WOODSIDE MONASH PARTNERSHIP 2025 ANNUAL REPORT

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A partnership between:

Monash University | Woodside Energy | FutureLab

In the dynamic landscape of the Woodside Monash Partnership, we have witnessed continued evolution and adaptation.

WOODSIDE MONASH PARTNERSHIP LEADERSHIP

Lower-carbon: Woodside uses this term to describe the characteristic of having lower levels of associated potential greenhouse gas (GHG) emissions when compared to historical and/or current conventions or analogues, for example relating to an otherwise similar resource, process, production facility, product or service, or activity.

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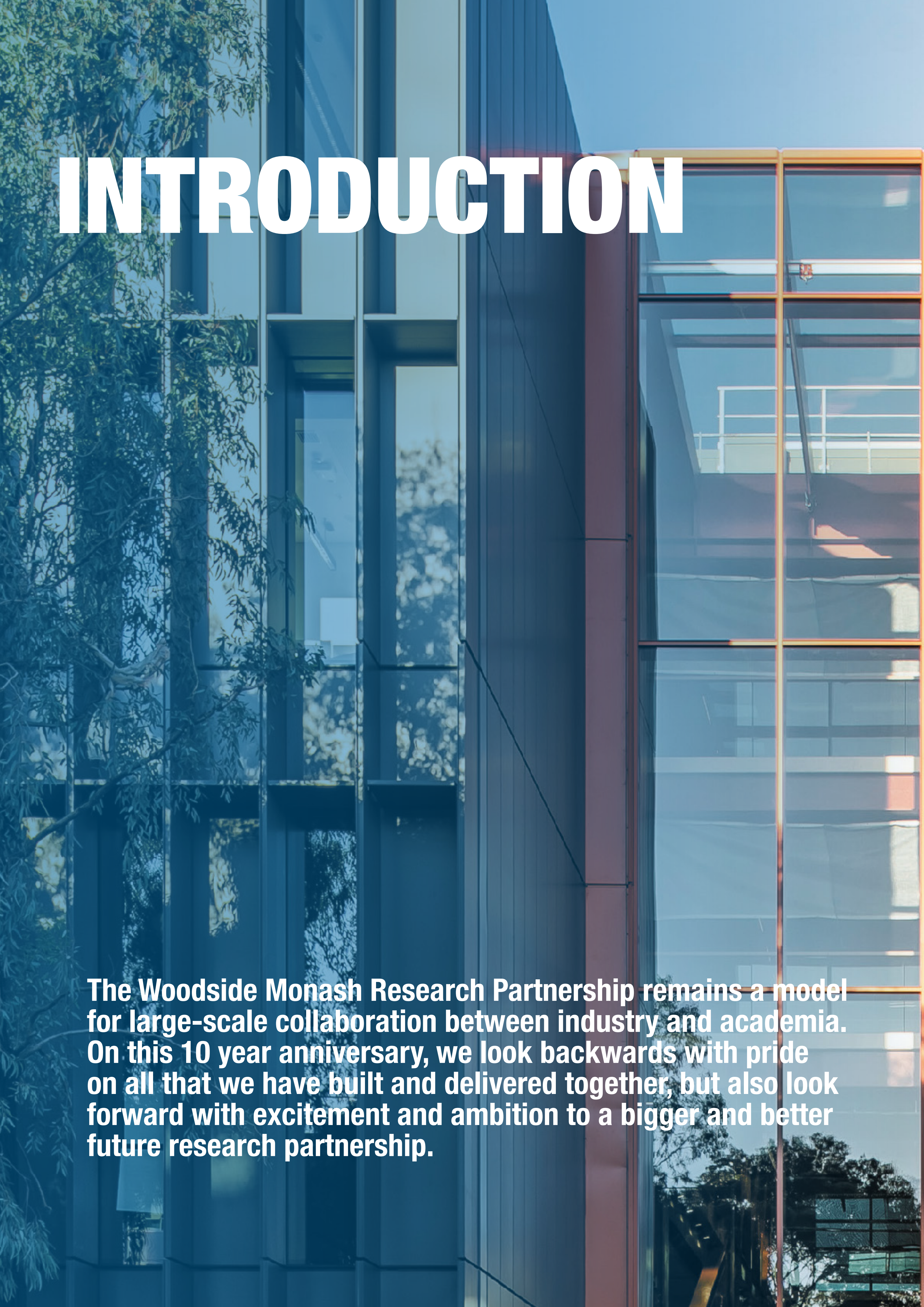


INTRODUCTION

The Woodside Monash Research Partnership remains a model for large-scale collaboration between industry and academia. On this 10 year anniversary, we look backwards with pride on all that we have built and delivered together, but also look forward with excitement and ambition to a bigger and better future research partnership.

FOREWORD FROM LEADERSHIP

2025 marks the 10 year anniversary of the research partnership between Monash University and Woodside Energy. It is a cause for reflection on all that we have achieved together, as well the important lessons learnt on how to build a long-standing and strategic industry-university research partnership.

2025 was also a year of substantial change. We said goodbye to Voula Terzoudi as Woodside's Australian partnerships manager and welcomed Andrew Glucina to the role. Voula has been part of the Woodside-Monash partnership since the very beginning and a huge supporter of our partnership. Prof Maria Garcia de la Banda also leaves the FutureLab team at the end of 2025. Maria has led the Data Science activities of the FutureLab since the beginning of the partnership and we wish her well in her retirement from Monash in 2026. Both Voula and Maria have been central to the identity and success of the FutureLab at Monash and their departures represent an end of an era. We also say goodbye to Lilyanne Price, our Operations Manager for the Woodside Monash Energy Partnership. Lilyanne has been core to our ability to deliver research outcomes and communication in a professional and efficient way and we thank her for her tireless commitment to our partnership. We wish her well in her future career!

With change comes opportunities. 2025 has also been a year of deep reflection on what has worked well and what can be changed to deliver even better impact in a future research partnership.

In 2025 we continued our record of delivering major new research outcomes to Woodside, including in-field deployments of new technologies (e.g. cold spray). These new advances include technologies across energy transition, advanced manufacturing, materials technologies, carbon utilisation and data-driven optimisation, each contributing to Australia's lower-carbon transition.

The Woodside Monash Research Partnership remains a model for large-scale collaboration between industry and academia. On this 10 year anniversary, we look backwards with pride on all that we have built and delivered together, but also look forward with excitement and ambition to a bigger and an even better research partnership.

Professor Maria Garcia de la Banda, Woodside FutureLab at Monash Co-Chair, Information Technology, Monash University

Professor Christopher Hutchinson, Woodside FutureLab at Monash Co-Chair, Engineering, Monash University

Professor Paul Webley, Energy Partnership Director, Monash University

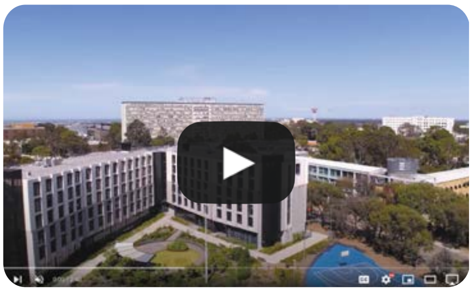
WOODSIDE MONASH PARTNERSHIP

INNOVATING TO SUPPORT A SUSTAINABLE FUTURE

At the forefront of the ever-evolving Woodside Monash Partnership, we are driving continuous innovation and progress across our core pillars: the Woodside FutureLab at Monash and the Woodside Monash Energy Partnership.

Woodside Energy and Monash University work towards a shared goal of pioneering innovative solutions for real-world challenges, recognising that transition towards a lower-carbon economy presents complex challenges.

Collaborating with some of the brightest minds at esteemed institutions like Monash University, Woodside Energy aspires to employ evidence-based, innovative approaches to disrupt conventional thinking.



Scan to watch video

WOODSIDE FUTURELAB AT MONASH

Established in 2016, the Woodside FutureLab remains steadfast in its mission to unlock the potential of additive manufacturing, materials engineering, and data science to tackle contemporary challenges. Our materials engineering endeavours address global issues such as corrosion through pioneering technologies and advanced materials. Simultaneously, our advanced manufacturing and design initiatives revolve around additive manufacturing (AM) as a game-changing technology. In parallel, the data science pillar employs cutting-edge machine learning, optimisation, and visualisation techniques to empower sophisticated decision-making, particularly in realms like crew allocation and energy network optimisation.

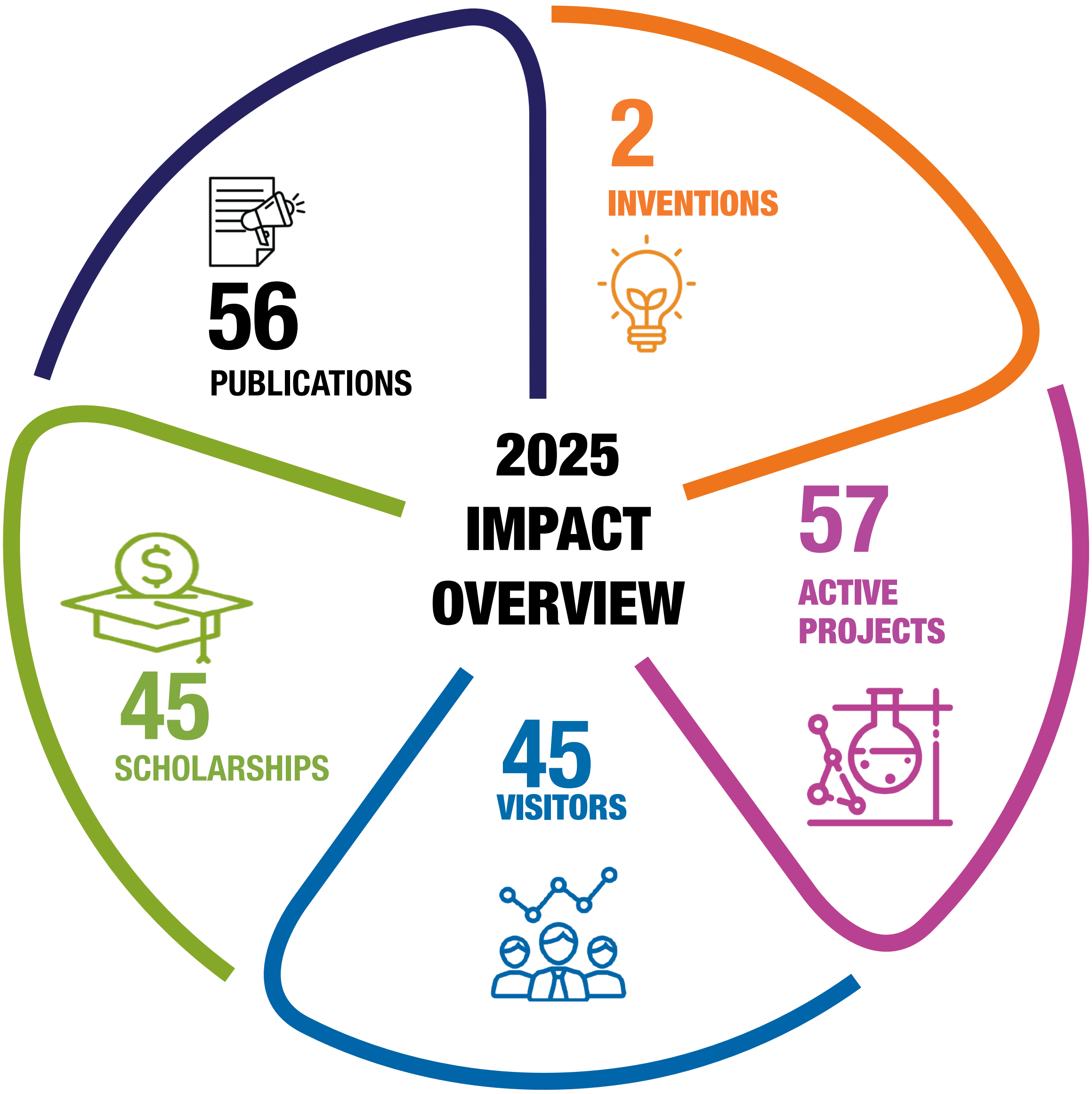
The Woodside FutureLab at Monash University focuses on researching opportunities for industry-wide technological innovation by assembling world-class, cross-disciplinary teams to explore disruptive, breakthrough technologies.

WOODSIDE MONASH ENERGY PARTNERSHIP

Woodside Energy and Monash have forged a robust, long-term research partnership to craft inventive solutions for real-world challenges. The Woodside Monash Energy Partnership is dedicated to collaborative research to build pathways toward a lower-carbon future.

Established in 2019, our approach revolves around the three core pillars: affordable; lower-carbon energy; carbon abatement; and thought leadership. These pillars align seamlessly with our fundamental themes: New Energy Technologies, Carbon Capture, Conversion, Utilisation, and Energy Leadership. Our initiatives are centred on hydrogen production and carbon abatement research, with a focus on exploring pathways to energy solutions that aim to be cost-competitive, scalable and enable value creation through carbon-based products.

As we look ahead, our continued focus on innovation, sustainability and leadership supports our efforts to contribute meaningfully in a rapidly changing world.



WE ARE VERY PROUD TO REPORT THAT DURING 2025 WE PRODUCED

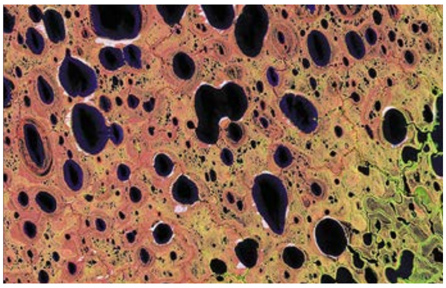
- **57 active projects**
- **56 publications**
  Journal articles, conference posters and presentations, and media (Magazine articles, web page articles, and Newsletter articles)
- **2 invention** disclosures
- **45 visitors** explored the FutureLab, WMEP, and Monash labs and facilities through the Woodside Monash Partnership
- **45 scholarships** including 30 PhDs, 1 Masters, and 12 Undergraduates

FUTURELAB

The Woodside FutureLab at Monash is an innovation and rapid-protoyping hub that supports technological innovation and collaboration in materials durability, additive manufacturing, and data science. FutureLab enables blue-sky thinking and creates shared opportunities for developing innovative solutions to complex industry challenges. The FutureLab emphasises agility in research and translation of research outcomes to the field as quickly as possible.

DATA SCIENCE

Using cutting-edge machine learning, optimisation, and visualisation techniques to empower sophisticated decision-making in areas such as crew allocation, and energy network optimisation.



ADDITIVE MANUFACTURING AND MATERIALS INNOVATIONS

Delivering additive manufacturing part supply as 'business as usual' at Woodside energy and designing novel materials and corrosion systems for integrity management solutions.

DECOMMISSIONING

Supporting innovation and sustainability in asset retirement.

PLUTO CAPABILITY MANAGER - CREW ALLOCATION

This project aims to support the work of Frontline Operators at production plant assets by developing a system that supports two crew allocation modes: clean-slate allocation for robust and balanced crew and role assignments, and replacement suggestions for planned and unplanned absences. It must be user-driven, enabling users to explore, compare, and fine-tune candidate solutions based on their expertise and preferences.

In 2025, the project delivered a working end-to-end system supporting realistic backfilling, swapping, long-leave, and PLA React scenarios. Key achievements include the integration of several major extensions; significant performance improvements, and the addition of clearly defined scenario modes with simplified, demo-ready workflows. The system was demoed in December to stakeholders and generated credible, scalable solutions for Woodside's operational use cases.

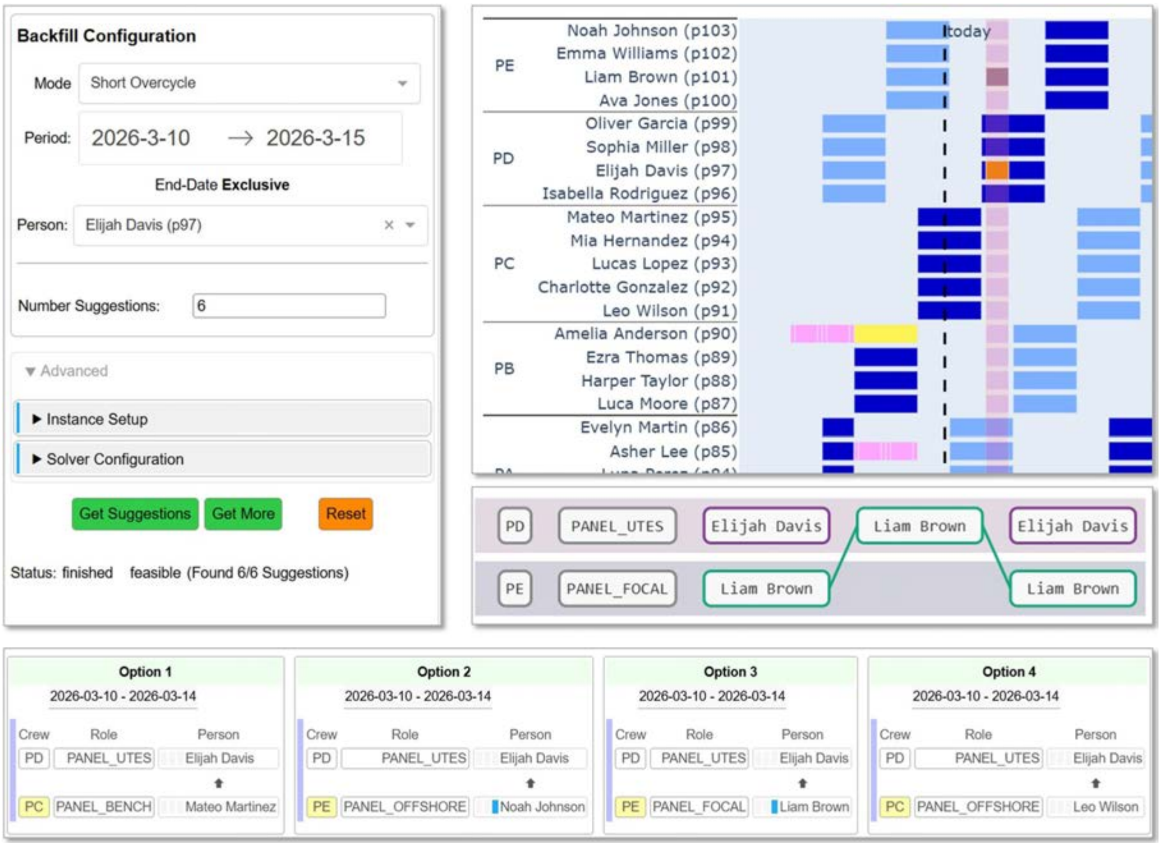
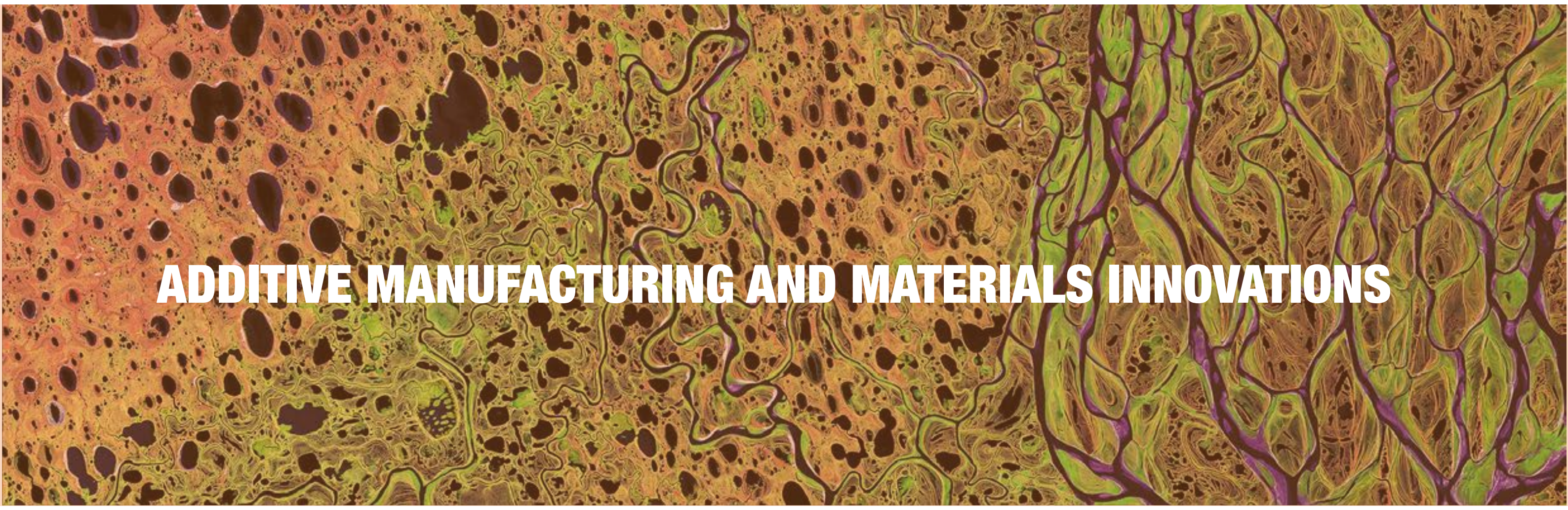


Image showing central user interface elements of the Pluto Capability Manager for solving a Re-Rostering (Crew Repair) scenario. The user can enter an absence request and view solutions using different visualisations, from familiar views for domain-users (time-chart top right), to more custom visualisations (centre right, and bottom), showing details about the (all) replacement strategies found by the underlying optimisation system



ADDITIVE MANUFACTURING AND MATERIALS INNOVATIONS

MOLYDISULFIDE LUBRICANT

This project investigates whether the use of molydisulfide lubricant may increase the local hydrogen concentration adjacent to subsea metallic materials subjected to cathodic protection. We demonstrate that under cathodic protection conditions, sulfur is liberated and an increase in hydrogen can be observed.

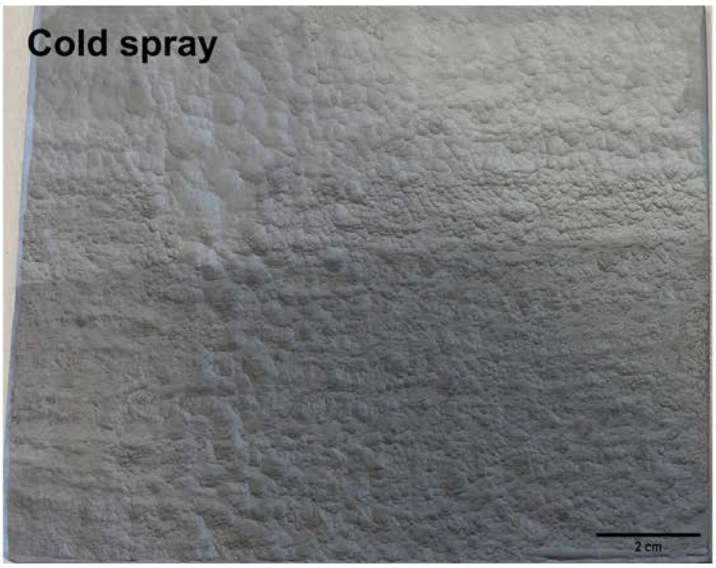
ROTOR DISTORTION ANALYSIS

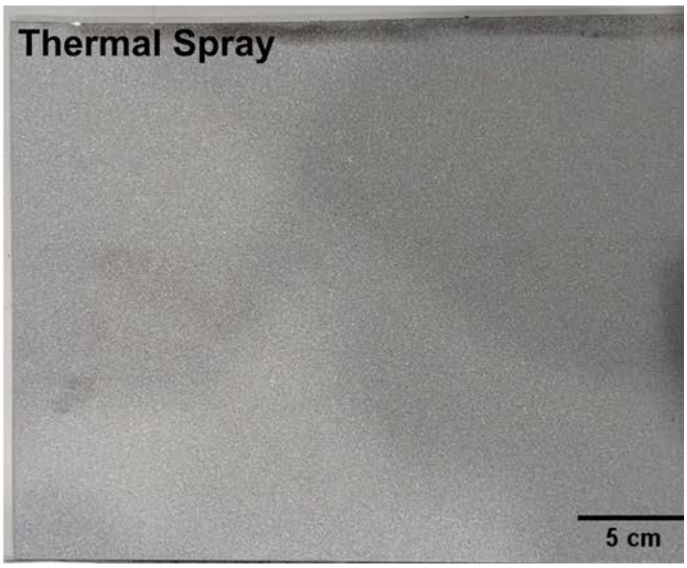
This project investigates the root cause of a distortion in a large rotor used in a turbine. We show that the heat treatment of the material was not performed correctly by the original equipment manufacturer and this, at least partially, contributed to the distortion. New acceptance procedures, involving a thermal stability test, have been recommended to avoid similar issues in the future.

COLD SPRAY

This project explores the use of cold spray aluminium as an in-situ repair technology for thermally sprayed aluminium (TSA) in offshore applications. We demonstrate that the corrosion resistance of cold spray coatings can be made similar to TSA and an offshore trial was successfully executed.

Cold spray coated plate (left) for corrosion testing. Benchmark thermal spray coated plate (right)





ADDITIVE MANUFACTURING AND MATERIALS INNOVATIONS

STRESS CORROSION CRACKING OF 3DAM MATERIALS

Metallic components 3D printed by laser powder bed fusion (LPBF) are much stronger than the traditional cast or wrought components they replace. The enhanced strength of these 3DAM components is not currently exploited in engineering applications. This project explores the stress-corrosion cracking behaviour of 3DAM stainless steels when loaded to stresses near the real strength of the 3DAM components. We define the loading stress range where the stress corrosion cracking behaviour remains acceptable and define the increased strength that could be exploited in service.

Salt spray test chamber with cold spray and thermal spray specimens. The test was performed according to ASTM standards to evaluate the atmospheric corrosion in marine-like environment

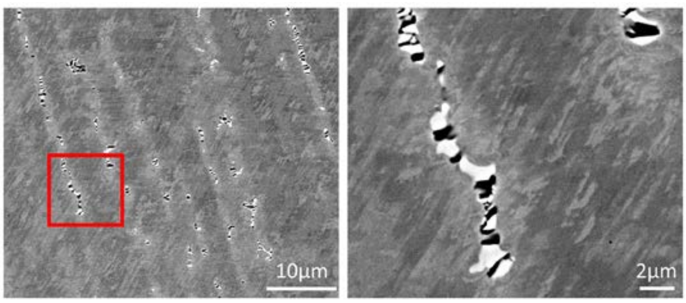
WIRE ARC ADDITIVE MANUFACTURING (WAAM) (FUTURE 3DAM)

The components currently printed using LPBF in 3DAM are small. This project begins Woodside's exploration of large format printing using Wire Arc Additive Manufacturing. The objective is to add the capability for large component printing to 3DAM. We report on the mechanical and corrosion properties of stainless steel and Ni alloys produced using WAAM. This represents the beginning of the journey of trying to add large component printing to 3DAM.

A plate of WAAM C22 built from bottom to top. This block was sectioned into mechanical and electrochemical samples for various testing. The ridges on the block show the as-deposited WAAM material

FUTURE LASER POWDER BED FUSION (FUTURE 3DAM)

The 3DAM program within Woodside uses LPBF. This technique builds components point-by-point and layer-by-layer. This sequential process provides opportunities to change the structure of the component from position to position and the new advances in LPBF are focussed on full 3D structure control throughout a component. This project explores these new directions of full 3D spatial structure control with a view to significantly enhancing the properties of 3DAM components. As an example, a new, ultra-high mechanical damping material was developed as part of this work.



SEM imaging of post-tensile testing WAAM C22 material. Chains of fractured precipitates can be seen within the matrix

PLASTIC RECOVERY FROM INDUSTRIAL DECOMMISSIONING

This project investigates opportunities for circularity for polymers recovered from subsea umbilicals, risers and flowlines (SURF) in Australia. It examines how these materials fit into Australia's existing recycling landscape, evaluates characteristics of the materials and their recyclability, and engages stakeholders to articulate options for higher circularity. The project is supported under the FutureLab program.

In 2025, the project centred on assessing how long-term subsea exposure affects the recyclability of key SURF polymers, particularly polypropylene and polyamide 11. Additional work included synthesising academic and industry evidence on decommissioning plastics, culminating in a presentation at the Society of Petroleum Engineers' Decommissioning Symposium.

PYROLYSIS OF POLYMERS FROM SUBSEA ASSETS

This project demonstrates how valuable products can be recovered from multi-material end-of-life subsea infrastructure. By applyingthermochemical (pyrolysis) conversion, the study confirms the feasibility of recovering high-quality liquid fuels, hydrogen-rich gases, and recyclable metals while minimising landfill outcomes. This work contributes to development of technical pathways for improving approach to decommissioning and supports Woodside's broader sustainability strategy.

DECISION-MAKING FOR ONSHORE WASTE MANAGEMENT

This project builds on work initiated in 2024 and aims to develop a multi-criteria decision analysis (MCDA) framework to evaluate onshore waste management options for decommissioning waste. The framework directly informs decommissioning strategies by embedding sustainability and circular economy considerations into decision-making.

In 2025, the project focuses on refining and advancing the framework developed in 2024 through close collaboration with Woodside to enable practical industry application. The project is supported under the WMEP program. Further details and key achievements for 2025 are provided in the WMEP project summary.

(L-R) Flowlines cut down to 1m size, followed by shredding of the outer sheath (outer layer) followed by injection moulding into new products

ENERGY PARTNERSHIP

Our research and development initiatives are aligned with the United Nations Sustainable Development Goals, with a focus on leadership and novel technologies in the hydrogen value chain and carbon abatement. The Energy Partnership focuses on transformational research to activate technology breakthroughs and accelerate novel technologies of scale and impact.

NEW ENERGY TECHNOLOGIES

High-efficiency and low-cost solutions to generate, store, and export lower-carbon energy, including hydrogen and its carriers.

CARBON CAPTURE, CONVERSION, AND UTILISATION

Commercially viable solutions that reduce atmospheric carbon dioxide emissions through chemical, thermal, and biological approaches.

ENERGY LEADERSHIP

Understanding and enabling the interplay of economics, energy security, policy and governance on the transitioning energy system, including carbon markets.

NEW ENERGY TECHNOLOGIES

LOW-TEMPERATURE CERAMIC ELECTROLYSIS CELLS

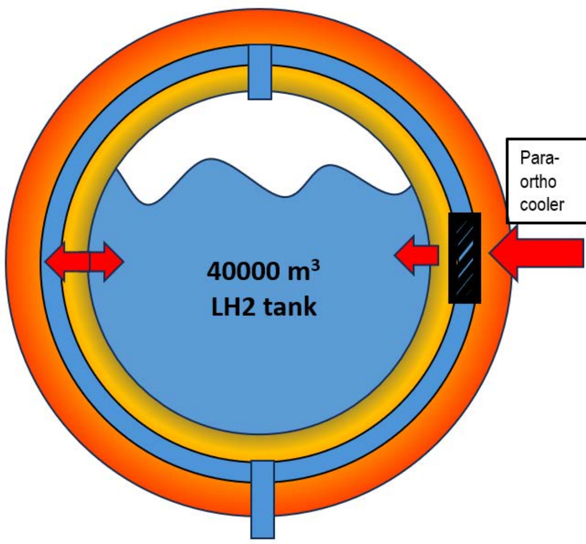
This research advances high-efficiency electrolysis cells for renewable hydrogen production at reduced operation temperatures. By engineering durable proton-conducting membranes and robust electrode architectures, it enhances conversion efficiency and long-term stability under variable renewable energy inputs. The outcomes support the development of cost-effective hydrogen production systems and contribute to Australia's capabilities in hydrogen technologies.

In 2025, zirconium phosphate and antimony phosphate nanosheets were synthesised and used to fabricate durable nanosheet membranes for high-temperature proton conduction. The resulting nanosheet membranes demonstrated strong electrolysis performance and high proton conductivity under high-temperature operation, supporting stable and efficient hydrogen production conditions. These results establish a robust nanosheet-membrane platform suitable for integration into high-temperature electrolysis systems and future scale-up studies.

LH$_2$ BOIL-OFF MANAGEMENT

This project addressed energy losses in liquid hydrogen systems arising from boil-off gas (BOG). It focused on the thermodynamic analysis and design of BOG management, reliquefaction, and energy recovery strategies to improve the efficiency, safety, and scalability of large-scale liquid hydrogen storage and transport.

In 2025, the project delivered detailed thermodynamic and system-level models for LH$_2$ BOG recovery and utilisation. Two major technical reports were completed: one assessing para-ortho hydrogen conversion for enhanced cooling and reduced boil-off, and a second comparative review of semi-analytical and high-fidelity methods for modelling liquid sloshing dynamics relevant to LH$_2$ storage and transport.



Vapour cooled shield intercepts heat leak and accelerates tank cool down time

NEW ENERGY TECHNOLOGIES

EXPLORING THE INTEGRATION OF LIQUID AIR ENERGY STORAGE WITH SOLAR AND LNG SYSTEMS

This initiative explores integrating Liquid Air Energy Storage (LAES) with solar power and Liquefied Natural Gas (LNG) operations. The team is evaluating the potential for storing excess renewable energy as liquid air, which can later be expanded to generate electricity. By coupling with LNG facilities, the system improves efficiency through heat exchange and energy recovery. This research provides a blueprint for hybrid systems that combine renewable power generation with industrial resilience.

In 2025, multiple integration scenarios between LAES and LNG production were investigated. Energy, exergy, and techno-economic analyses were conducted for several LAES liquefaction configurations developed in the earlier stages of the project. These studies aimed to demonstrate both the feasibility of the proposed integrations and the performance differences among the scenarios.

ELECTROLYSER TECHNOLOGY FOR GRID STABILITY

This project investigated the potential of utility-scale hydrogen electrolysers to provide system support services and grid balancing for hydrogen hubs, while also examining key challenges related to stack operational limitations, stack degradation, and scale-up requirements. A detailed electrolysis plant and network analysis was undertaken to assess capabilities for frequency control and voltage support within the context of Woodside Energy’s GW-scale hydrogen hub project. In addition, laboratory experiments on kW-scale electrolysers were conducted to further examine degradation under flexible operation and service provision and to characterise stack non-linear behaviour and its impacts on service provision.

The studies showed the potential for electrolysis plants to provide system support services including frequency control, voltage control, and grid balancing, which will reduce the need for battery installation in large-scale hydrogen production projects. In this context, however, ramp-rate limit, partial-load limit, and stack degradation may limit the capabilities of these technologies in provision of system support services. The volume and speed of system services from electrolysis plants may also change depending on their scale-up strategy and internal interconnections.

Digital twin model

CARBON CAPTURE, CONVERSION AND UTILISATION

DIRECT AIR CAPTURE OF CO_2

This project advances Direct Air Capture (DAC) toward industrial deployment through pilot-scale operation, contactor engineering, and energy-efficient regeneration strategies. The program integrates materials, process design, modelling, and system validation to de-risk scale-up and enable integration with downstream CO_2 utilisation pathways relevant to the energy and resources sector.

In 2025, the UniDAC pilot achieved stable, repeatable cyclic operation following resolution of critical leakage and desorption constraints, marking a step-change in system reliability. The pilot demonstrated >50% peak CO_2 purity and significant productivity gains relative to earlier operation. The LabDAC was rebuilt to provide a flexible test platform for rapid cycle optimisation, enabling validation of sweep-assisted desorption strategies that improved CO_2 recovery and reduced energy intensity. A next-generation heat exchanger–based DAC contactor has been engineered to substantially lower thermal energy demand and is scheduled for commissioning in 2026, positioning the program for TRL advancement and field-relevant demonstration.

UniDAC Pilot

CARBON CAPTURE, CONVERSION AND UTILISATION

3D-PRINTED CATALYTIC MONOLITHS FOR CARBON CONVERSION

Using additive manufacturing, this project created intricate, renewable-energy-powered inducted heated catalytic monoliths that enhance chemical reactions by maximising surface area. The 3D-printed structures improve mass transport and heat management, significantly increasing reaction efficiency. If implemented, these breakthroughs may reduce energy demand and greenhouse gas emissions from high-temperature chemical processes, advancing a new generation of sustainable catalytic reactors.

CONVERSION OF WASTE GASES INTO HIGH-YIELD PRODUCTS

This study reimagines waste gases as feedstock for bio-based manufacturing. By cultivating and engineering specialised microbes, the project converts industrial emissions into useful chemicals and feedstocks. It lays the groundwork for carbon-neutral production lines that capture emissions instead of releasing them. The outcomes have been transferred to the RECARB Hub for scale-up, highlighting strong continuity between the partnership's programs.

Inductively heated monolith at 900°C

Professor Chris Greening and his team on a sampling expedition looking for new gas converting microbes at Burning Mountain, New South Wales, Australia

Team photo with experimental rig (L-R): Ashwin Hatwar, Raihan Arfin, Hamza Asmat, Akshat Tanksale

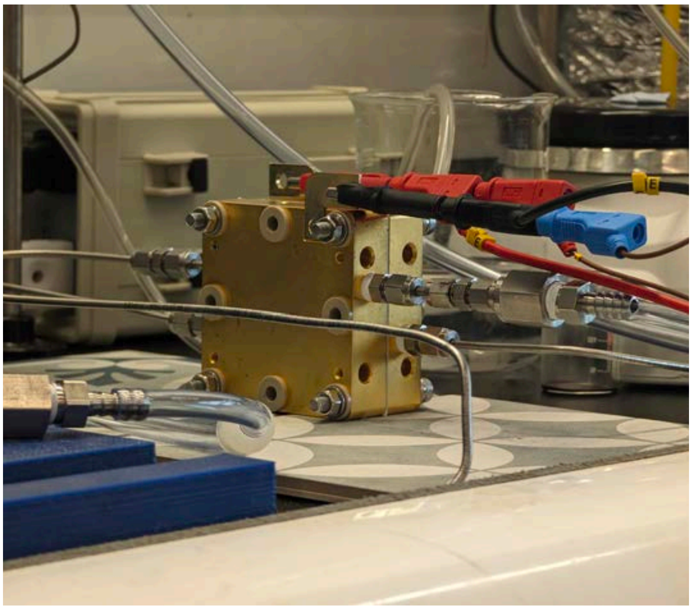
CARBON CAPTURE, CONVERSION AND UTILISATION

MEDIUM-TEMPERATURE ELECTROLYSIS OF CO_2

The overarching goal of this project is to acquire the fundamental knowledge and technical know-how needed to develop commercially viable routes for the medium temperature electrolysis of low-grade carbon dioxide (CO_2) into value-added chemicals and fuels using renewable electricity. The programme consists of developing a reliable prototype that does pure-gas electrolysis without the use of aqueous electrolyte under acidic media.

In 2025, we have attained nearly 70% faradaic efficiency for the CO_2 reduction to CO (syngas) operating at a constant current density of 100 mA cm-2 under ambient conditions. Our research has optimised the amount of Cobalt required, delivering CO_2 conversion above 50% during 5 hours of continuous operation.

Subsequent process optimisation has further enhanced energy efficiency, reducing average operating cell potential from 0.90 V to 0.70 V (vs 1.30 V in commercial cells) while maintaining the same current density and faradaic efficiency output under ambient conditions. While elevated temperature operation is hindered by parasitic reactions, our system delivered excellent CO_2 conversion rates at room temperature. The subsequent phase focuses on water management strategies for cathode GDE to surpass current faradaic efficiency.

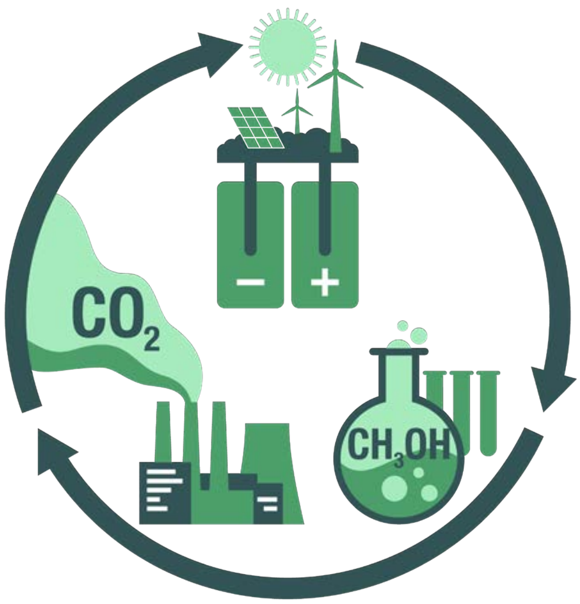


A zero-gap, acidic proton exchange membrane CO_2 electrolytic cell operating at room temperature in absence of mobile, aqueous electrolyte

CO_2e EMISSIONS INSIGHTS ON ALTERNATIVE METHANOL PATHWAYS IN THE ENERGY TRANSITION (PhD Student)

This project developed a unified framework to evaluate CO_2equivalent (CO_2e) emissions of biogenic and recycled-carbon methanol under transitional energy system conditions. Forestry residue gasification and cement-derived CO_2 utilisation were assessed as case studies, with hydrogen sourcing and electricity carbon intensity treated explicitly to enable deployment-relevant comparison.

This project has been completed. Carbon origin defines the maximum emissions potential a methanol pathway can achieve, but does not determine whether reductions occur in practice. Hydrogen supply and electricity carbon intensity are the dominant drivers of CO_2e performance. Fossil hydrogen with and without carbon capture and storage emerges as a credible near-term transitional enabler, delivering reductions prior to deep electricity decarbonisation, whereas electrolysis-based pathways exhibit threshold sensitivity to grid carbon intensity and require very lower-carbon, low-cost power. Even where performance is favourable, lower-carbon feedstocks are intrinsically scale-limited and boundary definitions can alter comparative outcomes. Together, these findings indicate that alternative methanol pathways in the energy transition will require a portfolio of pathways rather than a single dominant solution.



CO_2 emissions in alternative methanol production pathways

OPTIMISING AUSTRALIA'S ELECTRICITY SYSTEM: THE ROLE OF BLOCKCHAIN TECHNOLOGY

This project explored the development of a unified and secure system for energy transition and trading, by leveraging informatics and blockchain technologies. This research shed new light on the interaction between Sustainability Informatics and the operations of electricity systems. Specifically, it offered insights into how blockchain can be used to design an electricity transition scheme with a set of emerging solutions, which can assist the Australian government in providing a more reliable energy supply system.

FUTURE POTENTIAL HYDROGEN DEMAND AND REFUELLING STATION SITING FOR AUSTRALIAN HEAVY-DUTY TRANSPORT: A GEOSPATIAL APPROACH (PhD Project)

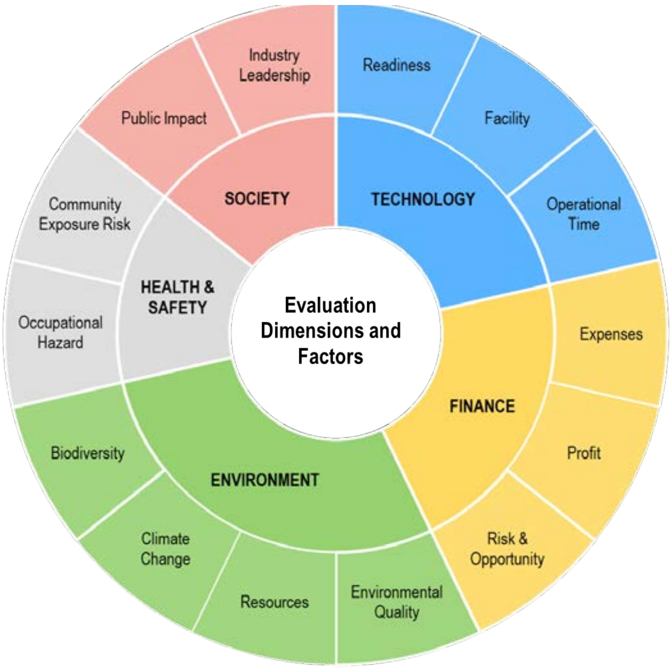
The transition to hydrogen-powered transport in Australia faces significant challenges due to demand uncertainty and limited refuelling infrastructure. This project addresses these issues by estimating future hydrogen demand for heavy-duty trucks and identifying optimal locations for hydrogen refuelling stations nationwide.

In 2025, hydrogen demand in 2050 and its spatial distribution were assessed at multiple scales, including regional patterns, freight-intensive demand centres, and major freight corridors. A comprehensive geospatial optimisation framework was developed, integrating multi-criteria suitability analysis with network-based service optimisation based on the demand. These outcomes offer spatially informed insights that can support strategic infrastructure planning and the effective placement of hydrogen refuelling stations to enable lower-carbon heavy-duty freight transport.

DECISION-MAKING FOR ONSHORE WASTE MANAGEMENT

This project develops a multi-criteria decision analysis framework to evaluate onshore waste management options for decommissioning waste. The framework is grounded in evidence from more than 160 academic studies and industry reports and has been shaped through engagement with key industry stakeholders. It supports decision-making on waste management strategies in decommissioning by integrating criteria related to environmental performance, resource recovery potential, health and safety, societal impact, technological feasibility, and financial outcomes

In 2025, the framework was translated into an operational assessment tool through detailed criteria development and close collaboration with the asset owner. The tool was designed to scale by incorporating input from additional stakeholders and integrating Monte Carlo simulation to quantify confidence in decision making, demonstrating its practical application for evaluating decommissioning pathways and supporting future industry adoption.



Multicriteria decision-making framework

THE ARC RESEARCH HUB FOR CARBON UTILISATION AND RECYCLING

The ARC Research Hub for Carbon Utilisation and Recycling (RECARB Hub) aims to develop technologies to transform carbon dioxide emissions from the energy and manufacturing sectors into valuable products, creating pathways to market that drive industry transformation. This hub aims to achieve this by developing novel electro-, thermo-, and bio-chemical methods for converting CO_2 from hard to abate sectors by developing technological pathways for CO_2 recycling. The outcomes of this Hub are likely to be transformative for industries, the economy, and society by transforming the fate of CO_2 from pollutant to feedstock. The benefits to Australia are intended to be the developing of a new industry, a skilled workforce for this emerging industry and a contribution to meeting CO_2 reduction targets.

PROGRAM 1: ELECTRO- & PHOTO-CHEMICAL CONVERSION OF CO_2 TO PRODUCTS

P1.1 - SYNGAS PRODUCTION BY SOLID OXIDE ELECTROLYSIS (SOEC)

This project delivered important progress in the field of high-temperature CO_2 electrolysis by developing an advanced perovskite electrode material for solid oxide electrolysis cells (SOECs). The primary achievement was the successful partial substitution of Ba for Sr in the perovskite $SrFeMnO_{3-\delta}$ (SFM). This substitution effectively enlarged the crystal lattice volume due to the incorporation of larger Ba^{2+} ions. As a result, the Ba-modified SFM electrode exhibited high CO_2 electrolysis activity and improved performance under SOEC operating conditions compared with the unmodified SFM material.

High-temperature CO_2 electrolysis setup for catalyst and electrode evaluation (Curtin)

P1.2 A & B - ELECTRODE ARCHITECTURAL DESIGN FOR ENHANCED CO_2 REDUCTION

This project is being conducted by two research teams from The University of Queensland (UQ) and Monash University. The UQ team has developed a new fabrication approach for the direct deposition of mesoporous copper (Cu) electrocatalysts onto carbon substrates for CO_2 electroreduction. This approach is readily extendable to mesoporous copper alloy catalysts incorporating additional metals (e.g., Au and Ag), demonstrating the broader applicability of the platform. The Monash team has developed a porous solid electrolyte (PSE) based flow cell architecture for direct bicarbonate electrolysis. Their approach explores a novel liquid-fed electrode design in which bismuth powder is placed directly within the reactor flow channels, and a solid-state electrolyte layer is sandwiched between the cathode and Proton Exchange Membrane (PEM) to enhance the electrochemical performance.

P1.3 - PLASMONICS FOR PHOTOCHEMICAL CONVERSION

This study combines nanotechnology and photochemistry to drive CO_2 reduction using sunlight. The project demonstrated how plasmonic nanoparticles enhance catalytic activity, offering new strategies for solar-driven carbon conversion. It represents a key step toward integrating renewable light energy into industrial chemical production.

PROGRAM 2: BIOCHEMICAL CONVERSION

P2.1 - TWO-STEP BIOCONVERSION OF CO_2 INTO FUELS AND LUBRICANTS

This project is being conducted by three research teams from The University of Queensland (UQ), Queensland University of Technology (QUT) and Monash University.

UQ integrates anaerobic CO_2 conversion to acetate with aerobic chain elongation in a two-bioreactor/two-strain system. To enable direct and continuously feeding acetate-enriched, cell-free fermentation broth to *P. putida*, adaptive laboratory evolution (ALE) is used to improve acetogen temperature compatibility with mesophilic *P. putida*.

Monash investigated three structurally distinct bio-based plasticisers to disrupt the crystallinity of polyhydroxybutyrate (PHB), thereby improving its processability and functional properties. This project will contribute to new insights into biobased plasticiser-PHB interactions as a baseline for methyl ketone-based plasticisers relevant to sustainable packaging applications.

QUT will investigate the catalytic pathways for methyl ketone conversion to lubricants and fuels. Their work will commence in mid-March 2026.

P2.3 - CONVERSION OF MIXED POLLUTANT GASES INTO SUSTAINABLE ANIMAL FEEDS

This pioneering project uses microbial bioconversion to transform mixed waste gases into protein-rich biomass. By converting pollutants into valuable feedstock, it contributes to food security, waste reduction, and emission control simultaneously.

This project is being conducted by two research teams from The University of Queensland (UQ) and Monash University. The Monash team has successfully isolated numerous novel microbial species from soils impacted by an underground coal fire emitting gas mixtures enriched in CO, H_2, CO_2, CH_4, and H_2S, supporting mixed waste-gas bioconversion studies. Through collaborations with UQ and University of Western Australia, they have developed and validated genetic engineering methods for three industrially relevant chassis strains, to study metabolic engineering and optimisation of product formation.

P2.7 - ENHANCING PHOTOSYNTHETIC CONVERSION OF CO_2 INTO SUGAR FOR SUSTAINABLE BIOMANUFACTURING

The project enhanced photobioreactor performance by improving light distribution and nutrient control in cyanobacterial systems. These refinements increase productivity and scalability, paving the way for bio-based material and chemical production at industrial levels.

Initial designs for synthetic pathways in cyanobacteria have been generated, improving energy efficiency and redox availability and expected to overcome light limitation in photobioreactors.

Catalyst deposition was scaled on Mark 1-100 monoliths, and a high-pressure Mark 2-50 reactor was 3D-printed to test industrial robust conditions. A modular Mark 3 platform was conceptualized, and Mark 1-20 reactor studies were published in peer-reviewed studies, confirming scalability and efficiency.

UQx bioreactor system in operation, with Dr Timothy McCubbin (UQ)

PROGRAM 3: THERMOCHEMICAL CONVERSION OF CO_2 TO PRODUCTS

P3.2A - SYNGAS AND CO_2 CONVERSION TO FUELS, METHANOL, FORMIC ACID AND ACETIC ACID

This project is being conducted by two research teams from The University of Queensland (UQ) and Monash University.

The Monash team explores direct CO_2 hydrogenation as a pathway for carbon utilisation, employing MOF-derived catalyst systems such as MIL-88B and Co-BDC, and systematically optimising catalyst design and reaction parameters to yield carboxylic acids. They have synthesised and evaluated MOF-based catalysts for direct CO_2 hydrogenation. In parallel, they are developing and testing graphitic carbon nitride (g-C_3N_4) based materials that have produced measurable amounts of formic acid.

The UQ team have developed strategies to build a physics-based model drawing and it was validated against experimental data. The model is refined and has been used to generate synthetic data to train an artificial neural network that captures the underlying relationships among hydrogenation temperature, reaction time, and initial feedstock composition.

P3.3 - SCALE-UP OF INDUCTIVELY HEATED DRY REFORMER

This project is being conducted by two research teams from Curtin University and Monash University. For the scale-up of inductively heated reactor, an 84% reduction in heat losses was achieved in the inductively heated reactor using high-temperature ceramic and Refrasil® insulation, enabling stable operation at 900 °C with 600 W. The electrified reformer showed >90% CO_2 and CH_4 conversions at GHSV 60,000 L.h-1.kgcat-1 over 50 h. Catalyst deposition was scaled on Mark 1-100 monoliths, and a high-pressure Mark 2-50 reactor was 3D-printed to test robust industrial conditions. A modular Mark 3 platform was conceptualized, and Mark 1-20 reactor studies were published in peer-reviewed studies, confirming scalability and efficiency.

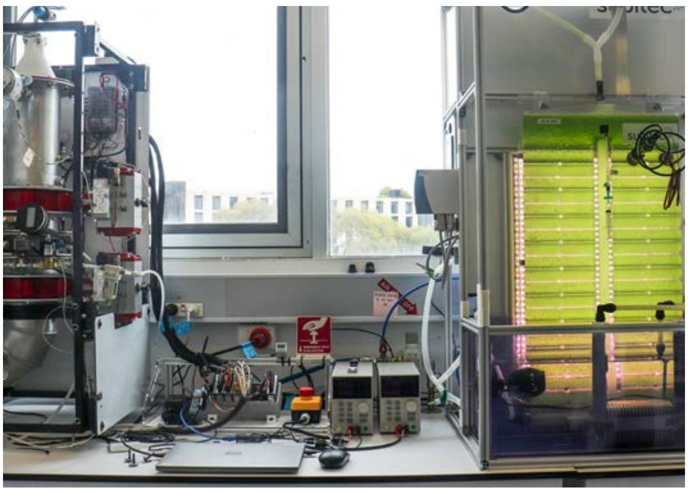
Dr Shakir Mohammad (Postdoctoral Researcher, Curtin University) setting up an electrified reactor for dry reforming reactions

PROGRAM 4: CARBON RECYCLING BY DIRECT AIR CAPTURE

P4.1 - CARBON RECYCLING BY DIRECT AIR CAPTURE

This project delivers fundamental advances underpinning solid-sorbent Direct Air Capture (DAC), spanning adsorbent synthesis, co-adsorption science, kinetic characterisation, and laboratory-scale process modelling. The work integrates materials development, advanced characterisation, and cyclic testing to build a rigorous scientific foundation for scalable DAC systems.

In 2025, detailed DVS and TGA studies quantified coupled CO_2–H_2O adsorption behaviour and regeneration kinetics, informing improved co-adsorption models and non-equilibrium cycle simulations. The LABDAC platform was rebuilt and instrumented to enable controlled laboratory cyclic testing, allowing systematic evaluation of regeneration strategies and validation of adsorption/desorption models. Parallel adsorbent development and characterisation activities strengthened understanding of structure–performance relationships under realistic humidity conditions. These results provide the mechanistic and modelling framework required to rationally design next-generation DAC materials and processes.



LabDAC to microalgae biocultivation demonstration

PROGRAM 5: MARKET ACTIVATION

P5.1 - FRAMEWORKS TO SUPPORT TRADE IN EMBEDDED CARBON PRODUCTS

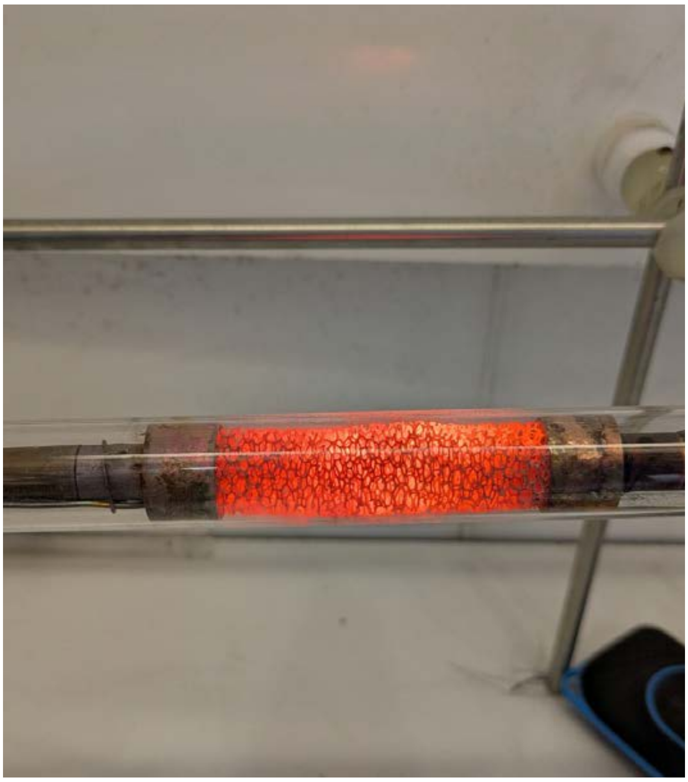
This project is being conducted by two research teams from Australian National University and Monash University. The research team has developed a global database of emissions calculation methodologies for land-based products, generating insights highly relevant to the RECARB Hub that will be integrated into its outputs. The project has also contributed to national policy development through submissions to the Australian Government on the Guarantee of Origin (GO) scheme and the Bioenergy Feedstock Strategy, complemented by direct engagement with the Department of Climate Change, Energy, the Environment and Water (DCCEEW) GO team. Key research outputs include a systematic review of Carbon Capture and Utilisation (CCU) policies and the ongoing development of a comprehensive CCU policy database.

P5.2 - INNOVATION AND EARLY-STAGE MARKET ACTIVATION

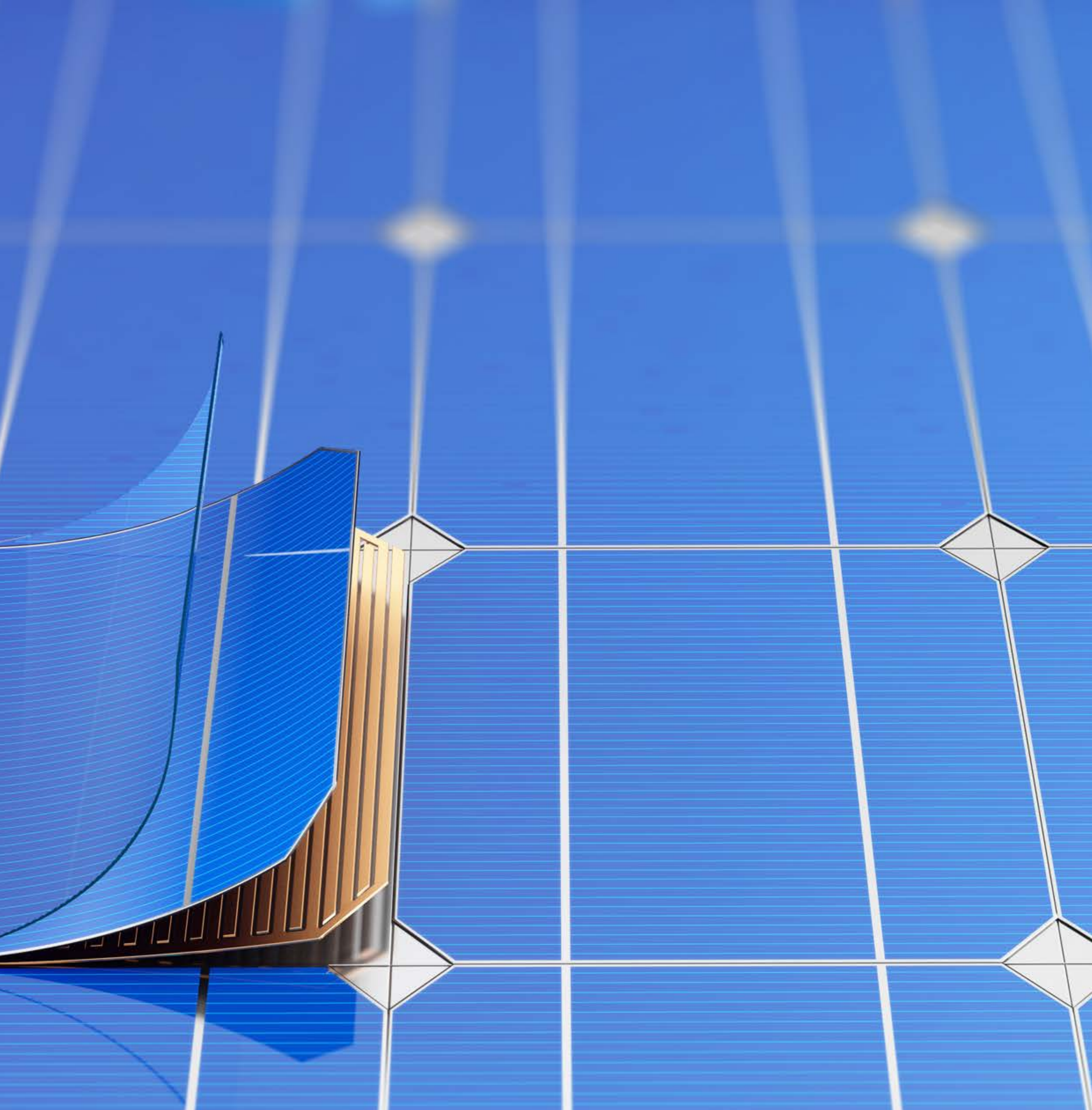
This project explores how emerging lower-carbon technologies can be accelerated from research into early-stage market deployment. The team assesses innovation pathways, investment conditions and ecosystem requirements that enable new climate-tech solutions to gain commercial traction. By identifying barriers and opportunities across policy, industry and finance, the work supports the activation of early-stage markets and strengthens Australia's capacity to scale lower-emissions technologies.

P5.3 - EFFICIENT REGULATORY PATHWAYS TO AUSTRALIA'S LOWER CARBON FUTURE

The project focuses on identifying and mapping international and domestic (federal and state) legal obligations governing different carbon management strategies in Australia. The focus will lie on carbon capture and utilisation (CCU) technologies, pathways and processes but also draw on carbon capture and storage and carbon dioxide removal regulatory frameworks where relevant, with the aim of detecting and highlighting gaps and blind spots. The researchers will also review the regulatory frameworks in other relevant jurisdictions with regard to CCU, specifically Europe. Particular attention to carbon offsets/credit schemes will be paid. Based on this research, a regulatory framework for CCU technologies, processes and pathways in Australia will be proposed.



Direct Joule heating reactor set up at 800 °C



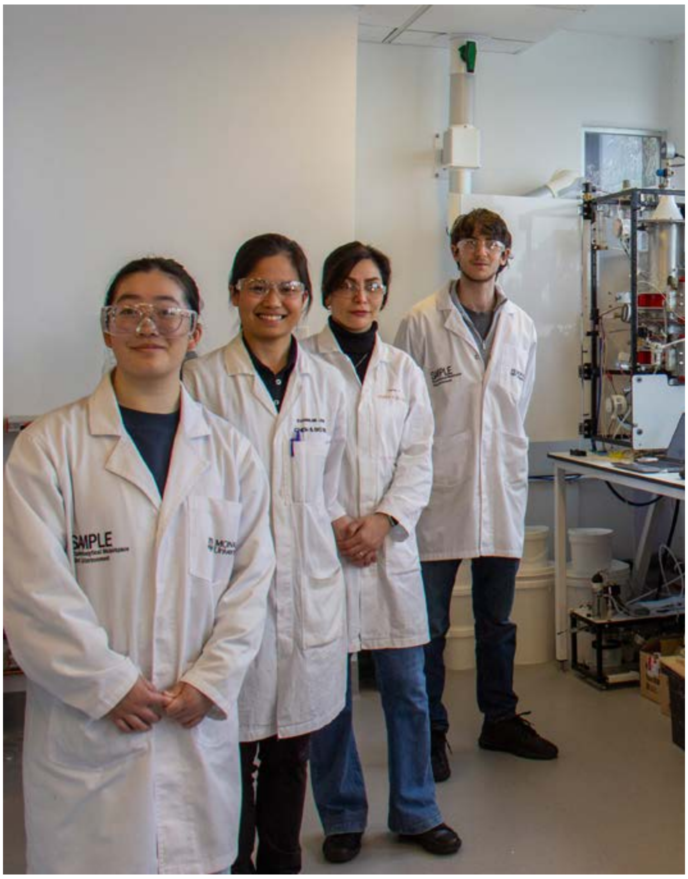
We are committed to working with Woodside to help the company develop new lower-carbon products and services.

AUSTRALIA'S ECONOMIC ACCELERATOR (AEA) GRANT

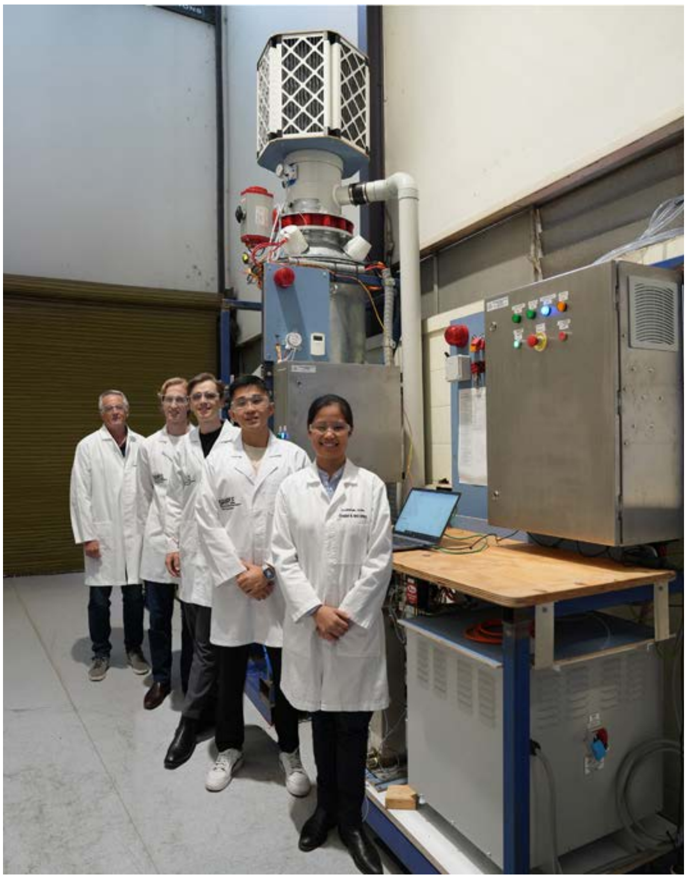
In 2025, the DAC2BIO team secured A$301,000 in funding from the Department of Education's Australia's Economic Accelerator (AEA) Ignite program focused on developing scalable Direct Air Capture (DAC) systems to capture and provide decentralised CO_2 streams tailored for downstream biological utilisation for conversion into lower-carbon alternative bioproducts.

This initiative builds on the foundational investment from the Woodside Monash Energy Partnership (WMEP). The DAC2BIO project - building on its earlier success on the preceding AEA Seed grant - continues to bring together partners which include Woodside Energy, The University of Queensland and Bondi Bio; strengthening the co-investment into the project to date. The team is advancing field-deployable DAC units that can integrate with bioindustry infrastructure to directly supply captured CO_2. This approach reduces reliance on high-pressure gas cylinders or trucked-in-fossil-derived CO_2, potentially contributing to Australia's broader decarbonisation goals.

The AEA Ignite funding will support system integration, product validation, and early-stage commercial readiness, with the team preparing for multi-partner demonstrations. The project also strengthens the partnership's Direct Air Capture program by developing continuous multi-bed DAC systems and demonstrating integration with industrial biomanufacturing. This award leverages Woodside's long-term support to accelerate translation of Monash DAC technology toward a TRL-6 industry demonstration.



Chloe Hsieh, Evangeline Leong, Dr Parisa Eslami and Reuben Rosengarten with the LabDAC



Prof Paul Webley, Jayden Cooke, Maksis Darzins, Joel Wong and Evangeline Leong with the UniDAC

FUTURELAB AND WMEP ALUMNI

2025 GRADUATIONS: CELEBRATING STUDENT SUCCESS

The Woodside Monash Partnership proudly celebrates another significant milestone as we recognise the completion of doctoral studies by our newest WMEP and FutureLab alumni. In 2025, seven PhD researchers, Dr Jefferson Lam, Dr Javad Jeddizahed, Dr Garv Bhardwaj, Dr Liam Turner, Dr James Wang, Dr Thomas Nobes and Dr Marc Peters, reach this defining moment in their academic careers. Several more researchers will submit their doctoral theses in the first months of 2026: Cristian Costa, Sheng Ning Meng and Jingjie Huang. Their research has delivered meaningful contributions to energy innovation. These contributions advance technologies and knowledge that align with the core mission of our partnership, which is to accelerate impactful solutions through strong academic and industry collaboration.

As they transition into the next stages of their professional journeys, we acknowledge their dedication, expertise and commitment to shaping the future of energy. Their achievements highlight the strength of the WMP initiative in fostering world-class research capability and developing the next generation of leaders in industry and academia.

We extend our warmest congratulations to all graduating researchers and look forward to witnessing the ongoing influence of their work across the energy sector. As pioneers in the growing WMP alumni community, they continue to set a high benchmark for the scholars who will follow, inspiring innovation and excellence across the partnership.

Dr Jefferson Lam

Thesis Title: *Silica-Based Coatings for Solar Spectrum Control*

Dr Jefferson Lam's PhD research explores novel silica-based coatings inspired by nature to improve the performance and durability of solar panels. Hierarchical surface structures and compounds found on the surface of plant leaves have evolved over many millennia to impart many ideal properties for solar energy conversion. These include enhanced light capture and anti-reflection, self-cleaning properties, strong barriers to moisture, and UV resistance. His work delves into the mechanism and structure-property relationships that drive these properties, and applies these ideas onto photovoltaics modules via highly engineered coatings.

Dr Javad Jeddizahed

Thesis Title: *Process integration of NET Zero energy, hydrogen, and ammonia production*

Dr Javad Jeddizahed's research examines the integration of zero-emission energy pathways with a focus on hydrogen and ammonia production. His work models process interactions that improve efficiency and reduce the carbon intensity of interconnected production systems. Key contributions include identifying optimised configurations for net zero energy production and improving understanding of hydrogen and ammonia integration at industrial scale.

Dr Garv Bhardwaj

Thesis Title: *Plasmon-Mediated Photocatalytic Conversion of Carbon Dioxide into Products*

Dr Garv Bhardwaj's research investigates the photocatalytic pathways for converting carbon dioxide into valuable products through plasmonic materials. By developing bimetallic plasmonic systems, his work aims to increase light absorption and demonstrate production of multi-carbon products. Key findings include comparison of different catalyst architectures for carbon dioxide hydrogenation and elucidating their mechanisms under solar-relevant illumination.

Dr Thomas Nobes

Thesis Title: *Voxel-Based Pathfinding: Algorithms and Applications*

Dr Thomas Nobes' research advances computational pathfinding in 3D through the development of voxel-based algorithms for use in robotics, navigation and digital simulation. His work delivers new methods for optimally routing through massive and complex environments with high precision. Key outcomes include scalable algorithms for automatic design of piping layouts for large industrial plants.

Dr Liam Turner

Thesis Title: *Investigating the kinetics of the catalytic para to orthohydrogen conversion and its application for cooling in liquid hydrogen systems*

Dr Liam Turner's PhD focuses on the kinetic behaviour of catalytic para to ortho hydrogen conversion, which is an essential process for efficient liquid hydrogen storage and cooling. His research provides new insights into catalyst design, reaction pathways and methods for operational optimisation. Key outcomes include refined models for hydrogen conversion kinetics and strategies that support safer and more efficient liquid hydrogen technologies.

Dr Marc Peters

Thesis Title: *Design of Corrosion-Resistant Ni-Cr-W Alloys for Additive Manufacturing*

Dr Marc Peters' research develops a new class of corrosion resistant alloys specifically for additive manufacturing that are immune to sensitization (a type of corrosion susceptibility).These alloys will be especially interesting for large format printing where the cooling rates during manufacturing are slow and sensitization will compromise the corrosion performance of traditional materials.

Dr James Wang

Thesis Title: *Modelling liquid hydrogen storage for bulk maritime transportation*

Dr James Wang's research models large-scale liquid hydrogen storage for shipping and challenges associated with boil-off gas management. His work examines the behaviour of liquid hydrogen and optimising shipping operations from a technoeconomic perspective. Key contributions include new thermodynamic models to inform the design of specialised transport vessels and identifying strategies to minimise the economic cost of boil-off losses.

MONASH INDUSTRY DOCTORAL PROGRAM

The Industry Doctoral Program (IDP) at Monash University is a collaborative, industry-driven PhD pathway in which sponsoring organisations shape the research direction, scope and objectives. Through the Woodside–Monash partnership, candidates undertake research projects aligned to industry priorities, drawing on Monash's world-class facilities, academic leadership and research capability.

The program is designed for both Monash-enrolled candidates and industry-based professionals, creating an integrated environment where academic insight and operational expertise intersect. Woodside employees complete their doctoral research while continuing in their professional roles, embedding research directly into practice. Monash-based candidates, in turn, benefit from immersive industry engagement and close collaboration with Woodside specialists.

By combining academic rigour with real-world application, the partnership enables candidates to test new ideas, accelerate innovation and deliver tangible outcomes that address complex industry challenges.

Meet our Industry Doctoral Program candidates below.

WOODSIDE BASED EMPLOYEES

Anrie Helberg*

Thesis title: *Sustainable Technology: Understanding the Trade-Off and Synergies Between Energy, Greenhouse Gas Emissions, and Food Security for optimised technology solutions*

The project aims to improve industry's ability to evaluate the sustainability of technology. With the development of novel solutions to reduce greenhouse gas emissions, there may be synergies and trade-offs between emissions reduction and other resources, such as food security. This project will enhance the evaluation of sustainable technologies by providing a better understanding of the interdependencies between energy, greenhouse gas emissions, and food security.

Andy R Watt

Thesis title: *Optimising Subsea Gas Pipeline Decommissioning via Real-Time Data Gathering and Innovative Tracking*

The decommissioning of subsea gas pipelines presents technical, environmental, and economic challenges. This research focuses on optimising decommissioning strategies through real-time data gathering and advanced tracking technologies. By integrating sensor-based monitoring, predictive analytics, and innovative tracking systems, the study aims to enhance efficiency, safety, and environmental compliance in pipeline decommissioning. The findings will contribute to cost-effective and sustainable decommissioning practices, reducing risks and supporting industry efforts to meet regulatory and environmental standards while advancing responsible offshore infrastructure management.

*No longer at Woodside Energy

MONASH BASED EMPLOYEES

Gabi Newman

Thesis title: *Decommissioning of Industrial Equipment and Opportunities for Plastic Waste Recycling in Australia*

As industries transition towards sustainability, the decommissioning of industrial equipment presents both challenges and opportunities, particularly in plastic waste management. This research explores innovative recycling pathways for plastic materials recovered from retired industrial assets in Australia. By assessing current decommissioning practices, regulatory frameworks, and emerging recycling technologies, this study aims to identify economically viable and environmentally sustainable solutions. The findings will contribute to circular economy strategies, helping industries reduce landfill waste while maximising resource recovery and reuse.

Jose Lobo Del Canto

Thesis title: *Innovation, Design and Development of Low-Cost Solar Photovoltaic Systems*

As the global demand for renewable energy grows, affordable and efficient solar photovoltaic (PV) systems are key to expanding energy access and sustainability. This research focuses on the innovation, design, and development of low-cost PV technologies, exploring novel materials, manufacturing and deployment techniques, and system optimisation strategies. By improving cost-effectiveness and performance, this study aims to enhance the feasibility of widespread solar adoption, particularly for lightweight solar PV systems. The outcomes will contribute to advancing lower-carbon energy solutions, supporting the transition toward a more sustainable and accessible energy future.

Evangeline Leong

Thesis title: *Integration of Direct Air Capture with Biological CO_2 Utilisation for Low-Carbon Bioproduct Production*

This research develops a DAC-enabled biomanufacturing platform that converts atmospheric CO_2 into commercially relevant bioproducts. The project integrates modular Direct Air Capture systems with microbial fermentation to produce biodegradable polyhydroxyalkanoate (PHA) bioplastics and single-cell protein (SCP) for aquafeed applications. Emphasis is placed on optimising system-level design and process integration to enhance operational efficiency and scalability. By linking carbon capture with value-generating biological conversion, this work advances carbon circularity, supports lower-emissions supply chains, and demonstrates the production of sustainable materials and alternative proteins from air-derived carbon.

Maksis Darzins

Thesis title: *Mechanical Design Of Direct Air Capture Pilot Plants For Carbon Dioxide Capture And Recycling*

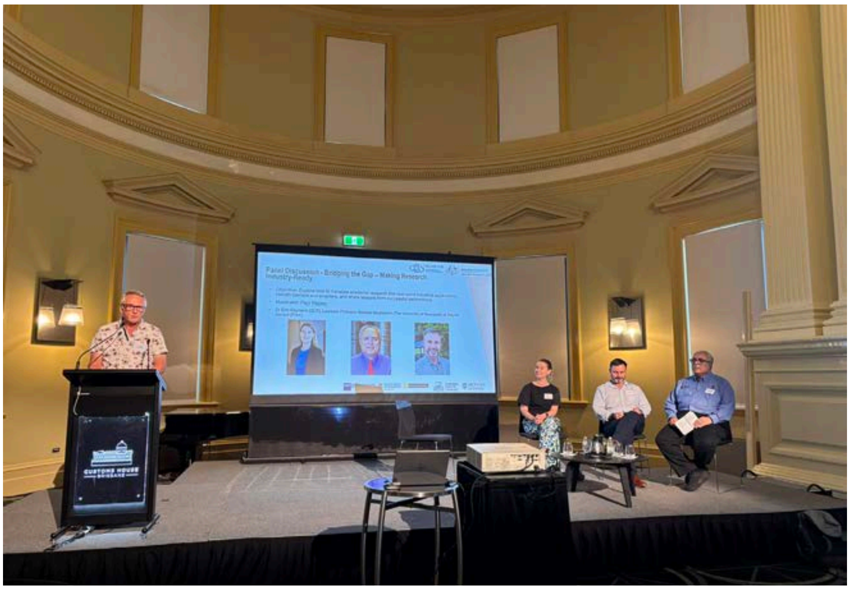
As climate change mitigation efforts intensify, Direct Air Capture (DAC) technology is emerging as a crucial solution for reducing atmospheric CO_2 levels. This research focuses on the development and scale-up of DAC systems, exploring advancements in mechanical design, process optimisation, and energy efficiency in materials, process optimisation, and energy efficiency to enhance feasibility and cost-effectiveness. By addressing key challenges in scalability and deployment, this study aims to support the widespread adoption of DAC for carbon removal and utilisation. The findings will contribute to global decarbonisation efforts, enabling more effective carbon management strategies and advancing the transition to a sustainable, lower-carbon future.

RECARB HUB SYMPOSIUM

The RECARB Hub 2025 Symposium, held on 25 November 2025 at Customs House in Brisbane, brought together researchers and industry partners to showcase progress in carbon utilisation and recycling and to strengthen cross-sector collaboration. The event highlighted the Hub's ongoing commitment to transforming carbon dioxide (CO_2) into valuable products that support Australia's transition to a lower-carbon economy. Presentations had a strong focus on translating research outcomes into scalable, commercially relevant solutions. PhD students and early career researchers actively contributed through presentations and discussions, showcasing emerging research and gaining valuable exposure to industry perspectives.

Invited speakers provided valuable perspectives on deployment challenges, market opportunities and regulatory considerations, reinforcing the importance of aligning research innovation with practical implementation. The Symposium fostered productive discussion, strengthened partnerships and identified priorities for the next phase of research translation and commercial engagement. Overall, the symposium has provided a national platform driving collaborative innovation and contributing to the adoption of carbon recycling technologies in Australia.

Participants at the RECARB Hub 2025 Symposium in Brisbane.



Panel discussion at the RECARB Hub 2025 Symposium (from left to right): Prof Paul Webley (Director of the RECARB Hub, Monash University), Dr Erin Rayment (Queensland University of Technology), Wayne Gerard (Partner), and Laureate Prof Behdad Moghtaderi (University of Newcastle).

PERSONNEL

LEADERSHIP AND OPERATIONS

NAME	INSTITUTION	ROLE	INITIATIVE
Julie Fallon	Woodside Energy	Executive Vice President Technical & Energy Development	Woodside Monash Partnership
Gabrielle Pennock	Woodside Energy	Vice President Engineering	Woodside Monash Partnership
Jenny Johnson	Woodside Energy	Head of US Partnerships	Woodside Monash Partnership
Professor Yiannis Ventikos	Monash University	Dean, Faculty of Engineering	Woodside Monash Partnership
Professor Jacek Jasieniak	Monash University	Pro Vice Chancellor (Research Infrastructure)	Woodside Monash Partnership
Professor Maria Garcia de la Banda	Monash University	Monash FutureLab Co-Chair, Information Technology	Monash FutureLab
Professor Christopher Hutchinson	Monash University	Monash FutureLab Co-Chair, Engineering	Monash FutureLab
Dr Erin Brodie*	Monash University	Research and Innovation Lead	Monash FutureLab
Dr Marc Peters	Monash University	Deputy Research and Innovation Lead	Monash FutureLab
Associate Professor Sebastian Thomas	Monash University	Materials Durability Lead	Monash FutureLab
Michael Brameld	Woodside Energy	GM Engineering - Technical & Energy Development	Monash FutureLab
James McKechnie	Woodside Energy	Practice Lead MICE & Technical Authority	Monash FutureLab
Dr Lee Djumas	Woodside Energy	AM Subject Matter Expert	Monash FutureLab
Dr Claudia De Los Rios Perez	Woodside Energy	Innovation Partnership Advisor	Energy Partnership & Monash FutureLab
Voula Terzoudi	Woodside Energy	Innovation Manager	Energy Partnership & Monash FutureLab
Andrew Glucina	Woodside Energy	APAC Innovation Ecosystems Manager	Energy Partnership & Monash FutureLab
Professor Paul Webley	Monash University	Energy Partnership Director	Energy Partnership
Lilyanne Price	Monash University	Operations Manager	Energy Partnership
Dr Jitendra Joshi*	Woodside Energy	New Energy and Carbon Theme Leader	Energy Partnership
Peter Metcalfe	Woodside Energy	Energy Leadership Theme Leader	Energy Partnership
Gareth Wright	Woodside Energy	Head of Climate Strategy and Engagment	Energy Partnership
Professor Akshat Tanksale	Monash University	Carbon Theme Leader	Energy Partnership
Senior Lecturer Tom Hughes	Monash University	New Energy Theme Leader	Energy Partnership
Professor Fang Lee Cooke	Monash University	Energy Leadership Theme Leader	Energy Partnership
Professor Murali Sastry*	Monash University	Global Partnerships Theme Leader	Energy Partnership
Aneeka Meyers	Monash University	Operations Coordinator	Energy Partnership
Evangeline Leong	Monash University	Research Officer	Energy Partnership

*No longer working at Woodside Energy or Monash University.

FUTURELAB

THEME	TOPIC	TEAM	
		MONASH	WOODSIDE
DATA SCIENCE	PLUTO CAPABILITY MANAGER – CREW ALLOCATION	Maria Garcia de la Banda, Michael Wybrow, Matthias Klapperstueck, Ilankaikone Senthooran, Frits de Nijs	Matteo Miceli
ADDITIVE MANUFACTURING AND MATERIALS TECHNOLOGY	MOLYDISULFIDE LUBRICANT	Sebastian Thomas Victor Cruz de Faria Christopher Hutchinson Jingjie Huang	Michael Brameld, James McKechnie
	ROTOR DISTORTION ANALYSIS	Christopher Hutchinson Cristian Costa Jing Ng	Michael Brameld, James McKechnie
	COLD SPRAY	Sebastian Thomas, Victor Cruz de Faria, Christopher Hutchinson, Erin Brodie*	Michael Brameld, James McKechnie
	STRESS CORROSION CRACKING OF 3DAM MATERIALS	Sebastian Thomas, Victor Cruz De Faria	Michael Brameld, James McKechnie
	WIRE ARC ADDITIVE MANUFACTURING (WAAM) (FUTURE 3DAM)	Christopher Hutchinson, Marc Peters, Victor Cruz de Faria	Michael Brameld, James McKechnie
	FUTURE LASER POWDER BED FUSION (FUTURE 3DAM)	Christopher Hutchinson, Marc Peters, Sheng Ning Meng	Michael Brameld, James McKechnie
DECOMMISSIONING	PLASTIC RECOVERY FROM INDUSTRIAL DECOMMISSIONING	Jenny Zhou, Matthieu Gresil, Erin Brodie*, Gabi Newman	Lendyn Philip
	PYROLYSIS-BASED RECOVERY OF SUBSEA ASSETS	Sankar Bhattacharya, Chandan Kundu	Lendyn Philip
	DECISION-MAKING FOR ONSHORE WASTE MANAGEMENT	Jenny Zhou	Lendyn Philip

*No longer working at Woodside Energy or Monash University.

ENERGY PARTNERSHIP

THEME	PROJECT TITLE	TEAM	
		MONASH/UQ	WOODSIDE
NEW ENERGY TECHNOLOGIES	LOW-TEMPERATURE CERAMIC ELECTROLYSIS CELLS	Huanting Wang, Kaiqing He, Qiuning Li	Jitendra Joshi*, Sahil Garg, Qiqing Shen
	LH_2 BOIL-OFF MANAGEMENT	Paul Webley, Tom Hughes, Liam Turner, James Wang	Jitendra Joshi*, Adrian MacMillan*, Mirhadi Seyyedsadaghiani, Zac Douglas-Moore
	EXPLORING THE INTEGRATION OF LIQUID AIR ENERGY STORAGE WITH SOLAR AND LNG SYSTEMS	Tom Hughes, Roger Dargaville, Mohamad Shams	Geoffrey Byfield
	ELECTROLYSER TECHNOLOGY FOR GRID STABILITY	Behrooz Bahrani, Mehdi Ghazavi Dozein	Shervin Fani
CARBON CAPTURE, CONVERSION AND UTILISATION	DIRECT AIR CAPTURE OF CO_2	Paul Webley, Akshat Tanksale, Joanne Tanner, Aaron Guo, Evangeline Leong, Maksis Darzins, Joel Wong, Mohsen Ghasemian, Chani Karandagaspitiya, Hashini Udugoda, Jayden Cooke, Emilia Sutherland, Reuben Rosengarten, Nicholas Teo, Edwin	Jitendra Joshi*, Qiqing Shen, Boon Liaw, Min Ao
	3D-PRINTED CATALYTIC MONOLITHS FOR CARBON CONVERSION	Akshat Tanksale, Hamza Asmat, Mohammad Raihan Arfin, Ashwin Hatwar	Jitendra Joshi*, Boon Liaw, Min Ao
	CONVERSION OF WASTE GASES INTO HIGH-YIELD PRODUCTS	Monash: Chris Greening, Akshat Tanksale, Anthony Kohtz, Surbhi Jain, Bob Leung, Nadeesha Athukorala, Evangeline Leong University of Queensland: Esteban Marcellin, James Heffernan, Hemanshi Galaiya, Antonia Ebert	Jitendra Joshi*, Sahi Garg, Boon Liaw, Min Ao
	MEDIUM-TEMPERATURE ELECTROLYSIS OF CO_2	Jie Zhang, Paul Webley, Calvin Chow, Hsiwen Wu	Jitendra Joshi*, Sahil Garg, Qiqing Shen
	CO2e EMISSIONS INSIGHTS ON ALTERNATIVE METHANOL PATHWAYS IN THE ENERGY TRANSITION	Paul Webley, Miriam Blaine	Gareth Wright
ENERGY LEADERSHIP	OPTIMISING AUSTRALIA'S ELECTRICITY SYSTEM: THE ROLE OF BLOCKCHAIN TECHNOLOGY	Xin Ma, Joseph Liu, Fang Lee Cooke	Gareth Wright
	DECISION-MAKING FOR ONSHORE WASTE MANAGEMENT	Jenny Zhou	Lendyn Philip
	FUTURE POTENTIAL OF HYDROGEN DEMAND IN AUSTRALIAN TRANSPORT AND ENERGY-INTENSIVE INDUSTRY SECTORS: A GEOSPATIAL APPROACH	Xuan Zhu, Fang Lee Cooke, Warsini Handayani	Gareth Wright

*No longer working at Woodside Energy or Monash University.

THE ARC RESEARCH HUB FOR CARBON UTILISATION AND RECYCLING

PROGRAM	PROJECT CODE	PROJECT TITLE	PRIMARY CHIEF INVESTIGATOR (PCI) & PRIMARY INVESTIGATORS (PI)
PROGRAM 1: ELECTRO- & PHOTO-CHEMICAL CONVERSION OF CO_2 TO PRODUCTS	P1.1	SYNGAS PRODUCTION BY SOLID OXIDE ELECTROLYSIS (SOEC)	CI: Zongping Shao (Curtin University) PI: Jitendra Joshi*, Sahil Garg (Woodside Energy Technology Pty Ltd)
	P1.2 A&B	ELECTRODE ARCHITECTURAL DESIGN FOR ENHANCED CO_2 REDUCTION	CI: Yusuf Kaneti (The University of Queensland), Jie Zhang (Monash University) PI: Jitendra Joshi*, Sahil Garg (Woodside Energy Technology Pty Ltd), Naoya Kobayashi (NK Energy Frontier Co. Ltd)
	P1.3	PLASMONICS FOR PHOTOCHEMICAL CONVERSION	CI: Akshat Tanksale (Monash University), Zongyou Yin (The Australian National University) PI: Jitendra Joshi*, Qiqing Shen (Woodside Energy Technology Pty Ltd), Jan Haesner (BASF Australia Ltd)
PROGRAM 2: BIOCHEMICAL CONVERSION	P2.1	TWO-STEP BIOCONVERSION OF CO_2 INTO FUELS AND LUBRICANTS	CI: Birgitta Ebert, Esteban Marcellin, Muxina Konarova (The University of Queensland), Laleh Vash Moghaddam, Darryn Rackemann (Queensland University of Technology), Leonie van 't Hag (Monash University) PI: Jitendra Joshi*, Boon Liaw (Woodside Energy Technology Pty Ltd), Andrew Gilbert (Bioplatforms Australia Ltd)
	P2.3	CONVERSION OF MIXED POLLUTANT GASES INTO SUSTAINABLE ANIMAL FEEDS	CI: Chris Greening, Leonie van 't Hag, Bob Leung (Monash University), Esteban Marcellin (The University of Queensland) PI: Jitendra Joshi*, Boon Liaw, Sahil Garg (Woodside Energy Technology Pty Ltd), Andrew Gilbert (Bioplatforms Australia Ltd), Thomas Hennessy (Agilent Technologies Australia Pty Ltd)
	P2.7	ENHANCING PHOTOSYNTHETIC CONVERSION OF CO_2 INTO SUGAR FOR SUSTAINABLE BIOMANUFACTURING	CI: Tim McCubbin, Esteban Marcellin (The University of Queensland), Paul Webley (Monash University) PI: Jitendra Joshi* (Woodside Energy Technologies Pty Ltd), Gabriel James (Solarferm Limited), Andrew Gilbert (Bioplatforms Australia Ltd)
PROGRAM 3: THERMOCHEMICAL CONVERSION OF CO_2 TO PRODUCTS	P3.2A	SYNGAS AND CO_2 CONVERSION TO FUELS, METHANOL, FORMIC ACID AND ACETIC ACID	CI: Akshat Tanksale (Monash University), Muxina Konarova (The University of Queensland) PI: Jitendra Joshi*, Qiqing Shen, Min Ao (Woodside Energy Technologies Pty Ltd), Jan Haesner (BASF Australia Ltd), Jodie Kimber (Wesfarmers Chemicals, Energy & Fertilisers)
	P3.3	SCALE-UP OF INDUCTIVELY HEATED DRY REFORMER	CI: Akshat Tanksale (Monash University), Tejas Bhatelia, Milinkumar Shah (Curtin University) PI: Jitendra Joshi*, Boon Liaw, Min Ao (Woodside Energy Technologies Pty Ltd), Jan Haesner (BASF Australia Ltd)

*No longer working at Woodside Energy or Monash University.

THE ARC RESEARCH HUB FOR CARBON UTILISATION AND RECYCLING

PROGRAM	PROJECT CODE	PROJECT TITLE	PRIMARY CHIEF INVESTIGATOR (PCI) & PRIMARY INVESTIGATORS (PI)
PROGRAM 4: CARBON RECYCLING BY DIRECT AIR CAPTURE	P4.1	CARBON RECYCLING BY DIRECT AIR CAPTURE	CI: Paul Webley, Akshat Tanksale (Monash University), Tejas Bhatelia, Arash Arami-Niya, Chunyan Fan (Curtin University) PI: Jitendra Joshi*, Qiqing Shen, Boon Liaw (Woodside Energy Technologies Pty Ltd), Jan Haesner (BASF Australia Ltd), Benjamin Davies (Agilent Technologies Australia Pty Ltd), Jodie Kimber (Wesfarmers Chemicals, Energy & Fertilisers)
PROGRAM 5: MARKET ACTIVATION	P5.1	FRAMEWORKS TO SUPPORT TRADE IN EMBEDDED CARBON PRODUCTS	CI: Emma Aisbett (The Australian National University), Roger Dargaville, Paul Webley (Monash University) PI: Peter Metcalfe (Woodside Energy Technologies Pty Ltd), Matthias Raab, Kwongsoon Chan (CO2CRC Limited), Jodie Kimber (Wesfarmers Chemicals, Energy & Fertilisers)
	P5.2	INNOVATION AND EARLY-STAGE MARKET ACTIVATION	CI: Emma Aisbett ((The Australian National University) PI: Peter Metcalfe (Woodside Energy Technologies Pty Ltd), Matthias Raab, Kwongsoon Chan (CO2CRC Limited)
	P5.3	EFFICIENT REGULATORY PATHWAYS TO AUSTRALIA'S LOWER CARBON FUTURE	CI: Steve Kourabas, Gerry Nagtzaam (Monash University) PI: Peter Metcalfe (Woodside Energy Technologies Pty Ltd)

*No longer working at Woodside Energy.

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FURTHER INFORMATION

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