
	Measured	4.97	0.96	0.37
	Indicated	19.51	0.88	0.32
	Inferred	5.45	1.05	0.31
	Total	29.93	0.93	0.32
	Contained (kt)	277	96	
Ore Reserves as at January 2023:	Reserve Category	Tonnes (Mt)	SiO ₂ (%)	Nd ₂ O ₃ + Pr ₆ O ₁₁ (%)
	Proved	4.89	0.95	0.37
	Probable	16.03	0.88	0.32
	Total	20.93	0.90	0.33
	Contained (kt)	188	69	



Project Status

Stage 1: Pre Construction
Stage 2: Feasibility Study
(Staged development Feasibility Study 31 May 2023)



Offtake Available

Two-thirds of annual production under offtake with thyssenkrupp Materials Trading – remaining one-third of production available.



Min Mine Life (Yrs)

17



Post-tax IRR:

Stage 1: 27.5%*
Stage 2: 50.9%
(May 2023)



Capital Cost:

Stage 1: A\$470m
Stage 2: A\$478m (May 2023)



Post-tax ungeared NPV^{11%}:

Stage 1: A\$538m*
Stage 2: A\$1,018m (May 2023)



Product & Annual Production Rate:

Stage 1:

• **Rare earth concentrate (27% TREO):** 37,000tpa (containing around 3,400tpa NdPr oxide)

Stage 2:

• **Mixed rare earth carbonate (59% TREO):** 315,000tpa (containing around 3,400tpa NdPr oxide)

*ASX Release – 31 May 2023. Potential for improved economics (Stage 2 project metric) through tolling and/or profit sharing arrangements

Scandium

Projects

Nyngan Scandium

65





Nyngan Scandium

Scandium International Mining Corp.

TSX:SCY • scandiummining.com

Investment summary

As the world's first scandium-only mining project, Scandium International (SYC) welcomes discussion regarding financing of the Nyngan Scandium Project. The Company is actively progressing offtake agreements focusing on solid-oxide fuel cells, 3D printing, and aluminium-scandium master alloy sales. An 11-hole drilling program was completed in August 2023 defining further near surface scandium enriched laterite at the western edges of the Mineral Resource. Early on-site construction works commenced in October 2023 including surveying of the site, removal and stockpiling of topsoil from the construction site, and construction of a temporary site office. The Company has completed its EIS and have development approval and clearances from Aboriginal Heritage.

Project description

The Nyngan Scandium Project is based on a shallow and surface-mineable lateritic clay deposit with an attractive scandium enrichment. Annual mining activity will be conducted in short campaigns lasting 4-6 weeks each. Mining and ore sizing will produce feedstock for a continuous high-pressure acid leach autoclave system (HPAL), followed by a solvent extraction (SX) concentration of scandium. Final scandium oxide product is made through an oxalate stage, calcine finish, and packaging. All processing, refining and packaging will be undertaken on-site to produce a saleable scandium oxide product (Sc_2O_3 , or scandia). Considerable bench scale and small pilot metallurgical test work has been conducted with third party laboratories to finalize the flowsheet and SX specifics. A pilot testwork program completed in 2020 assessed production of aluminium-scandium master alloy (aluminium alloys containing 2% scandium) from scandium oxide using SCY's proprietary process. A patent was awarded to SCY in 2021 for this process.

Commodity(ies):	Scandium		
Mineral Resources as at May-16 (100ppm Sc cut-off):	Resource Category	Tonnes (Mt)	Sc (ppm)
	Measured	5.7	256
	Indicated	11.2	225
	Inferred		
	Total	16.9	235
	Contained (kt)		4.0
Ore Reserves as at May-16	Reserve Category	Tonnes (Mt)	Sc (ppm)
	Proved	0.8	394
	Probable	0.6	428
	Total	1.4	409
	Contained (kt)		0.6



Project Status
Feasibility Study
(May 2016)



Offtake Available
Yes



Min Mine Life (Yrs)
20



Post-tax IRR:
33% (May 2016)



Capital Cost:
US\$87m (May 2016)



Post-tax NPV_{8%}:
US\$225m (May 2016)



Product & Annual Production Rate:
• **Scandium oxide (Sc_2O_3):**
38.3tpa
(Also potential to further refine scandium oxide to produce aluminium-scandium master alloys)

Silicon

Projects

Arrowsmith North Silica Sand	67
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Arrowsmith North Silica Sand

VRX Silica Ltd

ASX:VRX • vrxsilica.com.au

Investment summary

VRX Silica has five high-grade, low-impurity silica sand projects in WA boasting multi-decade scale contiguous sand deposits with a combined +1.38b tonne Mineral Resource of 99.6% to 99.9% SiO₂ grade silica sand. The Arrowsmith North Project is the first project to be developed. Mining Leases have been granted. Native Title and Aboriginal Heritage agreements are in place. Environmental and mining approvals are well advanced with completion expected early 2024. Silica sand is the raw material required to produce critical silicon components to meet global decarbonisation commitments with global supplies of silica sand dwindling rapidly, particularly in Asia. Arrowsmith North Silica Sand has a range of uses including; glassmaking sand, three foundry sand products, solar panel backing plate glass, thermal sponge “blade” used for thermal protection between battery packs in Li ion batteries, and high tensile fiberglass yarn used to cover wind turbine blades. Offtake has been agreed for export to the South Korean foundry market subject to final approvals and pricing.

Project description

Arrowsmith North is located 270km north of Perth adjacent to highway and rail connections to Geraldton Port. It is the most advanced of VRX’s projects, with purchasing of key equipment having commenced in May 2022 and production anticipated to commence in 2024. Exploration, metallurgical testwork, process circuit design, and detailed engineering has been completed. Loose sand will be mined from the surface to 8-12m deep with loaders feeding a mobile trommel and progressive rehabilitation. Sand will be processed on-site including screening, attritioning, flotation, and classification to produce a range of silica products.

Commodity(ies):	Silica Sand						
Mineral Resources as at May 2023:	Resource Category	Tonnes (Mt)	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	TiO ₂ (%)	LOI (%)
	Measured	10	95.9	1.90	0.70	0.30	0.70
	Indicated	237	97.7	1.00	0.40	0.20	0.50
	Inferred	266	98.4	0.69	0.29	0.23	0.36
	Total	513	98.0	0.86	0.35	0.22	0.43
Ore Reserves as at May 2023:	Reserve Category	Tonnes (Mt)	AFS20 (%)	AFS35 (%)	AFS55 (%)		
	Proved	7.4	0.8	3.9	2.7		
	Probable	177.7	24.2	102.5	51.1		
	Total	185.2	25.0	106.4	53.8		

See tech data on Reserve products [https://vrxsilica.com.au/resources/tech sheets/](https://vrxsilica.com.au/resources/tech%20sheets/)



Project Status

Pre Construction
(BFS completed August 2019)



Offtake Available

Yes, subject to final approvals
From late 2024 (estimated)



Min Mine Life (Yrs)

25



Post-tax ungeared IRR:

79% (August 2019)



Capital Cost:

Approximately A\$28m
(August 2019)
(estimate currently
being updated)



Post-tax ungeared NPV_{10%}:

A\$242m (August 2019)



Product & Annual Production Rate:

• Silica sand at 99.7% SiO₂
and 500ppm Fe₂O₃ (foundry
and glassmaking sand):
2Mtpa



Beharra Silica Sand

Perpetual Resources Ltd

ASX:PEC • perpetualresourceslimited.com.au

Investment summary

Beharra is the lowest known impurity silica sand project WA's Mid-West region. Recent metallurgical testing has materially improved product quality assisting with advancement of offtake discussions for fully-processed and unprocessed silica sand, with discussions subject to ongoing testing by potential customers. Environmental approvals have progressed, with the decision by the WA EPA to assess the Project under a Part IV approval process, expected to take until 2024. Remaining environmental approvals activities include flora, fauna, and water studies and a public comment period. Completion of a DFS is planned in 2 HCY 2024. A Heritage Agreement is in place with the Yamatji Southern Regional Corporation (YSRC), the local Indigenous group, with whom Perpetual has exceptional relationships. A water access agreement for the Project is also in place with YSCR. Perpetual is open to investment in Company and/or Project as well as debt funding options.

Project description

The Beharra Project is located 96km south of the deep-water port town of Geraldton. Perpetual completed a PFS for Beharra in 2021 on production of +1.5Mtpa of >99.5% SiO₂ purity silica sand with low impurities, targeting the high-end Asian float and cover glass markets. The Beharra orebody is free-flowing material and will be mined using dozers and front-end loaders. The silica sand will be processed using simple conventional gravity and magnetic separation, with product trucked to Geraldton port. The environmental footprint is small as the orebody is progressively mined and rehabilitated. The Beharra exploration license is only 40% explored with significant upside potential.

Commodity(ies):	Silicon (Silica Sand)					
Mineral Resources as at 15 December 2022 (no cut-off grade applied):	Resource Category	Tonnes (Mt)	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	TiO ₂ (%)
	Measured – In-situ	44.7	98.6	0.45	0.18	0.33
	Indicated – In-situ	93.1	98.6	0.41	0.26	0.35
	Total	137.8	98.6	0.42	0.24	0.34
	Contained (kt)		135,871	N/A	N/A	N/A
Ore Reserves as at 17 March 2021 (no cut-off grade applied):	Reserve Category	Tonnes (Mt)	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	TiO ₂ (%)
	Probable – In-situ	64.1	98.6	0.42	0.20	0.35
	Probable – Saleable Product	47.6	99.6	0.18	0.028	0.035
	Contained (kt)		N/A	N/A	N/A	N/A

Note: The Saleable Products Ore Reserve shown above is the saleable product reserve recoverable from the in-situ ore reserve. The saleable product ore reserve is a subset of the in-situ reserve and they are not additive.



Project Status

Pre Feasibility Study
(April 2021)



Offtake Available

Yes – available for contracting immediately and for product delivery post FID and construction (likely 1 HCY25)



Min Mine Life (Yrs)

32



Post-tax ungeared IRR:

55% (April 2021)



Capital Cost:

A\$39m (April 2021)



Post-tax ungeared NPV_{10%}:

A\$231m (April 2021)



Product & Annual Production Rate:

- High-grade silica sand (>99.5% SiO₂ with low impurities <200ppm Fe₂O₃): >1.5Mtpa

Note: impurity profile achieved in recent representative metallurgical test work is superior to that reported in the March 2021 Reserve calculation.



Cape Flattery Silica Sand

Metallica Minerals Ltd

ASX:MLM • metallicaminerals.com.au

Investment summary

Metallica Minerals (MLM) welcomes potential offtake partners interested in securing a high-purity silica sand product from its Cape Flattery Silica (CFS) Project in Far North Queensland. Strategic investment opportunities to support the commercialisation of the Project will also be considered. First silica sand production from the Project is forecast to be in Q2, 2027. MLM has applied for the Project to be a coordinated project by the Queensland Office of Coordinator General (OCG) with the final guidelines for an EIS included. Negotiations with the Traditional Owners are continuing and an economic share of the Project and significant employment opportunities will benefit the nearby townships of Hope Vale and Cooktown.

Project description

The CFS Project is being progressed in the world class silica sand region of Cape Flattery. The DFS, completed in July 2023, confirms the Project's potential as a long-life, low-cost producer of high-purity silica sand suitable for use in the manufacturing of high-quality glass, in particular solar photovoltaic (PV) glass used in solar modules. The Project includes simple sand extraction using front end loaders, and proven processing methods with high yields to process the raw sand to a saleable high-purity silica sand. Approximately 1.85Mtpa of raw sand will be slurry pumped to the processing plant which will reduce Fe_2O_3 levels via screening, spirals, attritioning, classification, and magnetic separation, to produce approximately 1.45Mtpa of high-purity silica sand product. Product will be exported via a nearby barge loading facility, and a transshipment solution capable of loading cape size vessels.

Commodity(ies):	Silicon (Silica Sand)					
Mineral Resources as at 17 July 2023:	Resource Category	Tonnes (Mt)	SiO_2 (%)	Fe_2O_3 (%)	Al_2O_3 (%)	LOI (%)
	Measured	16.1	99.20	0.08	0.22	0.13
	Indicated	33.2	99.05	0.10	0.25	0.15
	Inferred	0.2	99.00	0.12	0.28	0.13
	Total	49.5	99.10	0.09	0.24	0.14
	Contained (Kt)		N/A	N/A	N/A	N/A
Ore Reserves as at 17 July 2023:	Reserve Category	Tonnes (Mt)	SiO_2 (%)	Fe_2O_3 (%)	Al_2O_3 (%)	LOI (%)
	Probable	47.0	99.11	0.09	0.15	0.24
	Total	47.0	99.11	0.09	0.15	0.24
	Contained (Kt)		N/A	N/A	N/A	N/A

Note: Ore Reserves are on an In-Situ basis.



Project Status

Feasibility Study
(July 2023)



Offtake Available

Yes



Min Mine Life (Yrs)

25



Pre-tax IRR:

32.9%

Post-tax IRR:

26.6% (July 2023)



Capital Cost:

A\$165m (July 2023)



Pre-tax NPV_{10%}:

A\$437.3m (July 2023)



Product & Annual Production Rate:

• High-purity silica sand (99.9% SiO_2 , 100ppm Fe_2O_3): Approximately 1.45Mtpa



Galalar Silica Sand

Diatreme Resources Ltd

ASX:DRX • diatreme.com.au

Investment summary

Diatreme is seeking suitable project partners, whether for investment or offtake, for its high-grade silica sand projects in Far North Queensland, including its Galalar Silica Sand Project (GSSP) and Northern Silica Project (NSP). This includes partners for potential downstream processing opportunities in Townsville, QLD. Environmental and cultural heritage baseline studies for the EIS for the GSSP are well advanced. Diatreme has a close relationship with affected Native Title holders including Hopevale Congress.

Project description

GSSP is a high-grade silica sand project located around 20km north of Cooktown, QLD. The Project lies in close proximity to the world's largest operating silica sand mine at Cape Flattery. The GSSP PFS completed in November 2021 showed the potential to develop a long-life, low-capex and highly-profitable operation with attractive economics. The GSSP's high-purity, low-iron silica sand resource of 75Mt is part of a total resource of around 310Mt of high-grade silica sand across Diatreme's Galalar and adjacent NSP. A Scoping Study for the NSP demonstrated its potential to become a valuable long life mining operation, with a potential target production rate of 5Mtpa, capable of being sustained for 25 years. The Galalar Project's high-grade product satisfies the required specifications for the solar PV and other specialty glass markets, supporting global decarbonisation.

Commodity(ies):	Silicon (Silica Sand)				
Mineral Resources as at 13 September 2021 (98.5% SiO ₂ cut-off)	Resource Category	Silica Sand Tonnes (Mt)	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)
	Measured	43.12	99.21	0.09	0.11
	Indicated	23.12	99.16	0.09	0.13
	Inferred	9.22	99.10	0.11	0.16
	Total	75.46	99.18	0.09	0.12
	Contained (kt)	74,841			
Ore Reserves as at 9 November 2021 (98.5% SiO ₂ and 1200ppm Fe ₂ O ₃ cut-off's)	Reserve Category	Silica Sand Tonnes (Mt)	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)
	Probable	32.5	99.20	0.08	0.11
	Total	32.5	99.20	0.08	0.11
	Contained (kt)	32,240			

Note: Ore Reserves are on an In-Situ basis.



Project Status

Pre Feasibility Study
(Nov 2021)



Offtake Available

Yes



Min Mine Life (Yrs)

23.5



Pre-tax IRR: 74%

(Nov 2021)

Post-tax IRR: 66%

(Nov 2021)



Capital Cost:

A\$60.1m (Nov 2021)



Pre-tax NPV_{8%}: A\$495m

(Nov 2021)

Post-tax NPV_{8%}: A\$358m

(Nov 2021)



Product & Annual Production Rate:

- High-grade silica sand (99.9% SiO₂, <110 ppm Fe₂O₃): 1.26Mtpa



Muchea Silica Sand

VRX Silica Ltd

ASX:VRX • vrxsilica.com.au

Investment summary

VRX has five high-grade, low-impurity silica sand projects in WA boasting multi-decade scale deposits with combined a Mineral Resource +1.38billion tonnes of 99.6% to 99.9% SiO₂ silica sand. Following the development of the Arrowsmith North Silica Sand Project, the high-grade Muchea Silica Sand Project will be the second project to be developed. One Mining Lease has been granted with a second under application. Native Title and Aboriginal Heritage agreements are in place. Environmental studies have been completed with WA EPA referral targeted in early 2024. Muchea high-grade silica sand is expected to be used in ultra-clear solar panel glass manufacture. Burgeoning uptake of solar panels is expected to drive exponential growth in demand for high-quality silica sand. Global supplies of silica sand are dwindling rapidly. VRX Silica will consider investment for production of high-grade silica sand and potential downstream processing for solar panel cover glass, silica flour and high-tensile fibreglass yarn.

Project description

Muchea is located 50km north of Perth, adjacent to highway and rail connections to Kwinana Port and adjacent energy infrastructure. It is one of a few world-class silica sand projects with an outstanding high-grade purity of 99.9% SiO₂ and <150ppm Fe₂O₃, essential to produce ultra-clear solar panel cover glass. Exploration, metallurgy and process circuit design is complete and detailed engineering is underway. Loose sand will be mined to a depth of 12-20m with loaders feeding a mobile trommel and progressive rehabilitation. Sand will be processed on-site including, screening, attritioning, flotation and classification to produce high-grade (99.9% SiO₂) low-iron sand for export via Kwinana Port.

Commodity(ies):	Silicon (Silica Sand)						
Mineral Resources as at Oct 2019:	Resource Category	Tonnes (Mt)	SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	TiO ₂ (%)	LOI (%)
	Indicated	29	99.6	0.09	0.03	0.07	0.22
	Inferred	172	99.6	0.05	0.02	0.10	0.23
	Total	208	99.6	0.06	0.02	0.10	0.23
Ore Reserves as at Oct 2019:	Reserve Category	Tonnes (Mt)	F80C Perth Ultra Premium (Mt)	F80 Perth Premium (Mt)	F150 Perth Fine (Mt)		
	Probable	18.7	4.3	10.2	4.3		
	Total	18.7	4.3	10.2	4.3		

See tech data on Reserve products [https://vrxsilica.com.au/resources/tech sheets/](https://vrxsilica.com.au/resources/tech%20sheets/)



Project Status

Feasibility Study
(Oct 2019)



Offtake Available

Yes. Following Environmental Approval and Processing Plant Construction 2025



Min Mine Life (Yrs)

25



Post-tax ungeared IRR:

96%
(Oct 2019)



Capital Cost:

A\$50m
(Oct 2019)



Post-tax ungeared NPV_{10%}:

A\$338m (Oct 2019)



Product & Annual Production Rate:

- High-grade silica sand at 99.9% SiO₂ with <150ppm Fe₂O₃; 2Mtpa

Titanium

Projects

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Balranald

Iluka Resources Ltd

ASX:ILU • iluka.com

Investment summary

The Balranald critical minerals development is the next evolution of Iluka's operations, located in the northern Murray Basin, NSW. It focuses on the high-grade West Balranald deposit, which contains significant quantities of rutile and zircon, as well as smaller but material quantities of rare earths. Iluka completed the Balranald DFS in late 2022, which confirmed the technical and commercial viability of Iluka's Underground Mining Method (UGM) technology. Iluka's Board approved the FID for Balranald in February 2023. The A\$500m Balranald Project investment will be internally funded by Iluka. Construction activity commenced in August 2023 and is expected to take 18 months, with commissioning currently scheduled for Q1, 2025.

Project description

Iluka has developed a novel, remotely-operated UGM to access the Balranald deposits, which are located ~60 metres below surface. Iluka's UGM technology enables access to ore bodies previously thought uneconomic, with marked reductions in both environmental disturbance and carbon intensity, relative to traditional mineral sands extraction techniques. ROM ore will be processed on-site to produce a heavy mineral concentrate which will be transported to the Company's processing and refining assets in WA for further value addition. Balranald's rare earths will be a supplementary source of feed for Iluka's Eneabba refinery. The Balranald development enhances Iluka's portfolio offering of high-grade, high-quality critical minerals products produced in Australia. This includes rutile, zircon, synthetic rutile, and rare earths.

Commodity(ies):	Titanium (Rutile, Ilmenite), Zirconium (Zircon), Rare Earth Elements					
West Balranald Mineral Resource Estimate as at 31 December 2022:	Percentage of Total Heavy Metals					
	Resource Category	Resource Tonnes (Mt)	Total HM Grade (%)	Ilmenite Grade (%)	Zircon Grade (%)	Rutile Grade (%)
	Measured	5.9	43.9	65	12	13
	Indicated	26.3	32.6	64	11	12
	Inferred	4.5	26.2	62	8	9
	Total	36.8	33.6	64	11	12
	Contained (kt)		12,378	7,932	1,342	1,482
						Monazite + Xenotime Grade (%)
						0.9
						0.7
						0.9

Project Status Construction (DFS completed Q4 2022; FID in February 2023; Construction commenced in August 2023)	IRR: N/A	Product & Annual Production Rate: <ul style="list-style-type: none"> Heavy mineral concentrate: 500ktpa* (containing 60ktpa rutile; 50ktpa zircon; 50-70ktpa synthetic rutile; 4ktpa rare earth concentrate (M+X); and 150ktpa sulphate ilmenite)
Offtake Available Yes	Capital Cost: ~A\$500m	<p>*Based on two mining units from commencement of operations.</p>
Min Mine Life (Yrs) ~9.5	NPV: N/A	



Barrambie

Neometals Ltd

ASX:NMT • neometals.com.au

Investment summary

With one of the world's largest and highest-grade hard-rock titanium and vanadium deposits, Neometals welcomes discussions regarding project equity ownership, joint venturing, project financing and offtake for the Barrambie project. With a significant Mineral Resource Estimate and Ore Reserve, and a PFS completed in May 2023, the Project is mine-ready with a granted Mining Lease and EPA approval granted in 2012. Negotiations for a Native Title mining agreement are currently in progress.

Project description

Barrambie is unique owing to its exceptionally high-grade titanium resource coupled with high vanadium content and the weathered nature of the orebody (low contaminants). A number of flow sheets and target markets have been evaluated to maximise potential value. The Barrambie PFS is based on a capital-light development strategy including conventional open-pit mining of 2.18Mtpa (LOM ave) ore supplying an on-site Crush Mill Beneficiation (CMB) Plant producing a mixed titanium/vanadium/iron gravity concentrate. The mixed gravity concentrate will be exported via the Port of Geraldton. Offtakers will likely utilise the mixed gravity concentrate in the titanium pigment process, or target the ilmenite contained in the mixed gravity concentrate in a smelting process to produce a chloride-grade titanium slag as well as an iron vanadium product. Titanium slag is an intermediate product used to feed the fast-growing demands of the Chinese pigment and titanium metal market. A potential future option also exists to produce ilmenite and iron-vanadium concentrate near Geraldton via a low-temperature reduction roast followed by magnetic separation (not included in the May 2023 PFS).

Commodity(ies):	Titanium, Vanadium						
Mineral Resources as at 17 Apr-18 (0.2% V₂O₅ or 10% TiO₂ cut-off):	Resource Category	Tonnes (Mt)	TiO ₂ (%)	V ₂ O ₅ (%)			
	Indicated	187.1	9.61	0.46			
	Inferred	93.0	8.31	0.40			
	Total	280.1	9.18	0.44			
	Contained (kt)		25,713	1,232			
High-Grade TiO₂ Mineral Resources as at 17 Apr-18 (14% TiO₂ cut-off)	Resource Category	Tonnes (Mt)	TiO ₂ (%)	V ₂ O ₅ (%)			
	Indicated	39.3	21.18	0.65			
	Inferred	14.3	21.15	0.58			
	Total	53.6	21.17	0.63			
	Contained (kt)		11,347	338			
Ore Reserves as at 15 May 2023:	Reserve Category	Tonnes (Mt)	TiO ₂ (%)	V ₂ O ₅ (%)	Fe ₂ O ₃ (%)	SiO ₂ (%)	Al ₂ O ₃ (%)
	Probable	27.6	22.3	0.57	43.7	16.5	10.4
	Total	27.6	22.3	0.57	43.7	16.5	10.4
	Contained (kt)		6,155	157	12,061	4,554	2,870

Note: Cut-off is based on achieving an average concentrate grade of 32% TiO₂ (see 15 May 2023 announcement for further information).



Project Status

Pre Feasibility Study (May 2023)



Offtake Available

Yes



Min Mine Life (Yrs)

13



Pre-tax IRR:

25% (May 2023)



Capital Cost:

A\$215.3m (May 2023)



Pre-tax NPV_{10%}:

A\$374.9m (May 2023)



Product & Annual Production Rate:

- 1Mt DSO in first year, followed by 1Mtpa of >35% TiO₂ mixed gravity concentrate in years 2 to 5, and then >30% TiO₂ for remainder of life.



Copi

RZ Resources Ltd

Unlisted Private Company • rzresources.com

Investment summary

Copi is one of Australia's largest mineral sand projects (JORC resource of 2.54Bt) which will produce finished critical mineral products from the Company's established Pinkenba Mineral Separation Plant in Queensland for export across the globe into the ceramic, pigment, energy, high-end aviation, automotive and medical markets. The DFS is underway, targeting completion in November 2023. Most aspects of the project studies and operations readiness are nearing finalisation including environmental, land ownership, infrastructure, mining, processing, logistics, market offtake, and construction funding. RZ Resources is currently preparing to submit its application for environmental approvals in early 2024, followed by its Mining Lease application. No matters of national significance identified, no major environmental issues, no Native Title or cultural heritage issues have been identified. The Project will be development-ready pending approvals in early 2025. RZ Resources is a 100% privately owned Australian company, is well-funded, has zero debt and welcomes discussions on investment in the Company, Project and/or offtake.

Project description

Copi is located in the NSW Murray Basin and will consist of an open-cut wet dredge mining and processing facility utilising unpotable salt brine which removes the heavy minerals via gravity separation to produce heavy mineral concentrates. The heavy mineral concentrates will be transported via rail and road to the Company's Pinkenba Mineral Separation Plant in Brisbane, QLD for conversion into final products using electrostatic, gravity and magnetic fractionation to final product exported via the Port of Brisbane. Exploration drilling at Copi is yet to determine the deposit boundaries suggesting possible extension of the mine life.

Commodity(ies):	Titanium (Ilmenite, Rutile, Leucoxene), Zirconium (Zircon), Rare Earth Elements (Monazite and Xenotime)							
Mineral Resources as at September 2023	Resource Category	Tonnes (%)	Total HM (%)	Ilme-nite (%HM)	Leuco-xene (%HM)	Rutile (%HM)	Zircon (%HM)	Monazite Xenotime (%HM)
	Measured							
	Indicated	1,960	1.3	45	8.9	15	15	1.19
	Inferred	580	0.9	43	9.4	15	12	0.98
	Total	2,540	1.2	45	9.0	15	15	1.15
	Contained (Kt)			13,916	2,791	4,691	4,566	358

Note: Valuable Heavy Mineral grades are reported as a percentage of THM



Project Status

Pre Feasibility Study (May 2023) (targeting DFS completion in Nov 2023)



Offtake Available

100%
Advanced discussions underway with potential customers with MoU's in place for ~50% offtake.



Min Mine Life (Yrs)

19



Pre-tax IRR:

21.3% (Sept 2023)



Capital Cost:

~A\$940m (Sept 2023)



Pre-tax NPV_{8%}:

A\$1,100m (Sept 2023)



Product & Annual Production Rate:

- **Zircon:** 70,000tpa
Zircon Concentrate 41,000tpa
- **Rutile:** 28,000tpa,
- **Leucoxene:** 23,000tpa
- **Ilmenite:** 215,000tpa
- **Monazite and xenotime:** 5,000tpa



Medcalf

Audalia Resources Ltd

ASX:ACP • audalia.com.au

Investment summary

In 2022, Audalia completed an updated PFS on production of high-grade titanium lump ore (HTLO) from the Medcalf Project for use as a hearth liner in blast furnaces. Highlights from the PFS include a low capex of less than A\$40m, and a 6-year mine life. The Project has a granted Mining Lease and an agreement in place with the Traditional Owners. The Medcalf Project environmental review document was submitted to the WA EPA in July 2022 for assessment targeting environmental approval during the March quarter 2024. Audalia is seeking a potential purchaser of the vanadium-titanium-iron fines.

Project description

The Medcalf Project is located 470km from Perth. The titanium-vanadium-iron deposit outcrops as surface and dips gently to the north. Approximately 1.5Mtpa ore will be mined from three open-pit mines over an initial 6-year mine life to a depth of around 50m below surface with no expected dewatering requirements. The DSO ore will undergo a two-stage crushing and screening process to meet the lump size (10-60mm range) requirement producing approximately 975ktpa of HTLO at a grade of 12.4% TiO_2 , 0.7% V_2O_5 , and 59.2% Fe_2O_3 . Lump recovery is estimated at 65%. The HTLO product will be trucked 220km to the Port of Esperance for export to the Asian markets. The fines fraction will be stockpiled at the Medcalf site for potential future processing to produce a concentrate suitable for pelletisation as potential value addition to the Project. The Project has potential to expand through an upgrade in the Inferred Resource and additional exploration.

Commodity(ies):	Titanium, Vanadium, Iron					
Mineral Resources as at March 2022 (6% TiO_2 cut-off)	Resource Category	Tonnes (Mt)	V_2O_5 (%)	TiO_2 (%)	Fe_3O_4 (%)	Al_2O_3 (%)
	Indicated	15.0	0.60	11.01	56.4	8.5
	Inferred	10.6	0.40	8.54	43.0	9.6
	Total	25.7	0.52	9.98	50.9	9.0
	Contained (Kt)		134	2,565	13,081	



Project Status

Pre Feasibility Study (July 2022)



Offtake Available

3.0Mt @ 12.4% TiO_2 , 0.7% V_2O_5 and 59.2% Fe_2O_3 of fines (<10mm) from Year 5.



Min Mine Life (Yrs)

6



Pre-tax IRR:

146.3% (July 2022)



Capital Cost:

A\$32.8m (July 2022)



Pre-tax NPV_{8%}:

A\$177.9m (July 2022)



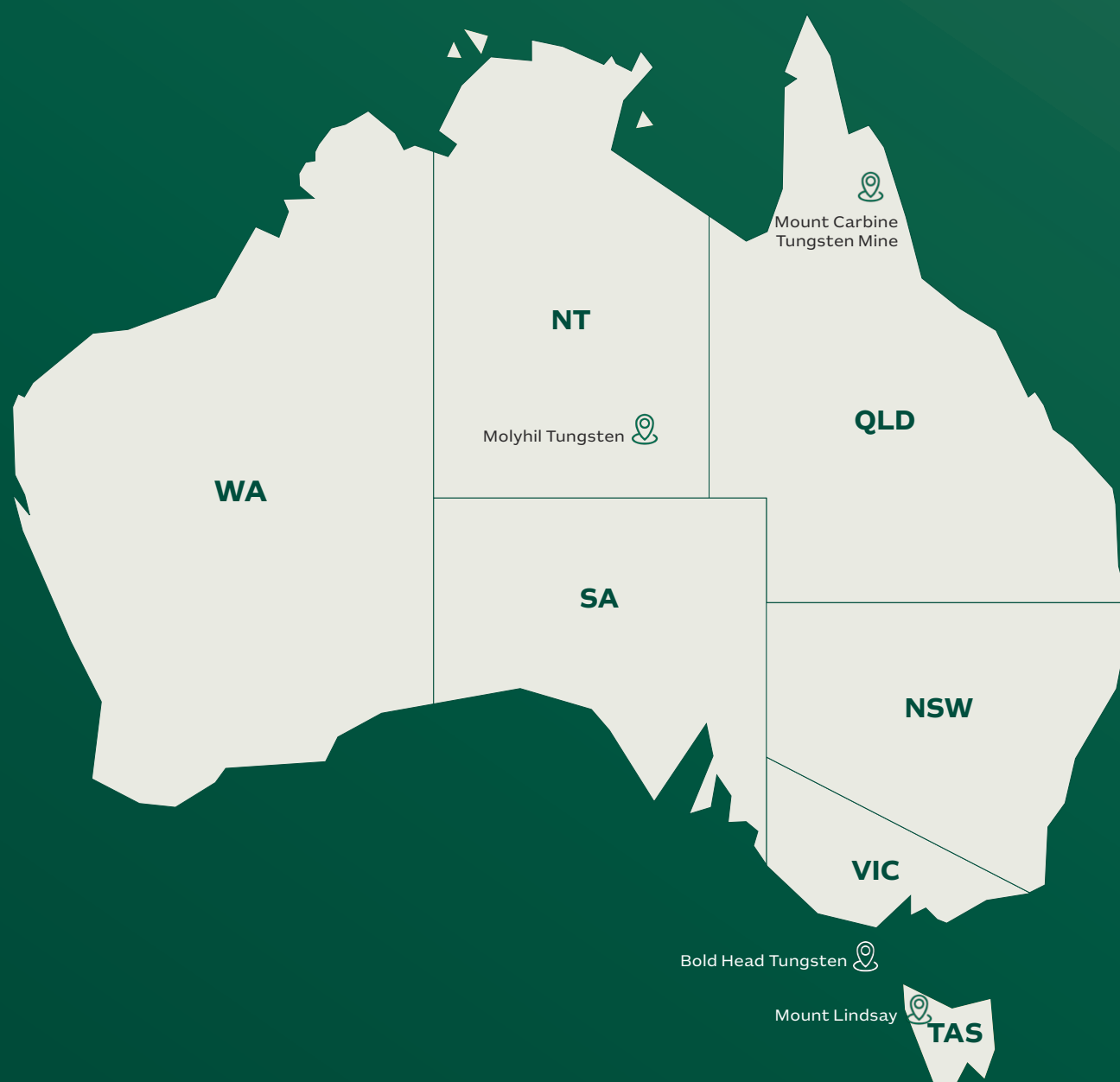
Product & Annual Production Rate:

• High titanium lump ore (HTLO) (12.4% TiO_2 , 0.7% V_2O_5 and 59.2% Fe_2O_3): 975ktpa

Tungsten

Projects

Bold Head Tungsten	78
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Bold Head Tungsten

Group 6 Metals Ltd

ASX:G6M • g6m.com.au

Investment summary

The Bold Head Tungsten deposit is planned to be developed as a satellite mine to the larger Dolphin Tungsten Mine, supplying the existing Dolphin Processing Plant. The Bold Head Mining Lease has been granted, full Feasibility Studies are underway and EPA Tasmania referral is targeted for the second half of 2024. Capital investment for the Bold Head Project is expected to be provided from cashflow the larger Dolphin Tungsten Mine cashflow. Offtake agreements are in place with Wolfram Bergbau und Hutten AG and Traxys for 65% of the first 4 years production from the Dolphin Tungsten Mine. 20% of offtake remains available.

Project description

G6M are currently developing and commissioning the Dolphin Open Cut (OC) mine and processing plant. A PFS on mining the Bold Head deposit and processing at the Dolphin Tungsten plant was completed in June 2023. The Bold Head satellite deposit is planned to be mined in parallel with the Dolphin operation when the Dolphin OC is at or near completion. Initially, 50kt of the Bold Head Probable Ore Reserves will be mined from a small OC at a strip ratio of 13:1, followed by underground (UG) mining of 390kt of the Bold Head Probable Ore Reserves over a four year period. Ore produced will supplement production at the Dolphin Processing plant during and after the Dolphin mine OC-UG transition. Bold Head is planned to produce approximately 100ktpa ROM ore over a four to five year period, supplementing the 300-400ktpa ROM ore produced from the Dolphin Mine.

Commodity(ies):	Tungsten		
Mineral Resources as at November 2019 (0.2 % WO ₃ cut-off):	Resource Category	Tonnes (Mt)	WO ₃ (%)
	Indicated	0.15	0.85
	Inferred	1.61	0.92
	Total	1.76	0.90
	Contained WO₃ (Kt)		16,080
Ore Reserves as at June 2023 (includes open-pit reserve at 0.20% WO ₃ cut-off and underground reserve at 0.70% WO ₃ cut-off):	Reserve Category	Tonnes (Mt)	WO ₃ (%)
	Probable	0.45	0.9
	Total	0.45	0.9
	Contained WO₃ (kt)		3,960



Project Status

Pre Feasibility Study (Jun 2023)



Offtake Available

100%



Min Mine Life (Yrs)

4



Pre-tax IRR:

51% (June 2023)



Capital Cost:

A\$19.5m (June 2023)



Pre-tax NPV_{8%}:

A\$14.4m (June 2023)



Product & Annual Production Rate:

• Tungsten concentrate (68% WO₃): >1,000tpa containing 680t of WO₃



Molyhil Tungsten

Thor Energy Plc, Investigator Resources Ltd

ASX & AIM:THR • ASX:IVR

Investment summary

The Molyhil Tungsten Project is owned by Thor Energy with Investigator earning-in to a JV interest. The Project was awarded Major Project status by the NT Government in 2020. Thor's Feasibility Study in 2018 confirmed Molyhil as a technically and economically viable project producing tungsten concentrate to be exported to customers for downstream processing. Investigator will complete resource validation and extension drilling and re-validation of the Mineral Resource Estimate in the second half of 2023, followed by an updated Feasibility Study in 2024 with a view to secure project financing to commence rapid development of the Project.

Project description

The Molyhil deposits occur as skarn bodies containing scheelite, molybdenite, and chalcopyrite mineralisation. Thor's 2018 Feasibility Study was based on a single, simple open-pit mine, with a life of 7 years. Molyhil ore will be processed on-site to produce tungsten, molybdenum, and copper concentrates using industry standard ore sorting and flotation processing techniques. Mineralisation has been identified below the planned open-pit with the potential to extend the mine life. In addition, the adjacent Bonya deposits, approximately 30km from Molyhil, host JORC 2012 Mineral Resources of 0.74Mt @ 0.21% WO₃ and 0.09% Cu and 0.2Mt @ 2.0% Cu, with the potential to extend the operational life of Molyhil for several years. Further mineralisation has been identified 30 km to the north at Bonya Deposits which will further extend the Molyhil mine life. Potential of an offset extension to the Molyhil mineralisation has also been identified in a largely undrilled magnetic target to the west. A NT co-funded regional gravity survey will be undertaken to further improve geological understanding and identify opportunities for similar mineralisation.

Commodity(ies):	Tungsten, Molybdenum, Copper				
Molyhil Mineral Resources as at 31-Mar-2021 (0.07% WO₃ cut-off):	Resource Category as at 31 March 2021	Tonnes (Mt)	WO ₃ (%)	Mo (%)	Cu (%)
	Measured	0.46	0.28	0.13	0.06
	Indicated	2.98	0.27	0.09	0.05
	Inferred	0.99	0.26	0.12	0.03
	Total	4.39	0.27	0.10	0.05
	Contained (tonnes)		11,800	4,400	2,190



Project Status
Feasibility Study
(August 2018)



Offtake Available
100%



Min Mine Life (Yrs)
7



Post-tax IRR:
59% (Aug 2018)



Capital Cost:
A\$69m (Aug 2018)



Post-tax NPV_{5%}:
A\$101m (Aug 2018)



Product & Annual Production Rate:

- **Tungsten concentrate:**
(65% WO₃): 1,850tpa
- **Molybdenum concentrate:**
(51.4% Mo): 850tpa
- **Copper concentrates:**
minor



Mount Carbine Tungsten Mine

EQ Resources Ltd

ASX:EQR (In-Situ Material 100% EQR. LGS 50% EQR / 50% CRONIMET)

Investment summary

EQ Resources' (EQR) Mt Carbine tungsten project, Australia's leading primary tungsten producer, boasts low-cost operations, tech integration, and a favourable commodity outlook. The acquisition of leading European tungsten producer, Saloro S.L.U, and award of an exploration permit (EPM) covering 488km² over the Wolfram Camp tin-tungsten field in northern QLD positions EQR to become the leading Western tungsten producer. The 2023 BFS update, featuring a 43% Ore Reserves increase, and a 47% increase in NPV, demonstrates significant growth potential with only 17% of mineral resources currently utilised. EQR's strong ESG commitment, fast-growing supply and sales, and Australian Government Critical Minerals Accelerator Initiative support make it an attractive prospect.

Project description

Mt Carbine is a fully permitted brownfields operation currently in production, undergoing a two-phase expansion initiated in 2019. Phase 1 involves early works upgrades, while Phase 2, focusing on efficiency and capacity enhancement, is in progress. Phase 2 also launched open-pit mining of the 5.93Mt in-situ ore reserves in Q2 2023. The currently defined resource feeds open-cut ore and historic low-grade stockpiles to the processing plant for ~10 years. In Q3 2023, open-pit concentrate production saw a remarkable 181% Q-on-Q growth, producing 422 tonnes of 50% WO₃ concentrate. EQR has scoped a 15-year underground mine demonstrating promising economic prospects. Ongoing exploration and drilling aims to uncover resources for both open-cut and underground operations. Acknowledged for its commitment to sustainability with the 2022 AMEC Environment Award, this project remains on target, meeting all significant benchmarks, set to be further bolstered by the benefits of Saloro and potential of Wolfram Camp.

Commodity(ies):	Tungsten					
Mineral Resources as at 18 May 2023	Low Grade Stockpile + In-Situ Low Grade (0.05% WO ₃ cut-off)			In-Situ (0.08% WO ₃ cut-off)		
	Resource Category	Tonnes (Mt)	WO ₃ (%)	Resource Category	Tonnes (Mt)	Nickel (%)
	Indicated	10.13	0.075	Indicated	18.06	0.30
	Indicated	2.75	0.07	Inferred	10.68	0.30
	Inferred	0.83	0.06	Total	28.74	0.30
	Total	13.71	0.07	Contained (Kt)	86.23	
	Contained (Kt)			9.60		
Ore Reserves as at 18 May 2023	Low-Grade Stockpile			Open Cut		
	Reserve Category	Tonnes (Mt)	WO ₃ (%)	Reserve Category	Tonnes (Mt)	WO ₃ (%)
	Probable	9.77	0.075	Probable	5.93	0.28
	Total	9.77	0.075	Total	5.93	0.28
	Contained (kt)			7.33		
	Contained (kt)			16.60		



Project Status

Phase 1: Operating. **Phase 2 Expansion:** Feasibility Study (May 2023) (Pre-Construction complete, open-pit mining commenced, further plant upgrades set for commissioning early 2024).



Offtake Available

First 25,000t WO₃ concentrate under offtake agreement with JV partner CRONIMET. Thereafter, 100% of offtake is available.



Min Mine Life (Yrs)

10 (LGS and Open Pit)



Pre-tax IRR:

477% (May 2023)



Capital Cost:

A\$26.3m (May 2023) (total over project life)

(*Note A\$307.1m NPV is Project NPV; NPV attributable to EQR as 50% portion of LGS JV and 100% of Open Pit results to A\$270M)



Pre-tax NPV_{8%}:

A\$307.1m* (May 2023)



Product & Annual Production Rate:

• Tungsten concentrate (50% WO₃): 4,060tpa



Mount Lindsay

Venture Minerals Ltd

ASX:VMS • ventureminerals.com.au

Investment summary

Venture Minerals completed a Feasibility Study in 2012 on the 100% owned Mount Lindsay tin-tungsten-magnetite project which is located within the world-class mineral province of north-west Tasmania and is one of the largest undeveloped tin-tungsten projects in the world. An updated Underground Mine Feasibility Study is underway, targeting Mount Lindsay to become a responsible producer of tin and tungsten by 2026, with access to renewable hydro and windpower, combined with the commitment to minimising the carbon and environmental footprint, through underground mining and simplified gravity-focused processing strategies. Venture welcomes discussion regarding financing of the project construction and/or offtake.

Project description

The 2012 Study was based on extracting 1.75Mtpa of tin, tungsten, magnetite, and copper bearing ore from an open-pit mine with minor underground development from the pit base to access some deeper mineralisation. Work completed includes; over 83,000m of diamond core drilling within the Project's two high-grade orebodies defining a significant resource, along with extensive engineering, environmental, hydrogeological and metallurgical studies. The process plant was designed to concentrate magnetite, copper sulfides, tin oxide, and scheelite through flotation and/or gravity processing with the scheelite further upgraded to ammonium paratungstate, before being trucked to the Port of Burnie for export. The Project has access to existing infrastructure. The updated Study is focused on the higher-grade portions (0.7% SnEq cut-off: 4.7Mt @ 0.3% WO₃ & 0.4% Sn) using a more cost-effective, gravity-focused, processing flowsheet. Recently CSIRO determined that extraction of tin, boron, and iron from tin-borate minerals within the tailings stream was possible.

Commodity(ies):	Tungsten, Tin, Copper, Iron					
Mineral Resources as at 17-Oct-12 at 0.2% SnEq cut-off:	Resource Category	Tonnes (Mt)	WO ₃ (%)	Sn (%)	Cu (%)	Mass Recovery of Magnetic Iron (Fe) Grade ¹ (%)
	Measured	8.1	0.1	0.2	0.1	17
	Indicated	17	0.1	0.2	0.1	15
	Inferred	20	0.1	0.2	0.1	17
	Total	45	0.1	0.2	0.1	17
	Contained (kt)		32	81	30	7,520
Ore Reserves as at 7 Nov 2012	Reserve Category	Tonnes (Mt)	WO ₃ (%)	Sn (%)	Cu (%)	Mass Recovery of Magnetic Iron (Fe) Grade ¹ (%)
	Proved	6.4	0.2	0.2	0.1	18
	Probable	7.3	0.1	0.2	0.1	13
	Total	14.0	0.1	0.2	0.1	15
	Contained (kt)		16	30	14	2,150

¹ The mass recovery of the magnetic iron shown is determined mostly by Davis Tube Results. Pilot scale metallurgical testwork for the 2012 Feasibility Study resulted in a recovery for iron in the form of magnetite at 98%, as a saleable concentrate with a grade of 65% Fe.



Project Status

Feasibility Study (Oct 2012)



Offtake Available

100%



Min Mine Life (Yrs)

9



Pre-tax IRR:

21% (Oct 2012)



Capital Cost:

A\$198m (Oct 2012)



Pre-tax NPV_{8%}:

A\$143m (Oct 2012)



Product & Annual Production Rate:

- **Tin concentrate (45-50% Sn):**
5,000tpa (tin in concentrate: 2,350tpa)
- **APT (Ammonium Paratungstate):**
1,500tpa
- **Magnetite concentrate (65% Fe):**
240,000tpa
- **Copper concentrate (~24% Cu):**
3,500tpa (Cu in concentrate: 800tpa)

Vanadium

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Victory Bore Project	86
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Australian Vanadium Project

Australian Vanadium Ltd

ASX:AVL • australianvanadium.com.au

Investment summary

With a BFS released April 2022, extensive pilot testwork completed and Mining Lease granted, the Australian Vanadium Project is one the most advanced vanadium projects in the world. Project approvals are well progressed, including engagement with the Traditional Owners of the project minesite, the Yugunga-Nya people, exploring and further defining the basis for an enduring partnership. Baseline studies have been completed and the Environmental Review Document has been submitted to the WA EPA for review. Australian Vanadium is seeking offtake, debt and equity. On 25 September 2023, Australian Vanadium (AVL) announced its intention to merge with Technology Metals Australia Ltd (ASX:TMT) via a Scheme of Arrangement. If approved, the merger will create a leading Australian vanadium developer with a world-class asset of scale, located in a Tier 1 mining jurisdiction.

Project description

The Project is based on an open-pit mine with on-site crushing, milling & beneficiation (CMB) and a processing plant located near Geraldton for conversion to high-quality vanadium pentoxide (V_2O_5). The Project has a high vanadium ore grade to the CMB plant (1.03% V_2O_5), thereby realising a high-concentrate mass yield; possibly the highest of current vanadium operations worldwide. The CMB flowsheet is based on standard, industry-proven processes, including magnetic beneficiation producing a concentrate at a ~1.4% V_2O_5 . The processing plant will use an alkaline roast leach and ammonium metavanadate extraction process to produce 11,200tpa of high-purity V_2O_5 product and 900,000tpa of iron titanium coproduct. AVL is also pursuing downstream opportunities through manufacture of vanadium electrolyte and battery installations, adding more value within Australia.

Commodity(ies):	Vanadium, Titanium		
Mineral Resources as at Nov-21	Resource Category	Tonnes (Mt)	V_2O_5 (%)
	Measured	11.3	1.14
	Indicated	82.4	0.70
	Inferred	145.3	0.71
	Total	239	0.73
	Contained (kt)		1,745
Ore Reserves as at Apr-22	Reserve Category	Tonnes (Mt)	V_2O_5 (%)
	Proved	10.5	1.11
	Probable	20.4	1.07
	Total	30.9	1.09
	Contained (kt)		337

Refer to 1 November 2021 ASX Announcement for information on cut-off grades used to report the Mineral Resource. Within the Total Mineral Resource, a Total High-Grade Portion of the Resource of 95.6Mt @ 1.07% V_2O_5 was also defined in November 2021.



Project Status

Feasibility Study (April 2022)



Offtake Available

100%



Min Mine Life (Yrs)

25



Pre-tax IRR:

20.6% (April 2022)



Capital Cost:

US\$435m (April 2022)



Pre-tax NPV^{7.5%}:

US\$600m @ US\$10.5/lb V_2O_5 and A\$: US\$ 0.72 (April 2022)



Product & Annual Production Rate:

- V_2O_5 as mix of flake or powder: 11,200tpa
- FeTi co-product (54%Fe): 900ktpa



Murchison Technology Metals Project (MTMP)

Technology Metals Australia Ltd

ASX:TMT • tmtlimited.com.au

Finalised merger with Australian Vanadium Ltd expected in January 2024.

Investment summary

The Murchison Technology Metals Project (MTMP) is one of the world's highest-grade primary vanadium projects, with feasibility studies confirming it will be a large-scale, low-cost, high-quality vanadium producer. Extensive consultation on heritage and cultural protection with Traditional Owners has been undertaken and is progressing towards a Mining Agreement. Environmental assessment is underway with the WA EPA leading to expected EPA Board review and consideration. Cornerstone investment by Resource Capital Funds endorses the asset quality and underpins establishment of a clear pathway to project funding, supported by end-user engagement in both the steel and battery industries. In September 2023, the Company announced a proposal to merge with Australian Vanadium Ltd via a scheme of arrangement which would consolidate the ownership of one contiguous orebody and provide enhanced project economics and material synergies.

Project description

MTMP, comprising the Gabanintha and Yarrabubba deposits, is located in a Tier 1 mining jurisdiction serviced by excellent infrastructure and involves three open-cut mines feeding an on-site processing plant, incorporating beneficiation, salt roasting and leaching to produce high-purity (>99%) vanadium pentoxide (V_2O_5) and ilmenite (TiO_2), with expected lowest quartile operating costs, over a mine life > 25 years. The Integration Study undertaken in August 2022 combined the high-grade Yarrabubba deposit into the MTMP mine plan. With high vanadium in concentrate grades (1.61% V_2O_5) in conjunction with high yields to concentrate, excellent recoveries and the addition of ilmenite product revenue, Yarrabubba is expected to materially enhance the economic metrics of the MTMP.

Commodity(ies):	Vanadium, Titanium					
Global Mineral Resource for the MTMP as at 7 November 2022 at a cut-off grade of 0.4% V_2O_5	Resource Category		Tonnes (Mt)	V_2O_5 (%)	TiO_2 (%)	
	Measured		12.1	1	11.4	
	Indicated		51.2	0.9	10.1	
	Inferred		90.5	0.8	9.5	
	Total		153.7	0.8	9.8	
	Contained (kt)			1,230	15,063	
Vanadium Ore Reserves as at 5 August 2022:	Reserve Category		Tonnes (Mt)	V_2O_5 (%)		
	Proved		1.12	0.95		
	Probable		43.36	0.89		
Titanium Ore Reserves as at 5 August 2022:	Total		44.48	0.89		
	Rec. V_2O_5 (M lb)			590.3		
	Reserve Category		Tonnes (Mt)	TiO_2 (%)		
	Probable		15.88	10.0		
	Total		15.88	10.0		
	Rec. TiO_2 (kt)				1,132.6	



Project Status

Feasibility Study (August 2022)
(Integration Study)



Offtake Available

Yes



Min Mine Life (Yrs)

25



Pre-tax IRR:

23% (August 2022)



Capital Cost:

A\$604m (August 2022)



Pre-tax NPV_{8%}:

A\$942m (August 2022)



Product & Annual Production Rate:

- High-purity vanadium pentoxide (V_2O_5) +99% purity: 12,500tpa
- Ilmenite (TiO_2): approximately 96,500tpa in the first nine years



Richmond – Julia Creek Vanadium

Richmond Vanadium Technology Ltd

ASX:RVT • richmondvanadium.com.au

Investment summary

One of the largest undeveloped oxide vanadium resources in the world which can produce globally significant supply for the steel and emerging energy storage markets. A BFS is underway in parallel with an EIS, with both due for completion by Q4 2024. The EIS will lead to grant of a Mining Lease over ground where Native Title has been extinguished. The BFS may offer several development options with the Company welcoming discussions on financing or offtake agreements.

Project description

The Project has many differentiators, including a very large Mineral Resource and Ore Reserve, minimal environmental impact, progressive rehabilitation, low capex, conventional processing, non-toxic waste and a long mine life. The deposit commences from surface and is hosted in soft marine sediments, making it amenable to low-strip, open-cut, free-dig mining. The 2021 PFS was based on mining 4.2Mtpa and on-site processing in North Queensland to produce 790,000tpa vanadium concentrate (12,700tpa contained V_2O_5) exported via Townsville, with recovery of vanadium pentoxide flake by offshore customers. Metallurgical testwork has been undertaken and a provisional patent application lodged covering the method for vanadium extraction. RVT's vision is to be mining, concentrating and producing high-purity vanadium in Australia, over the fence from electrolyte and battery makers. This is aligned with the vision of the Queensland Government who are building a common user facility and funding construction of the CopperString 2023 electricity transmission line. RVT has adopted the World Economic Forum's ESG framework to guide its progress at the Project.

Commodity(ies):	Vanadium		
Mineral Resources as at December 2019 (0.30% V ₂ O ₅ cut-off):	Resource Category	Tonnes (Mt)	V ₂ O ₅ (%)
	Indicated – Lilyvale	430	0.50
	Inferred – Lilyvale	130	0.41
	Inferred – Rothbury	1,202	0.31
	Inferred – Manfred	76	0.35
	Total	1,838	0.36
	Contained (Kt)		6,650
Ore Reserves as at January 2020 (0.30% V ₂ O ₅ cut-off):	Reserve Category	Tonnes (Mt)	V ₂ O ₅ (%)
	Probable	459	0.49
	Total	459	0.49
	Contained (kt)		2,250



Project Status

Pre Feasibility Study (Updated August 2021)
(Based on production of vanadium concentrate in Australia with recovery of vanadium pentoxide by offshore customers)



Offtake Available

60%



Min Mine Life (Yrs)

25 with potential for 100+



Post-tax IRR (First 25 years):

38% at US\$9.60/lb V_2O_5 price (August 2021)



Capital Cost:

US\$176.8m (August 2021)



Post-tax NPV_{10%}:

US\$448m at US\$9.60/lb V_2O_5 price (August 2021)



Product & Annual Production Rate:

• **Vanadium concentrate (1.82% V_2O_5):** 790,000tpa, (12,700tpa contained vanadium pentoxide flake (V_2O_5))



Victory Bore Project

Surefire Resources NI

ASX:SRN • surefireresources.com.au

Investment summary

The Victory Bore project contains over 465Mt of JORC resource vanadium in titanomagnetite, located near existing infrastructure and has completed PFS. A simple open-cut mining and beneficiation operation is planned at the mine site with downstream processing of magnetite in the Kingdom of Saudi Arabia (KSA), lowering emissions and operating costs. An MOU with the Ministry of Investment in KSA signed for downstream development. A Mining License application is in place with environmental and Native Title surveys completed with no impediments. The Company seeks development partners in Australia and KSA and is reviewing offtake agreements and investment.

Project description

- Updated Mineral Resource of 465Mt @ 0.30% V_2O_5 , 5.1% TiO_2 and 17.7% Fe (Measured, Indicated and Inferred Resources) was reported in accordance with the JORC Code (2012).
- Flagship Project located close to existing infrastructure with direct transport links to Geraldton Port in WA.
- The operation will involve optimal mining rate of 4Mtpa of ore to produce approximately 1.25Mtpa of high-grade magnetite concentrate, processed into six end products.
- Mining and magnetite concentration will occur at Victory Bore, with magnetite concentrates shipped to KSA for downstream processing into final high-value end products.
- Standard open-cut mining methods: low strip ratio (<0.9:1), drill and blast, load and haul
- Downstream processing will use traditional methods with modern applications and advanced flow processing.
- Processing in KSA enables lower operating and capital costs with proximity to markets. The KSA Government has proposed downstream processing in an industrial hub specifically for ferro-alloy processing.

Commodity(ies):	Vanadium, Titanium							
Mineral Resources as at December 2023 (0.15% V_2O_5 cut-off)	Resource Category	Volume (Mbcm)	Tonnes (Mt)	V_2O_5 (%)	TiO_2 (%)	Fe (%)	Al_2O_3 (%)	SiO_2 (%)
	Measured	7.6	25.3	0.35	4.96	19.20	17.0	34.9
	Indicated	33.9	113.2	0.32	4.70	18.19	17.4	35.9
	Inferred	99.3	326.1	0.28	5.28	17.41	16.0	36.4
	Total	140.7	464.6	0.30	5.12	17.70	16.4	36.2
Reserve as at December 2023 (0.15% V_2O_5 cut-off)	Reserve Category	Tonnes (Mt)	V_2O_5 (%)	TiO_2 (%)	Fe (%)			
	Probable	93	0.35	5.2	19.8			

Note: Resources at a 0.15% V_2O_5 cut-off.



Project Status

Pre Feasibility Study
(December 2023)



Pre-tax IRR:

42% (December 2023)



Product & Annual Production Rate:

• 1.25Mtpa of vanadium-titanium magnetite concentrate to produce:

- High-purity vanadium: 2,580tpa
- Ferrovandium: 5,760tpa
- Titanium slag: 192,880tpa
- Pig iron: 364,480tpa
- High-purity iron oxide pigment: 245,480tpa
- High-grade iron ore: 245,480tpa



Offtake Available

Yes



Capital Cost:

US\$498m



Min Mine Life (Yrs)

24



Pre-tax NPV_{10%}:

US\$1.2b (December 2023)



Windimurra

Atlantic Vanadium Pty Ltd

Unlisted Private Company • atlanticptyltd.com.au

Investment summary

Atlantic Vanadium (AVPL) owns 100% of the world-class Windimurra vanadium project. AVPL is completing an updated DFS for the Windimurra project development and expects to make a FID for the project development mid 2024. Windimurra has all development approvals in place. AVPL is currently in advanced discussions with prospective project financiers and strategic offtake partners for the Windimurra project, however AVPL welcomes interest from prospective project financiers and offtake partners.

Project description

Windimurra will be the world's next major primary vanadium producer leveraging significant existing infrastructure at the project site. In particular, Windimurra enjoys the following competitive advantages:

- Significant historic investment, making it the lowest capital intensity primary vanadium project development in the world.
- Redevelopment works consist of new milling and beneficiation plant, and recommissioning of existing infrastructure, plant and equipment.
- All critical infrastructure (roads, mine pit, gas pipeline, kiln, power station, village) already constructed and under care and maintenance.
- Ore Reserves deliver an initial 31-year mine life with upside through additional large Mineral Resources.
- Attractive economics based on low strip ratio, legacy investment, proven extraction process, and long mine life.
- Attractive vanadium market fundamentals with forecast strong vanadium demand growth driven by Chinese rebar standards and vanadium flow battery demand.

The Windimurra project will produce a high-purity V_2O_5 flake product utilising proven open-cut mining and vanadium production processes including ore milling, magnetic separation, salt roasting, leaching, and vanadium recovery to produce the final product. AVPL continues to investigate and develop downstream processing options in anticipation of becoming a vertically integrated vanadium flow battery producer.

Commodity(ies):	Vanadium		
Mineral Resources as at December 2019 (0.28% V_2O_5 cut-off)	Resource Category	Tonnes (Mt)	V_2O_5 (%)
	Measured	34.6	0.49
	Indicated	123.5	0.50
	Inferred	51.6	0.50
	Total	209.7	0.50
	Contained (kt)		1,048
Ore Reserves as at December 2019 (0.28% V_2O_5 cut-off, DFS 2020)	Reserve Category	Tonnes (Mt)	V_2O_5 (%)
	Proved		
	Probable	87.5	0.49
	Total	87.5	0.49
	Contained (kt)		429



Project Status

Care and Maintenance
(Feasibility Study Completed April 2020.
Updated DFS underway targeting completion in late 2023)



IRR:

Expected late 2023



Product & Annual Production Rate:

• High-purity V_2O_5 flake:
7,600tpa



Offtake Available

100%



Capital Cost:

Expected late 2023



NPV:

Expected late 2023



Min Mine Life (Yrs)

31

Zirconium

Projects

Avonbank	89
Cyclone	90





Avonbank

WIM Resource Pty Ltd

Unlisted Private Company • wimresource.com.au

Investment summary

Avonbank is Tier 1, world-class zircon-rich heavy mineral sands project, with proven & probable reserves underpinning a 36-year operation. WIM completed the Environmental Effects Statement (EES) in 2023, and Avonbank secondary approvals and a Mining Licence are on track to bring the Project to a shovel-ready stage by late 2024. The EES studies demonstrated that no significant adverse environmental or social impacts will occur. The EES studies showed that there will be a significant positive economic impact for Victoria, as Avonbank will create 1000 FTE jobs per annum for 36 years. WIM Resource Pty Ltd welcomes discussions regarding product offtake or financing of Avonbank.

Project description

Avonbank Project will be the single largest approved zircon mine in Victoria, when approved and will be regarded as a Tier 1 zircon mine globally, based on its mine life, exceptional revenue to cost ratio, and return on investment. Avonbank will involve the mining of 10Mtpa of ore from a shallow, low strip ratio, open-pit mine using dry mining with a rapid rehabilitation method, that will return land back to its pre-mining state within four years. A Trial Mine & Demonstration Scale Wet Concentration Plant has successfully demonstrated the ore is amenable to standard mineral sands gravity separation using conventional. Detailed downstream demonstration and product quality assessment trials have also been successfully completed. WIM has built a strong 'social and environmental license', having successfully rehabilitated the Avonbank Trial Mine within two years of mining, back to a productive broad acre agricultural crop.

Commodity(ies):	Zirconium, Titanium , Rare Earth Elements								
Mineral Resources as at 31-Dec-2017 (1% THM cut-off)	Resource Category	Tonnes (mt)	Total HM (%)	Zircon	Rutile	Leuco-xene	Ilme-nite	Mona-zite	Xeno-time
	Measured	300	4.3	20	15	8.5	26	2.0	0.6
	Indicated	150	3.6	19	17	9.3	28	1.9	0.6
	Inferred	40	3.0	21	16	9.0	27	2.3	0.6
	Total	490	4.0	20	16	8.8	27	2.0	0.6
	Contained (kt)		19,600	3,920	3,136	1,725	5,292	392	118
Ore Reserves as at 1-Jun-18 (1% THM cut-off)	Reserve Category	Tonnes (mt)	Total HM (%)	Zircon	Rutile	Leuco-xene	Ilme-nite	Mona-zite	Xeno-time
	Proved	220.4	4.4	20.2	14.9	8.4	26.4	2.0	0.6
	Probable	91.4	4.0	19.3	16.9	9.1	28.5	2.0	0.6
	Total	311.8	4.3	19.9	15.4	8.6	27.0	2.0	0.6
	Contained (kt)		13,407	2,668	2,065	1,153	3,620	268	80

Note: Valuable Heavy Mineral grades are reported as a percentage of THM



Project Status
Feasibility Study
(Feb 2021)



IRR:
Please contact WIM Resource for further information.



Product & Annual Production Rate:
• **Heavy mineral concentrate** (30% Zircon, 55% Titanium and <2.5% Rare Earths by-products): 500,000tpa



Offtake Available
100%



Capital Cost:
Please contact WIM Resource for further information.



Min Mine Life (Yrs)
42



NPV:
Please contact WIM Resource for further information.



Cyclone

Diatreme Resources Ltd

ASX:DRX • diatreme.com.au

Investment summary

Cyclone is an attractive investment opportunity amid the lack of suitable high-grade zircon supply. Diatreme is engaging in discussions and negotiations with a range of potential project partners including offtakers and technical partners, with the aim of either selling the Project or funding the development of this high-grade zircon project located in WA's zircon-rich Eucla Basin. The Project is 'shovel-ready' with primary approvals and permitting in place, including environmental and First Nations approvals. With a structural supply deficit of zircon projected amid shrinking supply and rising demand, Cyclone is an attractive opportunity for a development partner to advance Australia's zircon production for the global market, supporting the growth of this critical mineral industry.

Project description

Cyclone has the potential to become a significant global supplier of zircon, accounting for an estimated 6% of global zircon supply. Cyclone also contains titanium minerals such as leucoxene, rutile and ilmenite and has potential for supply of the rare critical mineral hafnium within the zircon component of its heavy mineral concentrate (HMC). Shallow free-dig mining using a bulldozer and dozer trap method with progressive rehabilitation as the pit advances, will mine approximately 10Mtpa ore supplied to a wet concentrator plant (WCP) on-site. The WCP will process the sand via several stages of gravity concentration using spirals, classifiers and shaking tables producing a HMC. Life of mine production is estimated at 1.94Mt of HMC containing 936kt of zircon and producing 772kt of final zircon product.

Commodity(ies):	Zircon, Titanium, Hafnium								
Mineral Resources as at 31 December 2021 (1% HM cut-off grade):	Resource Category	Tonnes (Mt)	Total HM (%)	Zircon (% HM)	Rutile (% HM)	Leucoxene (% HM)	HiTi (% HM)	Altered Ilmenite (% HM)	Siliceous Ti-oxide (% HM)
	Measured	156	2.4	28	3	6	24	12	22
	Indicated	48	1.9	21	2	5	33	16	18
	Total	203	2.3	27	3	6	26	13	21
	Contained (kt)		4,669	1,262	140	280	1,214	607	980
Ore Reserves as at 31 December 2021:	Reserve Category	Tonnes (Mt)	Total HM (%)	Zircon (% HM)	Rutile (% HM)	Leucoxene (% HM)	HiTi (% HM)	Altered Ilmenite (% HM)	Siliceous Ti-oxide (% HM)
	Probable	138	2.6	28	3	7	23	13	22
	Total	138	2.6	28	3	7	23	13	22
	Contained (kt)		3,588	1,005	108	251	825	466	789

Note: Valuable Heavy Mineral grades are reported as a percentage of THM.



Project Status

Feasibility Study
(November 2018)



Offtake Available

Yes



Min Mine Life (Yrs)

13.2



Post-tax IRR:

27.2%
(November 2018)



Capital Cost:

A\$135m (November 2018)



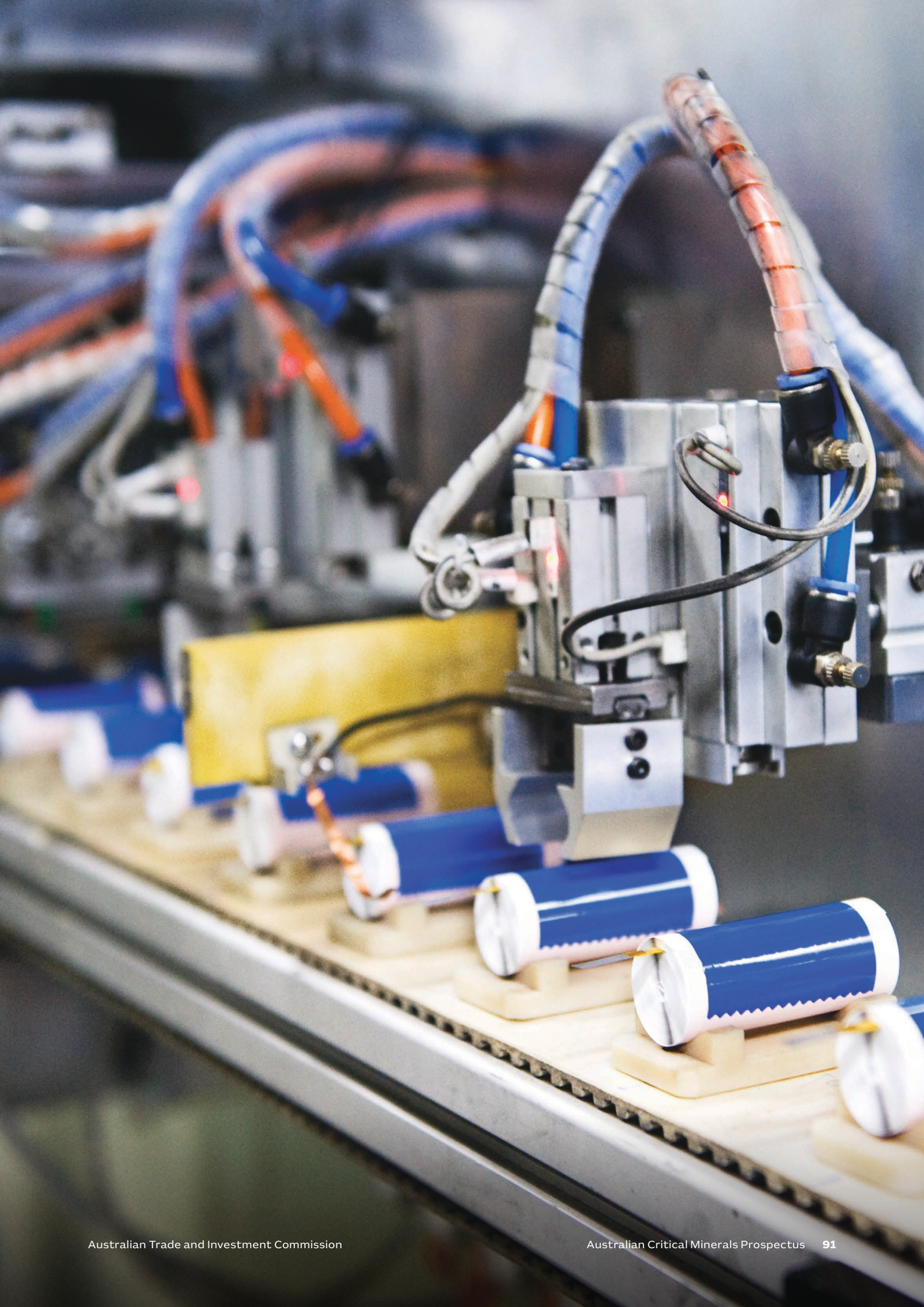
Post-tax NPV_{10%}:

A\$113m (November 2018)



Product & Annual Production Rate:

• **HHMC:** 147ktpa
(containing 59ktpa Zircon,
9ktpa HiTi87, 49ktpa
HiTi67)



Developing the midstream

Australia is an increasingly popular destination for midstream processing. A collaborative and supportive ecosystem in addition to a highly educated workforce means that there are significant reasons to develop Australia's capability in midstream processing.

Below is a non-exhaustive list of advanced Australian midstream projects that exemplify critical minerals processing in Australia.

Cobalt projects for the battery market

Kwinana Cobalt Refinery – Cobalt Blue Holdings Ltd (ASX:COB)

Cobalt Blue plans to produce cobalt sulphate for the battery market at its Kwinana Cobalt Refinery. An updated PFS was completed in 2020 based on; (a) mining and production of an intermediate mixed nickel-cobalt hydroxide precipitate (MHP) at Cobalt Blue's Broken Hill Cobalt Project located 25km south-west of Broken Hill, NSW, and (b) further processing to produce battery-grade cobalt sulphate and a sulphur by-product, now planned to be undertaken at the Kwinana Cobalt Refinery along with processing of third party nickel-cobalt ore. A DFS on the Kwinana Refinery is underway targeting FID and construction commencement in 2024 and Stage 1 commissioning in 2025.

- **Forecast production of 3.0ktpa cobalt sulphate (Stage 1) increasing to 7.5ktpa cobalt sulphate (Stage 3).**



NiWest Project – Alliance Nickel Ltd (ASX:AXN)

Alliance Nickel plans to produce cobalt sulphate and nickel sulphate for the battery market at its NiWest project located ~300km north-east of Kalgoorlie. A PFS was completed in 2022 based on mining shallow laterite ore and on-site processing using heap leaching, solvent extraction, and crystallisation to produce battery-grade nickel sulphate and cobalt sulphate.

- **Forecast production of 90ktpa nickel sulphate and 6.8ktpa cobalt sulphate.**



Rover 1 Project – Castile Resources Ltd (ASX:CST)

Castile plans to produce 99% purity cobalt and copper metal for direct sale to battery manufacturers at its Rover 1 project located 67km south-west of Tennant Creek. A PFS was completed in 2022 based on mining and on-site processing to produce 99% purity cobalt and copper metal, gold doré, and 96% purity magnetite.

- **Forecast production of 0.3ktpa cobalt metal, 6.9ktpa copper metal, 28.7kozpa gold doré, and 75.3ktpa magnetite.**



Sconi Project – Australian Mines Ltd (ASX:AUZ)

Australian Mines plans to produce cobalt sulphate and nickel sulphate for the battery market at its Sconi Project located ~220km north-west of Townsville. Following a BFS completed in 2019 on mixed nickel-cobalt hydroxide precipitate (MHP) production, Australian Mines is now targeting production of cobalt sulphate and nickel sulphate, as well as high-purity scandium oxide from shallow lateritic ore mined and processed on-site at Sconi. Australian Mines is targeting FID in 2026 and commissioning in 2028.



- **Forecast production of 47ktpa nickel sulphate, 7ktpa cobalt sulphate, and 74tpa scandium oxide.**

Sunrise Project – Sunrise Energy Metals Ltd (ASX:SRL)

Sunrise plans to produce cobalt sulphate and nickel sulphate for the battery market at its Sunrise project located ~350km west-northwest of Sydney. A Project Execution Plan (Feasibility Study update) was completed in 2022 based on mining shallow lateritic ore and on-site processing using pressure acid leaching (PAL), solvent extraction, and crystallisation to produce battery-grade nickel sulphate and cobalt sulphate as well as high-purity scandium oxide.



- **Forecast production of 97ktpa nickel sulphate, 21ktpa cobalt sulphate, and 18tpa scandium oxide.**

Townsville Energy Chemicals Hub (TECH) – Queensland Pacific Metals Ltd (ASX:QPM)

QPM plans to produce cobalt sulphate and nickel sulphate for the battery market as well as high-purity alumina and hematite pellets at its Townsville Energy Chemicals Hub (TECH). A Feasibility Study was completed in 2022 on processing imported laterite ore from New Caledonia in the TECH plant incorporating a sulphate refinery to produce battery-grade cobalt sulphate and nickel sulphate, an HPA refinery to produce high purity alumina (4N HPA), and a hematite pellet plant to produce hematite pellets. Binding offtake agreements are in place with General Motors, LG Energy Solutions, and POSCO for nickel and cobalt products. Significant progress made on construction funding working towards FID and all major project approvals are in place.



- **Forecast production of 16ktpa (metal content) nickel sulphate, 1.8 (metal content) ktpa cobalt sulphate, 4ktpa high purity alumina, and 600+ ktpa hematite pellets.**

Lithium hydroxide production for the battery market

Kemerton Lithium Hydroxide Processing Plant – Albemarle Corporation

Albemarle has recently completed construction of two processing trains at its Lithium Hydroxide Plant in Kemerton near Bunbury and approved the construction of two additional trains. With four trains at full capacity, the plant will annually process 1m tonnes of spodumene concentrate from Talison Lithium's Greenbushes mine, producing up to 100,000 metric tonnes of battery-grade lithium hydroxide per year, making it the biggest lithium processing operation in the world.



- **Forecast production is 50ktpa currently being expanded to 100ktpa of battery-grade lithium hydroxide.**

Kwinana Lithium Hydroxide Refinery – Tianqi Lithium Energy Australia (Tianqi Lithium Corp/IGO Ltd JV)

Australia's first battery-grade lithium hydroxide was produced in May 2022 in the Kwinana Industrial Area, using feedstock from the Talison Lithium Mine in Greenbushes. The plant, which is a JV between Tianqi and IGO, plans to supply global customers producing rechargeable batteries for the EV and energy storage industries.



- **Forecast production is 24,000tpa of battery grade lithium hydroxide from each production train. The first train is commissioned with ramp-up underway and front-end engineering and design (FEED) completion for the second train targeted in mid 2024.**

Kwinana Lithium Hydroxide Refinery – Covalent Lithium (Sociedad Química y Minera de Chile S.A. (SQM)/Wesfarmers Ltd JV)

In July 2021, Covalent commenced construction of the Kwinana Lithium Hydroxide Refinery in the Kwinana Industrial Area which will produce battery-grade lithium hydroxide from spodumene concentrate supplied from its Mt Holland Mine and Concentrator currently being commissioned. Construction of the Kwinana Refinery is underway with first production of lithium hydroxide expected in H1 CY25.



- **Forecast production is 50ktpa of battery-grade lithium hydroxide.**

Precursor cathode active material (pCAM) projects for the battery market

Mt Thirsty Project – Greenstone Resources Ltd (ASX:GSR) and Conico Ltd (ASX:CNJ) JV

The Mt Thirsty Project, located ~170km south of Kalgoorlie, aims to become Australia's first fully integrated cathode precursor producer. Following a PFS completed in 2020 on mixed nickel-cobalt hydroxide precipitate (MHP) production, a new Scoping Study is nearing completion based on mining shallow laterite ore and on-site processing in a fully integrated cathode precursor and sulphate production plant using high-pressure acid leaching, solvent extraction and crystallisation to produce cathode precursor, cobalt sulphate, nickel sulphate, and manganese sulphate products for the battery market.



- **Forecast production rates to be included in the Scoping Study expected to be completed in late 2023.**

Precursor cathode active material (pCAM) projects for the battery market

WA pCAM Hub – Pure Battery Technologies

Pure Battery Technologies plans to build a precursor cathode active material (pCAM) Hub refinery in the Kalgoorlie-Coolgardie region of WA. The WA pCAM Hub will be an integrated nickel manganese cobalt battery material refinery. The project Feasibility Study is progressing.

- **Forecast production of 50ktpa precursor cathode active material (pCAM) expandable to 100ktpa within 5 years.**



Battery anode material (BAM) production projects

Battery Anode Material Facility – EcoGraf Ltd (ASX:EGR)

EcoGraf plans to develop a vertically integrated processed graphite business including developing a mine a concentrator at its Epanko project in Tanzania and a battery anode material (BAM) processing facility in Australia. The BAM Facility Update (Feasibility Study update) was completed in 2022 on processing of Epanko Graphite Concentrate to produce purified spherical graphite (PSG) using EcoGraf's proprietary hydrofluoric acid-free processing technology. A Product Qualification Facility (demonstration plant) is currently being constructed near Perth, WA. Testwork is also underway aiming to develop a solution for recycling battery anode scrap. EcoGraf has a A\$40m conditionally approved loan to develop the Project from the Australian Government's Critical Minerals Facility.

- **Forecast production is 20ktpa PSG.**



Battery Anode Material Facility – Renascor Resources Ltd (ASX:RNU)

Renascor Resources plans to develop a vertically integrated processed graphite operation in SA with graphite concentrate to be supplied from its Siviour mine and concentrator on Eyre Peninsular and a battery anode material (BAM) processing facility in Bolivar. The BAM Feasibility Study was completed in 2023 with Stage 1 based on processing of ~75,000tpa of Siviour Graphite Concentrate to produce purified spherical graphite (PSG). Renascor has a A\$185m conditionally approved loan to develop the Project from the Australian Government's Critical Minerals Facility.

- **Forecast Stage 1 production 50ktpa PSG.**



Collie Graphite Hub – International Graphite Ltd (ASX:IG6)

International Graphite is developing a vertically integrated processed graphite operation in WA with its graphite processing hub at Collie and graphite mine and concentrator at Springdale. A pilot plant was commissioned at Collie in 2022 and has successfully produced micronised and spheroidised graphite. A Feasibility Study was completed in 2023 for a 4ktpa commercial micronising facility expected to be operational in 2024. Also in 2023, a Scoping Study was completed on a large-scale Battery Anode Material (BAM) Facility at Collie which will process 40ktpa graphite concentrate to produce coated spheroidised purified graphite (CSPG) for use in lithium-ion batteries.

- **Forecast production of 4ktpa micronised graphite in Stage 1 and 20ktpa CSPG and 17ktpa micronised graphite by product in Stage 2.**



REE oxide production projects to power our renewable energy future

Dubbo Project – Australian Strategic Materials Ltd (ASX:ASM)

Australian Strategic Materials plans to build a vertically integrated mine and processing plant located 25km south of Dubbo, NSW to produce individual rare earth oxides (NdPr oxide, Tb oxide, Dy oxide), zirconia, ferroniobium and hafnium oxide on-site. ASM completed its Dubbo Project Optimisation Study (Feasibility Study update) in late 2021. Stage 1 engineering, procurement, and construction definition (EPCD) work for the Dubbo Project was completed in 2023 and non-process infrastructure study work to advance the engineering maturity of the design in key areas outside of the process plant was recently commenced, which will contribute to ASM making FID on the Dubbo Project.



- **Forecast production of 1.342ktpa NdPr oxide, 22tpa Tb oxide, 142tpa Dy oxide, 16ktpa zirconia, 2.65ktpa ferroniobium, and 30tpa hafnium oxide**

Eneabba Rare Earths Refinery – Iluka Resources Ltd (ASX:ILU)

Iluka is building Australia's first fully integrated rare earths refinery at Eneabba in WA. The refinery receives funding via a loan under the Australian Government's Critical Minerals Facility. Early construction works for the Eneabba refinery commenced in late 2022 with Front-End Engineering Design (FEED) progressing in 2023, targeting commissioning in late 2025. The Eneabba Refinery will produce individual rare earth oxides initially from concentrate produced at Iluka's 1Mt rare Eneabba earths stockpile. Thereafter, it will be fed by rare earths from Iluka's Australian operations and from third parties including the Northern Minerals Browns Range project. Iluka is also undertaking a PFS into rare earth metallisation – the next step in the value chain.



- **Forecast production of 17.5ktpa – 23ktpa rare earth oxides.**

Nolans Rare Earths Project – Arafura Resources Ltd (ASX:ARU)

Arafura is developing the Nolans Rare Earths Project 135km north of Alice Springs, NT. The Nolans deposit is particularly endowed in the 'magnet feed' rare earths neodymium and praseodymium (NdPr). Early construction works for the Project commenced in the first half of CY2023, with Arafura targeting financial contractual close in the first quarter of CY2024. The Project will encompass all mining and production of NdPr Oxide at a single site. Arafura has binding offtake agreements in place with Hyundai and Kia, and Siemens Gamesa Renewable Energy.



- **Forecast production of 4.4ktpa NdPr oxide, 0.47ktpa HRE carbonate, and 144ktpa phosphoric acid by product.**

High purity alumina projects

HPA First Project – Alpha HPA Ltd (ASX:A4N)

With growing global demand for high purity aluminium products for application in LED lighting, synthetic sapphire, semiconductors, and lithium-ion battery industries, Alpha HPA is committed to supplying the world's most pure and sustainable ultra-high purity aluminium materials to market. Stage 1 of the HPA First Project located in Gladstone entered commercial production of Al-nitrates in November 2022, and will enter small-scale commercial production of high purity alumina powders, and pellets; high-purity boehmite (alumina-hydroxide); high-purity aluminium precursors (Al-sulphates) from December 2023. From February 2024, the facility will produce synthetic sapphire from their high purity alumina pellets. Stage 2 production is planned for 2026, representing a large-scale commercial production facility of these products.



- **Forecast production of ~0.3ktpa Al-nitrates and Al-sulphates, 10-15tpa HPA and boehmites and 7tpa synthetic sapphire in its Stage 1 facility. This will increase to ~13ktpa in the Stage 2 facility.**

Premium HPA Project – Cadoux Ltd (ASX:CCM)

Cadoux plans to build a vertically integrated high purity alumina (HPA) business in WA including mining from its Cadoux kaolin project and construction of its HPA Production Plant located in the Kwinana Industrial Area. A Feasibility Study was completed in 2021 based on producing premium quality HPA (>99.99% Al_2O_3 purity) from a commercial scale production plant at Kwinana using Cadoux's innovative hydrochloric acid leach and precipitation process. Engineering design is currently underway for a small-scale 1,000tpa demonstration plant which Cadoux now plans to build and operate as the first stage of its Premium HPA Project.



- **Forecast production of 1ktpa Premium Quality HPA in Stage 1 demonstration plant increasing to 10ktpa Premium Quality HPA in the Stage 2 commercial scale plant.**

Vanadium oxide projects

Australian Vanadium Project – Australian Vanadium Ltd (ASX:AVL)

AVL plans to develop its Australian Vanadium Project in WA. A BFS was completed in 2022 based on; (a) production of vanadium concentrate from a mine and beneficiation plant located 43km south of Meekatharra, and (b) further processing in a Processing Plant located near Geraldton using an alkaline roast leach and ammonium metavanadate extraction process to produce a high-purity V_2O_5 product. In Nov 2023, Technology Metals Australia (ASX:TMT) lodged a Scheme of Arrangement with ASIC under which AVL would acquire TMT. If approved the merger would create a leading Australian vanadium developer with a world-class asset of scale.



- **Forecast production of 11.2ktpa high-purity vanadium pentoxide (V_2O_5) and 900ktpa FeTi (54% Fe) co-product.**

Vanadium oxide projects

Murchison Technology Metals Project – Technology Metals Australia Ltd (ASX:TMT)

Technology Metals Australia (TMT) plans to develop its Murchison Technology Metals Project in WA. In 2022, an Integration Study was completed based on mining its Gabanintha and Yarrabubba vanadium deposits located ~40km south of Meekatharra and on-site processing using beneficiation, salt roasting and leaching to produce high-purity (>99%) vanadium pentoxide (V_2O_5) and ilmenite (TiO_2) products. In Nov 2023, TMT lodged a Scheme of Arrangement with ASIC under which Australian Vanadium Ltd (ASX:AVL) would acquire all the shares in TMT. If approved by shareholders, the merger would create a leading Australian vanadium developer with a world-class asset of scale.



- **Forecast production of 12.5ktpa high-purity vanadium pentoxide (V_2O_5) and 96.5ktpa ilmenite (TiO_2).**

Windimurra Vanadium Project – Atlantic Vanadium Pty Ltd

Atlantic Vanadium Pty Ltd (Atlantic) plans to become the world's next major primary vanadium producer through re-development of its Windimurra Vanadium Project, located 80km south-east of Mount Magnet in the Midwest Region WA. Atlantic is currently updating the Windimurra Feasibility Study completed in 2020 based on construction of a new milling and beneficiation plant, and recommissioning of existing project infrastructure, plant, and equipment. The Project will produce high-purity vanadium pentoxide (V_2O_5) flake using a magnetic separation, salt roasting, leaching, and vanadium recovery process. Atlantic is targeting FID on project development in mid 2024.



- **Forecast production of 7.6ktpa high-purity vanadium pentoxide (V_2O_5) flake.**

Magnesium metal projects

Latrobe Valley Magnesium Project – Latrobe Magnesium Ltd (ASX:LMG)

Latrobe is constructing its Magnesium Demonstration Plant in the Latrobe Valley, VIC to produce 99.9% purity magnesium metal from Yallourn power station flyash feedstock. Latrobe are targeting commissioning of the Demonstration Plant by March 2024. Following successful commissioning of the Demonstration Plant, Latrobe plans to complete a Feasibility Study on building an Australian Commercial Plant producing 10,000tpa plus magnesium metal in the Latrobe Valley from Yallourn flyash.



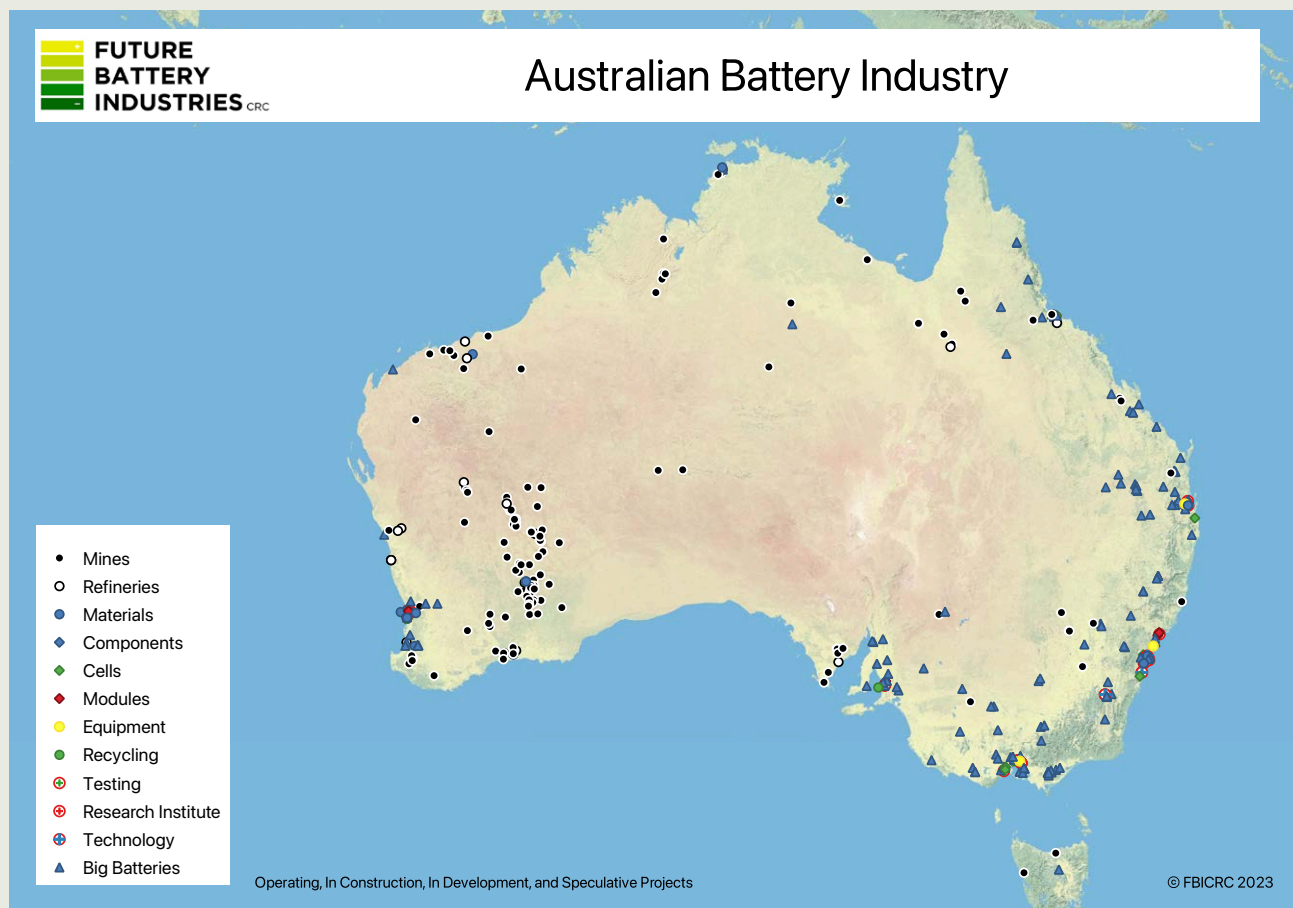
- **Forecast production of 1ktpa magnesium metal in Demonstration Plant increasing to 10ktpa magnesium metal in the Australian Commercial Plant (subject to Feasibility Study results).**

Scandium oxide projects

Nyngan Scandium Project – Scandium International Mining Corp. (TSX:SCY)

SCY plans to produce scandium oxide for use in solid-oxide fuel cells, 3D printing, and aluminium-scandium master alloys from its Nyngan Scandium Project in NSW. A Feasibility Study was completed in 2016 based on mining the shallow Nyngan lateritic clay deposit and on-site processing using high-pressure acid leaching (HPAL), solvent extraction and calcine finish to produce a saleable scandium oxide product. A pilot testwork program was also completed in 2020 on production of aluminium-scandium master alloy from scandium oxide using SCY's proprietary process with a patent awarded to SCY in 2021.

- **Forecast production of 38tpa scandium oxide.**



Map courtesy of FBI CRC 2023



Spotlight on lithium

Lithium demand and overview

Lithium is needed to produce virtually all batteries currently used in EVs as well as consumer electronics. Lithium-ion (Li-ion) batteries are widely used in applications, from energy storage to air mobility.¹²

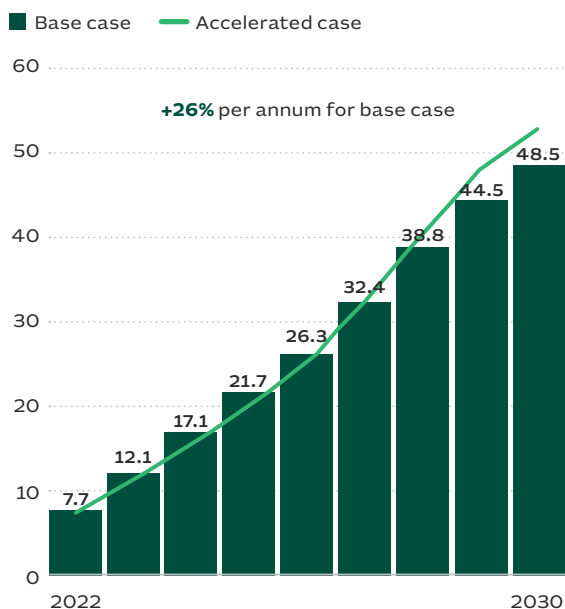
Over the last ten years we have seen the demand for lithium continue to grow in parallel with the rise of EVs. Overall, the global passenger EV market, which relies on lithium-based batteries, is expected to grow annually by 26% through to 2030. Globally, governments are trending towards green policies, which continue to drive the uptake of EVs and Li-ion batteries.¹³

These initiatives and others from the private sector are expected to increase the global demand for batteries by around 14 times the 2018 levels of 184 gigawatt hours (GWh), to more than 2,600GWh in 2030, according to a report by the World Economic Forum's Global Battery Alliance.¹⁴

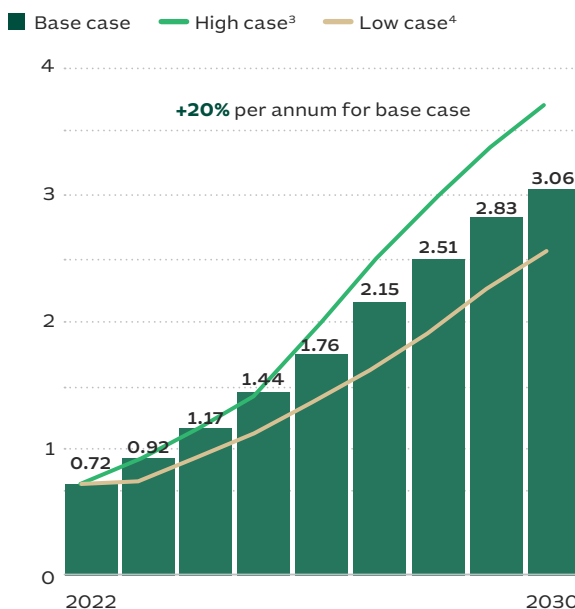
The challenge remains for industry to find a secure, safe, consistent, and reliable source of lithium to facilitate the change in the automobile and battery sector.

Electric vehicle production is growing 26% annually, resulting in lithium demand growth of 20% per annum

Projected battery-electric-vehicle (BEV) production by scenario,¹ million units



Projected refined lithium demand by scenario,² million tons of lithium carbonate equivalent (LCE)



1. Indicative; doesn't include hybrids, commercial vehicles, or 2 and 3 wheelers that also use lithium ion batteries.

2. High case scenario assumes that lithium (Li) metal anodes will start to be visible on the market as of 2026.

3. High case for Li demand is based on base BEV production case, with higher Li content for battery cells.

4. Low case for Li demand is based on slower BEV production case.

Source: McKinsey Battery Insights; McKinsey Center for Future Mobility; McKinsey MineSpans

12. McKinsey "Australia's potential in the Lithium Market"

13. McKinsey "How new production technology could fuel the Global EV Revolution"

14. Department of Industry, Science and Resources "Resource and Energy Quarterly 2023"

Australian lithium production and processing

Australia accounted for 50% of global lithium extraction in 2022, the majority of which is processed overseas. Nearly all of Australia lithium is hardrock and derived from spodumene deposits. 2022-2023 saw record Australian lithium exports of A\$20 billion, a significant increase from the previous record of A\$5 billion in 2021–22. The increase was driven by a near-tripling in prices over the period, as well as volumes of spodumene exports increasing by 46%.

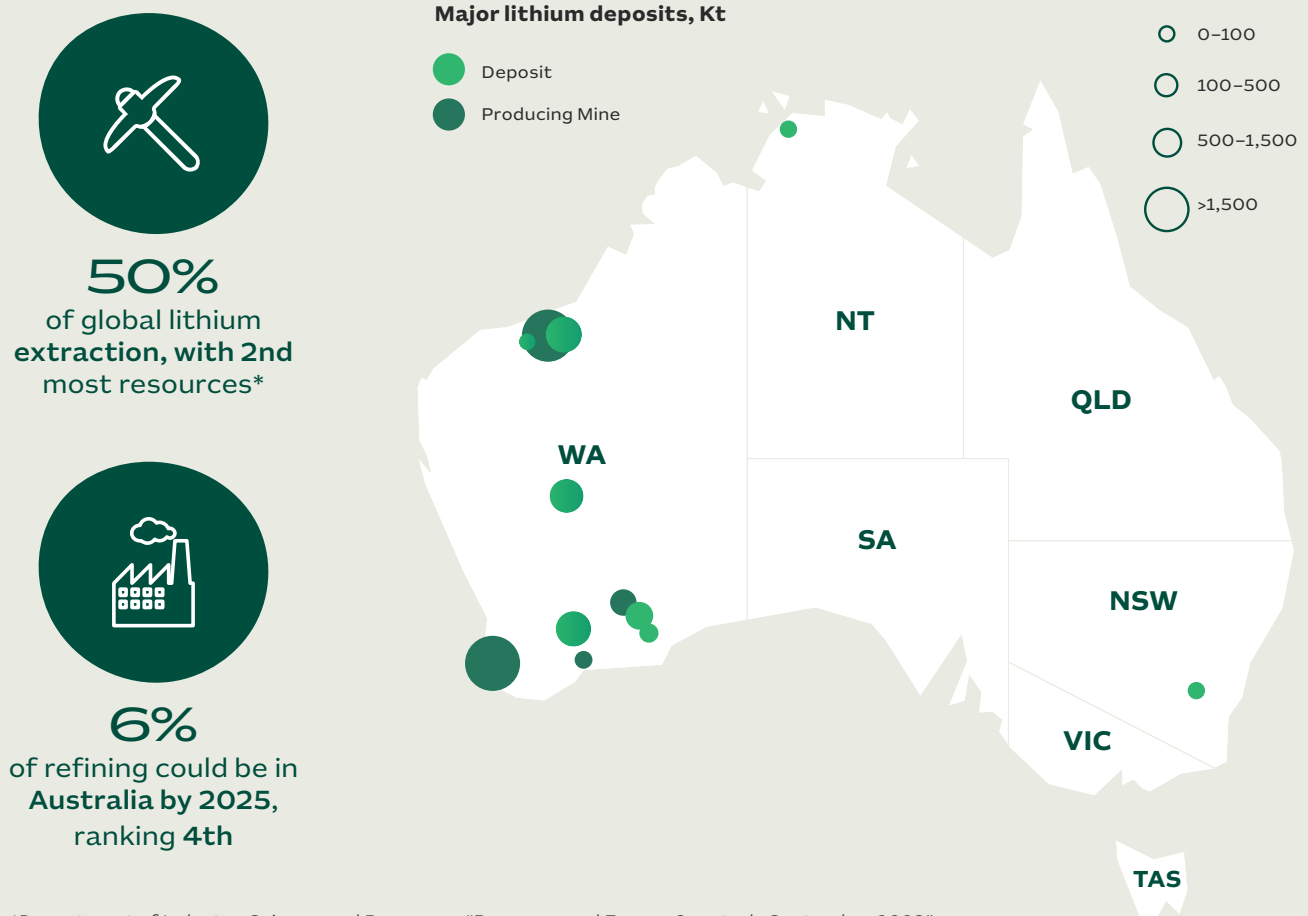
As seen in our *Developing the midstream* section the processing of lithium rock to lithium hydroxide is ramping up within Australia, leveraging Australian geological and geographical endowment to provide lower-cost lithium hydroxide. There are currently three lithium hydroxide refineries either operating or under development (two based in Kwinana and one in Kemerton).



“Emerging Australian lithium companies are witnessing a surge in buyouts as their lower valuations and cash needs attract some of the world’s top producers of the battery material and other suitors who are racing to secure supplies.”

– Reuters¹⁵

Australia’s lithium sector



*Department of Industry, Science and Resources “Resource and Energy Quarterly September 2023”

15. Reuters “Lithium buyers eye cheaper early-stage deals in Australia”

Business activity in lithium production and processing

Over the past five years, the Australian lithium mining industry has undergone a transformative journey, propelled by surging global demand for lithium-ion batteries. New mines have begun operating and the midstream capacity has grown.

This has seen demand from investors pick up as they engage at earlier stages along the value chain to target a lower market valuation. This is reshaping the lithium industry, witnessed by more investors moving further towards the ‘drill bit’ to acquire stakes in projects without the large premiums that are attached to operating or near-operating projects.

As the nation evolves into a key supplier, the industry’s rapid development underscores the urgency for investors to engage early in projects to capitalise on the growing demand for lithium and lithium products.

Integrated battery-electric-vehicle (BEV) production by scenario¹, million units

Weighted average cost breakdown for lithium hydroxide (LiOH) refining facilities, 2030¹, Real 2023 \$ per ton of lithium carbonate (LCE)



1. Inclusive of sustaining capital cost, freight.

2. Europe inclusive of UK.

3. Level of integration across mining and refinement players within each country (based off number of integrated players).

Source: McKinsey MineSpans

Consolidation and select investment deals (2023–ongoing)¹⁶

Date	Target	Acquirer	Stage of key project	Approximate Consideration	Details
Jun-23	Delta Lithium	Idemitsu	Exploration	A\$53m for 15% ¹	Minority Interest acquired by Japanese company Idemitsu, proceeds to further the Mt Ida Project
Jun-23	Western Lithium	Albermarle Lithium	Exploration	A\$30m ²	Purchase of Western Lithium's (subsidiary of Lithium Power International) WA based tenements
Oct-23	Liontown	Albermarle	Construction	A\$6.6b ³	Acquisition attempt by US company Albermarle to acquire WA based Liontown
Oct-23	Essential Metals	Develop Global	Exploration	A\$152.6m ⁴	Acquisition of Essential Metals by Develop Global, driving the Pioneer Dome project
Nov-23	Bald Hill	Mineral Resources	Operating	A\$260m ⁵	Purchase of Bald Hill from Alita Resources and its administrator
Ongoing	Allkem	Livent	Operating	A\$16b ⁶	Merger of equals to form Newco (Arcadium Lithium)
Ongoing	Azure Minerals	SQM/Hancock Prospecting	Exploration	A\$1.7b ⁷	Proposed joint acquisition of Azure Minerals by Chilean company SQM and Australian company Hancock Prospecting

1. Idemitsu “Press Release: Investment in Delta Lithium”

2. Lithium Power International “ASX Statement: A\$30m cash sale agreed for Western Lithium”

3. AFR “Albermarle walks away from \$6.6b Liontown bid”

4. Reuters “Australia’s Develop Global to acquire Essential Metals for US\$102 million”

5. AFR “MinRes pays \$260m for mine in WA lithium heartland”

6. The Australian “Allkem chairman Peter Coleman says outlook bright after shareholders approve Allkem’s \$16bn merger”

7. AFR “Rinehart joins forces with lithium giant SQM in \$1.7b Azure bid”

16. Various News Reports (Mining Australia, Reuters, The West, AFR)

Australia's lithium resource

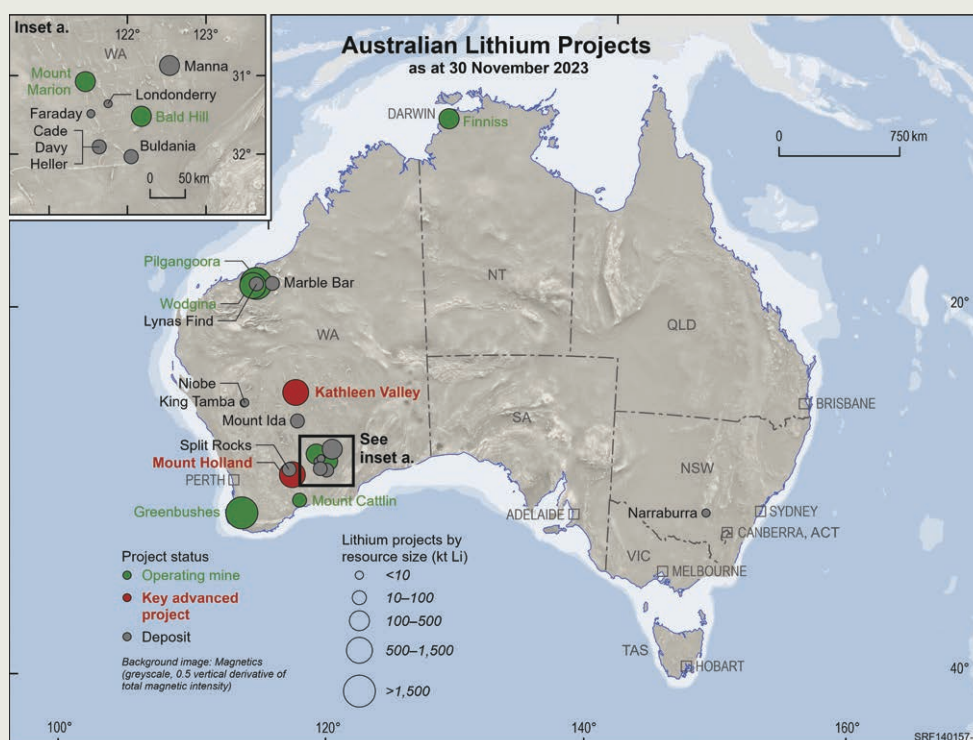
Australia is already the world's largest producer of spodumene concentrate, and has the second largest lithium ore reserves globally.

Australia is well placed to meet global demand, with many hard-rock, pegmatite-hosted lithium resources, largely in WA. These include a number of producing or developing deposits in western and northern Australia.

"As the world's largest producer of lithium, a key component in batteries for electric vehicles, our minerals sector has an enormous role to play in the success of the energy transition over the coming decades, ...Demand for battery minerals is surging with the uptake of electric vehicles and our lithium sector is going from strength to strength."

– Hon Madeleine King MP, Minister for Resources and Minister for Northern Australia, 6 March 2023

Australia and lithium



#2

Global ranking
for resource

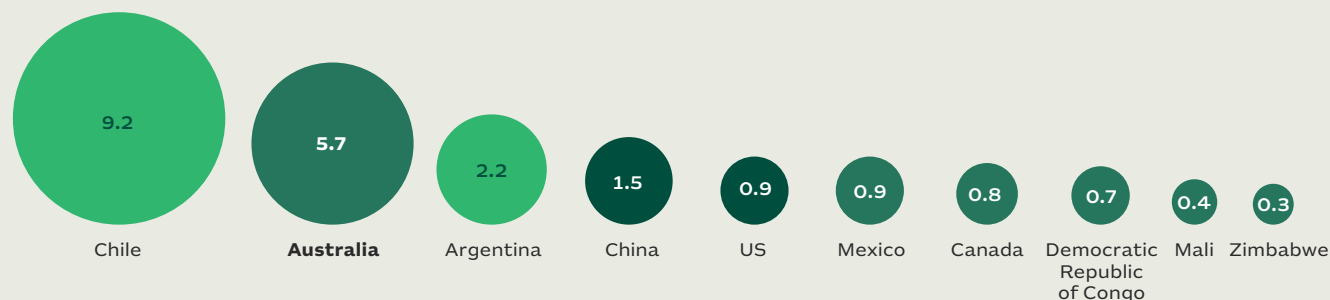


#1

Global ranking
for production

Top 10 countries with largest lithium reserves, million metric tonnes

● Brine ● Minerals ● Brine and minerals



Source: McKinsey and Company, United States Geological Survey; MineSpans

A pipeline of developing projects and opportunities

The lithium projects profiled below have a defined Mineral Resource and are intended to illustrate the burgeoning pipeline of opportunities that exist in Australia. The projects profiled below have a defined Mineral Resource and are intended to illustrate. This is not an exhaustive list, and there are more lithium projects than are listed below. Please note that two advanced lithium projects are also included in the main section of the Prospectus.

Bald Hill Lithium Mine

Mineral Resources Ltd (ASX:MIN)

In September 2023, Mineral Resources Ltd entered into an agreement with the Administrators of Alita Resources Ltd (Alita) to acquire the Bald Hill Lithium Mine located in the Eastern Goldfields region, 105km south-east of Kalgoorlie, WA. On 22 September 2023 the Supreme Court of WA ruled that the Administrators could proceed with placing Alita into liquidation to allow the acquisition to be implemented.

The Bald Hill Lithium Mine was placed on Care and Maintenance in 2019 when Alita Resources went into administration during a downturn in Lithium prices. At the time, Bald Hill had a remaining Total Mineral Resource of 26.5Mt @ 1.0% Li₂O and 149ppm Ta₂O₅ along with an additional tantalum resource of 4.4Mt @ 336ppm Ta₂O₅. Ore Reserves prior to closure were 11.3Mt @ 1.0% Li₂O and 160ppm Ta₂O₅ of lithium ore and 2.0Mt @ 313ppm Ta₂O₅ of tantalum ore. Prior to closure, ~1.2Mtpa ore was mined from the Bald Hill open-pit mine supplying an on-site lithium concentrator to produce ~150ktpa lithium concentrate at a grade of ~6% Li₂O. Mineral Resources hope to double the production rate. Bald Hill also has a 320,000tpa on-site tantalum processing facility for processing tantalum ore.

In May 2019, an exploration campaign identified an additional exploration target of 17-24Mt @ 1.25-1.40% Li₂O and 150-180ppm Ta₂O₅ within a series of pegmatites adjacent to the Bald Hill mine.



Buldania

Liontown Resources Ltd (ASX:LTR)

The Buldania Project is located 200km south-east of Kalgoorlie in the Eastern Goldfields region of WA. Drilling of the Anna deposit has identified eight mineralised pegmatites over an area of 1,400m by 380m and to a depth of 300m. A maiden Total Mineral Resource of **15.0Mt @ 1.0% Li₂O and 44 ppm Ta₂O₅** was defined in Nov 2019. The Anna mineralisation is open down dip and along strike. A 42 hole RC drilling program for 6,338m completed in 2022 identified shallow lithium mineralisation extending ~150m to the east of the deposit. Significant lithium results were also returned over a strike length of ~800m at the Northwest prospect, 5-10 kilometres north-west of the Anna deposit.

Further drilling, metallurgical testwork, environmental and water studies with engineering and other studies commencing in the September 2023 quarter.



Manna Lithium Project

Global Lithium Resources Ltd (ASX:GL1)

The Manna Lithium Project is located 100km east of Kalgoorlie, in the Eastern Goldfields region of WA. An updated Total Mineral Resource of **36.0Mt @ 1.13% Li₂O and 54ppm Ta₂O₅** was defined in July 2023 within a series of outcropping pegmatites, based on 231 RC and diamond drillholes for 51,622m. A Scoping Study was completed in February 2023 based on an open-pit mine and concentrator producing an average of 2.2Mtpa spodumene concentrate (5.5% Li₂O) over a minimum 10 year mine life.

A 50,000m drilling program commenced in August 2023 targeting completion in December 2023 and a Mineral Resource update in H1 CY24. DFS level metallurgical testwork has been completed demonstrating excellent Li₂O recoveries above 70%. The DFS is targeting completion in H1 CY24 with FID expected in CY24. The deposit remains open in all directions and has clear potential for increased growth.



Marble Bar Lithium Project

Global Lithium Resources Ltd (ASX:GL1)

The Marble Bar Lithium Project (MBLP) is located 160km south-east of Port Hedland, in the Pilbara region of WA. An updated Total Mineral Resource of **18.0Mt @ 1.00% Li₂O and 51ppm Ta₂O₅** was defined in July 2023 within a series of pegmatites in the Archer pegmatite corridor, based on 465 primarily RC drillholes for 66,478m. Preliminary metallurgical test work has been undertaken on drill core samples from MBLP with positive results demonstrating Li₂O recoveries of 75%.

Exploration drilling completed to date has identified additional exploration targets over a 25km strike length within which four additional pegmatite corridors which will be the focus of additional drilling in 2024.



Pioneer Dome Lithium Project

Develop Global Ltd (ASX:DVP)

The Pioneer Dome Project is located 130km south of Kalgoorlie in the Eastern Goldfields region of WA. An updated Total Mineral Resource of **11.2Mt @ 1% Li₂O** was defined in December 2022 over the Dome North deposit where a series of pegmatite dykes associated with the Pioneer Dome granite intrude the overlying greenstone sequence. A Scoping Study was completed in Feb 2023 based on an open-pit mine and concentrator producing an average of 1.2Mtpa spodumene concentrate (5.7% Li₂O) over a 7.3 year mine life.

In May 2023, the Pioneer Dome Project Feasibility Study was commenced with work currently underway on a metallurgical drilling and testwork program, environmental studies, permitting and approvals and exploration drilling to extend the resource. Essential Minerals Ltd, the owners of the Pioneer Dome Project, were acquired in November 2023 by Develop Global Ltd.



Source: Company websites, ASX announcements, WideRange Consulting

Glossary

ANSTO – Australian Nuclear Science and Technology Organisation

BFS – Bankable Feasibility Study

CEFC – Clean Energy Finance Corporation

CMO – Critical Minerals Office

CSIRO – Commonwealth Scientific Industrial Research Organisation

DFAT – Department of Foreign Affairs and Trade

DFS – Definitive Feasibility Study

DISR – Department of Industry, Science and Resources

EDR – Economic Demonstrated Resources

EFA – Export Finance Australia

EIS – Environmental Impact Statement

EM – Electromagnetic

EPBC – Environment Protection and Biodiversity Conservation Act

ESG – Environmental, Social & Governance

EV – Electric vehicle

FBI-CRC – Future Battery Industries Cooperative Research Centre

FID – Final Investment Decision

HPAL – High-pressure acid leaching

JV – Joint venture

NAIF – Northern Australia Infrastructure Fund

NSW – New South Wales

NRF – National Reconstruction Fund

NT – Northern Territory

PFS – Pre Feasibility Study

QLD – Queensland

SA – South Australia

TAS – Tasmania

VIC – Victoria

WA – Western Australia



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