THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

UQ Dow Centre for Sustainable Engineering Innovation

Annual Report 2023


UQ DOW CENTRE

Contents

Message from the Vice-Chancellor, President, and Chair of the UQ Dow Centre Advisory Board

As a centre of innovation in the area of sustainable energy, The University of Queensland's (UQ) Dow Centre is dedicated to developing practical solutions to decarbonise the global economy and mitigate the impacts of climate change.

Now in its 9th year, the Centre is comprised of a team of people who are passionate about progressing the global transition to net zero carbon emissions by conducting research related to four key themes: (1) socio-techno-economic analysis, (2) e-mobility, (3) carbon dioxide utilisation, and (4) green hydrogen production. Under each of these themes, the researchers from the UQ Dow Centre are continuing to make significant contributions to advancing the energy transition.

One of the Centre's most important achievements this year was the official launch of the Net Zero Australia Study in April. The result of a collaboration between UQ, The University of Melbourne, Princeton University, and the Nous Group, this significant national study outlines the scale and complexity involved in reducing Australia's carbon footprint to net zero by 2050.

Drawing on the expertise of academics from across mining, energy, agriculture, atmospheric science, economics, politics, and engineering, the Net Zero Australia Study provides a detailed outline of the changes that will be needed in Australia to realise our national goal of net zero emissions by 2050. The study has been widely praised and welcomed, by government and industry alike, as the most comprehensive roadmap we have for tackling Australia's energy transition.

Another highlight of this year was the establishment of the Australian Research Council Centre of Excellence for Green Electrochemical Transformation for Carbon Dioxide (ARC CoE GETCO2), led by Professor Xiwang Zhang. This new Centre of Excellence aims to sustainably convert carbon dioxide into valuable products, such as chemicals and fuels. This is important and exciting research, with enormous potential.

This year, the UQ Dow Centre team continued to strengthen ties with a range of international partners and engaged in collaborative research initiatives aimed at helping to solve the shared global challenge of energy transition and climate change mitigation. Representatives from the UQ Dow Centre visited Dow Chemicals in Shanghai and the Dow Middle East Innovation Centre in Abu Dhabi, with an eye to strengthening ties and fostering future collaboration. The Centre also hosted several events that attracted leading global researchers and industry partners, including forums that explored the latest research and innovations in materials science and hydrogen production.

UQ Dow Centre researchers published more than 60 journal articles in 2023, many of which were published in high impact journals, as well as 10 scientific reports in their fields of expertise.

I would like to especially acknowledge and thank Professor Xiwang Zhang and Associate Professor Simon Smart for their leadership of the UQ Dow Centre over the past year. And I look forward to seeing how the highly talented and passionate team at the UQ Dow Centre continue to contribute to global sustainability efforts in the years and decades ahead.

Professor Deborah Terry AC

Vice-Chancellor and President
The University of Queensland
Chair of the UQ Dow Centre Advisory Board

Director's report

It has been a year since I commenced as the Director of the UQ Dow Centre, and I am privileged to be part of a team that continually improves and innovates to resolve one of our world's biggest environmental questions: 'How can we contribute towards Net Zero?'.

I am grateful for the support I received since joining the University of Queensland, making my move from Monash University smooth and seamless. Centre research activities have started to gain traction, with several new members recruited to support these activities.

This year saw the launch of the Net Zero Australia project, a study which applies the approach pioneered by Princeton University's Net Zero America study to Australia in a technology-neutral, evidence-driven and non-political manner to illustrate net zero pathways that reflect the boundaries of the Australian debate for both our domestic and export emissions. The study examines scenarios and pathways to decarbonise the energy, industrial and transport sectors whilst enhancing the natural land sink. It also considers the contribution that Australian exports can make to global decarbonisation whilst potentially offsetting the national and regional impacts caused by the decline in traditional fossil-fuelled industries.

Given the many sources of uncertainty and the contested nature of the net zero challenge, the scenarios in the study explored variations in the rate of electrification, renewable build rates, limits on fossil fuel use, and limits on the usage of carbon capture, utilisation and storage (CCUS).

Irrespective of the pathway taken, achieving net zero emissions for both Australia's domestic and export energy systems is an immense challenge and a once-in-a-generation, globally significant and nation-building opportunity. We will have to deliver an energy transformation that is unprecedented in scale and pace. We have the opportunity to transform our exports to be an essential contribution to the global decarbonisation effort. To do so, we will need to invest in our people and our lands to share benefits and reduce impacts.

Additionally, UQ Dow Centre researchers and affiliates successfully attracted an estimated of AUD$47 million of external research funding. The most significant research funding received is from the Australian Research Council through the Centre of Excellence for Green Electrochemical Transformation of Carbon Dioxide (CoE GETCO2).

This 7-year project involves 12 universities and 7 industry partners, both nationally and internationally, and will position Australia as a global leader in carbon dioxide transformation. I believe that the research impact that we create will be amplified through a team of like-minded researchers and industry partners working collaboratively towards one common goal and I am excited for what lies ahead.

In 2023, engagement activities in the form of seminars, forums, and presentations from key experts in the field were organised to attract collaborations between academic researchers and industry partners in the field of sustainability. I hope that through such engagements, researchers can connect and pitch their ideas to potential industry partners, building a network of field experts which can work together to come up with solutions that can impact society.

I would like to take the opportunity to thank the advisory board members for generously providing strategic advice and direction for the UQ Dow Centre. Their support and generosity have brought the centre to where it is today.

I would also extend my appreciation to Associate Professor Simon Smart, who led the Dow Centre through challenging times, and paved the way for a smooth transition in the leadership. Lastly, I would like to thank all UQ Dow Centre staff and students for their contributions and support. I look forward to more opportunities and achievements in 2024.

Professor Xiwang Zhang

Endowed Dow Chair in Sustainable Engineering Innovation

Director of the UQ Dow Centre

Professor and ARC Future Fellow at the UQ School of Chemical Engineering

People

Advisory board members

Professor Deborah Terry AC

Vice Chancellor and President, UQ, and
Chair of the UQ Dow Centre Advisory Board

Professor Deborah Terry AC is a highly experienced leader in the Australian university sector – and an internationally recognised scholar in psychology. She was made an Officer in the General Division of the Order of Australia (AO) in June 2015, in recognition of her distinguished service to education in the tertiary sector. Since August 2020, Professor Terry has served as Vice-Chancellor and President of The University of Queensland (UQ). Prior to this, she was Vice-Chancellor of Curtin University in Western Australia, from 2014 to 2020.

Having grown up in Perth and Canberra, Professor Terry completed her PhD in Social Psychology at the Australian National University in Canberra. She moved to Brisbane in 1990 and progressed through a range of academic and senior leadership roles at UQ.

Professor Terry is a Fellow and past President of the Academy of Social Sciences in Australia and an appointed member of the Australian Research Council Advisory Council. She currently serves on the Boards of AARNET, Brisbane Girls Grammar School and Westpac Scholars, and is also as a member of the Universitas 21 Executive Committee.

Ms Karen Dobson

Managing Director
Dow Australia and New Zealand

Karen Dobson is Managing Director of Dow Australia and New Zealand, based in Melbourne, Australia. In this role she is responsible for Dow's business and operations and advancing the company's strategy and reputation across Australia and New Zealand.

Karen joined Dow as a graduate chemical engineer at the Altona manufacturing plant in Melbourne and has over thirty years' experience with Dow. She has held a variety of technical, marketing and business roles including Global Marketing Director for membrane technologies in Dow Water & Process Solutions, Asia Pacific Corporate Marketing & Business Development Director, Global Business Director for mining in Dow Oil, Gas & Mining and Global Commercial Director for Dow Olympic and Sports Sponsorships. Karen has extensive international business experience having been posted to roles in Hong Kong, Sydney, Minneapolis and Shanghai.

Dr Rui Cruz

Global R&D Director for Industrial Solutions

Dr. Rui Cruz is currently the Global R&D Director for Industrial Solutions at Dow, responsible for the business innovationpipeline and a global organization dedicated to technical services, process, product and application development for a diverse pool of technologies dedicated to enabling manufacturing at our customers, with focus in key market segments among which Crop Defense, Performance Lubricants, Electronics and Coatings. He joined Dow in Brazil in 2001, having worked in Human Resources, Customer Services, Technical Services, and Research and Development for several different businesses and technologies. In 2010 he moved to Freeport, Texas, serving as the leader for Polyglycols and Surfactants R&D and later for Epoxy Process Research, Amines and Chelants, Plastics Additives and Oil and Gas. Dr. Cruz studied Chemical Engineering at the Polytechnic School of the University of São Paulo and the Karlsruhe University in Germany and holds a PhD in Chemical Engineering by the University of São Paulo, having a strong background in modelling, process evaluation, product and application development, pulp and paper technology, alternative feedstocks and biotechnology.
In 2014, he received the prestigious HENAAC Great Minds of STEM Professional Achievement award.

Ms Julia Woertink

Chief Technology Officer for Dow Asia Pacific

Julia Woertink is the Chief Technology Officer for Dow's Asia Pacific region. In her 14 years with Dow, she has held a number of technical, leadership, and strategy roles across multiple businesses including Electronic Materials, Packaging & Specialty Plastics, and Core R&D. She has led global R&D departments and managed technical pipelines across multiple businesses and has had strategic oversight over Dow's new business development, external partnerships, and disruptive research portfolios. At Dow, Julia has also held roles in R&D Strategy and was responsible for the R&D integration activities related to the DowDuPont merger and subsequent spins. Julia has a diverse technical skill set in product development, spectroscopy, catalysis, characterization, and inorganic chemistry. Julia's expertise lies in industrial research and development, global technical leadership, and technical strategy. She holds a Ph.D. in Chemistry from Stanford University and a B.S. in Chemistry from the California Institute of Technology and is currently based in Singapore.

Mr Noel Williams

Specialist Manufacturing Advisor,
UQ Alumni Representative

After a career with Dow spanning 36 years as a chemical engineer and later as a senior executive, Mr Noel Williams now works in consultancy as a Specialist Manufacturing Advisor and on charitable not-for-profit boards. Most recently in his career at Dow, Mr Williams was appointed as Vice President to lead Dow's Business Development efforts in Asia Pacific, while previously he had been President of Dow in South East Asia, Australia and New Zealand, all based in Singapore. Mr Williams is a past Chairman of the Board of the Institution of Chemical Engineers (IChemE) in Australia, and was a Governor and Treasurer of the American Chamber of Commerce in Singapore. He is a past President and Director of the Australian Plastics and Chemicals Industry Association (now Chemistry Australia). Mr Williams also serves as chairman on the UQ School of Chemical Engineering Advisory Board.

Professor Sue Harrison

Executive Dean, Faculty of Engineering,
Architecture and Information Technology, UQ

Professor Sue Harrison is the Executive Dean of the Faculty of Engineering, Architecture, and Information Technology (EAIT) at the University of Queensland., in which she is focused on the delivery of educational programmes and research that are leading edge in terms of technology, socially relevant, focused on addressing global challenges and deliver transformational excellence. Prior to this, she served as Deputy Vice-Chancellor: Research and Internationalisation at the University of Cape Town, where her portfolio included research, innovation, postgraduate studies, and internationalisation with a strong focus on embedding social responsiveness into research. Sue has a long, varied track record in management and leadership in the academic arena, built up through a 30-year academic career in the field of bioprocess engineering and its application to the circular economy, green technologies for the resource sectors and improved health care and well-being.

Professor Justin Cooper-White

Head of School, School of Chemical Engineering, UQ

Professor Justin Cooper-White is the Head of School & Professor of Bioengineering in the School of Chemical Engineering at The University of Queensland (UQ). He is Director of the Australian National Fabrication Facility – Queensland Node (ANFF-Q), Co-Director of the UQ Centre in Stem Cell Ageing and Regenerative Engineering (UQ-StemCARE), Chief Scientific Officer of Scaled Biolabs Inc., and Editor-in-Chief of APL Bioengineering, published by American Institute of Physics Publishing (New York). He has more than 200 high impact journal papers in the field of Bioengineering (including ACS Nano, Science Advances, Nature Communications, Nature Protocols, Nature Microbiol.), as well as six Worldwide patent families that have reached National Phase Entry in USA, Europe, and Australia in the areas of formulation design for agriproducts, microbioreactor arrays and tissue engineering scaffolds.

Professor Alan Rowan

Director, Australian Institute for Bioengineering and Nanotechnology, UQ

Professor Alan Rowan is Director of the Australian Institute for Bioengineering and Nanotechnology (AIBN) at The University of Queensland. He is a world renowned physical organic chemist and an ARC Laureate Fellow, who has performed his research at the interface of chemistry and biology with seminal and pioneering work on processive catalysis and functional self-assembly. His latest scientific achievement has been the development of the first truly biomimetic hydrogel which mimics the mechanic and functional properties of the extracellular membrane, which is now being developed commercially for wound dressing, drug therapeutic and cell growth. He has published more than 320 publications, cited more than 20,000 times.

Senior Staff

Professor Xiwang Zhang

Endowed Dow Chair in Sustainable Engineering Innovation, Director of UQ Dow Centre, ARC Research Future Fellow and Professor, School of Chemical Engineering, UQ

Professor Xiwang Zhang is the Endowed Dow Chair in Sustainable Engineering Innovation at the University of Queensland, Director of UQ Dow Centre, and Director of ARC Centre of Excellence for Electrochemical Transformation of Carbon Dioxide (GetCO2). He was the Founding Director of ARC Industry Transformation Research Hub for Energy-efficient Separation (EESep) and the Deputy Director of Monash Centre for Membrane Innovation (MCMI) at Monash University before he moved to UQ in 2022. Professor Zhang has more than 15 years of R&D experience in both academia and industry with demonstrated achievements in technology development and translation. His research focuses on membrane and advanced oxidation technologies for energy-efficient separation, water and wastewater treatment, resource recovery, green chemical synthesis, and renewable energy generation. He was the recipient of the prestigious ARC Australian Research Fellowship, Future Fellowship and Monash Larkins Fellowship.

Associate Professor Simon Smart

Deputy Director of the UQ Dow Centre and Associate Professor, School of Chemical Engineering, UQ

Simon Smart is Associate Professor in the School of Chemical Engineering at The University of Queensland. His research is centred around the sustainable production and use of energy and chemicals - including the development of enabling technologies and processes for the production of clean energy, materials and water. Simon has been involved in the Rapid Switch initiative, in relation to pathways to decarbonisation of the global economy, since its inception at the UQ Dow Centre for Sustainable Engineering Innovation, and is the UQ project leader for the Net Zero Australia project (a collaborative partnership with the University of Melbourne, Princeton & Nous).

Simon has 126 publications including 9 book chapters and 105 international journal articles at an h-index of 35, with two Highly Cited papers in chemistry and geoscience. He was selected as one of the 2018 Class of Influential Researchers by Industrial & Engineering Chemistry Research. Simon was awarded a prestigious Early Career Researcher Fellowship in 2012 from the Queensland Government to investigate silica based membranes for desalination applications in the coal seam gas industry, and a prestigious UQ Foundation Research Excellence Award for work on 'Low CO2 Iron and Petrochemicals Production' in 2016. Simon was the Secretary for the Membrane Society of Australasia from 2011 – 2013, where he served on the board of directors from 2010–2014.

Professor Lianzhou Wang

Professor and ARC Australian Laureate Fellow, School of Chemical Engineering, UQ

Senior Group Leader, Australian Institute for Bioengineering and Nanotechnology, UQ

Professor Lianzhou Wang an Australian Research Council (ARC) Australian Laureate Fellow in the School of Chemical Engineering and Australian Institute for Bioengineering and Nanotechnology (AIBN). He received his PhD degree from Shanghai Institute of Ceramics, Chinese Academy of Sciences in 1999. Before joining UQ in 2004, he has worked at two leading national research institutions (NIMS and AIST) of Japan as a research fellow for five years. Since joining UQ, he has worked as ARC Queen Elizabeth II Fellow (2006), Senior Lecturer (2007), Associate Professor (2010), Professor (2012-now) and ARC Future Fellow (2012-16). He has won a number of prestigious Fellowships/awards and is an elected fellow of Royal Society of Chemistry and Academia Europaea. On professional services, he serves as the chair of National Committee for Materials Science and Engineering, Australian Academy of Sciences, and the President of Australian Materials Research Society.

Professor Liu Ye

Professor, School of Chemical Engineering, UQ

Professor Liu Ye is the Greenhouse Gas (GHG) research program leader at UQ urban water engineering. Her research is focused on sustainable environmental engineering, and she is dedicated to finding innovative and practical solutions to tackle challenges in achieving net zero emissions, climate resilience, and sustainability, particularly from urban wastewater systems. She has also received numerous scientific awards and is a Fellow of the Royal Society of Chemistry (RSC) and an elected member in the Strategic Council of International Water Association (IWA). She is also a member of the Australia Association for Engineering Education (AAEE) and Engineers Australia (EA). She currently serves as the Associate Editor of Environmental Science: Water Research and Technology and in the Editorial board of Engineering journal.

Professor Mark Hickman

Professor and Chair of Transport Engineering, School of Civil Engineering, UQ

Dr. Mark Hickman is the TAP Chair and Professor of Transport Engineering within the School of Civil Engineering at the University of Queensland. Prof. Hickman has taught courses and performed research in public transit planning and operations, travel demand modeling, and traffic engineering. His areas of research interest and expertise include public transit planning and operations, urban transportation planning, and the application of remote sensing technology for traffic management.

Professor Tapan Saha

Professor, School of Information Technology and Electrical Engineering, UQ

Professor Saha received his PhD from the University of Queensland in 1994. He joined the University of Queensland in 1996 and has been a Professor of Electrical Engineering since 2005. He is a Fellow of the Institute of Electrical and Electronic Engineers (IEEE) and the Institution of Engineers Australia. He is also a Chartered Professional Engineer (CPEng) of Engineers Australia and a Registered Professional Engineer of the State of Queensland (RPEQ).

Professor Saha is the founding director of the Australasian Transformer Innovation Centre and he also leads a number of programs and initiatives across UQ, such as UQ Solar, Power, Energy and Control Engineering Discipline and Industry 4.0 UQ Energy TestLab. His current research projects are in the fields of renewable energy integration to electricity grid and smart condition monitoring for transformers and other ageing assets.

Associate Prof. Jingwei Hou

ARC Future Research Fellow; Associate Professor, School of Chemical Engineering, UQ

Associate Professor Jingwei Hou received his PhD in Chemical Engineering from the University of New South Wales in 2015. He then joined the UNESCO Centre for Membrane Science and Technology (2015-2017) and University of Cambridge (2017-2019, affiliate of the Trinity College). In 2019, he joined the School of Chemical Engineering (UQ) as an ARC DECRA Fellow, which was followed by an ARC Future Fellowship in 2021. He is currently the group leader of the Functional Materials Engineering (FME) Lab. His main research focuses on understanding the physical properties of the microporous materials and translating them into useful devices for membrane separation, optics, energy storage and catalysis.

Associate Prof. Tom Rufford

Associate Professor, School of Chemical Engineering, UQ

Tom Rufford is an Associate Professor in the UQ School of Chemical Engineering and former ARC Discovery Early Career Researcher Award recipient (2014- 2016). Tom completed his BE and PhD degrees in Chemical Engineering at the University of Queensland in 2000 and 2009, respectively. Tom's PhD thesis investigated the use of porous carbon materials derived from waste coffee grounds for energy storage via hydrogen or supercapacitors on board electric vehicles. From 2001 to 2005 he worked as a process engineer and technologist on the crude distillation columns, naptha reformers and hydrogen purification plant at Shell's Geelong Oil Refinery. From 2010 to late 2012, Tom was a research fellow at the University of Western Australia working on natural gas processing and LNG production research projects with the UWA's Chevron Chair in Gas Process Engineering, Professor Eric May.

Dr Hong Peng

Amplify Senior Lecturer, UQ

Dr Hong (Marco) Peng is now Amplify Senior Lecturer at School of Chemical Engineering, the University of Queensland (UQ). He gained a Bachelor degree in Minerals Engineering and a Master degree in Microbiology at Central South University, China followed by a PhD degree in Chemical Engineering at UQ. Before joining UQ, he had industry experience as a chemical engineer at Olympic Dam site and Newcastle Technology centre, BHP Billiton. His research focusses on fundamental aspects of chemical engineering processes, with a specialisation in unlocking nucleation and crystallization phenomena via both experimental and molecular simulation approaches. Mr KS Chan has been appointed at UQ Dow Centre as an Adjunct Industry Fellow and he brings 30 years of industry experience in energy and technology innovation both domestically and abroad.

Dr Muxina Konarova

Advance Queensland Industry Research Fellow

Senior Lecturer, School of Chemical Engineering, UQ

Dr Muxina Konarova is Advance Queensland Industry Research Fellow (Mid-Career) and Senior Lecturer in the UQ School of Chemical Engineering. She gained her PhD in Chemical Engineering at Tokyo Institute of Technology, Japan. Dr Konarova has led four academia/industry projects since 2016, securing >$2M as lead CI and her team partnered with five large organisations under her Advance Qld Research (Early) and Mid-Career Fellowships, ARENA UQ, ARC-Linkage and Innovation Connections. Dr Konarova's research team focuses on the development of sustainable chemical processes and is directed to address climate change, waste utilisation and provide technical solutions for a circular economy.

Professional Staff

Dr Eloise Larsen

Centre Manager, Research Operations, UQ Dow Centre for Sustainable Engineering Innovation

Eloise Larsen is an accredited research manager with a PhD in microbiology from The University of Queensland. With a background in both academia and industry, Eloise is passionate about applying her unique skillset to support and foster high impact research. For almost a decade, she played a key role in the success of inter/nationally leading, industry-intensive research centres, the Australian Centre for Water and Environmental Biotechnology (ACWEB, formerly AWMC), and the CRC for Water Sensitive Cities (CRCWSC). She commenced as the Dow Centre Manager in June 2022.

Emilyn Tan

Acting Centre Manager, Research Operations, UQ Dow Centre for Sustainable Engineering Innovation

Emilyn Tan commenced as the Acting Dow Centre Manager in July 2023. Her previous role as a Lab and Quality Assurance Manager at the UQ Protein Expression Facility has given her broad project management skills and experience in customer service. In 2022, Emilyn won a UQ Award for Excellence in Innovation as PEF's Lab and Quality Assurance Manager, leading the ISO9001 accreditation process.

Catherine Johnson

Executive Assistant, UQ Dow Centre for Sustainable Engineering Innovation

Catherine Johnson commenced with the Centre in March 2023. Catherine has worked at UQ for over 12 years and has gained knowledge and skills in various departments across the University, which will certainly be utilised in her role as Executive/Administrative Assistant with the Centre.

Research Fellows

Dr Dia Smith Adhikari

Tritium E-mobility Research Fellow, UQ

Dr Dia Adhikari Smith is the Tritium E-Mobility Research Fellow at The University of Queensland's Dow Centre for Sustainable Engineering Innovation and the Transport Engineering Group (School of Civil Engineering). Her current research focusses on advancing the performance, economics, and uptake of E-Mobility globally, with a particular focus on the decarbonisation of both on-road and non-road heavy vehicles used in transport, construction, and mining sectors in Australia. Dia's research expertise in low and zero emission heavy vehicles powered by electric, hydrogen and advanced biofuels, has been demonstrated through several industry and government engagements to deliver decarbonisation feasibility studies, emissions modelling, cost benefit analyses, total cost of ownership scenarios and developing strategic roadmaps and recommended policy packages to achieve net zero emissions. Dia has a PhD in Power and Energy Systems Engineering from Glasgow Caledonian University, UK and worked as a Postdoctoral Fellow at the Centre for Integrated Renewable Energy Generation and Supply, Cardiff University, UK.

Dr Haijiao Lu

ARC DECRA Research Fellow, UQ

Dr Haijiao Lu obtained her dual bachelor's degrees in Science and in Engineering from Nankai University and Tianjin University (China) respectively in 2014. Supervised by Academician of Chinese Academy of Engineering Prof Jingkang Wang, she obtained PhD degree from Tianjin University in 2019. She worked as a postdoctoral research fellow at The Australian National University (ANU) in 2019-2021, and then at UQ with Prof Lianzhou Wang. In Jan 2023, she commenced as an ARC Discovery Early Career Researcher Award (DECRA) Research Fellow. Her research is characterised by its interdisciplinary feature, laying at the intersection of materials science, photo(electro)catalysis, and chemical engineering. Dr Lu has secured funding from the Australian Nuclear Science and Technology Organisation (ANSTO), 2023 Philanthropic grants for EAIT Early Career Researchers and 2023 QUEX institute accelerator grant. She has also received research awards including the 2022 Early Career Researcher Award (EAIT Faculty), the 2022 Research Excellence in Energy Nanomaterials (Nanomaterials Centre), and Inaugural (2023) Early Career Research Leadership Award (EAIT Faculty).

Dr Kai Li Lim

St Baker Research Fellow in Electromobility, UQ

Dr Kai Li Lim is the inaugural St Baker Fellow in Electromobility at The UQ Dow Centre for Sustainable Engineering Innovation. As a trained computer engineer with more than nine years of experience developing mobility and navigation frameworks, his early forays saw him designing navigational algorithms for mobile robots and indoor pedestrians. More recently, his applications employ techniques relating to data engineering, the Internet of Things, cloud computing, computer vision and deep learning, resulting in tangible products for real-time vehicle and infrastructural telematics and computer vision based autonomous driving. Kai Li received the BEng (Hons) degree in electronic and computer engineering from the University of Nottingham in 2012, the MSc degree in computer science from Lancaster University in 2014 and the PhD degree from The University of Western Australia in 2020, where he was fully supported by the Australian Government under the Research Training Program.

Dr Mike Tebyetekerwa

ARC DECRA Research Fellow, UQ

Dr Mike Tebyetekerwa is an incoming Australian Research Council (ARC) Discovery Early Career Researcher Award (DECRA) Research Fellow at the UQ Dow Centre (from 2024). He completed his PhD in Engineering at The Australian National University (ANU) in July 2022, where he studied advanced optical spectroscopy of semiconducting materials and their devices for energy technologies. Mike also holds a Master's degree in Materials Processing Engineering from Donghua University, Shanghai, where his research focused on fibrous materials for flexible energy storage. His current research at UQ involves integrating high performance fibrous materials and 2D materials for various applications, including catalysts/membranes for water oxidation/reduction, electrodes for energy storage and CO2 capture, and water treatment.

Dr Xiangkang Zeng

ARC DECRA Research Fellow, UQ

Dr Xiangkang Zeng is currently an ARC DECRA fellow. He earned his PhD in Chemical Engineering from Monash University, Australia in 2017. Prior to that, he obtained a Master in Fermentation Engineering and a bachelor's degree in Biological Engineering in 2012 and 2010, respectively at Jiangnan University. His current research is centred around the development of 2D functional catalysts, metal-organic frameworks (MOFs), and covalent-organic frameworks (COFs) for applications in renewable energy to chemical energy conversion, water treatment, and antibacterial purposes.

Dr Rijia Lin

ARC DECRA Research Fellow, UQ

Dr Rijia Lin obtained his PhD from the School of Chemical Engineering at the University of Queensland in 2016. His main research interests include metal-organic frameworks, membrane gas separation, and porous glass materials. He has published over 50 articles in high-impact journals. He was awarded the ARC DECRA fellowship and commenced his fellowship in July 2023.

Dr Zhe Yang

ARC DECRA Research Fellow, UQ

Dr Zhe Yang commenced as an ARC DECRA fellow in December 2023. He received his PhD degree in Environmental Engineering in 2018 at the University of Hong Kong. Yang was appointed as a research assistant/ postdoc fellow at HKU from Nov 2018 to July 2021 and was further promoted to Research Assistant Professor from July 2021 to Dec 2023. Yang has more than 10 years of R&D experience in membrane technology. His research interests mainly focus on the development of high-performance membranes for water purification and resource recovery.

Dr Zhiliang Wang

ARC Research Future Fellow, UQ

DDr Zhiliang Wang is an ARC Future Fellow in The University of Queensland. He has focused on renewable energy conversion processes, including water splitting, carbon dioxide fixation and methane conversion. He has accumulated rich experiences in the design of photocatalysts and photoelectrodes and achieved over 80 publications in highly ranked journals with over 7000 citations. He has received multiple awards, including the ARC DECRA award, J G Russell Award by the Australia Academy of Science, UQ FREA award and the ECR Research Award by UQ.

Dr Chao Xing

Dr Chao Xing commenced with the Centre in March 2023. He was awarded his Bachelor's degree in Science from Griffith University in 2019 and Bachelor's degree in Pharmaceutical Engineering at Dalian University of Technology in 2016. He then undertook his PhD in Chemical Engineering at Griffith University (2019- 2022), studying the application of two-dimensional material membranes in water purification and energy storage. His postdoctoral work involves the development of membrane-related equipment, and the application of two-dimensional material membranes in the fields of clean energy and protein separation.

Dr Ying Lu

Dr Ying Lu completed his PhD at UQ in 2022 in transport planning/behaviour. He is contributing his expertise in geospatial analysis towards the AURIN Green Australian Vehicle Ownership (GreenAVO) project, supervised by the St Baker E-Mobility Fellow, Dr Kai Li Lim. Dr Lu will spatially estimate the maximum transport emissions potential for each Australian region. He will be working on the GreenAVO project until the end of June 2023.

Dr Zhuyuan Wang

Dr Zhuyuan Wang commenced in Jan 2023, and is an active researcher in the field of membrane separation with 6 years of experience. Previously, he worked at a listed membrane manufacturing company in China (2016 2019), focusing on developing Polyamide Thin Film Composite (PA-TFC) for water treatment. He then commenced his PhD at Monash University under the supervision of Prof Xiwang Zhang and Prof Huanting Wang (2019-2023). He is currently investigating ion-exchange membranes and has developed a scalable production method which was twice awarded the "Best project of the year" from the ARC Industry Transformation Research Hub for Energy-efficient Separation (EESep).

Visiting Academics

Dr Chuanbiao Bie

Dr Chuanbiao Bie joined the Centre in November 2023 as a visiting scholar for a one-year term. He received his PhD in Materials Science and Engineering from Wuhan University of Technology in 2021 and is currently a postdoctoral researcher at the Laboratory of Solar Fuel of China University of Geosciences (Wuhan). His research interests focus on semiconductor photocatalysis, including H2 evolution, H2O2 production, CO2 reduction, and organic synthesis.

HDR Students

Mr Alister Sheil

Project/Research interests: Methane pyrolysis in molten salts to produce low emission hydrogen

Mr Gabriel Rioseco

Project/Research interests: Economics of energy systems, specifically the integration costs of variable renewables and their impact on the rate of deployment of renewables

Mr Gregory Siemon

Project/Research interests: Enterprise-wide optimisation in steelmaking

Mr Hao Zhang

Project/Research interests: Rational design and engineering of two-dimensional membranes for ionic and molecular separation

Ms Jie Yang

Project/Research interests: Development of membrane materials with high efficiency proton transmission ability

Mr Jindi Yang

Project/Research interests: Development of photocatalyst and bipolar membrane for sustainable production

Mr Junyang Zhang

Project/Research interests: Development of photocatalytic membranes for water purification

Ms Hongxia Zhang

Project/Research interests: Preparation of bipolar membranes and their application in CO2 reduction.

Mr Kaige Sun

Project/Research interests: Energy-efficient electrochemical CO2 capture for high-performance CO2 capture materials and devices

Miss Lijun Guo (visiting student)

Project/Research interests: Development of biomass materials for water purification

Mr Mark McConnachie

Project/Research interests: Novel process to produce near-zero-CO2 hydrogen and fuels through methane pyrolysis

Mr Mark Hodgson

Project/Research interests: Methods to mitigate CO2 emissions associated with the production of cement

Mr Ryota Okajima

Project/Research interests: Investigating bubbles and solid particle behaviour in molten metals/salts for hydrogen production technology through methane pyrolysis

Mr Umer Javed

Project/Research interests: Development of electrode nanomaterials for electrochemical energy conversion and storage devices

Mr Wenming Zhao

Project/Research interests: Sustainable Hydrogen Production from Used Water

Mr Xin Sun

Project/Research interests: Development of advanced polymer-based catalysts for efficient production of hydrogen peroxide from water, air, and sunlight.

Mr Xuefeng Li

Project/Research interests: Development of polymeric membranes for protein separation

Mr Zhonghao Xu

Project/Research interests: Constructing vertically-aligned, chemically-tailorable and porous 2D nanosheets for high-precision selective membranes

Achievements

Engagement

The UQ Dow Centre continues to achieve greatly in 2023 through engagements with internal and external stakeholders as well as success in research grants. Engagement styles with stakeholders are varied across research themes and the UQ Dow Centre team is often called upon on their expertise to provide feedback and opinions in various research of interest particularly E-mobility and Net Zero Australia.

Expert contribution

Expert contributions are usually through involvement in conferences, forums, and seminars. As a Tritium Fellow, Dr Dia Adhikari Smith is actively engaged in organising and speaking at academic and industry forums on transport decarbonisation, including the inaugural Electric Transport Industry Forum that was jointly hosted by RACQ, UQ, and QUT on 17th March 2023. The forum brought together researchers, industry leaders, advocates and government representatives to share insights and debate plans for the future of an electric transport industry in Queensland. Link to the forum can be found on https://www.racq.com.au/about-us/news-and-media/news/2023/3/key-sectors-unite-to-electrify-queenslands-transport-industry

Dr Dia was also a keynote speaker on a panel session to speak on 'Creating a sustainable future – Challenges and Opportunities' at the Australian and New Zealand National Council for Fire and Emergency Services Conference (AFAC) 2023 that was held in August 2023 as well as a keynote speaker at the Repower NetZero for Construction and Mining Conference in Nov 2023, where her expertise in decarbonising heavy vehicles will bring much value in shaping the future of energy in mining and construction.

Her expertise was also called upon by the Federal Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts in Canberra to present her research proposal on the EV-Biofuel Range Extender. This is in collaboration with the RACQ and QFES teams, focussing on developing EV-biofuel REX solutions for hard-to-decarbonise edge use cases. These critical areas include sectors like Fire & Emergency, Law Enforcement, Forestry, Agriculture, and Defence, often operating in remote locations.

The Net Zero Australia project led by Associate Professor Simon Smart has produced numerous briefings or presentations throughout 2023. Associate

Professor Smart has presented in several government and industry meetings throughout the year to unfold findings from Net Zero Australia. The stakeholders involved include, but not limited to, the Department of Climate Change, Energy, Environment and Water, Department of Prime Minister & Cabinet, Department of Industry, Science and Resources, Dept of Agriculture, Fisheries & Forestry – Climate Strategy Group and the Australian Energy Council.

The Net Zero Australia project led by Associate Professor Simon Smart has produced numerous briefings or presentations throughout 2023. Associate

Professor Smart has presented in several government and industry meetings throughout the year to unfold findings from Net Zero Australia.

Image above: Panel session in the Hydrogen for Queensland seminar (from left to right): Dr Matthew Brannock, Water for Future Fuels Lead at GHD; Susan Mallan, Director of Outlook Energy Advisory Pty Ltd; Mr Peter Goggin, Hydrogen Development Manager at Stanwell Corporation; and Professor Xiwang Zhang, Director of the UQ Dow Centre.

National and International Collaboration

UQ Dow Centre intentionally strives to reach out to new and existing industry partners to build connections and discuss opportunities for joint proposals or potential collaborations in student training and education. This includes, but is not limited to, visits to Dow Chemical China, King Abdullah University of Science and Technology (KAUST) and Dow Middle East Innovation Centre (MEIC).

During Professor Xiwang's visit to Dow Chemical China in June 2023, he was welcomed by the R&D Director for Asia Pacific at Shanghai Dow Chemical where discussions on opportunities for joint proposals and student co-supervision were initiated. His visit to KAUST in October 2023 was an invitation to give a platinum presentation at KAUST's School of Chemical Engineering. He also took the opportunity to meet Khaled Abou Ghoneim (Associate R&D Director) and his team from the Dow Middle East Innovation Centre (MEIC) where potential collaboration between Dow, KAUST and UQ, particularly on student training and education were discussed.

The UQ Dow Centre has contributed their expertise through various briefings and presentations in specific topics like sustainability, E-mobility and decarbonisation. With the UQ Dow Centre being part the Net Zero Australia research work, the team has continued to present their findings and learnings to governments and industry partners to provide insight into what needs to be done to achieve Net Zero in Australia. Associate Professor Simon Smart hosted a workshop on Pathways to net zero emissions by 2025 at the third national State of Energy Research Conference focused on partnership and collaboration – between researchers, with industry, with the innovation ecosystem, with the finance system and with communities. This workshop was joined by panel speakers, Maria Lopez, PhD student from University of Melbourne, Jamie Lowe, CEO National Native Title Council, and Dr April Reside, UQ School of Agriculture and Food Sciences.

The UQ Dow Centre also co-hosted the Hydrogen Energy for Queensland seminar with the Australian Academy of Technological Sciences and Engineering (ATSE) to create opportunities for engagement and collaboration between researchers and industry to discuss hydrogen as a sustainable energy source and how Queensland can play a role in this emerging industry. This event, aligned with the state's aspiration for net-zero emissions, cast a spotlight on hydrogen's vital role in Queensland's evolving energy landscape and has attracted more than 150 people attending in-person, with a third of the audience from industry. The discussion session were led by a panel of experts from academia and industry and the discussion topics include government policies and initiatives in the hydrogen industry as well as the technological insights and market development surrounding hydrogen.

The UQ Dow Centre was privileged to host Noble Laureate Professor Sir Konstantin Novoselov, whose work has been at the forefront of material science innovation. His seminar titled 'Materials for the Future' has attracted an audience of more than 300 people, indicating that his presentation topic held broad appeal across a diverse audience.

This year, Dr Kai Li Lim has secured a visiting fellowship at the Institute of Transportation Studies, UC Davis and has commenced as the Fellow for 6 months. This has enabled a cross continental E-Mobility Research Hub for robust and ongoing collaborations to be established between UQ E-Mobility and UC Davis' EV Research Centre, seeking to bridge the knowledge gap between Australia and the United States, leveraging global datasets, UC Davis's expertise, and innovative business models.

Both Dr Kai and Dr Dia have submitted a proposal to the Queensland Department of Regional Development, Manufacturing and Water in collaboration with PricewaterhouseCoopers Australia (PwC) in response to Zero Emission Vehicle Industry Roadmap for Queensland. This proposal has highlighted UQ's research capabilities in zero emission vehicle and local manufacturing space. The E-mobility team also contributed a submission to the consultation paper on the National Electric Vehicle Strategy: https://consult.dcceew.gov.au/national-electric-vehicle-strategy/submission/view/425. The consultation will help shape a truly national strategy to ensure Australians can access the best transport technologies and help meet emission reduction targets.

Media and interviews

The E-mobility team has actively engaged and presented at academic and industry forums on transport decarbonisation. Dr Adhikari Smith was among 28 invited experts specialising in key areas such as power electronics, battery production and biofuel-electrification, vehicle manufacturing and industry policy.

In 2023, Dr Dia was interviewed by iMOVE CRC on the topic of 'Lighter fuels for heavy freight' as well as by Samantha Hawley from Australian Broadcasting Corporation (ABC) News Daily discussing the National EV Strategy and the benefits it could bring to Australia. www.abc.net.au/listen/programs/abc-news-daily/australias-new-plan-for-cheaper-evs/102247580?utm_campaign=abc_radio&utm_content=linked-in&utm_medium=content_shared&utm_source=abc_radio

Dr Kai Li Lim also contributed to a commentary on Australia's electric vehicle strategy released by the Australian Science Media Centre expert reaction on Australia's electric vehicle strategy: EXPERT REACTION: Australia's electric vehicle strategy released - Scimex as well as in 'The Conversation: How far to the next electric vehicle charging station – and will I be able to use it?' on how to create a reliable network.

Recognition

Dr Dia has been nominated as the UQ representative for the Committee for Brisbane's (CFB) Connectivity subcommittee. The Connectivity pillar's policy and program areas are related to future transport and mobility. She is also appointed in an advisory role to the Brisbane City Council Transport and Infrastructure Futures Board.


Metro in Testing
HESS
9001
BRISBANE CITY
Dedicated to a better Brisbane
METRO 01

Research success

In 2023, UQ Dow Centre researchers were very successful in securing grant funding totalling more than AUD$47 million. Below is a snapshot of the research grants secured by UQ Dow Centre researchers in 2023.

Project focus	Investigators and partners	Grant value (AUD)
ARC CoE for Green Electrochemical Transformation of Carbon Dioxide	Xiwang Zhang, Simon Smart, Tom Rufford, Jingwei Hou	$35 million (7 years)
ARC Research Hub in Zero-Emission Power Generation for Carbon Neutrality	Zhi-Gang Chen, Debra Bernhardt, Hongxia Wang, Jingwei Hou	$5 million (5 years)
ARC Research Hub for Value-Added Processing of Underutilised Carbon Waste	Lian Zhang, Muxina Konarova, Xiangkang Zeng	$4.96 million (5 years)
ARC Linkage Project (Integrated solar to chemical production and membrane concentration system)	Jingwei Hou, Lianzhou Wang, Debra Bernhardt, Zhiliang Wang, Matthew David and GRAPHENEX Pty Ltd	$644K (ARC) & $450K (Industry)
Emissions and economic modelling of road and rail freight in NSW	iMove Cooperative Research Centre; Dia Adhikari Smith, Sohrab Nizami, Kai Li Lim, Mark Hickman, Flavio Menezes	$400K
Boasteel BAJC project (Membrane CO2 capture processes for iron and steel industry)	Rijia Lin, Jingwei Hou	$200K
Queensland-Chinese Academy of Sciences Collaborative Science Fund	Xiwang Zhang, Xiangkang Zeng	$200K

Project focus	Investigators and partners	Grant value (AUD)
Evaluating the benefits of price incentives for electric vehicle charging: evidence from a field experiment with telematics data: Energy Consumers Australia	Andrea La Nauze, Jake Whitehead, Flavio Menezes, Lionel Page, Lana Friesen, Kai Li Lim	$132K
Transitioning to zero emission construction machinery	Dia Adhikari Smith	$40,590
Transition towards zero emissions heavy vehicles: Analysis, Planning & Policy	Dia Adhikari Smith	$21K
Decarbonisation Strategic Technology Roadmap (Consulting project with KPMG)	Simon Smart, Jennifer Yarnold	$11K

Research

Socio-Techno-Economic Analysis

Background

Techno-economic Analysis (TEA) plays an important role in determining which processes and projects are economically competitive and scalable as well as environmentally and socially acceptable. Here are some projects which the UQ Dow Centre has contributed to.

Net Zero Australia

Led by Associate Professor Simon Smart and Dr Eloise Larsen, the Net Zero Australia public release event was held on Wednesday 19th April 2023 at UQ Customs House in Brisbane with more than 130 attendees in person and 825 joining online. UQ Dow Centre Advisory Board Chair, Professor Debbie Terry AO opened the event and Advisory Board Member Karen Dobson attended in person. UQ's media report showed that coverage on this public release potentially reached 143 million people with 104 related articles published. This successful event was the result of intensive collaborative efforts of UQ, University of Melbourne and Nous. Final modelling results: Charting pathways to Net Zero are publicly available at www.netzeroaustralia.net.au/.

Following the final modelling results is the Mobilisation report: How to make net zero happen. This report was made public on 12th July 2023 in Melbourne and is available at www.netzeroaustralia.net.au. University of Melbourne's media report showed that coverage potentially has reached 8.82 million people and has 341 media exposures on this event.

Technoeconomic Modelling of Hydrogen Production Technologies

There are many carbon-reducing hydrogen production pathways available to produce large scale volumes of future fuels and chemical intermediaries. This project provides detailed technoeconomic analyses to assist in determining technologies most viable for Australia. Technoeconomic models are developed to evaluate and compare production routes, emissions profiles, energy and chemical efficiency, scale, and economic viability. In this project, the University of Melbourne, University of Adelaide and The University of Queensland, model core technology and assess relevant economic parameters.

Reference systems were established to estimate relevant engineering data related to operating and capital costs. The project delivered a preliminary assessment of the economic performance of these processes compared to published literature information. Parameters that drive the technical and economic viability of selected production routes were modelled to determine how these can be expected to affect local and international markets. Models were used to analyse sensitivity factors and estimate the major influences on technology viability. A summary report is being finalised and a webinar was presented. in May 2023.

Methane Pyrolysis

The use of fossil fuels is responsible for the majority of anthropogenic GHG emissions. Natural gas offers the greatest energy potential per unit carbon dioxide emission, is abundant and, in many locations, can be produced at a relatively low cost. This project seeks to advance zero CO2 options for hydrogen, chemicals, and liquid fuels production through alternative chemistry. The current focus is almost exclusively methane pyrolysis with liquid metal and molten salt catalysis to produce hydrogen and solid carbon. The key advantage is that by using a liquid catalyst we eliminate any issues with deactivation that have plagued past efforts on solid catalysis. The molten metal/salt system also simplifies the removal of the carbon through density differences. The project is currently trialling a variety of metal alloys, molten salts and slurry mixtures in the bubble column as well as optimising the use of catalyst to lower the operating temperatures. Combining the findings of what makes a good catalyst with information about how to make a good molten salt offers insight into how the molten salt can be designed to operate for large-scale pyrolysis. Future work will involve identifying a range of salts and catalysts to be tested and focussing on catalyst development and carbons produced in May 2023.

Green Hydrogen Production

Background

Hydrogen (H2) can be produced through numerous pathways, with 'grey' and 'blue' being the most common. Green hydrogen is produced through water electrolysis, specifically where the electricity used in the process comes from renewable energy sources, such as wind, solar, or hydropower. The production of green H2 results in zero greenhouse gas emissions, making it an environmentally friendly fuel source. Thus, there is a huge push for green hydrogen production because it relies on renewable energy sources and does not emit greenhouse gases. Its development is a key component for achieving a sustainable and renewable energy future.

Key focus areas of the UQ Dow Centre include:

- Sustainable production of green hydrogen from wastewater.
- Co-production of hydrogen, hydrogen peroxide, and ozone from water/wastewater.
- Impurities mapping and their effects on the production of hydrogen and other chemicals from water/wastewater.
- Design of tough and selective membranes for the co-production of hydrogen and other chemicals from water

Epitaxial Stacking of Nanoporous Nanosheets for Next-generation Membranes

Developing high-precision selective membranes are urgently needed in Australian key industries for solute-solute separation. This project constructs vertically-aligned and chemically-tailorable nanochannels using two-dimensional porous nanosheets as building blocks. It expects to generate advanced knowledge in the areas of nanosheet synthesis and functionalisation, membrane design and fabrication, selective transport of solutes and applications. Development of these membranes is hypothesized to make existing separation processes more effective and sustainable, which in turn will advance emerging applications in pharmaceutical, dairy and mining industries, providing significant economic and environmental benefits to Australia. Up to date, a water stable aluminium-based metal organic frameworks (Al-MOF) is successfully synthesized and it has demonstrated that its nanosheets were in single layer thickness. Further optimisation work is proposed to improve nanosheet stacking and other functionalized nanosheet materials to verify the feasibility of the proposed methods.

Bioinspired Photocatalysts for Solar-Driven Hydrogen Peroxide Production

Developing advanced photocatalysts that can efficiently produce hydrogen peroxide from just water, air, and sunlight is a challenge. However, the team at the UQ Dow Centre is doing so by mimicking the structure and function of the natural photosynthetic apparatus. The key innovations are expected in the design of reaction-oriented conjugated polymer-based photocatalysts at the atomic and molecular nanostructure levels, which will generate new knowledge in artificial photosynthesis and rational design of functional materials, and sustainable technology for hydrogen peroxide production. This cross-disciplinary research will benefit Australia by the development of biomimetic catalysts for advancing solar energy conversion and enabling sustainable manufacturing of commodity chemicals.

Hydrogen Production from Used Water

Water scarcity in hydrogen production is one of the biggest challenges. This project aims to develop an innovative approach of using used water as the feed for water electrolysis and will result in an in-depth understanding of the impacts of water impurities in used water on the performance and durability of water electrolysers, as well as develop guidelines for the design of highly durable water electrolysers and the operation and upgrade of existing wastewater treatment plants. The project will advance the practical applications of water electrolysis for scalable and sustainable hydrogen production and help Australia secure a leading position in the global emerging hydrogen economy. Experiments have been successful under laboratory conditions, and demonstrate promising results under industry-related conditions, particularly in terms of current densities. Our industry partners, Water Research Australia, Melbourne Water, and Water Corporation Australia have given positive feedback on the preliminary findings, indicating our project's potential for real-world application.

Carbon Molecular Sieve Membranes for Organic Solvent Separation

Organic solvent separation is one of the most pressing challenges faced by numerous industries. This project aims to develop molecular sieve membranes with outstanding selectivity and solvent tolerance by constructing zeolite-carbon mixed matrix membrane via incorporating zeolite nanosheets into carbon materials. The project is expected to generate advanced knowledge of nanosheet synthesis, membrane fabrication and selective molecule transport. The membranes developed in the project has shown to improve the production capacity and sustainability of Australian industries, e.g., pharmaceutical manufacturing, bioethanol production and petroleum refining, providing significant economic and environmental benefits to Australia.

Development of water purification systems for remote communities

Access to clean water is one of the biggest challenges in rural communities. The team has been working with Oxfam Australia to develop suitable water purification devices for remote communities, which have limited access to grid electricity, chemicals and other key infrastructures. A compact, solar-driven, chemical-free water purifier has been successfully prototyped where the water purifier integrates latest foldable solar photovoltaics with low-pressure membrane technologies. By innovative design, membranes in the purifier can last for a long period without chemical cleaning. Preliminary field testing of the water purification system has been conducted in collaboration with an indigenous community. The team has successfully completed the preliminary design of medium-sized utility vehicle-mounted water treatment equipment, capable of supplying clean water to a small community of approximately five families.

Integrated Solar to Chemical Production and Membrane Concentration System

The efficient conversion of low-cost raw materials to high-value chemicals using solar energy has been a long sought-after goal. This project aims to create an integrated photoreactor and membrane separation system for efficient photocatalytic water splitting. The integrated system will efficiently produce hydrogen and ultrapure hydrogen peroxide, a critical and costly reagent used in the semiconductor and solar panel manufacturing industries. The integrated system addresses current challenges in the production of high-quality hydrogen peroxide and demonstrates a practical solar-to-chemical process with economic benefits. It also advances knowledge in the fields of nanomaterials engineering, photocatalytic devices, and membrane technology.

Efficient Conversion of Hydrogen to Future Fuels

Direct catalytic hydrogenation of CO2 to methanol (MeOH) with hydrogen (H2) is one of the most effective approaches to generate a viable future fuel as well as mitigate anthropogenic greenhouse gas emissions. This project focuses on developing membrane reactor technology, with embedded catalyst, to achieve high performance CO2 hydrogenation. Project partners comprise: University of Queensland, University of Melbourne, University of Adelaide, Woodside, GPA Engineering, Santos, Jemena, APA.

The latest work focused on the development of the catalyst and the resulting catalyst compatibility with the polymeric membranes. The outcome was a viable membrane reactor fabrication that successfully incorporates the catalyst in a configuration that is acceptable for CO2 hydrogenation. This represents the first integrated step of the technology development, the linking of the catalyst and membrane material. The next stage of the project is to maximise the catalyst functionality, verify that the catalyst covering of the membrane surface does not impact the membrane separation performance, as well as establish the performance characteristics of the catalyst-membrane configuration in synthesizing methanol.


THE UNIVER
OF QUEENSL
AUSTRALIA
CREATE CHANGE

E-mobility

Background

The need to reduce greenhouse emissions coupled with rising fuel has led to greater demand to move into electromobility. Here at the UQ Dow Centre, we have research teams who are working on several key focus areas in e-mobility. They include:

- Analysing charging and mobility behaviours: Investigating the habits of current electric vehicle (EV) owners and assessing broader consumer preferences towards EVs to identify challenges and opportunities for creating sustainable, affordable, and resilient energy systems.
- Decarbonising heavy vehicles: Conducting research on the transport, construction, and mining sectors through feasibility studies, emissions modelling, cost-benefit analyses, total cost of ownership scenarios, strategic roadmap development, and policy assessments. This research explores electric, hydrogen fuel cell, electric-biofuel range extenders, and advanced biofuel technologies to achieve net-zero emissions.
- Infrastructure planning and management: Focusing on the placement, planning, energy management, and grid connection of charging and refuelling infrastructure for electric and hydrogen-powered vehicles, as well as electrified construction sites.
- Developing policy packages: Crafting a suite of policies to facilitate decarbonisation by addressing financial and regulatory barriers, supporting industry development, and promoting trials.

Highlights & outlook

Collaborative partnership with industry

The E-mobility team has worked alongside Lendlease to investigate the range of low and zero-emission technologies that could drive the transition to fossil fuel free and ultimately zero emission construction sites. There is also active engagement with Australian Construction Association (ACA) and Laing O'Rourke to explore opportunities for piloting a low and zero-emission construction site in Queensland, which involved a stepwise approach of transitioning to a fossil fuel-free emission site and working towards the ambition of an emission-free construction site by introducing innovative low and zero emission solutions.

There is also a collaboration together with the Volt Advisory Group, commissioned by the Association of Marine Park Tourism Operators (AMPTO) to submit and present a research project proposal on a feasibility study to analyse opportunities to decarbonise the Great Barrier Reef marine tourism vessels.

UQ Dow Centre's St Baker Research Fellow, Dr Kai Li Lim has visited the Institute of Transportation Studies at UC Davis (ITS-Davis) for a period of six months to foster collaboration and exchange of ideas between the two institutions, particularly in the areas of electric vehicle (EV) adoption, travel behaviours, and consumer associations with electric vehicles in Australia and California. This exercise entails the setting up of the cross-continental EV Research Hub to foster a robust and ongoing collaboration in e-mobility research between UQ and UC Davis.

Electric heavy vehicles

After the surge in fuel cost and the rising need for decarbonisation, the demand for electric vehicles has increased. With this, there is a constant push for improvements such as increased accessibility to infrastructure supporting electric vehicles and incentives to electric vehicle purchases. The UQ Dow Centre's e-mobility research team is actively involved in projects that highlights the benefits of price incentives for electric vehicle charging through telematics data, consolidates vehicle uptake data and match against the Australian Green Vehicle Guide to estimate vehicle emissions and offsets from EV uptake, creates smart city logistics hub to reduce congestion and promote sustainable transportation practices.

Currently, Australia relies heavily on heavy vehicles for goods transportation across the country. The need to electrify heavy vehicles is crucial in minimising greenhouse gas emissions. Through the iMOVE CRC, the team has secured research projects with to model the reductions in emissions and the economic benefits that will result from decarbonising the freight sector in New South Wales as well as pilot trial of zero-emission battery-electric tow trucks in Queensland and New South Wales. Another significant project was with the Queensland Fire and Emergency Services to undertake a thorough research analysis, real-world trials, and scenario testing of low and zero emission trucks along important routes in Queensland. The study will particularly concentrate on evaluating technologies such as battery-electric trucks and alternative fuels like renewable diesel/HVO.

Carbon Dioxide Utilisation

Background

Increasing levels of greenhouse gases, particularly carbon dioxide (CO2) has led to the increase occurrences of severe weather events like droughts, wildfires and floods. Achieving net-zero emission of CO2 by 2050 will be critical to limit the devastating impacts of climate change. The UQ Dow Centre Director, Professor Xiwang Zhang leads the Australian Research Council Centre of Excellence for Green Electrochemical Transformation of Carbon Dioxide (GETCO2), which is aimed to sustainably convert the abundant supply of CO2 to valuable products. The Centre brings industry partners, national and international universities to resolve one of the world's biggest challenges.

The key focus of GETCO2:

- Advancing fundmental knowledge of CO2 conversion in electrochemical systems toselevtively manufacutre diverse value-added products
- Developing innovative electrolysers and key components (catalysts, membranes and electrodes) for highly efficient, scalable and durable electrochemical CO2 conversion
- Demonstrating CO2 conversion to value-added commodity and fine chemicals to enable industry-ready CO2 utilisation technologies supporting the emergent Australian circular carbon economy industry
- Training the next generation of highly skilled scientists and engineers, equipped with unique expertise in catalysis, materials and advanced manufacturing for CO2 research, development and deployment across Australian research communities and industries.

In November 2023, GETCO2 hosted a 3-day international symposium to gather all stakeholders and like-minded researchers with a goal to tackle one of the world's biggest challenges, how to utilise carbon dioxide utilisation. Held in Brisbane at the Grand Chancellor Hotel, the International Symposium on Green Transformation of Carbon Dioxide (ISGTCO2) attracted more than 250 national and international delegates.

This event has created a platform for researchers in the field to exchange ideas and advanced research collaborations using carbon dioxide as a resource and developing solutions to accelerate the progress toward net-zero. This event was very well-received and has shown the importance of bringing experts to work together towards a sustainable future.

2023 Publications

In addition to securing grant fundings, researchers at the UQ Dow Centre were also creating impact through publications in 2023.

Journal articles

Ahmed, Mohamed HM, Batalha, Nuno, Atanda, Luqman, Jamil, Anas, and Konarova, Muxina (2023). The catalytic processes for the deoxygenation and densification of biofuels. Handbook of Biofuels Production. Elsevier.401-418. https://doi.org/10.1016/b978-0-323-91193-1.00003-2

Ahmed, Mohamed H. M., Batalha, Nuno, Karim, Mohammad Rezaul, Alnaser, Ibrahim Abdullah, Yamauchi, Yusuke, Kaneti, Yusuf Valentino, and Konarova, Muxina (2023). Design of trifunctional catalysts for promoting sequential condensation, deoxygenation, and aromatization of pyrolyzed mixed waste. Journal of Materials Chemistry A 11 (26) 14404-14415. https://doi.org/10.1039/d3ta01368e

Alcaide-Godinez, Indira, Bai, Feifei, Saha, Tapan Kumar, and Memisevic, Rizah (2023). Contingency reserve evaluation for fast frequency response of multiple battery energy storage systems in a large-scale power grid. CSEE Journal of Power and Energy Systems 9 (3) 873-883. https://doi.org/10.17775/CSEEJPES.2022.01050

Alrazen, Hayder A., Aminossadati, Saiied M., Mahmood, Hussein A., Hasan, M.M., Abdulkreem- Alsultan, G., and Konarova, Muxina (2023). Theoretical investigation of combustion and emissions of CI engines fueled by various blends of depolymerized low-density polythene and diesel with co-solvent additives. Energy 282 128754 128754. https://doi.org/10.1016/j.energy.2023.128754

Alrazen, Hayder A., Aminossadati, Saiied M., Mahmudul Hasan, Md, and Konarova, Muxina (2023). Effectiveness of co-solvents in boosting LDPE depolymerization in diesel. Fuel 345 128135 1-10. https://doi.org/10.1016/j.fuel.2023.128135

Azim, M. Imran, Lankeshwara, Gayan, Tushar, Wayes, Sharma, Rahul, Alam, Mollah R., Saha, Tapan K., Khorasany, Mohsen, and Razzaghi, Reza (2023). Dynamic operating envelope-enabled P2P trading to maximise financial returns of prosumers. IEEE Transactions on Smart Grid 1-1. https://doi.org/10.1109/tsg.2023.3297366

Chai, Milton, Chen, Ruiqi, Xu, Kaijie, Chen, Yuelei, Ma, Shengchun, Lin, Rijia, Chen, Vicki, and Hou, Jingwei (2023). Ion transport and conduction in metal–organic framework glasses. Journal of Materials Chemistry A 11 (38) 20302-20314. https://doi.org/10.1039/d3ta03192f

Chen, Ping, Wu, Yuming, Rufford, Thomas E., Wang, Lianzhou, Wang, Geoff and Wang, Zhiliang (2023). Organic molecules involved in Cu-based electrocatalysts for selective CO2 reduction to C2+ products. Materials Today Chemistry, 27 101328, 1-15. doi: 10.1016/j.mtchem.2022.101328

Chen, Ruiqi, Chai, Milton, and Hou, Jingwei (2023). Metal-organic framework-based mixed matrix membranes for gas separation: recent advances and opportunities. Carbon Capture Science and Technology 8 100130 1-12. https://doi.org/10.1016/j.ccst.2023.100130

Duan, Haoran, Zheng, Min, Li, Jiyun, Liu, Tao, Wang, Zhiyao, Shrestha, Sohan, Wang, Bingzheng, Ye, Liu, Hu, Shihu, and Yuan, Zhiguo (2023). High hydraulic loading rates favored mainstream partial nitritation: experimental demonstration and model-based analysis. ACS ES and T Water 3 (2) 556-564. https://doi.org/10.1021/acsestwater.2c00569

Fan, Yuying, Liang, He, Jian, Meipeng, Liu, Ruiping, Zhang, Xiwang, Hu, Chengzhi, and Liu, Huijuan (2023). Removal of dimethylarsinate from water by robust NU-1000 aerogels: Impact of the aerogel materials. Chemical Engineering Journal 455 140387 1-11. https://doi.org/10.1016/j. cej.2022.140387

Gao, Shuai, Peng, Hong, Song, Bing, Zhang, Jinxuan, Wu, Weixi, Vaughan, James, Zardo, Peter, Vogrin, John, Tulloch, Sylvia and Zhu, Zhonghua (2023).Synthesis of zeolite from low-cost feeds and its sustainable environmental applications. Journal of Environmental Chemical Engineering, 11 (1) 108995, 1-18. doi: 10.1016/j.jece.2022.108995

Ghasemi, Mehri, Li, Xuemei, Tang, Cheng, Li, Qi, Lu, Junlin, Du, Aijun, Lee, Jaeho, Appadoo, Dominique, Tizei, Luiz H. G., Pham, Sang T., Wang, Lianzhou, Collins, Sean M., Hou, Jingwei, Jia, Baohua, and Wen, Xiaoming (2023). Effective suppressing phase segregation of mixed-halide perovskite by glassy metal-organic frameworks. Small:nano micro, 19 (50) 2304236 e2304236. https://doi. org/10.1002/smll.202304236

Hu, Xiaoyi, Lu, Jun, Liu, Yue, Chen, Liang, Zhang, Xiwang, and Wang, Huanting (2023). Sustainable catalytic oxidation of glycerol: a review. Environmental Chemistry Letters 1-37. https://doi.org/10.1007/s10311-023-01608-z

Hu, Yichao, Rufford, Thomas E., Chen, Jian, Hao, Liangyuan, Li, Mengran, Qiu, Yinxuan, Garg, Sahil, Rudolph, Victor and Wang, Geoff (2023). Opportunities to reduce energy consumption and CO2 emissions from ironmaking blast furnace using Photocatalytic Ammonia Production. Industrial & Engineering Chemistry Research 62 (36) 14130-14143. https://doi.org/10.1021/acs.iecr.3c02177

Huber, George W., Konarova, Muxina, Lim, Jason Y. C., and Wilson, Karen (2023). Harnessing the power of biorefining: paving the way for sustainable fuels and chemicals. Sustainable Energy & Fuels 7 (16) 3738- 3740. https://doi.org/10.1039/d3se90047a

Idros, Mohamed Nazmi, Wu, Yuming, Duignan, Timothy, Li, Mengran, Cartmill, Hayden, Maglaya, Irving, Burdyny, Thomas, Wang, Geoff and Rufford, Thomas E. (2023).Effect of dispersing solvents for an ionomer on the performance of copper catalyst layers for CO2 electrolysis to multicarbon products. ACS Applied Materials and Interfaces, 15 (45), 52461- 52472. doi: 10.1021/acsami.3c11096

Iglesias van Montfort, Hugo-Pieter, Li, Mengran, Irtem, Erdem, Abdinejad, Maryam, Wu, Yuming, Pal, Santosh K., Sassenburg, Mark, Ripepi, Davide, Subramanian, Siddhartha, Biemolt, Jasper, Rufford, Thomas E. and Burdyny, Thomas (2023). Non-invasive current collectors for improved current-density distribution during CO2 electrolysis on super-hydrophobic electrodes. Nature Communications, 14 (1) 6579, 1-11. doi: 10.1038/ s41467-023-42348-6

Kang, Yuan, Hu, Ting, Wang, Yuqi, He, Kaiqiang, Wang, Zhuyuan, Hora, Yvonne, Zhao, Wang, Xu, Rongming, Chen, Yu, Xie, Zongli, Wang, Huanting, Gu, Qinfen, Zhang, Xiwang (2023) Nanoconfinement enabled non-covalently decorated MXene membranes for ion-sieving. Nature Communications 14, 4075, https://doi.org/10.1038/s41467-023-39533-y

Kuang, Yizhu, Rabiee, Hesamoddin, Ge, Lei, Rufford, Thomas E., Yuan, Zhiguo, Bell, John and Wang, Hao (2023).High–concentration electrosynthesis of formic acid/formate from CO2 : reactor and electrode design strategies. Energy and Environmental Materials, 6 (6) e12596. doi: 10.1002/eem2.12596

Kumar Dey, Thuhin, Hou, Jingwei, Sillanpää, Mika, and Kumar Pramanik, Biplob (2023). Metal-organic framework membrane for waterborne micro/ nanoplastics treatment. Chemical Engineering Journal 474 145715 1-21. https://doi.org/10.1016/j.cej.2023.145715

Kumar, Manish, Bolan, Shiv, Padhye, Lokesh P., Konarova, Muxina, Foong, Shin Ying, Lam, Su Shiung, Wagland, Stuart, Cao, Runzi, Li, Yang, Batalha, Nuno, Ahmed, Mohamed, Pandey, Ashok, Siddique, Kadambot H. M., Wang, Hailong, Rinklebe, Jörg, and Bolan, Nanthi (2023). Retrieving back plastic wastes for conversion to value added petrochemicals: opportunities, challenges and outlooks. Applied Energy 345 121307 121307. https://doi.org/10.1016/j.apenergy.2023.121307

Lee, Jaeho, Wang, Lianzhou, and Hou, Jingwei (2023). Emerging microporous materials as novel templates for quantum dots. Microstructures 3 (2) 2023021. https://doi.org/10.20517/microstructures.2023.08

Lin, Rijia, Chai, Milton, Zhou, Yinghong, Chen, Vicki, Bennett, Thomas D., and Hou, Jingwei (2023). Metal–organic framework glasscomposites. Chemical Society Reviews 52 (13) 4149-4172. https://doi.org/10.1039/ d2cs00315e

Liu, Hanwen, Zhou, Qianqin, Xia, Qingbing, Lei, Yaojie, Long Huang, Xiang, Tebyetekerwa, Mike and Song Zhao, Xiu (2023). Interface challenges and optimization strategies for aqueous zinc-ion batteries. Journal of Energy Chemistry, 77, 642-659. doi: 10.1016/j.jechem.2022.11.028

Lu, Chenghai, Hu, Chengzhi, Chen, Zhibin, Wang, Peiyao, Feng, Fan, He, Guangzhi, Wang, Fuyi, Zhang, Yanyan, Liu, Jefferson Zhe, Zhang, Xiwang, and Qu, Jiuhui (2023). Dehydration-enhanced ion-pore interactions dominate anion transport and selectivity in nanochannels. Science Advances 9 (27) . https://doi.org/10.1126/sciadv.adf8412

Lu, Xuanyu, Oehmen, Adrian, Zhao, Jing, Duan, Haoran, Yuan, Zhiguo, and Ye, Liu (2023). Insights on biological phosphorus removal with partial nitrification in single sludge system via sidestream free ammonia and free nitrous acid dosing. Science of the Total Environment 895 165174 165174. https://doi.org/10.1016/j.scitotenv.2023.165174

Marriam, Ifra, Tebyetekerwa, Mike, Chen, Hao, Chathuranga, Hiran, Motta, Nunzio, Alarco, Jose A., He, Zhenjiang, Zheng, Junchao, Du, Aijun and Yan, Cheng (2023).Few-layer MoS2 nanosheets with and without silicon nanoparticles as anodes for lithium-ion batteries. Journal of Materials Chemistry A, 11 (6), 2670-2678. doi: 10.1039/d2ta08886j

McConnachie, Mark, Konarova, Muxina, and Smart, Simon (2023). Literature review of the catalytic pyrolysis of methane for hydrogen and carbon production. International Journal of Hydrogen Energy 48 (66) 25660-25682 https://doi.org/10.1016/j.ijhydene.2023.03.123

McConnachie, Mark, Sheil, Alister, Konarova, Muxina, and Smart, Simon (2023). Evaluation of heterogeneous metal-sulfide molten salt slurry systems for hydrogen production through methane pyrolysis. International Journal of Hydrogen Energy.
https://doi.org/10.1016/j.ijhydene.2023.08.072

McMahon, C., Cameron, I., Zughbi, H., Biasutti, M., Halstead, A. and Smart, S. (2023).Byproduct use optimization in a combined sinter plant and blast furnace model. Chemical Engineering and Processing, 183 109216, 109216.
doi: 10.1016/j.cep.2022.109216

Mishra, Deepti, Balyan, Sonit, Zhao, Xiu Song, Konarova, Muxina, and Pant, K. K. (2023). Microwave-assisted impregnation of highly dispersed Mo over HZSM-5 using various Mo precursors for methane dehydroaromatization. Reaction Chemistry and Engineering 8 (11) 2757-2775.
https://doi.org/10.1039/d3re00143a

Mishra, Deepti, Modak, Arindam, Pant, K. K., Ambeth, P. Vanaraja, Konarova, Muxina, and Zhao, Xiu Song (2023). Catalytic conversion of methane into benzene over ceria–zirconia-promoted molybdenum-supported zeolite formethane dehydroaromatization. Applied Organometallic Chemistry 37 (7) e7101. https://doi.org/10.1002/aoc.7101

Muhammad Yazid Bin Zulkifli, Ruiqi Chen, Rijia Lin, Yuqi Yao, Milton Chai, Dominique Appadoo, Wupeng Wang, Zhonghua Zhu, Kang Liang, Vicki Chen, Jingwei Hou (2023) Regulating thermal dynamics and gas transport of MOF glass through silver composites, AiCHE Journal.
https://doi.org/10.1002/aic.18287

Parsa, Seyed Masoud, Norozpour, Fatemeh, Momeni, Saba, Shoeibi, Shahin, Zeng, Xiangkang, Said, Zafar, Guo, Wenshan, Ngo, Huu Hao, and Ni, Bing-Jie (2023). Advanced nanostructured materials in solar interfacial steam generation and desalination against pathogens: combatting microbial-contaminants in water - a critical review. Journal of Materials Chemistry A 11 (34) 18046-18080. https://doi.org/10.1039/d3ta03343k

Peng, Hong, Vu, Ngoc Quy, Vaughan, James, Wang, Sicheng and Gao, Shuai (2023).Revealing the mechanisms of metal adsorption by bauxite residue. Industrial and Engineering Chemistry Research, 62 (8), 3515-3524.
doi: 10.1021/acs. iecr.2c02928

Raja, Naif, Monsalve-Bravo, Gloria M., Kaneti, Yusuf Valentino, Mensah, Jim, Wilson, Karen, Lee, Adam F., and Konarova, Muxina (2023). Thermogravimetric kinetic analysis of catalytic and non-catalytic pyrolysis of simulated municipal solid waste. Chemical Engineering Journal 470 144046 1-12. https://doi.org/10.1016/j.cej.2023.144046

Sun, Kaige, Tebyetekerwa, Mike, Wang, Chao, Wang, Xianfen, Zhang, Xiwang, and Zhao, Xiu Song (2023). Electrocapacitive Deionization: Mechanisms, Electrodes, and Cell Designs. Advanced Functional Materials 33 (18) 2213578 1-33. https://doi.org/10.1002/adfm.202213578

Sheil, Alister, Konarova, Muxina, and Smart, Simon (2023). Catalytic alkali and transition metal cations to produce low-emission hydrogen from methane pyrolysis. ACS Sustainable Chemistry and Engineering 11 (30) 1124811258.
https://doi.org/10.1021/acssuschemeng.3c02384

Tesfaye, Fiseha, Hamuyuni, Joseph, Iloeje, Chukwunwike O., Peng, Hong and Verhulst, Dirk (2023).High-Temperature Phases and Processes for Enabling Cleaner Production of Metals and Energy. JOM, 75 (5), 1435-1438.
doi: 10.1007/s11837-023-05777-8

Tian, Qiang, Zeng, Xiang-Kang, Zhao, Chen, Jing, Ling-Yan, Zhang, Xi-Wang, and Liu, Jian (2023). Exceptional photocatalytic hydrogen peroxide production from sandwich-structured graphene interlayered phenolic resins nanosheets with mesoporous channels. Advanced Functional Materials 33 (21) 2213173 1-12. https://doi.org/10.1002/adfm.202213173

Vogrin, John, Santini, Talitha, Peng, Hong, Zhao, Ling and Vaughan, James (2023). Synthesis of zeolites using kaolin in concentrated sodium hydroxide-aluminate solutions. Applied Clay Science.
https://doi.org/10.1016/j.clay.2023.107106

Vogrin, John, Peng, Hong, Santini, Talitha, Lee, Li Jie, and Vaughan, James (2023). The influence of sodium sulphate on sodium aluminosilicate solubility in Bayer liquor aiding the desilication process. Hydrometallurgy, 219 106079, 1-9.
doi: 10.1016/j.hydromet.2023.106079

Wang, Lianzhou, Tang, Junwang, Maeda, Kazuhiro, Zhang, Qiang, and Richards, Ryan M. (2023). Editorial: Small–Structure Innovation of Catalysis Powers a Sustainable Future. Small Structures 4 (6) 2300116 .
https://doi.org/10.1002/sstr.202300116

Wang, Sicheng, Dube, Bugalo, Vaughan, James, Gao, Shuai and Peng, Hong (2023).Silica gel free region and rare earth metal extraction correlations in reprocessing bauxite residue. Minerals Engineering, 199 108115, 108115.
doi: 10.1016/j.mineng.2023.108115

Wang, Sicheng, Nguyen, Tuan, Peng, Hong, Wu, Songlin, Parry, David, Urban, Anja and Huang, Longbin (2023). Sodium removal from bauxite desilication product (sodalite) aided by chelating effects of inorganic and organic acids. Journal of Environmental Management, 338 117837, 1-12. doi: 10.1016/j.jenvman.2023.117837

Wang, Sicheng, Vaughan, James, Xia, Fang, Etschmann, Barbara, Brugger, Joël, Brand, Helen and Peng, Hong (2023). Revealing the effect of anions on the formation and transformation of zeolite LTA in caustic solutions: an in situ synchrotron PXRD study. Crystal Growth and Design, 23 (5), 3660-3670. doi: 10.1021/acs.cgd.3c00106

Wang, Wupeng, Chai, Milton, Bin Zulkifli, Muhammad Yazid, Xu, Kaijie, Chen, Yuelei, Wang, Lianzhou, Chen, Vicki, and Hou, Jingwei (2023). Metal–organic framework composites from a mechanochemical process. Molecular Systems Design and Engineering 8 (5) 560-579. https://doi.org/10.1039/ d2me00211f

Wang, Wupeng, Chai, Milton, Lin, Rijia, Yuan, Fangfang, Wang, Lianzhou, Chen, Vicki, and Hou, Jingwei (2023). Amorphous MOFs for next generation supercapacitors and batteries. Energy Advances 2 (10) 1591-1603. https://doi.org/10.1039/ d3ya00306j

Wang, Zhuyuan, Yan, Xue, Hou, Qinfu, Liu, Yue, Zeng, Xiangkang, Kang, Yuan, Zhao, Wang, Li, Xuefeng, Yuan, Shi, Qiu, Ruosang, Uddin, Md Hemayet, Wang, Ruoxin, Xia, Yun, Jian, Meipeng, Kang, Yan, Gao, Li, Liang, Songmiao, Liu, Jefferson Zhe, Wang, Huanting, and Zhang, Xiwang (2023). Scalable high yield exfoliation for monolayer nanosheets. Nature Communications 14 (1) 236 1-8. https://doi.org/10.1038/s41467-022-35569-8

Whitehead, Jake, Newman, Peter, Whitehead, Jessica and Lim, Kai Li (2023). Striking the right balance: understanding the strategic applications of hydrogen in transitioning to a net zero emissions economy. Sustainable Earth, 6 (1) 1. doi: 10.1186/s42055-022- 00049-w

Wibowo, Ary Anggara, Tebyetekerwa, Mike, Bui, Anh Dinh, Truong, Thien N., Saji, Sandra, Kremer, Felipe, Yang, Zhongshu, Yin, Zongyou, Lu, Yuerui, Macdonald, Daniel and Nguyen, Hieu T. (2023). Hybrid alkali salt catalysts promoted CVD growth of 2D MoSe2–WSe2 and WSe2–MoSe2 lateral heterostructures. Advanced Materials Technologies, 8 (15) 2300143. doi: 10.1002/ admt.202300143

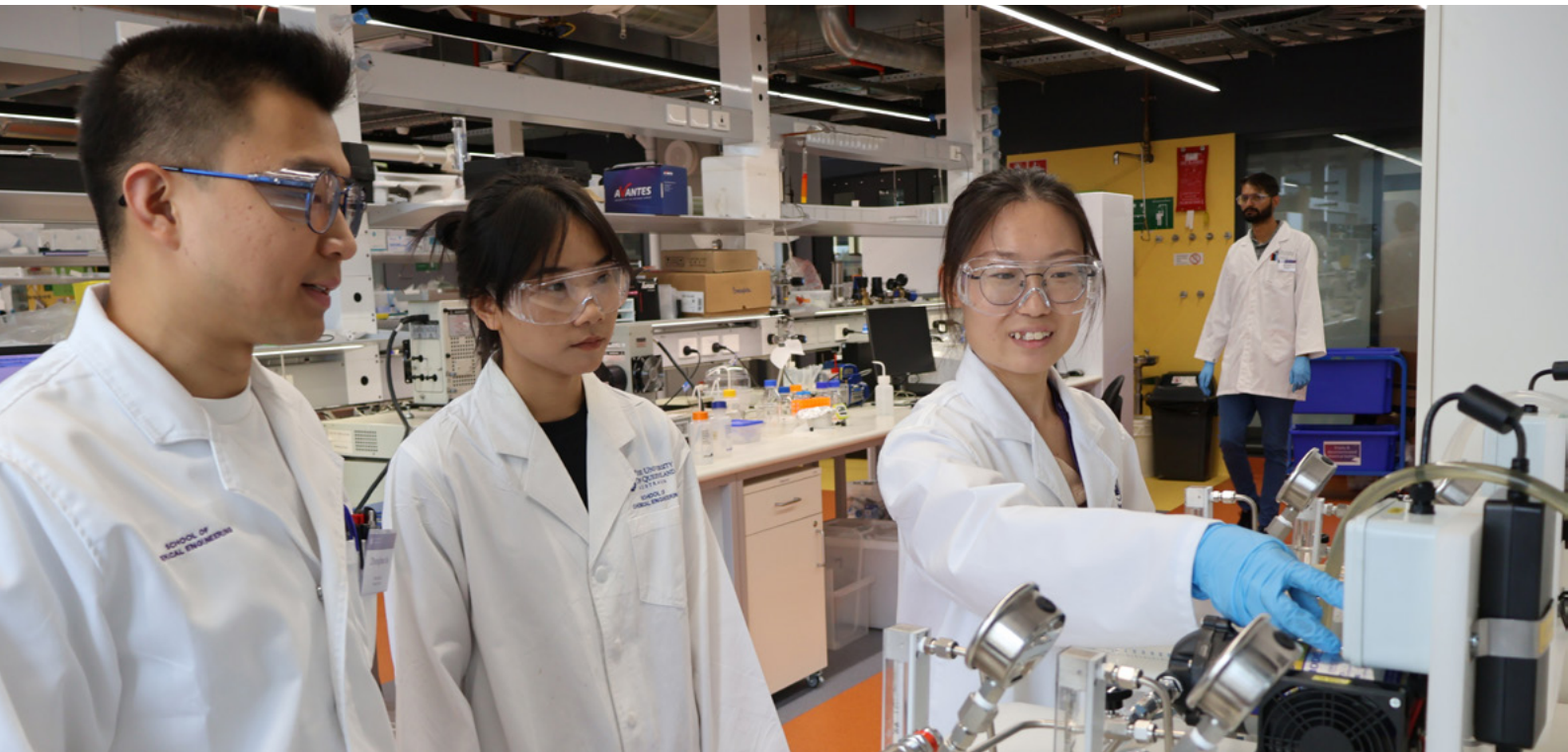
Wu, Xing, Zhang, Xiwang, Wang, Huanting, and Xie, Zongli (2023). Smart utilisation of reverse solute diffusion in forward osmosis for water treatment: a mini review. Science of the Total Environment 873 162430 1-13. https://doi.org/10.1016/j.scitotenv.2023.162430

Wyn, Hons, Konarova, Muxina, Quintero Olaya, Sebastian, and Yermán, Luis (2023). Effect of ZrO2/CeO2 mixed oxides on fuel gas production during self-sustaining smouldering combustion of lignocellulosic wastes. Sustainable Energy and Fuels 7 (10) 1-7. https://doi.org/10.1039/d3se00307h

Xu, Lingxiang, Tebyetekerwa, Mike, Zhang, Jian, Hu, Chen, Wang, Xiaomei, Bai, Yang, Zhao, Zhenbai, Ma, Yong, Chen, Yong and Li, Weili (2023). Self-stratifying coating enables facile fabrication of robust superhydrophobic sponges for oil-water mixture separation. Progress in Organic Coatings, 183 107705, 1-8. doi: 10.1016/j. porgcoat.2023.107705

Yacou, Christelle, Leo, Adrian, Motuzas, Julius, Smart, Simon, Zhang, Shude, Liu, Shaomin and Diniz da Costa, João C. (2023).High oxygen production membranes by Ag catalytic surface modified BSCC perovskite. Separation and Purification Technology, 317 123829, 123829. doi: 10.1016/j.seppur.2023.123829

Yan, Penghui, Nur Azreena, Idris, Peng, Hong, Rabiee, Hesamoddin, Ahmed, Mohamed, Weng, Yilun, Zhu, Zhonghua, Kennedy, Eric M. and Stockenhuber, Michael (2023).Catalytic hydropyrolysis of biomass using natural zeolite-based catalysts. Chemical Engineering Journal, 476 146630, 1-13. doi: 10.1016/j.cej.2023.146630



Yan, Penghui, Peng, Hong, Vogrin, John, Rabiee, Hesamoddin and Zhu, Zhonghua (2023). Selective CO2 hydrogenation over zeolite-based catalysts for targeted high-value products. Journal of Materials Chemistry A, 11 (34), 17938-17960. doi: 10.1039/ d3ta03150k

Yan, Penghui, Xi, Shibo, Peng, Hong, Mitchell, David R. G., Harvey, Luke, Drewery, Matthew, Kennedy, Eric M., Zhu, Zhonghua, Sankar, Gopinathan and Stockenhuber, Michael (2023). Facile and eco-friendly approach to produce confined metal cluster catalysts. Journal of the American Chemical Society, 145 (17), 9718-9728. doi: 10.1021/ jacs.3c01304

You, Lei, Ma, Hui, and Kumar Saha, Tapan (2023). A CVaR-constrained optimal power flow model for wind integrated power systems considering Transmission-side flexibility. International Journal of Electrical Power and Energy Systems 150 109087 109087. https://doi. org/10.1016/j.ijepes.2023.109087

Zhang, Jianzhong, Fang, Yang, Zhang, Anlin, Yu, Youming, Liu, Lina, Huo, Siqi, Zeng, Xuesen, Peng, Hong and Song, Pingan (2023).A Schiff base-coated ammonia polyphosphate for improving thermal and fire-retardant properties of unsaturated polyester. Progress in Organic Coatings, 185 107910, 107910. doi: 10.1016/j.porgcoat.2023.107910

Zhang, Mengchen, Xing, Chao, Huang, Jianan, Li, Peishan, Jiang, Long, Liu, Lingfeng, Jia, Jianbo, Zhang, Xiwang, Zhang, Shanqing and Liu, Changyu (2023). Adaptive Gating Enhances Intelligent Membranes for Cellular Functions and Precise Separations. Advanced Functional Materials. doi: 10.1002/adfm.202310647

Reports

Transport Academic Partnership (TAP) Project: Opportunities to Decarbonise Queensland's Road Freight Task: developing a strategic roadmap to a smooth transition to low and zero emission technologies. Brisbane, QLD Australia: The University of Queensland. https://espace.library.uq.edu.au/view/UQ:47df58d

Bharadwaj B, Pascale, A, Beiraghi J, Smart S 2023, 'Downscaling – Energy export systems', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Energy-export-systems.pdf

Bharadwaj B, Pascale, A, Beiraghi J, Smart S 2023, 'Downscaling – Onshoring of industry', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Onshoring-of-industry.pdf.

Bharadwaj B, Pascale, A, Beiraghi J, Smart S (2023), 'Downscaling – Water use and transmission', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Water-use-and-transmission.pdf.

Davis, D, Pascale, A, Vecchi, A, Bharadwaj, B, Jones, R, Strawhorn, T, Tabatabaei, M, Lopez Peralta, M, Zhang, Y, Beiraghi, J, Kiri, U, Vosshage, Finch, B, Batterham, R, Bolt, R, Brear, M, Cullen, B, Domansky, K, Eckard, R, Greig, C, Keenan, R, Smart, S (2023), 'Modelling Summary Report', Net Zero Australia, ISBN 978 0 7340 5704 4, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Net-Zero-Australia-Modelling-Summary-Report.pdf.

Pascale, A, Davis, D, Watson, J, Smart, S, Brear, M, McCoy, J, Lopez Peralta, M, Keenan, R, Eckard, R, Reside, A, Ward, M, Possingham, H (2023), 'Downscaling – Net-zero transitions, Australian communities, the land and sea', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Land-use-impacts-on-Australian-communities-the-land-sea.pdf.

Pascale, A, Greig, G, Tabatabaei, M, Vosshage, O, Smart, S (2023), 'Downscaling – Carbon dioxide capture, transmission, use, and storage', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-CO2-capture-transmission-use-storage.pdf.

Pascale, A, Kiri, U, Davis, D, Smart, S, (2023), 'Downscaling – Solar, wind and electricity transmission siting', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Solar-wind-electricity-transmission-siting.pdf.

Pascale, A, Smart, S, 2023, 'Downscaling – Natural gas and synthetic methane transmission', Net Zero Australia, <https://www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Natural-gas-synthetic-methane-transmission.pdf>

Pascale, A, Tabatabaei, M, Smart, S (2023), 'Downscaling – Hydrogen and synthetic fuel production, transmission and storage', Net Zero Australia, www.netzeroaustralia.net.au/wp-content/uploads/2023/04/Downscaling-Hydrogen-synthetic-fuel-production-transmission-storage.pdf.

Strawhorn, T, McCall, A, Vecchi, A, Davis, D, Pascale, A, Zhang, Y, Batterham, R, Brear, M, Domansky, K, Greig, C, Smart, S, Bolt, R, (2023), 'How to make net zero happen – Mobilisation Report', www.netzeroaustralia.net.au/mobilisation-report.

Thank You

The UQ Dow Centre sincerely thank our valued donors: Dow Chemical, The Trevor and Judith St Baker Family Foundation and industry partners.

The vision and generosity of our donors has enabled the endowment of the Dow Chair in Sustainable Engineering Innovation and the Tritium and St Baker E-mobility Research Fellows. The support we received enables researchers to innovate and accelerate research outcomes that contribute to a sustainable future.

To learn more about opportunities to make an impact, please visit: **alumni.uq.edu.au/giving** or contact: **dowcentre@uq.edu.au**.

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

UQ Dow Centre for Sustainable Engineering Innovation

E dowcentre@uq.edu.au

The University of Queensland
School of Chemical Engineering
Brisbane QLD 4072
Australia

dow.centre.uq.edu.au