RESOURCES
RESEARCH ROADMAP

Guiding research with impact for a prosperous, resilient and sustainable future

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

nier

SOLUTIONS FOR GLOBAL CHALLENGES
ENERGY RESOURCES FOOD WATER

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CONTENTS

Acknowledgement of Country

The University of Newcastle and NIER acknowledge the traditional custodians of the lands within our footprint areas: Awabakal, Darkinjung, Biripai, Worimi, Wonnarua, and Eora Nations. We also pay respect to the wisdom of our Elders past and present.

The University of Newcastle is committed to accelerating growth opportunities that ensure Australian industries remain at the forefront of the global resources sector

INTRODUCTION

Australia is a world-leader in producing and exporting a range of resource commodities. As the sector evolves and expands into new markets, the University of Newcastle is delivering enabling technologies that support sustainability and productivity. We are committed to leveraging our expertise to build diverse, safe and rewarding jobs and increase competitive advantage.

The International Energy Agency's *World Energy Outlook 2021* forecasts a significant increase in the demand for resources, particularly critical minerals and rare earth commodities. Growing economies and new technologies (digital, advanced manufacturing, defence and renewable energy) will drive this demand, shaping new industries, and the transition to a low emissions economy.

Australia's resource sector is in a strong position to lead a new wave of resource exploration, extraction, production where transformational mining practices and processes will extract new value for mining and manufacturing sectors.

This Roadmap articulates our University's vision to leverage its core capabilities to benefit the Australian resource sector. Ranked 23rd in the world for 'mineral and mining engineering' (QS Rankings by subject 2021) speaks to the University's significant track record and capacity in this area.

At the Newcastle Institute for Energy and Resources (NIER) an active and multi-disciplinary research and development (R&D) ecosystem is accelerating breakthroughs in mineral processing, geomechanics, material handling, transport and logistics, low carbon iron and steelmaking, mine safety and mine rehabilitation.

This Roadmap outlines NIER's commitment, through the University's 'Looking Ahead' Strategic Plan, to build on our research teams' innovation excellence in four key areas:

- Next Generation Resources for Future Mining
- Health, Safety & Environment
- Resource Recovery & Circular Economy
- End-user Functionality.

Our research plan will guide activity to support a vibrant sector, dedicated to achieving environmentally sustainable solutions while fostering a highly skilled workforce through knowledge networks, PhD Programs and infrastructure support.

Through our strategic partnerships, we will guide increased collaboration both nationally and internationally, working in-hand with government, mining and mining equipment technologies and services (METS) companies, universities, and research organisations to lead the decarbonisation of the sector.

SECTOR SNAPSHOT

Modern technologies and renewable energy solutions require new resource development, skills and infrastructure to support a low carbon future

Achieving the sustainability of the Australian resources sector requires a focus on higher product recovery while reducing costs and environmental impact. Expanding markets and securing supply chains during periods of rapid change and uncertainty, growing and supporting the health and safety of the resources workforce, and identifying solutions to improved environmental and social outcomes presents both challenges and opportunities for the sector.

NEXT GENERATION RESOURCES AND THE NEW ENERGY ECONOMY

The energy sector is emerging as a major influencing force for demand within the mineral markets. These minerals also have a range of high-tech applications across a variety of other sectors of strategic significance beyond energy into aerospace, defence technologies, automotive (particularly electric vehicles), telecommunications and agri-tech.

Forecasted demand growth for critical minerals presents an important economic opportunity for the sector. Examining opportunities for critical mineral downstream industries and circularity is a priority as companies actively embed sustainable consumption and production policies into business operations.

EXTERNAL SHOCKS AND SUPPLY CHAIN RESILIENCE

COVID-19 has acted as a major disruptor, both as a catalyst to drive the adoption of new technologies in some situations and in exposing supply chain vulnerabilities in others. It has highlighted a need to build sovereign manufacturing capabilities to accelerate product and services delivery to market.

A shift in the geopolitical balance in the Asia Pacific region is generating new market opportunities for Australia's products and services but also increased competition.

Research and industry partners working in-hand with government can build stronger supply chains in critical growth areas. The deployment of strategic demonstration projects that deliver commercial outcomes faster can also act to challenge end-user customer perceptions.

WORKFORCE ATTRACTION, FUTURE SKILLS AND SAFETY

Investing in, and developing future skills, particularly in regional communities, is critical to maintaining safe, effective and reliable operations.

To remain competitive, Australian resource companies must stay at the forefront of knowledge creation and technical problem solving, particularly in areas such as environmental management, business productivity, safe mining practices and processing innovation.

Highlighting the diverse opportunities available in Australia's future resources sector and ensuring more people are job-ready requires greater industry-aligned education and training offerings, and a focus on contemporary offerings to attract talent to the sector.

TECHNOLOGY INNOVATION AND DECARBONISATION

With the global transition towards net zero emissions by 2050, there is an unprecedented need to advance technologies to deliver the decarbonisation objective, while developing new technologies to concentrate the minerals and rare earths that underpin decarbonisation.

The sector recognises the need for accelerated efforts to reduce emissions across the value chain including greater recovery, recycling and reuse of materials in supply chains, low emission technologies in processes such as ironmaking.

The University of Newcastle is committed to working with the sector to strengthen supply chains, bolster new resources regions and deliver future workforce skills through targeted market driven solutions

GUIDING PRINCIPLES

The University of Newcastle has built an innovation ecosystem that positions the resources sector at the global forefront. Together with our partners, we will continue our commitment to develop the sector's future workforce, improve environmental performance, and build stronger communities and regions.

ACCELERATE MARKET DRIVEN SOLUTIONS FOR NEXT GENERATION RESOURCES

Priority setting cycles will identify and drive commercialisation outcomes with industry partners - accelerating the Australian resource sectors innovation agenda at-speed and at-scale. Commitment to expand world-leading capability behind the National Manufacturing Priority - Resources Technology and Critical Minerals, we will be proactive in our engagement with industry and academia to deliver a cooperative research commercialisation framework that strengthens capability at the institutional level to accelerate market driven solutions.

DELIVER HIGHLY SKILLED AND DIVERSE WORKFORCE PARTICIPATION

Opportunities for rapid research translation through doctoral training will provide mechanisms to fast-track job-ready skills for industry and better support early career researchers and industry professionals. Established targeted STEM programs in schools, work integrated learning opportunities and career mentoring will feed greater opportunities for female participation across the sector. Our Indigenous education offerings will ensure regional students and communities can actively shape and deliver on industry objectives.

STRENGTHEN SUPPLY CHAINS THROUGH COLLABORATION

The key to success and competitive advantage for companies lies in their ability to accelerate commercial innovation. As such the University will continue to prioritise the delivery of collaborative knowledge sharing opportunities to strengthen the agility of the sector. We will also act as a focal point for global collaboration, building engagement platforms and an integrated research network across the value chain.

GROW RESOURCES REGIONS

Our commitment lies in strengthening community resilience through evidence based applied research and best practice engagement to support new resources regions. We maintain a focus on social performance including safety, environmental stewardship and community licence for optimal outcomes in these regional areas.

STRATEGIC ELEMENTS

Underpinned by strong partnerships, our approach will focus on delivering four interconnected and mutually reinforcing strategic elements.

Through our actions, regional benefits will be derived from applied research, enhanced capacity, greater communication and knowledge translation, leading to the delivery of innovative and sustainable outcomes.

KNOWLEDGE BROKERAGE

Through NIER's engagement model, our programs will provide opportunity for increased dialogue between researchers and stakeholders to define the challenges to be solved through research.

We will focus on building relationships between knowledge producers and end-users to enable research to better respond to regional, national and local needs.

APPLIED RESEARCH

Researchers will actively seek research partners in the development and demonstration of market and community led research that supports evidence based best practice, ensures strategic alignment to regional needs, and promotes greater productivity, efficiency and sustainability.

Multidisciplinary teams will work across four key areas:

- Next Generation Resources for Future Mining
- Health, Safety & Environment
- Resource Recovery & Circular Economy
- End-user Functionality.

KNOWLEDGE TRANSLATION

The University will ensure that knowledge gained through research extends beyond the life of individual research projects to practice and skill development. We will focus our activities on experiential, interdisciplinary and regionally focused knowledge translation - sharing solutions to common social, economic and environmental challenges.

In particular, our activities reinforce the University's 'Looking Ahead' Strategic Plan by:

- Supporting work-ready graduates
- Delivering opportunities for workforce skills
- and training
- Maintaining an Asia Pacific focus
- Reinforcing STEM outreach.

CATALYSING INNOVATION

NIER will advance solutions through Research Development and Demonstration (RD&D), leading to service and product improvements. Our activity will support research initiatives that act as a driver for economic growth and as a drawcard for innovative companies looking to relocate or diversify.

Through NIER, the University assists in overcoming barriers to innovation whilst capitalising on the opportunities that next generation resources presents by:

- Accelerating the development of new enabling technologies
- Stimulating RD&D opportunities
- Maintaining a platform for successful commercial outcomes.

DEVELOPMENT ACTIVITIES

LEVERAGING STRATEGIC PARTNERSHIPS TO EXTEND OUR INTERNATIONAL REACH

Working in partnership with major resource companies and multi-institutional, international entities, NIER will deliver competitive advantage at the energy resources nexus.

We will **leverage** and **expand** our impact and international reach by:

- Strengthening research commercialisation structures to accelerate commercial readiness, including the adoption of innovative Intellectual Property arrangements, and clear pathways for academics engaged in commercialisation activity
- Furthering research capabilities aligned to the National Manufacturing Priorities
- Focusing industry alignment, including collaborative partnerships with industry and co-funding from business partners, greater workforce mobility between businesses and universities, and offering courses in priority areas that are endorsed by industry.

EXPANDING INDUSTRY CO-LOCATION & ACCESS TO DEMONSTRATION SCALE FACILITIES

Our activities will focus on addressing barriers to scale for industry. For many companies the capital needed to develop and demonstrate new technologies at scale and the risks to first movers is prohibitive.

We will embark on a growth program seeking government co-investment to expand University infrastructure in R&D areas of unmet need. We will increase opportunities for co-location and co-investment to de-risk activities in accordance with the Government's national manufacturing priorities.

Successful university-industry partnerships will be built with a focus on:

- Recruiting and supporting leading research staff to engage in breakthrough research commercialisation activities
- Training staff to build greater commercialisation capability
- Research infrastructure and other facilities to support commercialisation outcomes
- Developing new courses to address skills gaps in priority areas
- Engaging in new partnerships with industry, including opportunities for staff mobility.

DELIVERING FUTURE SKILLS & TRAINING IN AREAS OF CRITICAL NEED

The Doctoral Training Centre (DTC) for Advanced METS is a key initiative driving innovation in the Mining Equipment, Technology and Services (METS) sector. We will expand the DTC beyond Advanced METS to encompass opportunities for students in resource engineering, environmental science and management, and health and safety - particularly geared to regional communities where these skills are needed most.

Over the next 7 years we will support more than 70 PhD students and 15 postdoctoral researchers through the COE Minerals to pave the way for a new generation of research leaders for future low carbon mining.

NIER will develop pathways for the delivery of a number of tailored industry short courses designed to respond to regional industry demand for high quality training and skills shortages.

The resources sector will continue to be a major employer in indigenous communities. We will focus our efforts, alongside the University's Office of Indigenous Strategy and Leadership, to support opportunities for our indigenous students.

NIER will support women in the resources sector through the University's HunterWiSE STEM Program to improve high school female students' participation in STEM subjects and promote future careers in STEM.

ACCELERATING REGIONALLY SIGNIFICANT DECARBONISATION PROGRAMS

NIER will expand its facilitation model with additional engagement pathways for research commercialisation. As a vehicle for knowledge exchange, the NSW Energy and Resources Knowledge Hub (NSW ERKH), will host targeted events to build end user connections.

We will align our activities to key Federal and State government programs towards net zero by 2050. These include the Modern Manufacturing Initiative, the Critical Minerals Strategy, and the NSW Government Net Zero Industry Innovation Program

We will take a leadership role in decarbonisation initiatives such as the ARC Industrial Transformation Training Centre for the Global Hydrogen Economy and the CRC HILT.

We will build engagement networks in resources regions to support new markets. The Orana and Central West regions of NSW are major focal points for renewable energy, METS and infrastructure projects for NSW.

An area of additional focus relates to circular economy. NIER will seek to build engagement opportunities through networks such as NSW Circular and take a "Living Lab" approach to local waste challenges.

RESEARCH FOCUS AREAS

Coordinating and developing new technologies, techniques and human capabilities to address long-term, sector-wide challenges including:

- **NEXT GENERATION RESOURCES FOR FUTURE MINING**
- **HEALTH, SAFETY & ENVIRONMENT**
- **RESOURCE RECOVERY & CIRCULAR ECONOMY**
- **END-USER FUNCTIONALITY**

NEXT GENERATION RESOURCES FOR FUTURE MINING

Enduring impact through the delivery of next generation resources for a prosperous and sustainable future

Shifting from a carbon to a metals based economy brings with it important challenges for the sector. The need to accommodate this demand while addressing declining grade of the most accessible ore bodies, and the increased need for minerology and extracting ores from deeper mines will require a transformational shift in thinking and practice.

The University of Newcastle is seeking to advance a sustainable and competitive future for Australia's minerals and metals industries through the delivery of transformational technologies and a new generation of research leaders to support the sector.

THE UNIVERSITY AT A GLANCE

- Advanced microanalytical and spectroscopic techniques and facilities to boost understanding of critical mineral ores, mineral chemistry and chemical process development
- Field and structural geology, geochemistry, regional mapping, mineral systems studies and age dating of mineralisation
- Definition of optimum technology, operating parameters and blends for new deposits
- Novel particle beneficiation technologies to reduce energy and water us in critical minerals and rare earth processing including fundamental, applied science and engineering of particulate systems for faster and eco-efficient separation technologies using flotation and agglomeration
- Identify ways to efficiently recover and concentrate metal ions at high-feed fluxes and low concentrations without compromising the recovery process
- Hydrodynamics of flotation and foam fractionation for enhanced particle recovery, de-sliming and throughput
- Ultrafast agglomeration using concentrated water-based emulsions
- Classification of minerals and sands and the optimisation of manganese sand beneficiation
- Exploitation of centrifugal forces to achieve gravity separation of ultrafine particles
- Synthesis of polymers for exploitation in mineral processing
- Mineral particle recovery from mining waste streams
- Dry stackable tailings using fast efficient beneficiation of fine particles to solid-liquid separation design and development of advanced materials technologies using natural clay based halloysite
- Developing new models and innovative computational methods to better predict the behaviour of geomaterials, metals and composites
- Design and operation of storage systems (silos, stockpiles), feeders, in-plant conveyors (bucket elevators, screw conveyors, en-masse conveyors, pneumatic conveyors) and long distance conveyors (belt conveying and hydraulic conveying)
- New crushing modes to achieve fracture along the mineral grain boundaries, novel reagents, and new separators to remove the waste rock at a coarser size offer significant prospects
- Dust suppression and vibration effects in material handling, storage and transport systems
- Transportable moisture limits for safe ship transportation of ores and minerals
- Adhesion and flow behaviour in wet and sticky material
- Evolution of moisture migration from oscillatory motion induced by bulk material handling systems
- Specialised conveyor belt and idler roll test facilities
- Interface of feeders and transfers in problematic material
- Estimation and control for complex networked dynamic systems, design and development of stockyard management system, data and maintenance planning tools for export supply chains
- Transportation stressors on logistics chains
- Knowledge translation for community led initiatives.

MAJOR INDUSTRY R&D PRIORITIES

- Longer-term R&D focus to capture future opportunities
- Greater coordination and collaboration to address common sector-wide challenges
- Advancing on and off-earth exploration knowledge, tools and technologies, including for deep and unconventional resources.
- Advancing knowledge and understanding of modular solutions, standardisation and interchangeability (e.g. for provision of mobile or incremental processing and materials handling capacity, plug and play capability, etc.)
- Advancing resource engineering and beneficiation technologies (e.g. selective mining, comminution, classification, reducing tailings/reject streams, in-situ recovery, small scale robotics for continuous mining, bio-leaching and nanotechnology).

CASE STUDY

CENTRE OF EXCELLENCE IN MINERALS

Critical minerals are essential building blocks to a low carbon future. The transformation of the minerals industry and establishing a new generation of research leaders and innovation is essential in creating a green economy for the future.

Through a national collaboration of multiple universities and industry partners headquartered at NIER, the ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals (COE Minerals) will develop and commercialise new and more sustainable mining technologies as demand for minerals increases.

Led by Laureate Professor Kevin Galvin, the Centre oversees collaboration with researchers from seven other Australian universities, the CSIRO, industry partner organisation and leading international researchers.

The COE Minerals plays a key role in bringing researchers together to find sustainable technologies to reduce the environmental footprint of mineral recovery. Over the next seven years, more than 70 PhD students and 15 postdoctoral researchers together with consortia members will be working across multiple research disciplines to achieve the Centre's transformational solutions.

Pressures associated with extracting some minerals and the expenses and environmental impact make it urgent to transform the value addition of mineral processing. COE Minerals will seek to double energy and water productivity, reducing the loss of high value metals during processing by up to 90 per cent.

The COE Minerals is playing a critical role in developing the next generation of scientists and engineers that will have a significantly positive impact on the economy and the environment of a sector.

HEALTH, SAFETY & ENVIRONMENT

Providing a healthy and safe environment to all industry workers and their surrounding communities.

The Australian minerals industry is a world leader in workplace health and safety and lists workplace safety as the sector's number one priority. Good environmental stewardship is also fundamental to responsible business practice and industry is working across the mining lifecycle to reduce environmental impact.

Researchers at the University of Newcastle are developing effective health, safety and environmental programs based on the industry and community core values. Preventive measures are being implemented regarding workplace culture, mental health, hazards and planning to support mine closure and rehabilitation.

THE UNIVERSITY AT A GLANCE

- Geotechnical analysis for mine safety and productivity including stability analysis of very high spoil piles and large-scale direct shear testing of waste rock
- Improved management of rockfall hazards at the base of highwalls and rockfall hazard metrics for risk reduction in mine sites
- Rockfall risk assessment and management for transportation infrastructure
- Understanding horizontal closure and its impact on deformation and height of fracture
- Quantitative assessments of hazardous areas, experimental testing and numerical modelling
- Ventilation air methane (VAM) abatement technology for mine safety
- Airbag explosion suppression system for mitigation of VAM explosions
- Fire safety and kinetics of chemical reactions in combustion systems, extinction of flames and mitigation of fires, mass and heat transfer and, fluid mechanics in fires
- Dust extinction moisture standard
- Managing material flows to benefit human health, the environment and the economy
- Development and implementation of evidence-based programs and virtual health systems to improve mental health, risk taking behaviours, reduce fatigue, alcohol and other drug use related problems in mining
- Management of overweight and obesity
- Task rotation in underground coal mine sites
- Risk based management and innovative remediation methods for contaminated soil and groundwater
- Advanced wastewater treatment technologies and water recycling systems
- Enhanced models for community participation in decisions about land use, coexistence and the sustainability of critical regional industries
- Post mining rehabilitation design assessment
- Final void behaviour and the impact of final void filling and post mining land use
- Landform evolution modelling
- Geo-remediation and contaminant migration
- PFAS remediation technologies and risk assessment in current and legacy sites
- Risk based management of petroleum hydrocarbon contaminated ground water
- Climate and disaster risk modelling
- Water supply security and hydroclimatic data modelling
- Characterising the epidemiological and biological effects of particulate matter exposures in mining health service delivery to remote areas and models of health practitioner training
- The feasibility, acceptability and effectiveness of online therapy for the treatment of mood, alcohol and other substance use concerns
- Examining community wellbeing and social determinants of health
- Sound evidence base to better understand individuals, communities and industries

MAJOR INDUSTRY R&D PRIORITIES

- The rapidly growing application of digital technologies including the Internet of Things (IoT), Data Analytics, Artificial Intelligence (AI) and Machine Learning, Automation and Autonomy, and Robotics for mine safety and rehabilitation.
- Demonstration of leading practices in social performance including health, safety, environmental stewardship and community licence.
- Improving remediation and rehabilitation techniques for old, ongoing and future workings.
- Establishing a cohort(s) of academic and industry leaders to develop the economic, social and environmental performance associated with the sector's technological innovation.

CASE STUDY

ROCKFALL HAZARD REDUCTION

Rockfall risk is largely considered and managed in the context of civil infrastructure, such as road or railway corridors. Rockfall is also a significant hazard in the context of mining environments, threatening human lives, machinery and portal structures for underground entry areas located at the toe of highwalls. Safety of workers in all mine areas affected by rockfall has to be rigorously managed and appropriate mitigation measures are necessary to reduce the risk to an acceptable level. In addition, rockfall hazard can have significant financial consequences if the production must stop for safety reasons.

An Industry led project focused on the development of a rockfall hazard matrix for risk reduction in mine sites is extending existing rockfall hazard methodology with a new Evolving Rockfall Hazard Assessment (ERHA) methodology that incorporates field data, current analytical and numerical tools and cutting-edge research developments in rockfall hazard assessment and zoning.

Supported by Glencore, BHP and Anglo American through the Australian Coal Industry's Research Program, mining and civil sectors can now efficiently identify the most hazardous areas and assess for critical zones, which helps them define exclusion zones and mitigate site-specific risks.

Led by Professor Anna Giacomini through the University's Priority Research Centre for Geotechnical and Materials Modelling, these results provide greater accuracy in locating personnel, machinery, and structures across work sites, thereby improving safety and reducing the risk of interruptions in production.

The research was developed in an Australian context but is applicable to a broader international context, both in civil and mining environments.

RESOURCE RECOVERY & CIRCULAR ECONOMY

Development and deployment of technologies and strategies to revolutionise Australia's waste systems

Waste and resource management practices are shifting in Australia and globally. The value of resources and embodied energy in waste is now recognised. There is an economic opportunity and growing desire to recapture resources and recirculate them within the economy. The vision of developing a circular economy is gathering pace, as community reaction against waste hardens, and bans on export of some of our waste places communities under extreme pressure.

NIER offers a collaborative platform to deliver increased productivity and sustainability for industry through innovation in resource recovery and waste management. Researchers are working across industry, local governments and businesses, and across the supply chain in areas including waste characterisation, the development of new applications for resource recovery and re-use, handling and remanufacturing. We measure our impact through increased sustainability by reducing energy and water consumption while maximising resource recovery and product grade and delivering sustainability, efficiency and productivity gains.

THE UNIVERSITY AT A GLANCE

- Separation of phosphorus from steelmaking slag, allowing recycling of iron and fluxes and the production of high phosphorus co-products for agriculture
- Solid-liquid separation for the recovery of waste solids, with reduced water losses and increased water productivity and enhanced de-watering capabilities.
- Electrolyte recycling to value-added materials for agriculture, environmental remediation
- Waste heat recovery systems using co-generation plants and heat pumps
- Waste minimisation techniques including biochar, char from coal tailing, and chemical looping of municipal solid waste
- Tailings management as a soil amendment for agricultural re-use and mine rehabilitation
- Second generation dewatering systems
- High value brown coal liquefaction products
- Examination of pore structure development of the blends of Australian coking coals and plastic wastes during the coking process
- Transformation cross linking structures in the plastic layers during coking of Australian coal and its role in coke formation
- Treating emerging contaminants from waste streams
- Sustainable and integrated waste processing and utilisation with energy recovery and generation
- Adaptation of design tools for rehabilitation and management of industrial waste
- Assessing the effectiveness of using recycled material in new products and construction materials
- Innovative methods for reuse of materials, including proof-of-concept demonstration
- Socio-economic analysis to assist with waste reduction and increased use of recycled materials
- Improved material characterisation, sorting and re-processing
- Options for the management and quantification of waste stockpiles.
- Information to support innovation, guide investment and inform consumer decisions
- Waste systems analysis modelling using artificial intelligence machine learning and blockchain technologies
- Harmonising policies and standards for the use of recycling and reused products
- Circular design of new products incorporating recycled materials
- Systems for better identification, tracking and monitoring of hazardous waste.

MAJOR INDUSTRY R&D PRIORITIES

- Responsible, technology-led resource management with enhanced analytics and automation
- Increases in the interoperability of equipment and systems, to help maximise the capability and benefit of automation, integration and data analytics
- Exploring new commodities and products
- Providing deep technical support for industry in a regulatory environment
- Water, energy (carbon emissions) and miscellaneous emissions (pollution, tailings and waste) and the acceleration of efficient technologies.

CASE STUDY

MINE REHABILITATION USING TAILINGS FOR TOPSOIL

In partnership with Muswellbrook Shire Council, Bengalla Mining Company, Jord International, MACH Energy and Australian Coal Association Research Program (ACARP), NIER researchers at the Centre for Bulk Solids and Particulate Technologies are advancing a “Tailings to Topsoil” project. This project is exploring alternative solutions to tailings disposal in mining operations by transforming suitable tailings into a soil additive for developing high-performance biomass production.

Using innovative technologies, the project aims to convert raw mine tailings into topsoil that can be used to grow crops for mine rehabilitation, energy or biofuel production. PhD students at the Advanced METS Doctoral Training Centre are also assessing the cost-effectiveness of the technology for farmable topsoil addition and germination and plant growth techniques.

Evaluating tailings and soil blends to optimise germination and plant growth and to further improve the qualities of tailings samples is occurring through greenhouse trials at NIER, and field trials at mine sites.

The flow on benefits of the project include the creation of additional pathways for agribusiness on mined land, improving fertility through carbon availability, and water retention on marginal lands.

Photo credit: ABC Rural

END-USER FUNCTIONALITY

Responding to changing market demands, and supporting emissions reduction across the value chain, by working with end-users to achieve sectoral decarbonisation

As industry matures, innovations rely on more sophisticated and complex technologies brought to market through collaboration with resources companies, universities and key suppliers to look at existing resources in new ways. To remain competitive, Australia needs to stay on the crest of the technology wave to ensure its resources sector has the most comprehensive knowledge to make the most informed decisions.

NIER researchers are evolving a portfolio of technologies that enable industrial transformation through step-change improvements and solutions to complex problems.

THE UNIVERSITY AT A GLANCE

- Optimising iron ore blending, granulation and sintering conditions to maximise sintering process performance and quality
- In-situ investigation of coking phenomena, microstructure, microtexture analysis and mechanical properties
- Ferrous material properties and the behaviour and performance of these in the blast furnace
- Impact of hydrogen injection on the performance of ferrous burdens and coke in the blast furnace.
- Interaction of ferrous burden materials in the cohesive zone of the ironmaking blast furnace under hydrogen operation
- Achieving high grade metallurgical coal concentration
- Novel hydrogen production using brown coal and the suitability of plastic layers during coking of Australian coals
- Application of the Reflux Flotation Cell in achieving high grade metallurgical coal concentration
- Advanced low emission carbon manufacturing to produce carbon based storage systems, carbon foams, fibres and films
- Improved understanding of efficiency, emissions, process parameters, and feedstock requirements of low-carbon ironmaking technologies
- Identification of the coal and coke quality parameters (e.g. rank, fluidity, maceral composition) that influence the performance of sustainable cokemaking and ironmaking units
- Developing valid criteria to allow meaningful assessment of the suitability of Australian metallurgical coals
- Utilise the vast resources of low-grade coal and biomass in Australia as precursors for advanced carbon materials
- Explore brown coal as a precursor for the synthesis of advanced carbon materials for energy storage
- Investigate the fabrication of foam-like carbon composite materials from the blend of brown coal with coal tar pitch
- Better understand the evolution of pore structure during high-pressure pyrolysis and the development of graphitic microstructure for process optimisation
- Utilising the synthetic porous graphitic composites as anode materials in energy applications.
- Investigating the effect of inherent heteroatoms in the composite carbon material on the catalytic graphitisation process and electrochemical performance

MAJOR INDUSTRY R&D PRIORITIES

- Optimising resources to supply fit-for-market products and support the transition to a more sustainable position in the global marketplace
- Continued identification, development and adoption of new measures and technologies to reduce carbon emission
- Better understanding of modelling interactions between inputs for greater productivity and efficiency
- Partnering to accelerate low carbon processes and technologies.

CASE STUDY

LOW-CARBON IRON AND STEELMAKING TECHNOLOGIES

Greenhouse gas emissions from steelmaking represent around 7-10 per cent of global total estimated emissions and the industry remains one of the most difficult sectors in the world to abate. The creation of new technologies and pathways capable of emissions reduction is essential to move in the direction of a sustainable future.

The Centre for Ironmaking Materials Research (CIMR) at NIER has partnered with BHP to support ongoing research into decarbonising steelmaking. This expanded research program focuses on low carbon iron and steelmaking using BHP's iron ore and metallurgical coal, including conventional blast furnace ironmaking with the addition of hydrogen, and emerging alternative low carbon ironmaking technologies.

BHP has a long history with the city of Newcastle, and with the University dating back to commencement of collaborative iron and steel research in 1957. The establishment of NIER in 2010 was a major step in BHP's support for the local community of steelmaking research.

The partnership between BHP and the CIMR will define the link between fundamental iron ore and metallurgical coal properties and their performance in the ironmaking process. This ongoing research into decarbonising steelmaking recognises the critical role Australia needs to play in the optimisation and innovation of the industry.

Through the development of these new innovative energy technologies, the Australian iron and coal industry can transition to a more sustainable future and position in the global marketplace.

ENGAGE WITH US

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