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# CHINA-BASED BATTERY GRADE HIGH-PURITY MANGANESE PRODUCTION STRATEGY

## INVESTOR SITE VISIT PRESENTATION

APRIL 2024

ASX: FRB

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Firebird is not aware of any new information or data that materially affects the information included in its announcement dated 21 November 2023, and all material assumptions and technical parameters underpinning the estimates continue to apply and have not materially changed.

For full details refer to ASX announcements 10/3/22, 30/1/23, 23/3/23, 26/6/23, 30/8/23, 1/9/23, 18/10/23, 21/11/23, 13/12/23, 29/1/24. and 13/3/24

## **JORC Compliance Statement**

This announcement contains references to Exploration Results and Mineral Resource Estimates, which have been extracted from previous ASX announcements as referenced. For full details of Exploration Results and Mineral Resource Estimates in this release that have been previously announced, refer to those announcements.

The Company confirms that it is not aware of any new information or data that materially affects the information included in the said announcements, and in the case of estimates of Mineral Resources, that all material assumptions and technical parameters underpinning the estimates in the relevant market announcements continue to apply and have not materially changed.

# BUILDING A LOW-COST HIGH-PURITY MANGANESE SULPHATE PLANT

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## **Unique, Low-Cost, Speed-to-Market Strategy**

Successfully executing a high-purity manganese sulphate strategy to supply into the rapidly expanding LMFP battery market . Investor Site visit in China to demonstrate the compelling opportunity for Firebird to establish itself as a key, low-cost, near-term producer



## **Sustainable Economics and Perfect Timing**

Firebird to become of one of the lowest-cost battery grade  $MnSO_4$  producers, placing the Company in a competitive position in all market environments, at a time when the LMFP market is forecasted for exponential growth and become a >US\$20 billion market by 2030



## **Management, Board and In-Country Team with Sector Leading Credentials**

Led by a Board and Management team with proven abilities of building companies through the lifecycle and into production. Assembled a proven and high-quality team in China, who are leaders in the development and production of high-purity manganese



## **Well-Funded and Supported**

Strong cash position of \$7.36m (as of 31 Dec 2023) to fund key workstreams across China strategy and at Oakover. Firebird has attracted a strong investor register supported by a highly-reputable investor Canmax Technologies Co., Ltd with a 9.7% holding

# DEVELOPMENT PROGRESS IN CHINA CONTINUING AS PLANNED

- **Preliminary design work, R&D centre, equipment supplier due diligence & project permitting are all being progressed at full speed**
- Estimated permitting & design on track for completion by late Q3 2024
- **European customer site visits & off-take discussions commenced with excellent feedback**
- Formal advice from Jinshi Government & relevant departments on process to repatriate profits and capital from operations
- **As further proof of the strong levels of support in-country, Firebird will also receive a preferential tax rebate for 6 years**
- **Australian investor & broker site visit to key areas in China, including Jinshi High-Tech Industrial Park, Pilot Plant and Jinshi Port to take place on April 23**
- Oakover project development continues as planned and forms an integral part of Firebird's long term manganese battery materials strategy

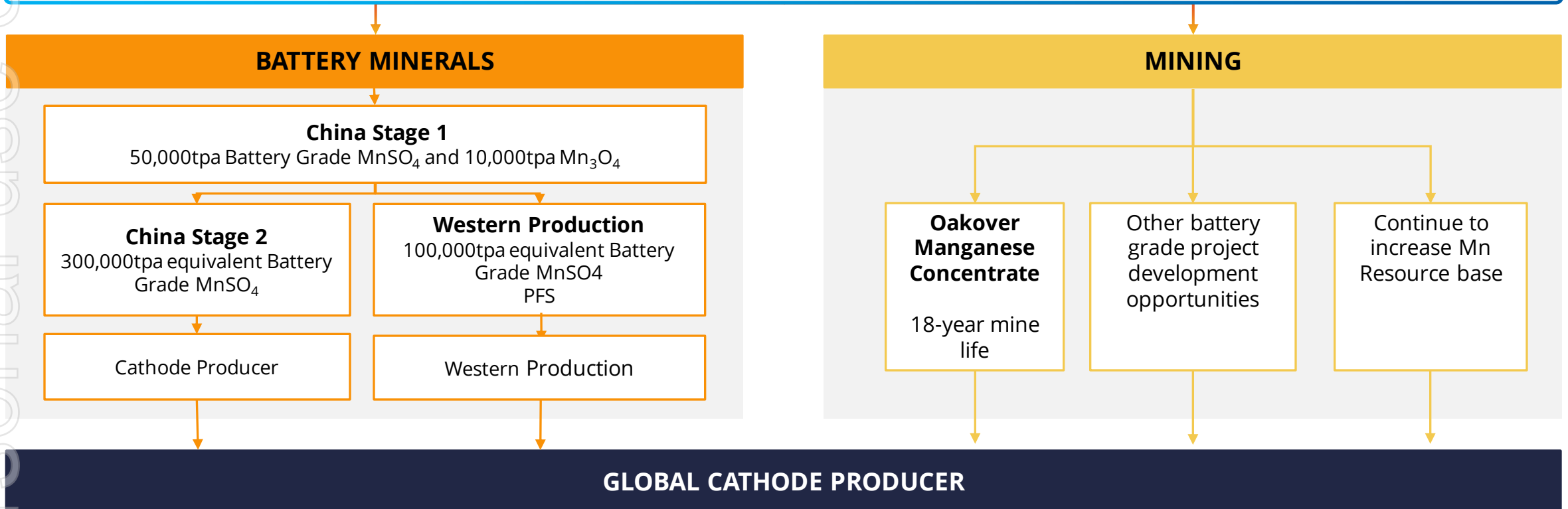


# THE FIREBIRD VISION

## COMPANY VISION

Become a global leader in the manganese industry by seamlessly combining mining and downstream processing, with a profound dedication to the advancement of Li-ion & Na-ion battery sectors.

By harnessing the power of innovation and sustainability, Firebird aims to play a pivotal role in shaping the future of energy storage solutions and significantly contributing to a more sustainable and electrified world.



# THE CRITICAL ROLE OF MANGANESE IN BATTERIES

## Traditional Uses

- Manganese has a long history of being a cathode material for batteries in the form of Electrolytic Manganese Dioxide (EMD)
- Current production market sizes are 482,000t in China and 107,000t for rest of the world

**Ford F150**  
65-95 kg/Mn



**VW ID.4**  
40-60 kg/Mn



**Chevrolet Bolt**  
30-40 kg/Mn



Manganese content (kg) in per battery in each vehicle above

Source: Benchmark Mineral Intelligence

## Manganese Lithium-ion Batteries

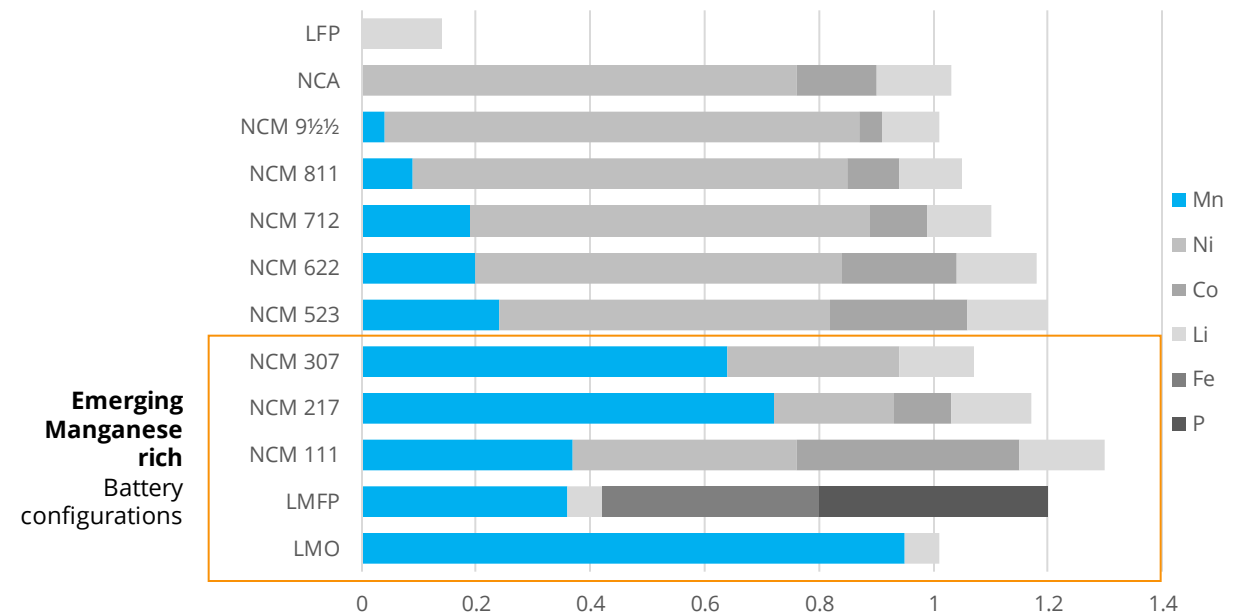
- Mn is used Li-ion batteries, including NCM, LMO and LMFP – Due to significant benefits of LMFP, the use of this cathode mix is set for massive growth
- **Size and growth of LMFP market is potentially the largest in medium to long term (est. avg. 900kg of MnSO4 per 1 tonne of LMFP)**

## Na-ion Batteries

- Na-ion batteries inherently have lower density
- Sodium batteries contain around 30% Mn

**Research and advocates for manganese rich batteries is on the rise, due to manganese being abundant and relatively inexpensive compared with nickel and cobalt**

Indicative Metals Intensity By Battery Type



Source: Benchmark Mineral Intelligence and company research

# LMFP IS THE FUTURE CATHODE FOR EV BATTERIES

- Lithium Iron Phosphate (LFP) is the world's most used Li-ion cathode material for EV batteries
- Three critical key considerations for battery manufacturers when assessing and developing a cathode mix is safety, cost and capacity
- **Adding high purity manganese sulphate (MnSO<sub>4</sub>) to LFP, creates LMFP and delivers significant operational and safety benefits to a battery**
- **LMFP is an upgrade from LFP by introducing manganese to replace iron**
  - LMFP has a higher thermal run-away temperature than nickel-based batteries
  - LMFP costs approximately 30% of nickel-based batteries
  - Enhances the voltage platform and increases energy density by 15-20%
  - LMFP is flexible, used on its own or mixed with nickel-based batteries
- Soochow Securities forecast **LMFP will replace 50% of LFP batteries by 2030**
- Caitong Securities forecast **blending LMFP with nickel-based batteries in China to reach 30% by 2030**
- **Firebird is executing its LFMP battery strategy at the perfect time and will be well-positioned to supply into this rapidly growing market**

## EV manufacturers using LFMP



## Battery manufacturers using LFMP



## Cathode material manufacturers using LMFP





# CHINA OPERATIONS



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# INDUSTRY LEADING MANGANESE TEAM

- Firebird has recruited an industry leading, high-purity manganese team to ensure the Company develops into a long-term, low-cost  $MnSO_4$  producer
- In-country team brings proven track record of success and value generation across the development and operational lifecycle in China
- Team led by manganese sulphate specialist Mr Zhou Qiyun, Chief Operating Officer of Hunan Firebird Battery Technology Co Ltd (Chinese subsidiary of Firebird Metals)
- Mr Zhou was previously a part-owner of a battery grade  $MnSO_4$  plant and has consulted to many existing  $MnSO_4$  plants in China.
- Across his career, Mr Zhou has been involved in the development, optimisation and commercialisation of technologies for  $MnSO_4$  processing (including patents)



*Hunan Chemical Engineering Design Institute (PFS engineering group) and Hunan Firebird Battery Technology staff including Mr Zhou*

# INDUSTRY LEADING MANGANESE PARTNERS

- Firebird's partners are leaders within their industries
- **Cooperation agreement with China Chemical Strategic Cooperation Agreement, which will deliver Firebird a significant amount synergies and advantages:**
  - China Chemical invested in and manages the Jinshi High-Tech Chemical Industrial Park, where the Company's plant and operations will be located
  - China chemical has significant technical expertise and proven credentials in construction of chemical plants
  - China Chemical has the highest qualification for installation of chemical equipment
- **A dedicated technical team will be formed with China Chemical, once preliminary design work is completed**
  - Hunan Chemical Engineering Design Institute (HCEDI) engaged to complete the Feasibility Study & Engineering Design
  - **HCEDI is the leading MnSO<sub>4</sub> project design institute globally and Firebird's in-country technical team have previously worked closely with HCEDI on several projects**



# OPERATIONS LOCATED IN THE EPICENTRE OF MNSO4 DEMAND

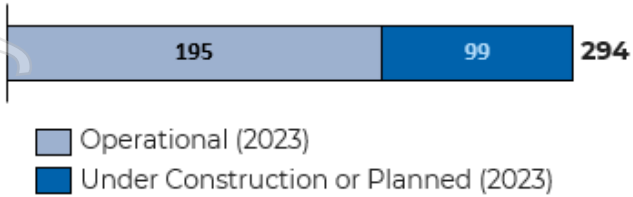
*After thorough due diligence and assessment of many possible location opportunities in China for the Firebird's high-purity manganese plant, Jinshi, Hunan was selected as the Company's stage 1 Battery Grade MnSO4 & Mn3O4 site*

*Importantly, Hunan and the Company's proposed operations are located at the epicentre of Chinese MnSO4 demand*

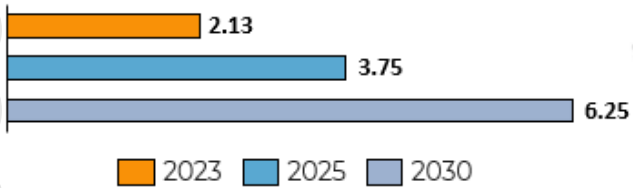
- **Excellent location for operations.** Close proximity to existing and potential customers - within a 150km radius, LFP capacity is just under 3Mt/a
  - **Even if a fraction of conversion from LFP to LMFP is actioned, it will significantly exceed Firebird's production capacity**
- **Strong support from central and local governments on foreign investment and for the Company's strategic ambitions to establish operations in China**
  - Firebird's permitting is being fast-tracked and being the first fully owned foreign entity in Jinshi, is a significant project for the region
- **World class chemical industrial park built by China Chemical and the local government.** The Park has attracted more than 100 companies and currently demand for land for additional projects far outweighs supply
- **Access to tier-one infrastructure including easy access to Yangtze River, which is the most cost-efficient transport system in China,** close proximity to key input materials and several cement plants
- **Attractive land price & tax incentive. Firebird has received better incentives than any other company in the Chemical Industrial Park** and also qualifies for all Chinese domestic company grants

# HUNAN IS AT THE EPICENTRE OF CHINESE MNSO4 DEMAND

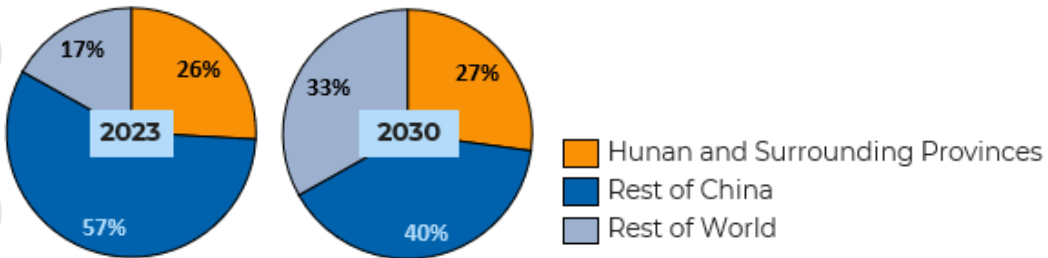
## China Gigafactory Status



## China Gigafactory Capacity (TWh)



## Share of Gigafactory Capacity

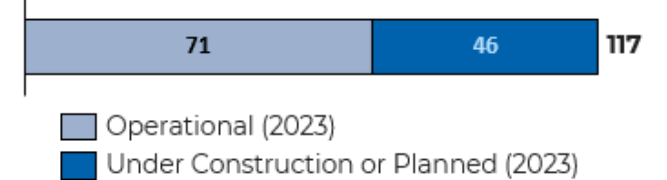


\*Chongqing is a Municipality  
\*\* Guangxi is a Region

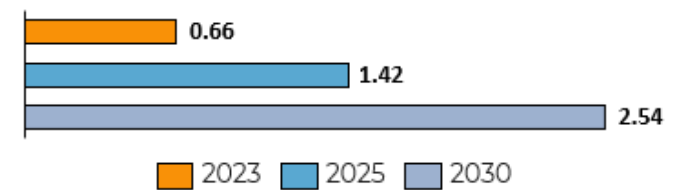
Hunan and Surrounding Provinces			
1	Hunan	6	Guizhou
2	Chongqing*	7	Guangxi**
3	Sichuan	8	Guangdong
4	Hubei	9	Jiangxi
5	Yunnan		



## Hunan and Surrounding Provinces Gigafactory Status



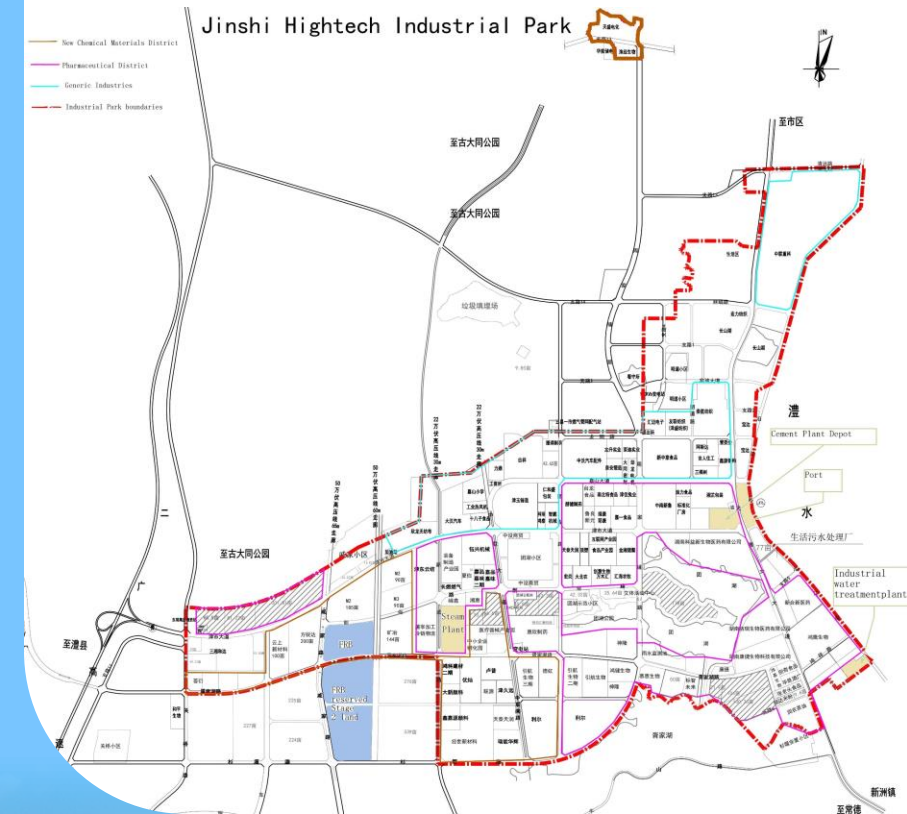
## Hunan and Surrounding Provinces Gigafactory Capacity (TWh)



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# JINSHI HIGHTECH INDUSTRIAL PARK

- The High-Tech Industrial Park (Park) is located ~8km away from town centre
- **The Park is ranked as one of the highest in Hunan Province for its services and facilities**
- The Park is conveniently located on Lishui River, which connects onto the Yangtze river. The bulk terminal has a capacity of over 10 Mt/annum
- **Provides access to tier-one infrastructure such as a steam plant, dual power lines, water treatment plant, cement plant depot**
- The Park is divided into three districts; New Chemical Materials, Pharmaceutical and General
- Currently over 100 companies operate in the Park. Several new businesses have set up pilot plants within the development area. Firebird currently operates from the development area





## RAPID DEVELOPMENT PROGRESS



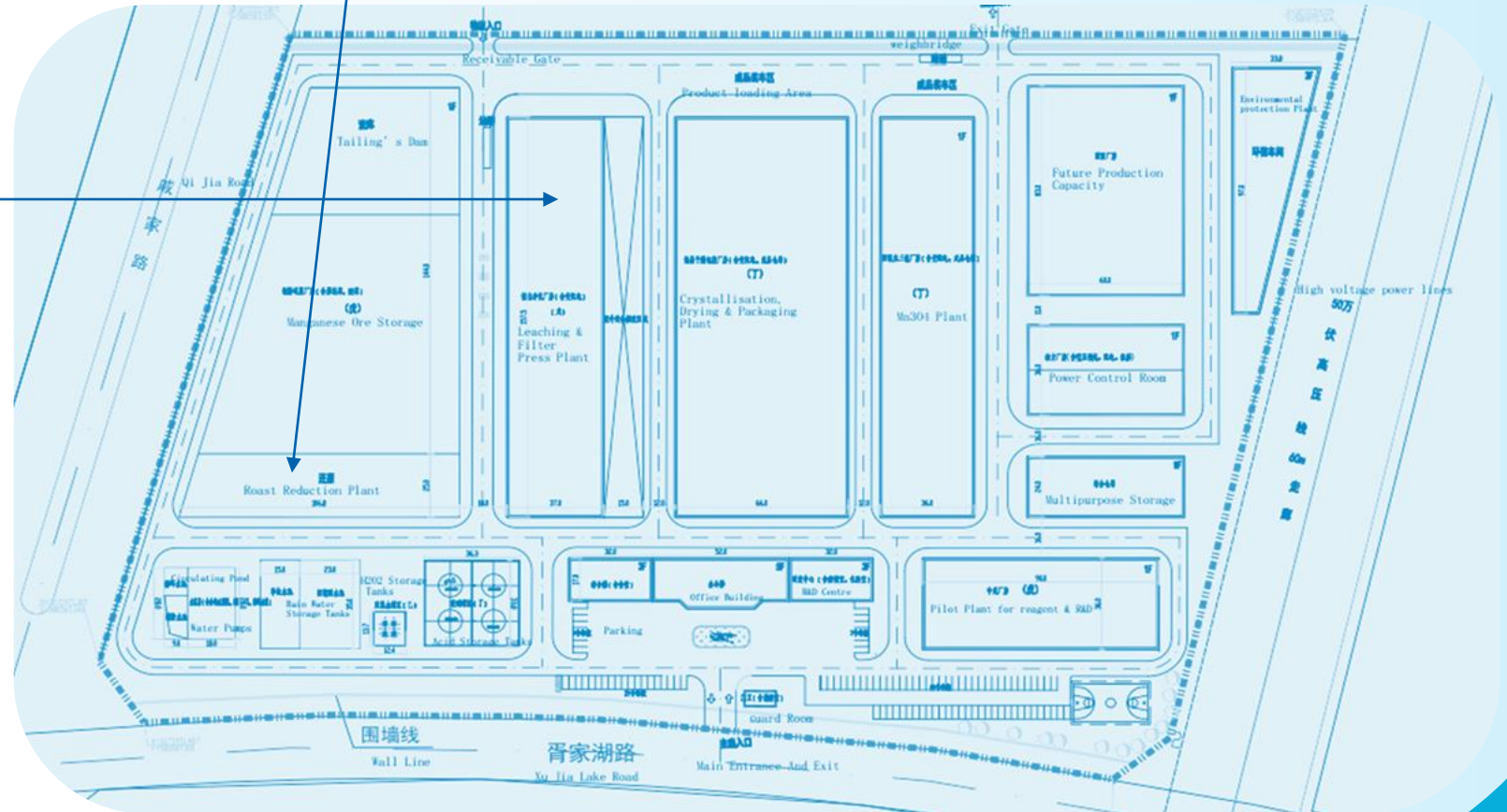
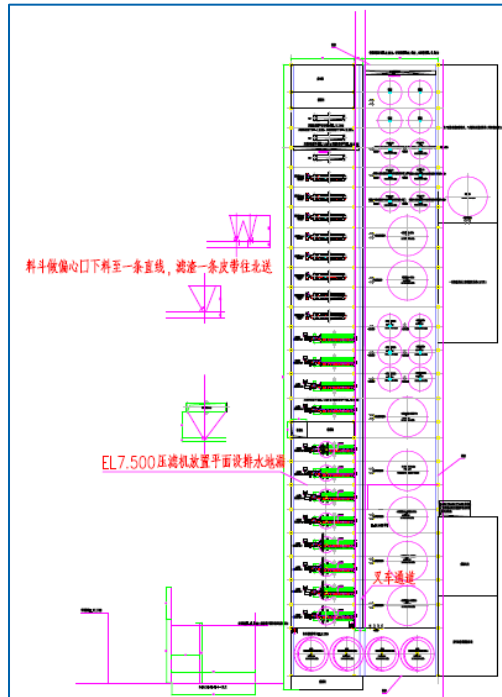
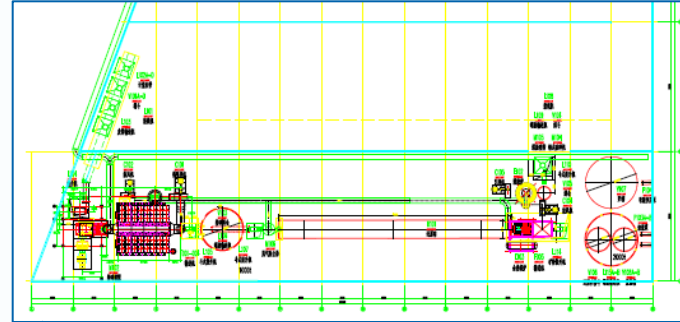
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# R&D LAB COMPLETE, PILOT PLANT TRIALS UNDERWAY

- Firebird completed construction of the Research and Development lab in January 2024, ahead of schedule and under budget
- **Pilot Plant operational and produce samples of  $MnSO_4$  and  $Mn_3O_4$  for potential customers and offtake parties**
- **Testing results on site is consistent with 3<sup>rd</sup> party analysis and meets the highest quality standards required by potential customers**
- Pilot Plant has design capacity to produce 10kg of battery-grade  $MnSO_4$  per day (can be increased to suit our needs)
- The Pilot Plant will also be used to demonstrate the production process to financiers
- R&D lab will be used to complete testing on several other potential Mn rich precursor Cathode Active Materials (pCAM)



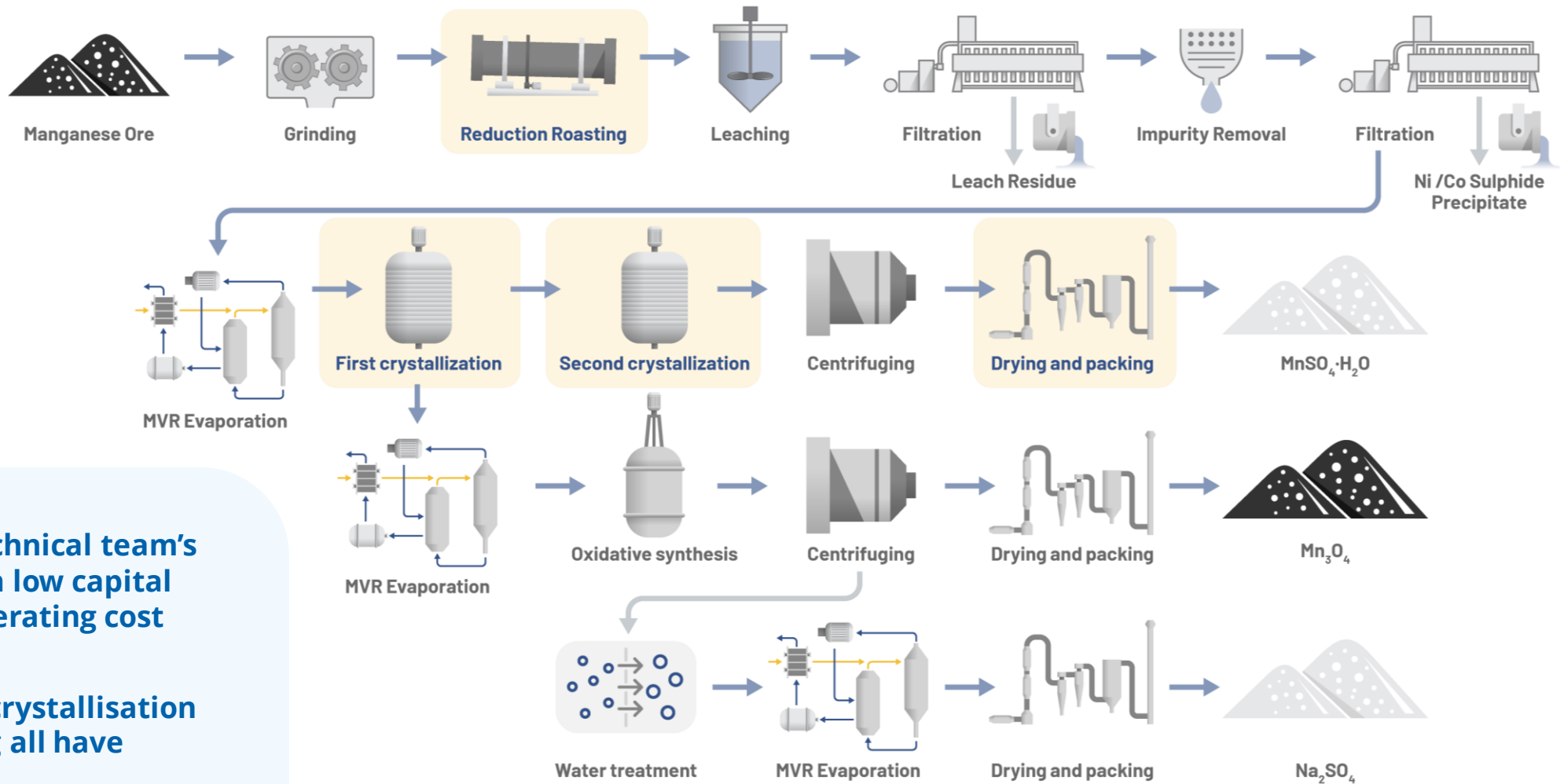
# STAGE 1 BATTERY-GRADE MNSO4 & MN3O4 PLANT LAYOUT



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# HIGH-LEVEL PROCESS FLOW DIAGRAM - 50KTPA HIGH PURITY $MnSO_4 \cdot H_2O$ AND 10KTPA HIGH PURITY $Mn_3O_4$



Firebird's Chinese technical team's expertise reflected in low capital intensity and low operating cost process

Reduction roasting, crystallisation and drying & packing all have patents

# 5<sup>th</sup> GENERATION CONTINUOUS HIGH PRESSURE CRYSTALLISATION REACTOR IS WORLD LEADING

1<sup>st</sup>



**1<sup>st</sup> generation** Single effect evaporator  
• Indirect heating to concentrate solution

2<sup>nd</sup>



**2<sup>nd</sup> generation** Multi-effect evaporator  
• 60% energy use of 1<sup>st</sup> generation  
• Recycle residual heating to pre-heat incoming solution

3<sup>rd</sup>



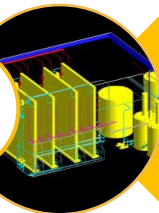
**3<sup>rd</sup> generation** MVR  
• 40% energy use of 1<sup>st</sup> generation  
• More efficient heating and recycle energy

4<sup>th</sup>

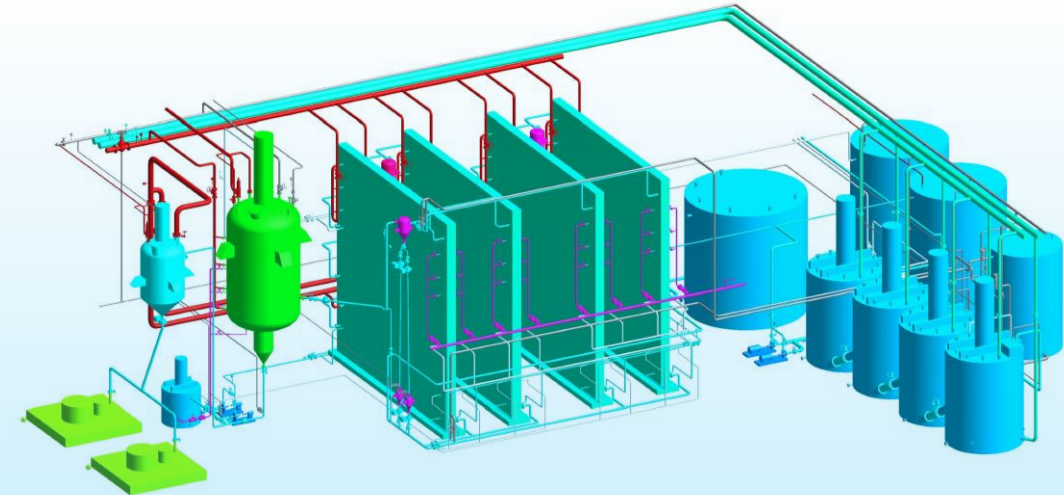


**4<sup>th</sup> generation** Single High pressure, high temperature reactor  
• 25% energy use of 1<sup>st</sup> generation  
• Like a pressure cooker, efficiency improved due to high

5<sup>th</sup>



**5<sup>th</sup> generation** (patent technology) Continuous high-pressure system, 8% energy use of 1<sup>st</sup> generation  
• 1/3 energy use of 4<sup>th</sup> generation  
• Based on 4<sup>th</sup> generation system, it operates continuously & residual energy is used in pre-heating feed solutions

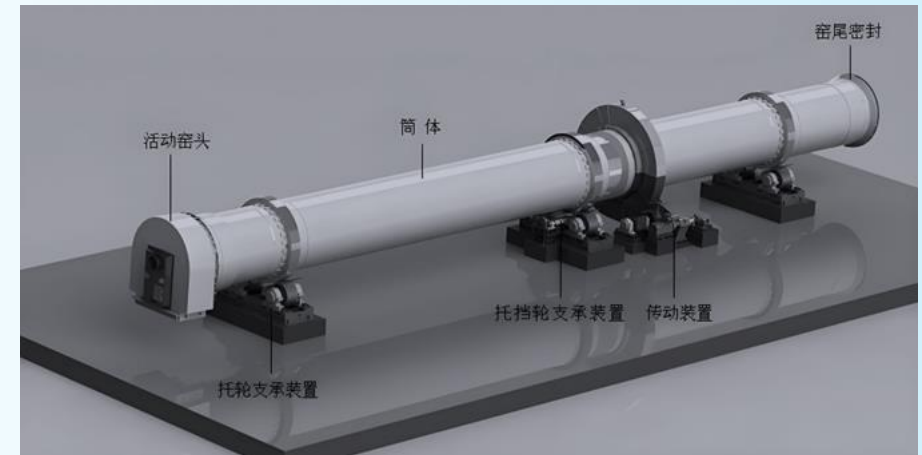
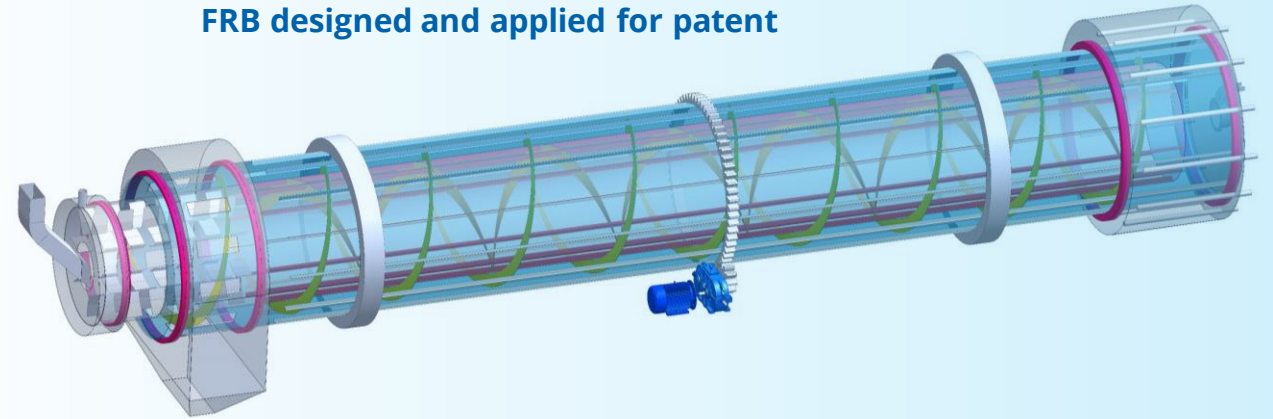


- Most Chinese companies currently using 1<sup>st</sup> to 4<sup>th</sup> generation
- **5<sup>th</sup> generation** is successfully used in Commercial Production

# CALCINING UNIT

- Conventional Calcining technology consumes minimum 300kwh per tonne of feed
- Materials are heated to 900 degrees Celsius and then cooled down by using a combination of water and air - **energy is wasted during cooling**
- Firebird has lodged an application to patent a modified system that will significantly reduce energy use
- **The essence of Firebird's technology is utilising heat from calcined material to pre-heat incoming material**
- Firebird is sourcing a supplier to build a pilot plant about 1/15 of actual size
- Cost of the build is financed through savings from R&D Lab
- **If proven, Firebird technology could potentially reduce energy use to 1/6 of conventional system**

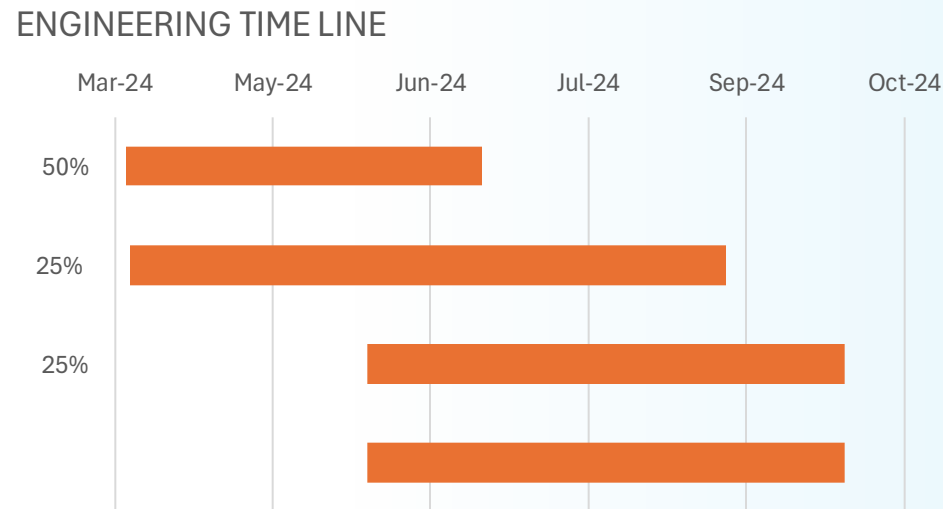
FRB designed and applied for patent



Conventional system with water cooling at second half of the system

# PROGRESS UPDATE – ENGINEERING & CIVIL DESIGN

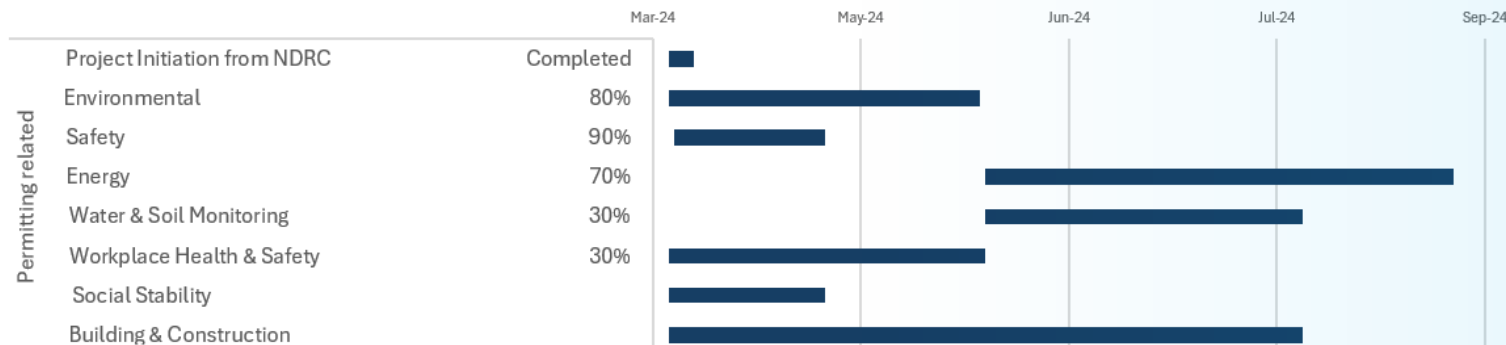
- Firebird is currently focused on preliminary engineering & civil work design
- More than 50% of preliminary design work has been completed
- Firebird has engaged several high-quality equipment suppliers
- Equipment costs being fed into the design work and detailed estimates
- Once completed, the design work will be reviewed by relevant department for preliminary permitting of construction process
- Firebird funded to complete full detailed engineering work



# PROGRESS UPDATE - PERMITTING

- **Government permitting is progressing rapidly**
- 8 major permits required before construction begins, key permits being:
  - **Environmental impact assessment report should be completed in April** and then goes on Expert Panel review. Full approval is expected before the end of financial year
  - **Safety report is approved by Expert Panel** and changes in design have been made to reflect the Panel's review points. Permit is likely to be received at the end of April
  - **Energy consumption report is being drafted and expected completion is mid-April.** Expert panel review and permitting is expected to be received before the end of June

PERMITTING TIME LINE



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# OAKOVER PROJECT

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# OAKOVER UPDATE



## Over the long term, Oakover will be an integral part of Firebird's manganese battery material strategy

- Near-surface, gently dipping geology
- Metallurgical test work demonstrated saleable 30 - 32% Mn Concentrate product achievable
- Hydrometallurgy test work demonstrated Battery Grade  $MnSO_4$  achievable
- Concentrate DMS Scoping Study – 18-year mine life, 1.2Mtpa with low strip ratio and mining costs

Mineral Resource Classification	Tonnes (Mt)	Mn (%)	Fe (%)	SiO <sub>2</sub> (%)	Al <sub>2</sub> O <sub>3</sub> (%)	P (%)
Indicated	105.78	10.1	8.9	39.2	9.8	0.10
Inferred	70.87	9.6	8.0	36.5	9.5	0.09
<b>Total</b>	<b>176.65</b>	<b>9.9</b>	<b>8.6</b>	<b>38.1</b>	<b>9.7</b>	<b>0.10</b>



# LARGE RESOURCE WITH STRONG GROWTH UPSIDE

- Firebird has successfully explored and developed Oakover into a sizeable manganese project, with exciting growth potential
- Development work, including completion of a Dense Media Separation (DMS) Manganese Concentrate Scoping Study and Sulphate Scoping Study highlighted the Project as a long-life, high-quality operation
- The Company's primary focus is on the execution of its China-based LMFP battery strategy; however, development and environmental work will continue over next 12 to 18 months with key activities including:
  - Environmental surveys and studies to be completed in H1 2024
  - Diamond drill program for ongoing metallurgical test work to be completed in H2 2024
  - PFS metallurgical test work program
  - Hydrology/water monitoring
  - Finalisation of the Mining Lease Application, including native title and heritage negotiations
- **Execution of these workstreams will see Firebird successfully deliver on its vision to become a global leader in the manganese industry, combining mining and downstream processing and building WA's next major manganese operation**

*For full details refer to ASX announcements 10/3/22, 30/1/23, 23/3/23, 26/6/23 and 30/8/23*





# CORPORATE SNAPSHOT



## **EVAN CRANSTON** Chairperson

Mr Cranston is an experienced mining executive, with a background in corporate and mining law.



## **PETER ALLEN** Managing Director

Mr Allen is a mining executive, with more than 20 years' experience in the marketing of manganese and lithium products and a range of other commodities.



## **WEI LI** Finance Director

Mr Li is a Chartered Accountant with extensive experience in the mineral resource industry. Mr Li managed a private base metals' exploration company in the Northern Territory and assisted in commissioning a A\$150 million Electrolytic Manganese Dioxide (EMD) plant in Hunan China.



## **ASHLEY PATTISON** Non-Executive Director

Mr Pattison has over 20 years' experience in the resources sector from both a corporate finance and operational perspective. Qualified as a chartered accountant, he has extensive experience in operations, finance, strategy and corporate finance.



## **BRETT GROSVENOR** Non-Executive Director

Mr Grosvenor is an experienced mining executive, with over 25 years' experience in the Mining and Power industry. Holding a dual tertiary qualification in Engineering and a Master in Business.

Firebird Metals Limited	ASX:FRB
Share price as of 18th April 2024	\$0.15
Shares on issue	142.36 M
Market capitalisation	\$21.3 M
Options @ \$1.00	12.0 M
Performance rights	2.2 M
Options @ \$0.30	12.5 M
Options @ \$0.40	12.5 M
Cash on hand (31st December 2023)	\$7.36 M

## Major Shareholders

Canmax Technologies	9.7%
Tolga Kumova	9.5%
Mining Equities	3.2%
Board (incl. related parties) & management	15.05%

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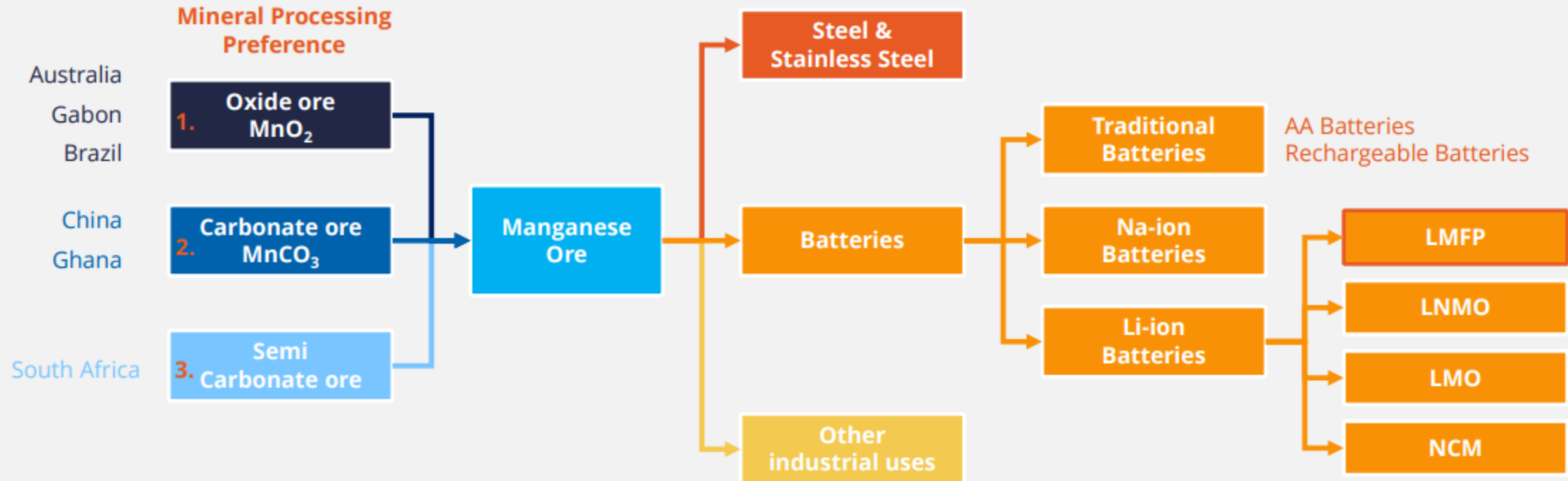
**THANK YOU**

**ASX:FRB**

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# MANGANESE AND ITS USES – RAPID GROWTH IN BATTERIES



## Some facts about Mn

- Seaborne priced in CIF (delivered port of discharge)
- Priced in USD per DMTU (Dry Metric Tonne Unit) or 1%
- High grade >40%, medium grade >30%
- Roughly 60MT seaborne ore traded and China buys 30MT

## Battery terms

**EMD** Electrolytic Manganese Dioxide  
**EMM** Electrolytic Manganese Metal  
**HPMSM** Battery Grade Mn Sulphate & High Purity  $MnSO_4$  & HPMSM means the same

**Li-ion** LMFP - Li Mn Fe  $PO_4$   
 NCM - Ni Co Mn  
 LMO - Li Mn O  
 LNMO - Li Ni Mn O

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# MANGANESE RESOURCES SNAPSHOT

Significance of the Oakover Manganese Project cannot be underestimated from the perspective of global supply, with continued decline of worldwide manganese production grades and limited number of ASX manganese developers

## GHANA (~6% of Seaborne Trade)

- **Full carbonate ore**
- Overall grade decreasing
- 27% Mn
- Production grown under Chinese ownership

## GABON (~20% of Seaborne Trade)

- **Oxide ore**
- Only country to significantly increase high grade (>40% Mn) ore production

## SOUTH AFRICA (~50% of Seaborne Trade)

- Semi carbonate
- Overall grade decreasing
- **Production mainly 35-37% Mn (semi carbonate ore)**
- Grown from 18% in 2011 to 39% in 2022 of world (IMnI)
- However, plagued with logistics issues
- **Semi carbonate most suited to steel production**

## CHINA

- **Mainly carbonate ore**
- Combination of depleting resources and environmental policies making mines unprofitable
- Overall grade decreasing
- Production decreasing
- Largest market for Mn ore
- Imports grow each year (currently ~30Mtpa)

## AUSTRALIA (~16% of Seaborne Trade)

- **Oxide ore**
- Overall grade and production decreasing
- Several existing producers
- Some of existing mines approaching end of mine life and processing tailings