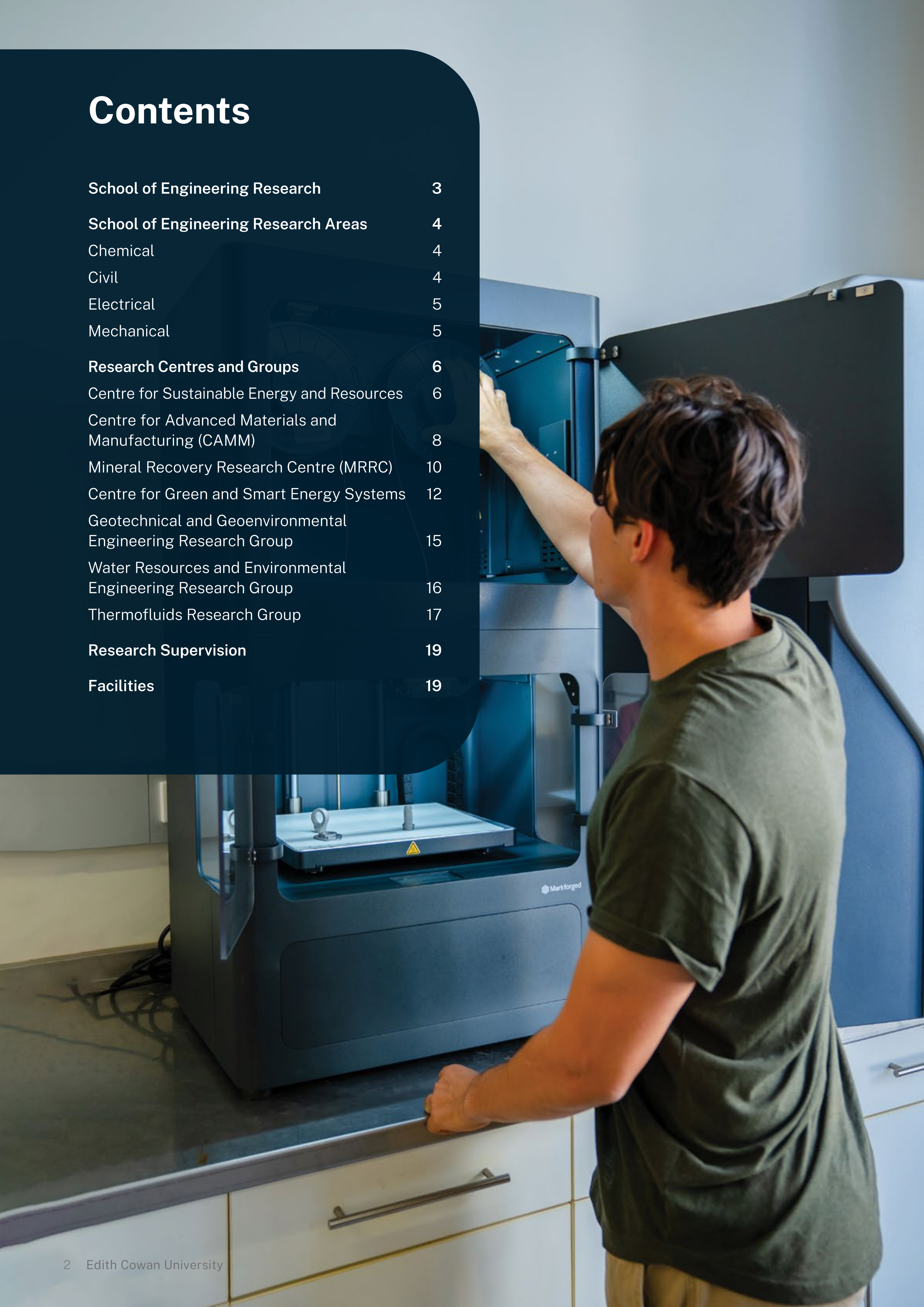
Engineering the Future

Research Activities 2024

Contents



School of Engineering Research

The School of Engineering at Edith Cowan University (ECU) is one of the fastest growing engineering schools in Australia.

The School enjoys some of the best equipped hardware laboratories in the nation, with regular multi-million dollar investments into expanding and maintaining its world-class infrastructure.

Research at the School encompasses a broad range of engineering disciplines and allied sciences including chemical, civil, mechanical, electrical, and energy & resources.

This breadth of disciplines positions us well to undertake research in sustainability engineering, which is multidisciplinary in nature. Sustainability of energy, water, materials and resources is at the core of our research.

The School has an outward looking research and development perspective. We endeavour to proactively identify and develop innovative solutions to real-world engineering problems, particularly those relevant to Australian industry and the community.

School of Engineering Research Areas

Our research focuses on three main themes:

- Energy, resources and the environment
- Communication, monitoring and control
- Materials, manufacturing and infrastructure

Our research is conducted in the main disciplines of engineering: Chemical, Civil, Electrical and Mechanical

Research Areas

Chemical

Areas covered include:

- Solar energy conversion; environmental nanotechnology; mining and mineral processing; and hydrocarbon synthesis from methane and carbon dioxide; battery materials and recycling.
- Advanced materials design; materials synthesis; microstructure characterisation; and material properties evaluation for various engineering applications.
- Carbon geo-sequestration; hydrogen geo-storage; blue and green hydrogen production; enhanced oil and gas recovery; reservoir modelling; unconventional resources (coal, gas hydrates, shale); hydraulic fracturing/fracture stimulation; formation damage control.
- Membrane separation and purification processes, functional materials development and applications, plastic waste and pollution control, environmental nanotechnology including advanced material design.
- Mining and mineral processing.
- Artificial intelligence and machine learning in chemical processing.

Civil

Areas covered include:

- Environmental fluid mechanics; hydraulics; urban water; pollutant transport; desalination; water and wastewater treatment; renewable energy in water and wastewater treatment applications.
- Geosynthetics and fibres for sustainable developments; utilization of wastes in construction; ground improvement techniques; earth pressure and slope stability; environmental, mining and pavement geotechnics; soil-structure interaction.
- Structural engineering research focuses on providing sustainable construction materials and systems with minimal environmental footprint. This includes: environmental-friendly construction materials; fastening systems in concrete structures and seismic performance of masonry infill panels.

Electrical

Areas covered include:

- Modelling and integration of renewable energy sources; microgrids; energy management; demand forecasting; demand management; energy storage systems; electric vehicles, battery technologies and testing, battery repurposing.
- Intelligent monitoring and surveillance for natural and industrial environments; structural health monitoring; intelligent embedded systems; decision making and machine learning; digital image processing, signal processing; intelligent control.
- Green communications; next generation wireless broadband networks; wireless underwater communications, acoustics.

Mechanical

Areas covered include:

- Composite manufacturing techniques; additive manufacturing; hydraulic valve development; non-intrusive experimental flow visualisation; design optimisation; and automotive design and development.
- Machine vision and image processing, artificial intelligence and machine learning; industrial automation; field robotics and robotics in unstructured environments, enhanced teleoperation, UGV navigation and SLAM, and deep learning approaches to robotic grasping.
- Energy conversion systems; renewable energy; stand-alone energy systems; alternate fuels; biomass; combustion; heat transfer; fluidic behaviour; physical process modelling and optimisation.

School of Engineering Research Centres and Groups

Centre for Sustainable Energy and Resources

The Centre for Sustainable Energy and Resources stands as a beacon of innovation and excellence, dedicated to spearheading transformative advancements in the realm of energy sustainability. Our overarching mission is twofold: to decarbonise the energy supply chain and bolster energy efficiency, all while ensuring steadfast energy security.

At the heart of our endeavours lies pioneering research across a spectrum of critical domains. From blue, green, and natural hydrogen production and storage to enhanced methods for natural gas and oil recovery, and cutting-edge initiatives in carbon capture, utilization, and storage (CCUS), our research activities span the breadth of the energy landscape. Through rigorous experimentation, computational modelling, and interdisciplinary collaboration, we strive to push the boundaries of scientific knowledge and technological innovation.

The tangible outcomes of our research hold immense promise for the global community. By fostering the transition towards cleaner energy resources and significantly reducing greenhouse gas emissions, our efforts yield far-reaching societal benefits.

Moreover, our focus on enhancing energy security and reducing costs directly translates into economic prosperity, both at the national and global levels.

In addition to our core research endeavours, we recognize the paramount importance of fostering collaborative partnerships. Through strategic alliances with industry stakeholders, government organizations, and individual researchers, we facilitate industry-led integrated learning, positioning businesses at the vanguard of a career-ready innovation and engineering workforce. Our commitment to collaboration extends an open invitation to all who share our vision, offering a platform for mutually beneficial engagement and collective progress towards a sustainable energy future.

Vision

Our vision is to lead the global energy transition towards cleaner and greener sources, fostering a more liveable planet for all. Through innovative research and collaboration, we strive to accelerate the adoption of cleaner energy technologies and enhance energy efficiency. By driving this transition, we aim to mitigate climate change and create a sustainable future where communities thrive in harmony with the environment.

Capabilities

The Sustainable Energy and Resources Laboratory features state-of-the-art equipment and unique capabilities unrivalled in Australia, creating promising possibilities for the future of energy.

The cutting-edge facilities enable next-generation research in carbon capture and storage and underground hydrogen storage to deliver real-world solutions to the complex challenges facing the upstream oil and gas industries.

With some of the most advanced equipment and specialist expertise in Australia, new discoveries and industry applications can be realised contributing to sustainable energy production, decarbonisation, and climate change mitigation.

Hydrogen production and storage

Hydrogen stands as a cornerstone in the transition towards sustainable energy production, heralding the dawn of a greener future. At the forefront of this pivotal technology, the researchers at the Centre for Sustainable Energy and Resources are spearheading both experimental and applied research initiatives aimed at revolutionising hydrogen production and storage methodologies.

Our dedication to advancing hydrogen technologies encompasses a multifaceted approach. Firstly, our efforts are directed towards enhancing techniques for hydrogen production, encompassing various methodologies ranging from traditional methods to cutting-edge innovations. This includes a particular focus on natural hydrogen production from subsurface reservoirs, leveraging geological formations to extract hydrogen in a sustainable and efficient manner.

Furthermore, our research extends to the realm of hydrogen storage, recognising the critical importance of developing robust and scalable storage solutions to facilitate the widespread adoption of hydrogen as an energy carrier. In this regard, we are actively engaged in pioneering research endeavours aimed at advancing large-scale hydrogen geo-storage technologies, harnessing the geological subsurface as a secure and viable reservoir for storing hydrogen on a massive scale.

Our research activities in the field of hydrogen production and storage are underpinned by a commitment to innovation, sustainability, and real-world applicability. By pushing the boundaries of scientific inquiry and bridging the gap between theory and practice, we endeavour to unlock the full potential of hydrogen as a clean, versatile, and sustainable energy resource, driving us closer to achieving our collective goals of a cleaner, greener future.

Carbon capture, utilisation, and storage

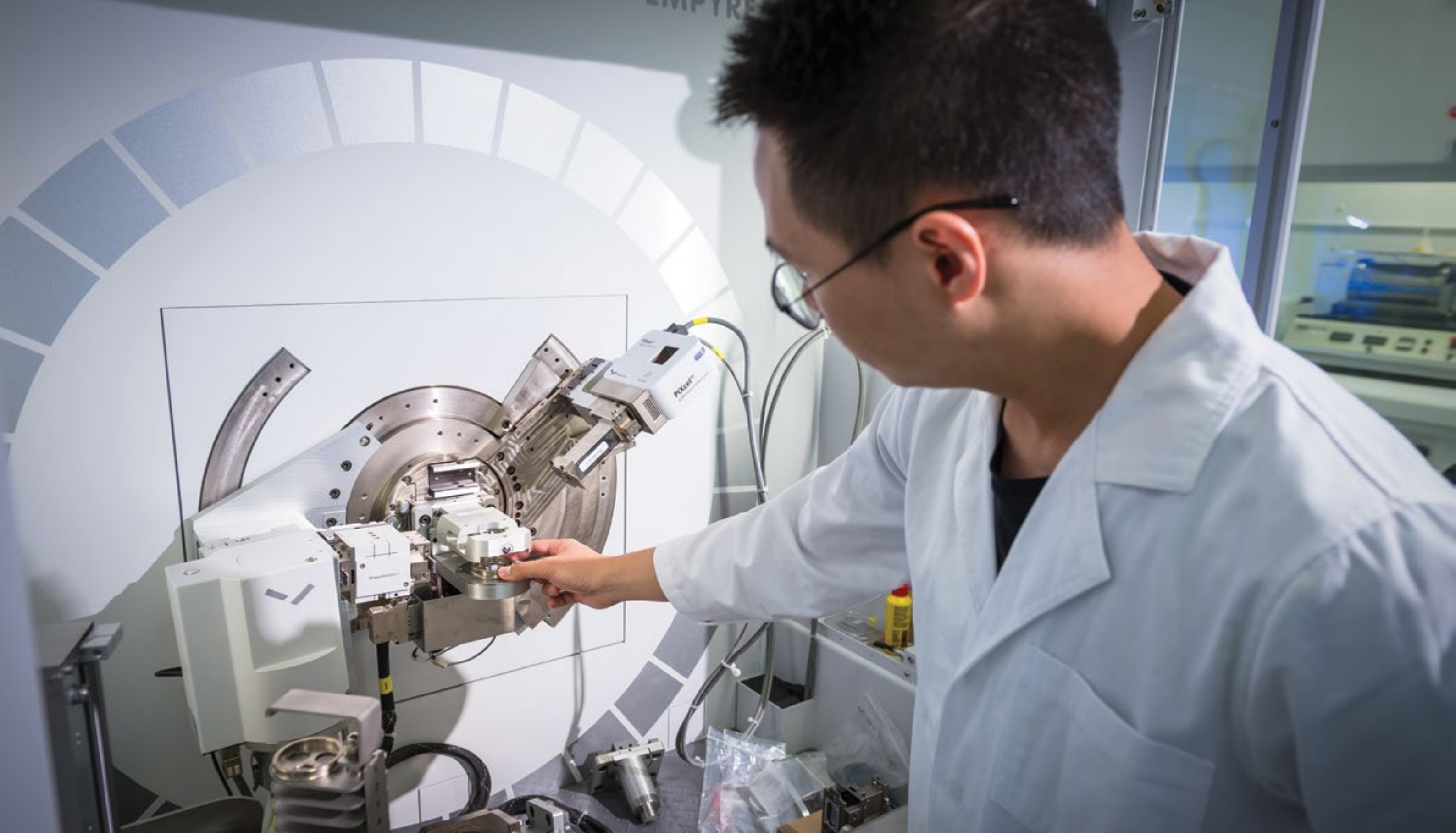
As we strive to address the pressing issue of climate change and work towards achieving the target of net zero emissions by 2050, the importance of carbon capture, utilisation, and storage (CCUS) cannot be overstated. At the “Centre for Sustainable Energy and Resources”, our research endeavours in the domain of CCUS are deeply rooted in the urgency of mitigating CO2 emissions, recognising them as a significant driver of global warming.

Our focus lies in CO2 geo-sequestration, a pivotal technology in the fight against climate change. Through a combination of experimental and computational approaches, we are dedicated to advancing the understanding and implementation of CO2 geo-sequestration techniques. Our research not only delves into the development of novel methodologies for capturing CO2 emissions but also explores the utilisation of captured CO2 for beneficial purposes, thereby contributing to the circular economy.

Furthermore, our efforts extend beyond mere technological advancements; we are committed to fostering interdisciplinary collaborations and engaging with stakeholders to ensure the real-world applicability and scalability of our solutions. By pushing the boundaries of scientific knowledge and innovation, we aim to play a significant role in accelerating the transition to a low-carbon future and achieving the ambitious goal of net zero emissions by 2050.

Advancing Clean Techniques in Upstream Oil & Gas: Harnessing Natural Gas for Energy Transition

Our focus extends to the upstream oil and gas industry, where we are dedicated to developing techniques for cleaner operations that align with the evolving energy landscape. Central to our research is the pivotal role of natural gas in the energy transition. Through innovative approaches and advanced technologies, we seek to optimise extraction processes, minimise environmental impact, and maximise efficiency in natural gas production. By prioritising sustainability and harnessing the potential of natural gas as a cleaner alternative, we aim to catalyse positive change within the industry, facilitating a smoother transition towards a low-carbon future.



Centre for Advanced Materials and Manufacturing (CAMM)

The Centre for Advanced Materials and Manufacturing (CAMM) conducts research in the following key areas of interdisciplinary material research: 3D printing/Additive manufacturing; design, synthesis and advanced characterisation of materials; biomaterials and composites; lightweight alloys and structures; high-strength alloys and composites; functional nanomaterials; mechanical behaviour and deformation mechanisms; corrosion behaviour.

The CAMM uses advanced tools and techniques to characterise material properties and performance and understand the underlying mechanism. The CAMM uses many advanced characterisation techniques for its studies, such as transmission electron microscopy, atom probe tomography, scanning electron microscopy, X-ray diffraction, thermal analysis, mechanical testing (mechanical properties evaluation, fatigue and three-point bending test) corrosion resistance and 3D scanning equipment (such as Artec 3D Space Spider). The CAMM houses many highly specialised facilities, such as ConceptLaser 3D printing machine, Markforged Metal X, HP Projet 660 binder jet printer, various SLA and FDM plastic 3D printers, PANalytical X-ray diffractometer, JEOL scanning electron microscope, Instron mechanical testing machines (5569 static and 8801 dynamic), nanoindentation system, UV-Vis spectrometer and advanced electrochemical workstation systems (Solartron EchemLab, PARASTAT 2273), which provides our researchers and research students with a fantasticating research platform. In addition, CAMM has access to traditional workshop facilities with 5-axis CNC machining, waterjet cutting, heat treatment, laser cutting, etc.

3D Print of metallic materials

Traditional subtractive manufacturing processes are basically a type of material removal process and controlled by removing undesirable layers of a large material block to fabricate a product with a shape. Unlike subtractive manufacturing processes, emerging advanced additive manufacturing (commonly known as 3D printing) technologies facilitate the fabrication of parts with almost no geometric constraints, and is economically feasible down to a batch size of one. 3D printing has emerged as a transformative technology with profound implications across various industries. It encompasses a set of techniques that add material incrementally and construct objects layer-by-layer from digital models, offering unprecedented design flexibility and efficiency. Particularly within the domain of metals, 3D printing process involves selectively melting or sintering metal powders to create intricate three-dimensional structures, which presents an innovative approach to fabricating complex structures and components, revolutionising traditional manufacturing processes. The CAMM is one of several well-known pioneering research teams in the field of 3D printing, which conducts extensive research on the application, design, processing, microstructure, mechanical properties and corrosion behaviours of different types of metallic materials (mainly with titanium, aluminium and stainless steel) manufactured by two popular powder-bed 3D printing technologies, i.e. selective laser melting and electron beam melting.

Biomedical titanium alloys and composites

As the number of older people increases rapidly in many countries, so does the demand to replace dysfunctional hard tissues with artificial components such as hip and knee implants. Titanium alloys are receiving a great deal of attention in both medical and dental applications over the years and remain the materials of choice of load-bearing implants owing to their outstanding performance in various aspects. One of the significant drawbacks of the traditional biomedical titanium alloys (such as Ti-6Al-4V) is that they have a much higher stiffness (10 times that of bone). Mismatch of the stiffness between the implant and the surrounding bone can cause stress shielding in bone. This eventually leads to bone resorption and is one of the primary causes of implant loosening, which requires painful revision surgery. Low-modulus beta titanium alloys comprising non-toxic and non-allergic alloying component are currently being developed for the next generation of load-bearing metallic implant material. The CAMM has been committed to developing low-modulus and non-toxic biomedical titanium alloys as load-bearing hard tissue implants.

Lightweight alloys and structures

Lightweight alloys and structures continue to receive increasing attention for a wide range of potential applications in the structural and transportation sectors that require significant improvements in performance, efficiency, and sustainability. Light-weight alloys and structures creates the possibility of weight and energy savings of structures, and enhances their strength, durability, and resistance to corrosion and fatigue. The CAMM has made extensive effort in design and manufacture of lightweight alloys and structures, taking into account the perspectives of new lightweight materials/structures and associated processing routes, as well as new application areas and design strategies in these sectors.

Nanomaterials for water treatment

The entire world is heading for a very serious water shortage. The demand of water for consumption and industrial purposes has been increasing significantly in the last two decades due to rapid population growth and industrialisation. Nanotechnology has been used to remove contaminants in water treatment applications, which is associated with the reduction of contaminants such as bacteria, harmful heavy metals, pesticides, and other persistent toxic chemicals. The CAMM has been developing many novel types of nanomaterials to degrade the wastewater.

Industrial Applications of Metal 3D Printing

With an increased focus on sustainability, environmental impact and energy usage, there is growing demand on higher efficiency and/or functionality of components and/or systems. The combination of high computer processing power, 3D scanning and image processing, and 3D printing technologies has allowed both the generation and manufacture of extremely complex geometries. These complex geometries can improve the functionality and/or efficiency of components and/or systems than those traditionally manufactured. The CAMM has applied these advanced technologies to improve the overall performance of heat exchangers through the use of biomimicry to generate shark denticle inspired heat exchanges. Similarly, the CAMM has applied these technologies to improve the erosion resistance of butterfly valves in industrial slurry pipelines. Furthermore, CAMM is researching into sustainable, industrial-scale metal additive manufacture through solid-state recycling and additive manufacture.

Mineral Recovery Research Centre (MRRC)

Located in the heart of Western Australia's mineral-rich area, the Mineral Recovery Research Centre (MRRC) stands as a stronghold of scientific inquiry and technological innovation. As a flagship initiative under Edith Cowan University's (ECU) support, MRRC exemplifies a commitment to advancing the frontiers of mineral recovery science and engineering. MRRC tries to address mining challenges through environmentally conscious and eco-friendly research methods in collaboration with its partners.

Pioneering Research and Vision

MRRC's research agenda is underpinned by a constant dedication to pushing the boundaries of scientific knowledge in critical mineral recovery technologies. Employing a comprehensive approach that integrates materials science, chemical engineering, and computational modelling principles, MRRC seeks to develop novel methodologies for the sustainable extraction and processing of critical mineral resources. The core of the Centre's vision lies in a profound commitment to environmental stewardship and resource efficiency as MRRC strives to mitigate the environmental impacts of mining operations and foster the transition toward a zero-carbon and circular economy. MRRC wants to help Australia reach zero carbon emissions by 2050 with new technologies.

MRRC Structure and Research Spectrum and Core Objectives:

The MRRC is structured around four main thematic areas, each supported by key personnel from Engineering and Science disciplines:

1. Chemical Processing:

Focused on developing sustainable chemical processes for mineral extraction and processing.

- **Mineral Processing Innovations:**
  - Direct Mineral Extraction: Investigating physicochemical processes for efficiently extracting minerals from aqueous and non-aqueous sources while minimizing environmental impact.
  - Decarbonization: Advancing methodologies to reduce carbon emissions in mineral processing operations, fostering sustainability.
  - New Technologies: Developing cutting-edge techniques such as advanced comminution and hydrometallurgical processes for enhanced mineral recovery.
- **Material Science and Recovery Technologies:**
  - Selective Mineral Recovery: Designing tailored adsorbents and membranes to selectively recover target minerals from complex leached ore matrices.
  - E-Waste Recycling: Pioneering innovative recycling pathways for electronic waste, focusing on critical metal and rare earth element recovery.
- **Integration of AI and Digital Twinning:**
  - AI in Mineral Processing: Leveraging machine learning algorithms and data analytics to optimize process control and resource utilization.
  - Digital Twinning: Exploring the potential of digital twinning in mineral processing to enhance efficiency and predictive capabilities.

2. Water Treatment & Recycling:

- Addressing challenges related to water usage in mining operations through innovative treatment and recycling solutions.

3. Battery Manufacturing and Recycling:

- Dedicated to advancing battery technologies and implementing efficient recycling methods.

4. Mineral Bioleaching:

- Investigating environmentally friendly bioleaching methods for mineral extraction.

Strategic Roadmap and Future Directions

While MRRC's current focus is within these thematic areas, the Centre is actively exploring new avenues for research. Initiatives such as digital twinning in mineral processing using AI hold significant potential and may be pursued in collaboration with other centres at ECU.

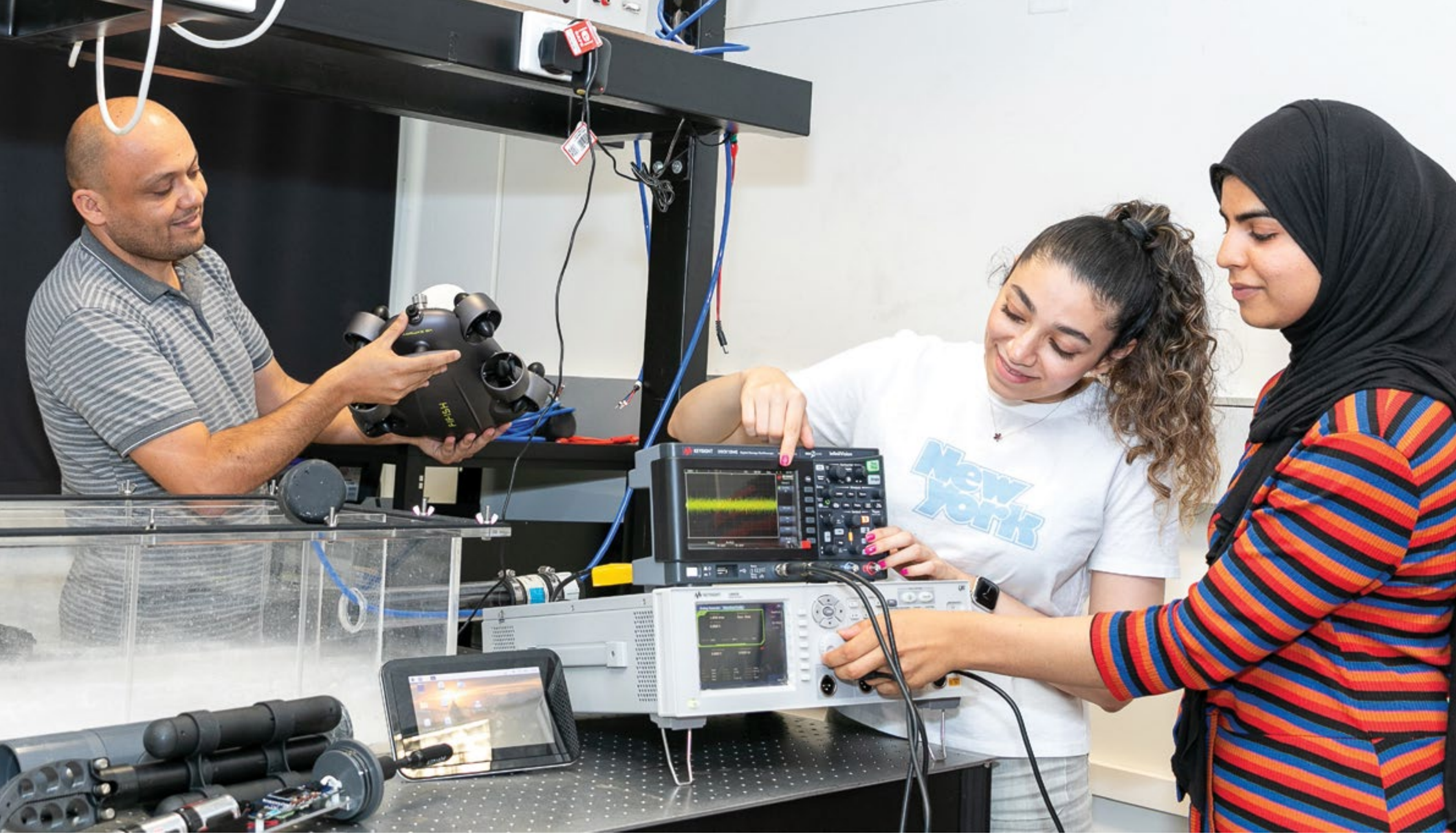
Through our commitment to innovation, sustainability, and collaboration, the MRRC aims to drive positive change in the mining industry, leading to more efficient, net-zero carbon emissions by 2050, environmentally friendly, and socially responsible practices.

Guided by scientific excellence, MRRC aims to:

- Achieve ECU Level recognition for research excellence
- Foster strategic partnerships with the industry for impactful scientific applications.
- Establish global excellence in mineral recovery research
- Ensure financial sustainability through diverse funding streams

Opportunities for Students and Industry Engagement

MRRC serves as a crucible for scientific talent development and industry engagement, offering many opportunities for aspiring researchers and industry stakeholders. Prospective PhD and Master's students are invited to explore scholarship opportunities and engage in cutting-edge research projects under the mentorship of our esteemed faculty. Furthermore, MRRC seeks to foster collaborations with industry partners, providing avenues for joint research initiatives, technology transfer, and knowledge exchange.



Centre for Green and Smart Energy Systems (CGSES)

The Centre for Green and Smart Energy Systems (CGSES) is home to technology innovation and expertise where we work in close collaboration with industry on cutting-edge projects towards greener and smarter systems for energy generation, transmission and storage, as well as monitoring, communication and control technologies for a more sustainable environment.

At CGSES, we are on the frontline of the energy revolution, developing innovative and practical architectures and solutions that impact Australia's net-zero goals. The centre has strong ties and ongoing collaborations with industry leaders and organisations in the energy and technology sectors.

CGSES research programs encompass two main themes: Smart Energy Systems, and, Smart Digital Technologies.

Smart Energy Systems

In a world where sustainability is no longer a choice but an imperative, the Smart Energy Systems research theme plays a core and fundamental role towards achieving emission reduction objectives whilst supporting the energy requirements of industry and the community. Our comprehensive research program seeks to transform the energy landscape by harnessing renewable resources to their fullest potential. It covers the core aspects of energy generation, storage, distribution, and management of renewable energy resources, where they interface with electrical energy, either within a utility grid or a microgrid. The Smart Energy Systems theme helps develop the backbone of a resilient energy future, connecting and managing renewable resources in the intricate web of modern electrical networks. The stakeholders for this research theme include electricity utilities, industries with high energy requirements, federal and state governments, and local communities.

The research capabilities in this theme are based on well-established research track records in the following areas:

- Enhancing power grid reliability and resilience
- Battery storage systems, battery repurposing and testing
- Cost-effective and lifecycle analysis of energy systems
- Operation and planning of electricity networks in generation, transmission, distribution, and consumption levels
- Modelling net-zero energy systems and sustainable renewable energy procurement
- Demand response and energy sharing in residential areas
- Placement, sizing and optimisation of hybrid power plants
- Integration of hybrid synchronous condensers in isolated power systems
- Stabilisation of utility grids in the presence of large and fluctuating volumes of renewable energy
- Management of demand response within utility grids
- Optimal sizing and placement of storage systems in utility grids
- Optimal design of microgrids with a high level of renewable energy integration in rural and regional areas
- Electric vehicle charging networks
- Managing the impact of electric vehicles on the aging of utility assets
- Integration of electric vehicle batteries with utility-level energy storage systems
- Second-life utilisation of retired electric vehicle batteries
- Capture of waste heat for reuse and the reduction of carbon emissions

The above capabilities are critical components towards net-zero emission objectives, as they help deal with challenges that result from the growing penetration of renewable energy in utility grids and in industrial applications with high energy demands. Overcoming these challenges through advancements in smart energy systems is part of our commitment to a sustainable future, ensuring that our research contributes positively and effectively to our world's environmental health.

Smart Digital Technologies

We live in an age of hyper-connectivity, where information is power. Nowhere is this truth more resonant than in the intricate interplay of complex systems, from the thrumming machinery of industry to the vital pulses of the environment. Smart Digital Technologies stands at the forefront of sensing, communication and control systems, utilizing state-of-the-art real-time embedded systems to capture, decode and analyse the complex layers of information hidden in our natural and built environments. We delve into the heart of these systems, capturing the subtle signals of sensors and translating their data into actionable insights. Imagine a future where industrial equipment alerts us to impending failures before they happen, where renewable energy integrates smoothly into the grid, and where the depth of oceans resonates with clear communications. This is the world where our research in Smart Digital Technologies helps create added intelligence for improved decision-making and for optimising our interactions with the world around us.

These technologies play a pivotal role in advancing how we interact with and manage complex systems, ensuring efficiency and reliability in critical operations. By leveraging the latest in embedded systems, we provide more accurate and timely data, leading to better decision-making and improved system operations. The versatility and scope of these technologies make them essential tools in a wide range of industrial and environmental protection applications.

The research capabilities in this theme include:

- Condition monitoring of systems and processes
- Sensor design and calibration
- Signal processing and data analytics
- Applications of artificial intelligence and machine learning to large data
- Underwater communications and sensing for enhancing undersea information capabilities
- Underwater positioning and navigation for real-time tracking Autonomous Underwater Vehicles (AUVs)
- Green communication technologies for industrial Internet of Things
- Environmental monitoring and control systems

The above capabilities can assist the uninterrupted operation of complex systems to maximise productivity and unlock the full potential of access to the information that is embedded in every process and system. We develop solutions that support and guide the digital industry of the future.

There is a strong and growing interest in these capabilities for various applications in different industries, including defence, mining, energy, agriculture, manufacturing, transport, public utilities, security, etc. This is where we continuously partner with forward-thinking industries and organisations to realise the full potential of data and shape a future defined by intelligence, sustainability, and resilience.

Geotechnical and Geoenvironmental Engineering Research Group

The Geotechnical and Geoenvironmental Engineering Research Group works on cost-effective, environmentally friendly and sustainable solutions to the problems in the broad area of civil engineering practice known as the Geotechnical and Geoenvironmental Engineering. They collaborate with several world-class universities, research institutions, industries and individuals on academic and field projects.

Current research focuses on several specific topics, such as geosynthetic applications in civil and mining engineering projects, fibre-reinforced soils, slope stability under static and dynamic loading conditions, engineered landfills, buried structures, static and dynamic earth pressures, utilization of mine and other wastes in construction, pavement structures and ground improvement techniques.

New areas for extending the research focus include soil-cement (cement may be waste cementitious materials from industries), biocementation (changing loose/weak geomaterials to dense/hard geomaterials by biological activities), soil erosion and air pollution, waste management, effect of climate change on geomaterials and geotechnical structures, effect of sea level rise on tunnels and other buried structures, sustainable construction materials, reduction of carbon footprint in civil/geotechnical construction, geological aspects of geothermal energy, rehabilitation/closure of old mines and landfills, mine excavation and mineral processing (geotechnical/geoenvironmental engineering aspects), and analysis and design of tailing dams.

Water Resources and Environmental Engineering Research Group

We focus on studying the sustainable management of water resources and environmental engineering challenges. The group actively contributes to developing new technologies, the design of resilient infrastructure, exploring eco-friendly solutions, and developing strategies for adapting to climate change impacts. We address the complex interaction of water resources and environmental engineering, aiming to provide practical solutions that contribute to the sustainable utilisation and protection of our water ecosystems.

Available to the Group is a wide range of advanced equipment such as a recirculating flume, 3D Acoustic Doppler, Laser Doppler Anemometry, Particle Image Velocimeters, optical air entrainment probes, water quality sampler, dissolved air floatation, adsorption, anaerobic water treatment, advanced oxidation, biofilm process, depth filtration as well as precipitation and flocculation systems.

Water Resources

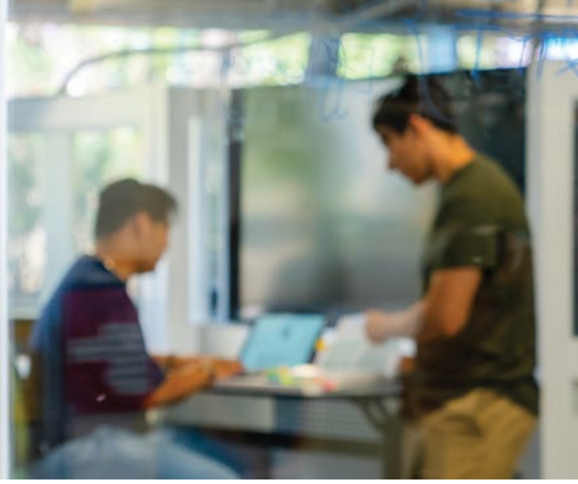
Our water resources activities are a multidisciplinary pursuit aimed at understanding, managing, and optimising the utilisation of water systems. We are focusing on a wide range of topics, including hydrology, hydraulics, water quality assessment, watershed management, and the sustainable development of water-related infrastructure. Through collaborative efforts, we develop sustainable solutions for water supply, flood control, and environmental conservation, which contribute significantly to addressing challenges related to water scarcity, infrastructure development, and the overall resilience of communities and ecosystems in the face of changing environmental conditions.

Water and Wastewater

Our water and wastewater research activities are critical components of addressing the global challenges associated with sustainable water management. Our focus is on developing innovative technologies and strategies to ensure the efficient treatment and reuse of water, as well as the safe disposal of wastewater. We aim to optimise existing processes or propose novel technologies to improve removal efficiency, energy efficiency and/or overall process sustainability. This includes exploring advanced treatment processes, such as membrane technology and biological treatment, to improve the quality of drinking water and reduce environmental pollution. We also investigate novel approaches for wastewater recycling and resource recovery, aiming to transform waste into valuable resources like energy and nutrients. We aim to play a pivotal role in promoting environmental conservation, safeguarding public health, and promoting sustainable development practices.

Desalination

The desalination process combined with the energy requirement has become a challenge for humanity, the development of combined desalination with thermal power system, increasing overall process performance and equipment efficiency, reducing carbon dioxide emissions and improving environmental impact with respect to green technology approach, will improve the desalination process. We'll use various separation technologies such as membrane, flash spray, and pool evaporation to desalinate sea and brackish waters for different applications. Our proposed technologies co-generate water and power, a pioneering technology based on the combination of a desalination system with a power cycle. The use of low-grade waste heat and renewable energy to power desalination systems is more effective in energy consumption making desalination more practical.



Thermofluids Research Group

Projects in this research group cover systems, renewable system and process modelling as well as optimisation using intelligent techniques, biomass fuel and its conversion and turbulent fluidic behaviour in processes of industrial relevance.

Research Themes

Alternate Energy

Optimal deployment of energy systems can be achieved by integrating renewables, such as solar-PV and wind in conjunction with energy storage through batteries, hydrogen, or others. Such deployment may also require efficient utilisation of (back-up) combustion-based thermal prime movers like reciprocating engines or micro gas turbines. Optimisation in these systems can additionally involve waste heat recovery and require the use of intelligent methods to size and select energy system components to reliably meet loads within cost constraints and a power management strategy.

Projects undertaken by the group have applied multi-objective optimisation and predictive methods in alternate energy systems to satisfy dynamically varying power, heating and cooling loads and provide potable water (through on-site desalination) in a sustainable and techno-economically viable manner.

Turbulent Jets

Turbulent jets find widespread application in process industries and operations which rely on convective flow currents for cooling, heating, mixing or to promote process efficiency.

The group has investigated a variety of free (unconfined), impinging or confined turbulent jets in gaseous or particle laden (pulverised biomass) flows. Collaborative projects have also been undertaken with other groups in the school into evaporating sprays. Overall, methods used combine experiments, including non-intrusive optical methods (infra-red thermography, laser-based PIV), with computational fluid dynamics modelling.

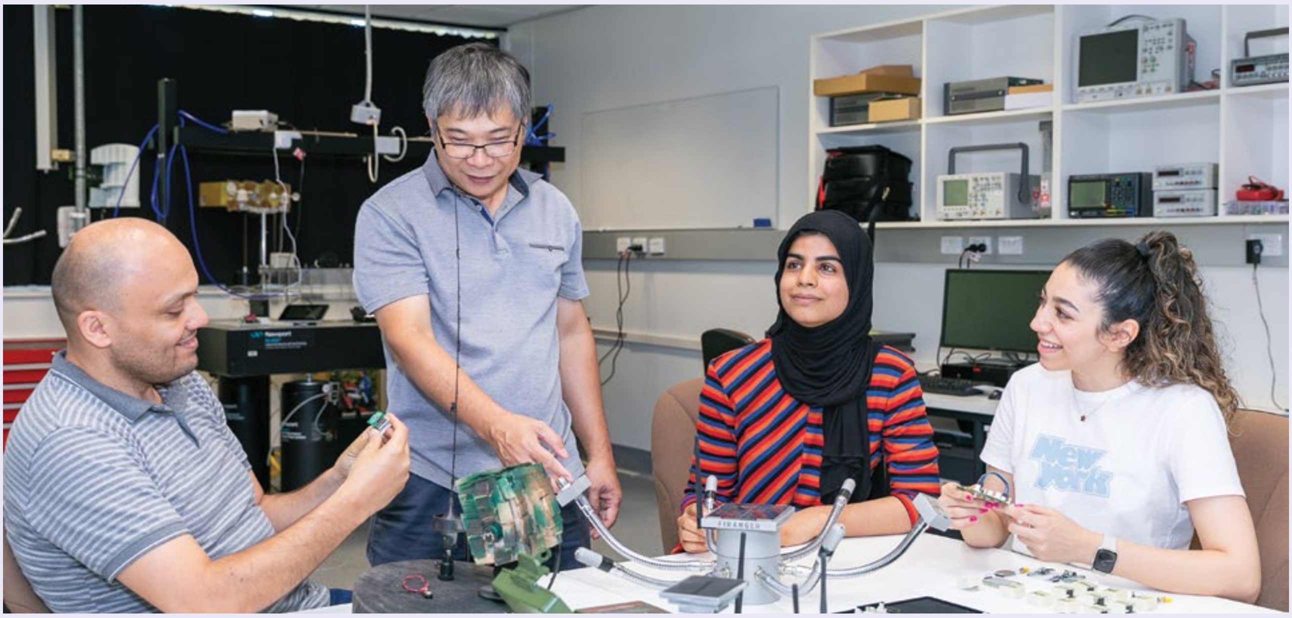
Combustion

Biomass has the potential to reduce reliance on fossil based (solid) fuels. However, a better understanding of the factors which influence its application is needed. The role of thermal treatments such as torrefaction have been studied by the group, with particular focus on how this impacts biomass handling and storage as well as its thermophysical and thermochemical properties. Research projects have also been undertaken into the combustion characteristics of raw and blended biomass. Additionally, the role of process variables on fouling deposits from (biomass) combustion have also been studied. The main methods used feature fixed-bed combustion, emissions analysis, and a range of laboratory (analytical) techniques to support.

Experimental Techniques

Diagnostics and experimental techniques are an important pathway to help understand various thermofluids related problems and validate modelling. Various research studies have been undertaken by the group to further develop methodologies in techniques such as Constant Temperature Anemometry (hot wires), infra-red thermography and image processing as well as Particle Image Velocimetry (PIV).

Staff in the School of Engineering are engaged in cutting-edge research in several important fields.



Research Supervision

Staff in the School of Engineering are engaged in cutting-edge research in several important fields, as represented by our diverse research areas. While our research activities are contributing to the advance of scientific knowledge in these fields, we are particularly keen to undertake projects that are directly beneficial to industries in Western Australia. We encourage prospective postgraduate research students to make contact with potential supervisors to discuss topics before applying.

A comprehensive list of our staff can be found at: **www.ecu.edu.au/schools/engineering/staff**

Please note that admission into a research degree is dependent on the availability and capacity of a supervisor to take on new research students.

For more information on research degrees, visit: **ecu.edu.au/research-study**

EU offers a number of scholarships including the Executive Dean's Master of Engineering Scholarship. For details of all scholarship opportunities visit **www.ecu.edu.au/scholarships**.

Facilities

The School of Engineering has an extensive range of well-equipped labs to support our teaching and research:

- Advanced instrumentation
- Advanced manufacturing
- Automotive characterisation and performance
- Circuits and systems
- Communication research
- Communications systems
- Concrete and construction materials
- Digital imaging
- Energy and environment
- Engineering materials
- Environmental engineering
- Fixed-bed combustion
- Fluid mechanics
- Flight simulator
- Geotechnical and pavement engineering
- Hydraulics engineering
- Manufacturing workshop
- Measurement and characterisation
- Microelectronics device characterisation
- Modelling
- Motorsports workshop
- Nanomechanical testing
- Optical and laser based diagnostics (infra-red imaging, shadowgraph, PIV, LDV)
- Optical systems
- Petroleum engineering
- Power systems
- Process engineering
- Renewable energy
- Robotics and automation
- Siemens instrumentation and control
- Structural engineering
- Surveying
- Schneider electric instrumentation control and automation
- Thermodynamics

ECU has a vibrant research community, actively supporting our student and staff researchers.

Contact us

E: seadmin@ecu.edu.au

ECU.EDU.AU/RESEARCH-STUDY

Find us at

ecujourney

edithcowanuni

edithcowanuniversity

edithcowanuniversity

edithcowanuni

school/edith-cowan-university