Offshore Wind

Network Capability

Electrification and Energy Systems Network
DECARB HUB

UNSW SYDNEY
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Electrification and Energy Systems Network

Offshore Wind power generation is a complex undertaking that draws on multiple disciplines to ensure successful planning, design, installation and operations phases. Projects must be successful for the proponents, sensitive to the local communities, for the environment and for provision of economic, reliable and safe power to populations. They also need to accord with the needs of government agencies from Energy, Environment, Finance,

The NSW Decarbonisation Innovation Hub (the Hub) is in the position to provide capabilities to specific industries, supported by the capabilities of its University Partners and Partner Government Agencies. The Electrification and Energy Systems Network (EESN) is an active network in the Hub and has been established to address these interdisciplinary challenges; the Network is delighted to put forward a combined offshore wind capability statement from its university partners: University of Newcastle; University of New South Wales; University Technology Sydney; University of Wollongong.

Each of our partners brings their particular strengths to bear in the area of offshore wind. EESN is proud to bring together these capabilities to meet the demands of the offshore wind community and government. Having local resources available to meet the exacting demands of the projects will enable local consultation and help turn around responses rapidly.

Please reach out to Mark Lewis for any questions: info@decarbhub.au

Network Partners

UNSW SYDNEY · THE UNIVERSITY OF NEWCASTLE AUSTRALIA · UTS · UNIVERSITY OF WOLLONGONG AUSTRALIA · NSW GOVERNMENT Department of Primary Industries

Establishing scientific foundations

For transformational electrification and energy systems technologies for a new generation of innovators and entrepreneurs.

Unlocking current potential

Optimising and taking advantage of synergies between technologies, facilitating a portfolio of industry-led commercial-scale demonstrations and/or deployments.

Creating a clear vision

Engaging with entities informing Network activities to develop effective policy suitable for large-scale rollout, supporting the creation of new jobs and economic growth in NSW.

The Electrification and Energy Systems Network is one of three innovation networks within the NSW Decarbonisation Innovation Hub (Hub). The Hub aims to facilitate a thriving innovation community, connecting industry with researchers and government to advance emerging decarbonisation technologies and services. We promote enterprise, investment and employment within NSW through grants, project funding, skills development and training to support targets to reduce emissions by 50% by 2030 and achieve net zero emissions by 2050.

The University of New South Wales (UNSW) is globally recognised for its multidisciplinary excellence in research and innovation and our contribution to energy and environmental issues. This is further supported by the UNSW 2025 Strategy which places social engagement and global impact at its core.

UNSW Capabilities

In offshore wind power generation, UNSW institutes can help solve complex engineering and environmental challenges encountered by the offshore wind and renewable sector. Capabilities range from offshore meteorology, through hydrodynamic testing to real-time simulation of energy systems.

UNSW Energy Institute coordinates energy activities across UNSW and collaborates with industry, government, community stakeholders and other research institutions. The Institute draws on the vision and work of UNSW's energy researchers based in the Tyree Energy Technologies Building and the Faculty of Engineering, working together with colleagues around the University from faculties such as Arts and Social Sciences, Science, Built Environment and Law. This allows the space to contribute to the development of new technology, policy advice, and the public's understanding of the challenges and opportunities facing Australia as it undergoes major energy transition. This coordination allows UNSW to take a 'system of systems' multi-disciplinary view of energy.

Tyree Energy Technologies Building (TETB) is a showcase, award-winning, six-star energy efficient building costing over $130 million. The TETB houses the School of PV and Renewable Energy Engineering, Petroleum Engineering, the Centre for Energy and Environmental Markets, the Cooperative Research Centre for Low Carbon Living, the Particles and Catalysis Research Laboratory, the Real Time Digital Simulation Lab, a vanadium redox flow battery and an 800kW trigeneration plant. TETB is also a "living lab" for researchers studying the building's power production and consumption, water utilisation and human interaction. More than 300 students, academics and researchers use the building each day.

ARC Research Hub for Integrated Energy Storage Solutions, formally launching in 2019, is a 4-year, $12m nationally significant program in partnership with industry and other research institutions. Research projects include: novel and conventional batteries and supercapacitors; novel fuel cells; power-to-gas; virtual storage (demand response); and systems control and optimisation.

UNSW Digital Grid Futures Institute launched in 2018 to future-proof global electricity systems, ensuring reliable, secure, affordable, sustainable electricity for economic advancement and transport. Research addresses five key priorities for the electricity grid of the future, including: energy storage; the electrification of transportation; robust physical connections across the grid; open yet secure cyber connections, and supportive socio-political, economic, regulatory and legal frameworks.

Real-Time Digital Simulation (RTDS) Laboratory, UNSW is the largest RTDS laboratory in Australia, and one of the largest in the world, with extended simulation capabilities in the areas of high-voltage DC networks, power system protection testing, smart grids, microgrids, renewable energy systems, distributed generation, power electronics, control system testing, and hardware-in-the-loop testing.

Particles and Catalysis Research Laboratory (PartCat), UNSW is one of the best catalyst/ photocatalyst fabrication and characterisation facilities available in Australia. It hosts state-of-the-art equipment dedicated to heterogeneous catalysis/photocatalysis research. It has been funded over $25 million by the ARC programs and industries for research centred on particle and catalysis projects.

The Mark Wainwright Analytical Centre (MWAC), UNSW houses contemporary instruments for materials characterisation, including vibrational spectroscopy, SEM, TEM, XRD, XPS etc. It features world-leading magnetic resonance facilities, including high-resolution solid-state NMR up to 700 MHz and X-band EPR.

The German-Australian Alliance for Electrochemical Technologies for the Storage of Renewable Energy
A joint international research alliance for stationary energy storage (CENELEST) has been established by UNSW and The Fraunhofer Institute for Chemical Technology (ICT). The alliance aims to strengthen the world-class expertise in redox flow batteries, and concurrently develop other types of batteries and fuel cells in order to cover the entire range of electrochemical energy storage needs for renewable energy.

The Centre for Energy and Environmental Markets is devoted to studying the challenges and opportunities of clean energy transition within market-oriented electricity industries. Key aspects of this transition are the integration of large-scale renewable technologies and distributed energy technologies (generation, storage and 'smart' loads) into the electricity industry.

Flow Battery Research Laboratory, UNSW is a world-leading facility for research into vanadium and other flow battery technologies.

Vanadium Redox Batteries (30 kW/120 kWh) are installed in the Ground Floor of the Tyree Energy Technologies Building, UNSW.

UNSW laboratory facilities of Chief Investigator Da-Wei Wang for battery testing, demonstration and integration.

ARC Training Centre for Fire Retardant Materials aims to create knowledge in novel green flame retardants, advanced fire models, innovative fire suppression technologies and new flammability fire tests. It gears to accelerate the transformation of Australia's industries in producing new fireretardant materials, high-value products and engineering services.

UNSW Projects

Energy Meteorology – weather forecasting and resource assessment for offshore wind: Expertise in using the connection between energy and meteorology to develop models that lead to promotion of cost-effective and sustainable weather and climate risk management strategies for the Energy industry. The focus areas extends from fundamental research on weather and climate forecasts to industrial scale applications of future technology development and planning for a changing climate.

Dams and pumped-hydro: The Water Research Laboratory (WRL) provides specialist services to dam engineering at its laboratory facilities in Manly Vale, Sydney. It provides both fundamental research of flow dynamics on spillways, and commercial large-scale physical modelling of hydraulic structures.

Renewable energy, energy efficiency and emissions policy mechanism design: Conducting interdisciplinary policy analysis and design—including carbon pricing, renewable energy and energy efficiency certificate schemes, reverse auctions, tariff design and other policy mechanisms—across the technology lifecycle to help determine the trajectory and cost of clean energy transitions, and the impacts on different stakeholders.

Hydrodynamic testing of offshore and coastal projects: The Water Research Laboratory (WRL) can help solve complex engineering challenges encountered by the offshore wind and renewable sector. WRL provides expertise in offshore renewable energy resource assessment, hydrodynamic modelling and coastal engineering, ensuring safe and successful development of offshore wind in the Australian marine environment.

Real-time digital power and energy system simulations: Real-time digital simulation of power and energy systems with sufficient resolution (2-50 µs) allows for monitoring, operation, control, testing, optimisation, validation and maintenance of large and complex electricity and energy networks.

Permanent-magnet synchronous machines for wind energy conversion: Specialists in design and control of permanent magnet (PM) type electric machines. Strong capabilities in design optimisation and control of various PM machine geometries for low-speed, high torque applications such as direct-drive wind energy conversion.

Hardware assessment of virtual power plant equipment: Using real-time simulation and testing expertise to assess the potential for maloperation of Virtual Power Plant (VPP) hardware, including inverter disconnections, communication system failures and energy swings between competing VPP operators.

Integration of large-scale variable renewable energy into the electricty market: Although there is a variety of technologies and market design features that can assist with the integration of large-scale Variable Renewable Energy (VRE), delivering reliable and low-cost electricity through the transition will require new approaches to planning, operation and market reform.
materials, high-value products and engineering services.

HVDC transmission and multiterminal DC systems: Real-time simulation and hardware-in-the-loop testing expedites innovative solutions for interconnecting electricity grids over long distances, the integration of large-scale remote renewables, addressing intermittency and the formation of super grids.

Intelligent monitoring of electricity grids: The electricity grid delivers electrical energy from diverse generation sources to end users. It is a complex, continuously evolving and dynamic system. Advances in sensing devices, digital technologies and communications make it possible to engineer systems for accurate, online, real-time monitoring of the grid and intelligent, automated control of its operation.

The University of Technology Sydney (UTS) has embedded sustainability in its UTS 2027 strategy. The vision of this strategy is to sustain our local and global environment, organisational health and our ability to create a positive, viable future.

UTS Capabilities

UTS has experience working with a variety of stakeholders across the energy industry generally, including offshore wind. Its capability areas span a wide range of topics, such as engineering and resource modelling, jobs and supply chains, and community impacts.

Institute for Sustainable Futures

The UTS Institute for Sustainable Futures (ISF) works to create a world that is socially, ecologically and economically just and safe, where everyone has the resources and skills they need to flourish. ISF brings together expertise from a range of disciplines to deliver practical solutions for project partners. ISF's Energy Futures team (https://www.uts.edu.au/isf/explore-research/energy) works on all aspects of the energy transition. The team works with a variety of stakeholders on topics relevant to offshore wind priojects, and has demonstrated experience and expertise in the following areas:

- Analysis of offshore wind resource potential
- Forecasting of offshore wind energy
- Feasibility and economic analysis of offshore wind farm projects
- Modelling and analysis of offshore wind in the context of the broader energy system and markets
- Wind industry employment and supply-chains analysis.

Specific projects led or contributed to by the ISF team include:

Offshore Wind Potential for Australia (2021)—This study, published by the Blue Economy CRC (blueeconomycrc.com.au/project/offshore-wind-potential-for-australia/), involved collaboration with the Maritime Union of Australia (MUA) and experts from CSIRO and Saitec. The work involved high level mapping of wind energy resource quality in 12 locations, a comparative analysis of the generation profile of offshore wind energy with onshore wind and solar to determining potential value within Australia's electricity market states, and research on the employment potential for offshore wind energy and the role it could play in a 'just transition' for coal, oil and gas workers. Key findings from the study were that:

- Australia has very high quality and abundant offshore wind resources in a range of locations
- Floating offshore wind technologies will be necessary to tap into many of the best resources
- The capacity factors for offshore wind are generally higher than onshore wind
- Offshore wind can provide diversity of energy supply and could become a key source of electricity supply
- Offshore wind could play a key role in a just transition for workers.
- The report has been widely quoted by policymakers, including on the Consultation Hub website of federal Department of Climate Change, Energy, the Environment and Water (DCCEEW).

Ukraine Solar + Wind (2023): Commissioned by Greenpeace Germany, this work involved laying the foundations for detailed scenarios of solar and wind energy supply in Ukraine. The work involved data gathering, renewable resources assessments using GIS data, and sector analysis, including global trends in power generation and decentralised power supply.

Offshore Wind – Employment and Supply-Chains (2022): Working with the consultancy GEP, this work involved analysis and assessments of supply-chains and employment scenarios for implementing offshore wind in Australia.

Global Wind Energy Outlook (2018): Global onshore and offshore wind power market projections for 10 world regions, 2020–2050 for the Global Wind Energy Council (GWEC).

CMC Wind Research (2017): Research on wind energy in Australia for the production of factsheets for the Climate Media Centre.

Global Wind Energy Outlook (2016): Development of three scenarios across 10 regions to assess the global outlook for wind power market development until 2050 for the Global Wind Energy Council (GWEC).

Faculty of Engineering and Information Technology

The UTS Faculty of Engineering and Information Technology (FEIT) delivers rigorous, practical and industry-focused education and research that encourages disruptive technologies and cultivates exceptional engineering and information technology professionals. FEIT's School of Electrical and Data Engineering (uts.edu.au/about/faculty-engineering-and-information-technology/electrical-and-data-engineering) has expertise across the scope of the electrical industry from individual generators, through to grid connection impacts and operating conditions.

FEIT has capabilities in a number of research areas, including:

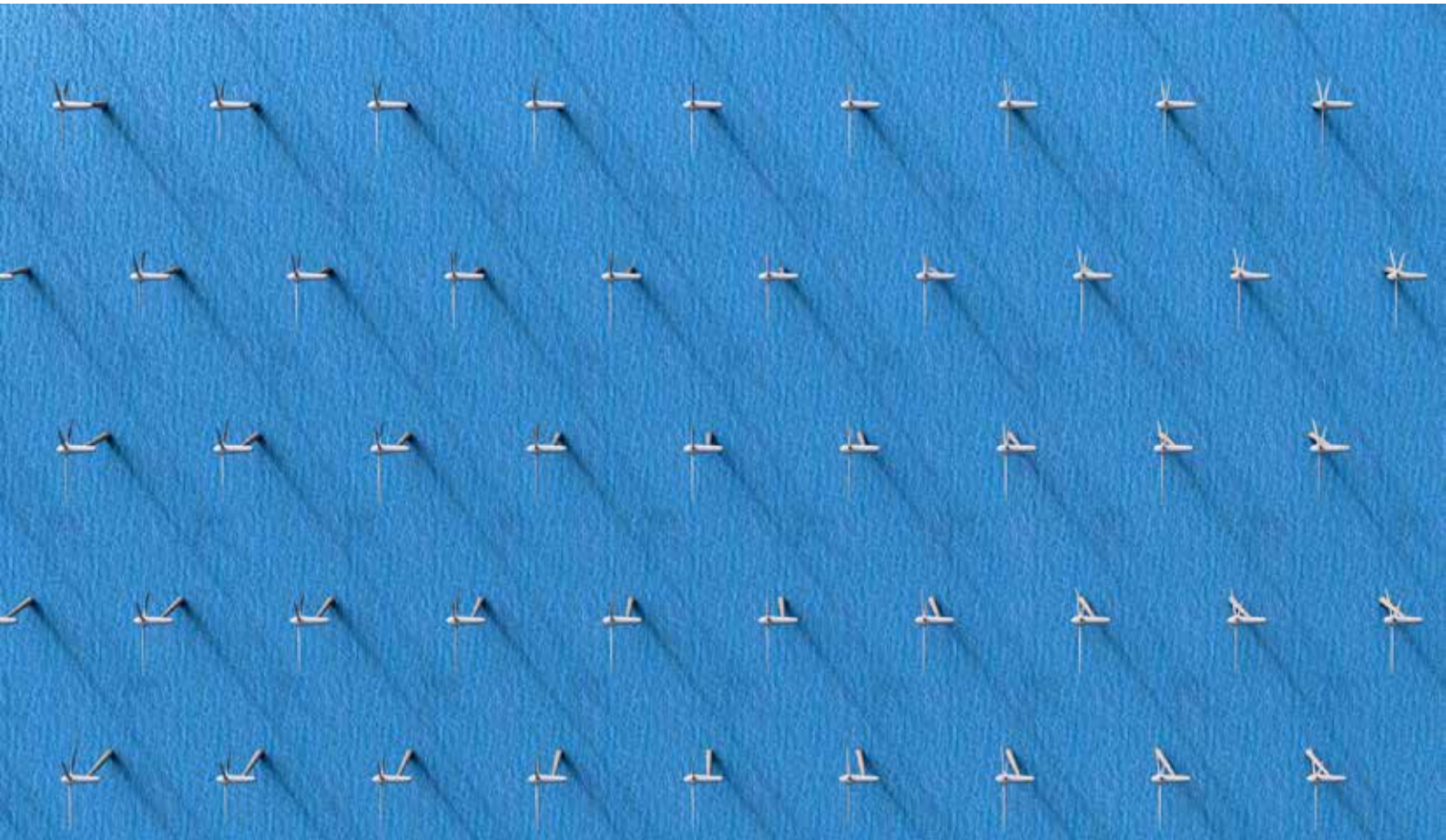
- Modelling and analysis of offshore wind farm integration into the transmission network: analysis of grid impacts, integration into weak or regional grids
- Mitigation of sub-synchronous stability issues, which can occur due to generator vibrations/oscillations
- Case studies of wind farm projects, including analysis of market participation
- Modelling and control related to the construction and operation of projects (e.g. offshore structures and cranes)
- Design of electrical generators and components (e.g. doubly fed induction machine and direct-driven generators).

Climate, Society and Environment Research Centre

The UTS Climate, Society and Environment Research Centre (C-SERC) builds understanding on how societies interact with energy, technology and the living environment. Based in UTS Faculty of Arts and Social Sciences (FASS), it brings together a range of social science expertise across other faculties, universities and partners, within Australia and internationally. C-SERC has developed comparative and Australia-based projects investigating the social dynamics of renewable energy transition and issues of coastal livelihood. These include:

- Multi-year funded fellowships centred on the social relations of community renewable energy and on the role of immersive media in communicating climate and energy transitions
- Local-level investigations into the potential for First Nation's renewable energy projects on Indigenous lands held by NSW Land Councils
- Large comparative projects focussed on qualitative ethnographic investigations into energy transitions, including a major project drawing lessons from utility-scale renewable wind and solar power in India, Germany and Australia
- Large ethnographic projects centred on livelihood and conservation for coastal communities in East Asia, the Pacific and Australia, including marine conservation and restoration questions and the Blue Economy governance
- A doctoral researcher comparing offshore wind in Taiwan and Victoria, now working for EnergyCo on REZ networks, and a current PhD student researching PPAs who consulted on NSW REZs and now works in the offshore wind sector

Across these fields, C-SERC researchers have extensive capacity to research issues of energy transition and off-shore wind power; especially in terms of qualitative ethnographic investigations of the implications for livelihood and the lived environment.



The University of Newcastle's research strengths in geotechnical research, marine ecology, coastal science and social impact can create world-leading technology and processes for the offshore wind industry. Interdisciplinary research brings together diverse capabilities to drive innovation and sustainable practices while fostering community inclusion and wellbeing.

University of Newcastle Capabilities

Geotechnical Engineering researchers at UON assess geotechnical behaviour and analyse risks for marine engineering, including offshore foundations. There is a focus on the development of innovative test procedures, site investigation, field monitoring techniques, mathematical models, and computational methods to predict the behaviour of soils, rocks, and structural foundations. Geotechnical risk and reliability analyses provide data on failure mechanisms and advice on futureproofing against climate change.

UON Materials Science researchers provide novel approaches to structural steel corrosion analysis and deterioration modelling for long-term prediction of structural service life and asset management in marine environments.

Marine Science researchers at UON specialise in the development of environmental monitoring programs addressing water quality, ecosystem health and ecosystem processes in estuarine and coastal environments. Research strengths include quantifying anthropogenic disturbances on estuarine and coastal ecosystems, and the use of Geographic Information System (GIS) and remote sensing for spatial analysis.

UON Coastal Science researchers' strengths are in coastal morphology, hydrodynamic modelling, risk assessment, and coastal management. This includes the hydrodynamics of waves after breaking and the implications this has for sediment transport; as well as risk analysis of coastal hazards such as storm surges and tsunami.

Researchers in the Earth Sciences discipline at UON predict climate-related risks to help prepare for and mitigate disasters. Research strengths include climatology, hydrology, palaeoclimatology, seasonal forecasting, climate change risk assessment, extreme event analysis, adaptation, and development of early warning systems. This research helps to understand of the drivers of climate variability and assess vulnerability in order to lessen biodiversity impacts and improve infrastructure planning and resource management.

Behavioural Ecology researchers at UON employ conservation psychology to understand cognitive and behavioural processes that allow animals to adapt to short-term and long-term environmental change and variability. Specific recent research of relevance to the offshore wind industry involves adaptive learning in shorebirds.

Social Impact researchers at UON look into the forces behind home, identity and belonging amongst people experiencing significant social and environmental change and, specifically, climate change. Research areas include the anthropological dimensions of built and natural environment, and the implications of large-scale infrastructure development (including energy transition) on communities. Researchers in this field regularly work closely with local communities in responses to development applications.

Researchers in the Newcastle Business School have expertise in tourism and recreation in the marine environment, including the effect on tourism from climate change, land use alterations and protected area conservation. Other research covers stakeholder attitudes about Newcastle as a home for cruise ship tourism, and econometric modelling of environmental impacts and solutions.

Electrical Engineering researchers at UON have strengths in the control and optimisation of renewable energy systems and the application of power electronics to electric machines, power systems and renewable energy systems.

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The ocean presents opportunities for sustainable economic growth, particularly in industries related to clean energy. Consequently, it is crucial to conduct evidence-based research that informs fair and efficient energy transformation in line with blue economy principles, ensuring equitable access to clean energy for all.

At the University of Wollongong (UOW), we apply a comprehensive research approach to explore all facets of energy transformation, from social and economic factors to technical aspects. As an anchor institution in the Illawarra region, UOW actively promotes regional collaboration and champions the shift from carbon-intensive industries to innovative, clean manufacturing and energy production, driving dynamic and sustainable economies.

University of Wollongong Capabilities

UOW's research capabilities reflect the interdisciplinary nature of our research collaborations. We unite researchers from a growing cross-section of the University, including the:

- Australian National Centre for Ocean Resources and Security
- Australian Centre for Culture, Environment, Society and Space
- UOW Energy Futures Network
- Sustainable Buildings Research Centre
- Australian Power Quality Research Centre
- ARC Training Centre in Energy Technologies for Future Grids
- Faculty of Business and Law
- School of Earth, Atmospheric and Life Sciences
- Faculty of Engineering and Information Sciences

The UOW Blue Energy Futures Lab, represented by these diverse research entities, stands as a beacon of innovation, collaboration, and dedication to advancing sustainable energy solutions.

We are an interdisciplinary research team focused on the emergence of new offshore sustainable industries, such as offshore wind and aquaculture. Expertise across the group includes law, social sciences, policy, economics, engineering, business, data science and analytics, and marine sciences. This collaboration of researchers is well-positioned to offer authoritative guidance to government agencies, utilities, regulatory bodies, equipment suppliers, and communities.

Blue energy blends clean energy innovations with blue economy principles, promoting sustainable resource use and conservation. This mix not only advances the use of environmentally friendly energy but also encourages sustainable coastal development, ensuring a balanced coexistence between human activities and marine ecosystems.

The Blue Energy Futures Lab is affiliated with UOW Energy Futures Network. This network supports research into renewable energy systems and integration, power systems, sustainability (including building design), power quality and reliability, battery energy storage and management systems, distributed energy generation, micro-grids, infrastructure modelling and economics, and R&D leading to a more hydrogen-intensive economy. The concept of the blue economy seamlessly integrates with clean energy initiatives, particularly in the context of offshore wind projects.

Our work is grounded in respectful acknowledgement of the critical role that First Nations communities must play in sustainable transitions. We endeavour to continually recognise and respect that our research is being carried out on Aboriginal Country, encompassing both land and sea. We ensure that this profound connection is always reflected in the decisions we make and in the way we conduct our research.

UOW prioritises engagement with Indigenous Knowledge into our research practices by actively seeking collaboration with local First Nations communities, Indigenous leaders, and researchers.

Blue energy blends clean energy innovations with blue economy principles, promoting sustainable
This has led to the Blue Futures Translational Research Initiative, which explores how communities respond to emerging offshore industries, such as wind energy and aquaculture. It involves collaboration between ANCORS, Aboriginal organisations and industry partners from across the South Coast.

The Australian Centre for Culture, Environment, Society and Space (ACCESS) has research strengths in regional economic transformation, human-environment relations, environmental, urban and regional governance, and social and cultural relationships with oceans and coastal regions. A long-term commitment to research in the Illawarra-Shoalhaven has enabled ACCESS to build trusted relationships in the region for over a decade and work with local communities to respond to the opportunities and challenges of sustainable regional transitions.

The Australian National Centre for Ocean Resources and Security (ANCORS) has strengths in several research areas, including ocean governance, human relationships with oceans and coasts, the impact of values and connections to the sea on social perceptions and the acceptability of offshore developments (referred to as Social Licence to Operate), maritime law, and the role of legal and regulatory processes in facilitating sustainable transitions.

UOW's Faculty of Business and Law (BAL) has strengths in accounting, law, regulatory frameworks, and economics, while the Sustainable Buildings Research Centre (SBRC) has research strengths in exploring solutions that address the challenge of transforming our buildings and built environment into sustainable, resilient and effective places in which people live and work.

ACCESS, our School of Business and ANCORS have a track record in high-impact research that examines the social dimensions of energy transitions, local jobs and supply chains, economic and social impact assessment, and ocean accounting.

UOW's School of Earth, Atmospheric and Life Sciences (SEALS) primarily focuses on environmental sciences research and teaching. Its interdisciplinary approach and expertise can also play a crucial role in advancing research related to ocean energy transformation, aligning with the broader goals of sustainable resource utilisation and conservation.

UOW's Faculty of Engineering and Information Sciences (EIS) is renowned for our dedication to cutting-edge research, robust partnerships with industry and government stakeholders, and a commitment to innovative pedagogical methods. This puts UOW at the forefront of shaping the future of sustainable energy through offshore wind technology.

Our Schools – encompassing the School of Civil, Mining, Environmental and Architectural Engineering, School of Computing and Information Technology, School of Electrical, Computer and Telecommunications Engineering, School of Mathematics and Applied Statistics, and the School of Mechanical, Materials, Mechatronic and Biomedical Engineering – foster interdisciplinary collaboration to provide a holistic approach to offshore wind technology research and development.

- Australian Power Quality Research Centre: specialising in power quality, reliability, and renewable energy systems
- National Institute for Applied Statistics Research Australia: dedicated to innovative statistical methods
- Sustainable Buildings Research Centre: addressing sustainability and resilience in building environments
- SMART Infrastructure Facility: where experts converge to tackle infrastructure and energy challenges
- Steel Research Hub: supporting sustainable steel manufacturing
- Centre for Medical Radiation Physics: advancing semiconductor detectors for clinical and high-energy physics applications

Research within UOW Energy Futures has a proven track record of developing and commercialising new technology, such as the development of the Hysata hydrogen production electrolyser.

The Australian Power Quality Research Centre is an internationally recognised centre of excellence which supports research, education and consulting in distribution and transmission system power quality, reliability and renewable energy systems. The ARC Training Centre in Energy Technologies for Future Grids is addressing complex challenges in the growth of renewable energy.

Furthermore, world-class education at UOW caters to the evolving workforce demands of emerging industries like offshore wind and aquaculture, playing a critical role in training the skilled professionals that will be required to develop, assess and monitor such emerging industries.

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