

NEWCASTLE INSTITUTE FOR ENERGY AND RESOURCES

ANNUAL REPORT 2021 - 2022





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.

CONTENTS

FOREWORD	2
GOVERNANCE AND MANAGEMENT	4
NIER BY NUMBERS	6
TRAILBLAZER FEATURE	8
WORLD-CLASS RESEARCH	10
REGIONAL ENGAGEMENT	12
INDUSTRY COLLABORATION	16
RESEARCH EDUCATION	20
INNOVATIVE SOLUTIONS	22
PhD PATHWAYS	24
RESEARCH CENTRES AND GROUPS	26

Front page cover image: Silicon carbide, a hard chemical compound containing silicon and carbon that has recently been used in linings and heating elements for industrial furnaces, as well as in energy application such as electric cars and solar energy.

FOREWORD

Last year, NIER celebrated our 10-year milestone, and this year we have started the next decade off strong.

Since expanding our value proposition to support the global priority sectors of energy, resources, food and water, the world-class research at the precinct has been more crucial than ever. Through our industry collaboration model, commitment to research education and delivery of innovative solutions, NIER has continued to make an impact in meeting the vital resource needs of the future.

We released the Resources Roadmap - the last roadmap of our four priority areas, which highlights the unique role the University of Newcastle is playing across the sector in priority areas including next generation resources for future mining, health, safety and environment, resource recovery and circular economy, and end-user functionality. As the sector rapidly expands with the rising global demand for modern, innovative and renewable technologies, the Roadmap will guide NIER's direction in supporting sustainable sector advancements into the future.

NIER researchers were recognised nationally for the work being conducted in energy technologies when the Federal Government announced that the University of Newcastle was successful in its joint bid with the University of New South Wales (UNSW) for the Australian Trailblazer in Recycling and Clean Energy (ATRaCE). The total investment of more than \$200 million will bolster research commercialisation initiatives that contribute to the delivery of sustainable solutions and systems to support national and global transition. The University, through NIER, also partnered with UNSW to establish the Decarbonisation Innovation Hub. The Hub will help fast-track research, development, and commercialisation to drive solutions for a low emissions economy, under the NSW Government's Net Zero Industry and Innovation Program.

NIER's enduring industry partnerships were highlighted over the past year, with the celebration of the continuation of our decade long partnership with BHP, and the extension of their funding of the Centre for Ironmaking Materials Research to include activities associated with decarbonising steelmaking. Additionally, continued success with companies including Jord International and FLSmidth has been demonstrated through the commercialisation of new technologies. These are just a few examples of the valued industry partnerships that are integral to NIER and the impact that our innovative research and technology is making on industry advancements.

While these wins have been momentous for the University and NIER, there are many more achievements to come in terms of the long-lasting benefit that these programs will have on our environment, economy and future. Please read on for a summary of the key achievements and developments we have made at NIER over the past financial year.

ARBroadfoot

PROFESSOR ALAN BROADFOOT

Executive Director



GOVERNANCE AND MANAGEMENT

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 Advisory Board contributions are valued for shaping NIER activities including identifying opportunity pathways, building capacity, and refocusing priorities to support our regional industries and communities, whilst ensuring our alignment to the Research and Innovation Division’s broader ambitions and the University’s overarching 2020-2025 Strategic Plan - Looking Ahead.

At the start of 2022, NIER welcomed the leadership of Professor Zee Upton as the new Deputy Vice-Chancellor (Research and Innovation), following on from her previous position as Vice-Chancellor of the College of Health, Medicine and Wellbeing. Prior to joining the University, Zee spent six years in Singapore as the Executive Director of the Skin Research Institute of Singapore and Executive Director of A*STAR Institute of Medical Biology. In these roles, Zee facilitated extensive collaboration with industry, and is particularly eager to support NIER’s expanded engagement model that positions the Institute as a hub for commercial acceleration, international collaboration, and rapid knowledge translation.

The Advisory Board also welcomed Professor Juanita Todd as Interim Pro-Vice Chancellor of the College of Engineering, Science and Environment. Juanita has been integral to the leadership of NIER for several years through her substantive role as Deputy Head of College.

NIER extends thanks to Professor Elizabeth Sullivan, former Acting Deputy Vice-Chancellor (Research and Innovation) and Professor Lee Smith, former Pro Vice-Chancellor of the College of Engineering, Science and Environment for their valued contributions to NIER’s leadership and governance during their tenure.

The Management Committee is responsible for oversight of high-level infrastructure and utilisation issues, including space allocation, safety and environmental management, large-scale demonstration plant risk management, and other areas of strategic and operational risk specific to precinct activities.

In recognition of their capacity to represent the interests of the College of Engineering, Science and Environment and collaboration with NIER, the Management Committee recently welcomed two new members - Laureate Professor Brett Neilan, Global Innovation Chair of Biotechnology in the School of Environmental and Life Sciences, and Professor Craig Wheeler, Acting Deputy Head of the College of Engineering, Science and Environment.

“NIER has championed a best practice model for industry engagement that focuses on value adding pathways for innovation, collaboration and cooperation. The model provides a supportive framework for strategic oversight and risk management, negotiation of complex contractual conditions, and high-level stakeholder engagement, which ultimately results in research outcomes and solid partnerships that benefit the objectives of both industry and the University.”

- Mr Kim Hockings

ADVISORY BOARD



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PROF ALAN BROADFOOT
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NEWCASTLE INSTITUTE FOR ENERGY AND RESOURCES



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METS IGNITED

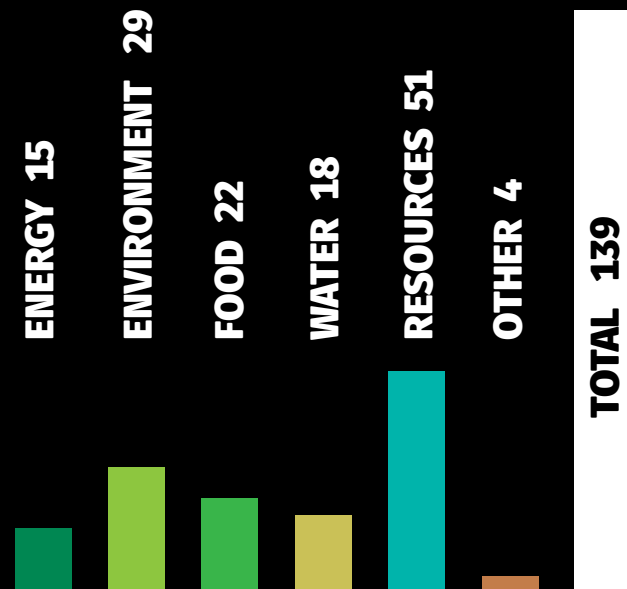


PROF JUANITA TODD
INTERIM PRO VICE-CHANCELLOR
COLLEGE OF ENGINEERING, SCIENCE & ENVIRONMENT

NIER BY NUMBERS

JULY 2021 - JUNE 2022

Grants by Sector



19

Research Centres
& Groups



136

Engaged University
Researchers



216

PhD Students Supported
by NIER Centres



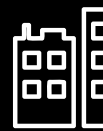
189

Active Industry
Partners



19

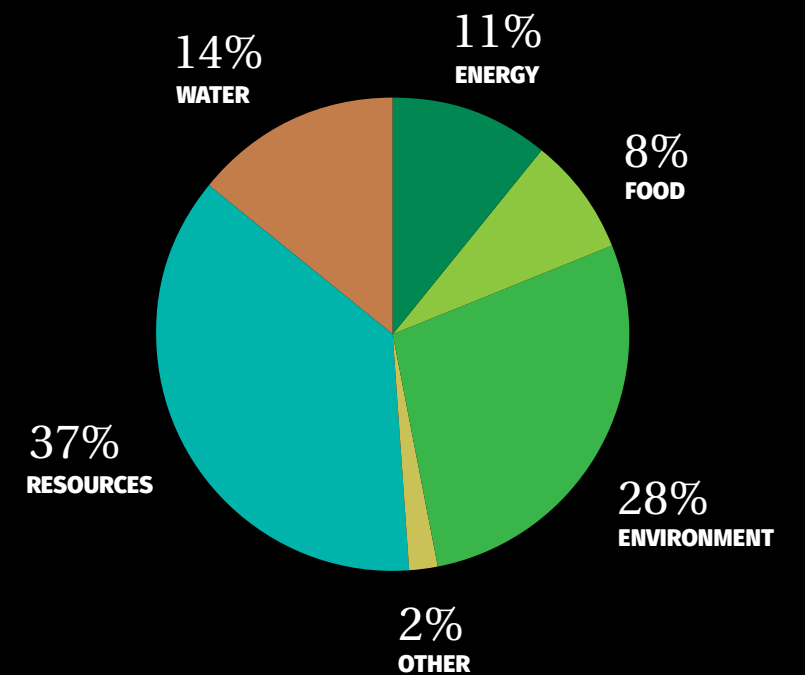
International Partners



3.8 ha

Precinct Size

Funding by Sector



34%

Repeat Clients



360+

Precinct
Occupants



2

Global &
Regional Nodes



5

Industrial
Workshops

& 3

Glasshouses

TRAILBLAZER

This year, NIER celebrated our biggest achievement in clean energy to date.

In partnership with the University of New South Wales, major energy and recycling companies, SMEs, end-users, and international entities, the University of Newcastle was successful in securing a bid to develop an Australian Trailblazer for Recycling and Clean Energy (ATRaCE).

The Federal Government announced the funding in May, as part of the Trailblazer Universities program. The partnership will include a total investment of \$280 million.

The ATRaCE recognises Australia's approach to reducing emissions is based on the opportunity provided by the creation and utilisation of new technologies, and that universities play a critical role in research translation for a sustainable nation. The proposal supports Australia's need to evolve a dynamic and responsive industrial ecosystem that integrates our energy and material systems to support a new circular energy economy through the Recycling and Clean Energy National Manufacturing Priority.

The investment means both universities will turbocharge Australia's clean energy and recycling industries and reinforces New South Wales' status as an energy powerhouse for the country, playing a critical role to accelerate the innovation agenda at speed and scale.

Professor Paul Dastoor from the Priority Research Centre for Organic Electronics (PRCOE) and Laureate Professor Behdad Moghtaderi from the Priority Research Centre for Frontier Energy Technologies and Utilisation (PRCFETU) were vital contributors to the campaign for their research in areas including next generation solar panels and green hydrogen. ATRaCE will also focus on cutting edge Pilot MICROfactories™, which are custom, cost-effective, small-scale units that transform waste into valuable materials, and sustainable aviation fuels for regional aircrafts.

The funding brings together the nation's best recycling and clean energy researchers with businesses to create an entire innovation ecosystem for recycling and clean energy stretching from the Hunter to Sydney, unlocking a full spectrum of existing facilities and infrastructure to support this critical industry.

Technologies developed through ATRaCE are projected to support up to 5,200 jobs in recycling and clean energy industries and their supply chains, in addition to a greater workforce mobility between businesses and universities and course offerings in targeted areas endorsed by industry.

ATRaCE is projected to create 52 new patents, bring 63 new products to market, avoid 180 megatons of greenhouse gas emissions and contribute up to \$15 billion to gross domestic product.

This program would not have been possible without CSIRO and our industry partners including AGL Australia, Ampcontrol, Ascon Group Germany, Hunter Hydrogen Technology Cluster, HunterNet, Kardinia Energy Pty Ltd, LAVO, Molycop, Muswellbrook Shire Council, NSW Energy & Resources Knowledge Hub, NSW Government Office of the NSW Chief Scientist & Engineer, Port of Newcastle, Siemens Energy Inc and Southern Green Gas Pty Ltd.

WORLD-CLASS RESEARCH

Sustainable solutions for global challenges through collaborative industry research, translation and education.

Global challenges need regional solutions, and community resilience depends on more sustainable approaches and optimised processes for the energy, resources, food and water sectors.

NIER's multidisciplinary research aims to support these national priority sectors to navigate new and emerging challenges relating to sustainability and security of the critical resources that underpin social, environmental and economic prosperity.

NIER centres and groups are supported in their research activity by a dedicated team working under the Executive Director's leadership in areas including research development and engagement, commercial operations, partnership management, precinct coordination, communications, governance and administration.

The research conducted through NIER's research centres and groups is defined across four key thematic areas:



INDUSTRIAL INNOVATION

Unlocking sector potential with a generation of new materials, processes, technology and services.



PRODUCTIVITY & EFFICIENCY

Solutions to reduce waste and optimise the use of the world's resources.



TECHNOLOGIES & UTILISATION

Transferring the latest technology into sectors of significance for sustainability and competitive advantage.



SUSTAINABILITY & SECURITY

Balancing environmental, social and economic activity for regional resilience.



NIER's research activity is reinforced by a unique 3.8-hectare industrial innovation research precinct at the University's Callaghan campus.

The infrastructure includes extensive research laboratories, pilot scale workshops and glasshouses, and offers opportunities for industry focused collaborative research, demonstration and training, and the mobilisation of market-ready solutions.

REGIONAL ENGAGEMENT

One of the University's goals is to play a central part in the advancement of vibrant and resilient regions.

The regions we work in have the unique social, environmental and economic challenges that demand a specialised approach. Quality engagement with our partners allows NIER to tap into local knowledge and leverage local attributes, which helps improve environmental outcomes and create new opportunities for regional resilience.

HUNTER

A primary focus of regional partnerships in the Hunter over the last year has been on pathways to the creation of a hydrogen industry. As an energy, research and innovation powerhouse, the region has the complimentary research, infrastructure and industrial expertise to accelerate renewable hydrogen generation, storage and use, along with a thriving network of stakeholders committed to delivering associated economic benefits including employment and industry growth. The University is taking a leading role in hydrogen research development and demonstration in the region, and with our partners, is connecting and developing the expertise technologies, resources and knowledge required for this emerging domestic and export industry.

Following a successful consortia bid to host a National Energy Resources Australia (NERA) Hydrogen Technology Cluster in the Hunter region, the NSW Energy and Resources Knowledge Hub, hosted at NIER, has been a key driver in the establishment and implementation of the Cluster – NewH2. The Hub has delivered regular forums and workshops, coordinated communications and website content and facilitated engagement with a high volume of industry and SME partners. NewH2 takes a market-driven, industry-led approach to support knowledge exchange and skill development and is facilitating the growth of new technologies, products and services.

The University also leads the Hunter Hydrogen Taskforce and is actively engaged with several regional Hydrogen Hubs located at the Port of Newcastle, Kooragang Island and the Upper Hunter. Hydrogen Hubs enable groups of hydrogen users to work together with common infrastructure for the local production, use and distribution of hydrogen. The Hub model works to reduce risk and costs for participants through streamlined coordination and economies of scale.

UPPER HUNTER

To support our activity in the Upper Hunter, the University manages a research and education facility at the Tertiary Education Centre, Muswellbrook. The Upper Hunter facility aids the delivery of regionally relevant collaborative research and engagement activities, and provides a flexible framework to accommodate industry partners, students and staff.

CENTRAL COAST

The University of Newcastle has joined the Central Coast Industry Connect (CCIC) in its project to develop a Food Manufacturing Innovation Hub in Lisarow. The project, also in partnership with TrendPac and Regional Development Australia, will boost jobs in food product manufacturing at the Central Coast and drive economic growth while expanding the local food and beverage market. The Hub will house a purpose-built facility designed to grow local business and assist small to medium sized food producers to scale up their business.

The partnership between CCIC and the University aims to position the Central Coast as an internationally renowned centre for excellence in food and agricultural innovation.

PACIFIC

Since its inception, the University's Pacific Node, facilitated by NIER, has focused on collaborative partnerships for development. With our partners, we have built capacity to deliver research for impact through a joint belief that a collaborative approach is needed to find solutions to the environmental challenges facing the Pacific, and to achieving the United Nations' Sustainable Development Goals. While the challenges of a pandemic resulted in the repatriation of our Pacific Engagement Coordinator, we continue to remain committed to and actively engaged in partnership and research activities in the Pacific region.

The University was a key partner in the Secretariat of the Pacific Regional Environment Programme (SPREP)'s Third Clean Pacific Roundtable along with the European Union, Ellen Macarthur Foundation, and members of regional networks in the waste and pollution sectors. The Roundtable aims to drive high-impact and scalable initiatives for pollution prevention and waste management in the Pacific to safeguard the health of Pacific communities, the ocean and the environment.

Alongside SPREP, the Government of Samoa's Ministry of Resources and Natural Environment and the Moata'a Village Council, the University was also central to the establishment of the Moata'a Living Lab, a collaborative partnership project which supports environmental education and eco-tourism development in a mangrove environment. The Living Lab, situated in Samoa, encourages activities that drive biodiversity, climate resilience, capacity development, innovation, community and ecosystem resilience, and sustainability. It is aimed at conserving areas of unique environmental and cultural heritage while showcasing the work of community, government and research partners.

PLASTICS POLLUTION TREATY

Pacific Engagement Coordinator, Dr Sascha Fuller's research has contributed to advancing Pacific needs in global plastics pollution policy discussions through the development of the United Nations' Environment Program (UNEP) factsheets on Marine Litter, Plastic Pollution and Human Rights that promote a lifecycle approach to plastics pollution. This places the onus of plastic pollution back onto the producers – a particularly important outcome for Pacific Island nations which contribute as little as 1.3 per cent to global plastics pollution yet are disproportionately impacted on the frontline of the plastic crisis.

ORANA

The Orana Opportunity Network (O2N) supports the growth and export development of businesses across the Orana and Central-West region of NSW, improving sustainability and increasing investment and connectivity. NIER facilitates the University's commitment as founding member of O2N, to support the relationship between the region and the Hunter, through the establishment of supply chain connections and regional partnerships.

This year, NIER was a key participant in a regional O2N online forum for over 120 delegates from the mining, technology, resources, energy and infrastructure sectors. With over 20 guest speakers, the forum identified significant resources and energy development opportunities in the Orana and Central West regions and showcased significant projects and initiatives with increased public and private investment. A subsequent workshop was coordinated by NIER to explore the opportunities in research and innovation for the region, which showcased projects from the Advanced METS Doctoral Training Centre and active research projects relevant for local industry, building awareness for future engagement and partnerships.





INDUSTRY COLLABORATION

As the vital link between academia and industry, NIER activates collaboration and collective capacity to underpin research translation.

To position the University as a major enabler of innovation delivering scientific and technological advances to benefit the sustainability of key industry sectors, NIER has now developed Research Roadmaps for all four of the sectors that we support – energy, resources, food & agribusiness, and water.

Our Roadmaps identify and define research capability and sector growth areas, guide strategic capacity building initiatives and career pathways for graduates, and provide a framework to coordinate efforts and impact through collaborative development activities.



ENERGY

Decarbonisation Innovation Hub

The University of Newcastle has welcomed a \$15 million investment from the NSW Government for a Decarbonisation Innovation Hub, co-hosted though NIER with UNSW, that will help fast-track research, development and commercialisation to drive solutions for a low emissions economy. The Hub is part of NSW Government's Net Zero Industry and Innovation Program which was initiated to support researchers, industry and government stakeholders in critical sectors to collaborate and increase the uptake of new technologies. The Hub is designed to build an integrated, open innovation ecosystem that will efficiently drive industry transformation and development through its extensive networks, training and capacity building.

The Hub has three primary focus streams – Electrification and Energy Systems, Land and Primary Industries, and Power Fuels including Hydrogen. This partnership which comprises a consortia of the NUW Alliance, University of Technology Sydney, NSW Department of Primary Industries and Climate-KIC aims to bring together some of the best researchers in NSW with industry and government, to reduce greenhouse emissions with a focus on renewable energy, clean energy storage solutions, electrification, and green fuels and chemicals. The Hub will build an entire 'innovation ecosystem' in NSW, to drive measurable outcomes and impact towards NSW's goal of Net Zero by 2050.

Port of Newcastle Partnership

The Port of Newcastle has established a strategic partnership with the University of Newcastle, formalised through the signing of a Memorandum of Understanding (MOU).

With our focus on energy innovation including hydrogen research expertise spanning production, storage, utilisation and cross-cutting technologies, NIER is recognised as the Port's technology and innovation partner for R&D related to their Green Hydrogen Hub. The Port is partnering with Macquarie Group's Green Investment Group and the Australian Renewable Energy Agency (ARENA) to support the development of a Hydrogen economy in the Hunter region. The Hub will initially be underpinned by a 40 megawatt electrolyser which can generate sufficient green hydrogen to power 900 buses a year, and over time, increasing to a capacity of more than 1 gigawatt.

Through the MOU, the Port will also be collaborating with the University to develop a broad suite of research and development projects utilising NIER's enabling platforms, such as the Energy Doctoral Training Centre, that will target skill development for our region. Together we will focus on broad knowledge-sharing opportunities and community engagement and collaboration, including with Aboriginal and Torres Strait Islander communities.

Australia-Germany Collaborations

NIER researchers have been successful in securing funding to support collaborative projects with researchers in Germany as part of the Australia-Germany Joint Research Cooperation Scheme. The scheme aims to foster collaboration of the highest quality between Australian and German researchers with a significant focus on early career researchers and supporting exchanges between member universities.

Professor Michael Stockenhuber from the Priority Research Centre for Frontier Energy Technologies and Utilisation is leading a collaborative project with Friedrich-Alexander University to advance a process in lab-scale studies which converts approximately 90 per cent of lean methane into a humid stream of air at significantly lower temperatures compared to other technologies. The collaboration aims to progress research developments in methane emissions associated with energy production, which are a significant contributor to anthropogenic greenhouse emissions. These emissions are being combusted to carbon dioxide to reduce the environmental impact as potency levels are usually 23 times greater than carbon dioxide.

A Research Assistant within the Priority Research Centre for Advanced Particle Processing and Transport, Siân Parkes, is actively involved in collaborating with the Helmholtz Institute Freiberg and Helmholtz-Zentrum Dresden-Rossendorf in Germany on a project that seeks to investigate the combined benefits and hydrodynamic advantage of the Reflux Flotation Cell, and advances in the selectivity and functionality of novel biosurfactants and measurement techniques for ion flotation. With promising outcomes from past flotation work on the Reflux Flotation Cell, Siân is hoping this project will make ion flotation economically viable, especially in recovering critical and battery metals as part of the circular economy. This project also has potential broader applications for wastewater treatment and the separation of radioactive materials.

RESOURCES

Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals

The Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals (COE Minerals), launched September 2021, focuses on developing and commercialising new and more sustainable mining technologies as demand for minerals, including those used in white goods, smart phones and solar panels, increases. COE Minerals is a national collaboration of multiple universities, CSIRO and industry partners headquartered at NIER and led by Laureate Professor Kevin Galvin.

Since its launch, the COE has enlisted 36 PhD students that will all gain valuable experience from the Centre's continued engagement strategy with the minerals industry. The COE has a large focus on gender diversity, with a significant proportion of its PhD students being female.

The team of researchers and PhD students at the COE have progressed several programs, including research into the physics of novel system hydrodynamics, chemistry of novel hydrophobic and selective interactions, and new engineered biopolymers and synthetic polymers. Over the last year, an Advisory Board was established to review and provide feedback on the COE's Strategic Plan, provide high-level advice on engagement with industry, government and community, and facilitate new opportunities. The COE's focus on developing and commercialising new technologies with industry partners is contributing to securing future availability of metals essential to modern living.

Making Progress in Green Steelmaking

The Centre for Ironmaking and Materials Research has made significant progress in the race towards green steelmaking. 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 process, which is expected to grow more than 30 per cent by 2050, has throughout history had a heavy reliance on metallurgical coal for its production. Emissions reduction in the steel industry is essential to meeting Australia's target of net zero emissions by 2050, and leading researchers from the Centre are undertaking critical research to help make this happen.

Among other methods, the Centre is investigating is the use of biomass to decrease the amount of coal needed to produce steel and using hydrogen instead of coal in conventional blast furnace ironmaking. The transition to green steelmaking could boost exports and help retain jobs in the industry. The Centre's research is one of many institutions supported by BHP's US\$400 million Climate Investment Program, which is projected to run over five years and contribute to training the next generation of PhD researchers and engineers with an aim of lowering our global carbon footprint.

The continued partnership with BHP is a clear example of the University's commitment to driving technological advancement through industry-engaged research at the NIER precinct.

PROUD HISTORY

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

The Centre for Ironmaking Materials Research was one of the first centres established at NIER to undertake ironmaking research supporting the use of BHP's iron ore and metallurgical coal in the conventional steelmaking process.

WATER

Drought Resilience Adoption and Innovation Hub

The University of Newcastle has joined the University of Southern Queensland in the Southern Queensland/ Northern NSW Drought Resilience Adoption and Innovation Hub, an initiative of the Australian Government's Research and Adoption Program. Through the Hub, researchers are delivering drought resilience projects to assist Australian farmers and agricultural-dependent communities, as well as encouraging businesses to adopt innovative approaches and technology to improve drought resilience.

Building on their expertise in farming and mental health, the Centre for Climate, Water and Land will develop online wellbeing toolkits. The toolkits will reduce the stigma around mental health problems and overcome barriers to seeking professional help, in turn assisting farmers, rural residents and support workers to identify and address the effects of drought-related stress. The Priority Research Centre for Frontier Energy Technologies and Utilisation will further develop their 'Hydro Harvester' project, which aims to address critical drinking water shortages in drought affected areas by harvesting atmospheric moisture. These projects aim to empower communities in regional areas through drought preparedness activities.

Remediation and Management for Threatened Coral and Coastal Ecosystems

Associate Professor Troy Gaston, Dr Vincent Raoult and Ms Hannah Finlay-Jones from the Coastal and Marine Science Research Group are conducting a study into the decline of soft coral habitats off the NSW coast, and the resulting risk to entire food webs. On the Central Coast and in Port Stephens, some soft coral habitats have declined by up to 90 per cent, leading to the species *Dendronephthya Australis* becoming the first soft coral in Australian history to be listed as 'threatened'. The decline is largely attributed to impacts of human activity such as boat anchoring, poorly installed boat moorings and fishing line entanglement, as well as sand movement. While previous work found that large fish don't directly feed on these corals, researchers found that small invertebrates relied on the corals as part of their diet – these invertebrates are important food sources for fish further up in the food web, signalling that a loss of these soft coral habitats could have broad, negative effects on our waterways. The study recommends remediation and management actions to ensure *Dendronephthya Australis* does not become extinct in the region.

FOOD

Improving Oyster Quality

The Food Science Research Group is investigating new methods for improving the quality of oyster meat for the restaurant industry. Led by Associate Professor Troy Gaston and Dr Taiwo Akanbi, the group is partnering with Broken Bay Pearl Farm based on the Central Coast. Oyster aquaculture in Australia is worth \$97 million annually. The project will assist Broken Bay Pearl Farm, operating in the Brisbane Water and Hawkesbury River estuaries, expanding the availability of Akoya oyster meat which is considered to have high potential for the domestic and export markets.

Carbon Neutral Winemaking

Praveen Kuppan, a PhD candidate from the Global Centre for Environmental Remediation, is developing a green sustainable Phycoremediation technology to be used in winery processes. Praveen's PhD project, '*Phycosol- A Novel Winery Wastewater Treatment in enhancing Circular Economy*', is geared towards establishing the potential of algae and solar energy for creating a bioeconomy in sustainable wastewater treatment. The process would simultaneously generate biomass for biofuels. Australian wineries have shown their commitment to making winemaking carbon neutral by 2050, with Wine Australia funding the project.

Maintaining Freight Quality

Dr Quan Vuong and his team from the Food Science Research Group are focusing on a project titled '*Automated Farm-To-Shop Freight Quality Monitoring and Assurance System*' which has a focus on the delivery of perishable goods being subject to stringent requirements. The environments in which the goods are delivered throughout the transport chain must be tightly controlled and monitored, as well as meeting the end-to-end delivery duration needs.

This project aims to develop an end-to-end freight quality monitoring and assurance system based on an IoT (Internet of Things) network architecture. The research focuses on the cradle-to-gate freight delivery of perishable cargo from farms to shops and aims to develop an automated system to monitor the quality of products in the freight system and maintain the product quality by taking necessary actions based on the real-time quality data obtained from the freight containers.

RESEARCH EDUCATION

NIER is focused on delivering research education and training to meet workforce needs of future industries.

DOCTORAL TRAINING CENTRES

Doctoral Training Centres (DTCs) support industry embedded PhD programs and provide additional training and engagement to produce impactful research outcomes, job-ready graduates and strong links between industry and universities. The cohort of PhD candidates work on research projects developed in collaboration with industry partners and are supported by a multidisciplinary, solutions-focussed academic team to enhance knowledge, outcomes, and skillsets.

Our established DTCs in Advanced METS and Food & Agribusiness continue to grow with a number of new projects commencing this year, including a METS project on hydrogen integration for blast furnace ironmaking, and a Food and Agribusiness project exploring an integrated approach for sustainable winery wastewater treatment for enhancing circular economy. We were delighted to showcase the DTCs at the Orana Opportunity Network (O2N) Energy, Mining and Innovation Forum in February, with the opportunity for some candidates to present their research in front of an industry audience spanning the state. During the year, candidates received tailored training on industry engagement and communications, as well as experiencing an informative technical site tour with a DTC industry partner in Muswellbrook.

Through initial planning activities including cross college academic consultation and an industry event, NIER has been working towards the establishment of an additional DTC in Energy to address another of our priority areas of energy, resources, food and water. The soon to be launched Energy DTC will focus on research areas including energy generation and storage, alternative energy including renewables, emissions reduction technologies, and grid systems and stability.

Modelling and Optimisation for the Generation of Advanced Materials

The Multiple Hearth Furnace (MHF) is a processing unit that is utilised in industrial processes including thermal treatment of ores, water waste treatment, and the regeneration of activated carbon. Samantha Clark, candidate within the Advanced METS DTC, is working on a project that aims to make an impact in the METS sector by optimising the MHF through the creation of a model that will enable the variations of inputs and adoption into other applications. The optimised model of the MHF will reduce operational costs and improve the quality of the desired products, and allow for it to be utilised across multiple sectors.

For her project, Samantha is collaborating with Jord International, a company that designs and produces process equipment solutions for a multitude of sectors in the energy and resources industries. Working closely with her industry contacts has allowed Samantha to have access to processing plants where a MHF is currently used, enabling her to alter and implement novel equipment to sample solids and gases within the hearth.

"The DTC has given me so many opportunities including gaining experience from working alongside industry, developing skills from their programs, and making connections from various networking forums where I have had the opportunity to present my work."

- Samantha Clark, DTC PhD Candidate



DTCs inspire the next generation of industry leaders with new ideas, new ways of working and smarter solutions to industry challenges.

PACIFIC NODE SCHOLARS

The Pacific Node oversees the Pacific Higher Degree Research (HDR) program with additional support for the candidates provided through NIER's DTCs. In 2021-22 eight Pacific HDR students were undertaking research in climate change resilience, waste management and pollution control, invasive species management and inclusive education. The HDR program is designed to provide supported development and advancement of knowledge and expertise which will aid global and regional impact for Pacific communities.

Pacific Students Strengthen Invasive Species Management for Climate Resilience

Invasive species can threaten biodiversity, food security, human health and ecosystem services, directly affecting species loss and ecosystem function causing a loss of resilience in responding to climate change. HDR candidates and academics from the University are supporting Pacific Island nations in their efforts to tackle the problem of invasive species.

With funding from the New Zealand Ministry of Foreign Affairs and Trade, a research partnership between the University of Newcastle and the Secretariat of the Pacific Regional Environment Programme (SPREP)'s PRISMSS mechanism has been established to support Pacific students working towards solutions. Projects include: measurement of responses of different environmental indicators such as birds, reptiles, invertebrates and coral reef health following rodent eradication; using remote sensing technology to improve our understanding of the role of cyclones in spreading invasive weeds in the Pacific to establish cost-effective monitoring methods to aid conservation management decisions; and, an examination of the values, attitudes, and practices towards invasive species and invasive species management to develop a gender and social inclusion toolkit for invasive species management tailored to Pacific Island communities.

"The project I am working on provides me the opportunity to apply and develop my technical skills in remote sensing for the management of invasive species in the Pacific but to also develop my soft skills with regards to project management and stakeholder engagement."

- Carol Chan, Pacific HDR student

INNOVATIVE SOLUTIONS

NIER drives technology transfer and impact at scale to improve social, economic and environmental outcomes for sectors of global significance.

NEW METHODS TO CAPTURE EMISSIONS FROM INDUSTRIAL PROCESSES

Dr Jessica Allen from the Priority Research Centre for Frontier Energy Technologies and Utilisation is uncovering solutions to significant energy challenges facing society. Supported through an Australian Research Council Discovery Early Research Award (DECRA) Fellowship, Jessica is developing a new method to effectively capture the carbon dioxide from industrial processes such as cement, ammonia and steelmaking, and using renewable solar thermal energy inputs to turn the CO² into a stable carbon product.

The hard carbon by-product of this process is a major component in next generation batteries and is typically generated from coal-based materials. This innovative new system for drawing CO² down into a solid carbon product has the potential to turn emissions from heavy industry into a valuable export. Jessica intends to see this early stage technology under development at NIER through to a commercial outcome.

RAIL RUNNING CONVEYOR PROVES ADAPTABLE SYSTEM FOR BULK MATERIALS TRANSPORT

Developed in a collaboration between TUNRA Bulk Solids, the Centre for Bulk Solids and Particulate Technologies and Thyssenkrupp, Professor Craig Wheeler's Rail Running Conveyor (RRC) represents a new, ultra-efficient, adaptable system for bulk material transport, with the efficiency of railway haulage but at much lower cost. Crucially, the RRC technology eliminates most frictional losses of conventional belt conveyors, which can contribute about 80 per cent of power and tension on long overland routes.

RRC's effectively merge two proven technologies – heavy rail and overland belt conveying, and through efficiencies, bring lower Capital Expenditure and Operational Expenses. Additionally, RRC's offer significant advantages including the elimination of idler-related maintenance costs, higher running speeds with lower tensions, and greater curvability. More recently, the research team has developed a pipe conveyor variant of the RRC technology leading to significant energy and cost savings over the traditional pipe conveyor technology.

Thyssenkrupp will soon partner with a top-10 global copper mining company to build two full-scale RRC systems, each 3km long, the first of their kind in the world. As a new technology being applied for the first time, both will be built as hybrids bringing significant power savings and capacity that can be quickly retrofitted back to conventional conveyors, covering any potential risk to the client.

REFLUX FLOTATION CELL AIDS VALUABLE MINERAL RECOVERY

Flotation is a prominent technique to recover and concentrate valuable minerals for making metals. Laureate Professor Kevin Galvin, Director of the ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals, invented the Reflux Flotation Cell (RFC) in 2011 to address the problems that existed with flotation, improving the process by promoting much faster separation and cleaner product. The technology formed part of the R&D partnership with Ludowici and in turn FLSmidth for the Reflux Classifier that began in 2002, and has since been proven to work at full-scale at a mine-site facility. The project cost \$4.5 million and consisted of a six-party industry consortium funded in part by the Department of Industry's Global Innovation Linkage scheme and the Australian Coal Industry's Research Program.

The RFC design will allow for much higher throughputs and a broader particle size distribution and recovery of finer particles, ideal for a broad range of critical minerals. A new RFC Upscaling project aims to extend the commercialisation of the technology, as a new product of FLSmidth, into copper and iron ore. The project has a group of global partners supporting the implementation of the technology. Multiple pilot plants and global fields trials are now underway.

CHARGE AROUND AUSTRALIA PROJECT HIGHLIGHTS PRINTED SOLAR CELL TECHNOLOGY CAPABILITIES

When Professor Paul Dastoor and his team at the Priority Research Centre for Organic Electronics first created their light weight, low cost, printed solar panels, they knew the technology would make global impact in the energy market. A partnership between Charging Around Britain Ltd and the University of Newcastle is demonstrating the potential for these plastic cells, known as Organic Photovoltaics to revolutionise travel with the Charge Around Australia Project.

The increasing popularity of electric vehicles has been vital in reducing emissions, but a lack of access to charging networks can cause challenges when it comes to driving longer distances. The project will highlight how solar energy can address this issue. By having a team drive around the entire coastline of Australia (over 15,000 kilometres) with a supply of the thin plastic solar cells, they will be able to roll them out in even the most remote regions to absorb solar energy when the car requires charging, creating their own portable power generators. This will demonstrate the viability and advantages of printed solar in remote locations.

The technology involves the creation of polymer based inks, which will then allow for high-speed printing to fabricate large areas, using roll to roll processing techniques. The printed solar modules produced are low-cost, lightweight, and easy to install, making them a more accessible alternative to the silicon-based solar panels we have today. The 12-month project includes the design and development of a custom electric vehicle charging system for printed solar modules, manufacture and characterisation of the printed solar modules, and an associated STEM outreach program that will be delivered in schools on the route. The trip will truly test the usability of the Centre's technology.

PhD PATHWAYS

As we work to build the industries of the future, we need to synergise the workforce, which means equipping the next generation of workers with the most up-to-date knowledge, technical abilities, and a skillset to solve problems that haven't emerged yet.

NIER is committed to the delivery of multidisciplinary education and training, with strong industry partnerships to facilitate a world class training experience, knowledge translation and research relevance. Here we meet three candidates at different milestones on their higher degree by research pathways.



DR TAHEREH JALALABADI

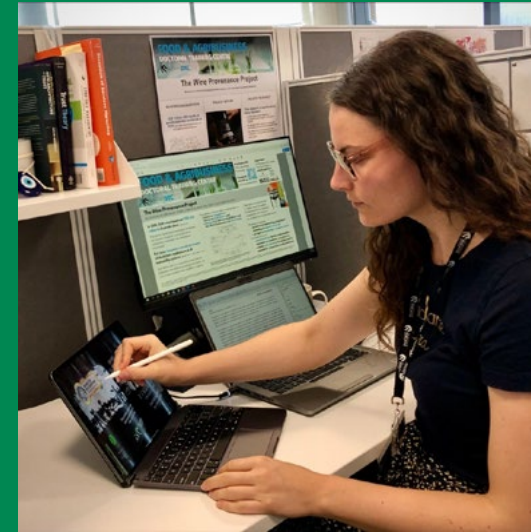
Former PhD Employed in Industry

In 2021, Dr Tahereh Jalalabadi secured her employment as a Technical Development Analyst in the Research and Development team with Licella. Prior to this, Tahereh undertook her PhD, 'Molten Salt Slow Pyrolysis for Advanced Carbon and Renewable Energy', at NIER under the supervision of Dr Jessica Allen.

Working closely with the Priority Research Centre for Frontier Energy Technologies and Utilisation, her project focused on how to turn the residue from agriculture and biomass materials into renewable carbon, with applications in energy storage devices such as batteries.

Attendance at several events held by Engineers Australia and Bioenergy Australia expanded her knowledge of the industry and interest in renewable fuels and circular economy, and the opportunity to work with Licella was an obvious and exciting next step in Tahereh's career.

NIER's focus on providing a link between industry and research has contributed to Tahereh's resolve to be proactive in strengthening industry-academia partnerships, and she is grateful for the extensive knowledge she has gained from working alongside NIER's multidisciplinary teams.



IRMA DUPUIS

Recently Commenced PhD

Irma Dupuis commenced her PhD in 2021 and is part of the DTC for Food & Agribusiness. Her project, 'The Wine Provenance Project: Blockchain-enabled Wine Labels - A New Era for Consumer Trust?', under the supervision of Dr Sidsel Grimstad, Dr Tamara Bucher, and Professor Lisa Toohey, focuses on blockchain-enabled wine labels and their effect on consumer trust. Blockchain technology can provide consumers with information about the wine they are purchasing, from its origin and where the grapes were harvested, to where it was packaged and sold.

Irma hopes to help producers use blockchain technology to better communicate authenticity and provenance information to consumers. She has received a Wine Australia HDR scholarship to further support her project.

Irma is partnered with Hunter Valley producers First Creek and Tamburlaine Organic Wines, along with MCC Label, a label company, and Laava, a smart label specialist. Tamburlaine Organic Wines has released two million bottles into the market with provenance smart labels, making Irma's research a valued asset.



CAROLINE GOMES DE OLIVEIRA

PhD Near Completion

Caroline Gomes De Oliveira is a PhD student in the DTC for Advanced METS. After completing her undergraduate degree in Materials Science and Engineering in Brazil, she commenced her PhD in 2018 under the supervision of Professor Kenneth Williams from the Centre for Bulk Solids and Particulate Technologies. Her project, 'Development of an Erosion Model for the Materials Handling Industry', is investigating the lifespan of various liner materials that are applied in transfer chutes inside mining machinery to protect their structure while particulate materials pass through. After identifying how these liners behave, Caroline will propose a method of predicting how they will last under different conditions before no longer functioning the way they need to.

The development of the model will significantly help the mining industry in planning around the replacement of the lining of the chutes, resulting in minimal disturbance to production. The method will also minimise the material and economic loss that can arise from the machinery stopping midway through a shift, which can cause workers to have to stay longer than accounted for.

Caroline is partnered with Metso Outotec, who have built innovative equipment for this project to enable more accurate erosion tests with large particles that are greater than 20mm. Regular visits to the Metso Outotec facilities, meetings with the company's engineers, technical support from the company regarding analysis, experimental planning, samples, and technical knowledge are all part of Caroline's industry engagement activities as part of her PhD.

NIER RESEARCH CENTRES AND GROUPS

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



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Image: Aerial shot of the NIER precinct showing newly installed 200kW Photovoltaic System on N Block.



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