THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CREATE CHANGE

UQ DOW CENTRE FOR
SUSTAINABLE ENGINEERING
INNOVATION

Annual Report 2020

Contents

dowcsei.uq.edu.au


FIRE HYDRANT
Dow Centre
for Sustainable Engineering Innovation

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 eighth year, the Dow Centre is continuing to tackle the challenges of the sustainable production of energy and use of materials through a combination of laboratory research, systems modelling, transdisciplinary collaboration and world-leading education.

Despite the many challenges and disruptions created by the COVID-19 pandemic, the UQ Dow Centre continued to advance its important work throughout 2020.

The Centre's Rapid Switch project reached an important milestone this year with the completion of the 'Net Zero America' project. Conducted in partnership with Princeton University, this important project aims to inform political, business and societal discussions around what it will take for the USA to achieve net-zero emissions of greenhouse gases by 2050.

The Net Zero America project shows in granular detail the changes that would be required across all major sectors of the economy during a net-zero transition. This ground-breaking study also details the economic and policy implications of the energy transition – and the impact on land use, employment, air pollution, capital mobilisation and the fossil fuel industry.

Throughout 2020, the Dow Centre continued its important contribution to a number of research projects that are being conducted by the Future Fuels Cooperative Research Centre (CRC). The Dow Centre's focus on hydrogen continued with the techno-economic analysis of a wide range of hydrogen production technologies and the low-carbon production of hydrogen from natural gas using pyrolysis in molten media. More recently, the team has been developing new membrane reactors for more efficient conversion of hydrogen to methanol.

This year, the Dow Centre team also continued to innovate in the field of energy storage as part of the Printed Batteries CRC-Project. The team successfully developed and tested two flexible, printed battery systems under real-world conditions and also proved that they could be scaled up for manufacturing.

The philanthropic funding of the Dow Centre's research has been a feature of the Centre since it was originally established with a US$10 million gift from Dow In 2020, we again recognise the generous $1.5 million contribution of Trevor and Judith St Baker to establish the St Baker Fellow in E-Mobility. The St Baker Fellow will work alongside the existing Tritium E-Mobility Research Fellow to lead research aimed at advancing the performance, economics and uptake of e-mobility.

We also recognise the contributions of Dr Martin Albrecht AC and Professor Chris Greig, both proud UQ alumni, who donated to research focussed on the role of coal in the coming energy transition, looking specifically at the production of blue hydrogen in the Latrobe Valley.

The Dow Centre continues to inspire engineering students to develop practical solutions that will contribute to sustainability and decarbonisation.

With COVID-19 preventing students from physically attending campus throughout much of 2020, the Dow Centre staff revitalised undergraduate and postgraduate courses through blended learning with tremendous success.

The Centre's leaders supervised 66 PhD students in 2020, with 12 PhD candidates receiving conferral through the year.

"Now in its eighth year, the Dow Centre is continuing to tackle the challenges of the sustainable production of energy and use of materials through a combination of laboratory research, systems modelling, transdisciplinary collaboration and world–leading education."

Finally, I'd like to acknowledge my predecessor, Professor Peter Høj AC, for his long-standing commitment to the Centre – and his leadership as Chair of the Dow Centre's Advisory Board over many years. I would also like to thank Professor Chris Greig who stepped down as Director in 2020 – and acknowledge Associate Professor Simon Smart's input and leadership as Acting Director of the Dow Centre.

I look forward to seeing how the highly talented and committed team at the UQ Dow Centre continue to build on their many successes in 2021.

Professor Deborah Terry AO
Vice-Chancellor and President
The University of Queensland

Director's report

2020 – A Year in Transition

2020 was a year of unprecedented change.

January started with the climate crisis front and centre, with UN Climate Change Deputy Executive Secretary Ovais Sarmad calling it "a critical year for addressing climate change." Nations prepared to submit new or revised climate action plans in accordance with the Paris Agreement. In Australia, temperatures soared and the bushfires that began in 2019 continued to rage uncontrolled across Australia, devastating more than 18 million hectares of land, decimating wildlife populations, destroying more than 5900 buildings and killing at least 34 people. More than 80% of Australians were affected in some way and, with an estimated total cost over $100 billion AUD, the environmental, social and economic impacts of unmitigated climate change were clearer than ever. There were renewed calls for Australia to set ever more aggressive climate targets, joining a global chorus of 'net zero emissions by 2050' from major corporations and various levels of government. But how could this be accomplished? What technologies should be deployed, and at what scale? How will nations and their economies be restructured? And, at a more granular level what will the benefits, costs and challenges be for specific industries and communities?

The UQ Dow Centre founded the Rapid Switch Project in 2016 to critically evaluate these kinds of questions; to understand global and regional capability to undertake deep decarbonisation of economies at the pace required to meet Paris climate targets. Working with (and for) the Andlinger Center for Energy and Environment at Princeton University, Dow Centre Director, Professor Chris Greig, completed the Net-Zero America: Potential Pathways, Infrastructure, and Impacts study. Using state-of-the-art modelling tools, the study provided five technologically and economically plausible pathways for America to reach net-zero emissions by 2050. The outputs included, among other outcomes: highly-resolved mapping, sector-by-sector, of the timing and spatial distribution of changes in energy infrastructure, capital investment, employment, air pollution, land use down to a community level. They found that each net-zero pathway results in a net increase in energy-sector employment, delivers significant reductions in air pollution, and could be accomplished with annual spending on energy that is comparable to what the nation spends annually on energy currently. However, building a net-zero America will require immediate, large-scale mobilization of capital, policy and societal commitment, with all transition pathways featuring historically unprecedented rates of technology and infrastructure deployment. In 2021, we will embark on our own Net Zero Australia Project in collaboration with the Melbourne Energy Institute, Princeton and Nous as well as expanding our network of Early and Mid-Career Research (EMCR) affiliates working with established Dow Centre leaders on a series of seed projects that will be leveraged into larger, industry-backed proposals.

Without warning, the climate crisis was sidelined in March by the world's first global pandemic since the 1918 Spanish flu. Nations shut their borders, cities ground to a halt and citizens were confined to their homes in an effort to contain the novel coronavirus. In many ways, the response to the pandemic mirrored the world's efforts to mitigate and adapt to climate change. Some nations attempted to a bold strategy of complete eradication – strong government control with immediate, definitive and transformative action; others attempted to 'flatten the curve' – government-controlled restrictions to limit the spread until a vaccine was available; a few nations even attempted to achieve herd immunity – no government oversight, relying solely on individual actions to reduce infections and/or adapt to the new normal.

Fortunately for the UQ Dow Centre, the very low case numbers in Brisbane meant that the pandemic had little impact of our research platform which forged ahead across our three research flagships: Energy Transitions, Low Carbon Energy and Materials and Circular Economy.

In addition to the Net Zero America study, our Energy Transitions work continued through the E-Mobility research group which took the first steps towards establishing a new Mobility-as-a-Service (MaaS) trial on UQ's St Lucia Campus and surveyed Queensland consumers on their attitudes towards EVs and road pricing.

The Low Carbon Energy and Materials research delivered fundamental new discoveries into methane pyrolysis and dry reforming, the combination of which, in stark contrast to previous research, can produce a tailorable syngas with net CO_2 consumption. Further they provided rich insights into the production costs for hydrogen across a broad sub-set of technologies.

In collaboration with Printed Energy, the flexible batteries team focused on the improvement of battery shelf-life, cycling stability, manufacturing techniques and integration into practical devices and testing under real-world conditions.

Our Next Generation Fertilisers research team developed a new slow release system which allows a wide range of fertilisers to be used. They are now testing with field plant trials.

I am very proud to report that, despite all the challenges of the global pandemic, the Dow Centre remained steadfast in its commitment to inspiring engineering students and delivering outstanding engineering courses related to our core research areas. At a moment's notice, Dow Centre staff rebuilt our undergraduate and postgraduate courses, adopting a blended learning approach to cater for both on-campus and external students. As a leader in entrepreneurial engagement and education, the Dow Centre saw several current Master of Engineering and Master of Sustainable Energy students (mentored by Dow Centre staff) achieve

"Despite all the challenges of the global pandemic, the Dow Centre remained steadfast in its commitment to inspiring engineering students and delivering outstanding research."

success through the UQ Ventures Industry Challenge, including the eventual winners Team Sol. Finally, I'd like to acknowledge the success of past Dow Sustainability Innovation Student Challenge Award (SISCA) winner, Ms Ashley Baxter. Ashley won the SISCA challenge in 2018 with her idea for a unique composting system. She further developed the idea and won the Shane Chidgzey Young Entrepreneurs Prize at UQ's Accelerator Pitch Night in 2019. In April 2020, Ashley secured funding to build her team and roll out a 100-unit launch: a pre-batch to test the product-making process prior to mass manufacture.

The global theme of change and transition was reflected in staffing changes in the Dow Centre across 2020. In August, Professor Chris Greig left the UQ Dow Centre to join the Andlinger Center for Energy and Environment at Princeton University as the Theodora D. ('78) and William H. Walton III ('74) Senior Research Scientist. I would like to take this opportunity to thank Chris for his tremendous contributions over the last 5 years as the Dow Chair in Sustainable Engineering Innovation and Director of the UQ Dow Centre.

In September, Centre Manager, Briony Beaumont, left the Dow Centre to join UQ Advancement and Ms Hayley McGreevy stepped into the role until the end of 2020, when she too left to further pursue her studies in psychology. I would like to acknowledge their outstanding contributions in managing all aspects of the Dow Centre's activities and wish them well in their new roles. In 2021, we will welcome Ms Kirsty Fraser into the Centre Manager role.

It was a great honour to take the role of Acting Director of the UQ Dow Centre for Sustainable Engineering Innovation. Having worked closely with the Centre since its inception I am passionate about the Centre's vision to provide knowledge leadership and innovative engineering solutions to decarbonise the global economy. I look forward to working with Centre staff and our Advisory Board to rejuvenate the Centre's affiliate network ready for the next Chair and Director to join in 2021.

I would like to acknowledge the tremendous support and counsel of our Advisory Board: UQ Vice-Chancellor and President, Professor Deborah Terry AO (Chair), Ms Karen Dobson (President and Managing Director, Dow Australia and New Zealand), Dr Weiguang Yao (Global Director, Asia-Pacific Chief Technology Officer, Dow), Noel Williams (Specialist Manufacturing Advisor, and UQ Alumni Representative), as well as UQ colleagues Professor Vicki Chen, Professor Justin Cooper-White and Professor Alan Rowan. We welcomed both Professor Terry and Professor Cooper-White to the board in mid-2020 and look forward to their support as the Dow Centre transitions to new leadership in 2021. I would also like thank Dr Andre Argenton (Vice President of Research and Development, Dow) for his insights and contributions to the Advisory Board, which aid the Centre in remaining closely connected with industry.

I also take this opportunity to acknowledge the invaluable contributions of our past chair: former UQ President and Vice-Chancellor, Professor Peter Høj AC, who stepped down this year after multiple years of valued service. Professor Høj chaired the Advisory Board since the inception of the Dow Centre in 2014 and has provided strong guidance, invaluable connections, and sage council in that time.

Last but not least, I would like to thank all Dow Centre staff for their continuing support and outstanding contributions in 2020. I look forward to expanding our networks in 2021.

Associate Professor Simon Smart

Dow Chair in Sustainable Engineering Innovation, and Director of the UQ Dow Centre

Key outputs 2020

Projects & funding

3
key research themes, spanning Energy Transitions, Low Carbon Energy and Materials, and Circular Economy

7
discrete research programs

21
projects, including one multi-year techno-economic analysis

$9M+
external research project funding

Centre staff

20
research and professional staff

3
Summer Research Scholars hosted

1
ARC Laureate Fellowship

1
Advance Queensland Industry Research Fellowship

Research outputs

33
publications, including book chapters, and peer-reviewed journal articles

66
PhD candidates supervised by UQ Dow Centre researchers

12
PhDs conferred, under supervision of UQ Dow Centre researchers

2
patents filed

Student experience

17
courses coordinated, lectured or tutored by UQ Dow Centre staff

2600+
students reached through teaching and coordination

23
BE/ME student theses supervised by UQ Dow Centre staff

1
UQ Dow Centre Summer Research Scholar awarded Chief Student Entrepreneur

Engagement

74
external organisations with whom UQ Dow Centre staff engaged

8
countries with whom UQ Dow Centre researchers collaborated

42
engagement events, including keynotes, media interviews and symposiums, in which UQ Dow Centre staff participated

53
Australian and international collaboration partners

Fast facts about UQ

55,300+
STUDENTS FROM MORE THAN
142
COUNTRIES

3
CAMPUSES

6
FACULTIES

#2 UNIVERSITY IN AUSTRALIA IN THE PRESTIGIOUS *NATURE* INDEX

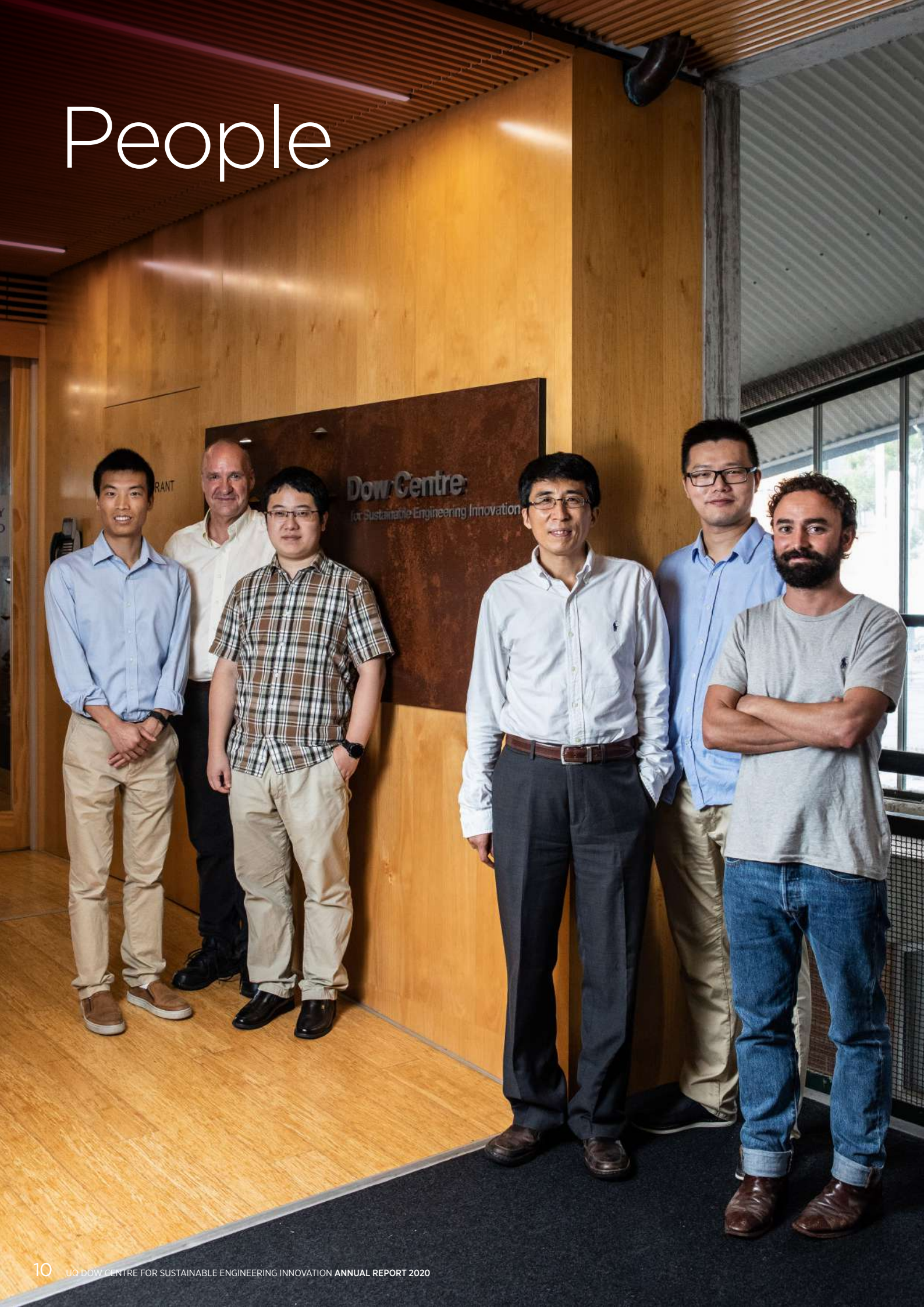
STATE-OF-THE-ART FACILITIES

#1 IN QUEENSLAND FOR GRADUATE EMPLOYABILITY

QS Graduate Employability Rankings 2020

MORE
NATIONAL TEACHING AWARDS THAN ANY OTHER AUSTRALIAN UNIVERSITY

People



Advisory board

Professor Deborah Terry AO

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

Professor Deborah Terry AO is Vice-Chancellor and President of The University of Queensland (UQ). Prior to commencing this role in August 2020, she served as Vice-Chancellor of Curtin University in Western Australia (from February 2014 to July 2020). Professor Terry 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. She is also Chair of the Board of Universities Australia; a Fellow and past President of the Academy of Social Sciences in Australia; an appointed member of the Australian Research Council Advisory Council; and serves on the Australia and New Zealand School of Government Board and Australia's Academic and Research Network Board (AARNET). Having grown up in Perth and Canberra, Professor Terry completed her PhD in Social Psychology at the Australian National University in Canberra. From there, she commenced her distinguished career at UQ in 1990, initially as an internationally recognised scholar in psychology. During her 24 years at UQ, Professor Terry progressed through a number of senior leadership roles to become Senior Deputy Vice-Chancellor, before leaving for her role as Vice-Chancellor of Curtin University in early 2014.

Ms Karen Dobson

Managing Director of 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. She returned to Melbourne in 2014.

Dr Weiguang Yao

Chief Technology Officer, Asia Pacific R&D; Global Director, New Ventures for Asia Pacific, Middle East and Africa, Dow

Dr Weiguang Yao is the Chief Technology Officer for Asia Pacific R&D. He is responsible for Asia Pacific R&D Strategy to ensure Asia Pacific Resources align with regional growth opportunities. He represents Dow R&D in the Asia Pacific region. He also takes responsibility as Board Director of East China University of Science and Technology. Dr Yao is based in Shanghai. Dr Yao joined Dow in April, 2007 as Sr. R&D Director for Dow Core R&D in Asia Pacific. He was responsible for building Asia Pacific core and business aligned research capability and strategy at Dow, and driving Asia Pacific core R&D innovation for regional growth.

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 Vicki Chen

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

Professor Chen holds a Bachelor of Science in chemical engineering from Massachusetts Institute of Technology (MIT) and a PhD from the University of Minnesota. She was formerly Head of the School of Chemical Engineering at the University of New South Wales (UNSW), where she strategically and successfully led the School's performance in research, teaching, infrastructure development, and academic recruitment. With multiple Australian Research Council Discovery grants and national and international industry linked research grants, Professor Chen is a highly successful researcher with close to 7000 citations to her name. Professor Chen has also held senior positions as the Director of UNESCO Centre for Membrane Science and Technology and has held other significant roles, leading major multi-institutional, collaborative projects with international industrial partners. Professor Chen's collaborations with industry stakeholders have seen a number of high profile outcomes, including the recent development of antifouling technologies, novel membranes for water purification and brine treatment, and high performance nano-composite membranes for greenhouse gas separation.

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, and is responsible for its strategic directions, scientific appointments, budgets, performance, representation and reporting to stakeholders. Professor Rowan 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. This work has received considerable attention since it is the first step to truly controlling cell behaviour, and is now being developed commercial for wound dressing, drug therapeutic and cell growth. He has a h-index of 68, with more than 320 publications, cited more than 18,000 times; 18 of which are in Science, Nature or the Nature family, and he has supervised more than 45 PhD students.

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., a lab-on-a chip start-up based in San Francisco, and Editor-in-Chief of APL Bioengineering, published by American Institute of Physics Publishing (New York). Professor Cooper-White has more than 200 journal papers, published in high impact journals in the field of Bioengineering (including ACS Nano, Science Advances, Nature Communications, Nature Protocols, Nature Microbiol., Biomaterials, Lab on a Chip, Cell Stem Cell, Stem Cells Trans. Med., Integrative Biology and APL Bioengineering). He has produced 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.

Senior staff

Associate Professor Simon Smart

Simon Smart is the Acting Director of the UQ Dow Centre and an Associate Professor in the School of Chemical Engineering at The University of Queensland. Simon is currently leading the Dow Centre's flagship projects into low CO2 production of materials and chemicals and contributes to the Rapid Switch initiative. He is actively involved in teaching at the undergraduate and Masters level, delivering courses in Energy Systems, Energy Principles and Renewable Energy and Engineering Innovation and Leadership. Outside the Dow Centre, Simon is the Director of the Functional Interfacial Materials and Membranes Laboratory (FIM2Lab) where he works on membranes for natural gas dehydration and carbon capture and utilisation.

Associate Professor Bronwyn Laycock

Bronwyn Laycock is a polymer scientist with an interest in advanced materials for sustainability. She is currently working across a range of projects, including novel biopolymers and their composites, particularly waste-derived, and the applications of these in controlled release formulations (for fertilisers, agricultural chemicals, and veterinary applications). She also has projects in self-assembled conducting peptides, spinifex to carbon fibre conversion, hydrogels for nutrient management, lignin-based polyurethane foams and waste to diesel conversion. Within the UQ Dow Centre, she is delivering the Next-Generation Fertiliser program, and has been instrumental in bringing the Fight Food Waste Transformation program in the Fight Food Waste CRC to the UQ Dow Centre. Bronwyn continues to pursue innovation in areas that will make a step change contribution to sustainability, such as in cost-effective nutrient management, food waste management and recovery, and delivering solutions for plastic use in the circular economy.

Professor Stephen Wilson

Professor Stephen Wilson is leading the global economic modelling component of the Rapid Switch project with the UQ Dow Centre. In 2018, Stephen was appointed as a Professor in the School of Mechanical and Mining Engineering, where he directs energy-related research in the newly formed Centre for Energy Futures. Research in the Centre for Energy Futures ranges from solar thermal generation and supercritical CO_2 cycles to simulation of proposed designs for inertial and magnetic fusion reactor containment. Stephen teaches Professional Practice to final year undergraduate engineers, as well as international Masters students from all engineering schools in the faculty. In addition, Stephen teaches a Masters-level course on Energy Markets, Law and Policy, which he developed in 2017. Stephen is a key member of the Rapid Switch team at UQ, and is the Principal Supervisor or Co-Supervisor of PhD students contributing to the Rapid Switch project.

Professor Lianzhou Wang

Lianzhou Wang is currently Professor in the School of Chemical Engineering, Director of the Nanomaterials Centre (Nanomac), and Senior Group Leader within the Australian Institute for Bioengineering and Nanotechnology (AIBN) at UQ. His research focuses on the design and development of semiconductor nanomaterials for energy conversion and storage application including nanocatalysts for solar hydrogen production, low cost high efficiency solar cells and rechargeable batteries. In 2019, Lianzhou was awarded a prestigious ARC Laureate Fellowship aiming to develop new generation artificial leaves for renewable solar fuel production. As co-Chief Investigator of the Flexible Printed Batteries CRC-P, Lianzhou leads and oversees laboratory research based at the AIBN.

Professor Peter Halley

Professor Peter Halley is a Professor in polymer processing in the School of Chemical Engineering, Chief Investigator in the Advanced Materials Processing and Manufacturing (AMPAM) Centre, an Affiliate Professor in the Australian Institute for Bioengineering and Nanotechnology (AIBN), and a founding member of UQ Plastics. Professor Halley is a Fellow of the Institution of Chemical Engineers (IChemE) and a Fellow of the Royal Australian Chemical Institute (RACI). Professor Halley is on the editorial board of Green Materials, Plastics, Rubbers and Composites, Starch and the Journal of Renewable Materials.

Associate Professor Steven Pratt

Steven Pratt is an Associate Professor in the School of Chemical Engineering at The University of Queensland, where he leads research on process development for sustainable waste management. His research focus is on utilising waste streams as feedstocks for the production of biomaterials and biofuels. The outcomes from these activities feed into broader biorefinery research programs, which aim for waste streams to be routinely utilised as feedstocks. He has authored over 50 scientific papers on related topics, with his major contribution to the field of environmental biotechnology being the invention of the TOGA® Sensor for examination and control of biotech/bioprocess systems. Widespread interest in TOGA® led to an agreement between Massey University and Scion for the commercialisation of the technology. Steven is also a Lecturer in Water Cycle Engineering with the International Water Centre (IWC), where he is program advisor for the IWC's Masters of Integrated Water Management.

Professional staff

Ms Briony Beaumont (to September 2020)

Briony joined the UQ Dow Centre in July 2018 as the Centre Manager. In this role, Briony is responsible for supporting the Director and Advisory Board, contributing to the implementation of Centre strategic initiatives, and overseeing all operational matters within the Centre. This includes operational planning and reporting, budget management, coordination of professional support services, and engagement with UQ Dow Centre stakeholders. Briony holds a Bachelor of Business Management from The University of Queensland, and has a professional background in business management and governance roles. Briony is also currently completing a Master of Business Process Management. As Centre Manager, Briony provides a key interface for the Centre's internal and external stakeholders.

Dr Jannie Grové

Jannie has over 25 years of broad experience in project evaluation, development, process design, implementation, commissioning and operation of chemical plants / projects in South Africa, the USA and Australia. Specific industry experience in the oil shale, coal-to-liquids, cement, alumina, vinyl chloride monomer and ethylene production industries includes roles at senior and executive management levels, primarily focused on project development and operations management. His formal qualifications include a Masters degree in Chemical Engineering from the University of Pretoria (South Africa) and a PhD from the University of Queensland. He also holds an MBA from Northwest University (South Africa), in which he graduated top of the class and received the Old Mutual Gold Medal for outstanding academic achievement. In addition to external consulting, Jannie lectures and tutors at UQ and assists with the management of the Printed Energy CRC project on a part-time basis.

Mrs Mojgan Tabatabaei Zavareh

Mojgan received her Bachelor of Engineering degree in chemical engineering and was awarded top student rank from Iran University of Science and Technology in 1993. As a graduate engineer, she joined the Air Quality Control Company in the position of environment engineer focusing on air pollution, establishing air monitoring facilities in Tehran with collaboration of international organisations including the World Bank and the World Health Organization. She then went on to earn her Master of Engineering degree in chemical engineering from Tehran University, Iran in 1997 and joined the Islamic Azad University as an academic staff. Mojgan has been involved in Front End Engineering Design and detailed design engineering of several mega scale industrial projects in a role of lead and principal process engineer from 2000. She joined the UQ Dow Centre in 2014 as a Techno-economic Analyst of various conceptual design processes.

Ms Meagan Wheeler

Meagan is a waste industry professional with experience spanning research, consulting, manufacturing, and government environments. She is currently the Program Coordinator for the Transform Program of the Fight Food Waste Cooperative Research Centre, managed through the UQ Dow Centre. Meagan has a Bachelor degree in Marketing and Communication, a Master of Business, a Graduate Certificate in Environmental Management, and is currently pursuing a Master of Environmental Management. Previously, Meagan worked for the Queensland Government Department of Environment and Science in the Waste Policy and Legislation team in a lead role developing the Plastic Pollution Reduction Plan. During her career, she has developed a specialisation in plastics, while her diverse background provides her with a broad understanding of the role of materials within societal and environmental systems.

Research fellows

Dr Jake Whitehead

Jake holds two PhDs in Transport Science and Transport Engineering, a Licentiate in Transport Engineering, in addition to a Master and Bachelor of Civil Engineering. His research career has focussed on analysing the impact of government policies on, and consumer preferences towards, novel transport technologies, including shared, automated and electric vehicles. Jake works closely with many Australian Governments to provide advice on sustainable transport policies, with one of his key achievements being the coordination, development and delivery of Australia's most comprehensive electric vehicle strategy: The Future is Electric - Queensland's Electric Vehicle Strategy. In his current role at the UQ Dow Centre as the inaugural Tritium E-Mobility Research Fellow, Jake is leading research into how novel transport technologies, such as electric vehicles, could support the development low carbon energy systems through the use of smart charging technologies.

Dr Sicong Tian

Dr Sicong Tian was awarded his PhD in environmental science and engineering from Tsinghua University (China) in 2016, with a focus on biogas dry reforming for syngas production and thermochemical CO_2 capture. Sicong worked as a Postdoctoral Research Fellow in the School of Engineering at Macquarie University (Australia) from 2017, and relocated to Brisbane to commence at UQ. His research interests include industrial decarbonisation, sustainable waste management, as well as thermochemical biomass conversion and CO_2 utilisation. Sicong is working with Associate Professor Simon Smart on the evaluation of new sustainable hydrogen production from methane pyrolysis, under the Future Fuels CRC 'Novel technology to produce low-cost blue hydrogen via methane pyrolysis' project.

Dr Luigi Vandi (to August 2020)

Luigi Vandi is a Research Fellow with a diverse background in Materials Science. His translational research activities have a strong focus on industry relevant-projects, including high-performance composites manufacturing for automotive and aerospace applications. His current focus and expertise is in biocomposites and biopolymers innovations for sustainable developments. In his role at the UQ Dow Centre, Luigi is focusing on the materials development for next generation fertilisers. Successful outcomes would address a global issue with nitrogen and phosphorous losses in agriculture. He finds being part of a multidisciplinary team at the UQ Dow Centre with a worldwide vision on sustainability, energy and waste management both valuable and stimulating.

Dr Miaoqiang Lyu

Miaoqiang obtained his PhD from the School of Chemical Engineering at the University of Queensland in 2017, and commenced as a Postdoctoral Research Fellow working on the Advanced Printing Technology for the Flexible Printed Batteries CRC-P in early 2018. He is experienced in material synthesis, characterisations and applications, in particular renewable energy generation and storage areas. In 2018, Miaoqiang was the recipient of an Advance Queensland Industry Research Fellowship (Early Career), and is currently working toward developing printable and self-powered electronics for Internet of Things (IoT) devices.

Dr Paul Luckman

Paul is a chemical engineer from The University of Queensland, with a Masters in Biological Engineering and a PhD in Biomaterials Engineering. Paul specialises in bio-polymer process engineering materials and technologies. Dr Luckman has worked on the boundary between academia and industry with a range of companies from start-ups to several of the world's largest users and manufactures of biopolymers to develop product solutions for a range industry sectors such as packaging, agriculture, mining, and food. His research career to date has been entirely collaboratively funded through industry-linked projects including Collaborative and Industry Engagement Fund, two ARC Linkages, an Advance Queensland Innovation Partnership, and an Advance Queensland Research Fellowship. Dr Luckman contributed to the UQ Dow Centre's research as the Program Leader for the Transform Program with the Fight Food Waste Cooperative Research Centre.

Dr Torsten Witt

Torsten is a polymer scientist from the School of Chemical Engineering, and has specialised in understanding the structure property-relations of biopolymers in a variety of multi-disciplinary and industry-focussed projects. This has included understanding the role of biology and chemistry in the production of native ordered structures; the influence of biopolymer processing in altering food structure and food quality; and the chemical and physical modification of biopolymers to transform them into renewable biodegradable plastic materials. Torsten obtained his PhD in 2013 with the UQ School of Agriculture and Food Sciences. As a member of the Next-Generation Fertilisers project, Torsten is currently working on producing biodegradable slow release fertiliser to combat environmental nitrogen loss in the Great Barrier Reef catchment area.

Dr Yuxiang Hu

Yuxiang Hu received his PhD degree from the School of Chemical Engineering at UQ in 2019, before commencing as a Postdoctoral Research Fellow working on the Advanced Printing Technology for New Generation Flexible Batteries CRC-P in late 2018. Previously, Yuxiang received a Bachelor of Science degree from the School of Chemistry and Chemical Engineering at Nanjing University in 2012, and later obtained a master's degree under the supervision of Prof. Jun Chen in the Key Laboratory of Advanced Energy Materials Chemistry (Ministry of Education, Nankai University). His research currently focuses on nanomaterials, catalysis, and metal-ion/oxygen batteries.

Research assistants

Mr Benoit Clement

Benoit is a PhD candidate within the School of Chemical Engineering at the University of Queensland. Benoit obtained his Bachelors degree in Chemical Engineering from the University of Queensland in 2013. After graduating, Benoit worked on several battery research projects in industry. He is experienced in the field of product development and has participated in the inception of a start-up company. His PhD project is investigating economical routes for manufacturing thin-film batteries en masse, intended for the market of small and flexible electronic devices. Benoit commenced as a member of the Flexible Printed Batteries CRC-P team at the UQ Dow Centre in 2018, and is working to bring next-generation flexible printed batteries to the market while completing his PhD

Mr Liam Darby (from September 2020)

Liam Darby joined the UQ Dow Centre in late 2020, working as a research assistant on the techno-economic assessment of clean-hydrogen production from Latrobe Valley brown coal in collaboration with Exergen, to investigate the feasibility of hydorgen production from a brown coal asset via gasification. Liam is in his final year of Bachelor of Engineering (Hons)/Bachelor of Business Management in chemical engineering and sustainabiliity.

Mr Jonathan Mendez (from September 2020)

Jonathan Mendez joined the UQ Dow Centre in late 2020, working as a research assistant on the techno-economic assessment of clean-hydrogen production from Latrobe Valley brown coal in collaboration with Exergen. Jonathan is a mechanical engineer with a Masters degree in Sustainable Energy from UQ. He has four years of professional experience in oil & gas and clean energy technologies including solar photovoltaic, biogas and hydrogen, particularly focused on production, process and project engineering.

Summer research scholars

Mr Siddhant Singh (November 2019 - February 2020)

Siddhant (Sid) Singh is a first-year Master of Engineering student majoring in Chemical Engineering. Sid joined the UQ Dow Centre in November 2019 as a Summer Research Fellow, under the supervision of Mojgan Tabatabaei Zavareh and Associate Professor Simon Smart. Sid's research focusses on the techno-economic analysis of various carbon-capture techniques, with greater focus on ammonia and mixed salts (as solvents). His interests lie in clean and sustainable energy. Sid aims to build on his experience at the UQ Dow Centre to gain more insight into these fields throughout his future education and career, and ultimately hopes to develop a clearer pathway to a more sustainable future through engineering innovation.

Mr Duohan Zhang (November 2020 to February 2021)

Duohan Zhang is a fourth-year Bachelor of Engineering(Hons)/Master of Engineering student majoring in Chemical and Environmental Engineering. From late November 2020 through February 2021, Duohan participated in a ten-week summer research program under the supervision of Mojgan Tabatabaei Zavareh & Associate Professor Simon Smart at the UQ Dow Centre, exploring modern technologies in wastewater treatment.

Miss Rachel Huang (November 2020 to February 2021)

Miss Rachel Huang is a fourth-year Bachelor of Engineering(Hons)/Bachelor of Science student majoring in Chemical & Biological Engineering and Biomedical Science, and is also UQ's Chief Student Entrepreneur. Rachel joined the UQ Dow Centre in November 2020 as a Summer Research Fellow, under the supervision of Alister Sheil and Associate Professor Simon Smart. Rachel's project involved investigating molten catalysts used in methane pyrolysis to produce low emission hydrogen. She was strongly interested in this project as she has always been interested in ways to contribute to a more sustainable future through new technologies and innovations. Rachel will build on her summer research experience at the UQ Dow Centre and continue her path in pursuing tech-driven sustainability solutions in her future academic endeavours and career.

HDR students

Mr Gabriel Rioseco

Gabriel holds a Bachelor of Science and Master of Science in Industrial Engineering, with a specialisation in environmental economics from the University of Concepción, Chile. In 2018 he graduated from the University of Queensland with a Master of Sustainable Energy. In 2018, Gabriel joined the UQ Dow Centre as a PhD student as part of the Rapid Switch project. Gabriel's research focusses on the economics of energy systems, specifically determining the integration costs of variable renewables, and analysing their impact on the rate of deployment of renewables and broader macroeconomic variables.

Mr Mark Hodgson

Mark is a mature-age PhD candidate sponsored by the Dow Centre. Mark's research explores methods to mitigate CO_2 emissions associated with the production of cement. He contributes to The University of Queensland's teaching outcomes via tutoring activities. Previous formal education includes a Bachelor of Engineering (Chemical) and a Bachelor of Economics. He is a Fellow of the Institution of Chemical Engineers, and serves as the Australian committee member of the Institution's Clean Energy Special Interest Group. Mark's working career included management of process performance benchmarking and improvement, optimisation, technology revamps, process safety, and technical auditing, within the oil and gas industry (both downstream and upstream). A career highlight was leadership of an international technical best practice working group for a major multi-national.

Ms Sara Zeinal Zadeh

Sara obtained her bachelor's degree in Mechanical Engineering from the K.N.Toosi University of Technology in 2000, after which she worked in the oil and gas industry as project engineer and project manager in Persian Gulf mega-projects. In 2012, she moved to Australia and in mid-2013 took up a one-year research project on Life Cycle Assessment of Solar Energy in Australia at the UQ Energy Initiative. After 12 challenging years dealing with fossil fuels and observing the real-in-site environmental impacts of conventional power generation technologies, she pursued a career change to contribute to improving the environment. Her PhD project involves solar energy technologies, solar policy and social impacts of solar deployment, and is part of the wider Rapid Switch project. Sara has been enhancing her skills in techno-political and techno-social modelling. Sara also tutors and mentors undergraduate students in engineering design and project management courses at UQ. Her aim is to become an academic in the clean energy space.

Mr Tongen Lin

Tongen is a PhD candidate with the School of Chemical Engineering, The University of Queensland. He received his bachelor's degree in Chemical Engineering and Technology from Sichuan University in 2013, and later obtained his master's degree from The University of Queensland in 2016. Tongen is currently a final-year PhD student studying under the supervision of Prof. Lianzhou Wang. Tongen's research focuses on lithium-rich cathode materials for lithium ion batteries. He joined the CRC-P team at UQ in October 2019, and is working on next-generation flexible printed batteries.

Mr Alister Sheil

Alister is a PhD student in the UQ School of Chemical Engineering and is working within the Future Fuels Cooperative Research Centre, researching methods of transitioning Australia safely and reliably to clean energy sources. He graduated from The University of Queensland in 2018 with a degree in chemical engineering with first class honours, over the course of which his interest in the energy sector and alternative energy solutions developed. Upon graduating, he worked as a process engineering consultant which allowed him to become familiar with the Australian energy landscape and gain an appreciation for the complexities involved in the energy transition. He is now investigating the production of low-emission hydrogen from natural gas, which has the benefit of creating reliable, low-cost hydrogen to contribute to the decarbonisation of fertiliser production, refining, heating and the transportation sector.

Research


THE UNIVERSITY OF QUEENSLAND
AUSTRALIA
SCHOOL OF
CHEMICAL ENGINEERING

Throughout 2020, the UQ Dow Centre continued to lead research across a number of projects, which all aim to make an original and significant contribution to global sustainability

Research at the Centre aligns with three key research themes:

Energy Transitions

Low Carbon Energy and Materials

Circular Economy

Energy Transitions

Rapid Switch

Project Leader

Professor Chris Greig (Princeton based and funded from August 2020)

Associate Professor Simon Smart (from August 2020)

Team Members

Associate Professor Simon Smart,

Professor Stephen Wilson (Mechanical Engineering),

Professor Karen Hussey (Centre for Policy Futures),

Dr Belinda Wade & Dr Saphira Rekker (UQ Business School).

Key Partners

Princeton University,

Carnegie Mellon University,

IIT-Delhi, IIT- Bombay,

Tsinghua University,

Ashoka Trust for Research in Ecology and the Environment, and the

Centre for Policy Research.

The global transition to a low carbon economy: Understanding bottlenecks, constraints and unintended consequences

This report highlights the Rapid Switch USA project, being co-led by Professor Chris Greig with colleagues at Princeton, and provides a look ahead for the CCS Barriers, Business Transitions for a Zero-Carbon Future, and Net-Zero Australia projects.

Background

Decarbonisation of the global economy to meet climate targets is an unprecedented challenge. It will require a long-term, adaptive and world-wide collaboration between governments, companies and communities to develop and deploy technologies and change behaviours. At the same time global societies seek to maintain or improve energy security, affordability and equity. Governments and businesses are now making public commitments to reach net zero emissions by 2050. Whilst many roadmaps and strategies have been published, there is a large gap in the work done to date, when compared to the rigour and detail that will be needed for policy and business planning.

The Rapid Switch initiative is a polycentric, global network of leading research institutions, which conceived in the UQ Dow Centre for Sustainable Engineering Innovation. Rapid Switch seeks to identify, anticipate and communicate industrial, regulatory and social bottlenecks and constraints that might impact the pace of decarbonisation of the global economy. This research aims to ground political and societal conversations about deep decarbonisation (scenarios consistent with the ambition to keep global average temperature rise to well below 2°C) with real-world assessments of the change required.

Highlights & Outlook

Rapid Switch USA: Net-Zero America

The multi-disciplinary and multi-national Rapid Switch initiative, founded by Professor Chris Greig in the UQ Dow Centre and continued at Princeton under Prof Greig's Andlinger Fellowship, developed scenarios for moving the US economy to net zero emissions by 2050. The research showed, for the first time, the degree of physical infrastructure change, social change and environmental change (air, water, land use, oceans and deep subsurface) in very fine geographic detail. The project had an oversight committee comprising representatives of Princeton senior executive, Environmental Defence Fund, Natural Resources Defence Council, The Nature Conservancy, The Clean Air Task Force, BP and Exxon Mobil.

"Set[ting] an entirely new standard in this genre ... Everybody seriously interested in the crucial question of this country's energy–climate future – not least the new Biden–Harris administration – needs to understand the findings of this extraordinary study ..."

John P. Holdren, former presidential Science Advisor and Director of the White House Office of Science and Technology Policy

Five central scenarios were developed including Diverse Unconstrained (+Hi Electrification) Renewable Energy Dominance (+Hi Electrification), and Renewables Constrained (+Hi Electrification) High Biomass (+Lo Electrification).

The unique element of this project was its downscaling (spatially and temporally) of the modelled scenarios to provide a very high-resolution perspective of the levels of physical infrastructure, social and environmental change.

The ground-breaking study, Net-Zero America: Potential Pathways, Infrastructure and Impacts, was released in November 2020, along with a number of journal papers.

CCS Barriers Project

The first stage of the CCS Barriers Project (UQ led) is also close to finalisation, with an invited manuscript under review at Nature Climate Change. Dr Andrew Pascale is undertaking additional work to finalise that manuscript. A collaborative project (led by UQ) has also commenced with Grantham Institute at Imperial College London, looking at the shipping CO_2 from emissions intensive regions that might lack suitable geological formations to store CO_2 to places like the Middle East where such geological resources are expected to be abundant.

Business Transitions for a Zero-Carbon Future (with UQ Business School)

Deep decarbonisation scenarios can only be achieved if all firms take serious and sustained actions to reduce the emissions intensity of their investments. Along with the unprecedented socio-economic risks comes abundant opportunity for innovative business models built around a low-carbon economy including new mineral extraction, renewable energy, service sectors, and technology development.

Good progress was also made on the Business Transitions for a Zero-Carbon Future project being led by Saphira Rekker and Belinda Wade (UQ Business School). The first stage has focused on developing and testing methods to track corporate climate performance, by benchmarking companies' historical, actual and projected greenhouse gas emissions against Science-Based Targets. The methods will be tested on companies in Australia's electricity sector and export-exposed mining sector to demonstrate their alignment with deep decarbonisation scenarios.

Net Zero Australia

In 2021, the Centre will continue the work of the Rapid Switch initiative, with a ground-breaking, collaborative $2M Net Zero Australia project, thanks to a $500,000 gift from Worley, matched by the Dow Challenge. This partnership between UQ, the University of Melbourne, Princeton University and Nous Group will build off the Net-Zero America project, utilising the same transitions framework and analytical tools to address Australia's critical and unique decarbonisation challenges.

Unlike the United States, however, Australia's domestic economy is dwarfed by the quantity and value of our current energy exports. Many of our major trading partners including China, Japan and South Korea have also adopted net zero targets by mid-century, increasing pressure on Australia to explore transformative pathways. The project is intended to inform the adoption of a firm Australian target, and planning for its implementation by governments, businesses, non-profit organisations and communities.

E-Mobility

Project Leader

Dr Jake Whitehead.

Key Partners

Tritium, Evie Networks, St Baker Energy Innovation Fund, Veitch Lister Consulting, and Queensland Government

It is estimated that each year in Australia there are at least 40 per cent more premature deaths from vehicle pollution than from vehicle accidents. The uptake of electric vehicles offers a promising pathway toward a healthier, more sustainable future

This research aims to identify key technological, social, economic and policy interventions that could accelerate a transition to electric vehicles.

Background

Globally, the problem of transport pollution is significant, with almost 400,000 premature deaths occurring annually due to transport-produced particulate and ozone pollution, resulting in an estimated $US 1 trillion in health damages .

This significant toll from transport pollution stems from our continued dependence on fossil fuels, burnt in internal combustion engines for mobility. However, rapid advancements in battery technology over the past decade are helping to make electric vehicles (EVs) a viable alternative. In addition to providing a pathway towards lower transport pollution, EVs also support the uptake of renewable energy and reduce greenhouse gas emissions, all while bringing down both transport and energy costs. However, electric vehicles still represent less than 1% of the global vehicle fleet, primarily to three consumer barriers:

- a lack of awareness and experience with electric vehicle technology
- limited charging infrastructure to support long-distance travel, and
- high upfront capital costs for both households and infrastructure providers

Governments globally are actively working to reduce these barriers through supportive policy to stimulate both demand for, and supply of this beneficial technology. However, further work is required to accelerate their uptake and address the potential negative impacts of uncontrolled charging on the electricity grid.

Through the generous support of the Trevor and Judith St Baker Family Foundation, the inaugural Tritium E-Mobility Visiting Fellow, Dr Jake Whitehead, has founded a multi-disciplinary E-Mobility research group to solidify UQ's research excellence in this field, with a research program focussed on advancing the performance, economics, and uptake of electric vehicle technology. This program of work has been enhanced through a number of successful funding arrangements, including: an Advance Queensland Industry Research Fellowship, an iMOVE CRC grant, Transport Academic Partnership funding, a multi-EAIT school funding collaboration, and further generous support provided by Judith and Trevor St Baker to support the creation of a second endowed E-Mobility Fellow.

The research delivered by the E-Mobility research group includes:

- establishing whether a viable locale exists for smart charging infrastructure, and using EVs as "batteries-on-wheels"
- developing policy to support the local uptake of EVs, and capturing the associated economic benefits
- understanding consumer preferences towards EVs and that spatial uptake of the technology locally
- investigating feasibility of heavy vehicle electrification in Australia, including buses, trucks, ships and construction machinery
- gaining insight into how local EV owner charging and driving behaviour, and how this compares to international markets
- analysing the impact of proposed road pricing schemes on EV uptake, and
- how E-Mobility uptake can be supported within the broader shift across transport towards Mobility-as-a-Service.

Highlights & Outlook

Significant progress has been made throughout 2020, across research strategy and design, grant applications, formal and informal collaborations, as well as public engagement and education.

Despite the challenges experienced globally during 2020 due to COVID-19, Dr Whitehead was able to recruit a number of new staff, including a new PhD student to support his Advance Queensland project; two new, multi-disciplinary post-doctoral fellows affiliated with the Dow Centre, Civil Engineering (CE), and Information Technology and Electrical Engineering (ITEE) to focus on the electrification of heavy vehicles; a new post-doctoral fellow affiliated with CE for the MaaS project (iMOVE CRC); in addition to a further generous donation from Judith and Trevor St Baker to established a second endowed E-Mobility research position – the St Baker Research Fellow in E-Mobility.

Advance Queensland Industry Research Fellowship

This research fellowship is a three-year study focussed on investigating how electric vehicles can deliver co-benefits to the energy sector. Over 2020 Dr Whitehead surveyed consumer preferences towards EVs which involved the collection of data from a representative sample of 500 Queensland vehicle owners. The survey respondents complete two separate stated preference tasks – the first focussed on electric vehicle features, the second focussed on road pricing. The results provided rich insights including that on average, Queensland consumers would be willing to spend:

- approx. $3,500 more for an EV with 400 km driving range (vs 300 km)
- approx. $3,000 more for an EV with 10 mins fast charging time (vs 20 mins)
- approx. $6,500 more for an EV if public charging infrastructure was perceived to be as
- easily available as petrol stations
- approx. $7,000 more for an EV if it included the ability to sell electricity back to the grid and/or power the consumer's own home like a stationary battery.
- a $1,000-$3,000 credit on consumer electricity bills would be a more effective incentive for EV uptake compared to a free/discounted parking and/or toll roads.

Many Queensland consumers would also support a transition to road pricing, specifically to phase out old-road taxes (stamp duty, registration, LCT, GST, etc) in favour of a new road pricing scheme. The key principle is that the new road pricing scheme must replace the old scheme - not be an additional tax; and highest support is for a scheme that applies to all vehicles, regardless of fuel type. Results suggest that if a 2.5 cent per km tax was introduced for EVs (as proposed by some jurisdictions in Australia), this could be perceived as a $4,500 increase in the upfront cost of an EV - with a significant, negative effect on EV uptake, threatening Australia's ability to reach net zero emissions by 2050, and potentially halving market share of EVs over the coming decade.

On the flipside, results suggest that if EVs were exempt from all existing road taxes, this would be perceived as a $11,500 discount on upfront cost, which could act as a significant incentive for EV adoption, and provide an opportunity to introduce a road pricing scheme with a low tax rate that increases over time, in line with EV sales targets.

A further study on charging behaviour was also designed, however, a major challenge throughout 2020 was that driving and charging behaviour was highly atypical compared to pre-COVID data. While it is unlikely regular driving behaviour will return, it does appear to be stabilising meaning that research can continue as planned in 2021. Learnings from these surveys will be invaluable for better understanding the current market, likely future uptake of EVs, and assessing viability of a smart charging infrastructure market in Australia.

Electric Heavy Vehicles

The role of electric vehicles in the heavy vehicles space is somewhat contested as technologies like hydrogen fuel cells gain momentum. With this in mind, the team undertook two projects in 2020 reviewing the current status of low and zero emission truck technologies and assessing feasibility of introducing Zero Emission Buses (electric and hydrogen) in Queensland. With this growing support for electrification of heavy vehicles, the E-mobility team have hired two new E-Mobility post-doctoral research fellows to further expand capacity on this topic in 2021.

Mobility-as-a-Service

Often E-Mobility is associated with private electric vehicles. The reality, however, is that the transport system is facing major disruptions in future that are likely to see E-Mobility far more commonly associated with a range of shared, potentially automated vehicles, as well as a range of micro-mobility devices, such as electric scooters, bikes and skateboards associated with rapid advancements in battery technology over recent years.

This research project, through support of the iMOVE CRC, will establish a Mobility-as-a-Service (MaaS) trial at UQ's St Lucia campus. It will involve bundling of different transport modes into a single subscription platform. It will also represent the first step towards exploring consumers' willingness to change transport habits, initially focusing on how willing consumers are to switch from a pay-as-you-go approach to transport (the current goCard model), to fixed subscription pricing bundles (including the possibility of unlimited public transport for a set monthly price) and shared e-mobility options, such as electric scooters, electric bikes, and possibly even electric demand responsive transit (DRT) – using electric taxis.

Through this real-world experiment, we will gain an appreciation of how popular subscription pricing for transport may be, and assess whether a sustainable business model exists for MaaS. This will also lead to analysis as to whether MaaS programs can further improve the economics of E-Mobility technologies, including electric vehicles, by reducing payback periods through increased use. These findings are of significant interest to industry partners who have keen interest in understanding how these vehicles might need to be charged in the future, and where the best locations to install this infrastructure might be. The UQ MaaS trial will also enable other research groups across UQ to leverage the on-campus experiments to support and pursue their own research agendas.

Public Engagement

Recognising that a lack of public awareness and understanding of e-mobility technologies is a key barrier to adoption, during 2020, Dr Whitehead continued in his concerted efforts to participate in a range of public forums, events, courses and interviews to disseminate evidence-based information on E-Mobility across Australia, and internationally. The vast majority of these engagements were held remotely or virtually.

In response to growing public and media attention on e-mobility, Dr Whitehead also participated in several tv, radio and print interviews resulting in over 100 media publications, with a combined advertised space rate of more than $3.3 million . Dr Whitehead also published three articles in The Conversation, which were viewed by over 50,000 readers.

Low Carbon Energy and Materials

Flexible Printed Batteries CRC-P

Project Leaders

Professor Lianzhou Wang,
Professor Chris Greig.

Team Members

Dr Miaoqiang Lyu,
Mr Tongen Lin,
Mr Benoit Clement,
Dr Jannie Grové.

Key Partners

Printed Energy,
The University of New South Wales (UNSW).

In partnership with Printed Energy, UQ is leveraging cutting-edge technology to create new opportunities for Australian manufacturing

This research aims to develop thin flexible batteries for use in products such as smart labels, thin flexible medical devices, wearable electronics, light weight disposable sensors, active IoT devices and many more exciting products.

Background

Printed Energy is in the business of developing and commercialising printed battery technology, and UQ and UNSW are research-intensive universities who have specialist knowledge in the area of applied battery and photovoltaic (PV) technology.

Printed batteries have potential applications in many fields, including therapeutic devices, food-freshness tracking devices, and powered Radio Frequency Identification (RFID) tags. The overall purpose of the project is to develop printed batteries into a mature and commercialised technology.

This work involves the identification of suitable materials for use as primary and secondary batteries (through characterisation and the understanding of reactions), the development of environmental barriers (sealants), the optimisation of battery design and performance, the integration of the battery with devices and finally commercialisation.

Highlights & Outlook

The work in 2020 was focused on the improvement of battery shelf-life, cycling stability, manufacturing techniques and integration into practical devices and testing under real-world conditions. Of particular note, a scaled-up roll-to-roll production line was designed and established for printing thin-film batteries which will deliver large production orders for the growing market. Further technology was implemented in several actual sports trials, where printed batteries were used to power RFID tags in road races, including the 'Warrior Healing' race in Arizona to compare performance.

Large orders for the thin-film battery powered race timer are forecast for 2021, highlighting the importance of the new production facility. The team continues to explore opportunities including a supply chain tracking pilot, medical wearable tracking devices, therapeutic applications and food freshness device companies.

A promising secondary zinc-manganese battery system was successfully developed by the UQ team who are working with Printed Energy to organise the IP for this technology.

Low CO_2 Hydrogen

Project Leader

Associate Professor Simon Smart.

Team Members

Mrs Mojgan Tabatabaei,
Dr Sicong Tian,
Mr Alister Sheil,
Mr Mark Hodgson.

Key Partners

Future Fuels Cooperative Research Centre,
Woodside.

Hydrogen may become one of the most important clean energy carriers in a decarbonised world

This research is exploring the techno-economic costs and benefits of different processes for producing clean hydrogen, and leading the development of an innovative process to make hydrogen from natural gas, with out generating CO_2 emissions.

Background

Australia, with its large gas and coal reserves and abundant renewable energy, is well placed to establish a strong domestic hydrogen economy and also be a major player in clean energy exports. There are many hydrogen production pathways available to produce the vast quantities of clean future fuels and chemicals that Australia will require for both domestic and export use, but none that are simultaneously commercially deployed, low CO_2 and cost effective. Development of innovative and sustainable technologies for hydrogen production is a key research theme spanning three specific research projects. The main focus is using liquid metal and molten salt catalysts to produce hydrogen, syngas and solid carbon materials for batteries through methane pyrolysis and dry reforming reactions. The key advantage here is that by using a liquid catalyst we eliminate any issues with deactivation that have plagued past efforts with solid catalysts and it simplifies the removal of the solid carbon by-product allowing us to design continuous rather than batch processes.

Highlights & Outlook

Methane pyrolysis for blue hydrogen production from natural gas

This project seeks to advance zero CO_2 options for the production of hydrogen, chemicals and liquid fuels through alternative chemistry using methane pyrolysis and high temperature liquid catalysts to produce hydrogen and solid carbon by-products which could be used to make the batteries of the future. The Dow Centre is investigating and optimising the molten catalyst system in order to achieve high conversions, fast kinetics at lowered temperatures and effective carbon separation.

Throughout 2020, the research team trialled a variety of metal alloys and molten salt combinations in our laboratory bubble column. The molten salt systems have shown great promise and in 2021 our work will focus on the optimisation of the molten catalyst system to lower the reaction temperature and improving the reaction selectivity for hydrogen. We, in partnership with the University of Adelaide, are aiming to design and build a high temperature, bench-scale bubbling reactor incorporating a solid carbon collection system. This will enable the research team to focus on a larger scale pilot to demonstrate this technology to industry, which in turn will serve to enhance the commercial value proposition for industry.

Dry reforming for CO_2 utilisation

This project departs from the typical Dow Centre perspective on CO_2 emissions – using innovative chemistry and process routes to avoid the production of CO_2 in the first place – and instead focusses on how to use innovative chemistry to utilise CO_2 with natural gas to produce feedstocks for the decarbonised economy. Dry reforming (DR) has long been investigated as a viable pathway for the conversion of methane to chemicals with the added benefit of CO_2 utilisation. However, traditional dry reforming technologies have been plagued by catalyst sintering, stability and coking. We are combining our existing catalytic molten metal and molten salt systems for methane pyrolysis with DR to enhance the overall efficiency and ultimately prevent catalyst deactivation. In turn this allows the combined reaction system to produce high value syngas with tailorable H_2:CO ratios. Further it has the potential to either unlock natural gas fields with high CO_2 content, or as an alternative option for a conventional carbon capture and storage where methane (eg. biomethane) is available.

COVID-19 significantly disrupted this research activity in 2020 as the team prioritised the methane pyrolysis work. In 2021 we will look to advance new system that incorporates a heterogeneous catalyst (e.g. Fe/Al_2O_3) in a molten salt for syngas production, where the CO_2 activation occurs mostly on the heterogeneous catalysts and the CH_4 cracking predominantly takes place within the molten salt.

Techno-economic analysis of hydrogen production technologies

There are many production processes for hydrogen and other future fuels. These processes all differ in their production routes, emissions profiles, energy and chemical efficiency, dynamic behaviour, appropriateness of scale, and economic viability.

This project, conducted through the Future Fuels CRC in collaboration with University of Adelaide and the University of Melbourne, is developing techno-economic analyses of a wide range of hydrogen production processes for large scale deployment within Australia.

During 2020, detailed process simulations were completed for all 38 cases under investigation, encompassing 14 technologies at both domestic and export scales using 22 feedstocks and producing 6 hydrogen carriers.

The project is scheduled to conclude in mid-2021 and will report detailed process costings and comparative levelized costs of hydrogen for each case. The results will feed into ongoing and future studies that build towards case studies of integrated hydrogen hubs and optimised hydrogen supply chains.

Next-generation fertilisers

Project Leaders

Associate Professor Bronwyn Laycock.

Team Members

Associate Professor Steven Pratt,
Professor Susanne Schmidt,
Professor Damien Batstone,
Dr Paul Luckman,
Dr Luigi Vandi,
Ian Levett (PhD student),
Dr Torsten Witt, and Dr Nicole Robinson.

Key Partners

School of Chemical Engineering, School of Agriculture and Food Sciences, the Queensland Department of Agriculture and Fisheries, James Cook University and the Manildra Group.

Approximately 50 per cent of the nutrients from conventional mineral fertilisers are released into the atmosphere, nearby waterways, or groundwater, creating negative impacts for land degradation, water quality, and the health of delicate ecosystems such as the Great Barrier Reef

This research aims to dramatically improve the efficiency of fertiliser use, reduce excess fertiliser run-off, and in turn reduce negative environmental impacts of fertiliser use.

Background

Modern agriculture relies on mineral fertilisers to replace the main essential nutrients (nitrogen, phosphorous, and potassium) removed with the harvest product. Approximately 50 % of the nutrients from conventional mineral fertilisers (being water-soluble salts) are released into the atmosphere, nearby waterways, or groundwater. As a result, plants often only absorb half of the nutrients from fertilisers. This is particularly true where a crop is in its early stages and cannot absorb the nutrients quickly. In addition, some existing slow-release fertilisers contain non-degradable plastics, contaminating soil with micro-plastics long after the fertiliser has been applied. These insights suggest that modern fertilisers are far from efficient or environmentally sustainable. The resulting environmental impacts are evident in agricultural settings throughout the world. In response to this challenge, the UQ Dow Centre is aiming to improve the efficiency of fertiliser use and reduce negative environmental impacts using material science and applications design.

Since the inception of the project, Dow Centre researchers have focussed on developing and testing new types of fully-biodegradable materials that slow the release of nutrients such as urea (a nitrogen containing compound, used as a cost-effective source of fertiliser for crops) into soil. The key research questions addressed are:

1. How do different biodegradable polymers form a composite with different fertilisers and how much do they reduce the release rate of fertilisers?
2. Can aluminosilicates trap urea in their structure to increase the amount of fertiliser present in composites and reduce fertiliser release rates?
3. What processing methods can increase the fertiliser component of the polymer-fertiliser composite without increasing the release rate of the fertiliser?
4. Do laboratory based water release results correlate with soil-based analytical methods or nutrient uptake in real plant systems?

The project has produced a biodegradable fertiliser which releases urea for more than 40 days in soil. Using different processing methods, the loading of fertiliser in the polymer composite increased with minimal increases in fertiliser release. These fertilisers have subsequently been included in two large scale plant trials in a tropical and subtropical region using a broad acre crop and a horticultural crop, as well as a full field trial looking at the in-field effect on grass growth. A techno-economic analysis showed that the cost of the biodegradable polymer and the proportion of fertiliser loaded into the composite were the greatest drivers of fertiliser cost. Prototypes were identified in conjunction with Manildra, which were produced at pilot scale for the field and pot trials. Discussions around commercialisation were held but a decision was made to instead seek further funding to extend materials development and field trial work.

Highlights & Outlook

Experimental work and techno-economic analysis

Experimental laboratory work producing, testing and characterising polymer–fertiliser composites was undertaken by Dr. Torsten Witt. Materials were produced for plant trials that continued through 2020 at James Cook University and at the Queensland Department of Agriculture and Fisheries. A further field trial looking at the effect of fertilisers in practice in field on grass growth was conducted at the Queensland Department of Agriculture and Fisheries in Toowoomba – and was delayed due to Covid, being started in August 2020 and should be completed in mid-February 2021.

Research outcomes

The work aimed to identify which polymer–fertilisers composites would maximise fertiliser loading while minimising fertiliser release rates. Plant trials were established to validate lab-based fertiliser release studies and to test the fertiliser-composites ability to outperform pure urea in a high water leaching environment. In practice, it was found that the results were more dependent on soil environment than anticipated, although a material that delivered the required field performance was identified.

Based on the knowledge developed in this project, a nonintuitive model system for the production of slow-release polymer/fertiliser composites was developed which allows a wide range of fertilisers to be used.

Exploring future prospects

The research team expect that the project will conclude successfully in 2021 to the satisfaction of all project stakeholders, demonstrating tangible outcomes for industry partners via the UQ Dow Centre and Translational Polymers Research Group. In the short term, there may be potential for further research work to be to further develop the prototype for commercialisation.

If this proves to be successful, a new fertiliser product may become available to the market, which is able to reduce nitrogen loss into the environment and improve nitrogen availability for plants in high leaching environments.

The longer-term implications of the technology developed for slow release means that this knowledge can be turned to a wide range of different commercial applications.

The final technical challenges of this project relate to controlling the release more precisely, particularly in an in-field environment, where it is clear that soil properties play a major role in nitrogen release from the composites.

Resolving these challenges will likely have potential use in a wider range of applications including veterinary, pharmaceutical and other agricultural applications, where controlled delivery of bioactives and other agents is required.

Circular Economy

Fight Food Waste CRC

Transform program

Program Leader

Dr Paul Luckman (Jan-Oct),
Prof Peter Halley (Oct-Dec)

Deputy Program Leader

Prof Peter Halley (July-Sept),
Ms Meagan Wheeler (acting Oct-Dec)

Program Coordinator

Ms Meagan Wheeler.

Key Partners

The Fight Food Waste Cooperative Research Centre (CRC) brings together 49 industry and 10 research partners from across Australia.

Food waste costs Australia over $20 billion each and every year, and directly affects Australia's food industry efficiency and reputation as a clean and green food producer

Background

Globally, if food waste were its own country, it would be the world's third largest emitter of carbon dioxide, behind China and the USA. Governments representing 50 percent of the world's population have set explicit national targets in line with the United Nations Sustainable Development Goal (SDG) 12.3 - By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

In November 2017, the Australian Government formally committed to address SDG 12.3 and the Fight Food Waste CRC subsequently commenced in July 2018. In acknowledgment of the scale and urgency of addressing food waste, The Australian Government Department of Industry, Innovation and Science CRC Program provided a $30 million grant to the Fight Food Waste CRC, matching the $33 million cash and $57 million in-kind funding raised by the 60 CRC participants.

The CRC comprises three programs, each underpinned by a platform of food safety and security. These include:

REDUCE food waste throughout the supply chain by:

- delivering supply chain analysis tools
- developing a framework for optimal packaging design
- innovative options to optimise food rescue.

TRANSFORM unavoidable waste into innovative products by:

- identifying and prioritising commercially valuable products from waste streams
- developing new technologies for waste transformation
- developing decision support tools
- identifying regulatory options to promote.

ENGAGE with industry and consumers to deliver behavioural change by:

- educating future industry professionals
- delivering industry dissemination and skills training
- facilitating household and business behaviour change.

During 2020, the Program Leaders from across the three programs worked together to establish further projects in the research portfolio. Progress throughout 2020 was strong, however by October 2020 it

was clear that the business development and project oversight roles in the TRANSFORM program (run by UQ Dow Centre members) were growing faster than resources available.

At the Fight Food Waste CRC TRANSFORM program workshop held in October 2020, a new 1.0 FTE Fight Food Waste CRC-funded program leader role was advertised, with the successful appointee to run an expanded TRANSFORM program, alongside current support of the Dow Centre-based deputy program leader and program coordinator.

Highlights & Outlook

In 2020, Dr Luckman and Ms Wheeler oversaw a wide range of projects, including:

- Making Australian Country Choice circular
- Fight food waste small to medium enterprise solutions centre
- Converting potato waste into pre-biotics and other valuable products
- Waste-to-energy: Fuelling sustainable wastewater treatment with food waste
- From food waste to smart compost formulations
- Nutraceutical extraction from Australian wine industry waste.
- Transformation of surplus/waste tomato and capsicum produce into value added products
- Pilot-scale production of enhanced-value anaerobic digestion waste (digestate) derived bioproducts on the Darling Downs
- Advancing regional agri-food waste valorisation
- Options for utilising apple and pear pulp residue
- Food Waste to Pig Feed – Safe and Bio-secure

Fight Food Waste CRC AGM and annual industry showcase presentations

A virtual FFW CRC AGM was held in November 2020 with project and program leaders presenting to industry and academic members via a virtual platform.

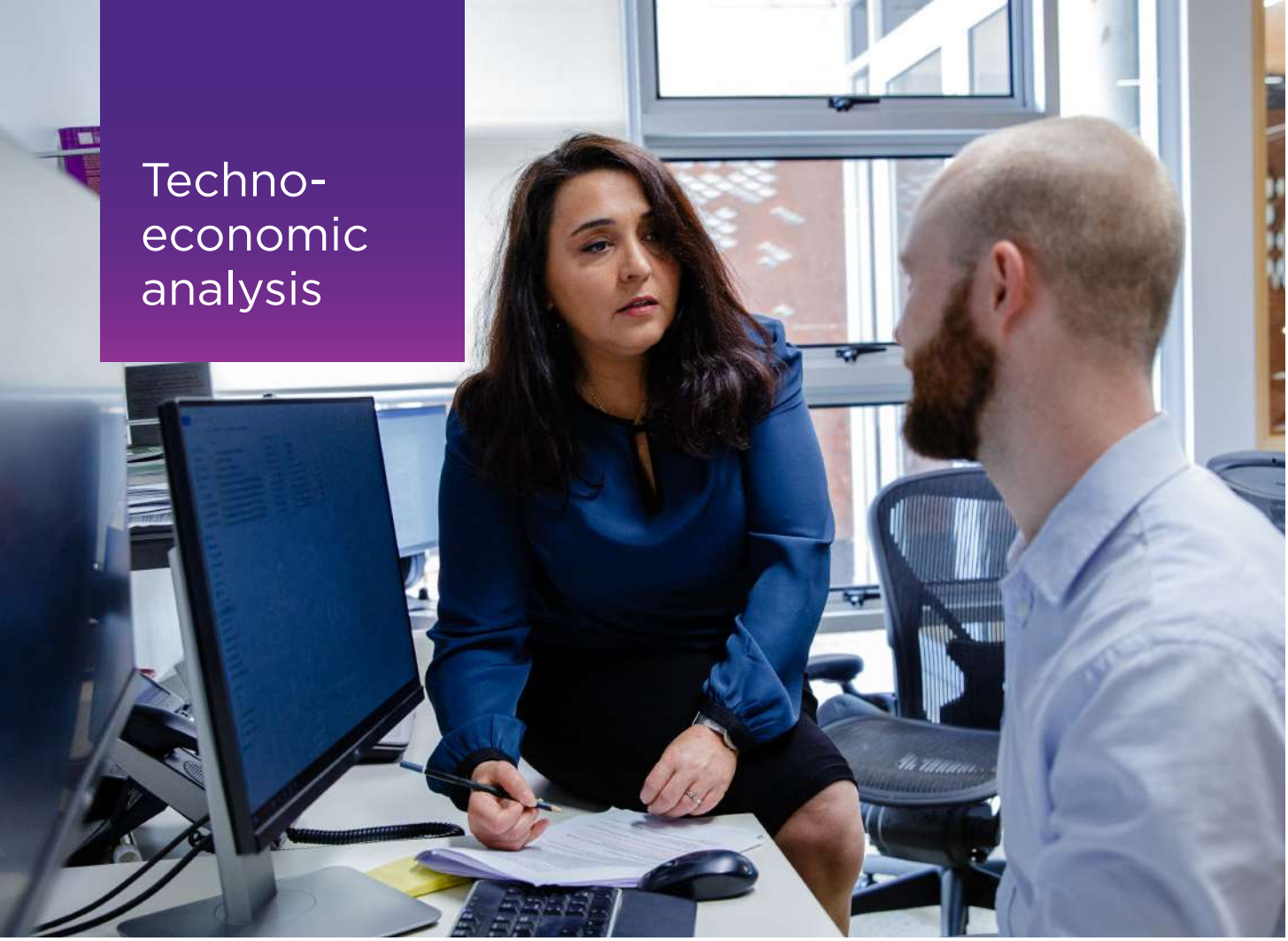
Stop Food Waste Australia Initiative

Stop Food Waste Australia, a $4m funding initiative was won by the Fight Food Waste CRC in late 2020. The initiative will bring together the brightest minds in supply chain management, food waste, NGOs and all tiers of government to tackle the problem of reducing

Australia's food waste by 50% by 2030. Stop Food Waste Australia will work with industry to create real, practical changes that help everyday Australians reduce their food waste like adding clearer instructions on packaging for storage or creating consistent package design with easier to find use by or packed by dates. It will link closely with the Fight Food Waste CRC and its research outcomes, making it a unique structure aligned with a CRC. Initial partners include ACT NoWaste; Australian Food & Grocery Council; Australian Food Cold Chain Council; Australian Institute of Packaging; Department of Agriculture, Water and the Environment; Fight Food Waste Cooperative Research Centre; Foodbank; Green Industries South Australia; National Farmers Federation; National Retail Association; New South Wales Environment Protection Authority; OzHarvest; Queensland Department of Environment and Science; SecondBite; Sustainability Victoria; Waste and Resource Action Programme (United Kingdom); Western Australia Department of Water and Environmental Regulation.

In 2021, the program leadership team will move from the Dow Centre to UQ's Queensland Alliance for Agriculture and Food Innovation (QAAFI) due to its more strategic links to future project areas, and Prof. Mike Gidley (QAAFI) will join the program leadership team.

Techno-economic analysis



The UQ Dow Centre's approach is to work only on systems and technologies which have the potential for sustainable and significant impact on both the environment and the economy

Techno-economic Analysis (TEA) is a highly specialised method of assessment, which can aid in determining the technical and economic viability of novel processes.

The UQ Dow Centre routinely assesses potential new projects and processes relating to the sustainable production and use of energy and materials to determine whether these are economically competitive and scalable, in addition to being environmentally and socially acceptable. These insights can in turn inform further research strategy, technological development, investment, and policy making.

TEA draws on a number of disciplines and practices such as process modelling, engineering design, and economic evaluation, and typically involves developing and applying advanced quantitative methods for techno-economic, life-cycle, and sustainability analyses.

The UQ Dow Centre's Techno-economic Analyst, Mrs Mojgan Tabatabaei, brings extensive experience in industrial process technologies, and strong techno-economic analytical skills to translate novel concepts and academic research into industrial applications. Mojgan combines her knowledge of process innovation and economic assessment to undertake in-depth techno-economic analyses for both the UQ Dow Centre and other research groups at UQ.

The UQ Dow Centre also consults with industry clients, to provide the information necessary to aid in a decision-making. This may identify opportunities for process improvement given various inputs and assumptions, and the technical and economic feasibility of a process at industrial scale.

In 2020, the TEA team conducted a scoping study to produce blue hydrogen from gasification of Latrobe Valley lignite with carbon capture and storage. The study, which was undertaken in conjunction with Exergen, found that blue hydrogen could be produced for around $\$3/kgH_2$ for a central case, however, moderate technology learnings. Marginally lower energy prices, coupled with Australian Carbon Credit Units at $\$16/tCO_2$ could reduce the levelized cost to within striking distance of the Federal Government's target of $\$2/kgH_2$.

Engagement


Systems
Design
Opportunities
Operations
Engineered Systems
General
Discipline
Project

The UQ Dow Centre actively identifies and fosters mutually beneficial partnerships with collaborators at The University of Queensland, across Australia, and globally

The Centre attracts and engages with both distinguished and emerging leaders from around the world, including representatives of world-class research institutions and think tanks, industry, startups, government bodies, not for profit organisations, as well as non-government organisations. Engagement efforts at the UQ Dow Centre focus on 5 core areas:

- Industry
- Public policy
- Research and academic collaborators
- Philanthropic partners
- Media and the broader community.

Industry

By focusing on current industry challenges, the UQ Dow Centre is able to contribute to the sustainability of industrial processes through collaborative projects, including – but not limited to – the Australian Cooperative Research Centres (CRC) Program, Advance Queensland Innovation Partnerships, jointly-funded research projects, and techno-economic analyses undertaken on behalf of industry clients.

Public policy

The Centre seeks to contribute to national and international policy-making through its capacity to deliver systems analysis and its focus on scalable, solution-focussed research projects. Researchers at the UQ Dow Centre are regularly called upon by Governments and think tanks to contribute their expertise to policy briefings, working groups, and events.

Research and academic collaborators

The Dow Centre's networks extend across Australia and internationally, to encompass leading Universities and research institutions in the USA, Europe and Asia. The UQ Dow Centre is proud to partner with our research and academic collaborators to pursue multi-disciplinary research projects, publish new knowledge, and contribute to the learning outcomes of undergraduate and postgraduate students.

Philanthropic partners

The discovery and impact achieved through the UQ Dow Centre would not be possible without the support of our donors. The generosity of our philanthropic partners has helped to further our objective to deliver solutions to globally significant challenges by generating new knowledge. The UQ Dow Centre warmly acknowledges and thanks each of our supporters - Dow, The Trevor and Judith St Baker Family Foundation, and The University of Queensland in America Inc. - for their vision and generosity.

Media and the broader community

Dow Centre researchers are regularly sought for public comment on matters relating to sustainability and innovation. This includes publishing media articles in high-profile publications (such as The Conversation), participating in media interviews, speaking to community groups (such as schools), and contributing to the improvement of public knowledge relating to the sustainable production and use of energy and materials.

Teaching and learning

Teaching

The UQ Dow Centre remains committed to UQ equipping a new generation of thinkers to tackle the complex issues in rapidly changing social, political and physical environments.

UQ Dow Centre leaders again contributed their experience and expertise to the teaching curriculum at UQ in 2020, through course-coordination, lecturing and/or tutoring UQ students through the following 17 undergraduate and postgraduate courses:

CHEE3301 Polymer Engineering – UQ Dow Centre contributor: Associate Professor Bronwyn Laycock

CHEE4001 Process Engineering Design Project – UQ Dow Centre contributors: Associate Professor Bronwyn Laycock, Dr Jannie Grové and Mr Mark Hodgson

CHEE4002 Impact and Risk in the Process Industries – UQ Dow Centre contributor: Dr Jannie Grové

CHEE4305 Biomaterials: Materials in Medicine – UQ Dow Centre contributor: Associate Professor Bronwyn Laycock

CHEE7103 Chemical Engineering ME Design Project – UQ Dow Centre contributor: Mrs Mojgan Tabatabaei

CHEM1004 Chemistry - UQ Dow Centre contributor: Dr Torsten Witt

ENGG1200 Engineering Modelling & Problem Solving – UQ Dow Centre contributor: Mrs Sara Zeinal Zadeh

ENGY4000 Energy Systems – UQ Dow Centre contributor: Associate Professor Simon Smart

ENGG4900 Professional Practice and the Business Environment – UQ Dow Centre contributors: Professor Stephen Wilson, Dr Jannie Grové, Mr Mark Hodgson and Mrs Sara Zeinal Zadeh

ENGY7000 Energy Principles and Renewables – UQ Dow Centre contributor: Associate Professor Simon Smart

ENGY7004 Energy Sector Investment and Finance – UQ Dow Centre contributors: Professor Chris Greig and Dr Jannie Grové

ENGY7117 Energy Markets, Law and Policy – UQ Dow Centre contributor: Professor Stephen Wilson

ENGG7901 Professional Engineering and the Business Environment: Global Practice – UQ Dow Centre contributor: Professor Stephen Wilson

ENGG7902 Engineering Innovation and Leadership – UQ Dow Centre contributor: Associate Professor Simon Smart, Mr Gabriel Rioseco and Mr Alister Sheil

ENGY7301 Energy Efficiency & Transport – UQ Dow Centre contributor: Dr Jake Whitehead

ENE372 Rapid Switch – Solving the Challenges of Rapid Decarbonisation (PRINCETON) – UQ Dow Centre contributor: Professor Chris Greig

Associate Professor Bronwyn Laycock, Dr Jake Whitehead, and Professor Chris Greig were also invited to deliver guest lectures to UQ undergraduate and postgraduate cohorts, including students of CHEE4001 Process Engineering Design Project, CHEE4305 Biomaterials: Materials in Medicine, and PLAN7116 Transport Planning.

Student and community outreach

Dr Jake Whitehead, Tritium e-Mobility Research Fellow, contributed to numerous student and community outreach events throughout 2020, delivering presentations to raise public awareness about electrical vehicles and electro-mobility. This included presenting to the New South Wales Department of Environment on the potential impact of EV taxes; a seminar on Zero Emission Bus technologies at the Australian National University; a live EV demonstration for UQ Sustainability Week; and an in-person E-Mobility presentation and demonstration for the Grade 5 and 6 students of Our Lady of Good Counsel Catholic Primary School in Gatton for their 2020 Sustainability Expo.

Dr Whitehead also shared his expertise in e-mobility with students at UQ, lecturing classes in Energy Efficiency & Transport (ENGY7301).

UQ Summer and Winter Research Programs

Each year, the UQ Summer & Winter Research Program provides current undergraduate (including honours) and Masters by coursework students with the opportunity to gain experience working directly alongside leading academics and researchers at The University of Queensland. As part of the UQ Dow Centre's commitment to fostering the next-generation of researchers, Associate Professor Simon Smart and Ms Mojgan Tabatabaei supervised three students - Siddhant Singh, Duohan Zhang, and Rachel Huang - during the summer internship period. These placements provided these students an opportunity to gain a real-world insight into the field of professional research, as well as develop analytical, critical thinking, and communication skills to support them in their journey toward becoming game-changing graduates.

Student successes

Past Dow Sustainability Innovation Student Challenge Award (SISCA) winner, Ms Ashley Baxter, won the SISCA challenge in 2018 with her idea for a unique composting system. She further developed the idea and won the Shane Chidgzey Young Entrepreneurs Prize at UQ's Accelerator Pitch Night in 2019. In April 2020, Ashley secured funding to build her team and roll out a 100-unit launch: a pre-batch to test the product-making process prior to mass manufacture.

UQ Dow Centre Summer Research Scholar, Ms Rachel Huang, became the University's 2021 Chief Student Entrepreneur. A chemical engineering/science student and ex-professional tennis player, Rachel was also awarded the Stavros Niarchos Foundation Scholarship and is now a scholar at the Liveris Academy. Rachel's summer research project involved investigating molten catalysts used in methane pyrolysis to produce low emission hydrogen.

2020 HDR candidates

TYPE	STUDENT NAME / PROGRAM	ADVISOR/S	PROJECT TITLE
#	Benoit Clement, PhD	Prof Lianzhou Wang Prof Chris Greig	Development of future generation rechargeable flexible energy storage
#	Leela Dilkes-Hoffman, PhD	A/Prof Bronwyn Laycock A/Prof Steven Pratt Prof Paul Lant	The development and sustainability analysis of high-performance, multi-layered, biodegradable food packaging
#	Mark Hodgson, PhD	A/Prof Simon Smart Prof Victor Rudolph	A global transition to low carbon economy - limits of possibility?
#	Xia Huang, PhD	Prof Lianzhou Wang Dr Bin Luo Dr Ruth Knibbe Prof Eric McFarland	Design of new two-dimensional hybrid materials for lithium sulfure batteries
#	Ian Levett, PhD	A/Prof Bronwyn Laycock A/Prof Steven Pratt Dr Christopher Pratt Dr Matthew Redding	Development of novel controlled release fertilisers for improved nutrient delivery efficiency
#	Tong'en Lin, PhD	Prof Lianzhou Wang Dr Bin Luo	Nano-materials for electrochemical energy storage
#	Romy Listo, PhD	Dr Jennifer Munro Dr Peter Ralph Westoby Prof Chris Greig	Power to empower? Exploring the role of energy in women's organising and empowerment in rural India
#	Sajna Manoj, PhD	A/Prof Bronwyn Laycock A/Prof Steven Pratt Dr Luigi Vandi	Drivers and barriers for commercial applications of waste derived diesel
#	Gabriel Rioseco, PhD	Prof Stephen Wilson Dr Joe Lane Dr Brian Fisher Prof Chris Greig	Electricity modelling in computational general equilibrium models under high variable renewable energy scenarios
#	Sara Zeinal Zadeh, PhD	A/Prof Simon Smart Prof Peta Ashworth Prof Chris Greig	Rapid switch to de-carbonization of electricity generation sector: understanding the supply constraints and determining the maximum deployment rate of solar power
#	Alister Sheil, PhD	A/Prof Simon Smart	Methane pyrolysis for hydrogen production
*	Heidi Cooper, PhD	Prof Nicole Gillespie Prof Chris Greig Prof Karen Hussey	The rise of the disempowered citizen and its impact on the development of effective responses to the Climate-Energy nexus
*	Heidy Cruz, PhD	Dr Ilje Pikaar A/Prof Bronwyn Laycock Prof Paul Lant	The fabrication and use of hydrogels as an innovative and cost-effective approach for targeted recovery of reactive nitrogen
*	Xin Fu Tan, PhD	Prof Kazuhiro Nogita Prof Lianzhou Wang	New manufacturing methods for advanced lithium ion battery anode materials
*	Russell Gordon, PhD	A/Prof Mary Fletcher A/Prof Bronwyn Laycock Dr Natasha Hungerford	Mitigating the effects of the plant toxin Simplexin on Australian livestock
*	Craig Jacobson, PhD	A/Prof Simon Smart Dr Ananthanarayanan Veeraragavan Dr Vigya Sharma	Applying systems modelling to tackle energy poverty challenge

Legend

Student whose research forms part of a Dow Centre project

* Student whose research is related to Dow Centre projects.

- Student whose research does not relate to Dow Centre projects

2020 HDR candidates

TYPE	STUDENT NAME / PROGRAM	ADVISOR/S	PROJECT TITLE
*	Jingjing Mai, PhD	A/Prof Bronwyn Laycock A/Prof Steven Pratt	Characterization and degradation of novel synthetic PHA materials
*	Gabriel Lopes Fraga, PhD	A/Prof Steven Pratt A/Prof Bronwyn Laycock	Environmental footprint of catalytic depolymerisation
*	Thanh Tung Nguyen, PhD	Dr Michael Heitzmann Dr Luigi Vandi	Development of sustainable engineered structural panels
*	Syarifah Nuraqmar Syed Mahamud, PhD	A/Prof Bronwyn Laycock Dr Steven Pratt Prof Paul Lant	Polyhydroxyalkanoate (PHBV) copolymer production using methanotrophic cultures
*	Peng Chen, PhD	Prof Lianzhou Wang Dr Jung Yun	Development of efficient and stable perovskite solar cells
*	Xiyue Peng, PhD	Dr Bin Luo Prof Lianzhou Wang	Design of new two-dimensional materials for lithium ion batteries
*	Lingbing Ran, PhD	Dr Ruth Knibbe Prof Lianzhou Wang	High voltage lithium-ion batteries
*	Thomas Reddell, PhD	Dr Ananthanarayanan Veeraragavan A/Prof Simon Smart	Biomass fired supercritical carbon dioxide power cycles: microgrid applications and modelling
*	Jiayong Tang, PhD	Prof Lianzhou Wang Dr Bin Luo	Two-dimensional hybrid materials for capacitive energy storage devices
*	Yue Yuan, PhD	A/Prof Bronwyn Laycock A/Prof Mary Fletcher	Modelling the controlled release of toxins from a rumen environment
*	Tianlong Zhang, PhD	A/Prof Bronwyn Laycock A/Prof Steven Pratt	Understanding catalyst performance in CPD diesel production from waste
*	Yue Yuan, PhD	A/Prof Bronwyn Laycock A/Prof Mary Fletcher	Modelling the controlled release of toxins from a rumen environment
*	Tianlong Zhang, PhD	A/Prof Bronwyn Laycock A/Prof Steven Pratt	Understanding catalyst performance in CPD diesel production from waste
~	Pradeep Basnayake, PhD	Dr Michael Heitzmann Dr Luigi Vandi Dr Juan Torres Dr Juan Medina	Advancing the properties of bio-composites: A study of fire-retarding natural fibre reinforced plastics, and the development of a biodegradable bio-based composite
~	Munkhjargal Bat-Erdene, PhD	Prof Lianzhou Wang Prof Alan Rowan	Two-dimensional nanostructured materials: synthesis and application
~	Abdulaziz Bati, PhD	Prof Joseph Shapter Prof Lianzhou Wang	Investigation of carbon-based hybrid nanomaterials for perovskite solar cells (PSCs)
~	Liam Brownlie, PhD	Prof Joseph Shapter Prof Lianzhou Wang	N-Type doping of single-walled carbon nanotubes for Si-CNT hybrid photovoltaics
~	Lee Burns, PhD	Dr Paul Luckman Dr Brenton Fletcher Prof Peter Halley	Modification and processing of starches for increased productivity in mineral flotation

Legend

Student whose research forms part of a Dow Centre project

* Student whose research is related to Dow Centre projects.

~ Student whose research does not relate to Dow Centre projects

2020 HDR candidates

TYPE	STUDENT NAME / PROGRAM	ADVISOR/S	PROJECT TITLE
-	Shanshan Ding, PhD	Prof Lianzhou Wang Dr Yang Bai	Designing new perovskite quantum dots with enhanced phase stability for efficient solar energy conversion
-	Xiangqian Fan, PhD	Prof Lianzhou Wang Dr Zhiliang Wang	Designing new semiconducting materials for solar water splitting
-	Mehri Ghasemi, PhD	Prof Lianzhou Wang Dr Jung Yun Dr Miaoqiang Lyu	Basics of charge generation in disordered optoelectronic materials
-	Nur Ab Hamid, PhD	Dr Liu Ye, A/Prof Simon Smart Dr David Wang	Forward Osmosis (FO) membrane-based technology in urbane wastewater treatment
-	Ekyu Han, PhD	Prof Lianzhou Wang Dr Jung Yun	Perovskite-based electronic devices for sensing application
-	Mengmeng Hao, PhD	Prof Lianzhou Wang Dr Jung Yun	Development of novel quantum dots sensitized solar cells
-	Syed Haseeb Ali Ahmad, PhD	Prof Lianzhou Wang Dr Yang Bai	High performance lead free-perovskite solar cells with improved transport properties
-	Jarrad Humphry, PhD	Dr Michael Heitzmann Dr Luigi Vandi A/Prof Rowan Truss Prof Darren Martin	Reactive processing as a novel processing route for high performance compositive manufacture
-	Yang Jiang, PhD	Dr Baojun Zhao Prof Guo-Xiong Wang Prof Lianzhou Wang Dr Junhong Chen	Development of advanced refractory materials for copper and steel industries
-	Christian Kudisonga, PhD	Dr Luigi Vandi Dr Michael Heitzmann	Novel reactive transfer moulding of thermoplastic composite materials
-	Charmaine Lamiel, PhD	E/Prof Joao da Costa A/Prof Simon Smart Dr Julius Motuzas Prof George Zhao	2D-3D carbon mixed matrix membranes
-	Christopher McMahon, PhD	A/Prof Simon Smart E/Prof Ian Cameron	Trace element modelling and optimisation in an integrated steel works
-	Sabiha Monny, PhD	Prof Lianzhou Wang Dr Zhiliang Wang	Semiconductor nanostructure engineering for photoelectrochemical energy conversion
-	Md Abdul Quader, PhD	A/Prof Thomas Rufford A/Prof Simon Smart	Evaluation of pressure swing adsorption systems for CO_2 removal and liquefied natural gas production
-	Gregory Siemon, PhD	A/Prof Simon Smart Prof Ian Cameron	Enterprise-wide optimisation in steelmaking
-	Samira Siyamak, PhD	A/Prof Bronwyn Laycock Dr Paul Luckman	Tailored starch based hydrogels: Renewable material solutions for wastewater and agriculture industries
-	Kelly Smith, PhD	Dr Maureen Hassall Prof Stephen Wilson	Using human factors approaches to improve energy management

Legend

Student whose research forms part of a Dow Centre project

* Student whose research is related to Dow Centre projects.

- Student whose research does not relate to Dow Centre projects

2020 HDR candidates

TYPE	STUDENT NAME / PROGRAM	ADVISOR/S	PROJECT TITLE
~	Armin Solemanifar, PhD	A/Prof Bronwyn Laycock Dr Albertus Mostert Dr Tuan Nguyen Ms Rhiannon Creasey	Bio-inspired conducting peptide nanowires
~	Andrew Wheatley, PhD	Prof Peter Knights Prof Stephen Wilson	Large scale asset procurement and management
~	Yue Yuan, PhD	A/Prof Greg Birkett Dr Julius Motuzas A/Prof Simon Smart E/Prof Joao da Costa	Inorganic mixed matrix for liquid processing
~	Chengxi Zhang, PhD	Dr Wuqiang Wu Prof Lianzhou Wang	Interfacial nanoengineering of electrodes for perovskite solar cells
~	Yurou Zhang, PhD	Dr Jung Yun Prof Lianzhou Wang	Defect engineering of halide perovskite materials for optoelectronic opplications
~	Haseeb Ahmad, PhD	Dr Xiaodong Ma Prof Lianzhou Wang Dr Baojun Zhao Prof Geoff Wang	Formation and control of sulfide inclusions in high-end gear steels
~	Dongxu He, PhD	Dr Yang Bai Prof Lianzhou Wang	Development of efficient and stable all perovskite tandem solar cells
~	Jaeho Lee, MPhil	Dr Jingwei Hou Prof Lianzhou Wang	Metal organic framework-pervoskite nanocomposite for efficient photocatalysis
~	Xianlong Li, PhD	Prof Lianzhou Wang Dr Zhiliang Wang	Photoelectrochemical water splitting based on Semiconductor-Metal Organic Framework (MOF) composite photoelectrode
~	Xuemei Li, PhD	Dr Jingwei Hou Prof Lianzhou Wang	Development of novel stimuli-responsive polymer membranes with antifouling property
~	Limin Lin, PhD	A/Prof Liu Ye A/Prof Steven Pratt	Freshwater Anammox bacteria for treatment of saline wastewater
~	Esmaeil Sarabian, PhD	A/Prof Greg Birkett A/Prof Steven Pratt Dr Bogdan Donose	Silica nanoparticles in CSG water treatment
~	Trent Seaby, PhD	Prof Lianzhou Wang Dr Yuxiang Hu	Novel Electrode Materials for High Performance Rechargeable Batteries
~	Cindy September, PhD	Prof Peter Halley Dr Timothy Nicholson	Thickened infant formula for paediatric dysphagia: A) Rheological characterisation and B) Flow rates through bottle teats
~	Christopher Turner, PhD	A/Prof Steven Pratt Dr Bogdan Donose Dr Kezia Kezia	Silica scaling on reverse osmosis (RO) membranes
~	Michael Walsh, PhD	Prof Susanne Schmidt A/Prof Bronwyn Laycock Prof Gerhard Schenk	Advancing the circular economy: phosphorus recycling and next-generation fertilisers
~	Julian Wilson, MPhil	Prof Stephan Riek Prof Lianzhou Wang	Testing a novel battery technology for use in remote areas

Legend

Student whose research forms part of a Dow Centre project

* Student whose research is related to Dow Centre projects.

~ Student whose research does not relate to Dow Centre projects

2020 HDR conferrals

TYPE	STUDENT NAME / PROGRAM	ADVISOR/S	PROJECT TITLE
#	Romy Listo, PhD	Dr Jennifer Munro Prof Chris Greig Dr Peter Westoby	Energy for empowerment: The role of energy in women's organising and empowerment in urban and peri-urban South Africa
#	Leela Dilkes-Hoffman, PhD	A/Prof Bronwyn Laycock Prof Paul Lant A/Prof Steven Pratt	Exploring the role of biodegradable plastics
#	Xia Huang, PhD	Prof Lianzhou Wang Dr Ruth Knibbe Prof Eric McFarland Dr Bin Luo	Design of New Two-dimensional Hybrid Materials for Lithium Sulfur Batteries
#	Ian Levett, PhD	A/Prof Bronwyn Laycock Dr Matthew Redding A/Prof Steven Pratt Dr Christopher Pratt	Understanding the mechanisms that control the release of a soluble crystalline agrichemical extruded with biopolymers
*	Peng Chen, PhD	Prof Lianzhou Wang Dr Jung Yun	Development of efficient and stable perovskite solar cells
*	Heidy Cruz, PhD	A/Prof Ilje Pikaar A/Prof Bronwyn Laycock	Tailored polymer hydrogels for mainstream ammonium recovery in domestic wastewater
*	Xin Tan, PhD	Prof Kazuhiro Nogita Prof Lianzhou Wang Dr Qinfen Gu	New manufacturing methods for advanced lithium ion battery anode materials
~	Mengmeng Hao, PhD	Prof Lianzhou Wang Dr Jung Yun	Development of low cost and high performance quantum-dot solar cells
~	Mehri Ghasemi, PhD	Prof Lianzhou Wang Dr Miaoqiang Lyu Dr Jung Yun	Low-toxic bismuth-based semiconducting light-absorbing materials for photovoltaics
~	Nur Ab Hamid, PhD	A/Prof Liu Ye A/Prof Simon Smart Dr David Wang	Forward Osmosis (FO) Membrane-based Technology in Urban Wastewater Treatment
~	Md Abdul Quader, PhD	A/Prof Tom Rufford A/Prof Simon Smart	Design and techno-economic evaluation of multi-stage membrane processes for helium recovery from natural gas
~	Samira Simayak, PhD	A/Prof Bronwyn Laycock Dr Paul Luckman	Functional starch-based hydrogels: Renewable material solutions for wastewater and agriculture industries

Legend

Student whose research forms part of a Dow Centre project

* Student whose research is related to Dow Centre projects.

~ Student whose research does not relate to Dow Centre projects

2020 UQ Dow Centre publications

The following were published by UQ Dow Centre researchers during 2020

Book Chapters

Nikolic, M, Colwell, J., Yeh, C.-L., Cash, G., Laycock, B., Gauthier, E., Halley, P., Bottle, S. and George, G. (2021). Real-World Factors That Impact Polyolefin Lifetimes. Lifetimes and Compatibility of Synthetic Polymers. edited by James Lewicki and George Overturf, Wiley.

Pratt, S., Bolan, N.S., Laycock, B., Lant, P., Bryson, E. & Dilkes-Hoffman, L. (2020) Biodegradable Plastics, in Particulate Plastics, in Terrestrial and Aquatic Environments. Eds. N.S. Bolan, M.B. Kirkham, C. Halsband, Y.S. Ok, Taylor & Francis, CRC Press, Boca Raton, Florida. pp. 425-434.

Journal Articles

Ab Hamid, N. H., Smart, S., Wang, D. K., & Ye, L. (2020). Achieving stable operation and shortcut nitrogen removal in a long-term operated aerobic forward osmosis membrane bioreactor (FOMBR) for treating municipal wastewater, Chemosphere, 260, 127581.

Ab Hamid, N. H., Smart, S., Wang, D. K., Koh, K. W. J., Ng, K. J. C., & Ye, L. (2020). Economic, energy and carbon footprint assessment of integrated forward osmosis membrane bioreactor (FOMBR) process in urban wastewater treatment. Environmental Science: Water Research & Technology, 6(1), 153-165.

Ballinger, B., Schmeda-Lopez, D., Kefford, B., Parkinson, B., Stringer, M., Greig, C., & Smart, S. (2020). The vulnerability of electric-vehicle and wind-turbine supply chains to the supply of rare-earth elements in a 2-degree scenario. Sustainable Production and Consumption 22, 68-76.

Ballinger, B., Motuzas, J., Smart, S., Ismail, S., Zubir, N A., Abd Jalil, S N., Diniz da Costa, J C. (2020). Catalysis of silica sol–gel reactions using a PdCl 2 precursor, Journal of Sol-Gel Science and Technology, https://doi.org/10.1007/s10971-020-05241-y

Chan, C., Vandi, L., Pratt, S., Halley, P., Richardson, D., Werker, A., & Laycock, B. (2020). Mechanical stability of Polyhydroxyalkanoate (PHA)-based Wood Plastic Composites (WPCs). Journal of Polymers and the Environment, 28 (5), 1571-1577. doi: 10.1007/s10924-020-01697-9.

Chen, P., Wang, Z., Wang, S., Lyu, M., Hao, M., Ghasemi, M., Xiao, M., Yun, J., Bai, Y. and Wang, L. (2020). Luminescent europium-doped titania for efficiency and UV-stability enhancement of planar perovskite solar cells. Nano Energy, 69 104392, 104392

Cruz, H., Laycock, B., Strounina, E., Seviour, T., Oehmen, A., & Pikaar, I. (2020) Modified Poly(acrylic acid)-Based Hydrogels for Enhanced Mainstream Removal of Ammonium from Domestic Wastewater. Environmental Science and Technology, 54, 9573-9583.

Fraga, G., Yin, Y., Konarova, M., Hasan, M. D., Laycock, B., Yuan, Q., Batalha, N., & Pratt, S. (2020) Hydrocarbon hydrogen carriers for catalytic transfer hydrogenation of guaiacol. International Journal of Hydrocarbon Energy, in press, https://doi.org/10.1016/j.ijhydene.2020.07.136

Ghasemi M., Zhang L., Yun J., Hao M., He D., Chen P., Bai Y., Lin T., Xiao M., Du A., Lyu M. and Wang L. (2020). Dual-ion-diffusion induced degradation in lead-free Cs2AgBiBr6 double perovskite solar cells. Advanced Functional Materials, doi: 10.1002/adfm.202002342

Gordon, R. J., Hungerford, N. L., Laycock, B., & Fletcher, M. T. (2020) A review on Pimelea poisoning of livestock. Toxicon, 186, 46-57.

Hao, M., Bai, Y., Zeiske, S., Ren, L., Liu, J., Yuan, Y., Zarrabi, N., Cheng, N., Ghasemi, M., Chen, P., Lyu, M., He, D., Yun, J., Du, Y., Wang, Y., Ding, S., Armin, A., Meredith, P., Liu, G. Cheng, H. and Wang, L. (2020). Ligand-assisted cation-exchange engineering for high-efficiency colloidal Cs1−xFAxPbI3 quantum dot solar cells with reduced phase segregation. Nature Energy, 5 (1), 79-88

Hu, Y., Ding, S., Chen, P., Seaby, T., Hou, J., Wang, L. (2020). Flexible solar-rechargeable energy system. Energy Storage Materials, 32, 356-376.

Larson, E., Kreutz, T., Greig, C., William R., Rooney, T., Gray, E, Elsido C., Martelli E., and Meerman, H. (2020). Design and Analysis of a Low-Carbon Lignite/Biomass-to-Jet Fuel Demonstration Project. Applied Energy. https://doi.org/10.1016/j.apenergy.2019.114209.

Laycock, B., X. Y. Wang, R. F. Liu, P. K. Annamalai, J. Cork, C. Derstine, M. Mills, and E. W. McFarland. (2020). Pyrolysis of Brominated Polyethylene as an Alternative Carbon Fibre Precursor. Polymer Degradation and Stability 172 https://doi.org/ARTN 109057

Levett, I., Liao, M., Pratt, C., Redding, M., Laycock, B., & Pratt, S. (2020) Designing for effective controlled release in agricultural products: new insights into the complex nature of the polymer–active agent relationship and implications for use. Journal of the Science of Food and Agriculture,100, 4723-4733.

Lin, R., Hou, J., Li, M., Wang, Z., Ge, L., Li, S., Smart, S., Zhu, Z., Bennett, T D., Chen, V. (2020). Interfacial engineering of a polymer–MOF composite by in situ vitrification, Chemical Communications, 56(25), 3609-3612.

Palmer, C., Upham, D. C., Smart, S., Gordon, M. J., Metiu, H., & McFarland, E. W. (2020). Dry reforming of methane catalysed by molten metal alloys. Nature Catalysis, 3(1), 83-89.

Pascale, A., Chakravarty, S., Lant, P., Smart, S, Greig, C. (2020). The rise of (sub) nations? Sub-national human development, climate targets, and carbon dioxide emissions in 163 countries, (2020) Energy Research & Social Science, 68, 101546.

Peerakiatkhajohn, P., Yun, J., Butburee, T., Chen, H., Thaweesak, S., Lyu, M., Wang, S., & Wang, L., (2020). Bifunctional photoelectrochemical process for humic acid degradation and hydrogen production using multi-layered p-type Cu2O photoelectrodes with plasmonic Au@TiO2. Journal of Hazardous Materials, 402, 123533. https://doi.org/10.1016/j.jhazmat.2020.123533

Pratt, C., Kingston, K., Laycock, B., Levett, I., & Pratt, S. (2020) Geo- agriculture: Reviewing opportunities through which the geosphere can help address emerging crop production challenges. Agronomy, 10(7), 971-

Quader, M. A., Rufford, T. E., & Smart, S. (2020). Modeling and cost analysis of helium recovery using combined-membrane process configurations. Separation and Purification Technology, 236, 116269.

Rabiee, H., Zhang, X., Ge, L., Hu, S., Li, M., Smart, S., Zhu, Z., Yuan, Z. (2020). Tuning the Product Selectivity of the Cu Hollow Fiber Gas Diffusion Electrode for Efficient CO2 Reduction to Formate by Controlled Surface Sn Electrodeposition, ACS Applied Materials & Interfaces, 12(19) 21670-21681.

Siyamak, S., Laycock, B., & Luckman, P. (2020) Synthesis of starch graft-copolymers via reactive extrusion: Process development and structural analysis. Carbohydrate Polymers, 227, 115066

Siyamak, S., Laycock, B., & Luckman, P. (2020) Synthesis of starch graft-copolymers via reactive extrusion and their ammonium sorption properties. Chemical Engineering Journal, 398

Siyamak, S., Luckman, P., & Laycock, B. (2020) Rapid and solvent-free synthesis of pH-responsive graft-copolymers based on wheat starch and their properties as potential ammonium sorbents. International Journal of Biological Macromolecules, 149, 477-486.

Solemanifar, A., Nguyen, T. A. H., Laycock, B., Shewan, H. M., Donose, B. C., & Creasey, R. C. G. (2020) Assessing the effect of aromatic residue placement on the α-helical peptide structure and nanofibril formation of 21-mer peptides. Molecular Systems Design and Engineering, 5, 521-531.

Syafutra, H., Yun, J., Yoshie, Y., Lyu, M., Takeda, S., Nakamura, M., Wang, L., and Jung, M. (2020). Surface degradation mechanism on CH3NH3PbBr3 hybrid perovskite single crystal by a grazing e-beam irradiation. Nanomaterials, 10 (7) 1253, 1253-8

Wyssusek, K., Keys, M., Laycock, B., Avudainayagam, A., Pun, K., Hansrajh, S., Van Zundert, A. (2020). The volume of recyclable polyethylene terephthalate plastic in operating rooms–A one-month prospective audit. The American Journal of Surgery https://doi.org/10.1016/j.amjsurg.2020.05.011

Zhang, Y., Lyu, M., Qiu, T., Han, E., Kim, I., Ng, Jung, M., Ng, Y., Jung-Ho, Y., & Wang, L., (2020). Halide Perovskite Single Crystals: Optoelectronic Applications and Strategical Approaches. Energies, 13(16). https://doi.org/10.3390/en13164250

Zhou, F., Zheng, Z., Whitehead, J., Washington, S., Perrons, R. K. & Page, L. (2020). Examining the impact of car-sharing on private vehicle ownership. Transportation Research Part A: Policy and Practice.

Zhou, F., Zheng, Z., Whitehead, J., Washington, Simon, Perrons, Robert K., & Page, L. (2020). Preference Heterogeneity in Mode Choice for Car-Sharing and Shared Automated Vehicles. Transportation Research Part A Policy and Practice, 132, pp. 633-650-.

Patents

Provisional patent filed on “Method for forming Carbon Fibres from PVC” – inventors Nuno Batalha, Bronwyn Laycock and Steven Pratt.

Provisional patent currently being filed on “Antibacterial effects of silver-embedded glass in water treatment” – inventors Zyta Ziora, Ross Barnard, Hasan Mahmudul, Bronwyn Laycock, Xing Wan, Ty Herman, Laurence J. Walsh.

Opinion Article

Halley, PJ, Sustainable Plastics Inspired by Nature (Sep 2020), Physics 13, 126, Physics Today – Trend Article, https://doi.org/10.1103/Physics.13.126

Thank you

The UQ Dow Centre warmly acknowledges and extends its sincere thanks to our valued donors: Dow, The Trevor and Judith St Baker Family Foundation, and The University of Queensland in America Inc.

The support of our donors enables our researchers, teaching staff, and students to actively pursue solutions to grand challenges in the production and use of energy and materials.

Throughout 2020, this support has provided the opportunity for talented undergraduate and postgraduate students to undertake work-integrated learning, gain first-hand experience developing and pitching entrepreneurial ideas, pursue a world-class education, and contribute new knowledge toward a more sustainable future.

The vision and generosity of our donors has also enabled the endowment of the Dow Chair in Sustainable Engineering Innovation, and the Tritium and St Baker E-Mobility Research Fellows. By endowing these prestigious positions, our donors have ensured that critical research can continue well in to the future, creating lasting impact.

To learn more about opportunities to drive discovery and impact, please visit **giving.uq.edu.au** 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

t: +61 7 334 63883

The University of Queensland
Brisbane QLD 4072
Australia

dowcsei.uq.edu.au