ENERGY RESEARCH ROADMAP

Guiding research with impact for a resilient, sustainable future

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

nier

SOLUTIONS FOR GLOBAL CHALLENGES
ENERGY RESOURCES FOOD WATER

NEWCASTLE.EDU.AU/NIER

CONTENTS

INTRODUCTION

The University of Newcastle, through its flagship research institute, NIER, is focused on securing environmentally and economically sustainable energy solutions

The University of Newcastle and NIER presents this Energy Research Roadmap, a plan to contribute advanced knowledge to grow the energy sector and equip a future workforce with the necessary skills and solutions to ensure economic and regional prosperity.

As a nation with abundant natural energy sources, Australia has long been bolstered by a strong energy and resources sector. In mitigating against climate change, the sector is undergoing rapid transformation which is re-orienting our economy and bringing with it new market opportunities.

Low emission technologies, distributed renewable generation, energy storage and smart grid technologies, are part of the new energy paradigm.

This Energy Research Roadmap was developed to set the priority actions necessary to support the energy transition and the sector broadly, to drive strategic initiatives that develop competitive advantage through industrial innovation, grow industries, strengthen supply chains, and build work skills for a low carbon future.

Together with industry, government and community partners, the University will enable industry to take advantage of new opportunities across regional NSW and Australia ensuring that our activities strengthen our economic position and diversify our economy to benefit future generations.

Through NIER, the University presents this Energy Research Roadmap to drive applied research, research education and knowledge exchange for affordable, reliable and sustainable energy.

The Roadmap highlights our key areas of strength and focus:

- Clean energy solutions
- Low emission technologies
- Energy productivity and utilisation
- Energy integration.

"Looking Ahead," The University of Newcastle's Strategic Plan 2020-2025, is reinforced through this Roadmap, as we work to build on the University's significant track record of success and the strengths of our world class researchers.

This Roadmap will deliver activities in concert with the Food and Agribusiness, and Water Research Roadmaps.

Our actions will endeavour to cement the University and our region's position as:

- An engine room for energy research and innovation
- A proving ground for innovation for the transformation of the energy sector for regional prosperity
- A test-bed for demonstration and research development
- A focal point for specialised workforce training and jobs
- An industry enabler for economic growth.

The University of Newcastle is committed to supporting long-term regional prosperity, and the competitiveness of Australian industry in the global, low-carbon economy

SECTOR SNAPSHOT

Australia's changing energy mix, the balance between domestic consumption and export demand for our resources, the needs of users in rural and remote areas, and the role of consumers, is shaping the opportunities and challenges we face in meeting our future energy needs.

Supporting the market and accelerating opportunities for the feasible deployment of technologies and services is a priority, requiring a collective commitment and focused strategies to support continued economic growth.

LOW CARBON FUTURE

Driven by the global recognition of the impacts of climate change and agreements made at the Paris COP21 meeting, countries are taking steps to reduce their carbon emissions either through alternative and renewable sources, or decarbonisation.

All Australian states and territories have committed to a net zero emission target by 2050. To achieve these commitments, strategies to reduce emissions and improve resilience to climate change are progressing towards a new energy economy.

We are now witnessing a drive toward innovative technologies and services that have lower emissions, less waste, and support climate change adaptation. Changes to the generation and consumption of energy is having significant, far reaching impact on planning and deployment of traditional power generation, and the fuels used in their operations.

ENERGY SECURITY

Secure, affordable and reliable energy is important in supporting the lifestyle expectations of a growing population. Reliable and price-stable supply of energy for businesses and industries is also essential to fuel job creation and economic growth.

In the international energy market, many developed nations are challenged by depleting energy supplies and are looking to international sources for their energy resources.

Domestically, Australia's energy sector is operating with volatile commodity prices, a rapidly evolving energy marketplace, changing societal energy expectations, an increasingly complex regulatory environment and a rapidly evolving global energy mix.

CHANGING ENERGY MIX

The established power distribution infrastructure networks in many developed nations are facing challenges in the transition to non-synchronous and distributed energy sources. With solar and wind in particular being more localised and intermittent in nature, governments and operators of traditional energy generation are responding to a rapidly changing energy mix.

By 2030, Australia is predicted to have up to 30 per cent of its electricity generation decentralised. In a decentralised yet integrated energy future, electricity networks must be responsive to the changing demands of traditional services while enabling new opportunities for energy resource sharing.

TECHNOLOGICAL DRIVERS

Technological advances over the past decade are contributing to substantial changes in the ways in which societies access and consume energy and how businesses are able to optimise their production and distribution of energy. These new and emerging technologies are transforming the way in which businesses operate and offer substantial opportunities for future development, supporting gains in safety and productivity. Examples of these include hybrid energy solutions incorporating clean technologies, low emissions technologies such as carbon capture and storage (CCS), as well as LNG for transport fuel, and remote operations technology.

Researchers are advancing low emission and clean energy technologies, transforming energy intensive processes, and driving the next wave of industrial innovation and jobs

GUIDING PRINCIPLES

Our goal is to deliver outcomes that allow for greater sustainability of our energy future and that lead on to the creation of new businesses, products and services from which future workforces will be built.

SUPPORTING THE ENERGY TRANSITION

Climate change presents environmental and economic challenges but also opportunities to increase economic productivity, create new industries and jobs, attract new investment, and grow exports.

At the University, we are focused on supporting energy transition through research programs that enable a lowering of emissions and fast-track clean energy solutions, ensuring their integration towards greater energy security and affordability.

DEVELOPING COMPETITIVE ADVANTAGE THROUGH INDUSTRIAL INNOVATION

Energy technologies have the potential to change the way existing industries operate and interface with one another, improving productivity, energy utilisation and in many cases providing a catalyst for new industries.

Our focus on industrial innovation is advancing solutions that have optimised energy intensive industrial processes, substantially reduced energy and water consumption, and waste, and improved environmental and social outcomes.

GROWING INDUSTRIES AND STRENGTHENING SUPPLY CHAINS

NIER's unique engagement model acts as a conduit between academia and industry to build pathways for knowledge exchange and 'industry-led' research. Our focus is on developing mid-tier and SME participation through engagement pathways including opportunities for co-location.

Deeper engagement with supply chain organisations and operators will bring new ideas forward faster, harness existing capabilities, and identify solutions that will improve the competitiveness in key sectors including energy and resources, food and agribusiness, and manufacturing.

BUILDING WORK SKILLS FOR A LOW CARBON FUTURE

The rapid deployment of new technologies will require new organisational structures, skills and capabilities. The University is focused on building a pipeline of talent that delivers the necessary skill base to operate existing facilities while preparing personnel that are adaptive to new market opportunities, customers and services.

Industry leadership and collaboration is essential in a disruptive energy market, as industries look to drive productivity and efficiency gains to optimise plants and processes.

STRATEGIC ELEMENTS

Underpinned by strong partnerships, our approach will focus on delivering four interconnected and mutually reinforcing strategic elements. Through our actions, regional benefits will be derived from applied research, enhanced capacity, greater communication and knowledge translation, leading to the delivery of innovative and sustainable outcomes.

KNOWLEDGE BROKERAGE

The focus on building relationships between knowledge producers and end users to enable research to better respond to regional, national and local needs. Through NIER's engagement model, our programs will provide opportunity for increased dialogue between researchers and stakeholders to define the questions they need answered by research.

APPLIED RESEARCH

Researchers will actively seek research partners in the development and demonstration of market and community led energy research that supports evidence-based best practice, ensures strategic alignment to regional needs, and promotes greater productivity, efficiency and sustainability. Multidisciplinary teams will work in four key areas:

- Clean energy solutions
- Low emission technologies
- Energy utilisation and productivity
- Energy integration

KNOWLEDGE TRANSLATION

The University will ensure that knowledge gained through research extends beyond the life of individual research projects to evidence-based practice and skill development. We will focus our activities on experiential, interdisciplinary and regionally focused knowledge translation - sharing solutions to common social, economic and environmental challenges. In particular, our activities reinforce the University's 'Looking Ahead' Strategic Plan:

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

CATALYSING INNOVATION

NIER will advance solutions through Research Development and Demonstration (RD&D), leading to service and product improvements. Our activity will support research initiatives that act as a driver for economic growth and as a drawcard for innovative companies looking to relocate or diversify. Fostering an innovation ecosystem adds capacity for existing industries and becomes an enabler for the new.

Through NIER, the University assists in overcoming barriers to innovation whilst capitalising on the opportunities that the new energy economy presents by:

- Injecting new enabling technologies
- Stimulating RD&D opportunities
- Maintaining a platform for successful commercial outcomes

DEVELOPMENT ACTIVITIES

LEVERAGE UNIQUE ASSETS & BUILD INTERNATIONAL CENTRES OF RESEARCH EXCELLENCE

NIER's demonstration scale workshops and laboratories cement our ability to deliver major research initiatives with significant environmental and economic benefit and provide unique opportunities for industry embedded research and work integrated learning for our student community. Our track record of research excellence in the delivery of competitive advantage for industry will continue to advance critical Australian sectors, providing fertile ground for further growth. Current major initiatives will be leveraged to allow the University to continue to build greater critical mass through a highly specialised pool of talent, as well as provide confidence to government and funding agencies. Most notably:

- The ARC Centre of Excellence for Enabling Eco-efficient Beneficiation of Minerals supports the development of transformational technologies that address climate smart mineral processing
- The Australian National Fabrication Facility is a unique open access asset that offers functional printing across a variety of applications in advanced manufacturing, water, energy, ag-tech, med-tech and defence solutions.
- Australia's only large-scale fugitive methane abatement detonation tube is a piece of infrastructure capable of safely testing the management of dangerous gases. The detonation tube was associated with a $30m Federal Government initiative and is capable of converting methane to benign gases. Researchers used the equipment to demonstrate significant reductions in emissions for mining operations.

Through this Roadmap we will focus on furthering opportunities for new strategic research centres and early and mid career researchers that:

- Accelerate carbon footprint reduction in industrial processes
- Build greater capacity in regional areas
- Expand national industry capability through strategic partnerships
- Nurture future research leaders.

DELIVER LARGE-SCALE DEMONSTRATION FOR THE NEW ENERGY ECONOMY

Investment in large-scale projects will allow the development and demonstration of novel technologies that lower carbon intensity and promote sustainable processes. The University will capitalise on NIER's unique test facilities to deliver projects that de-risk the transition to a new energy economy.

The University is focused on driving catalyst demonstration activity that:

- Supports the augmentation of industrial processes for the utilisation of energy and greater productivity and efficiency
- Improves energy and fuel security, and unlocks value across energy resources, manufacturing, food and agribusiness, and water sectors
- Grows regional and national economic diversification opportunities
- Leverages an existing skilled workforce and world-class education and research facilities
- Supports government strategies to boost productivity and efficiency throughout regional NSW - focused on greater integration of regional networks for the production and utilisation of hydrogen, transport and logistics.

CREATE WORK-READY GRADUATES THROUGH A DEDICATED DOCTORAL TRAINING CENTRE

NIER will work with University Colleges to establish a Doctoral Training Centre (DTC) in energy. Through this process, we will provide a supportive environment for the current generation of engineers and scientists to mentor future leaders in new energy technologies and systems.

The DTC will bring postgraduate students and researchers together with industry, business and government partners to inspire new ideas, new ways of working and smarter solutions to industry challenges. As a collaborative initiative, the DTC will provide industry partners with unprecedented access to a pool of knowledge for co-designed projects that support students to gain industry ready skills.

Flexible research education delivery mechanisms will be explored such as micro-credentialing, short courses and skill development partnerships to compliment the activities of the DTC.

Opportunities for work integrated learning at an undergraduate level will also provide practical industry exposure and training.

DRIVE ENABLING PLATFORMS FOR GREATER REGIONAL CONNECTIVITY

The University will actively progress opportunities for industry co-location with key strategic partners including research institutions, government associations and industry. We will invest our resources towards delivering collaboration spaces and industry-facing support programs such as NIER's Innovation Launchpad for SMEs, DTCs and the University's entrepreneurial network, I2N, that provide greater access to a multidisciplinary network of expertise, decision support tools and thought leadership.

We will translate these successful programs to other regional areas, working closely with strategic development partners to ensure our knowledge and expertise extends beyond the Hunter and Central Coast regions to benefit other important centres in NSW such as Orana, and beyond, to regional Australia and our Pacific neighbours.

We will ensure regional solutions are aligned to important government initiatives such as NSW Government Renewable Energy Zones (REZs) and Special Activation Precincts (SAPs). The University will actively support business attraction and investment to Regional NSW.

The NIER hosts the NSW Energy and Resources Knowledge Hub and will accelerate industry capacity, enabling a dedicated forward leaning focus on low emission and clean energy technologies and utilisation, through knowledge exchange and harnessing incentives for collaboration, to ensure action is targeted and productive.

RESEARCH FOCUS AREAS

Economies around the world are addressing important challenges integral to our long-term energy security. In meeting future demands, the University will leverage its existing expertise to support solutions across four key areas:

- **CLEAN ENERGY SOLUTIONS**
- **LOW EMISSION TECHNOLOGIES**
- **ENERGY PRODUCTIVITY & UTILISATION**
- **ENERGY INTEGRATION**

CLEAN ENERGY SOLUTIONS

Fuels, materials and technology for a sustainable energy future

Renewables play a crucial role in clean energy transition and global efforts to meet climate targets. Solar, wind, hydro, biofuels and waste to energy, are at the centre of the transition to a less carbon-intensive and more sustainable energy system.

Our research teams are focused on supporting the emergence of renewable industries through the development and deployment of fuels, materials and technologies that embed circular economy and deep sustainability principles. We are working to enable heavy industry and regional communities to become global leaders in the new low-carbon economy, whilst achieving tangible commercial and social outcomes.

THE UNIVERSITY AT A GLANCE

- Renewable energy systems for biomass and biosolids utilisation including co-firing chemical looping gasification, direct and indirect geothermal technologies and small wind systems
- Hybrid energy systems including geothermal and solar assisted power generation
- Microgrid scale energy storage (chemical looping energy on demand system for microgrids and miniaturised chemical looping energy on demand system for residential application)
- Pyroelectric and thermoelectric energy harvesting
- Building thermal efficiency with passive solar systems
- Micro energy systems including micro hydrogen generators
- Printed and recyclable solar material
- Electrochemical energy storage devices including ion batteries (lithium, aluminium, magnesium, sodium etc.)
- Supercapacitors, flow batteries and electrochemical energy storage compatible with circular economy principles
- Utility scale energy storage involving calcium looping, phase-change chemical looping and ilmenite looping
- Chemical looping gasification of biomass for hydrogen production and synthesis gas production
- Photo catalytic methods of hydrogen production
- Atmospheric water generation for green hydrogen production
- Novel fuel converter for production of hydrogen from natural gas
- Novel miniaturised fuel reformer for on-board hydrogen enrichment of gaseous and liquid fuels in combustion systems
- Demonstration of printed solar cells in a variety of settings
- Social research on sustainable energy advocacy coalitions
- Sociocultural research on community resilience and response to transitioning initiatives
- Social and cultural dimensions of diverse energy systems
- Research integrating digital and traditional social science methods exploring the social and cultural dimension of diverse energy futures

MAJOR INDUSTRY R&D PRIORITIES

- Improving energy literacy for the uptake of renewable energy solutions.
- Increasing workforce skills, capacity and knowledge in developing and evaluating renewable energy projects
- Increasing renewable penetration that is sustainable beyond pilot projects
- Price reduction around firming renewables for improved competitiveness

Image: Printed Solar Cell Demonstration installed at Lane Cove Council's vibrant new urban space 'The Canopy', this renewable energy material is being trialled in a public setting as it nears commercial readiness

CASE STUDY

REGIONAL HYDROGEN ECONOMY

For Australia to capitalise on the growth of a hydrogen economy, we need industrial-scale demonstration of cost-effective technologies and advanced capabilities in the utilisation of hydrogen as a fuel and feedstock in industrial processes.

The Hunter Region is Australia's energy capital. The region produces 63% of NSW's electricity, and its heavy industries comprise some of the largest users of energy in the state, providing essential grid stabilisation functions to the National Energy Market. The Hunter has an opportunity to accelerate the transition to the new hydrogen economy, creating the optimum environment for investment and jobs, leveraging its extensive energy transmission and network infrastructure, and unique assets including the Port of Newcastle.

NIER research teams are working actively to advance projects in hydrogen production, storage, utilisation and cross-cutting R&D to support the emergence of a hydrogen industry.

The recently awarded ARC Training Centre for the Global Hydrogen Economy, led by UNSW will see University of Newcastle researchers partner in the five-year program that will generate new technologies and equip industry focused engineers with advanced skills for the scaling-up of hydrogen generation and transport. Benefits include export of hydrogen fuel and advanced technologies, job creation, and a lower emissions domestic energy industry.

Our research supports Australia's National Hydrogen Strategy and reinforces the pivotal role the Hunter Region can play in enabling the growth of the hydrogen industry in Australia.

Our involvement in the Hunter Hydrogen Taskforce and NERA's Regional Hydrogen Technology Cluster will accelerate regional hydrogen projects and partnerships, and help deliver a suite of activities to position the Hunter as a competitive and attractive location for investment in hydrogen related business opportunities.

LOW EMISSION TECHNOLOGIES

Delivering emission reduction technologies across the energy resources sector

At the University of Newcastle our research teams are experts in low emission technology options for energy and processing industries that offer cost-effective, low and negative emission reductions at scale, strengthening both the economy and sustainable practice. Our focus has been on new, large-scale demonstration of long-term abatement potential, high-efficiency, low emissions (HELE) solutions, alongside carbon capture and storage (CCS) and carbon sequestration techniques for a low-carbon future.

As the world's largest exporter of liquefied natural gas, iron ore and metallurgical coal, we have developed world-class science and engineering capabilities that support Australian industry, and have reinforced regional strengths in the delivery of safe, reliable energy production and supply to the market. These inherent strengths provide a basis for our focus in emission reduction technologies that have kept the University at the forefront of knowledge creation and technical problem-solving.

THE UNIVERSITY AT A GLANCE

- Low emission technology options for mining and processing industries include Ventilation Air Methane (VAM) abatement technologies and waste heat recovery systems using co-generation plants and heat pumps
- Oxyfuel combustion technology
- Containerised Chemical-Looping based Oxygen Plants
- Chemical looping for energy production (air separation, combustion, gasification and reforming)
- Applications for direct injection carbon engines and direct carbon fuel cells
- High efficiency, low emission (HELE) blend characteristics, hybrid pyrolysis, gasification and combustion mechanisms in coking for steel making
- Combustion flue gas cleaning technology and smog reduction
- Social research exploring receptibility of high efficiency low emission (HELE) technologies and carbon capture and storage
- Case studies of social perceptions and attitudes of low emission technology
- Design and development of advanced materials technologies to transform natural clay based halloysite for CO_2 capture
- Advanced materials for the generation of hydrogen through photo and electrochemical conversion of water and its storage using low-cost adsorbent materials
- Novel mineral carbonation technologies for carbon capture and storage
- Ultra-high surface area advanced functional bio-carbons for application in adsorbent material for pre and post combustion and carbon capture
- Alternative emerging low-carbon emission technologies for iron ore production and iron and steel making
- Techno-economic analysis for upscaling, development and demonstration for production of sustainable fuels including bio-derived coke, leveraged from co-production of other feedstock, CO_2 capture and use
- Low carbon transition in the Australian technology sector

MAJOR INDUSTRY R&D PRIORITIES

- Achieving a low-risk path to transform industrial processes to operate with low net carbon emissions, both within Australia and for export markets
- Techno-economic assessments of the relative merit of alternative emerging low-carbon technologies
- Demonstration at an industrially relevant scale of technologies for heavy industries with strong potential to achieve step-change reduction, low-carbon digestion, calcination in alumina production, iron/steel making integrated capture of CO_2

Image: Abatement technology test rig capturing fugitive methane emissions from underground coal mining operations

CASE STUDY

NANOTECHNOLOGIES FOR CAPTURING CO_2 AND ITS CONVERSION TO FINE CHEMICALS AND CLEAN FUELS

University of Newcastle researchers are using a unique clay called halloysite to develop advanced nanotechnologies - driving the development of clean energy fuels and other applications.

Scientists have used tiny structures found in clay as a 'template' to create a new material capable of capturing carbon dioxide emissions or decontaminating water.

The process uses Australian kaolin clay, which contains tiny tubular structures called halloysite nanotubes (HNT). Due to their unique structure, HNT have binding properties to a range of molecules, effectively 'cleaning' by absorbing.

The Global Innovative Centre for Advanced Nanomaterials (GICAN) team has developed unique 'nanotemplating' skills that enable the HNT nanotubular framework to act as a kind of mould, which could then be coated with carbon-based materials to create a 'super material'.

The research team is currently working to convert the captured CO_2 into methanol, using sunlight and water to then utilise the methanol in a fuel cell that produces cleaner energy.

The GICAN team is also developing advanced materials for the generation of hydrogen through photo and electrochemical conversion of water and its storage using low-cost absorbent materials.

ENERGY PRODUCTIVITY AND UTILISATION

Novel applications for the efficient use of energy, greater competitiveness and sustainable outcomes

Improving the management of high cost activities and focusing on increasing efficiency and asset productivity is a major driver for energy intensive industries. Value creation through innovation and collaboration, with a focus on mid-tier and SME participation, is critical for sectors to remain competitive in a shifting energy paradigm.

At NIER we are fostering engagement between industry, government and multidisciplinary research teams to deliver applied research in strategic areas that delivers new market opportunities with improved application and performance of materials, processes and complex systems.

THE UNIVERSITY AT A GLANCE

- Eco-efficient beneficiation for mineral processing
- Fuel and material utilisation in manufacturing, process and chemical industries such as coking coal in ironmaking and carbon dioxide utilisation for food industries, enhanced oil recovery, chemicals and fire suppressants
- Environmental repair and pollution abatement including the development of energy efficient contaminated soil treatment
- Integrated waste processing and utilisation with recovery and generation
- Advanced carbon manufacturing to produce carbon based storage systems, carbon foams, fibres and films
- Novel extraction systems for bioenergy and biofuels
- Fuel conversion of hydrogen from natural gas
- Processes for on-demand generation of high value materials, chemicals and energy from waste
- Green steelmaking processes and the behaviour of iron ores and metallurgical coals in these processes
- Separation of phosphorus from steelmaking slag, allowing recycling of iron and fluxes and the production of high phosphorus co-products for agriculture
- Micro energy systems
- Poly-generation for the large-scale production of hydrogen and activated carbon materials combined with a flameless catalytic combustion process
- Thermal efficiency of processing plants and buildings
- Energy efficient desalination and wastewater treatment plants
- Advanced material technologies for next generation sodium and lithium-ion batteries and full cell devices

MAJOR INDUSTRY R&D PRIORITIES

- Optimisation of assets and de-risking capital investment
- Reducing the cost of emerging low-carbon fuels, oxidants, acids and adsorbents, and successful integration into industrial processes
- Independent science, data, R&D to measure techno-economic, environmental, safety and social performance
- Enabling platforms to accelerate knowledge exchange, supply chain development and SME growth
- Opportunities for manufacturing diversification
- Decreasing downstream emissions for Australia's mineral exports

CASE STUDY

CLIMATE-SMART MINING AND IRONMAKING

The new energy economy, digital revolution, and improved health and living standards all depend on minerals and metals supplied and manufactured at minimal environmental cost. Globally we are experiencing a decline in the quality and accessibility of mineral combined with more energy intensive production processes. Our current practices must transform if we are to become technologically, economically, and environmentally sustainable.

Through the $35 million Australian Research Council (ARC) Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals, the University of Newcastle is working towards achieving zero-emission mining by doubling energy and water productivity, and reducing the loss of high value metals during processing by up to 90 per cent.

The Centre will develop transformational technologies and train the next generation of leaders in resource sustainability to enable a competitive and environmentally sustainable future for Australia's mineral industry.

At the Centre for Ironmaking Materials Research (CIMR) researchers are focused on advancing low carbon iron and steel production. The Centre is supporting Australia's $135B per year export industry towards a low carbon future, while reducing waste products and greenhouse gas emissions across the value chain.

The Centre is advancing mineral processing techniques to increase the grade of iron ore. The Centre is also studying the optimal use of iron ores and metallurgical coal in ironmaking utilising hydrogen, and aims to quantify the value of co-products from beneficiation and slag as soil additives for agriculture.

Together with its industry partners, the Centre is hoping to achieve significant benefits such as increasing the iron content and, therefore, the value of iron ore exports; decreasing greenhouse gas emissions during ironmaking through the application of hydrogen; and creating soil that is more productive in a dry climate for agricultural purposes.

ENERGY INTEGRATION

Integrating new energy technologies and systems related to energy storage, grid systems, energy generation and alternative energy sources

The traditional centralised electricity generation paradigm is being disrupted by renewable and distributed generation technologies. Australia's electricity supply networks are becoming more susceptible to disturbances than ever before. Further, the pace of transformational change has been incredibly rapid and many industry sectors are finding the transition challenging.

Our researchers are working to better understand the requirements for the integration of distributed renewable energy systems and their impacts on electricity supply resilience, including the quality of supply, reliability, dynamics and stability, protection and management and control systems. The social geographical, historical and cultural elements that shape energy integration and transition is also an important focus. Research and education has a major role to play in regional energy solutions and through NIER, we are driving strategic partnerships, large-scale demonstration projects and industry engagement platforms to help unlock regional economic development opportunities.

THE UNIVERSITY AT A GLANCE

- Energy storage modelling, control and economic assessment and planning
- Electricity usage monitoring and modelling
- Load modelling
- Reactive power predictive control and scheduling
- Renewable energy generation grid connection
- Grid battery integration
- Distributed generation penetration impact
- Network peak demand reduction
- Wholesale energy price optimisation
- Voltage regulation
- Distribute generation and microgrid
- Smart control centres
- Microgrid planning, microgrid scheduling
- Smart grid tech-demand response
- Microgrid smart control centre technologies
- Energy trading and cyber security
- Network modelling, security and vulnerability
- Integration of renewable and distributed energy resources
- Consumer and network optimisation
- System modelling for voltage and frequency excursions
- Stable system operation for high renewable energy penetration
- Integration of energy storage technologies and electric vehicles
- Designing and planning future networks
- Electricity network optimisation, supply and usage paradigms
- Electricity distribution networks of the future
- Land use, social impacts and environmental humanities

MAJOR INDUSTRY R&D PRIORITIES

- Building greater resilience into supply systems including management of over voltage
- Commercially viable, fit for purpose energy storage for renewable integration
- Transformation of engineering workforce and blending of electrical, power, mechanical and chemical skill sets

CASE STUDY

BATTERY STORAGE INTEGRATION FOR ENERGY INTENSIVE PROCESSES

A collaboration between Magnis Energy Technologies, Fletcher International Exports and the University of Newcastle is seeking to establish a large-scale demonstration of lithium ion battery technology to explore the electricity supply chain, particularly the integration of battery storage and capacity into intensive agricultural energy processes.

Focused specifically on the meat processing industry, the project based in Dubbo NSW, will involve the installation of lithium-ion 'big batteries' that will be integrated into a 24-hour industrial processing line requiring high demand and variable energy loads. The project will test the load and cycle capabilities for energy storage optimisation and varying applications.

Incorporating mature sources of renewable energy, such as solar, within the initial 'big battery' program aims to provide competitive advantage to a typically energy intensive sector, increase energy efficiency and sustainability, and produce cost saving measures for future industries.

Areas for further exploration include battery installation, phase-in and energy chain 'switch-over' procedural protocols, production line risk management, operational continuity and demand response variations, safety and production line integrity, electricity load allocation (size, type, intra-plant application) and time-efficiency processes.

The partnership may see many under-utilised energy by-products and resources applied to future research projects including use of waste products for biomass and biofuel, waste heat capture, conversion and storage.

ENGAGE WITH US

For more information visit the Newcastle Institute for Energy and Resource website.

newcastle.edu.au/nier

+61 2 4033 9000

nier@newcastle.edu.au