

# NEWCASTLE INSTITUTE FOR ENERGY AND RESOURCES

ANNUAL REPORT 2019 - 2020



THE UNIVERSITY OF  
NEWCASTLE  
AUSTRALIA

| nier



NIER respectfully acknowledges the traditional custodians of the land on which our precinct is situated, the Pambalong clan of the Awabakal Nation. We also pay respect to the traditional owners of the lands on which our activities are undertaken, and acknowledge all Elders past, present and emerging from Aboriginal and Torres Strait Islander nations.

Front cover, pages 8-9 & 10:  
Hunter River, Hunter Valley NSW. Photos courtesy John Spencer/ Department of Planning, Industry and Environment.

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# FOREWORD

A decade ago, NIER was awarded its first round of funding from the Federal Government's Education Investment Fund to establish a collaborative research institute for energy innovation. NIER's objective was to build on the established strengths of the University and the Hunter region to advance research in clean energy production and energy efficiency solutions. With a focus on postgraduate research training, and by connecting multidisciplinary research leaders and industry partners, NIER has been equipping the energy and resources sector with advanced knowledge, innovative technology, optimised ways of operating and a skilled workforce ever since.

Much has changed in the last ten years, but the critical challenges stemming from the growing demand on global resources remains the societal, economic and environmental pinch point. It is clear that future resilience depends on more sustainable approaches to energy production, the efficient use and reuse of minerals and metals, advanced productivity in farming and food manufacturing, and optimal water management.

In response, the NIER research landscape has expanded to include food and water, with a key priority of the Institute to deliver innovation for the next generation of resources - securing ample, dependable and cost-effective energy, minerals and metals, food and water to meet the needs of the growing population.

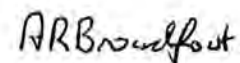
While the COVID-19 pandemic has changed global markets and supply chains, it has also shone a light on the importance of efficient, resilient resource production, processing and distribution, and the power of building local capacity. In this light, NIER's responsive, collaborative solutions and regionally focused approach to research is more relevant to today's challenges than ever before.

This report highlights how NIER research groups are delivering nimble solutions in diverse new areas such as the hydrogen economy, and in response to COVID-19 medical equipment shortages. It also showcases how NIER researchers are forging a competitive and environmentally sustainable future for Australia's minerals industry through the Australian Research Council (ARC) Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals. We have helped set in motion Australia's first ever on-campus functional materials manufacturing facility, which along with other initiatives like the Innovation Launchpad, is supporting the delivery of new products and services.

Serving our regions is a priority, with our connections to the Upper Hunter, Central Coast and Pacific Islands, in particular, leading to powerful outcomes that are helping move communities closer to a sustainable future.

As NIER enters another year of operations, we are even more committed and driven to provide the research leaders, facilities, high-quality education and training and multidisciplinary partnerships to deliver the solutions and the problem solvers that the world needs.

I share with you this summary of NIER's achievements from the past financial year.



**PROFESSOR ALAN BROADFOOT,**  
Executive Director



# GOVERNANCE AND MANAGEMENT

## ADVISORY BOARD

NIER's management, strategic direction and initiatives are steered by a dedicated governance framework representing both internal and external stakeholders and the research centres and groups that collectively create the NIER model. The framework provides collaborative guidance across a range of functions including precinct operations and infrastructure, research engagement priorities, and health and safety.

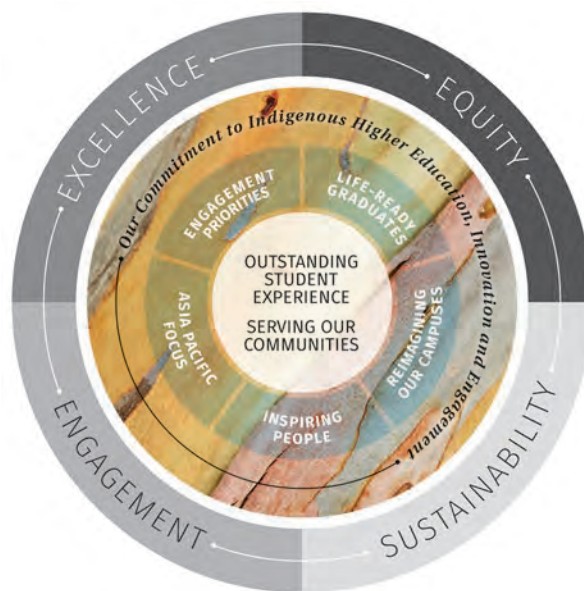
The overarching NIER Advisory Board brings a wealth of industry knowledge and know-how, and members play a critical role in providing consultative expertise on sector trends and priorities to ensure alignment to the University's strategic direction. Their valuable contributions shape outputs such as our Research Roadmaps, which guide capacity building initiatives to support industry, regional communities and help identify opportunity pathways through a coordinated research-business approach.

*"Through the Water Research Roadmap, the University of Newcastle has provided a focal point for industry to leverage research strengths and assets to better understand and advance regional priorities for the water sector."*

- Mr Rod Naylor  
National Water Lead, GHD

At the start of 2020, NIER welcomed the leadership of new Deputy Vice-Chancellor (Research & Innovation), Professor Janet Nelson, who joined the University from her previous position as Vice President for Research and Economic Development at the University of Idaho, USA. With extensive experience in the higher education realm, Prof Nelson is particularly eager to support multidisciplinary innovation and industry engagement activities that enhance the University's reputation both in Australia and internationally.

Under the guidance of Prof Nelson and with the combined strength of the Advisory Board, NIER is well positioned to deliver on the goals of *Looking Ahead, the University of Newcastle Strategic Plan 2020-2025*.



**DR MIRJANA PRICA**  
MANAGING DIRECTOR  
FOOD INNOVATION AUSTRALIA (CHAIR)



**DR PETER MAYFIELD**  
EXECUTIVE DIRECTOR - ENVIRONMENT, ENERGY AND WATER  
CSIRO



**MR JOHN RICHARDS**  
CHAIRMAN  
BLOOMFIELD GROUP



**MRS CLARE SYKES**  
INDEPENDENT CONSULTANT  
LARKIN SYKES



**MR ROB COOPER**  
SENIOR MANAGER STAKEHOLDER ENGAGEMENT  
AGL ENERGY



**PROF JANET NELSON**  
DEPUTY VICE-CHANCELLOR, RESEARCH & INNOVATION  
THE UNIVERSITY OF NEWCASTLE



**PROF BRETT NINNESS**  
PRO VICE-CHANCELLOR, FACULTY OF ENGINEERING AND BUILT ENVIRONMENT  
THE UNIVERSITY OF NEWCASTLE



**PROF ALAN BROADFOOT**  
EXECUTIVE DIRECTOR  
NEWCASTLE INSTITUTE FOR ENERGY AND RESOURCES



**MS LOUISE CORDINA**  
CHIEF EXECUTIVE OFFICER  
CORDINA GROUP (DEPUTY CHAIR)



**MR DARREN CLEARY**  
MANAGING DIRECTOR  
HUNTER WATER CORPORATION



**MR ROD NAYLOR**  
NATIONAL WATER LEAD  
GHD



**MR KIM HOCKINGS**  
SPECIALIST COAL TECHNICAL MARKETING  
BHP



**MR ADRIAN BEER**  
CEO  
METS IGNITED



**PROF LEE SMITH**  
PRO VICE-CHANCELLOR, FACULTY OF SCIENCE  
THE UNIVERSITY OF NEWCASTLE



# NIER BY NUMBERS

JULY 2019 - JUNE 2020

## Grants by Sector



**21**

Research Centres  
& Groups



**138**

Engaged University  
Researchers



**279**

PhD Students Supported  
by NIER Centres



**148**

Active Industry  
Partners



**19**

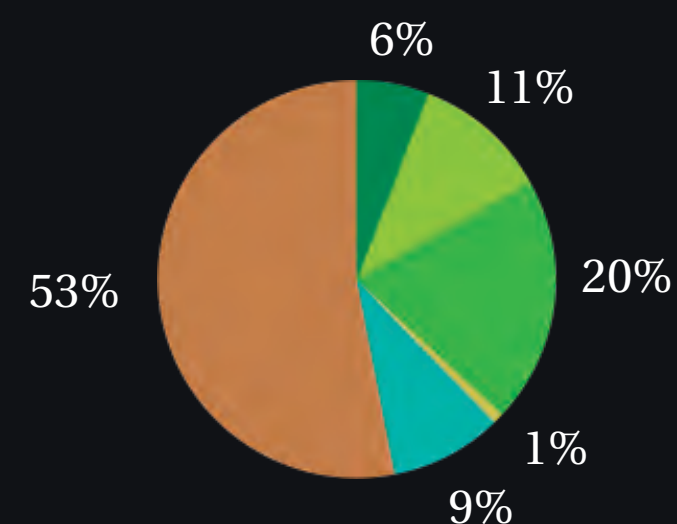
International Partners



**3.8 ha**

Precinct Size

## Funding by Sector



**22%**

Repeat Clients



**360+**

Precinct  
Occupants



**TWO**

Global &  
Regional Nodes



**FIVE**

Industrial  
Workshops



WATER



ENVIRONMENT



ENERGY



FOOD



RESOURCES



OTHER

# HIGHLIGHTS

WORLD-CLASS RESEARCH | INDUSTRY COLLABORATION | INNOVATIVE SOLUTIONS

NIER's reputation as an innovative leader on critical issues of global significance is driven by a commitment to quality engagement with partners, creating the collective capacity to facilitate technological advancements.

Highlights from the 2019/20 financial year show the diversity of research being undertaken through NIER. Food and water security have been bolstered as areas of priority due to the inextricable nature of the challenges and global need surrounding these vital resources.

NIER researchers are committed to serving our regions through research that matters, evident from projects across the Hunter, the Central Coast and in the Pacific. With the expansion of the Doctoral Training Centre initiative and the establishment of the ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals, there is also a focus on training future leaders to drive positive economic change nationally and globally.



Throughout Australia and the world, our regions face a convergence of critical challenges related to resource sustainability, energy and water security. As a regional University established to serve the needs of the Hunter and Central Coast, NIER is committed to the diversification and advancement of vibrant and resilient regions through the delivery of research and research education programs focused on the critical sectors of energy, resources, food and water.

## ADVANCED ENERGY

Integrated solutions for the supply of electricity that are sustainable, stable, and more affordable than conventional approaches remain a priority for our regions. As industry shifts towards greater reliance on non-network solutions, NIER is promoting a collective approach to create new knowledge and advanced energy solutions from which new businesses and future workforces will be built.

The Advanced Energy Integration Initiative brings together seven leading research centres from three universities – Newcastle, New South Wales and Wollongong. Launched this year, the initiative will provide ways for Australia to successfully integrate new energy technologies into the power grid.

To drive the University's contribution to this initiative, NIER and the Faculty of Engineering and Built Environment have established a dedicated Centre for Advanced Energy Integration. This Centre is focused on collaborative projects related to energy storage, grid systems, energy generation and alternative energy sources.

## RESOURCE SUSTAINABILITY

Rich in resources, the Hunter region is a powerhouse of economic productivity, with a local appetite for growth that captures opportunities for diversification and innovation. At NIER, researchers are optimising processing practices to improve efficiency and sustainability, focusing on developing new technologies that utilise waste as second generation resources.

NIER researchers are also driving the uptake of low emission technologies to progress the new energy economy. Working with government and industry stakeholders, projects are focused on capturing value from agricultural and forestry waste streams and characterising biomass for energy production, bringing new and innovative skills to the Hunter region. Diverse hydrogen projects also offer opportunity to support the utilisation of waste to energy and the burgeoning biomass sector.

This year, successful outcomes in mineral separation, landform rehabilitation, advanced rock mechanics, conveying and material handling, dewatering systems, and environmental remediation are delivering transformational solutions for end users while supporting the translation of knowledge to workforce skills in sustainable resource practices.

Throughout the reporting period our research centres were successful in securing competitive ARC funding to advance research with the potential to transform multiple industry sectors. An investigation of gas and solid liquid flows by the Priority Research Centre for Frontier Energy Technologies and Utilisation is one example that will lead to multiple applications in clean energy, food manufacturing, defence, and mineral processing.

## FOOD INNOVATION

Advancing the engagement strategy outlined in the Food and Agribusiness Roadmap launched last year, NIER is building on a formal partnership with Regional Development Australia Central Coast and Central Coast Industry Connect.

Leveraging the Central Coast's existing strengths in the food production sector, NIER has supported the establishment of the Central Coast Food Alliance (CCFA). Launched in September, the CCFA is further strengthening networks between industry, all levels of government and education institutions to accelerate innovation and provide a platform for economic growth.

In response to recommendations made in the Roadmap, and led by the Faculty of Science, the food laboratories at Ourimbah campus received a million dollar upgrade. This is enriching the student experience by providing the facilities to work alongside food manufacturers. Research capacity has been further enhanced through additional academic appointments in food science, human nutrition and consumer psychology.

## WATER ROADMAP

The current drought has sharpened the focus on how we can best support the management of critical water resources. NIER's activities support research directed at understanding current key priorities for the water sector. In consultation with industry and government stakeholders, NIER has championed a Water Research Roadmap to ensure our capacity building initiatives are positioned to best assist the water sector and support greater resilience across regional centres.

The Roadmap is a renewed opportunity for University researchers to engage with the sector in focus areas aligned to the 2020-2025 strategic plan:

- Regional water security
- Coast and catchment management
- Water utilisation
- Water recovery

The Roadmap focuses on supporting the University's research centres to deliver tools and response capabilities for water resource management, highly skilled human resources for future challenges, and interdisciplinary approaches to shared problems.



# ARC CENTRE OF EXCELLENCE

## FOR ENABLING ECO-EFFICIENT BENEFICIATION OF MINERALS

The ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals will develop transformational technologies for a competitive and environmentally sustainable future for Australia's minerals industry.

The Centre's research will focus on outcomes to produce higher resource recovery and reduce the environmental footprint of minerals processing through significant energy and water use efficiencies, while supporting the development of a new generation of future leaders.



Australian Government  
Australian Research Council

Our modern way of life is dependent on minerals, with everything from our smart phones to our whitegoods and motor vehicles relying on finite resources. As the world increases renewable energy production, demand for minerals will surge due to the mineral intensive nature of low-carbon technologies. We are effectively moving from a carbon to a metals-based economy.

The immediate demand for metals can only be met through mining and minerals processing, though ultimately continued availability and affordability of modern technologies will depend on widespread metal reuse and recycle strategies in a circular economy.

The ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals, based at NIER, has been awarded \$35 million by the Australian Government through the Australian Research Council (ARC) to carry out world-leading research to help solve some of these global problems.

This Centre is a collaboration with the University of Queensland, University of Melbourne, Deakin University, Monash University, University of South Australia, Curtin University, University of NSW and CSIRO as well as industry partners and leading international researchers. Over a seven year period, more than 70 PhD students, 15 postdoctoral researchers and more than 35 other researchers, will deliver transformational technologies and solutions to the minerals industry.

The University of Newcastle node, which is the largest in the Centre, includes the Centre Director, Laureate Professor Kevin Galvin, and eight other leading researchers – Laureate Professor Graeme Jameson, Professor Erica Wanless, Professor Geoffrey Evans, Associate Professor Elham Doroodchi, Associate Professor Grant Webber, Dr Roberto Moreno-Atanasio, Associate Professor Kenneth Williams and Dr Peter Ireland.

This collaborative Centre will reshape the minerals industry, establishing a new generation of research leaders to support the innovation needed to create a green economy for future generations.

[coeminerals.org.au](http://coeminerals.org.au)

Smart phones consist of 40% metal, with 62 different types of metal being used to manufacture these prized possessions.

[techradar.com](http://techradar.com)

The manufacture of a single 3MW wind turbine requires 4.7 tons of copper, 3 tons of aluminium, and 2 tons of rare earth elements, among other materials.

[worldbank.org/en/news/infographic/2019/02/26/climate-smart-mining](http://worldbank.org/en/news/infographic/2019/02/26/climate-smart-mining)

Global use of lithium, used in electric vehicle manufacture, has more than doubled since 2012.

[miningglobal.com](http://miningglobal.com)

## ENERGY AND WATER

Doubling energy and water productivity in the mining sector by 2030, maintaining the drive towards the 'zero-emission mine.'

## MINERAL RECOVERY

Reducing loss of high value metals during minerals processing by 90%, increasing the concentration of recovered products used in metals refining.

## NEW GENERATION

Establishing a new generation of scientists and research leaders in minerals beneficiation to support the innovation needed to sustain the Australian industry.



# PACIFIC NODE

The University of Newcastle continues to work with regional partners to invest in the capabilities of our students, staff and partners to deliver multidisciplinary research and research training to drive solutions to significant global issues.

NIER's Pacific Node provides a platform for collaboration to enhance regional capacity and contribute demonstrable impact for Pacific communities.

## STRATEGIC PARTNERSHIPS

Many of the challenges in Pacific Island countries cannot be addressed by a single government department, company, organisation or community group. As such, strong partnerships between governments, industry and academics are at the core of NIER's Pacific strategy to deliver sustainable solutions to problems of environmental protection and national priority.

Through the Pacific Node, the University of Newcastle and the Secretariat for the Pacific Regional Environment Programme (SPREP) have advanced applied research to enhance environmental outcomes. Focus areas include reducing the impacts of microplastics, improved water quality standards, strengthening social inclusion in climate and environment programs, monitoring invasive species, waste management, and coral rejuvenation.

[newcastle.edu.au/pacific-node](http://newcastle.edu.au/pacific-node)

## POSTGRADUATE PROGRAMS

This year we welcomed new Pacific Island PhD students into NIER's facilitated postgraduate programs.

In total, five PhD scholarships have been awarded to Pacific Island Nationals for projects tied to the environmental protection priorities of SPREP and other regional organisations. The PhD research areas focus on the effects of marine plastics, bioremediation of oil in WWII wrecks, ecosystem-based adaptation to climate change, coral reef adaptation to ocean acidification, and the impact of invasive species on ecosystem recovery. Project outcomes are set to directly benefit local communities with students working in the field in Samoa, Tonga and Fiji.

Additional projects are focused on identifying how, and to what degree, invasive species impact ecosystems following cyclonic activity, and research to better understand the relationship between humans and invasive species with the aim of improving management and climate resilience.

## CAPACITY DEVELOPMENT

The University is delivering short courses and training on topics of local importance. Leveraging the University's hosting of the UNITAR CIFAL, researchers from the Centre for Water, Climate and Land have delivered training modules through the Pacific-Australia Climate Change Adaptation Project, the Climate and Oceans Support Programme for the Pacific and the SPREP Pacific Meteorological Desk to build capacity in regional hydrological, meteorological, climate adaptation, and disaster management services in Pacific countries and territories.

A pilot "Training of Trainers" course in Disaster Waste Management, developed in collaboration with Pacific partners, was delivered with the aim of strengthening the capacity of Vanuatu to deal with the waste created by natural disasters.

## ACADEMIC EXPERTISE

Working closely with our Faculties and Schools, academics from across disciplines are progressing research projects to address environmental challenges. Research projects show the breadth of research underway across key themes; climate resilience, terrestrial and marine ecosystem monitoring and restoration, biodiversity conservation, restoration, disaster waste management, plastic pollution, environmental governance, gender and social inclusion, food security and healthy communities.

## PACIFIC RESEARCH ACTIVITY HIGHLIGHTS

- Effects of microplastics in marine food webs and human health
- Mining and environmental governance in the Solomon Islands
- Methods for bioremediation of oil in WWII shipwrecks
- Understanding coral reef adaptation to ocean acidification
- Measuring the impact of invasive species on ecosystem recovery
- Monitoring and modelling tools for coastal ecosystem adaptation
- Capacity building in disaster waste management in Vanuatu
- Development of the National Liquid Waste standards for the Solomon Islands
- Gender and social inclusion in climate information systems in Vanuatu
- Coral rejuvenation in the Hideaway Marine Sanctuary in Vanuatu
- Studies of global conventions related to plastic pollution in the Pacific
- The Pacific WriteShop on climate, oceans and climate change science
- Environmental education and eco-tourism development in Moata'a village, Upolu, Samoa



# DOCTORAL TRAINING CENTRES

NIER's Doctoral Training Centres (DTCs) bring students, academics and industry together to create new knowledge and drive better solutions for the use of natural resources, moving the world closer to a sustainable future.

Through the DTCs, research collaborators work to solve global resource challenges by experimenting with new technologies, teaching and learning approaches, policy concepts, cultural ideas, and commercial innovations.

PhD candidates work on research projects developed in collaboration with industry partners and are supported by a multidisciplinary, solutions-focused academic team to enhance knowledge, outcomes and skillsets. Additional training opportunities, site visits led by industry experts, and industry engagement events help boost employability and professional skills.

*"The greatest benefit of the DTC is the industry engagement. It guarantees that our research can be applied to real life industry problems, so it's not just a purely academic project, but something that can be taken to the real world."*

- Ms Priscilla Freire  
DTC Candidate,  
Advanced METS DTC

## ADVANCED METS

The Advanced METS DTC has been successfully operating since 2018 with engaged industry partners working with University research teams to support innovation in the Mining Equipment, Technology and Services (METS) sector.

Project partners play a pivotal role in working collaboratively with academic supervisors to support candidates to acquire a broad range of skills and experience, while helping to solve company-relevant challenges. The Advanced METS DTC is appreciative of the contributions of its many partners, including Bengalla Mining Company, Jord International, Muswellbrook Shire Council and MACH Energy.

The METS academic program is guided by Academic Convenor, Associate Professor Kenneth Williams and Deputy Academic Convenor, Dr Jessica Allen, with student support services led by DTC candidate Ms Priscilla Freire.

## FOOD AND AGRIBUSINESS

In 2020, NIER established the Food and Agribusiness DTC to help address the challenges and opportunities that are shaping and evolving this industry.

Based at the Ourimbah Campus, the DTC provides access to the intensive food and agribusiness industry activity in this region. Together, postgraduate students, researchers and industry are progressing research outcomes in product science, climate resilience and sustainability, advanced food technology and market access.

The first collection of projects within the DTC include the assessment of essential oils in treating fungal infection in citrus fruit, utilisation of by-products from plant based milk production, and optimal handling and storage of fresh fruit through packaging and cooling techniques.

The establishment of the Food and Agribusiness DTC has been possible thanks to the commitment of Dr Tamara Bucher in the role of Academic Convenor with the guidance of Kylie Shaw, Interim Dean of Graduate Research. NIER is also grateful for the support of industry partners including NSW Department of Primary Industries and Hort Innovation.

*"Food is a vital next generation resource. The DTC brings together partners in academia and industry to work together towards a sustainable food future."*

- Dr Tamara Bucher  
Academic Convenor,  
Food and Agribusiness DTC

## CASE STUDY: TAILINGS TO TOPSOIL

In partnership with Muswellbrook Shire Council, Bengalla Mining Company, Jord International, MACH Energy and Australian Coal Association Research Program (ACARP), the "Tailings to Topsoil" 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 energy or biofuel production.

DTC candidate Elif Ergun is exploring ways to achieve a successful, cost-effective technology to identify the valuable types of coal mine tailings for farmable topsoil addition. A second project with candidate Lauren Bradney is focused on evaluating these valuable tailings in their ability to support germination and plant growth and to further improve the qualities of tailings through modification.

# INNOVATION LAUNCHPAD



## AN INITIATIVE OF THE NSW ENERGY AND RESOURCES KNOWLEDGE HUB

Businesses are encouraged to bring their specific business problems to the Innovation Launchpad. The NIER engagement model together with the multidisciplinary network of the NSW Energy and Resources Knowledge Hub can help businesses discover innovative solutions, diversify and transform ideas into enterprise.

While the energy and resources sector is used to navigating downturns in the economy, the global COVID-19 pandemic shocked business operations with fast moving and unanticipated variables.

Markets, supply chains, business models and the competitive landscape have all changed, and there are new opportunities. The Innovation Launchpad is a vehicle to help businesses rethink, reinvent and move towards a more resilient and sustainable future.

The specific problem-solving infrastructure of the Innovation Launchpad has been designed to support small businesses to innovate, commercialise and scale-up. Through the Innovation Launchpad, business can access the most advanced technical thinking, the latest technology and novel experimental techniques to help find a new way forward.

The Innovation Launchpad can help businesses deliver new technologies, find new markets, optimise ways of operating and overcome barriers to moving forward. At this unique time in history, with unprecedented demand for novel solutions, the Innovation Launchpad is more vital than ever.

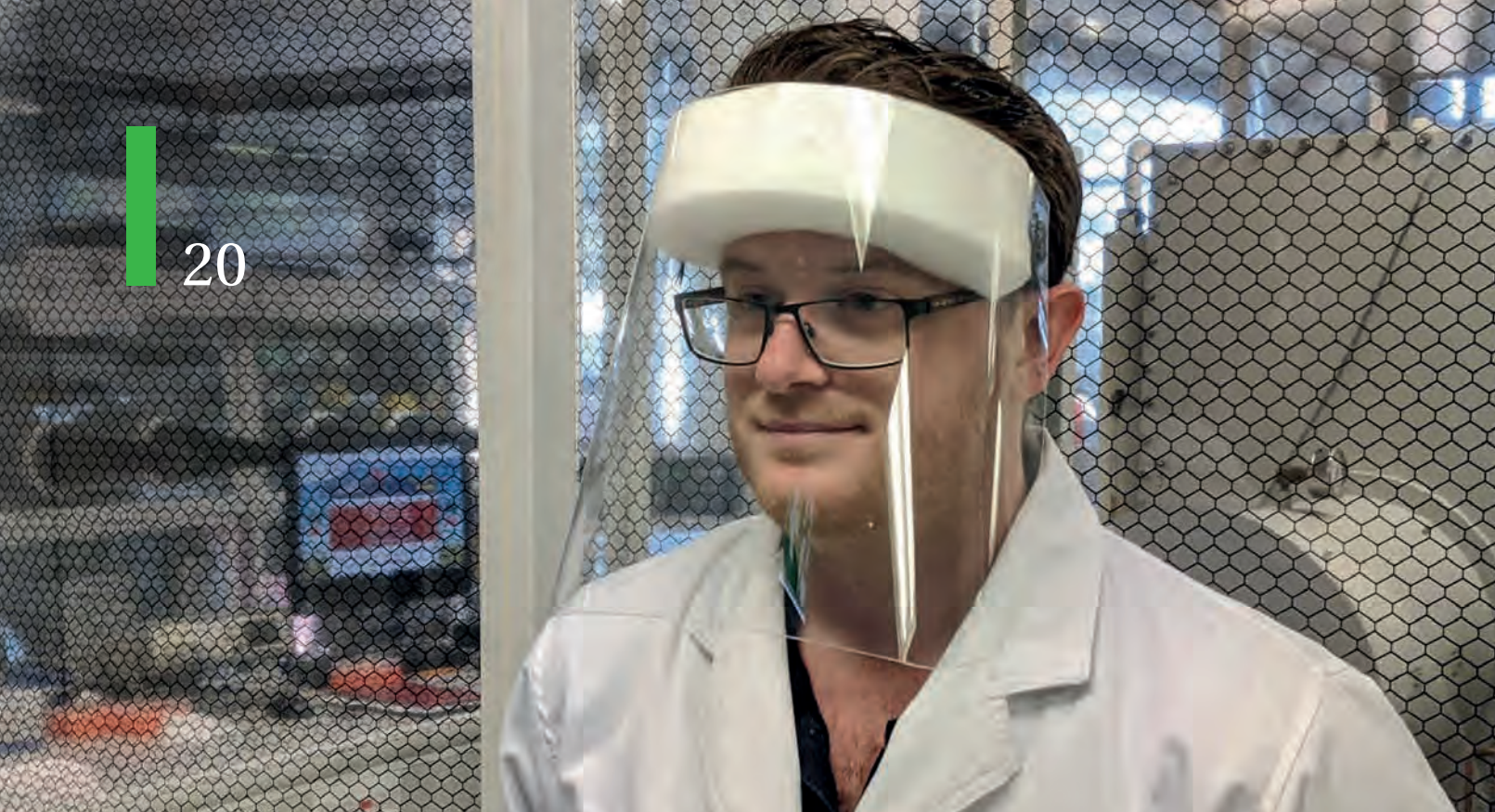
More broadly, the NSW Energy and Resources Knowledge Hub is operating via a NSW-wide network to help strengthen collaborative links between researchers, industry and government.

The engaged network of the Hub is working together to help understand and unlock emerging opportunities in fields such as circular economy, resources sustainability and advanced energy.

The Hub's role in facilitating information sharing through seminars and workshops across the state is helping businesses and communities advance their sector literacy and make informed decisions. Hub events such as the "Supporting the NSW Grid with Distributed Energy Storage" seminar, the "Collaborate to Innovate" workshop and program, and regional METS information sessions have been effective in engaging industry and providing up to the minute intelligence.

[energyinnovation.net.au](http://energyinnovation.net.au)





# INDUSTRY ENGAGEMENT

Through our partnerships, NIER creates the collaborative platform to deliver sustainable solutions to real world problems.

As we work toward a future that could look very different from today, our researchers are committed to integrating the experience and practical needs of industry partners with high standards of research and education to ensure research outcomes with impact.

## HYDROGEN

Australia's National Hydrogen Strategy was released in November 2019, setting the vision for a clean, innovative, safe and competitive hydrogen industry that helps Australia transition to a sustainable, affordable low-emissions future that benefits all.

As a region built on industrial innovation, the Hunter is poised to play a leadership role in enabling the growth of the hydrogen industry in Australia. The University is progressing a regional hydrogen strategy through the activation of a University led Opportunity Paper and associated development activities, such as the hosting of national hydrogen workshops and the formation of a regional taskforce.

With a focus on Research Development and Demonstration (RD&D), NIER research centres and affiliated groups are focusing on industry led advancements in hydrogen production, storage and utilisation.

In a new power-to-gas trial, researchers at the Priority Research Centre for Frontier Energy Technologies and Utilisation

are working with Southern Green Gas to demonstrate the generation of synthetic green methane as a hydrogen carrier. The \$1.1M ARENA funded project will be looking at whether gas pipelines on the east coast of Australia can be used to transport pure renewable energy domestically or for export.

## 10 YEARS WITH BHP

The Centre for Ironmaking Materials Research (CIMR) funding agreement with BHP was renewed for a further 5 years, demonstrating the strength of the ongoing partnership and the excellence of the research being undertaken which has far reaching impact on energy efficiency and productivity in the resources sector.

One of the first centres established at NIER, CIMR has been actively working in partnership with BHP for over 10 years to define the links between fundamental iron ore and metallurgical coal properties and their performance in the ironmaking process. These materials were the top two exports from Australia in 2018 and are critical to Australia's economic future.

## COVID INNOVATIONS

Many of the challenges that come with the global COVID-19 pandemic demand a smart, swift and innovative response, which is exactly how a multidisciplinary working group from the University of Newcastle answered the call for the rapid production of medical equipment.

As part of the broader University response to the COVID-19 pandemic, the Priority Research Centre for Organic Electronics (PRCOE), part of the Materials Node of the Australian National Fabrication Facility (ANFF), were able to design, manufacture and deliver an additional supply of face shields for local medical workers by mobilising their extensive rapid prototyping expertise.

The PRCOE developed their prototype face shield based on PET plastic normally used in the production of printed solar cells. The simple and fast to assemble design meant the time from the initial idea to the first delivery of 200 shields to frontline staff was only 10 days.

Over the following two weeks, 2000 face shields were delivered to the Hunter New England Health District for distribution among their service providers. This much needed support in a time of crisis was a product of collaborative innovation by University physicists, engineers, designers and health workers.



## ADVANCED GEOMECHANICS FOR THE FUTURE WORKFORCE

Growth in the technical and processing workforce for mine sites is expanding the mining and metals industry and providing opportunities to broaden skills, diversify and innovate. In response to market trends and the current resource engineering skills shortage in Australia, the Priority Research Centre for Geotechnical Science and Engineering, led by Professor Anna Giacomini, is delivering targeted education and research programs to meet the challenges faced by a rapidly changing resource sector.

The rockfall research team within the centre, which includes combination skills in rock mechanics and engineering geology, is leveraging their 15-year history of working with industry and their broad exposure to cutting edge research advancements to identify knowledge gaps, mobilise intelligence and train the next generation workforce. The team has delivered targeted industry short courses as a direct response to regional and national industry demand for high quality training.

A passionate advocate for gender diversity in industry, Anna also plays an important role in creating pathways for young women to move into the mining sector. The HunterWiSE (STEM) program provides avenues of mentorship and support to encourage young women into Science, Technology, Engineering and Maths careers, helping to lock in a diverse and strong future workforce in STEM fields.



# COMMERCIAL APPLICATIONS

Successful technology transfer is a crucial link in the innovation chain, enabling the delivery of research outcomes to markets and placing technology where it can be used to give communities, the environment and the economy a vital boost.

The collective capacity of technical experts at NIER, combined with its specialist facilities, and longstanding association with TUNRA, is helping to put innovative technologies into industries and communities world-wide.

## 50 YEARS OF TUNRA

In 2019, The University of Newcastle Research Associates (TUNRA) celebrated its 50th year in operation. Co-located at the NIER Precinct and led by General Manager Dr Tim Donohue, TUNRA plays a crucial role in the innovation cycle, with its focus on the application of research in industry. As a client facing, service based entity, TUNRA is the place where industry and business go to access current, research driven solutions to their problems.

While TUNRA has a long history of successful commercialisations, its role in bridging the gap between research and industry is arguably more important today than ever before. As businesses look for ways to innovate and diversify, TUNRA is providing specialised testing on products and samples, and opening doors to expert knowledge and information to help solve specific problems.

TUNRA and NIER enjoy a collaborative and mutually beneficial relationship driven by a focus on quality research outputs, industry engagement and the common goal of research application to solve industrial problems.

TUNRA Bulk Solids, TUNRA's longest running division, interacts closely with NIER researchers with specific expertise in materials handling. The Centre for Bulk Solids and Particulate Technologies (CBSPT) is actively involved in both fundamental and applied research on a range of problems associated with bulk solids and particulate technology.

## HYDRO HARVESTER

For the billions of people worldwide living in water scarce regions, the ability to produce water from air would be life changing. This concept is now one step closer to becoming a reality, after the Hydro Harvester project, developed by the Priority Research Centre for Frontier Energy Technologies and Utilisation (led by Professor Behdad Moghtaderi), was awarded \$330,000 from the NSW Physical Sciences Fund to prepare a prototype for commercial trial.

The Hydro Harvester uses absorption and desorption technology to produce potable water from air at a cost of less than five cents per litre. At night it absorbs water from the air using a proprietary adsorbent material. Then during the day, the device uses solar energy or waste heat to produce air that is hot and saturated with water. As the air cools again, water – which can be used for any residential, community or industrial application – is extracted.

Unlike other water generators of this kind, the Hydro Harvester process occurs independently of ambient temperature and humidity, making the system reliable in a variety of climates. Because it doesn't rely on certain weather conditions to produce the water, the cost per litre remains low. The simplicity, transferability and affordability of this technology has the potential to solve one of the most serious resource shortage problems for communities across the globe.

## AUSTRALIAN NATIONAL FABRICATING FACILITY (ANFF)

Australia's first 'campus factory' in functional materials manufacturing, the ANFF Materials Node, has been recognised through the expansion of the Node's Newcastle Hub at NIER.

Led by the team from the Priority Research Centre for Organic Electronics, the Hub serves as the ultimate test-bed for

innovation, providing an opportunity for researchers to collaborate across disciplines in partnership with industry in a 'living lab' model.

The new facility will leverage research strengths to provide expertise, rapid prototyping and solutions to innovation roadblocks, ultimately increasing commercialisation success rates and new sources of income, while delivering technologies with scalable and lasting impact.

## VIPER FILTRATION TECHNOLOGY

Providing an efficient and economic system for the dewatering of mineral concentrates and mine tailings is a critical process that is becoming increasingly more important for global mining companies. In particular, there is an intensifying need to improve recovery of water and increase mineral recoveries via finer processing at a mine site. Mounting government legislation and community pressure to eliminate tailings dams have driven this upswing in demand, and Jord and the University of Newcastle have responded with the Viper Filtration Technology.

The Centre for Bulk Solids and Particulate Technologies (led by Prof Craig Wheeler and Dr Peter Robinson) partnered with Jord International to optimise a Horizontal Vacuum Belt Filter (HVBF). The goal was to find a robust and reliable way to dewater fine and problematic materials without the high up-front and ongoing costs of the commonly used high pressure counterparts. The result was effective. The combined application of compaction and vibration to the material resulted in a marked improvement in the dewatering characteristics of the machine. Pilot and full-scale plant trials have demonstrated that this technology greatly enhances the throughput up to 60%, reduces the moisture content of the cake typically in the order of 25% and provides significant process flexibility when compared to standard belt filter operation.

This patented technology provides a bolt on solution for the proven reliable HVBF, broadening the application of this technology across a wider range of mining processes. With applications already realised in iron ore, magnetite, coal concentrate and a variety of tailings materials, this equipment can be retrofitted to existing machines, or supplied new, to provide an efficient low-cost solution to dewater fine and problematic materials.

# PhD PROFILES

Since its establishment, a core objective of NIER has been the development of work-ready graduates who take valuable skills and knowledge into jobs that help businesses achieve a higher level of efficiency, sustainability and innovation.

Access to industrial-scale facilities and the opportunity for Higher Degree Research (HDR) students to interact, engage with and learn from industry partners has enhanced the training and education experience offered through NIER.

Work-integrated learning initiatives such as the Doctoral Training Centres have supported students to graduate with industry-relevant experience and equipped them with high level technical knowledge and novel problem-solving abilities.

NIER's success can be measured by a high quality PhD experience and the delivery of talented graduates into the workplace, capable and ready to tackle solutions for the next generation. We are proud to showcase a selection of HDR students who have recently graduated and pursued careers in industries associated with our key research areas.



## ADAM ABBASFARD

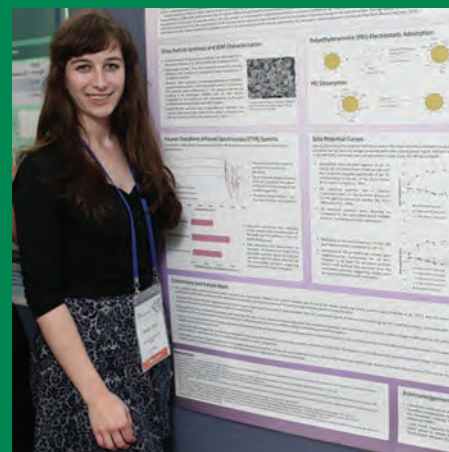
As a young engineer, Adam Abbasfard spent several years in heavy industries in the Middle East before making the move to Australia to commence his PhD in Chemical Engineering under the supervision of Dr Roberto Moreno-Atanasio and Professor Geoff Evans at NIER.

Adam's research focused on the fundamentals of separation processes widely used in the mining industry, in particular, on the settling and fluidisation of solid particles in liquid. Working alongside established researchers and academics, Adam produced six journal and conference publications before graduating in 2019.

Towards the end of his PhD, Adam's specific skill set helped him land a permanent role as a Process Engineer at Rio Tinto. His role has involved many interesting and challenging projects, with the main objective of his team to commission a wastewater treatment plant, which was successfully started in April 2020 to treat the alumina refinery residue stored in the residual disposal area.

*"Working alongside a team of professionals in a global company has helped me enhance my leadership and technical skills. I am fortunate to be part of a team of pioneers in mining and metals, producing materials essential to human progress."*

- Adam Abbasfard



## EMILY HYDE

Working as a Process Engineer for Hunter H<sub>2</sub>O, Emily Hyde enjoys the challenge of applying her technical expertise to solve the real-world needs of her clients. The direct interface with clients helps Emily understand the specific human, social and geographic requirements of each job, who then works to design a best-fit solution based on all the elements.

While at University, Emily completed a Double Bachelor's Degree in Chemical Engineering and Science majoring in Chemistry. Supervised by Dr Roberto Moreno-Atanasio and Dr Frances Neville, her PhD focused on the development of novel methods of silica shell functionalisation and biomimetic silica shell synthesis to coat magnetic particles. The aim of the project was to develop functionalised silica shell - magnetic core particles to be utilised as instruments for heavy metal ion extraction and fine mineral particle recovery.

Soon after graduating, Emily was selected following a competitive application process and offered the job with specialist water consulting company, Hunter H<sub>2</sub>O where she is helping to support sustainable and healthy communities through water solutions. Emily's work has exposed her to a wide range of water and wastewater treatment processes, their operation and the regulatory framework that guides wastewater and water treatment in Australia.

Emily has found that the skills she developed during her PhD have set her up to be an independent, flexible worker, capable of researching questions and ideas on her own and consulting effectively across a diverse team. Through her research, Emily enjoyed the deep dive into a topic that enabled her to draw meaningful conclusions and gain extensive knowledge on a subject. She is thankful to have the opportunity to apply her knowledge to practical projects and build on it through varied and diverse assignments.



## TOBIN HARVEY

While researching his PhD under the supervision of Professor Geoff Evans, Tobin Harvey was investigating the waste product called slag that comes out of iron and steel making processes.

Thanks to a connection he made through his research, Tobin is now employed by South Coast Equipment as a Technical Coordinator, working on waste recovery and recycling of products downstream of steel making. The company takes waste products such as slag, construction and demolition wastes as well as virgin quarry materials to make roadbases and concrete aggregates which are sold back to the construction industry. This process benefits the environment and the customer, being far more sustainable and cost effective than taking the raw materials out of the ground.

Tobin's day-to-day role involves managing the quality of the products for their use as construction materials and ensuring conformance to the relevant EPA requirements.

*"Every day is different. In industry you're jumping around doing this and fixing that, whereas research is about looking very deeply into one idea."*

Tobin acknowledges that the process of research gave him a head start in his job, with the occupational expertise he gained through his industry engaged research, as well as the transferrable skills of teamwork, problem-solving and critical thinking supporting his success in industry.



# NIER AWARDS

## THE NIER RESEARCH AWARDS

The NIER Research Awards recognise and reward researchers and higher degree research students for excellence in industry collaboration. The Awards highlight leading examples of solution-based approaches to industry-academia research partnerships aligned with the mandate of NIER. The Awards also acknowledge research excellence in NIER theme areas, as well as commitment to the promotion of NIER and its model of engagement.

### AWARD FOR HIGHER DEGREE RESEARCH (HDR) STUDENT EXCELLENCE

**Michael Carr**

**CENTRE FOR BULK SOLIDS AND PARTICULATE TECHNOLOGIES**

Michael's HDR research is strongly linked to iron ore mining operations in Australia and has helped the understanding of complexities and characteristics of sticky materials and their handleability. His research outputs are a testament to his practical thinking and commitment to delivering practical solutions to industry.

### AWARD FOR EARLY-MID CAREER RESEARCHER EXCELLENCE

**Dr Siddulu Naidu Talapaneni**

**GLOBAL INNOVATIVE CENTRE FOR ADVANCED NANOMATERIALS**

Siddulu extensively collaborates with colleagues, industry partners, and researchers across other Faculties, and provides leadership for students and staff of his Centre. He is an extremely talented, motivated and creative scientist who has made significant accomplishments during his academic career.

## AWARD FOR BEST PRACTICE INDUSTRY ENGAGEMENT

**Professor Anna Giacomini, Professor Stephen Fityus and Associate Professor Olivier Buzzi**

### ROCKFALL RESEARCH TEAM

Anna, Olivier and Stephen's research, collaboration, and engagement has produced PhD graduates who have secured positions of authority and influence in the mining industry. Their example is demonstrating the reliability and depth available at the University of Newcastle to both their peers and to industry.

## THE NIER HEALTH, SAFETY AND ENVIRONMENT (HSE) AWARDS

As a rapidly expanding industrial research facility, a comprehensive HSE Management System (HSEMS) is crucial in ensuring that occupying groups and tenants co-exist harmoniously and within the standards expected for an industrial site. The HSEMS aligns to the University's health and safety framework, policies and plans, and fosters a culture dedicated to improving the health, safety and welfare of those undertaking work at NIER.

The NIER Health, Safety and Environment (HSE) Awards recognises and rewards individuals and research groups who go above and beyond the NIER HSE Management System standards in their everyday workplace practices. They are an annual acknowledgement of best practice safety in the workplace.

## INDIVIDUAL AWARD FOR EXCELLENCE IN HSE LEADERSHIP AND CULTURE

**Steve Richardson**

**HEALTH AND SAFETY FACILITATOR, FACULTY OF ENGINEERING AND BUILT ENVIRONMENT**

Commended for consistently reducing and controlling risk via innovative HSE programs.

## INDIVIDUAL AWARD FOR EXCELLENCE IN HSE PRACTICE

**Andrew Maddocks**

**RESEARCH ASSOCIATE, PRC FOR FRONTIER ENERGY TECHNOLOGIES AND UTILISATION**

Commended for always adhering to NIER HSE policy, ensuring thorough risk assessments and process adherence.

## GROUP AWARD FOR EXCELLENCE IN TEAM HSE SYSTEMS AND PRACTICE

**Behdad Moghtaderi, Jafar Zanganeh, Mohammed Al Zuraiji, Javad Zanganeh, Omid Mowla**

**PRC FOR FRONTIER ENERGY TECHNOLOGIES AND UTILISATION**

Commended for conducting performance assessment of large size bat bags under fire and explosion. The project involved potentially high risks associated with fires and explosions, and the team used their expertise to carefully design experiments to minimise all potential risks.

# NIER RESEARCH CENTRES AND GROUPS

- Applied Electrochemistry Group
- ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals
- ARC Research Hub for Advanced Technologies for Australian Iron Ore
- Centre for Advanced Energy Integration
- Centre for Bulk Solids and Particulate Technologies
- Centre for Ironmaking Materials Research
- Centre for Multiphase Processes
- Centre for Optimal Planning & Transport
- Centre for Resources Health & Safety
- Centre for Social Research & Regional Futures
- Centre for Water, Climate & Land
- Coastal and Marine Science Group
- Food Science Group
- Frontier Geoscience Group
- Global Centre for Environmental Remediation
- Global Innovative Centre for Advanced Nanomaterials
- International Collaborative Centre for Carbon Futures
- Nanomaterials Research Group
- Priority Research Centre for Advanced Particle Processing & Transport
- Priority Research Centre for Frontier Energy Technologies & Utilisation
- Priority Research Centre for Organic Electronics



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