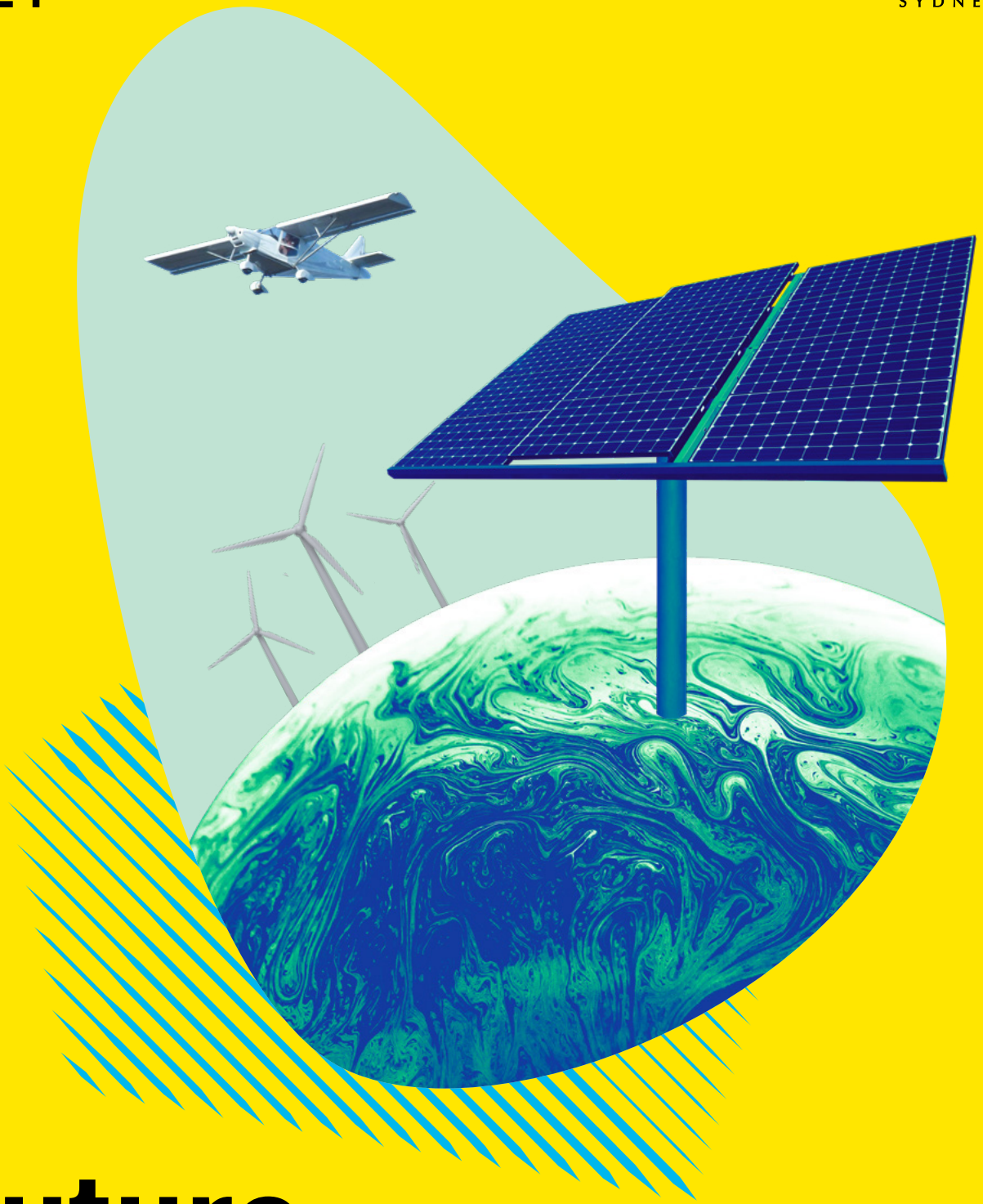
FUTURES
EXPO
SERIES
2024

UNSW
SYDNEY



Future Clean Energy

Discover UNSW research and innovation that's powering a more sustainable future.

Future Clean Energy, powered by UNSW

Welcome to the dawn of a new era in energy - a future fuelled by innovation and powered by wind, water and sun. The Future Clean Energy Expo 2024 is where solar and renewable technologies, electrification, new forms of energy storage, and the pursuit of green fuels and chemicals converge to redefine the energy landscape.

UNSW has been at the forefront of clean energy innovation since the 1980s, when Professor Martin Green and his team invented the photovoltaic solar cell. Our showcase brings you the next generation of groundbreaking technologies - from SunSwift, who holds the Guinness World Record for fastest EV over 1000km on a single charge, to SunDrive, who has the world's most efficient commercial-sized solar cell made with novel copper technology.

The success of photovoltaics brings with it the problem of what to do with end-of-life solar panels. By 2035, Australia will face a million tonnes of solar waste worth more than $1 billion. Researchers are tackling this challenge by developing recycling methods that reclaim valuable materials such as silicon, silver and copper from panels and contribute to a circular economy.

UNSW is actively exploring the green fuels space. Spinout, DeCarice, converts diesel engines to hydrogen-diesel hybrids, accelerating the decarbonisation of heavy industry, while OzAmmonia turns the nitrogen oxide found in wastewater and flue gas into ammonia, marking a significant advancement towards zero-emission fertilisers and fuels.

Together, we have the potential to unlock a future where sustainability is not just a goal, but a reality - a future where clean energy powers our world and propels us towards a brighter tomorrow.

Professor Stephen Rodda
Pro Vice-Chancellor Industry & Innovation
UNSW Sydney

Discuss your project or idea with UNSW

Future Clean Energy Overview

Future Clean Energy showcases the breadth and depth of translational research and technology at UNSW driving the clean energy transition. It includes research projects, groups, programs, institutes, and facilities. It also highlights pioneering companies, including spinouts, startups, and colocating enterprises, commercialising research within the UNSW innovation ecosystem.

Electrification & energy storage

Energy transition

Policy, infrastructure & behaviour

Green fuels & Chemicals

Solar & renewable technologies

Clean energy
Electrification & energy storage

Dovetail electric aviation

Aircraft electric conversion to fast-track zero-emissions commercial aviation

Co-located company

Dovetail Electric Aviation (Dovetail) specialises in transforming conventional small passenger aircraft into electric versions, achieving zero emissions and significantly lowering operating costs.

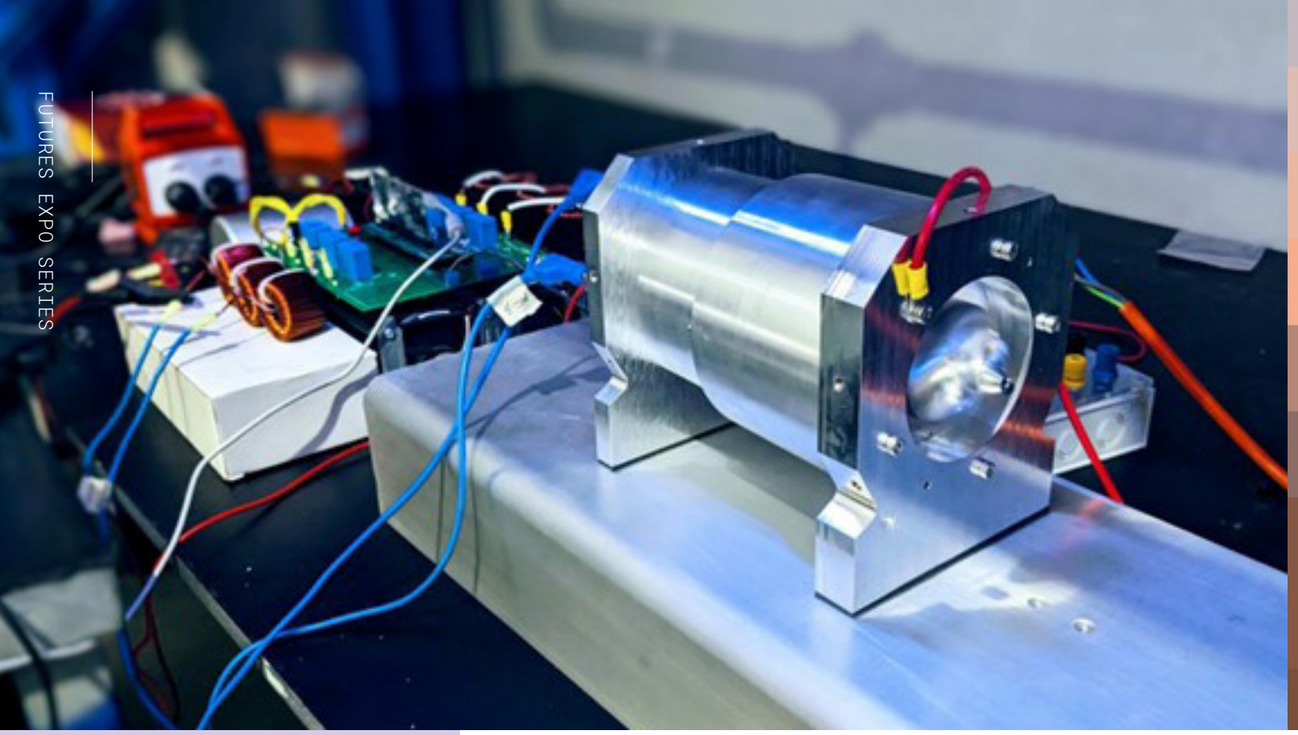
Traditional small aircraft are not only costly to operate, due to their fuel consumption and emissions, but also require an engine overhaul every 3,600 hours, with costs exceeding $0.5 million per engine. Seizing this overhaul moment, Dovetail replaces the internal combustion engines with electric powerplants, transitioning the aircraft to an electric model. This process not only reduces operating costs by 40% but also promises a return on investment in less than three years due to the lower maintenance and operating expenses associated with electric power plants compared to their conventional counterparts.

In collaboration with UNSW, Dovetail has been at the forefront of developing innovative battery systems and power distribution technologies, enabling the retrofitting of conventional aircraft into electric models.

The primary beneficiaries of this technology include aircraft operators and regional airlines, especially those managing small fleets in the under-19-seat category. These operators often serve small communities through activities such as island hopping and are sometimes subsidised by governments. They also cater to leisure activities like scenic tours and skydiving, which are increasingly under scrutiny for their environmental impact. By adopting Dovetail's electric aviation technology, these services can continue in a more sustainable manner, offering regional communities more environmentally friendly transport options. .

> Development of Australia's first aviation battery system.

> Introduction of Australia's first commercial electric aircraft to the market (currently in progress).



Electrical machines & drive systems

High-speed motors for an electrified future

Research group

The development of high-speed and fully-optimised motors is a major trend driving the transition to an electrified future. It allows electric-drive systems to achieve higher power density, more efficiency, and reduced use of critical materials. However, the mechanical and electrical stresses induced by the rotation also increase with speed and have been the major obstacle for high-speed motors.

This team has developed novel motor topologies, multiphysics modelling techniques, and genetic algorithm-based optimisation programs to push beyond the speed and performance limits of electric motors. These designs can be re-optimised to provide high powers of 100-300 kW for EV and industry servo applications. Several of the UNSW-developed motors are patented and in the early phase of full-scale commercialisation.

- Developed a prototype design (5kW, 100,000 rpm) that breaks the speed limit of interior-type permanent magnet motors. It is believed to be the world's fastest motor of its kind.
- A proven design shows the possibility of reducing critical rare-earth materials by up to 60% and material cost by 40% in the motors used in compressor applications.

Electrification & energy systems network

Knocking over industry, community, and government barriers to decarbonisation

Research network

The Electrification & Energy Systems Network (EESN) is part of the NSW Decarbonisation Innovation Hub, a partnership between four leading NSW universities (UNSW, University of Technology Sydney, University of Newcastle, University of Wollongong). The Hub has a dual mission: to accelerate the decarbonisation of industry, community, and government, and drive innovation from the lab through to commercialisation, scale, and impact.

The network has a series of industry-oriented projects in the pipeline due to launch in 2024. It also plans to invite partner universities to submit seed funding proposals that align with the network's strategic initiatives and support projects that contribute to its goals.

As part of its mission, EESN seeks to create a thriving ClimateTech research community across nine leading NSW universities, designed to share information on commercialisation pathways and upskill and network with ecosystem players and like-minded researchers.

- Developed alternative energy demonstration truck and trailer and toured NSW agricultural shows 2023/24, engaging agricultural communities in dialogue on energy transition.
- Issued Offshore Wind Capability Statement to industry proponents and NSW Government agencies.
- Curated academic responses to the NSW Government Consumer Energy Resource Strategy and the Federal Government Electricity and Energy Sector Plan.
- Established development plan for National Electrification Innovation Testing Centre.

- The outcome of this project would contribute to the successful transition of the air mobility industry from fossil fuel-based energy sources to hydrogen-based energy sources.

- Demonstrated manufacturing of a type V composite-overwrapped, pressure vessel using automated fibre placement process.

Intelligent composite H2 storage tank

Harvesting the power of hydrogen energy in land and air mobility

Research project

Hydrogen is emerging as a promising future energy medium in many land and air mobility industries, where it is stored in the gaseous state within pressure vessels. The composite overwrapped pressure vessels that are manufactured with Automated Fibre Placement offer lightweight solutions, design flexibility, and better fuel efficiency when compared to traditional metallic pressure vessels.

This research project aims to design and manufacture a smart, fibre-reinforced polymer composite tank with fibre-optic sensors for ground transportation and aviation applications.

Real-time Simulations laboratory (RTS@UNSW)

Real-time insights for tomorrow's power system

Facility

The Real-Time Simulations Laboratory (RTS@UNSW) is shaping the future of power systems. Its focus on integrating inverter-based resources (IBRs) into the grid marks a crucial move towards a more sustainable energy system. Leveraging its advanced simulation capabilities, RTS@UNSW pioneer solutions that enhance the reliability, efficiency, and adaptability of power systems in the era of increasing renewable energy sources.

The lab undertakes projects involving large-scale IBRs and energy storage solutions, distributed renewable energy resources (DERs), as well as medium- and high-voltage DC systems (MVDC/HVDC), and the creation of power system digital twins.

The contributions of RTS@UNSW extend beyond solving the technical complexities of power systems integration; they are instrumental in advancing the adoption of renewable energy technologies, driving the evolution of technical standards, and laying the groundwork for global energy sustainability initiatives.

- Implementing grid-forming capabilities through battery energy storage systems, including the project at Broken Hill Battery Energy Storage System.

- Creation of S-NEM2300, a publicly available synthetic network model of the National Electricity Market (NEM) designed for comprehensive power system analysis and the incorporation of inverter-based resources (IBRs).

- Active participation in the IEEE Power & Energy Society (PES) Task Force focused on developing innovative teaching methods for contemporary power and energy systems.

Solid state & materials chemistry group: all things batteries

> Collaborations with industry partners including Orica, Sicona, Kinaltek and Vecor.

> Pioneered the use of advanced characterisation tools for battery-based studies.

> Developed a sustainable and high energy density anode material for lithium-ion batteries.

Creating durable, high-capacity batteries for the future

Research project

The Solid State & Materials Chemistry Group develop better batteries. The core of their work lies in the synthesis and characterisation of new materials, such as metal acid, iron tartrate, which has twice the energy storage capacity of graphite anodes used in lithium-ion batteries and is significantly more sustainable. They also work with industry partners to test the performance of battery materials.

Battery degradation and survivability in the field are prominent concerns in the sector. The group use both invasive and non-invasive techniques to determine why batteries fail, or why materials within batteries degrade, and assess durability under different conditions.

Lithium-ion batteries are common due to their reliability and high energy density, however fluctuations in lithium supply and price present an opportunity to explore next-generation chemistries. The group is investigating sodium-ion, solid-state and lithium-sulphur batteries, which will act as the foundation for cheaper, safer and more energy dense batteries.

Overall, the group is dedicated to deepening their understanding of battery function. They apply a multifaceted approach to problem-solving, taking into account battery chemistry, partner requirements and the research question, and are eager to tackle challenges in the field.

UNSW high voltage laboratory

Enabling reliable electricity grids with advanced condition monitoring and diagnostic technologies

Research group

Advances in sensing devices, digital hardware technologies, AI techniques, and communications make it possible to engineer systems for accurate, online, real-time monitoring of the electricity grid, and intelligent, automated control of its operation.

The UNSW High Voltage Research Group has expertise in:

• HV AC and DC transmission systems, equipment, components, and devices.

• Smart-grid monitoring systems with embedded intelligence, e.g. novel sensing devices, signal processing, and machine learning-based data analytics. These provide online monitoring of power flow, power quality, losses/efficiency, and network abnormalities.

• Diagnostic techniques for insulation assessment, e.g. ultra-high frequency detection of partial discharges, dielectric spectroscopy, and frequency response analysis.

Laboratory facilities include:

• Various high-voltage power sources for testing impulse, 50 Hz AC, DC, VLF, and variable frequency.

• State-of-the-art measurement instruments for dielectric insulation study, including sensors, partial discharge, dielectric dissipation factor, space charge, time-and-frequency domain spectroscopy, thermal imaging, fast data acquisition systems, etc. and are eager to tackle challenges in the field.

> Online partial discharge monitoring in high-voltage cables and power transformers.

> Distributed online monitoring of SWER networks and detection of high-impedance arcing faults.

UNSW SMART grid with SMART consumers

An equitable partnership for a green future

Research group

The UNSW Smart Grid with Smart Consumers initiative takes an innovative approach to electrical distribution systems. It acknowledges the challenges and opportunities presented by the integration of rooftop solar panels and electric vehicles (EVs) and aims to foster an equitable partnership between consumers and the energy sector.

The traditional method of setting uniform power export and import limits across the network has proven to be inequitable, failing to accommodate the diverse needs and contributions of individual consumers. In response, UNSW has pioneered the development of customer-centric import and export limits, employing sophisticated algorithms that consider a wide range of variables including the network's characteristics, the distribution and usage patterns of solar energy and electric vehicles, and consumer preferences.

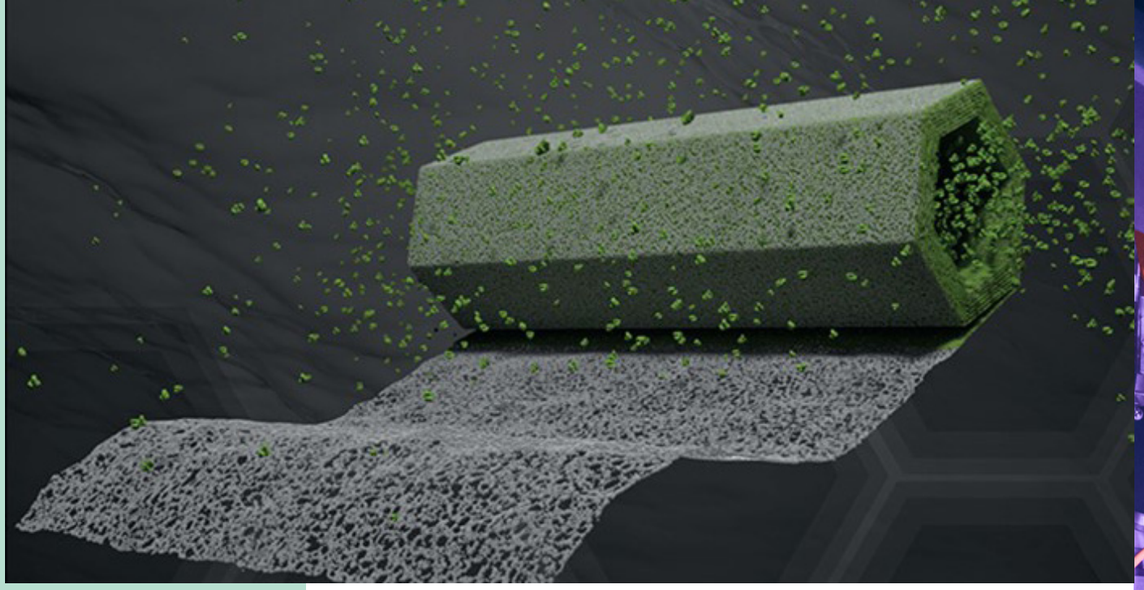
This advanced method not only promotes fairness among consumers but also significantly enhances the system's capacity to incorporate a greater volume of renewable energy and support an increased number of electric vehicles. Initial research conducted on small distribution systems in NSW has demonstrated the effectiveness of these algorithms, paving the way for broader implementation in collaboration with distribution companies.

UNSW is committed to developing key features and algorithms that recalibrate import and export limits to align with consumer-centric values and advance the transition towards a more resilient and sustainable energy ecosystem.

> Developed features that are most important for consumer-centric import and export limits.

> Developed algorithms to compute import and export limits.

> Demonstrated the algorithms on small NSW distribution systems.



- Energy: high-performance batteries made from low-cost and readily available raw materials.
- Environment: aqueous-based and low-power-demand processing using non-toxic materials.
- Industry: contribution to Australian Public Service (APS) Net Zero 2030 target.

Vecor technologies

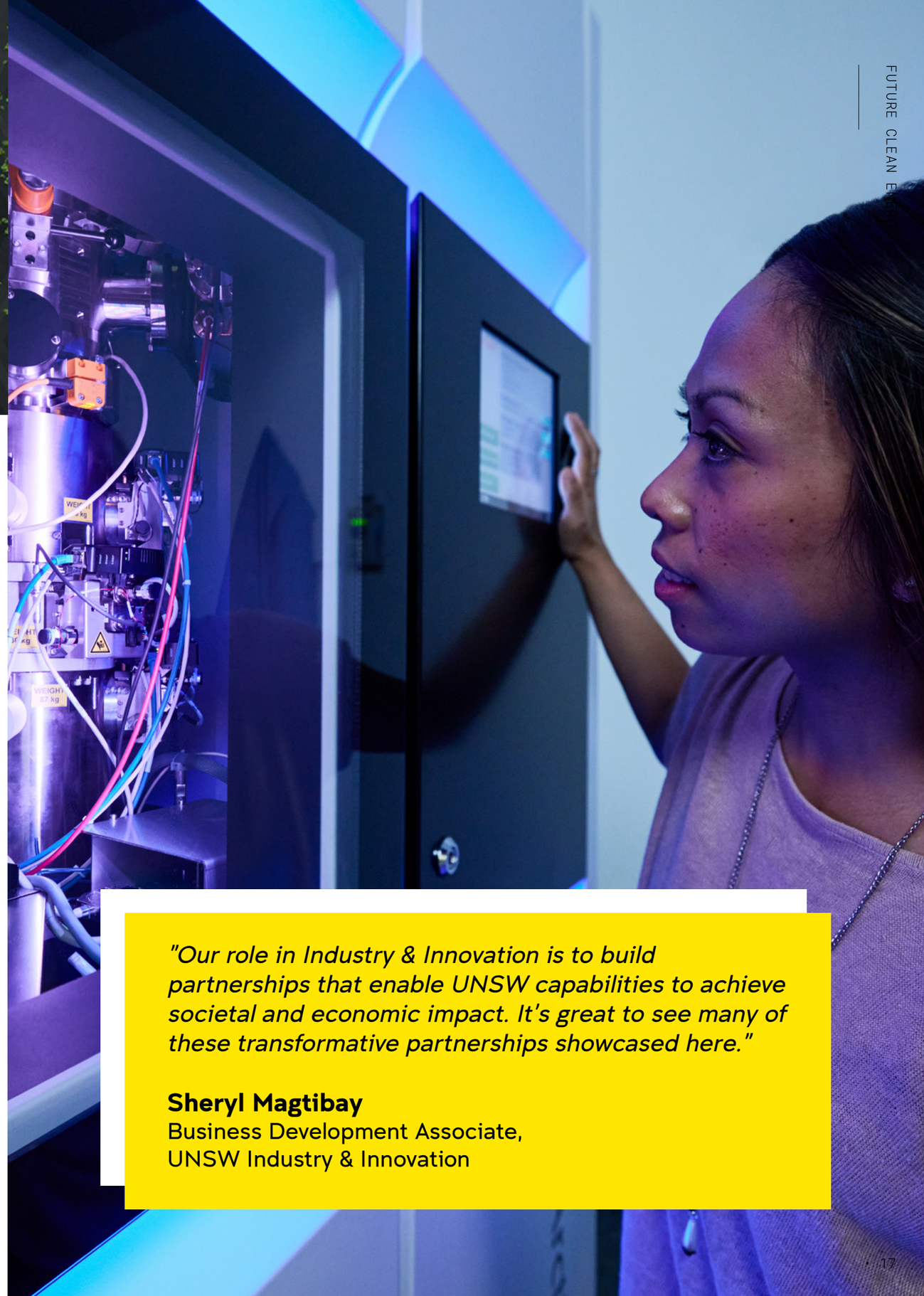
High-performance sodium-ion rechargeable batteries

Research project

Since its inception in 2008, Vecor Technologies Pty Ltd (Vecor) has established itself as a leader in environmental remediation, green recycling, and the renewable energy sector. It operates out of UNSW Sydney and extends its reach with locations in the USA and Philippines. At its core, Vecor is committed to transforming waste, especially from the power generation sector, into valuable products for industries such as mining, metallurgy, transport, and structural ceramics. Its innovative research has led to the development of the Vecor Ceramic Pigment (VCP), marking Vecor's entry into the paint and polymer markets.

In response to the growing demand for renewable energy solutions and the need to address the limitations of intermittent energy sources, Vecor has ventured into the energy storage and conversion arena. The company is at the forefront of creating technologies in catalysis, batteries, and hydrogen production from seawater. This diversification aligns with the projected surge in the global battery market, which is expected to grow from $102 billion in 2021 to $284 billion by 2030, at a compound annual growth rate of 12%.

Vecor is now tackling the challenges associated with lithium-ion batteries - such as high cost, security of raw material supply, safety, and environmental concerns - by developing rechargeable sodium-ion batteries. The project leverages novel electrochemical techniques to create sodium-rich transition metal oxide cathodes through electrodeposition at room temperature in water. This method eliminates the need for traditional binding and conductive agents, enhancing the mass reduction and efficiency of active materials used for energy storage. Vecor's approach not only reduces costs but also prioritises safety, scalability, and environmental friendliness by allowing precise control over the cathode's composition. It presents a promising solution to the renewable energy sector's storage challenges.



"Our role in Industry & Innovation is to build partnerships that enable UNSW capabilities to achieve societal and economic impact. It's great to see many of these transformative partnerships showcased here."

Sheryl Magtibay
Business Development Associate,
UNSW Industry & Innovation

- A patented invention extends the durability of the innovative aqueous-zinc battery technology from three months to three years under practically viable testing conditions.
- The battery already demonstrates the US DOE energy-density target of 50 Wh/kg for this battery type.
- Projects focusing on translational development of this battery technology have recently attracted funding from the Australian Government and RACE2030 CRC.

Zenquo

Aqueous zinc battery technology: empowering a safe, sustainable, and affordable energy future for all

Spin-out

Lithium-ion batteries are expensive and pose a significant financial burden, particularly for those opting to transition off-grid by integrating rooftop solar with a battery storage system. Additionally, safety concerns stem from the presence of highly flammable constituents, adding to apprehension around their adoption.

ZenQuo, a spinout from the School of Chemical Engineering at UNSW, is pioneering a revolutionary aqueous zinc battery technology, promising a paradigm shift in affordability, safety, and recyclability. This is made possible due to the use of abundant raw materials and a salt-water electrolyte.

A recent proprietary solution has been devised, effectively extending the lifecycle of this battery from a mere three months to three years. This breakthrough not only enhances the battery's durability but also addresses a pivotal barrier hindering its commercial viability. The team is working toward extending the battery lifetime further while maintaining the high-energy density and developing large-scale prototype cells and modules for demonstration.

Clean energy
Energy transition

- Insights to further enhance the current NSW EV Charging Master Plan.
- The world's first prompt-tuned and fine-tuned Large Language Models (LLMs) for energy demand forecasting.

AI research for energy

Sustainable and flexible innovations for a data-driven energy revolution

Research group

AI Research for Energy is a pioneering project driving sustainable innovation in the energy sector. Through detailed analysis of EV driving patterns, the team optimises charging station locations, enhancing infrastructure planning.

The research goal is to harness artificial intelligence (AI) and machine learning for precise energy forecasting and flexibility. Using advanced methods, the team ensures efficient resource allocation, grid stability, and emission reduction. It empowers organisations to align energy usage with renewable sources, cutting costs and environmental impact. In addition, it explores AGI's transformative potential in transportation, envisioning smarter and greener mobility systems.

The team's interdisciplinary approach includes energy forecasting, flexibility, and AGI to catalyse sustainable change across the energy and transportation sectors.

The project is currently in the early phases of national scale-up.

Business insights institute

Environment, Social and Governance (ESG) from strategy to implementation

Research group

ESG is a complex and challenging question for business that also comes with incredible opportunities. The UNSW Business Insights Institute helps businesses to better understand ESG, address its challenges, and take advantage of its opportunities.

The Business Insights Institute leverages the world-class expertise of UNSW to:

- Explore the opportunities of sustainable business.
- Navigate the complexity of ESG objectives.
- Benchmark businesses against evidence from global research.
- Find the right data to ensure compliance and purpose.
- Measure, report, and assure information on ESG performance.
- Implement best practice ESG management and governance.
- Assess and manage ESG capabilities and risk.

- Developed a Digital Sustainability Assessment Tool to help managers assess the maturity of their practices and provide a roadmap for progress.
- Assessment projects into how ESG impacts business performance.

- Building interdisciplinary and translational research capability.
- Scoping career pathways that will emerge in the decarbonisation of the economy.
- Establishing interdisciplinary teams to meet industry calls for the social aspects of the energy transition.

Digital Grid Futures Institute (DGFI)

Enabling the electrification of society for a smart, sustainable future through research, innovation, and education

Research group

Despite its transformative breakthroughs and advancements, academic research often doesn't realise its full potential. This can limit its impact at a time when bold and ambitious research agendas are needed to decarbonise the energy grid.

Early-career researchers need help in bridging the gap from theory to practical application. Digital Grid Futures Institute (DGFI) is dedicated to crossing boundaries to foster collaboration and build the necessary capacity to deliver real-world impact.

Through DGFI's Annual Seed Funding program, researchers gain autonomy to explore market-aligned translational activity and deliver a pipeline of new capability. This enables more meaningful connections with industry and a mindset of practical relevance among researchers, empowering them to address pressing issues like the energy transition.

Energy transformers

Teaching kids to be renewable energy transformers through gamification

Research project

To inspire the next generation and help them understand the crucial changes in our energy systems, we must engage them from a young age using innovative approaches.

Energy Transformers, a novel mobile game, offers upper primary to lower secondary school students an engaging way to learn about renewable energy, air pollution, and climate solutions. The game's content is closely aligned with the Australian curriculum, making it a valuable educational tool.

The vision is to expand the game by creating additional modules that develop essential skills and competencies while sparking children's interest in the diverse range of clean energy careers. By nurturing their passion for sustainable energy solutions, the game aims to empower students to become future leaders and innovators in the field, driving the transition to a cleaner, greener future.

- Classroom testing identified improved understanding of renewable energy policy in children who played the game.
- Circa 3,600 engagements pre-launch.

Firm renewable energy

Unlocking superpower - the future is renewable energy abundance

Research project

This research tackles the pressing issue of renewable energy intermittency by introducing an innovative strategy: use excess energy to secure a constant supply of renewable power. By increasing the capacity of solar and wind generation beyond immediate requirements, it becomes possible to use the extra energy for a wide range of purposes, from powering homes to supporting the decarbonisation of industries. This method not only addresses a fundamental challenge in renewable energy but also reimagines surplus energy as an asset for social and economic development.

With a focus on the Australian landscape, the project is pioneering the use of excess energy and marks a pivotal advancement towards a flexible and robust energy system. It employs a comprehensive approach that integrates both supply and demand aspects of energy system modelling and ensures the strategy can be applied within the National Electricity Market (NEM).

The research is paving the way for a future where renewable energy can be reliably and efficiently integrated into our energy systems, facilitating a sustainable transition to green power.

> The project was awarded funding from RACE2030 and Digital Grid Futures Institute in recognition of its novel approach.

> Research is conducted in partnership with Rewiring Australia and builds relationships between UNSW and partners with political influence.

First nations energy transition and climate justice

Living on Country: climate adaptation and mitigation activity and the NSW Aboriginal land estate

Research project

This project investigates the potential for renewable energy projects to be hosted on Aboriginal-owned land with a view to ensuring that energy transition in Australia leads to wider social transformation and economic prosperity for First Nations people.

Initial mapping reveals significant potential for solar and wind energy on Aboriginal freehold lands in NSW. Aboriginal landholders currently have more than enough renewable energy resources to ensure their own energy security, as well as participate in the commercial energy market. If outstanding land claims are approved, this capacity will expand greatly.

A series of workshops are planned in partnership with Local Aboriginal Land Councils (LALCs) to enhance their understanding of renewable energy opportunities, provide technical expertise, and build vital networks.

A parliamentary roundtable involving LALCs, policymakers and financiers, is scheduled for early 2025. The aim is to propel policies and partnerships that support renewable-energy projects owned by Aboriginal communities.

> Research aims to integrate Aboriginal community needs and perspectives in sustainable projects.

> Planned workshops with LALCs to enhance their understanding of renewable energy opportunities, provide technical expertise, and build networks.

> A parliamentary roundtable involving LALCs, policymakers and financiers, is scheduled for early 2025.

- Research-based outputs are widely noted and shared by industry and government leaders and reflected in the discourse of policymakers at the highest levels of government.

- Director, Elizabeth Thurbon, frequently invited to keynote, energy-related events to speak about Green Energy Statecraft.

Green energy statecraft

Advancing a more strategic role for the state in Australia's green energy shift to maximise security benefits

Research project

Green Energy Statecraft is a highly ambitious, globally informed, 'whole of nation approach' to governing the green energy transition. The approach is being embraced by some of Australia's most important energy, economic and geo-strategic partners and rivals, including South Korea, Japan and China, however it is poorly understood in Australia.

The Green Energy Statecraft project operates as a catalyst and engagement point for research and research-driven impact aimed at helping Australian policy makers understand and interpret the green energy statecraft of Australia's most important international partners and rivals. It also assists policymakers to develop an appropriately strategic Australian response.

Through its dedicated research and engagement activities, the project will help reshape Australian narratives and sharpen the focus of national debate about how to achieve a more strategic role for the state in governing the green transition. Although in its early phases, the project is already influencing policy discourse via media interventions and high-profile public addresses.

Making good media

Creating irresistible visions of a renewable energy future

Research project

Current media depictions of climate change often evoke themes that can lead to hopelessness and inaction. The team at UNSW creates short, shareable videos that employ a speculative design approach reminiscent of science fiction integrated with research from the UNSW Digital Grid Futures Institute. These videos explore potential futures to consider how different aspects of society might adapt to a world powered by renewable energy.

Questions posed in their work include: What would a TV weather report look like in a renewable energy future? Would television screens or mass media, as known today, still exist? Could a different framing of blackouts facilitate a quicker transition of large power generation companies to renewable energy?

This group, composed of designers, directors, visual effects creators, and writers, is currently in the pilot stage of the project. They have produced two speculative videos that have been exhibited and are now ready for release on social media, with four additional videos in development. Their work aims to transform complex problems related to climate change and the transition to renewable energies into inspiring and relatable content, adhering to the principle that 'seeing is believing'.

- The project pilots processes for translating research into positive social progress.

- Two 45-second pilot videos speculate on what a weather report might look like in a renewable energy future. The videos were exhibited at "Unconvention", an exhibition by UNSW ADA's "Massive Action", in March 2024. There are proposed presentations at SXSW Sydney in October 2024.

Ocean intelligence

Research addressing the most pressing social policy issues affecting health: poverty, disadvantage, exclusion and inequality

Spin-out

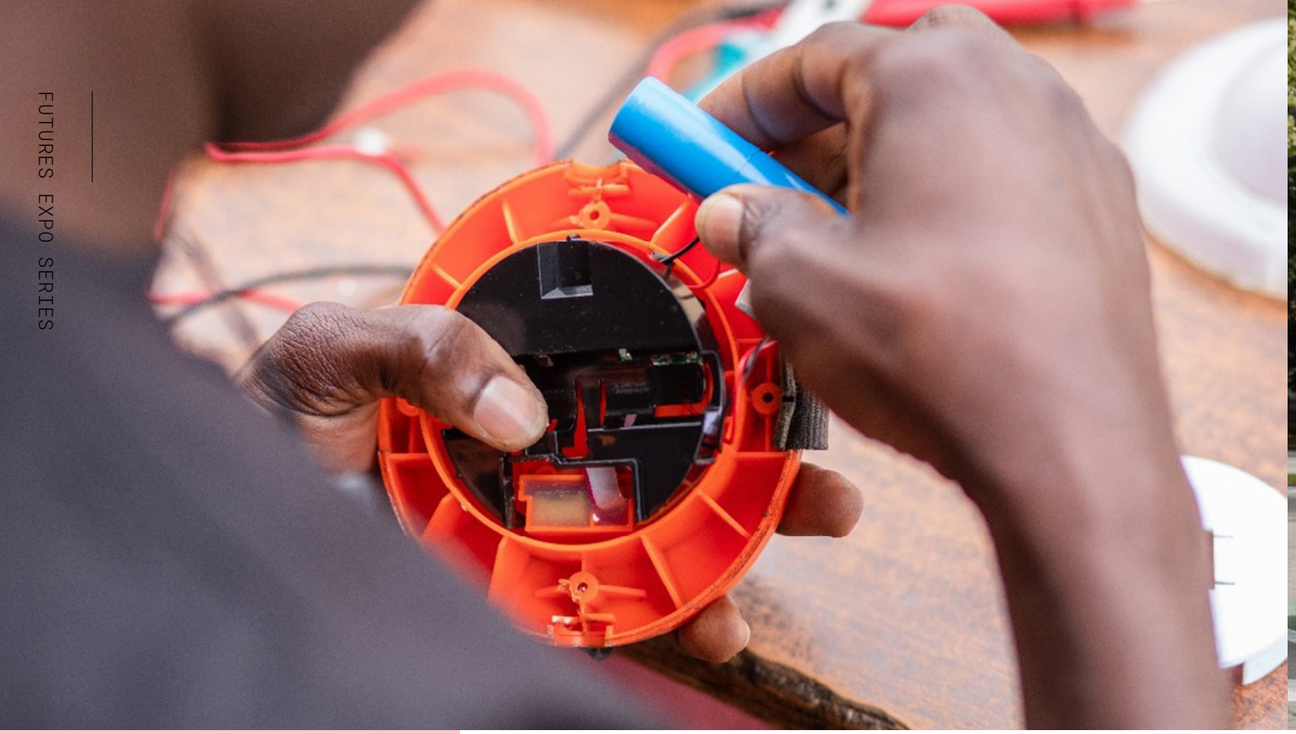
99% of all Australian exports are transported by sea, and maritime transport is vital to our jobs and businesses. In Australia, and globally, the shipping industry faces a perfect storm of market, security, and regulatory pressures to reduce its reliance on carbon-based fuels.

Ocean Intelligence is a UNSW spinout company that aims to commercialise a ground-breaking digital technology that allows cargo vessels to optimise transit time and minimise fuel consumption by 'riding' ocean currents. Their dynamic ship routing system uses state-of-the-art ocean forecast models, machine learning, and mathematical techniques to compare hundreds of thousands of possible routes in minutes.

Extensive testing revealed that the prototype achieves consistent fuel reductions of up to 20%, potentially saving shipping companies up to US$10 million a year for each ship. Ocean Intelligence is developing a fully integrated, market-ready prototype and interactive bridge system that will be field-tested at sea.

- In tests with real-world cargo ship data for over 70 different ships, the system consistently achieves up to 20% fuel savings.

- The Ocean Intelligence solution is positioned to transform the global shipping fleet, rapidly and at a scale, to help meet our net zero ambitions.



Repairable off-grid energy futures

Extending the lives of off-grid solar products in Africa and the Pacific

Research project

Small-scale, off-grid solar markets across Africa and the Pacific region have rapidly expanded. In particular, solar lamps and small solar home systems have become immensely popular as a primary lighting source for many rural and peri-urban households.

In the wake of this boom is the murkier story of solar e-waste. The off-grid solar market is largely unregulated, and many of these products are of poor quality and only have life spans of a couple of years. As a result, millions of off-grid solar products are in disrepair across Africa and the Pacific.

This project, with funding support from the Australian Research Council and the Department of Foreign Affairs and Trade, explores opportunities to increase the repair economy for off-grid solar products in Zambia, Malawi and Vanuatu. This includes working with companies to ensure greater reparable design in the sector and enhance localised repair capabilities.

- Published whitepaper, "Off-grid solar repair in Africa: from burden to opportunity" (2023), that sets a policy agenda for the off-grid solar sector to expand repairable approaches.
- Partnerships established with key local, regional, and international companies, NGOs, and governments to create and expand off-grid solar repair initiatives.
- Mini-document, title “The Afterlife of Solar” on off-grid solar waste in Malawi, launched in 2021.

Shaping the future of driving in Australia

Establishing norms for electric-vehicle (EV) charging etiquette

Research project

Road transportation in Australia accounts for 60% of transport-related greenhouse gas (GHG) emissions and the equivalent of 10% of total emissions as of 2022. A key solution to the problem is electric vehicles, however factors like limited charging infrastructure and range anxiety have contributed to slow adoption. The sharing of limited resources as new rules of engagement are being established has also caused confusion and conflict amongst EV and internal combustion engine (ICE) drivers alike.

This project employed implementation science methods to examine attitudes, perspectives, and behaviours at public charging stations in Australia. The aim was to identify factors that affect good charging etiquette and generate strategies to improve adherence to charging norms.

Funded by the Digital Grid Futures Institute (DGFI), the research team developed a report based on two comprehensive studies. The first study conducted a scoping review to identify the determinants of charging infrastructure in high-income countries. To identify these determinants within the Australian context, the second study encompassed a qualitative analysis of semi-structured interviews with everyday drivers and focus group sessions involving EV experts. Based on the report's recommendations, the project is in the early phases of developing creative knowledge translation resources for industry partners and the general public.

- Interdisciplinary use of implementation science frameworks to inform ways to change driver behaviour.
- Development of strategies that align public interests with policy initiatives, ensuring that new energy solutions are accessible, acceptable, and effectively integrated into existing systems.

Sustainable development reform hub

Designing energy law and regulations that build enduring support for Australia's transition to cleaner, cheaper energy

Research group

UNSW's Sustainable Development Reform Hub addresses the critical need for effective global sustainable development that integrates environmental, social, and economic goals. A key focus area of the Centre is Australia's energy transition.

By fostering partnerships and collaborative projects across more than 20 countries, the team develops and implements policy and governance reforms aimed at creating sustainable, inclusive economies and supporting zero-carbon transitions.

The team's research has evolved into practical initiatives like policy reforms and system development, directly influencing sustainable development practices worldwide.

- Designed improvements to the regulatory and policy framework that supports energy efficiency in the home, to accelerate support for energy savings and lower energy consumption in all Australian households.
- Research into how to effectively build social licence for new forms of energy in Australia, including how to structure community benefits for major energy projects.

UNSW energy institute

Reshaping our energy system to drive Australia's charge to net zero

Research institute

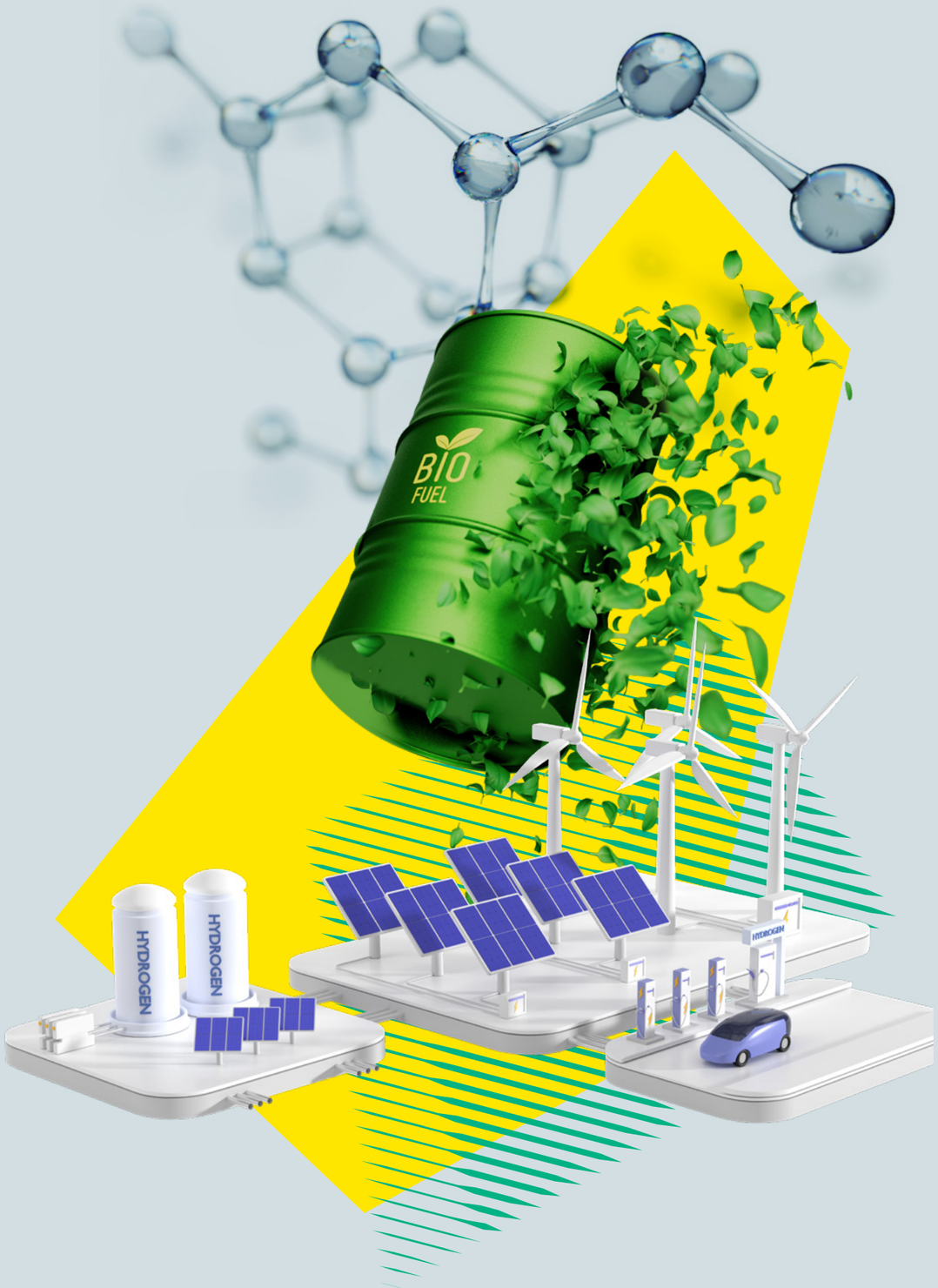
Over the last 30 years, UNSW has carved a formidable reputation as one of the world's leading research and technology hubs for energy innovation. The UNSW Energy Institute accelerates the role that energy plays in supporting a growing, zero-carbon economy.

Energy affects every aspect of human life, from healthcare to food production and transportation. The growing economic and social costs of a changing environment are fuelling the urgency for widespread transition from finite fossil fuel-based energy to clean, renewable resources that are readily available for all.

Australia has a once-in-a-generation opportunity to reshape its energy system for the future and embrace the wave of technological change that will accompany this transition. UNSW's vast and varied expertise addresses the global energy challenges of reliability, affordability, sustainability, and equity, and will play an important role in the global uptake of new energy technologies.

- UNSW has been at the forefront of energy technology innovation, developing groundbreaking advancements such as the modern solar panel and the vanadium redox flow battery.
- Supports national efforts towards achieving a 100% renewable power grid, facilitating the export of renewable energy, and fostering a community-driven approach to the energy transition.

Clean energy
Green fuels & chemicals



CO^2 Electrolyser system

Large-scale CO2 electrolysis: converting waste emissions to value-added products

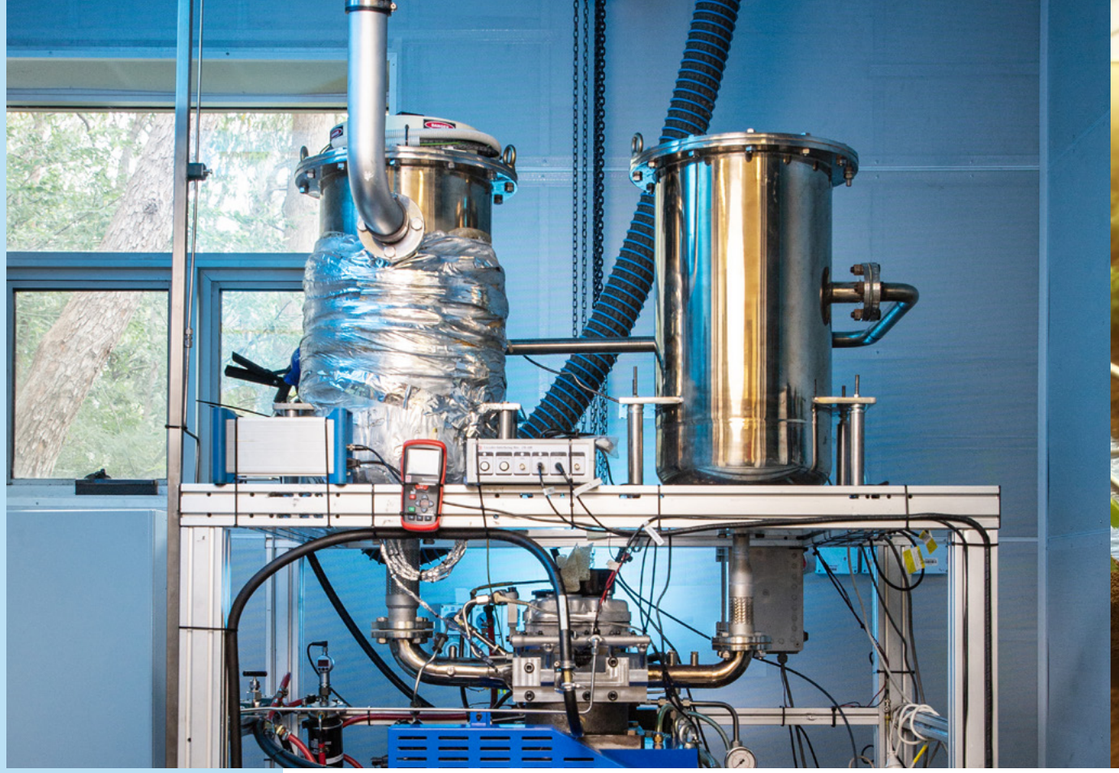
Research project

When powered by intermittent renewable energy sources, CO2 reduction provides a pathway for the conversion of waste CO2 and renewable energy to stable chemicals and chemical fuels (renewable Power-to-X) that are easy to integrate into current infrastructure. It is a 'stop-gap' or 'stepping-stone' solution to societal adoption of renewable energy technologies.

CO2 can be electrochemically converted to syngas, a key building block for producing a wide range of chemicals, from synthetic liquid fuels, such as sustainable aviation fuel, to plastic packaging materials.

This research focuses on designing nanomaterials and electrochemical systems for applying CO2 reduction to syngas on a commercial scale.

- The technology has been scaled to Technology Readiness Level (TRL) 6, including system fabrication and optimisation, and integrating catalysts designed and synthesised in-house.
- Attracted interest from engineering and investment companies to accelerate the scaling up and commercialisation of the technology.



Decarice

Accelerating the clean fuel transition of heavy industry

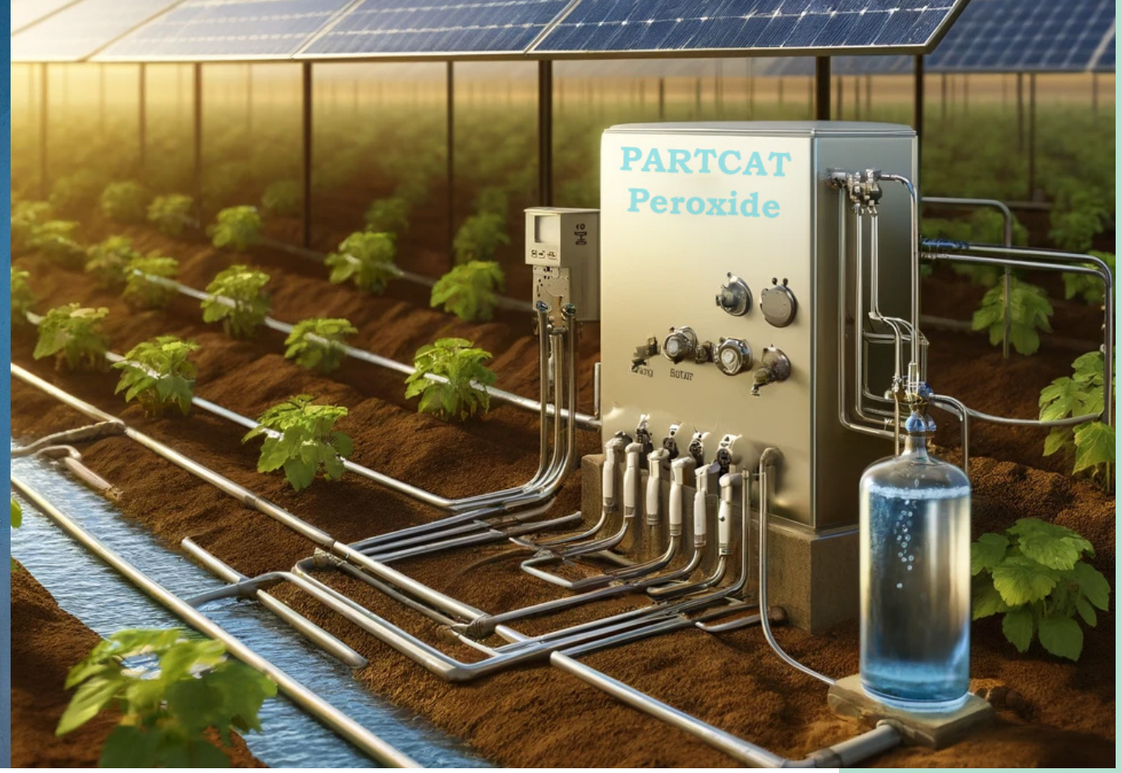
Spin-out

DeCarice is a UNSW spinout that is commercialising UNSW Engine Research Laboratory studies to convert existing diesel engines to hydrogen-diesel hybrids. It aims to enable 70-80% in-situ decarbonisation through 90% hydrogen gas substitution.

This technology reduces the perceived risk among industrial diesel fleet operators of moving to clean fuels by minimising up-front cost, and allowing retention of existing assets, often customised and mid-life. It will also enable diesel backup, meaning the assets can revert to pure diesel operation after conversion - an important step in an immature hydrogen supply environment.

DeCarice is now working to demonstrate converted engines in-field with two industry partners through 2024, with significant customer interest for 2025 onwards.

- **UNSW Engine Research Laboratory has achieved stable and reliable diesel engine operation with 90% hydrogen substitution.**
- **The hydrogen-diesel hybrid system achieves 70-80% decarbonisation with only 50-100 parts added to an existing engine, undercutting the up-front cost of electric and fuel cell systems by a factor of between 3x and 10x.**
- **The hydrogen-diesel hybrid system is capable of live transition to diesel-only operation, significantly reducing perceived risk among operators in an uncertain hydrogen supply environment.**



Green hydrogen peroxide production

A solution to sustainable agriculture and food safety

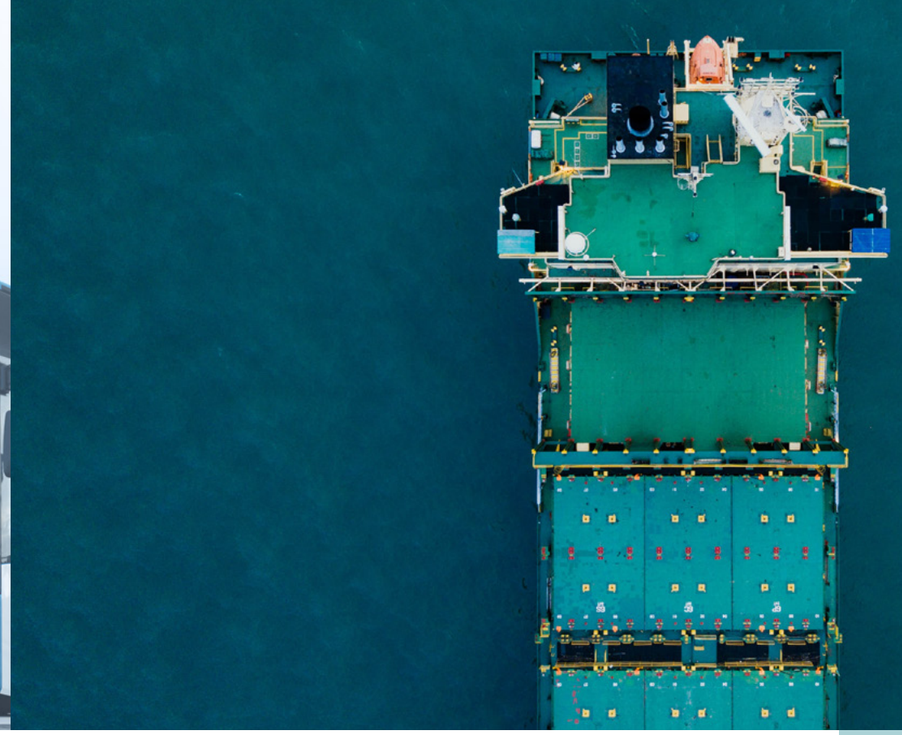
Research project

Hydrogen peroxide is one of the greenest chemical products, widely used in various fields including paper bleaching, food processing, agriculture, wastewater treatment, healthcare, mining, and semiconductors. Traditional hydrogen peroxide production is far from safe and sustainable. It requires large-scale infrastructure and hydrogen as inputs and generates substantial waste and emissions. Industrial hydrogen peroxide often contains impurities and poses significant hazards during transportation, handling, and storage.

Green hydrogen peroxide technology enables decentralised, on-demand, and high-quality hydrogen peroxide production, with only air, water, and electricity as inputs. As the peroxide is generated on-site, no transportation, specialised handling, or storage is required, enabling a safe and green production process. Green hydrogen peroxide is also free of impurities and stabilisers, allowing for robust bacteria and disease control and ensuring the safety of plants, food, and health.

This project pioneers the development of cutting-edge vertical graphene catalysts to address the longstanding trade-off between activity and efficiency in hydrogen peroxide synthesis and achieve a high concentration of production. This innovation significantly advances industrial-scale production processes.

- **Simultaneously achieved high current and efficiency while breaking concentration limits in the electrosynthesis of hydrogen peroxide.**
- **Completed more than 70 customer interviews and market validation through the CSIRO On Prime 14 program. Received On Prime certificate and research award.**



- Development of the world's most efficient low-cost catalyst to produce hydrogen.
- Achieved highest fuel cell performance through engineering approaches.

Nanoelectrochemistry lab: Hydrogen production & utilisation

Creating low-cost chemicals for hydrogen production, electricity generation, and CO2 conversion

Research group

The NanoElectrochemistry Lab is accelerating the transition to a sustainable hydrogen economy by synthesising next-generation catalysts used to produce hydrogen, generate electricity, and convert CO2 into valuable chemicals. Designed to increase the efficiency and affordability of hydrogen production, these catalysts are integrated into devices and then scaled to meet global demands.

The team comprises experts in chemistry, materials science, and engineering who understand that the future of energy hinges on the integration of ground-breaking research with practical, market-driven solutions. They partner with industry to ensure the lab's innovations align with real-world needs, navigating through Technology Readiness Levels (TRL) 3 to 6, from conceptual proofs to viable prototypes.

OZAMMONIA

Revolutionising green ammonia production by closing the NOx loop

Research project

The global ammonia market is projected to reach US$80 billion by 2030. The conventional Haber-Bosch process generates 2.4 tonnes of carbon dioxide per tonne of ammonia produced, accounting for about 2% of global carbon emissions. With rising industrial activities, nitrogen oxide (NOx) emission problems persist.

UNSW has developed a patented technology known as OzAmmonia, which facilitates the direct conversion of air (and water) into ammonia and can transform NOx found in waste flue gas and wastewater into ammonia. In doing so, the technology closes the NOx loop and unlocks the zero-emissions future for fertilisers, fuels and beyond.

Compared to the current energy-intensive and inefficient NOx treatment methods, OzAmmonia operates at room temperature and requires no additional reagent supply. The technology is scalable and can work on a decentralised model, allowing it to integrate seamlessly with renewable energy sources.

The project is currently optimising the multiphase electrolyser system and exploring cost reduction for both Air-to-Ammonia and Waste-to-Ammonia systems through ongoing process optimisation and integration of scaled-up electrolyser and prototype development.

- Successful in the latest round of the ARENA Hydrogen R&D Funding Round under the Transformative Research Accelerating Commercialisation (TRAC) Program.
- Attracted significant interest from engineering and investment companies to accelerate the scaling up and commercialisation of the technology.

Particles & catalysis research laboratory

Empowering innovation to catalyse a sustainable future

Research group

The Particles and Catalysis Research Laboratory (PartCat) is a world leader in the fusion of nanoscale materials, catalysis, renewable energy, sustainable environment, and circular economy fields. Directed by Scientia Professor Rose Amal, the PartCat team undertakes both fundamental and applied projects that tackle future societal and industry challenges. Its innovative work includes developing technologies for hydrogen production and storage, catalysis for CO2 conversion, and integrated power systems.

PartCat boasts extensive, advanced resources, including modern laboratories with specialised equipment for material and catalyst fabrication, a variety of instruments for particle and material characterisation, prototype scale-up reactor systems, and facilities for techno-economic and feasibility studies across the entire value chain.

The group's commitment to excellence is further demonstrated through its pioneering research and development initiatives, which are at the forefront of translating scientific breakthroughs into real-world applications. By harnessing the power of collaboration and cutting-edge technology, PartCat is addressing critical environmental issues and setting new standards in the sustainable technology landscape, promising a greener, more efficient future.

- Secured approximately $5 million in funding, driving the ARC Training Centre for the Global Hydrogen Economy and fostering partnerships with 13 industries and six universities.
- Leading the Power Fuels Network, PartCat focuses on de-risking power fuel projects. It is underpinned by a $15 million grant from the NSW Government.
- Exploring the conversion of sunlight and organic waste into renewable hydrogen, advancing sustainable energy solutions for remote communities.

Porous materials for energy related solutions

Reaching towards Net Zero using designer porous materials

Research group

In Australia, a significant amount of fuel is used to separate industrially relevant gases and hydrocarbons. Separations often involve energy intensive and expensive distillation processes which account for 10 – 15% of the world's energy consumption and lead to 100 million tonnes of carbon dioxide emissions each year.

This research finds ways to mitigate the problem by developing alternatives to distillation methods, such as creating adsorbent beds made of porous materials for selective separations. Highly porous metal-organic frameworks (MOFs) are the leading class of adsorbent materials and have huge potential to address these challenges.

The research is in the proof-of-concept stage, uncovering the potential for MOFs for both hydrocarbon separations (specifically hexanes) and carbon dioxide capture from energy demanding processes.

- Porous materials are used in life-changing respiratory canisters for Australian soldiers. They absorb toxic industrial chemicals before they affect the wearer.
- The widespread application potential for these porous materials has been realised globally, with industries around Australia already focussed on large-scale synthetic production.

The ARC centre of excellence for carbon science and innovation

Transforming carbon science and innovation for a clean and sustainable future

Research group

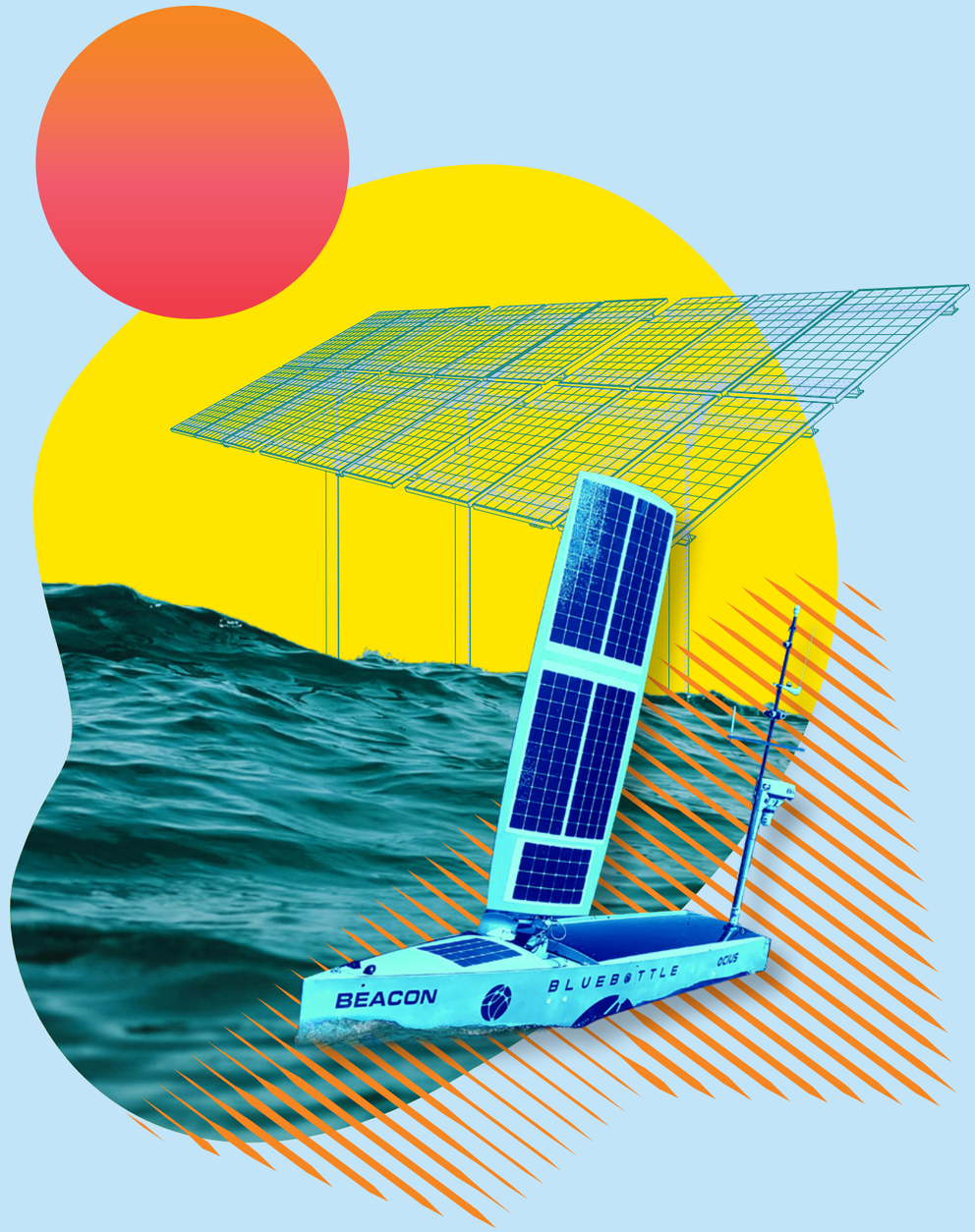
In Australia, a significant amount of fuel is used to separate industrially relevant gases and hydrocarbons. Separations often involve energy intensive and expensive distillation processes which account for 10 – 15% of the world's energy consumption and lead to 100 million tonnes of carbon dioxide emissions each year.

This research finds ways to mitigate the problem by developing alternatives to distillation methods, such as creating adsorbent beds made of porous materials for selective separations. Highly porous metal-organic frameworks (MOFs) are the leading class of adsorbent materials and have huge potential to address these challenges.

The research is in the proof-of-concept stage, uncovering the potential for MOFs for both hydrocarbon separations (specifically hexanes) and carbon dioxide capture from energy demanding processes.

- **Advancing Australia's capability in carbon science and innovation through translational research, industry linkages, and engagement.**
- **Development of advanced catalysts made from earth-abundant carbon dioxide, biomass, and other carbon-rich wastes.**
- **Training the next generation of world-class researchers, leaders, and students to tackle the challenge of decarbonisation.**

Clean energy
Solar & renewable technologies



Vecor technologies/ nemcat group: Hydrogen from seawater

- NEMCAT Group's catalytic materials and device technologies enable hydrogen generation from seawater without producing oxygen or chlorine gas.
- Secured two international patents for groundbreaking technologies, signalling recognition and commercial potential in green hydrogen production.
- The system design is tailored for both urban and remote locations, using catalytic ceramic materials for hydrogen generation from seawater, showcasing adaptability and scalability.

Materials and device technologies for the catalytic generation of green hydrogen from sustainable seawater

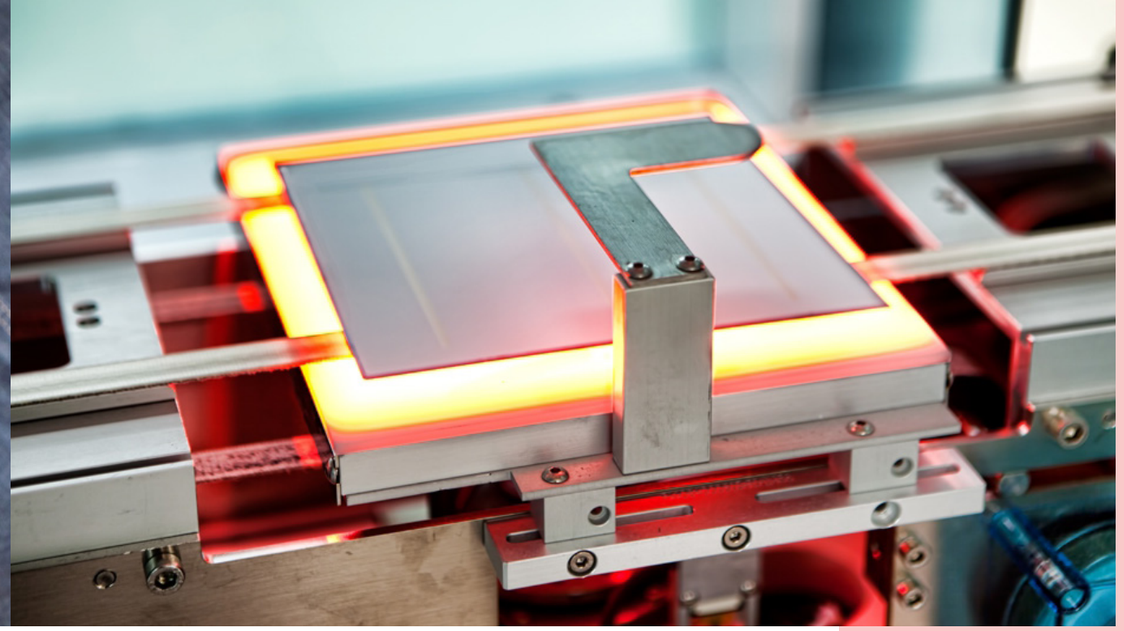
Research project

The transition from fossil fuels to clean and sustainable energy sources represents significant technological and economic global challenges. Although most renewables have shortcomings in intermittency and storage, this is not the case with hydrogen.

It has been projected that the global hydrogen generation market size will be worth US$146 billion in 2020, with a compound annual growth rate of 5.6% to 2028. The International Energy Agency estimated in 2022 that hydrogen will meet 18% of the world's energy needs by 2050.

Current technologies for hydrogen generation have limitations in terms of the need for ultrapure water and the formation of explosive gas mixtures of hydrogen and oxygen. The catalytic materials and device technologies under development by the NEMCAT group have generated hydrogen from seawater without producing oxygen or chlorine gas.

This project, supported by Vecor Technologies Pty. Ltd., is at Technology Readiness Level (TRL) 4.



Accelerated testing for next generation solar panels

- Development of ultrafast test for novel failure modes that are up to two orders of magnitude quicker than their counterparts.
- Identification of the root cause for four new failure modes in two types of silicon solar cells that are expected to gain significant market share.

Fast-tracking solar innovations that will last through new rapid reliability testing methods for solar cells and modules

Research project

Efficiency is often the focus of photovoltaics, however reliability is even more important in the drive to lower the cost of electricity. Novel solar cell or module architectures typically bring new failure modes, and the current reliability testing is unable to identify them. This project develops rapid testing methods for solar cells and modules that can quickly qualify and quantify new failure modes and help uncover their root causes.

The team works with several leading solar cell and module producers to improve the reliability of emerging technology.

The project results will be commercialised by the publication of new standards and the likely establishment of a domestic testing/consulting company.

Australian Centre for Advanced Photovoltaics (ACAP)

- Over 90% of the world's modules being manufactured rely on technology developed in Australia.
- The first 10 years of research at ACAP has delivered 16 international awards, 15 national awards, 16 benchmark cell efficiencies, and 216 new innovations patented.
- Funding to 2030 will see ACAP deliver 30% solar-cell efficiencies and 30c/Wp capital costs at scale in support of Australia as a renewable energy superpower.

A national research collaboration delivering performance increase and cost reduction in solar PV

Research project

Solar photovoltaic (PV) technology is revolutionary, despite being in its early stages. It needs to be deployed as quickly as possible to enable the continued learning and enhancement of the technology.

Concurrently, to fully decarbonise every sector of our economy, including the industrial processes needed for producing green steel and aluminium, we must invest in research and development. This will help drive down the cost of solar PV even further.

Research at ACAP will deliver a pipeline of opportunities for improved performance and lower cost. Targeting a cost of electricity as low as $15/MWh, ACAP is working on:

- High efficiency tandem solar cells.
- Performance, reliability, and durability.
- Manufacturing, sustainability, and end-of-life management.
- Education and training of the next generation of solar innovators, engineers, and technologists.

Foresight PV

High-precision simulation and improved decision-making for the future of solar

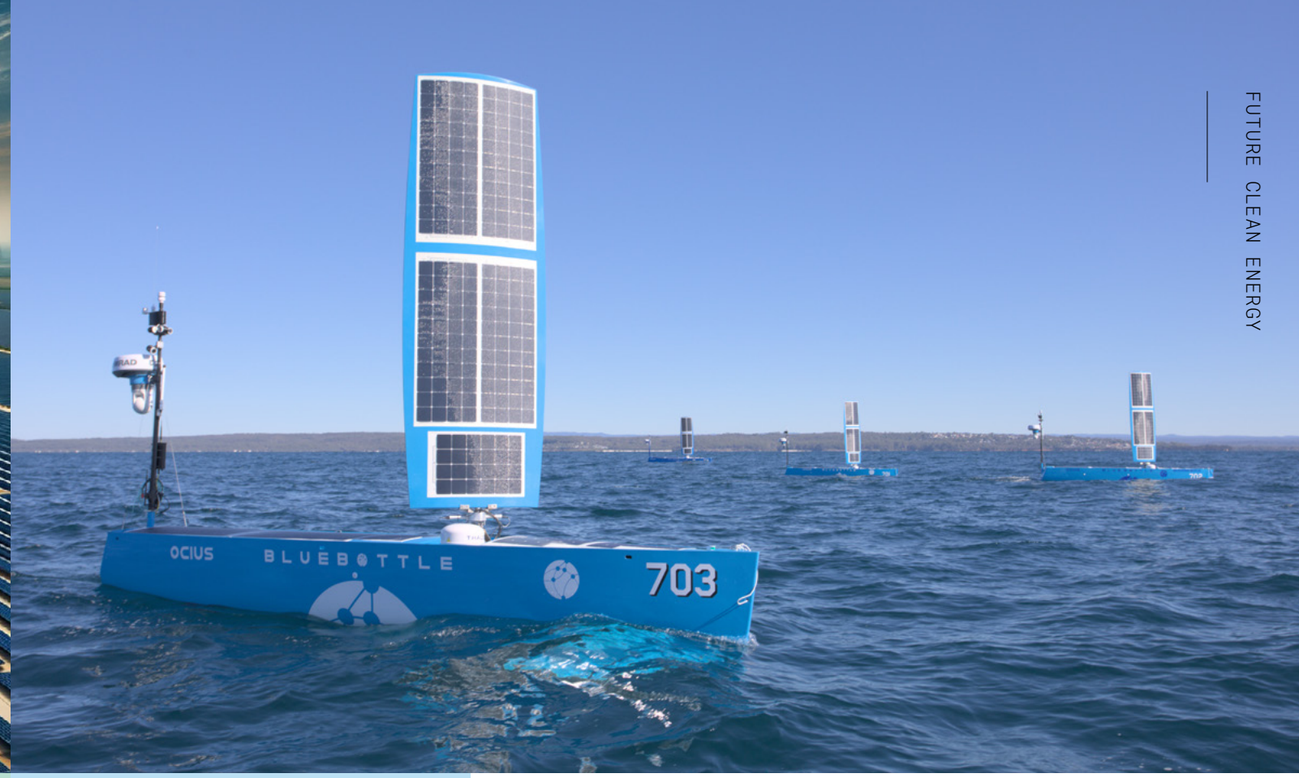
Spin-out

Photovoltaics is the fastest moving energy technology, both in installed capacity and new technologies entering the market. The next five years will see multiple GW scale projects begin in Australia using solar cells with conversion efficiencies over 26% and innovative deployment solutions such as the 5B MAVERICK. Current state-of-the-art simulation programs cannot accurately mimic the performance of these products, leading to uncertainty in yield projections, higher financing costs and sub-optimal decision-making around operation of the plants.

This project develops high-precision, first-principles based models for the optical, electrical, thermal and financial performance of next-generation photovoltaic products. These methods are shown to reduce uncertainty by up to 50% relative, enabling more accurate yield predictions and faster fault detection.

Future work will unlock accurate simulation of tandem devices, with conversion efficiencies over 30%, as well as detailed simulations of system degradation to extend project lifetime and performance.

- Secured funding from ARENA to seamlessly transition this endeavour into industry with support from two industry partners.
- Revealed that curtailing operations can cause operating temperatures to surge by over 5°C during peak summer periods.
- Created precise energy modelling for next-gen solar cell technologies. This modelling demonstrated a 50% increase in accuracy compared to currently commercial software.



Ocius technology ltd

Renewable-powered robot boats for science and surveillance

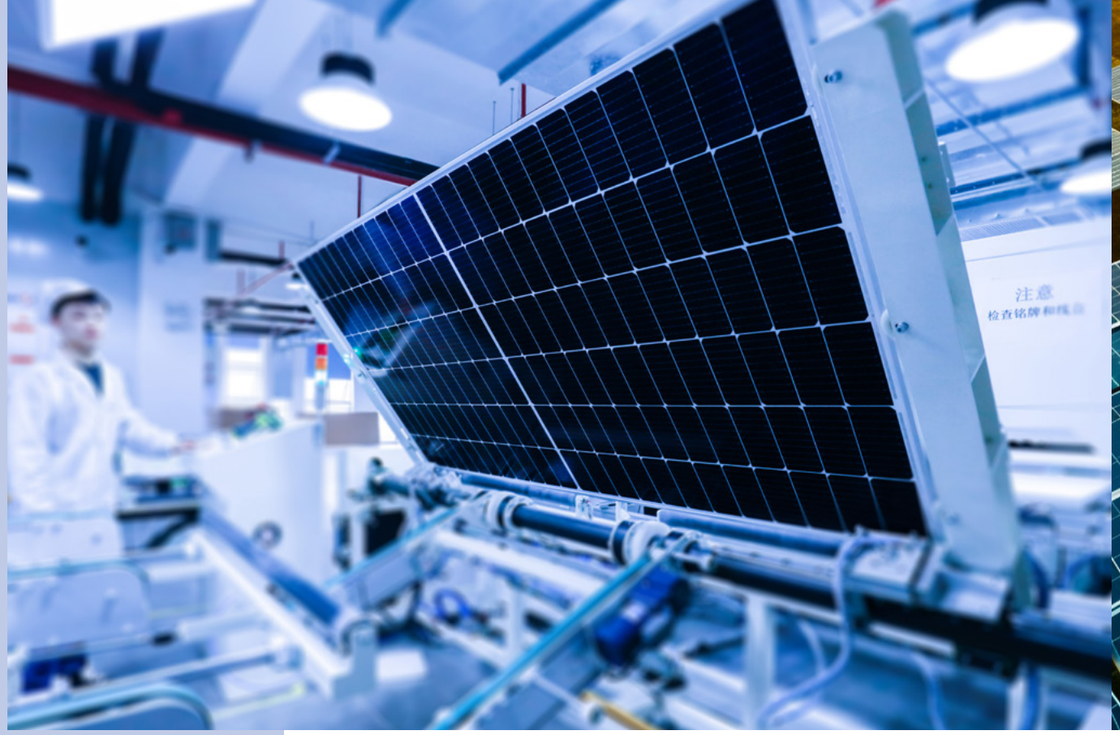
Co-located company

Australia has 8 million square kilometres of sovereign water and only 23 border security vessels. Ocius' uncrewed surface vessel (USV), called the Bluebottle, is a 100% renewable-powered robot sailboat designed to collect scientific and surveillance data for months on end and hundreds of kilometres from land. In doing so, these vessels survey Australia's coastline and collect data that is otherwise unable to be collected (dull, dirty, or dangerous) for a fraction of the manpower and cost.

The Bluebottle USVs are powered entirely by renewable energy sources, including solar, wind, and wave power, representing a significant environmental and operational advantage. This commitment to sustainability ensures that the vessels operate with a minimal carbon footprint, align with global ecological goals, and can operate in remote places for a longer duration than fossil fuel-powered vessels.

Ocius' commercialisation success is demonstrated by the sale of seven USVs to the Royal Australian Navy, along with their deployment in missions across Australia, the USA, and Japan. The technology is globally recognised to deliver a sustainable, reliable, and cost-effective solution to the study and protection of vast oceanic territories.

- Successfully surveyed a live volcano (Nishinoshima, Japan) using 100% renewable energy.
- Performed over 1000 days of on-water time across the fleet, removing the equivalent of 320 tonnes of carbon (based on our best estimates for an equivalent patrol-sized vessel).



- Demonstrated singlet fission on silicon solar cells from new organic materials.
- Singlet fission detected using magnetic fields in silicon solar cell photocurrent.

OMEGA-Si

Developing the solar cells of the future

Research project

Conventional silicon solar cells can convert a maximum of 29% of light from the sun into electricity. To move beyond 29%, a process is required to make better use of the spectrum, either by breaking high-energy light into smaller pieces or joining very small light quanta together.

The OMEGA-Si project is developing a coating for the front of solar cells which will enable high-energy light quanta to be split into two more efficiently used parts. The aim is to push silicon photovoltaics beyond 29% efficiency.

This project brings together three schools across two faculties at UNSW, and partners with eight of the world's top silicon photovoltaics companies. It will create a start-up company in two years, and then enter a commercialisation phase.

School of Photovoltaic & Renewable Energy Engineering (SPREE)

World-class research that is accelerating the clean energy transition

Research group

SPREE delivers world-class research to accelerate the global transition to clean energy. Its work spans fundamental research in solar-cell technology through to large-scale integration of renewable energy into our energy systems.

For the past 50 years, SPREE has carried out leading research on silicon solar cells, which have dominated the industry for decades. Its research has led to world-record efficiencies and is now used by the industry in more than 90% of all solar modules produced globally.

The ongoing research challenge is to continue to drive down the cost of solar cells whilst improving energy conversion efficiency. The researchers are exploring many pathways – new materials, new conversion processes, and new designs – to achieve the next breakthrough in solar cell technology. This will accelerate the industry's growth and success over the coming years and decades.

- UNSW PERC technology used by industry in more than 90% of all solar modules produced today.
- Development of photoluminescence diagnostic technology commercialised and applied to solar cells, modules, and utility-scale solar systems.

Solar panel recycling

Solar panel recycling: turning waste into value

Research project

Australia's solar photovoltaics success brings with it a looming crisis: a surge in solar waste. By 2035, the nation will face one-million tonnes of solar panel waste worth more than $1 billion.

The team's recent whitepaper, "Scoping Study: Solar Panel End-of-life Management in Australia," has garnered significant attention in media and government discussions, highlighting the imminent challenge of discarded solar panels.

The technical barrier lies in the lack of scalable, comprehensive, environmentally-friendly, cost-effective technology. The team is developing an innovative solution that meets the latter three criteria and is poised to move into the upscaling stage by building a commercial-size prototype.

The groundbreaking technology aims to transform solar waste into a valuable resource, contributing to a circular economy and reducing the environmental impact of the solar industry. The research is paving the way for a greener future in Australia, and beyond, by pioneering sustainable solutions.

> Alumnus Pablo Dias co-founded Solarcycle, the largest solar panel recycling company in the United States, which has raised $37 million in capital to date.

> Secured $525,000 in industry-funded research to date, driving the commercialisation of the research.

Sundrive solar

- Developed the world's most efficient commercial-sized solar cell utilising novel copper-based technology.
- Secured $21M Series A and $11M grant from ARENA to expand Sydney-based operations and commercialise the technology.
- Completed world-first pilot production and commercial demonstration copper plating line.

Revolutionising solar technology with high-performing sustainable solutions

Spin-out

SunDrive Solar (SunDrive) is a UNSW spinout that is revolutionising the solar industry with its pioneering copper-plating technology. By substituting silver with copper in solar cell production, the technology not only reduces costs by utilising a material that is 100x cheaper and more abundant, but also improves the overall performance of solar cells.

SunDrive's plated copper technology has led to the creation of the world's most efficient commercial-sized solar cell, setting new industry benchmarks. The recent $11 million investment from ARENA is a testament to SunDrive's potential, as it is set to expand its pilot production to commercial scale, solidifying its leadership in sustainable energy technology.

As global demand for renewable energy sources continues to rise, SunDrive is committed to leading the charge towards a more sustainable future. Their innovative technology, combined with their dedication to performance and affordability, positions them as a key player in the worldwide shift to sustainable energy.

Sunswift racing

- Winners of the 2023 Bridgestone World Solar Challenge.
- Guinness World Record holders for the world's fastest EV over 1000km, single charge of the battery.
- Australia's #1 engineering university project with a true focus on education, innovation, and collaboration.

Redefining the future of automotive technology

Research project

Sunswift Racing has been a UNSW initiative since 1996 when it was formed to design and build prototype vehicles to compete in the biennial Bridgestone World Solar Challenge. In 2024, this is still the case but it's also so much more.

Sunswift Racing is an undergrad Vertically Integrated Project - a course where Australia's finest engineering students innovate and create new technology.

The team is now moving towards the commercialisation of its technology, both internally and in collaboration with industry partners.

Sunswift 8, the team's latest vehicle, aims to be the world's first TriBrid – a road-legal car powered by solar, battery and a hydrogen fuel cell.

Supramolecular energy storage lab

Harnessing nature's power: sustainable energy from light-driven proton pumps

Research project

In a world grappling with the dual challenges of energy sustainability and climate change, the need for environmentally-friendly power solutions has never been more urgent. This project draws inspiration from nature's own energy systems, specifically, the light-driven proton pumps found in certain microorganisms, to address this critical issue.

The research project has developed a novel approach to energy harvesting by using meta-stable photoacids that mimic natural proton pumps, creating a system that converts light into a continuous flow of electric current. By harnessing reversible proton exchanges triggered by light, this technology not only offers a clean alternative to traditional energy sources but provides a stable and efficient method of electricity generation.

The project has reached the lab-scale stage, demonstrating the practicality of the photoacid-based proton gradient system. These devices effectively create and sustain a proton gradient, fundamental for converting electrochemical potential into electric power, echoing the processes used by nature to fuel life on Earth.

Currently, the team is focused on refining the molecular structures and conditions to optimise performance and prepare for potential market entry, paving the way for a new era in sustainable energy technology.

> Prototype development of light-driven proton gradient cells mimicking natural energy processes, with successful conversion rates that are poised to transform solar energy harvesting.

> Influenced preliminary industry guidelines for integrating photoacid technologies in renewable energy systems, marking a significant advancement in clean energy research.

- Development of contactless inspection methods for wafers, modules, and PV systems, which enhance quality and reliability.
- Creation of machine learning algorithms to improve solar cell production and reduce costs.
- Advanced models to predict soiling at any location, using freely available data, and optimise maintenance and efficiency.

UNSW ACDC research group

Saving the planet by pushing photovoltaic technologies to their ultimate potential

Research group

The ACDC Research Group advances photovoltaic (PV) technologies to address environmental challenges. They create novel inspection and analytics tools to improve the stability and reliability of PV devices and develop advanced solar cell structures to increase efficiency and reduce costs.

A key area of their research uses machine learning to optimise aspects of photovoltaics such as utility-scale power plant operations and recycling end-of-life PV products.

Their research also extends to innovative applications for photovoltaics, such as agri-photovoltaics (agriPV), building-integrated photovoltaics (BIPV), and PV technologies integrated with the Internet of Things (IoT), thereby broadening the impact of solar energy.

UNSW trailblazer waste to hydrogen project

Recovering renewable hydrogen from organic waste streams in remote communities

Research project

Replacing fossil fuel-derived hydrogen with sustainably-produced hydrogen is one of a suite of approaches designed to deliver net-zero carbon emissions by 2050. The use of an organic-containing waste stream in place of clean water as the feedstock to produce renewable hydrogen via solar photocatalytic reforming and/or sunlight-powered electrolysis offers distinct advantages. It improves the sunlight-to-hydrogen conversion efficiency, assists with managing the organic waste stream, and addresses potential competition for clean water with drinking and agricultural needs.

This project has partnered with an industry collaborator to examine the feasibility, and subsequently progress, the development of two unique prototype units capable of using only sunlight and a waste organic-containing stream to generate renewable hydrogen in a remote community.

The project is currently at the stage of adapting the prototype units to use in a practical environment.

- Two distinct, stand-alone, working prototypical units have been designed and constructed that can generate hydrogen using only sunlight and a waste organic feed.
- Funding was procured through the Trailblazer for Recycling and Clean Energy (TRaCE) Program to advance the prototypical units with the support of an industry partner.

ARC Research Hub for Integrated Energy Storage Solutions

Advancing energy storage solutions to enable a safe, reliable, secure and cost-effective energy supply

Research group

Technologies for harnessing energy from renewable energy sources are becoming increasingly cost-effective. These technologies will continue to displace fossil fuels as the costs of renewables continue to fall and nations move to decarbonising their energy sectors.

Energy storage and its effective integration into energy systems are key to this transition. Globally, widespread penetration of energy storage solutions has to-date been impeded by a range of technical, economic and systemic barriers.

The Hub, in partnership with industry, applies a highly integrated systems-based approach to addressing these barriers, focusing not just on energy storage technologies, but on the monitoring, control, integration and optimisation of storage systems.

Currently under development:

• A new generation of batteries for small-to-large-scale applications that are cheaper, safer and more reliable

• Flow battery technology to provide cost effective, commercial scale long-duration storage

• Efficient and cost-effective methods for converting surplus electrical power into usable gas

• Industrial-scale demand-side power management strategies to improve efficiency, reduce operational cost and support grid stability

• Technologies for integration and coordination of different energy storage systems in a smart grid

> Optimising the Vanadium flow battery to increase storage capacity, deliver grid-scale energy solutions and develop local manufacturing capability.

> Enabling power demand-supply balancing of energy-intensive aluminium smelting process through flexible power modulation.

> Launched an online tool to provide householders and small businesses across Australia with reliable, independent and tailored estimates about solar and batteries for free.

Discuss your project or idea with UNSW