TECHNOLOGY AND THE AGRICULTURE AND MINING SECTORS

Organisation: University of Newcastle

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Thank you for the opportunity to make a submission to the NSW Parliament Inquiry into Technology and the Agriculture and Mining Sectors.

Technological advancement, advanced manufacturing, climate change and land use pressures pose immense challenges for the mining and agricultural sectors that technology, and in particular university research, will be essential to addressing.

Technology in the Mining Sector

The University's recently released 'Resources Roadmap' outlines much of the challenge facing the mining sector.

The Australian resources sector is rapidly expanding with rising global demand for modern technology and renewable energy solutions requiring new resource development, skills and enabling technologies. Low carbon technologies require lithium, cobalt, nickel, manganese, and copper, while smartphones contain up to different metals including rare earths. With a projected global population of nine billion by 2050, strong growth in the need for these resources over the long term is being met with declining grades of the more accessible minerals and increasing complexity of minerology and the growing need to extract the minerals from deeper mines.

Achieving the sustainability of the Australian minerals industry requires higher metals recovery while reducing costs and environmental impact by reducing energy and water usage. 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 challenges and opportunities for the sector.

The University of Newcastle is a leader in critical minerals research and industry engagement, working with national and international companies to improve processes and develop new systems and equipment to continually increase efficiency, safety and productivity of Australian mining.

Critical to this success is an approach that enables us to work at an industrial scale with companies to pilot, test and refine processes. At the University's Newcastle Institute for Energy and Resources (NIER), we support an active ecosystem to accelerate breakthroughs in processing techniques, geomechanics, material handling, transport, and logistics, through to mine safety and rehabilitation.

NIER has laid a strong foundation for the future direction of our research and development efforts. Working in-hand with Government, mining and METS companies, universities, and research organisations we will continue to work confidently and collaboratively to bring about further transformation and success to the resources sector.

This approach has been built over years in partnership with the mining sector, and rests on a strong foundation of discovery. For more than 30 years, Distinguished Laureate Professor Graeme Jameson's work has revolutionised the way minerals are extracted from rocks. His most famous invention, the Jameson Cell, has recovered AU\$65.5 billion in export coal since 1992, and led to

significant savings energy consumption and greenhouse gas emissions. Professor Jameson worked directly with industry throughout his career to drive much of this discovery and has supervised many of today's leaders in the discipline, currently at NIER.

This work has evolved over time such that the University is the current home to the \$35 million <u>Centre for Enabling Eco-Efficient Beneficiation of Minerals.</u> 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.

Mining technology on display at NIER is not limited to critical mineral extraction. Companies located on the NIER precinct include those using mining-related products, such as coal, waste or tailings for other novel uses. For example, <u>Mineral Carbonation International (MCi)</u> has developed a scalable carbon platform technology that captures and converts industrial CO2 emissions into solid bulk materials used in new low-carbon products for construction, manufacturing and consumer markets - enabling a circular economy.

Skills and Research Training

Ongoing investment in human capital in mining technology is essential for the continued advancement of the mining sector.

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.

The University has deployed a Doctoral Training Centre (DTC) model for research students in the mining sector. The DTC in Advanced METS is a key initiative driving innovation in the Mining Equipment, Technology and Services (METS) sector, bringing research students together with industry and academia to work on industry problems in real-world settings. We are expanding 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.

The University will also 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.

University of Newcastle Resources Roadmap

The University Resources Roadmap is attached, and forms part of the submission. This Roadmap outlines our focus in four key areas:

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

Hunter Hydrogen Roadmap

The <u>Hunter Hydrogen Roadmap</u> was developed through the collaboration of multiple stakeholders and launched by the Committee for the Hunter in 2021. The relationship between mining and new energy, including hydrogen, involves human capital, supply chains and innovation, and is underpinned by technology. For example, from the Roadmap, "blending hydrogen into a natural gas network co located with hydrogen refuelling stations supplying ... forklifts, buses, trucks and cars and other activities can spawn a variety of new industries, greater diversification and jobs in regional NSW. A remote mining site could produce green hydrogen on site for use in vehicles as well as backup power supply replacing fossil fuel sources." The tech-intensive mining industry is likely to play a key role in the development of new energy, through considerable interdependencies in expertise and applications of technology.

Technology in the Agriculture Sector

Food producers, manufacturers and farmers are under increasing pressure to reconcile a number of complex and competing challenges around quality and efficiency, health and environmental sustainability and food security.

At the same time, food and agribusiness is increasingly becoming a focal point for regional innovation and development, changing the economic and social role of food production, processing, distribution and food services more generally.

Pressures from population growth, climate change, changing consumer demand and biosecurity risks challenge the sector constantly. Research and technology is essential for the Australian agriculture sector to evolve and gain competitive advantage in global market.

Skills and Training

The University of Newcastle's Doctoral Training Centre in Food and Agribusiness was established on the Central Coast in 2020. As the first centre of its kind on the Central Coast, the Food and Agribusiness DTC will provide a platform for inter-disciplinary research and training in an industry that has strong regional ties and is committed to collaboration and innovation through education and research.

DTCs support cohorts of PhD candidates grouped around a common research theme, with a strong focus on embedded industry engagement. The DTC focuses on four key areas in the Food and Agribusiness space: Product Science, Climate Resilience and Sustainability, Advanced Technology, and Market Access.

Agricultural Technology and Entrepreneurship

Agricultural technology is also supported through the University's Integrated Innovation Network (I2N), which was set up through funding from the NSW Government's now ceased Boosting Business Innovation Program. With support from I2N, and access to training, mentorship and networking, three former PhD students formed <u>Hone Group</u>, which has created novel handheld technology to use on farm to instantly analyse soil carbon and crop nutrients at a fraction of the current cost of laboratory samples. This technology has widespread application in carbon farming, and in food quality, which is challenged by climate change.

Soil CRC

The Soil CRC (CRC for High Performance Soils), headquartered at the University of Newcastle, was established in 2017 to give farmers the knowledge and tools they need to make decisions on extremely complex soil management issues. Its aim is to bridge the gap between soil science and farm management, ensuring that soil performance is increased not just in the short term, but in the long term. Through its soil research and innovation program, the Soil CRC is developing novel solutions that will unlock the potential of Australia's agricultural sector.

Food and Agribusiness Roadmap

The University's Food and Agribusiness Research Roadmap is attached and forms part of this submission.

RESOURCES RESEARCH ROADMA

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





SOLUTIONS FOR GLOBAL CHALLENGES ENERGY RESOURCES FOOD WATER

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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.

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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.

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



SECTOR SNAPSHOT

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 jobready requires greater industry-aligned education and training offerings, and a focus on contemporary offerings to attract talent to the sector.

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

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 atscale. 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 endusers 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
- 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 waterbased 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).

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 evidencebased 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.

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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 wa stem

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 reprocessing
- Options for the management and guantification 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.

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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.



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

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.



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

For more information visit the NIER website.



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AGRESS RESEARCE ROADWAP

Guiding research with impact for resilient regional communities



GLOBAL IMPACT CLUSTER ENERGY – RESOURCES – FOOD - WATER

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INTRODUCTION

Food producers, manufacturers and farmers are under increasing pressure to reconcile a number of complex and competing challenges around quality and efficiency, health and environmental sustainability and food security.

At the same time, food and agribusiness is increasingly becoming a focal point for regional innovation and development, changing the economic and social role of food production, processing, distribution and food services more generally.

This Roadmap identifies and defines priority actions necessary to position UON as a major enabler of innovation, delivering scientific and technological advances to improve productivity, efficiency and ultimately competitiveness for the food and agribusiness sector.

This Research Roadmap:

- Offers a strategic direction to guide capacity building to support industry and regional communities
- Provides a framework from which researchers and business can align and coordinate their efforts to increase impact
- Focuses workforce needs and priorities to enhance career pathways for graduates and postgraduates

The Global Impact Cluster for Energy Resources Food and Water (GIC ERFW), administered by the Newcastle Institute for Energy and Resources (NIER), is an enabling platform to deliver, through multidisciplinary collaboration and partnerships:

- Research and innovation to support superior products and services
- Growth, resilience and greater productivity
- Opportunities for scaling for export growth
- Social and environmental benefits

This Roadmap articulates UON's vision to leverage its core capabilities to benefit Australian industry. This 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 and infrastructure support. This Roadmap aligns the University of Newcastle's strengths in applied research and identifies key enabling activities required to build sector advantage.



SECTOR SNAPSHOT

Over the coming years a number of challenges and opportunities will shape the food and agribusiness sector and the communities they serve.

POPULATION GROWTH AND INCREASED DEMAND

It is expected the world's population will surpass 9.5 billion people by 2050, dramatically shifting the demand for food. High quality foods and varying food sources such as trends towards high protein products are expected. Further, by 2030, roughly 175 to 220 million hectares of additional cropland will be needed to meet projected food, feed, and fuel demand. In contrast almost 800 million people worldwide will have insufficient food, with over 2 billion suffering from micronutrient deficiencies.

CLIMATE CHANGE

Food and agricultural systems will continue to be challenged by the impacts of climate change. As rising temperatures, shifting rainfall patterns and extreme weather events put increased pressure on production systems, greater responsiveness will be required to adapt to new threats and food, water and energy security issues. Sustainable solutions maximising the efficient use of limited resources. technologies to maintain food quality and safety, and increased sustainability measures through circular economy approaches will be needed to satisfy consumer demand into the future.

The University of Newcastle will work actively to accelerate major scientific outcomes for increased productivity, enhanced biosecurity, resource sustainability, quality products and market opportunities.

CONSUMER CHOICE AND HIGH VALUE, QUALITY GOODS

The way consumers are seeking to engage with premium offerings will continue to change, with convenience and sensory experiences in growing demand. Coupled with continuing and intensifying competition in global commodity markets, an inability to compete on price means local businesses may have little option but to target premium and high quality global markets.

BIOSECURITY

The complexity of the food supply chain and the introduction of new technologies in food processing will increase food safety risk. Guaranteeing the safety and integrity of Australia's supply chain and protecting food from microbiological contamination, disease and pests will be ongoing challenges.

GUIDING PRINCIPLES

This Roadmap demonstrates UON's commitment to support research translation to deliver new and improved Australian products and services in domestic and international markets. We will focus the delivery of capacity building initiatives in accordance with the following principles: The University of Newcastle is committed to the provision of quality research and research education to deliver increased competitiveness to the food and agribusiness sector.

ESTABLISH PRIORITY SETTING CYCLES

Priority setting that keeps pace with the rate of change in the sector, and which complements government policy and investment will build opportunity for public-private sector partnerships. This will encourage stability to undertake large scale endeavours as well as incremental step change at an SME level. Attention will also be given to addressing gaps in the innovation system that present barriers to the uptake of new processes as well as reinforcing and strengthening current systems.

LEAD ACADEMIC, GOVERNMENT AND INDUSTRY SECTOR PARTNERSHIPS

Targeted enterprise engagement programs will provide exposure to career pathways and mentoring. Opportunities for advancement through doctoral training will provide mechanisms to fast-track solutions for industry and better support early career researchers and industry professionals.

DRIVE OPPORTUNITIES FOR RESEARCH COMMUNITY THROUGH REGIONAL DEVELOPMENT INITIATIVES

Strategic activities that enhance regional capability and harness UON's collective capacity will deliver opportunities for research to drive innovation and build equitable prosperity, social cohesion and healthy communities.

BUILD HUMAN CAPACITY THROUGH KNOWLEDGE TRANSFER AND SKILL DEVELOPMENT

Strategies aligned to workforce needs will enhance career pathways for graduate and postgraduate students and deliver regionally relevant programs. Novel delivery methods will be explored to enhance research training opportunities.

STRATEGIC ELEMENTS

In consultation with major stakeholders, UON seeks to support sector competitiveness by closely aligning its research and education programs to meet industry needs. In achieving this goal, our approach will focus on delivering five core strategic elements which are seen as critical to building capacity and sector strength. These common elements will be reflected in plans undertaken by UON to drive focused activity.

REGIONAL **ENGAGEMENT**

Enhance collaboration to better deliver outcomes to stakeholders by building skills and networks that support increased knowledge transfer and R&D adoption. Support resource intensive regions through collaboration, strategic partnerships and leadership aimed at economic diversification with the creation of new opportunities and innovations.

INTERNATIONAL COLLABORATION

Tackle global challenges collaboratively via an interdisciplinary network of researchers, students, industry partners and other stakeholders.

POSTGRADUATE TRAINING

Foster an enterprise culture and develop industry ready graduates through access to specialist research facilities and industry-focused, collaborative research partnerships.

TECHNOLOGY TRANSFER

Establish innovative platforms that give SMEs the resources, knowledge, networks and infrastructure to transform ideas into enterprise. Build critical mass to deliver R&D outcomes for businesses.

KNOWLEDGE **MOBILISATION**

Contribute to knowledge creation and transfer through the delivery of doctoral courses targeted to industry needs, and support accreditation pathways and funding avenues to upskill future work forces.

DEVELOPMENT ACTIVITIES

DRIVING APPLIED RESEARCH **THROUGH DEDICATED RESEARCH CENTRES**

Targeted industry-led research will be undertaken across the following research focus areas:

- Product Science
- Climate Resilience and Sustainability
- Advanced Technology
- Market Access

These focus areas align to state and federal government policy, national sector competitiveness plans and reflect international and national sector trends.

Strategic activities will support the needs of industry by concentrating interdisciplinary expertise within dedicated research centres.

BUILDING COLLABORATIVE PARTNERSHIPS

Modelled on the successful flagship institute, NIER, partner networks will be leveraged regionally, nationally and internationally to deliver tailored activities that support the research objectives of SMEs to benefit the sector as a whole.

UON will work closely with relevant government and industry peak bodies to develop strategic initiatives that respond to the needs of the food and agribusiness sector, supporting regional development and jobs arowth.

ENABLING INDUSTRY READY APPLICATION THROUGH THE PROVISION OF SPECIALISED FACILITIES

Investment in UON's existing research facilities will be made to ensure infrastructure such as open access laboratories, testing facilities and demonstration plants support the development of industry ready applications.

Collaboration spaces and associated support programs will also be available and highly visible to potential investors, partners and governments.

ESTABLISHING A DOCTORAL TRAINING CENTRE

A Doctoral Training Centre (DTC) dedicated to food innovation and agribusiness will be established. The DTC will bring postgraduate students and researchers together with industry, business and government partners to inspire new ideas, new ways of working and smarter solutions to industry challenges.

As a collaborative initiative, the DTC will provide industry partners with unprecedented access to a pool of knowledge for targeted projects while supporting students to gain industry ready skills.



COORDINATING ACTIVITY THROUGH ESTABLISHED **REGIONAL NODES**

Activity will be focused in regional nodes in the Upper Hunter, Central Coast and Pacific region. These regional nodes will leverage each other to solve shared challenges, boost sustainable regional development, promote economic diversification and improve social and health outcomes.

RESEARCH FOCUS AREAS

The food and agribusiness sector is faced with a number of challenges and opportunities that will shape its evolution over the next 5 to 10 years.

In meeting future demands, UON will leverage its existing expertise in applied research and build capacity to develop opportunities across four key areas:

- PRODUCT SCIENCE
- CLIMATE RESILIENCE & SUSTAINABILITY
- ADVANCED TECHNOLOGY
- MARKET ACCESS



PRODUCT SCIENCE

Optimising food and agriculture production to deliver economic, environmental and health benefits.

Challenges to the environment are predicted to place increased stress on production yields resulting in shorter growing seasons, increased heat stress and exacerbating water and food security issues.

Coupled with issues related to diet and associated health diseases, greater attention is needed on healthy consumption, lifestyle choices and overcoming challenges related to an ageing population.

UON integrates knowledge across a wide range of contributing disciplines encompassing plant, marine, food and health sciences to tackle these challenges and improve environmental and health outcomes.

UON AT A GLANCE

- Microbiology, genetics, genomic engineering and biotechnological approaches to generate plant lines resistant to environmental stress
- Soil health, amendments, delivery mechanisms and precision management solutions
- Soil moisture, water quality and hydrology, weathering and degradation
- Nutrient dynamics for crop productivity
- Optimised resource allocation for maximising food, fibre and fuel productivity
- Development of novel biomarkers for plant, human and animal health
- Advanced aquaculture methodologies
- · Molecular nutrition and health science
- Nutrigenomics, nutraceuticals for human health
- Microbiome and digestive health
- Clinical nutrition, diet quality, metabolic markers, stress responses in humans and animals

- Reproduction, biotechnology and advanced breeding
- Pharmaceuticals, disease control and smart supplements
- Bioactive compounds derived from natural materials

MAJOR INDUSTRY R&D PRIORITIES

- Health and wellness
- Soil health and land management
- Animal feed additives and health
- · Biopesticides and microbial fertilisers
- Advanced breeding and fertilisation



THE CENTRAL COAST FOOD INNOVATION REGION INITIATIVE

Building on a formal partnership between Regional Development Australia Central Coast and Central Coast Industry Connect, UON is leveraging the NSW Central Coast's existing strengths to grow the local food industry and boost economic and social outcomes.

The Central Coast Food Innovation Region Initiative is a catalyst project to grow jobs and, build regional business competitiveness through innovation, education and research. Partners are working to foster greater industry, academic and government collaboration that will:

- Concentrate expertise in specific fields across food industry disciplines, working towards making discoveries, strengthening capability and delivering holistic solutions
- Build a partner network supporting research objectives and broader strategic initiatives for the benefit of many
- Expand existing research facilities including laboratories, testing services, industrial scale workshops and large-scale demonstration plants enabling industryready applications
- Build a cohort of industry-ready graduates through access to specialised research facilities and industry-focused
- Develop collaborative research partnerships and innovation platforms giving SME's the resources, knowledge, networks and infrastructure to transform ideas into enterprise
- Grow a central hub of related food activity on the NSW Central Coast.



CLIMATE RESILIENCE AND SUSTAINABILITY

Providing sustainable solutions to environmental challenges.

The challenges posed by climate change and population growth will place increased pressure on limited natural resources, affecting the productivity and reliability of existing production systems. UON's world-renowned engineering and science expertise is focused on the development of new technologies to optimise resource sustainability and efficiency.

UON AT A GLANCE

- Climatology and vulnerability modelling
- Hydrodynamics, water management and water efficiency technologies
- Isotopic testing, tracers, GIS modelling and remote sensing for water and land management
- Beneficial utilisation of waste resources, solid waste minimisation and food waste conversion
- Low emission energy systems and advanced energy technologies (biofuels, biogasification, fermentation, mini smart grids)
- Energy efficiency (innovative processes for food preservation, advanced vapour compression drying, reduction in refrigeration use during storage and transport by controlled atmosphere)
- Advanced materials for sustainable packaging and waste utilisation
- Circular economy, waste to resources and waste to energy
- Water management technologies including micro-irrigation, off-grid desalination and sprayable polymers

- Climate change induced social and health impacts, food security, community displacement and resettlement
- Enabling technologies and handling solutions for waste management
- Efficient transport and logistics solutions
- Food safety testing and pathogen control

MAJOR INDUSTRY R&D PRIORITIES

- Energy smart food
- Energy efficient food production processes
- Food waste reduction and extraction
- Reducing food packaging waste
- Micro irrigation and water efficiency technologies



THE UON CENTRE FOR WATER, CLIMATE AND LAND

A dedicated Centre for Water, Climate and Land (CWCL) focuses on understanding and dealing with the impacts of climate variability and change in the Asia-Pacific Region. Specifically, the CWCL conducts work on:

- Hydrological extremes and how these may change in the future
- Characterising impacts of climate variability and change
- Seasonal and interannual hydroclimate forecasting
- Quantify current and future risk of climate extremes (e.g. flood, drought, bushfire, storms, cyclones, East Coast Low's)
- Hydrological and stochastic modelling
- Climate-smart agriculture
- Climate risk, resilience and adaptation
- Land use and landscape rehabilitation
- Geographic Information Systems (GIS) and Remote Sensing
- Water-energy-food security

CWCL has been involved in a wide range of projects where insights into the impacts of climate variability and change are used to enable stakeholders in the agriculture sector to better assess their climate related risks and opportunities to develop more informed climate adaptation and mitigation strategies. In a recent study of the impact of climate on growing grains in Australia, CWCL researchers explored Australia's climate variability in the context of a changing climate. The project demonstrated the importance of taking into account the impacts of natural climate variability and anthropogenic climate change when growing grains in Australia.

The study illustrated the historical variability associated with several climate products that are important to the Australian agriculture sector. This allowed:

- Assessment of vulnerability to negative climate impacts
- Identification of opportunities associated with positive climate impacts
- Existing climate risk management strategies to be evaluated and, where necessary, improved
- Projected impacts of anthropogenic climate change to be put into context and planned for.



ADVANCED TECHNOLOGY

Applying advanced technology to deliver efficiency and productivity.

A new wave of innovation is being triggered by the unification of information derived from data analysis and the deployment of key technologies related to robotics, autonomous systems and remote sensing.

UON is committed to working alongside business to develop technologies to support solutions for efficient resource allocation in farming systems to optimise supply chains and manufacturing processes.

UON AT A GLANCE

- Separation science extraction of bioactive and functional ingredients
- Encapsulation, prevention of oxidation, and sensory foods
- Novel food preservatives
- Cyanobacteria as biofertilisers and soil remediators
- Algal metabolites as fish and poultry feed stocks
- Food dehydration, food product development, natural bioactive compound utilisation in functional foods, edible coatings for extended shelf-life
- On-farm productivity including precision agriculture, mechatronics, robotics, automation and sensor technologies
- Seafood postharvest technologies, handling and storage of seafood products

- Data monitoring for marine ecosystems and rehabilitation and remediation of coastal areas
- Food engineering, food processing, membrane technology, packaging, product and process development

MAJOR INDUSTRY R&D PRIORITIES

- Agriculture cybernetics
- Sensors and sensor networks
- Precision agriculture and big data
- Agricultural biotechnology
- Product reformulation
- Functional food and food fortification
- Technology transfer support services



PERFORMANCE OPTIMISATION FOR THE SUGAR INDUSTRY

Smart systems in process industries, nanotechnology, signal and image processing, and biomedicine can improve performance and reduce pollution through improved efficiency.

A team of University of Newcastle researchers is focused on researching complex systems to improve productivity and efficiency such as:

- energy generation and distribution
- health delivery
- safety and security systems
- telecommunications and transportation networks
- manufacturing processes

A recent study is looking at control techniques to improve the operation of steam boilers in Australia's sugar industry. Sugar plants throughout the world burn sugar cane residue, known as bagasse, in boiler units to generate energy that powers the sugar factory and exports electricity to the grid.

While it is a source of renewable energy, it is a challenging material to burn and it is difficult to keep the boiler unit regulated. By developing new control methods, researchers hope to improve the sugar production and electricity cogeneration capabilities of the sugar industry.

Sugar mills are difficult to regulate as the boiler units have highly variable loads operating at inconsistent times, which severely hinders production. Stabilising the process will provide significant benefits to sugar manufacturing and biofuel energy generation in Australia more broadly.



MARKET ACCESS

Delivering quality and optimising market access through integrated supply chains and value-add.

Consumer preference is an increasingly important driver of food and agriculture production. Market signals impact product development, food standards, nutritional value, product presentation and sustainability measures. A driving force behind this is the recognition that improving nutritional value is critical for global food security and human health. The increasing demand for food combined with the use of data analytics and more sophisticated e-commerce platforms will also push the development of leaner, faster, more agile production with lower waste value chains.

UON AT A GLANCE

- Food safety, integrity and traceability, biosecurity, DNA testing, isotopic analysis, advanced packaging, high pressure processing, biosensing and pathogen control
- Consumer behaviour, nutrition information and food labelling
- Innovative packaging solutions
- Optimising food intake behaviours and diet related health across life stages and health conditions
- Nutrition education tools, augmented reality for portion size, diet quality assessments, online personalized nutrition, food addiction, fortified foods, personalised nutrition, "free from" and natural foods,
- Supply chain, statistics and inventory and production planning optimisation, scheduling, shelf life, product service flows
- Manual handling and safe work practices
- Sensors, data analytics and artificial intelligence

- E-commerce for perishable products
- Materials handling, mathematical modelling and logistics
- Performance optimisation through automated digital and complex systems
- Portion innovation and functional packaging
- Biomarkers, sensory technologies and nanocomposite films
- Waste process optimisation

MAJOR INDUSTRY R&D PRIORITIES

- Traceability and control
- Food safety and food fraud
- · Logisitics and shared mobility
- Supply chain transformation
- Warehouse operations
- Freight transportation
- Personalised nutrition



UON AND NSW DEPARTMENT OF PRIMARY INDUSTRIES WORKING PARTNERSHIP

The NSW Department of Primary Industries (NSW DPI) is one of the largest research providers supporting primary industries in Australia with a research portfolio across more than 50 disciplines. The Department seeks to improve the productivity, sustainability and biosecurity of the NSW primary industries and enters into strategic partnerships where appropriate to facilitate these outcomes.

University academics in nutrition, food, health and marine science work closely with NSW DPI through an institutional strategic collaboration to develop and implement science-based technologies. The NSW DPI's Centre of Excellence for Market Access and Greenhouse Horticulture is located on UON's Ourimbah campus and teams collaborate on a number of joint projects.

In addition, NSW DPI researchers conduct applied industry focused research in postharvest, supply chains and market access to provide innovative solutions to practical industry problems and have strong and active collaborations with University researchers including joint supervision of higher degree research students. There is opportunity to build on this foundation and explore areas of further collaboration across food and agriculture more broadly.

Current projects and active areas of research include:

- Product quality and postharvest quality maintenance through the supply chain of a range of horticultural and agricultural products
- Reducing energy costs through the optimised use of refrigeration in the supply chain,
- Research to maintain and improve market access for a range of horticultural commodities
- Collaborative research to facilitate the cost effective utilisation of waste
- Improving the efficiency of low-medium technology greenhouse vegetable production in Australia
- The nutrition of leafy vegetables including Asian vegetables in hydroponics
- Improving the cultivation of indigenous vegetables
- Improving the nitrate nutrition of Australian grown green tea
- Medicinal cannabis
- Development of organic transistor based biosensors for food-borne pathogens
- Circular economy and balanced land use promoting economic diversification



ENGAGE WITH US

For more information visit the Global Impact Cluster for Energy, Resources, Food and Water



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