FUTURE BATTERY INDUSTRIES CRC

Activity report 2022

Australian Government
Department of Industry, Science and Resources

AusIndustry
Cooperative Research Centres Program

CONTENTS

CHAIRMAN'S INTRODUCTION

TIM SHANAHAN - CHAIRMAN

Since the establishment of the Future Battery Industries Cooperative Research Centre (FBICRC) in 2019, the battery industry in Australia has experienced a great deal of growth and change. I believe that the work of the FBICRC team, has made a direct and positive contribution to the growth of the industry and the promotion of the goals of creating sustainable battery industries in Australia.

The four key strategic "pillars" of the FBICRC are:

- To leverage Australia's minerals and mining advantages into battery materials innovation and production.
- To accelerate the uptake of battery technologies in Australia.
- To advance our research and capability in battery materials and precursor manufacturing.
- To facilitate battery industry development.

These objectives remain as relevant today as when they were established back in 2018, and it is great to see material progress being made against the industry development objective.

During the reporting period Shannon O'Rourke was appointed as the new CEO to lead the FBICRC through the second half and most crucial stage of its life. His appointment has led to the pursuit of an ambitious industry development agenda and the energetic promotion of a visionary outcome for the country.

An expanded focus on government engagement and advocacy by the FBICRC team has reaped early rewards with the announcement of the Australian Made Battery Policy and development of the National Battery Strategy. The research outcomes already being delivered by the FBICRC participant research teams, have delivered credibility and momentum to the cause.

In July 2021, the FBICRC's influential Future Charge report painted a conservative picture of the battery industry's potential $7.4bn annual contribution and the 34,000 jobs that could be created by 2030. It is clear, that this initial estimate has already been surpassed with growth exceeding expectations and Australian lithium exports alone expected to exceed $13.8bn by 2023. Whilst the FBICRC's primary objective is to grow an Australian battery industry, we are cognisant of complex international and geopolitical factors at play that are currently impacting global energy policies and markets. With our rich endowment of critical minerals that are central to decarbonisation, the current global environment creates a vital opportunity for Australia to play a key role in the world's energy transition.

The FBICRC and our participants are continuing to develop capacity, drive clean tech innovation and to bring technologies to market that will be essential to achieving 2050 emissions targets.

I would like to acknowledge and thank the hard-working team at the FBICRC ably led by Shannon and to acknowledge the very welcome and insightful contributions from my fellow directors.

As I look ahead, I feel an even greater sense of optimism about the development of a thriving domestic battery industry, and I have every confidence the FBICRC team will continue to be at the forefront of national action in the sector.

CEO INTRODUCTION

SHANNON O'ROURKE - CHIEF EXECUTIVE OFFICER

During the reporting period, the Future Battery Industries Cooperative Research Centre (FBICRC) made sound progress across our portfolio with a significant ramp up in research activities.

At the midpoint of our operating life, and the challenges associated with the COVID 19 pandemic largely behind us, we are firmly focused on delivering project outcomes for our investors with the vast majority of the FBICRC's resources from government, research and industry partners now committed.

The last financial year saw the FBICRC increasingly focussed on strategic initiatives, advocacy and government engagement aimed at furthering Australia's domestic battery industry.

In the lead up to the Federal election in May, we developed and communicated our Pre-Budget Submission – *Towards 2030 Australia's Battery Powered Future* to a broad cross section of Ministers and Ministerial staff spanning the political divide. The document reflected a maturation of the FBICRC's strategy and outlined a clear pathway to deliver on an ambitious national goal to build a vibrant, diversified battery industry.

Just prior to the Federal election, the ALP announced a $100 million investment in a Queensland based battery manufacturing precinct, a $1 billion 'Value Adding In Resources Fund' and committed to develop a National Battery Strategy – one of the central recommendations of the Towards 2030 document. Following their election, the ALP have honoured those commitments and preparations for the National Battery Strategy have commenced. The strategy, and our engagement in the process is a significant result for our advocacy efforts.

The FBICRC has actively supported growth opportunities for our participants and for the industry in general. We supported our participants in successful Modern Manufacturing Initiative applications which delivered over $1.1 billion in new industry investment. We introduced domestic and international businesses to prospective domestic manufacturing investments, and we have also commenced mapping the Australian value chain to bring greater transparency to the rapid pace of growth in our industry.

From an international perspective, the FBICRC continues to build on research and industry partnerships. We have started to work in close partnership with Austrade and state trade agencies to engage our US, European, Indian, Indonesian, Korean and Japanese counterparts.

We continue to maintain a diverse community of participants across the battery value chain with 73 at the end of the reporting period, up from 66 at the end of last year. We have increased our engagement with a broad set of stakeholders and the community, using social media and targeted events to achieve impact.

The FBICRC has made excellent progress in developing Australia's capability. Together with the Braunschweig Institute in Germany we held masterclasses across the country. We increased our student cohort and are engaging with industry and government to identify further candidates.

Together with our valued participants, we will deliver a follow up to our influential 2021 'Future Charge' report and continue our positive engagement with all levels of government. Initial indications are that the opportunity is larger and more immediate than we had thought. We look forward to redoubling our efforts to ensure that Australia can secure our share of this significant economic prize.

PROJECT PORTFOLIO

The FBICRC is Australia's largest partnership of industry, government and researchers focused on developing Australia's battery industry. We have 15 research programs supported by ten leading research institutions that span the battery value chain.
We invest in research and commercially available prototyping facilities to support industry development.

As of 30 June 2022, eleven significant projects were fully underway (and a further project agreement for the $7m 'Beneficiation and processing of lithium minerals project stage 2' led by Murdoch University, signed on 30 June).

Nickel and cobalt extraction

THE PROJECT

Nickel and cobalt are essential minerals needed to make lithium batteries used in electric vehicles. This project uses new technology that will allow miners to extract nickel and cobalt from materials previously classified as mining waste.

THE IMPACT

As demand for electric vehicles soars worldwide, demand for nickel and cobalt is expected to rise greatly. Increasing the recovery of nickel and cobalt is essential to lower the cost of production and maximise value from mined ores.

Australia has the world's largest nickel deposits and yet is only the sixth largest producer of nickel globally. The project is supporting the further development of Australian battery industries by helping to release an estimated $20 billion dollars' worth of nickel and cobalt.

In addition to helping Australia become a dominant producer of nickel globally, the project strengthens Australia's capabilities, cost competitiveness in downstream processing and reduces the environmental impact of conventional extraction processes.

RESULTS SO FAR

The project team has already achieved excellent results, with over 80% recovery rates of nickel and cobalt from flotation slimes and tailings. We have successfully recovered metals to battery grade specifications with low impurity levels. The metals can be recovered from solution as a mixed sulphides precipitate (MSP). The leaching and metals precipitation is carried out using glycine which can then be recovered and recycled.

Nano-filtration has been successfully used to recover glycine and metals glycinate complexes from alkaline glycine solutions. Solvent extraction has been carried out by the University of Melbourne that confirmed the recovery of metals from glycine solutions.

Additional work is ongoing to optimise the leaching conditions for best nickel and cobalt recovery, working with parameters such as glycine and ammonia concentration and the addition of oxygen and grind size.

Image supplied by QUT

National battery testing centre

THE PROJECT

The National Battery Testing Centre (NBTC) is the first facility of its kind in Australia. It allows local battery system manufacturers to certify their products to Australian and international standards. Previously, Australian companies needed to rely on overseas testing, a costly and lengthy process.

The NBTC has developed world class testing facilities suitable for a range of different battery types, systems and sizes. It is accelerating the development of safety standards for cells, batteries and energy storage systems.

THE IMPACT

Australia needs energy storage that's safe, reliable and affordable. The NBTC will reduce the time and cost needed to test and validate battery systems that meet Australian and international standards. It will help Australian manufacturers to compete in a global market.

These kinds of prototyping and testing facilities are essential to freeze product designs, so they are ready for manufacture.

The facility will accelerate the pace of battery innovation by providing rapid assessments on novel technologies and will build a skilled workforce of experts in energy storage technologies through targeted training programs.

RESULTS SO FAR

The NBTC is providing testing facilities to a growing list of Australian manufacturers and distributors of batteries and battery components, and it has attracted interest from large manufacturers.

The NBTC has commenced battery testing for lithium, vanadium and iron flow batteries and will generate data to inform the development of Australian battery standards.

In June 2022, the Queensland Government committed a further $15 million to the NBTC facility, taking the total value of the project to an estimated $35 million.

Cathode precursor production pilot plant

THE PROJECT

The Cathode Precursor Production Pilot Plant (CPPPP) in Western Australia will produce the current generation of cathode chemistries used in electric vehicles from locally sourced materials for the first time in WA.

The project, involving a consortium of leading industries, government and researchers represents a vital step towards the development of technical capability to produce advanced battery materials on an industrial scale in Australia.

THE IMPACT

Cathode precursor is the highest cost component in a cell. Australia has leading mineral resources, emerging refinery capacity, but until now, no Australian facilities to prototype advanced cathode materials. These rapid prototyping facilities will help accelerate innovations from lab to market.

Scaling up production of precisely engineered materials is a challenge. These facilities help us move from gram to kilogram scale production, enabling industrial pilots at tonne scale and industrial production at kiloton scale for giga-factories.

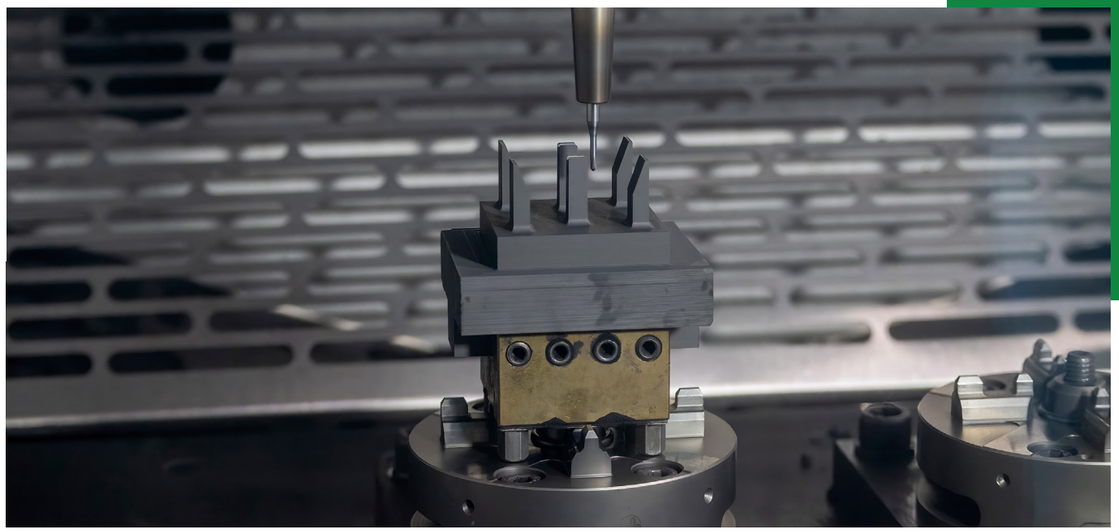
With increasing global demand for lithium-ion batteries, the CPPPP offers Australia a unique opportunity to transition into a major processing and manufacturing centre to increase our share of market value.

This project will contribute to the development of a skilled pipeline of future employees who have the breadth of chemistry skills and capabilities necessary to run a modern manufacturing industry.

RESULTS SO FAR

The facility is in the final stages of commissioning. Curtin University have successfully synthesized materials in the lab and first co-precipitation results are expected the first quarter of 2023.

Super anode



THE PROJECT

The project is working to produce fast charging, high powered anodes, whilst refining the manufacturing process and making recycling practices as sustainable as possible.

The project aims to deliver a reduction in graphite wastage of up to 30% during anode production and improve anode performance by up to 25%.

THE IMPACT

Alongside cathodes and electrolytes, a high functioning graphite anode is central to the production of world-class commercial batteries. As cost and environmental concerns grow, the demand for natural rather than synthetic graphite is expected to grow significantly.

Natural graphite needs to be refined via a complex set of procedures which leads to significant wastage and increased cost. The Super Anode project will contribute to the development of a more efficient anode that will deliver higher performance, lower costs and improve sustainability, allowing Australia to become more competitive in the global battery industry.

RESULTS SO FAR

Most of the work to date has been on silicon addition and spheronisation. Initial work spheronised graphite flake with yields of up to 66%, and further studies have increased yields of 4-25 micron particles to nearly 71%.

Caustic purification of natural graphite has been shown to work well and produce battery grade material matching that of the quality of industry-supplied spheronised purified graphite.

Work has been carried out to introduce silicon into graphite electrodes and preliminary results have shown a marked improvement in performance even without full optimisation.

Electrochemical testing

THE PROJECT

This project provides a facility for lithium-ion battery construction in Australia that will include performance testing and benchmarking of lithium-ion battery components used in EVs, defence and mining.

The project will deliver a standard set of operating procedures for battery production, ensuring that they are fit for purpose and that Australian produced battery-grade materials are accepted and competitive in a global market.

THE IMPACT

The Electrochemical Testing Centre project provides a vital link to other FBICRC projects providing validation data for cathode, anode, electrolyte and separator performance in cell formats suitable for commercial use and is an important step in the maturation of the Australian battery industry.

It has a strong focus on building Australian talent in the battery industry through targeted training programs with TAFE providers and close collaboration with higher degree students to ultimately produce employees with specialised skills.

Image supplied by QUT

RESULTS SO FAR

Installation of key capital equipment items is mostly complete with the team having successfully completed and validated the cathode materials benchmarking cell design (coin cell) and testing protocols, with the anode materials benchmarking cell design and test protocols ongoing.

Optimisation and establishment of a cell design benchmark for industry-representative, easily scalable single layered pouch cells is also underway. The manufacturing line for cylindrical battery cells is in place and producing high quality cells with low variability.

Microgrid deployment

THE PROJECT

The project aims to deliver a stable, reliable and robust microgrid system using a solar array, battery storage and backup diesel generation. It is being undertaken in the north-west of Western Australia in Karratha at Cherratta Lodge, a FIFO accommodation facility.

THE IMPACT

The project will use mathematical forecasting, optimisation and behavioural science in a practical remote edge-of-grid application. It will develop standard control approaches for batteries deployed into microgrids, improving interoperability between major equipment vendors. New power electronics will provide voltage and current scalability with reduced engineering effort and onsite installation costs.

Together these elements aim to reduce the cost and tariffs for remote edge-of-grid applications.

RESULTS SO FAR

The team has made good progress in modelling and optimising two microgrids currently being installed at Cherratta Lodge, in Karratha, WA. Installation and commissioning of the distributed solar array has been completed, which will also be supplemented by a Vanadium Redox Flow Battery (VRFB).

Battery connection approval to the grid has been received, the first 100kW solar array switched on and an additional 100 kW of solar generation capacity to be added.

Progress continues on the implementation and simulation of the functionalities and requirements of a 100kVA microgrid inverter and has been carried out to the most recent Australian standard AS/NZS 4777.2:2020 - grid connection of energy systems via inverters.

The low power module 5kW has been fully designed and is ready to be manufactured, and the design of a 50kW modular power converter also underway.

Life cycle analysis

THE PROJECT

The project is one of the first of its kind which aims to measure and improve the environmental impacts of mining Australian battery materials.

These impacts include carbon emissions, water quality and chemical toxicity over the lifecycle of battery materials.

THE IMPACT

As electric vehicles (EVs) become increasingly popular, demand for Australian battery materials like nickel and lithium continues to grow. At the same time, car manufacturers are under increasing pressure from consumers to ensure the sustainability of their products.

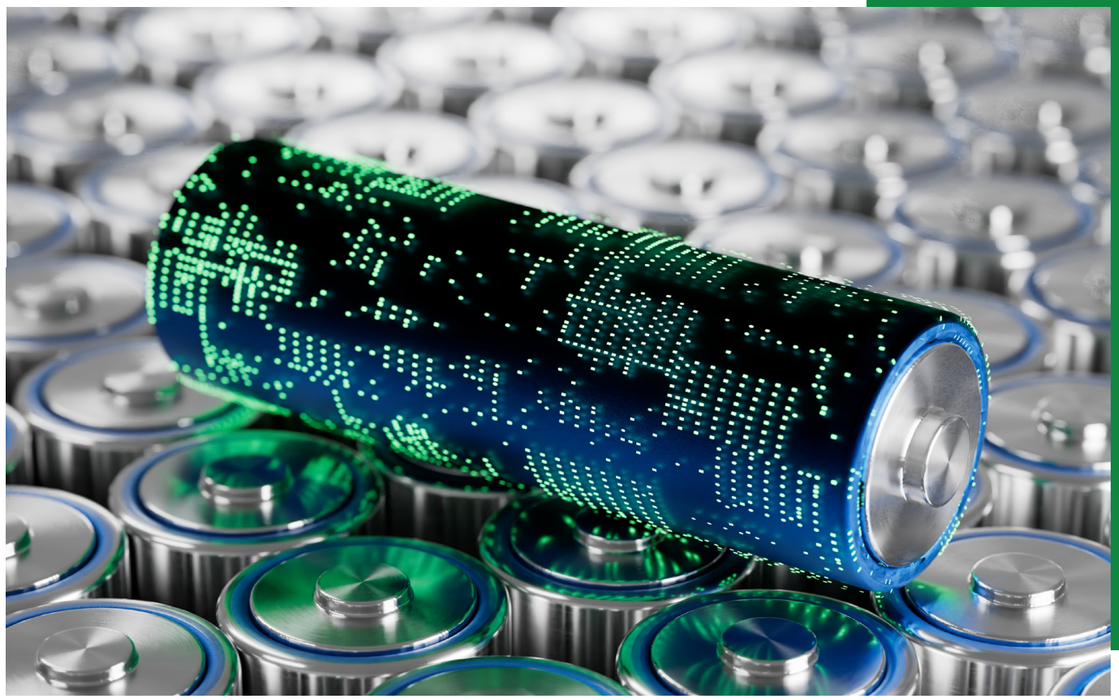
The project will help to establish trust in Australian supply chains through high traceability standards and position Australian industries as socially and environmentally responsible suppliers of battery minerals and materials in a circular economy.

RESULTS SO FAR

A thorough benchmarking survey on global systems for certification and sustainability assessment of battery materials has been carried out. From this work two major reports were completed; the 'Life cycle inventory (LCI) data gaps analysis for battery minerals' and 'Certification and sustainability assessment for battery materials – review of requirements and data commonalities'.

Progress has been made on the construction of LCA models based on the *OpenLCA* platform and freely accessible databases. The input data was informed by the mining and concentration technologies used by one of the project participants, and the results drafted as a journal paper for submission.

Future electrolyte systems



THE PROJECT

The project aims to enhance Australia's development of 'soft' battery components which are electrode binders, separators and the electrolytes.

This work will play a key role in developing the next generation of batteries which will use more stable substances, making them safer.

THE IMPACT

Lithium-ion batteries are used to power laptops, mobile phones, drones, electric vehicles, and grid-scale energy storage systems. These technologies demand small batteries with high energy densities, long life, fast charging capabilities and safe operation across a wide range of temperatures.

This project will help expand Australia's presence along the battery value chain, benefiting Australian commodities and materials producers and creating new market opportunities through improvements to battery performance and cell manufacturing. It will add to scientific understanding of emerging battery technologies and support the local industry in bringing more advanced products to market.

RESULTS SO FAR

A significant number of tests have been carried out under the three subprojects - electrolyte, binder, and separator. We have positive indications of improved safety and performance for these components.

Trusted supply chain

THE PROJECT

Sustainable and ethical sourcing of materials is a vital part of the battery supply chain ecosystem, for EV manufacturers as well as consumers.

The Trusted Supply Chain project is developing tools and platforms to connect customers to the sources of battery minerals and provide provenance and traceability.

THE IMPACT

Australia has an opportunity to be a leader in traceability. The outcomes of the Trusted Supply Chain project will give Australian producers of battery materials a significant competitive advantage over products with uncertain provenance. This will be a key contributor to unlocking the significant value available to Australia in creating a future battery industry.

By the end of 2025, new EU legislation will require importers to pay adjustment tax in relation to any direct carbon emissions created during the production of imported materials. This will make the validation and verification of responsibly sourced materials absolutely essential for European EV manufacturers.

Equally important, undisputable traceability will provide greater assurance for end users and consumers around the ethical, social, and environmental sustainability of Australia's battery value chain.

RESULTS SO FAR

The collection of critical trace elements data is complete, and analytical protocols finalised for the collection of lithium isotopic and trace element data. The immediate data analysis has identified very promising trace element candidates for the lithium fingerprinting proxies. These proxies and lithium isotopes have subsequently been prepared for cross-referencing activities to be carried out by the University of Wollongong.

The data taxonomy for a battery materials traceability platform has been established. An international partnership with Sustrab and TU Braunschweig in Germany has been established, connecting the project to developments in the European market related to supply chain provenance and traceability.

Mobile mine electrification

THE PROJECT

The Mine Operational Vehicle Electrification (MOVE) Project will use technology to help Australia's mining industry make informed decisions about the adoption of safer, greener and more efficient battery-supported electric vehicles (BEVs).

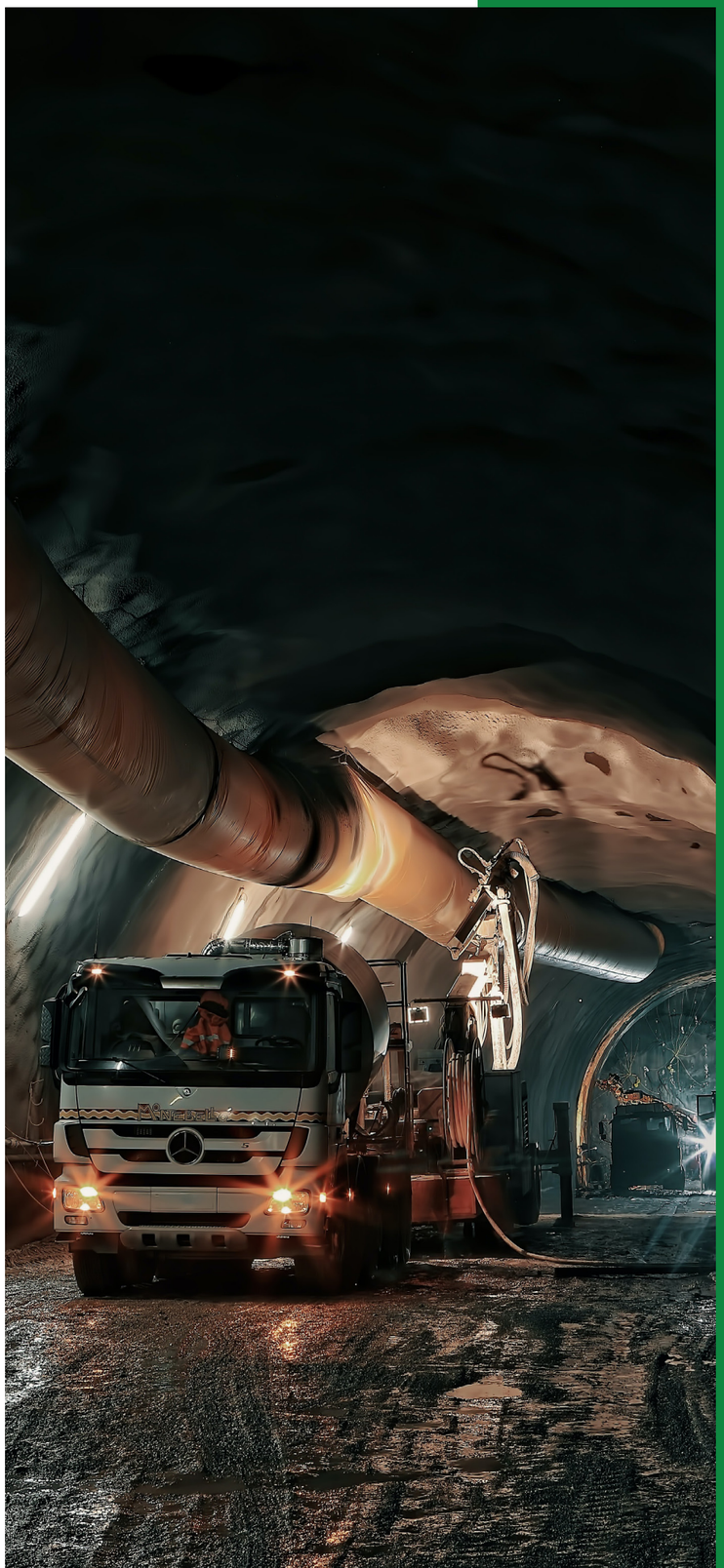
THE IMPACT

The mining industry currently relies on the use of predominantly diesel-powered vehicles for heavy equipment and machinery to transport materials between mining sites. With ESG and sustainability initiatives of increasing concern to investors and financiers, this project and its outcomes are particularly timely.

As a world-first, this project will help the mining sector to take the lead in the race to decarbonise, using the latest technology to improve decision making in terms of optimum timing and cost of deployment of BEVs.

RESULTS SO FAR

Site visits were undertaken to the BHP Nickel West mine in Leinster and the IGO mine.



Lithium extraction

THE PROJECT

The beneficiation and chemical processing of lithium minerals project aims to maximise production of Australia's lithium resource through improved processing.

By building on our chemical processing capabilities, the project will assist Australia to capture a greater share of the battery value chain in mineral refining.

THE IMPACT

With rising demand for lithium-ion batteries for electric vehicles and large-scale energy storage, there has been rapid development of new mines in Australia.

Many mines have struggled to maximise the amount of concentrate able to be extracted from the raw materials.

As a result, Australia is losing out on the higher value refinery market — worth approximately twice what is generated through producing concentrate.

The project aims to address these challenges to unlock and maximise production of Australia's lithium resource with lower capital and operating costs and reduced environmental impact. It is also developing cutting-edge cost-effective processing technology to help Australia perform refinery operations widely to capture a greater share of the global refinery market.

RESULTS SO FAR

The first stage of the project was completed in August 2021 and focused on the study of calcination technology using a flash calcination reactor. The results showed that this alternative approach is suitable for fine spodumene feed, as well as the coarse feed which is used in conventional processing technology. The results suggest some distinct advantages and opportunities which are being studied further.

Stage 2 commenced in early 2022 with the current focus on the completion of literature reviews and the development of research methodologies.

Process legacy

THE PROJECT

The Process Legacy project aims to find new ways of utilising mining ‘waste’ by turning residue resources into useful products.

In doing so, the project aims to reduce mining waste at its source, cut disposal costs while developing new and varied income streams for the mining industry.

THE IMPACT

Traditionally, in the process of mining, residue resources such as sand, rock, lime residues, geopolymer feedstocks and other minerals (known as tailings) are often disposed as waste.

Treating these by-products as waste, leads to high disposal costs, environmental impacts and inefficient utilisation of Australia’s valuable natural resources.

The Process Legacy project seeks to change the way we view mining and mineral processing residues to address this challenge.

By finding new ways of utilising mining ‘waste’, the project will help to lower costs for the mining industry, develop new and varied income streams and preserve valuable Australian resources while also creating new industrial jobs.

RESULTS SO FAR

Stage 1 of the Process Legacy project, completed in late 2021, identified options for development of by-products and resource recovery from the mineral processing industry.

Recycling, reuse and repurposing

THE PROJECT

The project aims to identify regulatory issues and barriers to large-scale recovery of end-of-life batteries.

The first phase of the project will include a review of Australian Regulations that cover storage, pre-treatment, and transport of end-of-life batteries in a commercial context. The second phase will deliver a set of recommended actions to improve battery recovery and recycling outcomes.

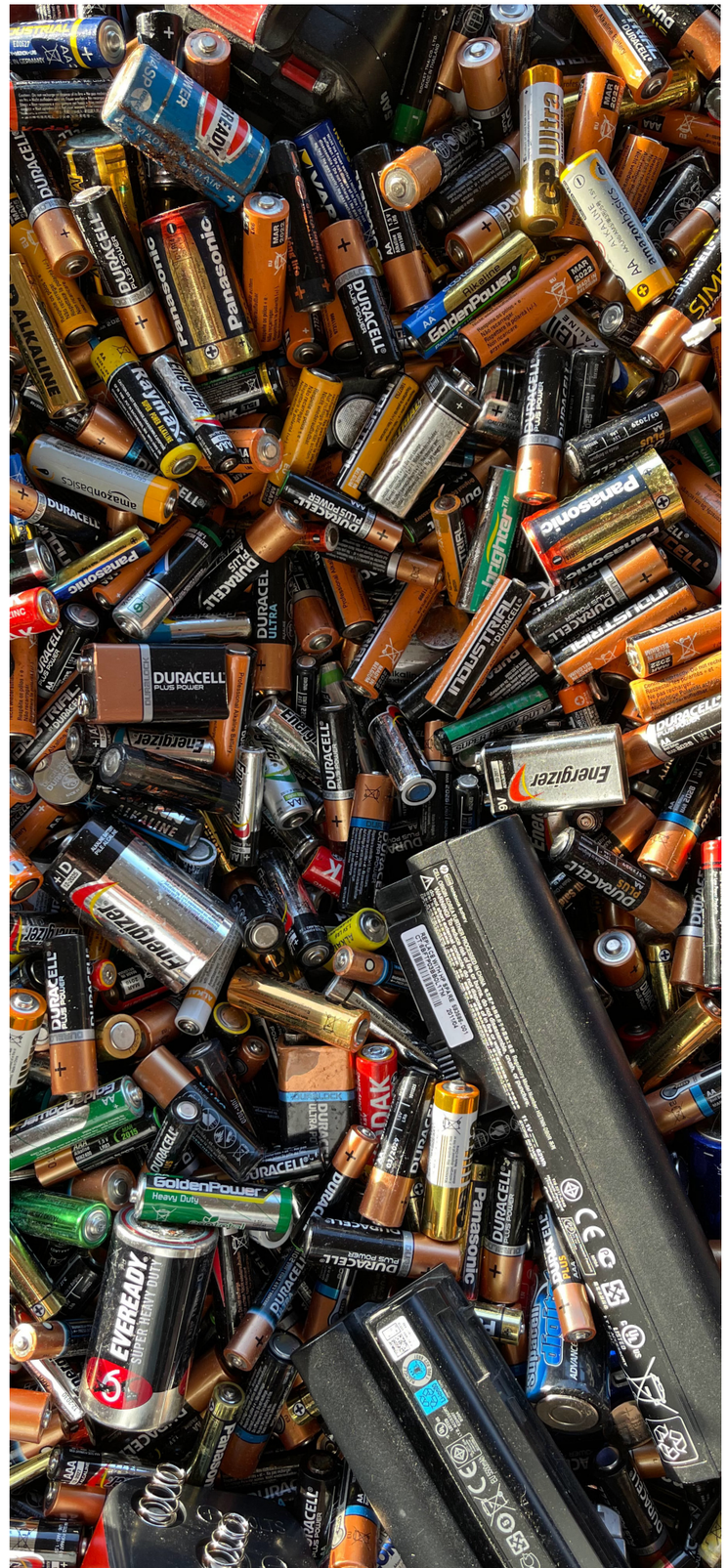
THE IMPACT

With battery usage predicted to grow ten-fold over the next decade, the need for effective end-of-life waste management strategies is becoming increasingly urgent.

Whilst delivering positive benefits for emissions reduction, the growth in battery demand and associated waste management, also creates potential safety and environmental issues for the community.

RESULTS SO FAR

The project received approval to commence outside of the reporting period in September 2022.



Development of vanadium electrolytes

Image supplied by Ultra Power Systems

THE PROJECT

Vanadium Redox Flow Batteries (VRFBs) are rechargeable batteries that use vanadium electrolytes to store energy. The electrolyte is one of the key components of a VRFB and has a direct impact on the battery's capacity and energy density.

In this project researchers are investigating the role and impact of additives and impurities to maximise electrolyte performance in a cost-effective manner.

THE IMPACT

This project will help to promote the further uptake of Vanadium Redox Flow Batteries (VFRBs) by maximising the performance of electrolytes and decreasing the cost to produce them.

Researchers are investigating the role and impact of additives and impurities to maximise performance in a cost-effective manner.

RESULTS SO FAR

The project received approval to commence outside of the reporting period in August 2022.

Stationary mine electrification

THE PROJECT

This project will help our largest miners transform their mine sites to cleaner technologies.

The project will also develop a virtual 'digital twin' which will allow companies to simulate, track and optimise the performance of their infrastructure and thereby reduce real world exposure to risk.

THE IMPACT

Mining and refining accounts for approximately 75% of the embodied emissions in battery cells. ESG performance is becoming more important in the mind of end consumers and lowering Australia's emissions will help improve our competitiveness.

RESULTS SO FAR

The project received approval to commence outside of the reporting period in August 2022.

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