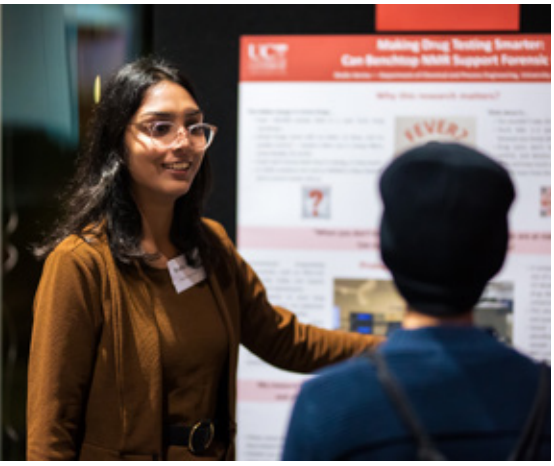
UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Chemical and Process Engineering

PEOPLE, PROCESS, PROGRESS

ANNUAL REPORT 2025



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Message from the Head of Department

This brief document is a new initiative this year to try to provide a snapshot of some of the activities in the Department of Chemical and Process Engineering (CAPE) in 2025. This was a big year for the department with a number of staff changes, and continued growth in the program.

Perhaps the biggest news of the year was the retirement of Associate Professor Ken Morison. Ken has been a cornerstone of the department since he started here in the 1990s. At his leaving function, we had alumni representatives from almost every year he taught here at UC. Everyone I spoke to regaled me with memories of his classes and demonstrations. It is hard to imagine many lecturers who have had such an enduring impact on generations of graduates.

This year also saw the retirement of Frank Weerts from our mechanical workshop team. Frank has been an integral member of the department for 35 years, ensuring our laboratory equipment was maintained and operating, and providing countless students with an introduction to key pieces of process plant equipment.

Alongside these changes, we have had continued growth in the department. We welcomed our biggest ever 2nd year cohort, with around 80 students joining the program taking the total number of students across the 2nd, 3rd and 4th years to almost 200. It is great to see the energy and excitement of these students as they join the program and move out to the work force! We also currently have around 50 postgraduate students in the department, emphasising the continued strength in our research activities.

Thank you to all the readers for your interest in our department and I hope you enjoy reading all about the activities going on in 2025. We love to hear from our alumni and others interested in the department, so please stay in touch and I look forward to hearing from you in the future.

Professor Daniel Holland
Head of Department | Tumuaki Tari

Staff

New Staff

Dr Ben Yin

Ben obtained his PhD in chemical and process engineering from the University of Canterbury with a thesis titled “Applications of porous inorganic-organic hybrid solid in membrane reactors and catalysis for hydrogen production”. Afterwards, he undertook a Postdoctoral Fellowship at the Advanced Membranes & Porous Materials Centre of the King Abdullah University of Science and Technology (KAUST) and led an industrial membrane product R&D project in China. He returned to New Zealand with funding from the MacDiarmid Institute and worked at Massey University to develop CO2 capture membranes. He then worked as a research scientist at the New Zealand Institute for Minerals to Materials Research, before moving to the Robinson Research Institute at Victoria University of Wellington. In April 2025, he returned to the University of Canterbury as a Senior Lecturer.

He is establishing the Advanced Membrane Technology (AMT) group at CAPE, currently consisting of five PhD students and one visiting master’s student. The research group focuses on developing advanced materials and their membranes for gas separation and water treatment. Additionally, the research at the AMT group strongly emphasises industrial and practical applications of membrane technology, participating in industrial consultancy projects and an MBIE Endeavour Research Programme.

Dr. Kai Sellschopp

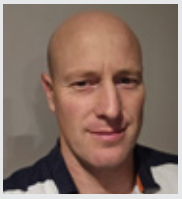
Kai is a Computational Materials Scientist with an interdisciplinary background, holding degrees in both materials engineering and physics from the TU Dresden (Germany). His PhD at the Hamburg University of Technology focussed on modelling interactions between small organic molecules and transition metal oxide surfaces. Following his interest in machine learning, he also spent four months at the EPFL in Lausanne as a visiting scholar. As a Postdoctoral Walter-Benjamin Fellow at the Institute of Hydrogen Technology at the Helmholtz-Zentrum Hereon, Kai studied metal hydrides for hydrogen storage applications using atomic-scale modelling methods.

Now that he is a Lecturer at CAPE, Kai is building a research group on the Computational Design of Sustainable Chemical Processes. Under the umbrella of this general topic, he plans to extend his existing research on metal hydrides for hydrogen storage, transition metal oxide catalysts for CO2 reduction, and magnetocaloric materials for harvesting waste heat. Additionally, Kai is keen to explore new areas, such as gas separations and catalysis with nanoporous materials to support the excellent experimental research in those areas at CAPE. To gain a better understanding of the relevant processes in these applications, his group employs multi-scale materials modelling techniques with a focus on ab initio calculations. As this can be computationally demanding, state-of-the-art machine-learning tools are used to build surrogate models that can speed up simulations and screen candidate materials at a fraction of the cost. Kai is passionate about connecting simulations with real-world applications, which is why his group establishes feedback loops with researchers working on experimental materials characterisation as much as possible.

In his spare time, Kai enjoys exploring the beautiful outdoors of Aotearoa New Zealand, playing boardgames with friends, and pub quizzes.

Nerissa Tannuwidjaja

In June, Nerissa joined the department as Lab Manager. After completing her doctoral research at the University of Canterbury, where she focused on the design and synthesis of novel organic compounds with sustainable applications—particularly in pest control and bioremediation—Nerissa gained valuable experience working within the Chemistry Department, including time in the chemical stores, before joining CAPE. Her background in multi-step organic synthesis and chemical characterisation, using a wide range of analytical techniques (NMR, IR, GC-MS and UV-Vis), has already proven to be a significant asset, and she will continue to be a valuable contributor to the department.



Rob Hurst

In July, Rob Hurst joined the Technical Services team as a Mechanical Technician. With a strong background as a toolmaker and maintenance engineer in industry, Rob brings a wealth of practical experience in maintenance, fabrication, design and training. His broad skill set, hands-on approach, and problem-solving abilities will be a great asset to the department and will strongly support both teaching and research activities.

Retiring Staff

Ken Morrison

Associate Professor Ken Morrison retired at the end of Semester One after more than 30 years of dedicated service to the Chemical and Process Engineering Department. Over the course of his career, Ken became a cornerstone of the department, known for his deep technical knowledge, thoughtful leadership, and unwavering commitment to students and colleagues.

Ken's passion for environmental stewardship has been a defining feature of his work, and this has continued beyond his academic career. He remains actively involved in major conservation and reforestation projects on Banks Peninsula, particularly in Purau and Little River.

As an educator, Ken was widely respected for his dedication to high-quality teaching and his genuine care for student development. He played a key role in shaping generations of chemical and process engineers, always encouraging critical thinking, practical problem-solving, and professional integrity.

Ken's legacy within the department is reflected not only in the many students he mentored, but also in the culture of excellence and responsibility he helped foster. While he will be greatly missed, his values and influence will continue to guide the department for years to come.

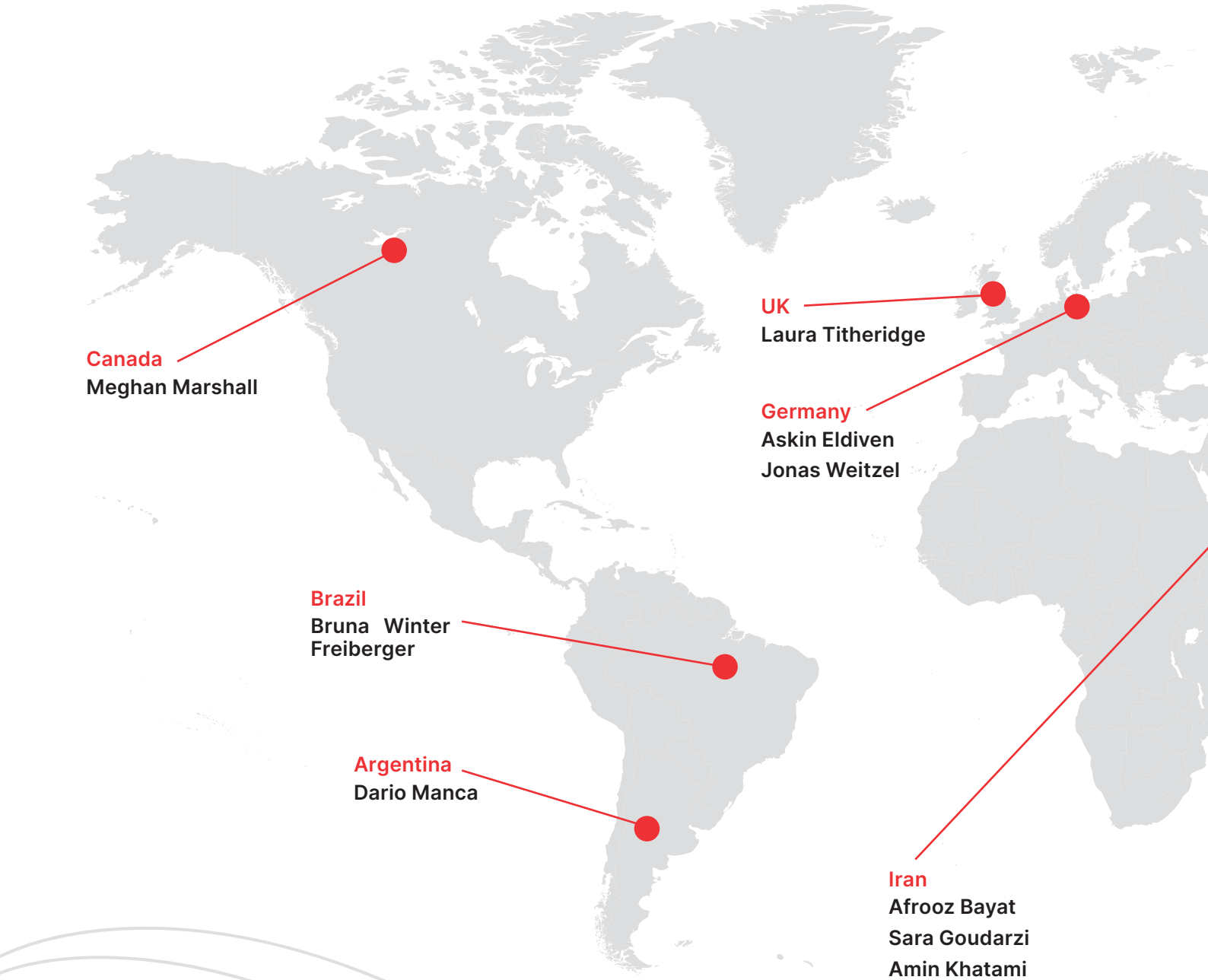
Franks Weerts

After 35 years of dedicated service to the Chemical and Process Engineering Department, Frank retired in April this year. Throughout his time in the mechanical workshop, Frank played a vital role in the success of countless teaching, research and industry-linked projects, many of which are now an enduring part of CAPE's legacy.

Frank was widely respected for his exceptional attention to detail, methodical approach, and unwavering commitment to safe and best-practice workshop standards. He was generous with his time and knowledge and took great pride in teaching students practical engineering skills, problem-solving techniques and professional workshop conduct.

His steady presence in the workshop and his willingness to support both staff and students made a lasting impact on the culture of the department. Frank's technical expertise, patience and mentorship helped shape generations of engineers, and his contribution will be remembered long after his retirement.

Postgraduates



Canada
Meghan Marshall

UK
Laura Titheridge

Germany
Askin Eldiven
Jonas Weitzel

Brazil
Bruna Winter Freiberger

Argentina
Dario Manca

Iran
Afrooz Bayat
Sara Goudarzi
Amin Khatami
Kaveh Rahmani
Zeinab Rahnama
Goudarz Taherkhani

China
Caihong Chen
Jiaojiao Du
Qianhui Li
Tianzhao Liu
Yiwei Shao
Chunyan Zeng
Chichi Zhang
Zepeng Zheng

Pakistan
Maleeha Hafeez

Nepal
Pitambar Podel

Republic of Korea
Soongseok Yoon

Hong Kong
Lok Sze (Vicky) Tsui

Philippines
Jhulimar Castro

Malaysia
Pavithran Devananthan
Angie Tan

Yemen
Mahmood Saeed

Indonesia
Harry Cahyanto

Sri Lanka
Isanthi Ranathunga Liyange

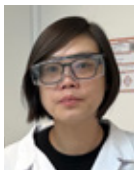
India
Sajith Kaniyadan Baiju
Ashwin Sidharth Narashima Moorthy
Vidhi Phutela
Harikrishnan (Harry) Raghavan
Shallu Verma

Aotearoa, New Zealand
Luca Alessio
Jaye Barclay
Ngāti Apa, Ngāti Hauiti, Te Āti-Haunui-a-Pāpārangi
Emma Britton
Tessa Burns
Katie Ellis
Christina Howat
Hemi Johnson
Gavin Lyall
Glen McClea
Jack Muir
Anna Pryor
Matt Rennie
Zoe Shuker
Dana Stone
Matthew Suter
Campbell Tiffin
Holly Wellford
Simon Winship

Department of Chemical and Process Engineering 2025

Virginia Baird, Emma Britton, Luke Brown, Joshua Brownrigg, Phoebe Burns, Duncan Butler, Archie Chandler, Rohan Damania, Emma Dobbie, Ruby Foskett, Claudia Fowler, Nathalie Fuentes, Louis Grant, Suzanna Haliburton, Thomas Hamilton, Madeline Hardy, Alex Hickman, Julius Hlavac, Naomi Holland, Jessica Scatchard, Matt Larsen, Stella Leong, Samuel Lund, Ethan Mackay, Charlotte Marshall, Andrea Mascarenhas, Annelise McKenie, Grace McMahon, Alice Napier, Ashlee O'Donovan, Hannah Patterson, Lucy Potter, Emily Rampton, Samantha Reilly, Fergus Robertson, Thomas Simpson, James Small, Rebecca Squire, Thomas van Asch, Astrid Veal, Harvey Williams, Tobin Wilson, Connor Winmill (not pictured: Frederick Coleman, Felix Finlayson-Hood, Lizzy McIntosh, Ping Ping Sheridan, Baily Robinson)

Post Doc Staff



Dr Chichi Zhang

Chichi's research focuses on developing CO_2-storing building materials to support global decarbonisation efforts through carbon capture and storage technologies.

She investigates alternatives to Portland cement and studies the interaction between CO_2 carriers and cementitious materials to engineer construction materials capable of capturing and storing carbon over their lifetime. Her work aims to develop carbonatable cements that solidify concentrated sources of CO_2 during production and continue to absorb atmospheric CO_2 during use, transforming cement from a carbon emitter into a long-term carbon sink.

Chichi's research also examines the properties of CO_2 carriers, including carbon density, release rate, cost and environmental impact, while ensuring minimal loss in material performance. Through this work, she contributes to redefining cement as a net-zero construction material with global potential for carbon capture.

Dr Danish Laidin

Danish's research focuses on developing biological technologies to mitigate methane emissions from agriculture, with an emphasis on overcoming gas–liquid transfer limitations and advancing scalable, sustainable treatment systems.

He investigates two complementary strategies:

- Bioaerosol systems – using aerosolized methanotrophs for the downstream processing of methane-laden air from dairy barns.
- Bio-trickling filters – applying solubility enhancers such as silicone oil to improve gas–liquid mass transfer and bioprocess efficiency.

Danish also works on bio-electrochemical systems for nitrate removal, studying how poised cathodic potentials influence microbial communities and denitrification pathways. His interdisciplinary background in bioprocess engineering, microbial systems design, and environmental biotechnology supports his goal of advancing sustainable technologies for climate and water resilience.

Dr Pitambar Poudel

Pitambar's research focuses on the preparation and modification of electrode materials for clean and sustainable energy storage applications.

He conducts experiments on electrode modification, performs material characterisation, and analyses electrochemical performance to optimise electrode design. Alongside his laboratory work, he continues to disseminate his PhD research through journal publications, maintaining continuity between his doctoral studies and current postdoctoral research.

Pitambar's work advances the development of innovative electrode materials that support the transition toward renewable and efficient energy systems.

Dr Johann Land

Johann's research focuses on developing low-carbon, locally produced cements that can act as long-term carbon sinks, supporting New Zealand's transition toward net-zero emissions.

Working in partnership with Earth Sciences New Zealand (formerly GNS Science) and industry stakeholders, Johann designs and evaluates CO_2-sorbent particles for carbonatable cements. He develops experimental devices and applies statistical modelling to understand how multiple parameters influence the carbonation of concrete and the full utilisation of captured carbon.

By combining materials science and industrial process design, Johann aims to create practical, economical and scalable solutions that enable the cement industry to significantly reduce its carbon footprint and meet national climate goals.

Dr Devyani Holmes

Before joining CAPE, Devyani worked as a Postdoctoral Research Fellow at the School of Biological Sciences, where she investigated the cellular composition of atherosclerotic plaques and their relationship to inflammatory status in stroke patients.

Her current research focuses on developing 3D-printed, biodegradable, cell-free scaffolds that guide the directional outgrowth of neurons after spinal cord injury. She employs bioimprint technology, melt electro-writing (MEW), and paracrine doping to design biomaterials that promote targeted neural regeneration.

Devyani's work integrates biochemistry, materials science and tissue engineering to advance the field of neural repair and regenerative medicine.

Dr Amr Morssy

Amr obtained his PhD in Artificial Intelligence from Victoria University of Wellington (VUW), New Zealand.

Prior to joining CAPE, Amr worked on a project funded by GNS Science, where he applied machine learning models to tsunami forecasting and modelling, improving the speed and accuracy of existing prediction methods. He now collaborates with Professor Daniel Holland on developing AI-driven tools to accelerate the prediction of NMR shifts of molecules in solution.

This research combines machine learning, computational chemistry, and environmental modelling to advance scientific discovery and data-driven sustainability solutions.

Research and Commercialisation

Enagain

The future company Enagain is the embodiment of 6 years research led by Matthew Cowan and Gavin Hedley from the Chemical and Process Engineering department. Their fundamental research into a new gas separation process design has been embodied in a prototype unit operating at Burwood Landfill since February 2025.

The Enagain team's technology is being utilized for the purification of raw landfill gas into renewable natural gas. They continue to be inspired by and contributing to the UC Research strengths by:

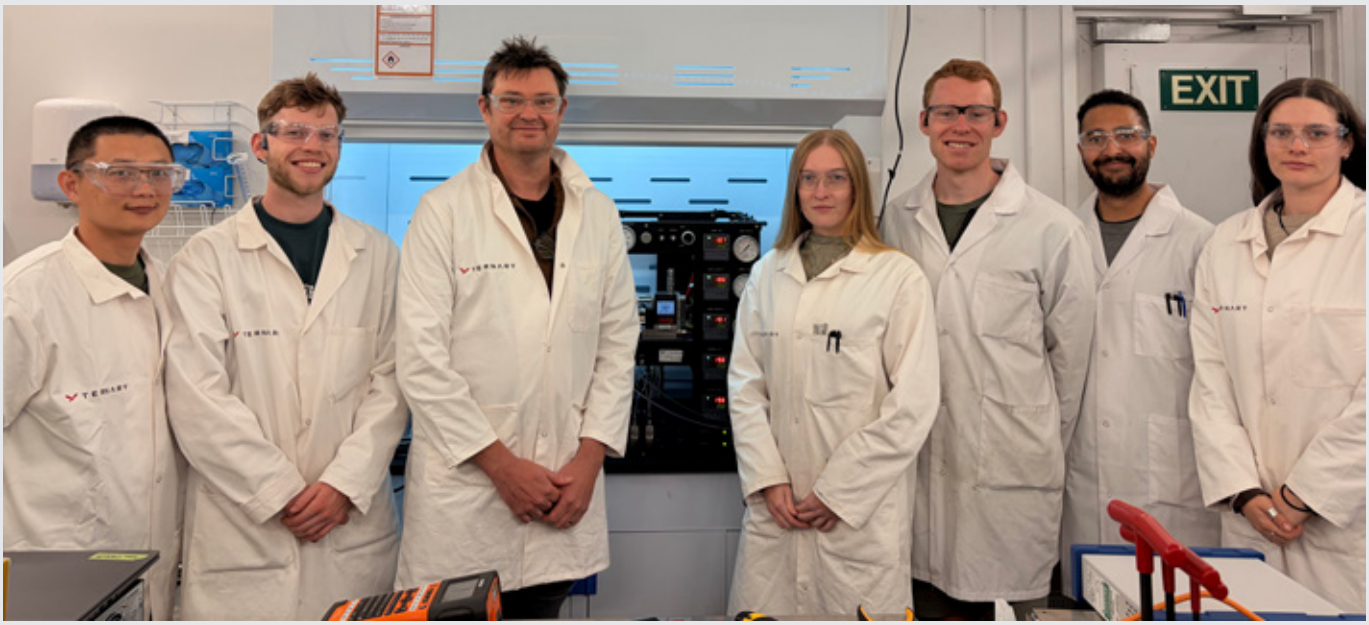
- Helping Aotearoa's industries survive by producing renewable natural gas to compensate for the decline in Aotearoa's natural gas reserves.
- Reducing the carbon intensity of fuels by replacing fossil fuel natural gas with renewable natural gas.
- Reducing the global warming impact of landfills by financially incentivising the capture of landfill gas to reduce methane emissions.

The success of this long-term project is attributed to the hard work and dedication of the team and the environment and leadership in the Department of Chemical and Process Engineering, which encourages academics to pursue practical application of their research and provides the freedom for academics to deploy discretionary funds to areas of greatest utility.

The team has been particularly grateful to multiple sources of support, particularly the Faculty of Engineering for a $5000 strategic research grant in 2023 that supported the project through a critical juncture; to Kiwinet for supporting market validation and a pilot unit; to the MacDiarmid Institute for commercialization support; and to the Aurora Climate Programme for business model development.

Top: Matthew Cowan, presenting for Enagain at the 2025 Aurora Climate Summit (Photo credit: BusinessDesk)

Left: Jo Hendy, CEO of the Climate Change Commission visiting the Burwood Prototype Site.



Ternary Kinetics – A New Approach to Clean Energy

Ternary Kinetics is developing a new liquid energy system that can be handled using the same infrastructure as today's conventional fuels, but without releasing carbon into the atmosphere.

The company's goal is to create a safe, practical, and scalable pathway for storing and transporting clean energy, helping accelerate the transition to a low-carbon future.

Working in Christchurch, Ternary has been able to establish custom laboratory facilities within the Department of Chemical and Process Engineering. This close relationship with CAPE has provided the ideal environment to develop and demonstrate new technology, while also showcasing how industry and academia can collaborate to drive innovation. Ternary has already hired six UC PhD graduates and is continuing to expand its team, with the ambition of supporting future undergraduate and postdoctoral research projects.

Gasifier

As part of Ternary's contribution to CAPE, they funded the redesign and upgrade of key areas within the Special Purpose Laboratories (D171, D173 and D174). This major upgrade marked the end of an era for the iconic CAPE gasifier, which had stood as a centrepiece of the department for more than a decade.


Before


After

The space once occupied by the gasifier is now unrecognisable and is being transformed into a modern analytical laboratory, designed to optimise the use of available space and significantly enhance research capability.

This redevelopment supports the continued growth of the department by creating flexible, high-quality laboratory environments that better meet the evolving needs of both industry-led research and academic innovation. The project was delivered through a strong collaborative effort between the CAPE technical team, Facilities Management, and the Ternary team, reflecting a shared commitment to strengthening infrastructure and enabling future-focused research and teaching.


Chemical and Process
Engineering Wing


Engineering
New Zealand
ENVI
AWARDS.
2025 FINALISTS
STUDENT ENGINEER AWARD

Teaching and Learning

Final year Student Field Trip

In April, thirty 4th year CAPE students participated in a three-day South Island field trip. The trip was designed to provide students with valuable exposure to real-world engineering practice across a range of industrial sectors.

The group departed from the University of Canterbury, visiting Aviemore Dam to learn about hydropower generation and Cardrona Distillery, where they explored the production of gin, whisky, and vodka.

On the second day, the group visited the New Zealand Aluminium Smelter at Tiwai Point and HWR in Invercargill, which is in the process of converting its fleet to co-injection of hydrogen. These visits offered valuable insight into the challenges and innovations driving New Zealand's transition to cleaner energy technologies.

The final day featured a visit to OceanaGold's Macraes Operation near Dunedin, where students gained first-hand understanding of large-scale mining and mineral processing operations before returning to Christchurch.

This field trip provided an exceptional opportunity for students to connect theoretical learning with real industrial practice. It fostered a deeper appreciation of how engineering principles are applied in diverse sectors across Aotearoa New Zealand. The trip was highly valued by both students and staff, with participants noting its strong contribution to their professional development and industry awareness.

Scholarships and Awards

We are proud of our colleagues' achievements in 2025, including awards of national and Australasian significance and equally important awards closer to home.

Professor Aaron Marshall was awarded the 2025 Pickering Medal from the Royal Society of New Zealand for innovation and excellence in technology that has generated significant impact and commercial success

Associate Professor Matthew Cowan was part of an international team of researchers who won the Dalton Horizon Prize from the Royal Society for their work on hybrid glasses.

Finn Trass: Engineering New Zealand ENVI Award for Student Engineer

Associate Professor Matthew Cowan: Finalist in the ENVI Engineering Educator category

Ben Sheppard: Erasmus Mundas Scholarship

Joe Francis, Anna Tsybizova, Gemma Hollway and **Angus Johnson**: winners of the NZGA scholarships for 2025.

Associate Professor Ken Morrison: ANZFChE Awards of Excellence for Student Experience and Development Chemeca Awards

Jenny Culliford (CAPE alumni): Chemeca Medal – the most prestigious Chemical Engineering award in Australasia.

Lucy Grigg, Aaryan Sharma, Linette Lengkeek and **Emelia Patrick**: IChemE Australia/New Zealand Design prize

Gavin Lyall, Anna Tsybizova, Thomas Davidson, Nils Bachmann, and **Matt Larsen**: Hackathon Challenge Winners 2025

Katie Ellis: Fullbright Scholarship

Professor Aaron Marshall and **Dr Rachael Wood**: MBIE Smart Ideas Funding

Shallu Verma: 2025 UC Student Award for Health and Safety

Pacific H2O and Mā te rauhiringa tātou e ora: Powerful Solutions teams: University of Canterbury Hapori Community of Practice Award.

'Best student Oral Presentation' award at the annual New Zealand Microbiological Society (NZMS) conference - **Meghan Marshall**

Faculty of engineering established teaching award: **Associate Professor Matthew Cowan**

Phoebe Burns won third prize worth $1000 at the Final Year Project showcase

Engagement and Outreach

Pūhoro

In 2025, CAPE, in collaboration with the UC Māori team, participated in two Pūhoro events, hosted at Ara Institute of Canterbury.

Both events hosted approximately 80 Year 12 and 13 students from various high schools across Canterbury. This year, CAPE delivered a Hydrogen Electrolysis laboratory, where students created hydrogen gas from water via electrolysis. Students first built their own electrolyser, then generated sufficient hydrogen gas to conduct a 'pop test' to confirm the presence of hydrogen.

Women in Engineering

Throughout 2025 CAPE participated in two Women in Engineering events.

The first, held in January was WiE CAN, an annual five-day, four-night residential programme that features interactive workshops, presentations, and fun social activities. The programme is for female Year 12 students who have an interest in innovation, problem-solving, and making a difference in society. In August CAPE hosted four workshops for Year 9 and 10female high school students as part of the EngineeringHER programme.

The full-day event is filled with workshops and demonstrations, as well as a variety of inspiring speakers from across engineering disciplines and provides students with the opportunity to experience what it means to be an engineer.

Aukaha Tau 12

At Aukaha Tau 12, taiohi Māori received information about courses and degrees offered at UC and what is required before starting university.

In addition, a range of interactive sessions allowed taiohi Māori to explore what UC has to offer. In 2025, CAPE hosted a session that included engaging discussions on the sustainability of hydrogen as a clean fuel source and how chemical and process engineering contributes to a more sustainable future through innovations in energy and materials.

Curious Minds

CAPE's outreach team led by Matthew Cowan successfully completed two outreach visits to Tongan high schools, run by PhD students Shallu Verma, Christina Howat and Meghan Marshall in conjunction with Dr. Taniela Lolohea (AUT).

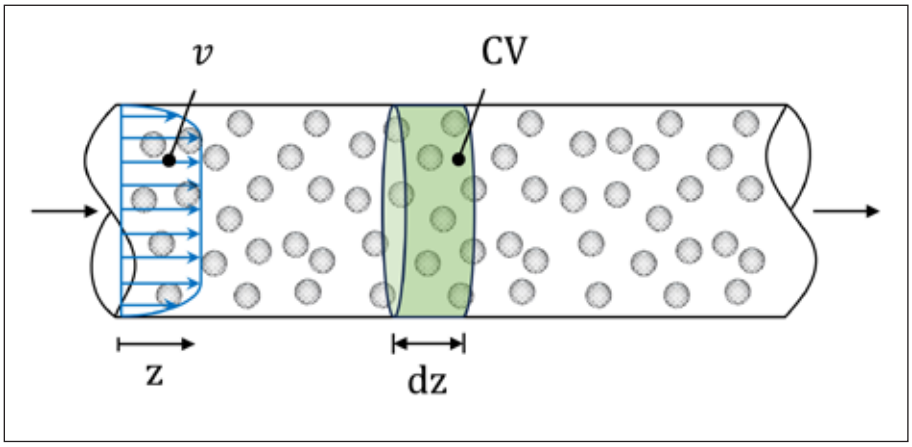
This trip was made possible by external funding from the MacDiarmid Institute and leveraging the resources produced in the 2024 MBIE Curious Minds project led by Matthew Cowan.

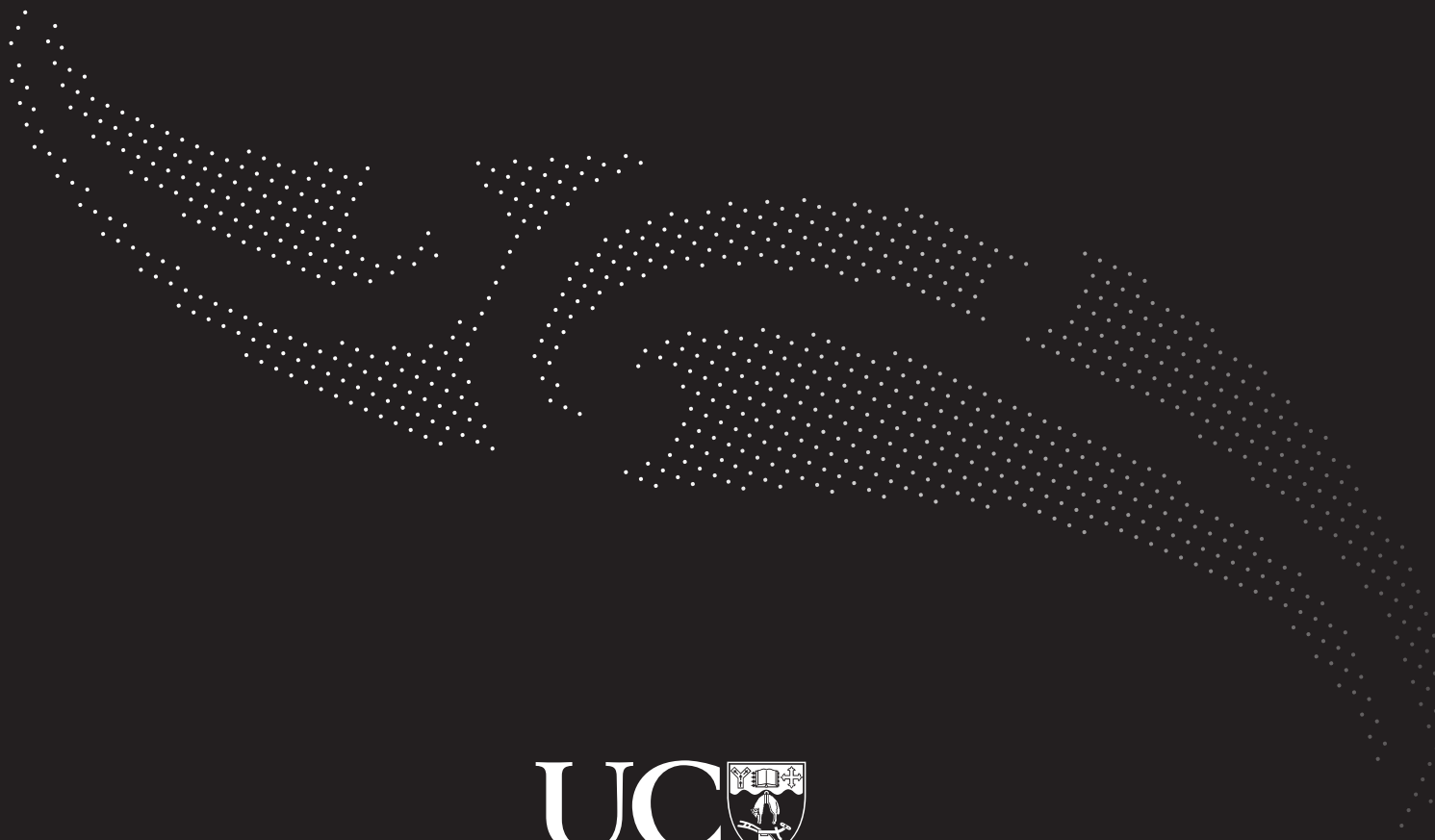
The team adapted online resources from the Pacific H2O water testing lab and energy module Mā te rauhiringa tātou e ora: Powerful Solutions, to an offline format compatible with Tongan schools. These labs allowed students to conduct water testing and learn about solid fuels and renewable

energy. The Tongan students had not experienced lab work before and were thrilled at the opportunity to explore.

This was a fantastic opportunity for the faculty to form a long-term engagement with Tongan high schools, helping to establish an enduring presence in Tonga, and a connection to the Pacific Community.

CAPE in Action





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