International conference on

Circular Economy for Climate and Environment

CECE 2026

Abstract Booklet

23 Sep – 25 Sep 2026

Aerial Function Centre,
University of Technology Sydney

Ultimo, NSW, Australia

Welcome note from the conference chairs

Dear CECE2026 delegates,

We warmly welcome you to the fourth edition of the International Conference on Circular Economy for Climate and Environment Conference (CECE 2026), hosted at the University of Technology Sydney (UTS).

Building upon the success of CECE in the last three years, this year's three-day event (September 23 - 25) offers a unique platform for interdisciplinary discourse on circular economy applications across various sectors.

CECE 2026, a joint initiative of UTS and the ARC industry research Hub for Nutrients in a Circular Economy, brings together thought leaders from academia, industry, government, and NGOs. Our conference aims to foster collaboration, knowledge sharing, and innovation in the field of circular economy and climate.

We have curated a diverse program featuring plenary sessions, keynotes, panel discussions, workshops, oral presentations, poster sessions, a gala dinner, prestigious CECE awards and technical tours. Renowned experts will share their insights on the latest advancements in circular economy and inspire us towards a more sustainable future.

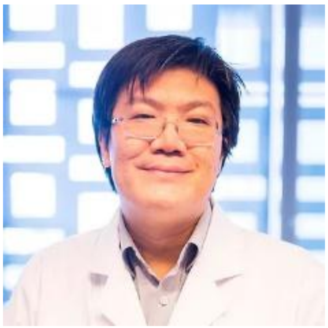
As you embark on this intellectual journey, we encourage you to actively engage in networking, collaboration, and the exchange of ideas. Together, we can shape a more circular and sustainable world.

We want to acknowledge our Platinum Sponsors NSW Office of the Chief Scientist and Engineers, ARC NiCE Hub, NiCE GreenTech, Asia Pacific Circular Hotspot, CityForest, DASCO and Bronze Sponsors Incitec Pivot Fertilisers and Roobuck for supporting this event.

We look forward to welcoming you to CECE 2026 and wish you a productive and enriching conference experience.

Thank you.

CECE2026 Chairs



Prof Hokyong Shon
UTS

A/Prof Dana Cordell,
Institute of Sustainable Futures, UTS

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- Prof Sandra Kentish, University of Melbourne
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- Dr Li Gao, South-East Water
- Prof Mikel Duke, Victoria University
- Prof Dikai Liu, UTS
- Dr Melita Jazbec, ISF, UTS
- Dr Ludo Dumee, Curtin University
- Dr Maja Arsic, CSIRO
- Dr Hanwei Yu. UTS

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- Dr Kashif Rasool, Hamad Bin Khalifa University
- A/Prof Hamid Arandiyan, RMIT

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- Prof Hokyong Shon, UTS
- A/P Sherub Phuntsho, UTS
- Dr Ibrahim El-Saliby, UTS
- Dr Hanwei Yu, UTS

Student volunteers

- Yeshi Choden, UTS
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- Karma Yangzom Dorji
- Hsin-Chieh Lin (Cindy)
- Ghaiath Almustafa, UTS
- Jegeon Lee
- Kaicheng Zhang
- Randi Herath Mudiyanselage
- Onyu Ha

Conference full programme

Day 0: Wednesday 23 September 2026

17:00	**Registration** University of Technology Sydney, CB02.04.150-Foyer
17:00 - 19:00	**Welcome drinks** University of Technology Sydney, CB02.04.150-Foyer

Day 1: Thursday 24 September 2026

Day 1 Morning Sessions

8:30 – 9:00	**Registration**		
9:00 - 9:30	**Opening ceremony**		
9:30-10:30	**Plenary Session 1 (Broadway and Jones rooms)** Circular Economy in Australia, **Lisa McLean**, Circular Australia Direct Potable Reuse: Global Lessons for Australia, **Michael Storey**, SUEZ Australia/New Zealand Chair**: Ho Kyong Shon**		
10:30-11:00	**Panel discussion (Panellists include Lisa McLean, Michael Storey, and Julie Jupp; Moderated by Ho Kyong Shon)**		
11:00-11:30	Morning tea break (Foyer and balcony)		
	Broadway – Circular Nutrients	**Jones – Circular Mining and Rare Earth Elements**	**Harris – Circular Policies/AI**
	Chair: **Veera Koskue**, University of Melbourne, Australia	Chair: **Ludovic Dumee**, Curtin University, Australia	Chair: **Melita Jazbec**, University of Technology Sydney, Australia
11:30-11:50	**Keynote** The deal before the deal **Django Seccombe**, Sydney Water, Australia	**Keynote** Two-dimensional Nanosheets as Membrane Building Blocks for Species Separations **Nicholas Low**, Nanjing Tech University, China	**Keynote** Public Inquiry - Australia's circular economy: Unlocking the opportunities **Joanne Chong**, Productivity Commissioner, Australia
11:50-12:10	**Keynote** Nutrient in a Circular Economy **Sherub Phuntsho**, University of Technology Sydney, Australia	**Keynote** Breaking Australia's Lithium Refining Competitiveness Cycle: Industrial, Technical, and Policy Barriers to Value-Added Processing **Amir Razmjou**, Edith Cowen University, Australia	Panel conversation chaired by Melita Jazbec Panellists: Mike Davis (Managing Director, Optimal Renewable Gas Australia), Joe Fowles (Director, Energy and Climate Advisory Deloitte), Emmanuelle Sloan (Department of Primary Industries and Regional Development) and J. Chong
12:10 -12.30	Panel conversation chaired by Veera Koskue Panellists: Django Seccombe and Sherub Phuntsho	*Panel conversation chaired by Ludovic Dumee Panellists: Nicholas Low, Salwan Al-Assafi and Amir Razmjou	
12.30–13:30	#28 Upscaling urine-to-fertiliser treatment systems **Veera Koskue,** University of Melbourne, Australia	***Invited:** Closing the Loop: Circular Economy in Minerals Processing **Salwan Al-Assafi**, Minerals Research Institute of Western Australia, Australia	P#20 When Do Electric Vehicles Really Reduce Emissions? **Ling Li,** The University of Auckland, New Zealand
	#31 Impact of pH on microbial community dynamics and	#37 Transforming mining waste into sustainable construction: A critical	P#60 Governing the circular nutrient economy: A case study of

	electrochemical performance in urine-fed bioelectroconcentration systems **Vania Mendez,** University of Melbourne, Australia	mineral tailings data repository for low-carbon concrete production **Amitha Varghese**, Murdoch University, Australia	international urine-derived fertiliser networks **Jordan Roods**, University of Technology Sydney, Australia
	#77 Space-efficient nutrient recovery from source-separated hydrolysed urine using GAC pretreatment coupled with an integrated submerged membrane aeration–filtration system **Hsin_Chieh Lin,** University of Technology Sydney, Australia	#79 Transforming Lithium Refining By-products into circular economy resources **John Moursounidis,** Chemistry Centre, WA, Australia	P#63 Policy and regulatory pathways for circular and low-carbon healthcare in Indonesia **Sri Astuti Thamrin**, Hasanuddin University, Indonesia
	#12 Time-Resolved Carbon Transformation and Nutrient Assimilation During Phototrophic Treatment of Fuel Synthesis Wastewater Using Purple Non-Sulfur Bacteria **Sultan Shaikh**, Hamad Bin Khalifa University, Qatar	#42 Development of Spinel HTO@MXene Electrodes for Efficient Lithium Recovery from Complex Brines **Mohsen Askari,** University of Technology Sydney, Australia	AI#76 Waste Polymer to Purpose-Built Materials: A Machine-Learning Framework for Mapping and Upcycling Routes **Pooria Pasbakhsh,** University of Melbourne, Australia
13:30 -14:30	Lunch break (Foyer and balcony)		

*Oral speaker will present before the panel conversation

Day 1 Afternoon Sessions

	Broadway – Circular Water	Jones – Circular Plastics	Harris – Circular Construction
	Chair: **Mikel Duke**, Victoria University, Australia	Chair: **Damien Giurco**, University of Melbourne, Australia	Chair: **Dikai Liu**, University of Technology Sydney, Australia
14:30-14:50	**Keynote** Closing the Loop on Water: Membrane Technologies for a More Circular and Climate-Resilient Economy **Geoffrey Johnston-Hall**, Dupont, Australia	**Keynote** Material Flow Structures and Quantitative Targets for a Decarbonised Circular Economy **Keisuke Nansai**, National Institute for Environmental Studies Japan	**Keynote** Industrialised Circularity: Prefabrication, Automation, and the Future Workforce **Alireza Fard Fini**, University of Technology Sydney, Australia
14:50-15:10	**Keynote** Purified Recycled Water for drinking water customers of data centres? **Stuart Khan**, University of Sydney, Australia	**Keynote** Partnering to solve plastic waste **Paul Hodgson**, CEO Solving Plastic Waste CRC, Australia	**Keynote** Circular Construction – The essential role of structural timber in Australia's Built Environment **Keith Crews**, University of Queensland, Australia
15:10-15:30	Panel conversation chaired by Mikel Duke Panellists: Geoffrey Johnston-Hall and Stuart Khan	*Panel conversation chaired by Damien Giurco Panellists: Keisuke Nansai, Rose Read, Pravin Siriwardena and Paul Hodgson	Panel conversation chaired by Dikai Liu Panellists: Alireza F. Fini and Keith Crews
15:30-16:45	**Keynote** Electrochemical ion-selective membrane for critical rare-earth mineral recovery	#4 Recycling medical plastic ***Emilie Gauthier,** The University of Queensland, Australia	**Invited:** From Circular Concrete to Circular Mining: Developing low carbon concrete mix designs from Australia's diverse mine wastes

	Gayathri Naidu, University of Technology Sydney, Australia		**Martin Anda**, Murdoch University, Australia
	#2 Circular Resource Recovery: Functionalized Glass Resins for Selective Extraction from Seawater and Brines **Carmelo Morgante**, Aalborg University, Denmark	#55 Molecular Insights into the Chemical Recycling of Polyolefin Plastics, **Martina Lessio,** University of New South Wales, Australia	#15 Valuing sand for mineral circularity: A review of valuation frameworks as critical enabler for the transition toward sustainable materials **Madhumitha Ardhanari**, The University of Queensland Australia
	#29 What six decades of chemistry tells us about lithium recovery **Ghaiath Almustafa**, University of Technology Sydney, Australia	#57 Computational Insights into Plastic Polyolefin Pyrolysis catalysed by UiO-66 **Christine Yu**, University of New South Wales, Australia	#19 Circular Economy and Net-Zero Emissions: Carbon Capture and Utilization Using Waste Calcium Silicate Boards **Cheng-Han Lee,** National Cheng Kung University, Taiwan
	#9 Polyketone ultrafiltration membrane fabrication for drinking water treatment **Hyeon-joo Lee & Yun Chul Woo***, Myongji University, Korea	#27 Mechanical recycling of polyhydroxyalkanoates via reactive extrusion with chain extenders **Alia Gallet-Pandellé,** The University of Queensland, (Australia)	#1 Material Revaluation Through Circular Design: Insights from Healthcare Plastics, Deconstructed Timber and Single-Use Products **Angelique Milojevic,** University of Technology Sydney, Australia
	#7 Low sludge metal-free Electro-Fenton treatment with nitrogen-doped rGO for semiconductor wastewater reuse **Junho Lee, Myongji** University, Australia	#56 Beyond Disposal: Computational Insights into Hydrogenolysis of Polyolefin Plastic Waste **Sohaib Umer**, University of New South Wales, Australia	#23 Development of a Buffer-free Alkali-producing Bioelectrochemical System for Mitigating Coastal Acidification **Chao-Chin Chang,** National Kaohsiung University of Science and Technology Taiwan
16:45-17:15	Afternoon tea break (Foyer and balcony)		
17:15-18:30	Campus tour		
18:30-21:30	Gala Dinner and CECE Awards Thomas and Wattle Rooms, Aerial Function Centre		

*Oral speaker will present before the panel conversation

Day 2: Friday 25 September 2026

Day 2 Morning Sessions

8:30	**Registration**		
9:00 - 10:00	**Plenary Session 2 (Broadway and Jones rooms)** Speakers The Big 8 – water sector challenges for research, **David Bergmann**, Water Research Australia Advancing circular economy for all, **Damien Giurco**, University of Melbourne, Australia Chair**: Sherub Phuntsho**, University of Technology Sydney, Australia		
10:00 - 10:30	**Panel discussion (panellists include David Bergmann, Damien Giurco, and Django Seccombe; Moderated by Sherub Phuntsho)**		
10:30 - 11:00	Morning tea break (Foyer and balcony)		
	Broadway – Circular Nutrients	**Jones – Circular Bioeconomy and Bioecology**	**Harris – Circular Energy**
	Chair: **Andrea Merenda**, Victoria University, Australia	Chair: **Maja Arsic**, CSIRO, Australia	Chair: **Yuting Zhuo**, University of New South Wales, Australia
11:00 - 11:20	**Keynote** Living Infrastructure 2.0: Bioactive Materials, Circular Resources and the Future of the Built Environment **Chris Allison,** City Forest, Australia	**Keynote** Harvesting valuable resources from industrial wastewater **Caitlin Byrt**, Australian National University, Australia	**Keynote** Synchronising Circular Construction Data: AI-Assisted, Cross-Platform Carbon Assurance **Julie Jupp,** University of Technology Sydney, Australia
11:20 - 11:40	**Keynote** Hydraulic response of LbL nanofiltration membranes **Tao He**, Shanghai Advanced Research Institute, Chinese Academy of Science, China	**Keynote** Placed-based approaches towards a circular bioeconomy **Pablo Juliano**, CSIRO, Australia	**Keynote** Integrated Process Development and Reactor Optimisation for High-Efficiency Recycling of End-of-Life Photovoltaic Modules **Yuting Zhuo**, University of New South Wales, Australia
11:40 - 12:00	Panel conversation chaired by Andrea Merenda Panellists: Chris Allison and Tao He	Panel conversation chaired by Maja Arsic Panellists: Caitlin Byrt and Pablo Juliano	Q&A session facilitated by **Yuting Zhuo**
12:00 - 13:15	Invited Speaker: Pilot scale recovery of nutrients from human urine: challenges and perspective **Andrea Merenda,** Victoria University, Australia	#80 Where to next for circular bioeconomy? **Maja Arsic**, CSIRO Agriculture and Food, Australia	#34 Circularising Hydrogen Export Systems: Economic Advantages of Reusing Dehydrogenated Carriers **Aditiya Harjon**, University of Technology Sydney, Australia
	#49 Harnessing Electroconductivity in Membranes for Microbial Fuel Cells and Resource Recovery **Swatantra Pratap Singh**, Indian Institute of Technology Bombay, India	#24 Adaptive Reuse: a key circular design strategy for urban regeneration **Valentina Petrone**, University of Sydney, Australia	#44 ZIF-67-GO Quaternized Polycarbazole Membranes for High-Performance Alkaline Electrolysis **Yeshi Choden**, University of Technology Sydney, Australia
	#54 Development of a Nutrient-Rich Liquid Fertilizer through Combined Membrane Bioreactor and Membrane Contactor Treatment	#70 Utilising pre-farm gate organics to build regional circular bioeconomy **Melita Jazbec,** University of Technology Sydney, Australia	#30 Techno-Economic Assessment of Mainstream Biogas Upgrading Technologies: Benchmarking for Next-Generation Biological Solutions **Menglin (Elin) Xie**, University of New South Wales, Australia

	Amirhossein Shafaghat, University of Technology Sydney, Australia		
	#11 Bioaugmentation Strategies for Mitigating Nitrite Accumulation in Urine Nitrification Systems **Lu Fu**, The University of Queensland, Australia		#74 Forward osmosis for concentrating lithium-enriched brine: From system design to salt diffusion control **Shucheng Mo**, ShanghaiTech University, China
13:15 - 14:15	Lunch break + **Poster Pitches** chaired by **Hanwei Yu** in Foyer		

Day 2 Afternoon Sessions

	Broadway – Circular Water	**Jones - Environmental Impact of Circular Economy / Issues in Upscaling CE Processes**	**Harris – Circular Other**
	Chair: Dallas Wilkinson, EPBA, Australia	**Chair: Sandra Kentish**, University of Melbourne, Australia	**Chair: Prashant Srivastava**, CSIRO, Australia
14:15-14:35	**Keynote** AI, Data Centres and Water: Australia's Next Infrastructure Test **Kate Dryden**, Sphere Infrastructure, Australia	**Keynote** A smart vision for a sustainable future: SMaRT technologies and MICROfactories™ creating sustainable materials and products from waste resources. Rethinking Circular Economy of Waste by Remanufacturing **Rumana Hossain,** University of New South Wales, Australia	**Keynote** Bhutan For Life: An Innovative Conservation Financing Mechanism for Climate Resilience and Sustainable Development **Pema Wangda,** Bhutan for Life, Bhutan
14:35 - 14:55	**Keynote** Water, Data Centres, Mining and the Circular Economy **Dallas Wilkinson**, EPBA, Australia	**Keynote** Australia's Cable Recycling Crisis and the Path to Circular PVC Recovery **Josh Robinson,** JR Hammer, Australia	**Keynote** Beneficial Reuse and Disposal Options for CSG Brine **Prashant Srivastava**, Environment, Waite Campus, CSIRO, Australia
14:55 - 15:15	Panel conversation chaired by Dallas Wilkinson Panellists: Kate Dryden, Gayathri Naidu and Glenda Stowell	Panel conversation chaired by Sandra Kentish Panellists: Rumana Hossain and Josh Robinson	Panel conversation chaired by Prashant Srivastava Panellists: Pema Wangda, Veera Koskue and Maja Arsic
15:15 - 16:30	AI#5 Physics-Informed Generative AI for Resilient Decentralized Water Quality Management **Gyuri Kim & Yun Chul Woo**, Myongji University, Korea	#36 The role of thermal treatment in a circular economy using PFAS as the example **Nathan Weber,** University of Technology Sydney, Australia	#33 Blending Biosolids with Garden Organics: A Pathway to Safer Biochar for Land Application **Nusrat Rezwana Binte Razzak,** Deakin University, Australia
	#21 Preparation of Green Biomass-based Lithium Ion-Imprinted Polymers (Green Li-IIPs) and Highly Selective Adsorption Application in Desalination Brine **Yi-An Wei,** National Cheng Kung University, Taiwan	#59 Soft plastics and the consumption crisis: Insights from a case study on sachets in the Philippines **KC Kasturi,** University of Technology Sydney, Australia	#46 Catalytic Upcycling of Mixed Plastic Waste toward Circular Resource Recovery, **Arshad Ali,** RMIT, Australia
	#32 Circular material flows in water sector	#68 Plastic, Wildlife, and Communities: Addressing Plastic	#6 Optimizing Cleaning Strategies for Fouled Reverse Osmosis Membranes in Industrial Wastewater ZLD Processes

	Glenda Stowell, Sydney water, Australia	Pollution in Indonesia's Coastal Communities **Nurul Ichsani,** Hasanuddin University, Indonesia	**Minseo Kim**, Myongji University, Korea
	#8 Comparative Evaluation of Commercial Nanofiltration Membranes for Selective Ion Fractionation in SWRO Brine **Hae Kang Cho**, Myongji University, Korea	#66 Preventive Environmental Impact Based on Local Wisdom in Indigenous Communities in West Sulawesi, Indonesia **Tuti Bahfiarti,** Universitas Hasanuddin, Indonesia	#40 Environmental Degradation of 3D-Printed Thermoplastics: Establishing Baselines for a Circular Plastics Economy **Azra Ghasemzadegan**, University of Wollongong, Australia
	#53 Engineering Pristine Biochar Adsorbents: An Activation-Free Strategy for Tuning Pore Architecture for Targeted Pollutant Removal **Ojima Wada,** Hamad Bin Khalifa University, Qatar	#16 Thermoeconomic Performance and Renewability Assessment of a Corn Stover Biorefinery Producing PLA, Succinic Acid, Xylitol, Adhesive, and Electricity **Reza Hessampour**, Queensland University of Technology, Australia	
16:30-17:00	Afternoon tea break		
17:00-17:30	Closing Remarks and Best Presentation Awards		

List of posters

Code	Name	Title
#50	**Kaicheng Zhang**	Recovery from Human Urine for Fertilizer Production A Systematic Review and Conceptual Process Assessment
#62	**Madeleine Miyamoto**	Rethinking the Life Cycle of Plastics: Polyethylene Upcycling
#67	**Ibrahim El Saliby**	Anthroponics: Nutrients recovery from urine and their use as fertiliser on mini green walls
#72	**Tosin Famakinwa**	Mechanical performance and structural stability of waste PC and HDPE during repeated direct hot-press recycling
#75	**Quan Yuan**	Competitive co-assembly for high-performance LbL nanofiltration
#78	**Takuma Watari**	Does the circular economy address material poverty
#41	**Juyeon Yu**	PHREEQC-XGBoost Hybrid Modeling of Mineral Carbonation from Seawater Desalination Brine considering Inhibition effects of Antiscalants8i
#73	**Jacob Fry**	Energy efficiency and decarbonisation pathways for Australian public hospitals
#38	**Alireza Boostan**	Development of a Design of Experiments to Assess the Mechanical Durability of 3D-Printed Recycled Polymers for Structural Applications

Plenary Speakers

Lisa Mclean

Managing Director and CEO, Circular Australia
E: lisa@circularaustralia.com.au

Title: Circular economy in Australia (TBC)
Day 1: Plenary session

Brief bio of plenary/keynote speaker
Lisa McLean is a circular economy and zero-carbon business transformation leader and Managing Director, CEO of Circular Australia, a national independent NFP leading the transition to a zero-carbon circular economy in Australia. She has been successfully advising industry and governments in developing new policy frameworks and regulations that bring about market change to enable the circular zero-carbon economy over the past 20 years. This work has covered the supply chains, infrastructure, energy, water, waste and mobility sectors in the UK and Australia.

Dr Michael Storey

Director of Innovation, SUEZ Australia/New Zealand
E: michael.storey@suez.com

Title: Direct Potable Reuse: Global Lessons for Australia
Day 1: Plenary session

Brief bio of plenary/keynote speaker
Dr Michael Storey is a trusted leader and adviser to the water industry, with 30 years experience across public, tertiary and private sectors. He has experience at Board, Executive and Senior Management level, corporate strategy and planning, customer services, research and innovation. He's a passionate water industry professional who has worked across all aspects of the local and international water sector. Michael has extensive experience in water quality and public health, customer experience and human-centred design, and have led and managed change in highly regulated environments. He's a university lecturer, Distinguished Fellow of the International Water Association and have made more than 350 local and international peer-reviewed publications and presentations, workshop and conference presentations to Prime Ministerial level.

Dr David Bergmann

Chief Executive Officer, Water Research Australia
E: david.bergmann@waterra.com.au

Title: The Big 8 – water sector challenges for research
Day 2: Plenary session

Brief bio of plenary/keynote speaker
Dr David Bergmann is the CEO of Water Research Australia, bringing nearly 25 years of experience in R&D across the chemicals, food, and water and wastewater sectors, from global multinationals to regional utilities. He holds a PhD in Chemistry from Monash University and is an AICD-qualified Company Director. David is an experienced manager and people leader of large R&D teams, spanning diverse industries, cultures, and organisations. He joined the water industry in 2015 at Victorian utility South East Water, where he significantly expanded their research portfolio and partnerships. His notable contributions included the innovative Aquarevo water- and energy-saving estate, the development of pyrolysis technology to produce Biochar from biosolids with RMIT, and various IoT devices for real-time monitoring. A holder of multiple patents and a collaborator in scientific publications on contaminants, alternative water, pyrolysis technology and biochar applications, David also has extensive leadership experience in the not-for-profit sector, including four years on the Board of WaterRA. As a strategic and practical thinker, David excels in developing collaborative partnerships, leading high-performing teams, and translating research into real-world solutions.

Prof Damien Giurco

Circular Economy Chair, University of Melbourne
E: damien.giurco@unimelb.edu.au

Title: Advancing circular economy for all

Day 2: Plenary session

Brief bio of plenary speaker

Professor Damien Giurco is the inaugural Chair of Circular Economy at The University of Melbourne. Prior to this, he worked for two decades at the UTS Institute for Sustainable Futures in roles including Associate Director Research and Distinguished Professor. He led UTS involvement in the NSW Decarbonisation Innovation Hub and was a foundation Director of the Product Stewardship Centre of Excellence. His research interests span responsible minerals and metals; material requirements for the clean energy transition; innovative business models and governance in the water, waste and resource sectors; advancing a circular economy to support sustainable consumption and production. Damien is a Deputy Director - Sustainability in the Australian Research Council's Training Centre for Resource Efficient Alloys in a Circular Economy and the Program Leader for Circular Economy within the Solving Plastic Waste Cooperative Research Centre whose mission is to change the way we design, use and reuse plastics. He collaborates widely with industry and government has co-chaired the World Resources Forum Asia Pacific, served on the NSW Ministerial Advisory Committee for the establishment of the Return and Earn container deposit system and his research has informed policy development on circular economy. He is a Fellow of the Australasian Institute of Mining and Metallurgy.

Keynote speakers

Living Infrastructure 2.0: Bioactive Materials, Circular Resources and the Future of the Built Environment

Chris Allison[1]

[1]CityForest
*info@cityforest.com.au

Brief bio of speaker
Chris Allison is Australia's leading vertical garden expert. His career started studying plant tissue culture and learning how plants can survive in any environment. Chris then worked for various hydroponic companies, building vertical farms and implementing advanced water systems. Chris then set up Hygrow Technologies, a company that designs and manufactures greenwall, greenhouse and hydroponics hardware. It was then that Chris combined all this knowledge to create The BioActive Wall. The BioActive Wall is a superior, innovative vertical garden system that leverages Chris' expertise in how plants survive, how to get them water most efficiently, and how to design and manufacture the equipment to do it. In 2010 Chris launched CityForest.

Abstract
As cities confront the challenges of climate change, biodiversity loss and resource scarcity, the built environment must evolve beyond static construction towards infrastructure that actively contributes to environmental performance. This keynote explores the emergence of Living Infrastructure 2.0—a new generation of integrated systems that combine advanced materials, living biomass, circular resource recovery and digital technologies to transform buildings into functioning ecological assets. Drawing on more than 25 years of experience delivering some of Australia's most significant living infrastructure projects, Chris Allison will discuss CityForest's transition from specialist green infrastructure delivery to the research and development of bioactive building systems that integrate vegetation directly into the fabric of the built environment. The presentation will examine how emerging bioactive ceramic composites, mineral-based growing substrates, intelligent water management systems and recycled material streams can be combined to create durable, fire-resilient and biologically active building envelopes designed for long-term environmental performance. A key component of this work is CityForest's collaboration with the University of Technology Sydney through the NiCE Hub, investigating circular nutrient technologies that recover valuable resources and return them safely to urban landscapes. This partnership demonstrates how circular economy principles can move beyond waste reduction to create regenerative nutrient cycles that support healthy vegetation while reducing dependence on conventional fertilisers. The presentation will argue that the next evolution of urban infrastructure lies in designing buildings that are not simply less harmful, but biologically productive—capturing carbon, cooling cities, supporting biodiversity, managing water and contributing to healthier urban ecosystems throughout their operational life. ather than treating vegetation as an architectural feature, Living Infrastructure 2.0 positions biomass as an integrated, measurable and essential component of future building systems.

Harvesting valuable resources from industrial wastewater

Caitlin Byrt

[1]Australian National University
*Caitlin.Byrt@anu.edu.au

Brief bio of speaker
Professor Caitlin Byrt is an Australian Research Council (ARC) Industry Fellow at the Australian National University, where she leads an innovative research program at the intersection of plant science, bioengineering, and membrane technology. Her work focuses on developing sustainable, bioinspired solutions to address global challenges in water use, waste management, and resource recovery.
Professor Byrt's team, working closely with a diverse network of collaborators across academia and industry, is pioneering bioengineered membrane technologies designed to extract valuable resources from industrial waste streams. Central to this effort is the development of BERST (Bioderived Element Resource Separation Technology), a modular membrane system that enables the efficient separation and recovery of critical resources such as metals, minerals, and nutrients from complex waste mixtures.
BERST represents a transformative approach to resource management. Rather than treating industrial by-products as pollutants, the technology reimagines them as reservoirs of valuable materials that can be recovered and reused. The system's modular design allows it to be adapted across a range of industries, supporting scalable solutions tailored to specific waste streams and resource recovery goals.
The broader vision underpinning Professor Byrt's work is to support a transition in industrial practice. Historically, industries have extracted clean water from natural environments, used it in production processes, and released

nutrient- and metal-rich wastes back into ecosystems, contributing to environmental degradation. By contrast, her team's biotechnologies aim to enable a circular model in which not only clean water but also embedded resources are efficiently recovered and reused.
Through this research, Professor Byrt is helping to shape a future where industrial systems are both environmentally responsible and resource-efficient, contributing to more sustainable and resilient economies.

Abstract
During the course of evolution, living organisms like plants gained highly sophisticated membrane separation systems to acquire water and nutrients from the environment while excluding or compartmentalising toxic or unnecessary elements. These biological processes rely on selective transport mechanisms capable of distinguishing between molecules with similar physicochemical properties, enabling plants to efficiently manage resource allocation, stress responses, and energy use. Plant membrane separation mechanisms operate across tissues, cell types, and subcellular compartments to maintain nutrient homeostasis under variable environmental conditions. These systems exemplify precision separation at the molecular scale and provide a framework for understanding how plants balance uptake of essential ions with exclusion or sequestration of harmful substances. The coordination and regulation of these processes underpin plant productivity and resilience and offer inspiration for engineering crops with enhanced performance in nutrient-poor or contaminated environments. Building on these biological principles, our team examined the growing role of membrane technologies in addressing critical challenges in water treatment, wastewater management, and resource recovery. As natural ecosystem services are increasingly strained by urbanization and intensive agriculture, there is a pressing need for scalable, efficient technologies that can selectively recover water, metals and nutrients from complex waste streams. Biomimetic membranes, particularly those incorporating selective transport proteins, represent a promising approach to replicate the high specificity and efficiency observed in living systems while reducing reliance on energy-intensive or environmentally damaging processes. We developed BERST (Bioderived Element Resource Separation Technology), which is a novel biomimetic membrane platform inspired by plant biological metal and nutrient transport systems. BERST leverages engineered, highly selective pore-forming structures to recover high-purity metals, minerals, and clean water from mining-influenced waters, which contain vast untapped economic value, and to recover high-value nutrients from agricultural and urban wastewaters, supporting fertiliser resource security. BERST demonstrates the potential of biologically inspired separation technologies to transform waste streams into valuable resources while improving environmental outcomes. Further progress in understanding and emulating plant membrane separation mechanisms is expected to contribute to driving the development of next-generation technologies for sustainable resource management. By bridging plant biology, membrane engineering, and industrial applications, this field of work supports the transition toward a circular green economy that recovers value from waste while minimising ecological impact

Public Inquiry – Australia's circular economy: unlocking the opportunities

Joanne Chong

[1]Commissioner, Productivity Commission
Adjunct Professor, Institute for Sustainable Futures, University of Technology Sydney
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Brief bio of speaker
Jo works across Australia and internationally to create solutions for sustainable development, through bridging diverse perspectives, sectors, knowledges and cultures. As Commissioner (Sustainable Development) at the Productivity Commissioner, Jo presides over independent inquiries requested by the Australian Government and required by legislation. Jo engages with industry, governments, researchers and communities to inform public policy analysis and recommendations that are tabled in the Australian Parliament. Over the last four years Jo has conducted inquiries into the Circular Economy, National Water Reform, the Future Drought Fund, the Murray Darling Basin Plan, and the Aboriginal and Torres Strait Islander Arts and Crafts sector. Jo is also a Steering Committee Member of the Australian Water Partnership, a Department of Foreign Affairs and Trade (DFAT) funded initiative to enhance sustainable management of water in the Indo-Pacific region and beyond. Jo previously held Research Director roles at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and at the University of Technology Sydney (UTS) Institute for Sustainable Futures. Through transdisciplinary and multidisciplinary research, partnership facilitation and knowledge brokering, Jo led programs and teams to address complex challenges across: water & sanitation, climate change adaptation, circular economy, Indigenous sciences, resilient infrastructure, responsible innovation, and regions and industries in transition.

Abstract
In August 2024, the Australian Government requested the Productivity Commission undertake an inquiry into Australia's opportunities in the circular economy to improve materials productivity and efficiency in ways that benefit the economy and the environment.
The PC provided its final report to government in August 2025, and it was tabled in the Australian Parliament in January 2026.

The recommended governments take further action across three broad areas:
• streamlining and harmonising regulations to encourage businesses to adopt innovative technologies and practices, while protecting the environment and human health
• strengthening obligations for businesses that supply products with high-risk or high-value waste streams, such as small electronics or small-scale solar photovoltaic systems, through product stewardship
• promoting circular activities and innovation through programs and services that facilitate coordination, collaboration and capacity building.
The PC also recommended that the Australian Government should develop an outcomes framework that connects each circular economy policy action to its related economic, social and environmental goals. This will support effective implementation, monitoring and evaluation of circular economy reforms.

Circular Construction –The essential role of structural timber in Australia's Built Environment

Keith Crews[1]

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Brief bio of speaker
Keith Crews is currently Professor & Director of the Australian Research Council Industrial Transformation Research Hub to Advance Timber in Australia's Built Environment, hosted at the University of Queensland. This is a 5 year national research program, with a cash and in-kind budget of $17m, involving some 140 investigators from some 25 Industry & Government Partners and 15 Universities. He is responsible for delivery on the Hub aims and objectives. Keith specialises in the research and design of large-scale timber structures and is internationally recognised as an expert in the area of Sustainable Infrastructure – particularly regarding bridge safety, structural assessment and timber engineering for non-residential buildings and physical infrastructure. He has extensive experience initiating and successfully managing large scale, multi-disciplinary research projects undertaken for Government and industry, having had a leadership role in over $35m of research & development projects over the past 30 years. He is an Advisory Board member for the Construction and Building Materials Journal and has received numerous awards for his research, including being a recipient the RW Chapman Medal in 2004 and the IEAust Structural College Eminent Speaker award for 2009. He was Chairperson of the World Timber Engineering Conference held in Brisbane in June 2025

Abstract
The ARC Advance Timber Hub commenced operation in November 2023 with the aim to facilitate an advanced manufacturing transformation of Australia's timber and construction industries, developing a roadmap to change that unlocks substantial industry and social value. Large-scale advanced manufacture of innovative engineered wood products (EWP) provides an opportunity for the Australian timber industry to shift production up the value chain, whilst simultaneously being a critical driver for the building construction sector in Australia to significantly reduce its greenhouse gas emissions by 2030 and to be on the path to net zero by 2050.
The Hub has brought together an outstanding, national & international research team of 145 industry and academic investigators, with the skill sets necessary to undertake research activities and deliver the aims of this Hub. Throughout the process of designing the R&D program for the Hub, the leadership team has listened carefully to the views expressed by all sectors in the supply chain, especially the concerns of end users.
This process of engagement is ongoing and as industry challenges are addressed throughout the operation of the Hub, we maintain a particular focus on sustainable supply of timber products and building systems for the residential and commercial building sectors

AI, Data Centres and Water: Australia's Next Infrastructure Test

Kate Dryden

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Brief bio of speaker

Kate Dryden is a Partner at Sphere Infrastructure Partners and a senior leader in water and waste infrastructure with more than 20 years' experience advising on and delivering complex, high-value programs. She is known for bringing clarity to projects that sit at the intersection of regulation, community expectations, commercial reality and delivery risk, helping clients move from ambition to executable, bankable outcomes.

With senior executive experience at Veolia, Kate brings a strong operator's lens to strategy, procurement and transaction management. She works with governments, utilities, corporates and investors to select fit-for-purpose delivery models, design robust procurement processes, and negotiate contracts that align incentives, allocate risk sensibly and stand up to scrutiny. Her experience spans major projects and long-term service arrangements, including O&M, DBO, BOOT, and PPP structures, as well as broader M&A and investment support across the waste and circular-economy value chain.

Kate's recent work includes leading commercial and procurement workstreams for the City of Gold Coast's residual waste-to-energy initiative, serving as the lead commercial and transaction advisor for ACT NoWaste's new recycling facility procurement, and supporting local governments with strategic reviews of municipal waste and recycling collection contracts. She has also advised clients on O&M services contract procurements for water recycling facilities and delivered market and due diligence insights for investors assessing opportunities in organics, recycling and broader waste infrastructure.

Kate is a former Non-Executive Director of Sydney Water, where she contributed to governance and decision-making for one of Australia's most critical utilities. She also supports clients and teams in translating circular economy ambition into practical, investable, and deliverable commercial structures for the Australian market.

Abstract

The rapid expansion of artificial intelligence and cloud computing is driving a new wave of data centre development across Australia. While most attention has focused on electricity demand, data centres also introduce significant water requirements for cooling. In some regions, this demand is beginning to challenge the capacity of existing urban water systems. However, the core issue is not simply water consumption. Data centres represent a new form of infrastructure load that concentrates large, continuous demand for power, water and land in specific locations. Traditional infrastructure planning frameworks were not designed for assets of this scale or intensity. This creates a broader planning challenge. Utilities, governments and developers must now consider how emerging digital infrastructure integrates with energy networks, water systems and urban growth. Without coordination, individual project decisions can trigger expensive upgrades, strain local infrastructure capacity and generate community concern over resource allocation. This presentation examines data centres as a case study in the need for **precinct-scale infrastructure planning**. Drawing on Sphere's experience advising governments and utilities across water, energy and waste infrastructure, it will explore how integrated planning approaches can better manage new infrastructure demand. The session will discuss practical strategies including the use of recycled water for cooling, co-location with renewable energy generation, and the importance of aligning planning and approvals with infrastructure capacity. It will also consider how procurement and commercial frameworks can support coordinated infrastructure delivery across multiple private developments within a precinct. As Australia's digital economy grows, infrastructure systems will increasingly need to accommodate new forms of demand that cut across traditional sector boundaries. Data centres highlight the need for a more integrated approach to planning infrastructure precincts where water, energy and digital infrastructure are developed together rather than in isolation.

Industrialised Circularity: Prefabrication, Automation, and the Future Workforce

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Bio
Associate Professor Fini is Director of the Construction Management Program at the UTS School of Built Environment. He has over 27 years of combined experience across research, teaching, and professional practice in the construction industry. His expertise focuses on industrialised building construction and Modern Methods of Construction (MMC), with a particular emphasis on advancing prefabrication methods and integrating construction automation into both offsite manufacturing and onsite processes.

He has secured more than AUD $25 million in competitive research funding, supporting innovation in prefabricated construction systems, construction automation, and onsite digital technologies. He is the Academic Director of a CRC-Project focused on establishing an advanced manufacturing facility for timber building construction. He also leads the UTS Affordable Housing Network and serves as the UTS Node Leader in an ARC Hub for human–robot teaming for sustainable and resilient construction. His work bridges academia and industry, with a strong focus on translating research into practical solutions that accelerate the transformation of the built environment.

Abstract
Circularity is often framed as a downstream sustainability challenge focused on recycling, reuse, and material recovery at the end of a building's life. However, this keynote argues that circularity is fundamentally determined much earlier - at the moment materials, components, and systems are connected together within increasingly industrialised construction processes.

As Modern Methods of Construction (MMC) evolve, the industry is shifting from fragmented site-based production to integrated systems of prefabrication and automation. This transition enables greater precision, repeatability, and efficiency in how buildings are manufactured offsite and installed onsite. However, it also introduces new levels of complexity at the interface between materials and systems, where multiple structural, mechanical, and architectural layers must interact without compromising future adaptability or disassembly.

This presentation explores how industrialised building circularity depends on more than technological advancement alone. Through a real-world case study, it examines how complex prefabricated building systems comprising multiple material assemblies and interface conditions are delivered through a combination of automated production processes and skilled human decision-making. While automation enables consistency and scalability in manufacturing, human expertise remains essential in managing material interfaces, ensuring quality outcomes, and embedding circular design intent into production and installation processes.

The case also highlights a critical challenge: current workforce capabilities are not yet fully aligned with the demands of human–machine collaboration in both factory and site environments. In manufacturing settings, skilled workers must adapt to working alongside automation systems to enable efficient customisation and high-precision assembly. On site, installation teams must develop new competencies to handle increasingly sophisticated prefabricated systems designed for adaptation, reuse, and eventual disassembly.

This keynote argues that the success of industrialized circularity depends on aligning three interdependent dimensions: circular design intent, automation technologies, and human capability. Where these elements are effectively integrated, construction can transition from linear project delivery to circular product systems capable of retaining and regenerating material value across multiple life cycles.

The presentation concludes by proposing that workforce transformation is not a secondary consideration, but a core enabler of circular construction. The future of the built environment will be defined not only by how buildings are designed and manufactured, but by how effectively humans and machines collaborate to deliver systems that are both highly efficient and inherently circular.

Circularity is not achieved at the end of a building's life. It is determined at the moment materials are connected together, and by how automation and human skills intersect in that process.

Hydraulic response of LbL nanofiltration membranes

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Brief bio of speaker
Professor Tao He is Co-Editor-in-Chief of *Desalination* and Executive Editor of *Desalination and Water Treatment*. He has more than 30 years of experience in membrane science and technology, focusing on the development of advanced membranes for ion separation, organic contaminant removal, and acid purification. He began his career at X-Flow/Norit BV and later served as Technical Director at Aquasource/Degremont SA. He is currently a researcher at the Shanghai Advanced Research Institute, Chinese Academy of Sciences, and a part-time professor at ShanghaiTech University. Professor He has secured over 30 research projects with total funding exceeding RMB 46 million. He has published more than 100 peer-reviewed papers and has an H-index of 56 (Google Scholar). He is a recipient of the Royal Society's Newton Advanced Fellowship. His research focuses on novel membrane materials and processes for resource recovery, micropollutant removal, and sustainable energy applications, with particular interests in nanofiltration, forward osmosis, and isotope separation.Web profile: https://people.ucas.edu.cn/~het

Abstract:
Resource recovery processes often rely on the separation of ions or organic compounds, a task that is frequently accomplished using nanofiltration (NF) membranes. By selectively allowing certain species to permeate while retaining others, NF membranes inevitably experience severe concentration polarization, leading to elevated osmotic pressure at the membrane surface. Consequently, higher operating pressures are required to achieve high resource recovery rates. Under these conditions, NF membranes are continuously subjected to substantial hydraulic stress, which can significantly affect their structural integrity and separation performance.

In this study, the unique hydraulic response of layer-by-layer (LbL) nanofiltration membranes, in both flat-sheet and hollow-fiber configurations, is systematically investigated for the first time. The substrate and the LbL selective layer are examined separately under hydraulic stress, and the key factors governing membrane performance are identified. We report the intriguing phenomenon of overcompensation within LbL membranes, which unexpectedly enhances both their chemical and hydraulic stability under acidic conditions.

Our results reveal that flat-sheet LbL membranes exhibit an elastic response, enabling the recovery of separation performance upon release of the applied stress. In contrast, hollow-fiber LbL membranes initially undergo compaction of the selective layer, followed by the existence of a critical pressure (or stress) beyond which the loss in separation performance becomes irreversible. The mechanisms underlying these distinct hydraulic responses are elucidated, and potential strategies for preserving the long-term separation performance of LbL nanofiltration membranes in both configurations are discussed.

Keywords: Nanofiltration; Layer-by-Layer; Lithium; acid purification; mechanical stability.

Circular Manufacturing via SMaRT technologies and MICROfactories to generate materials and products from waste resources

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Brief bio of speaker
Dr Rumana Hossain is a Lecturer at UNSW Sydney. She completed her PhD in Materials Science and Engineering at UNSW in 2020. Rumana is an environmental materials scientist whose research focuses on transforming complex waste streams—including plastics, packaging, electronic waste, spent batteries, automotive residues, textiles and thermosets—into valuable materials and products. Her work integrates waste characterisation, recycling and resource recovery, materials synthesis, environmental remediation, and the study of structure–property relationships. Rumana has authored more than 80 peer-reviewed publications, holds three granted patents and has delivered more than 30 invited and keynote presentations internationally. She has contributed to Australia’s first microplastics characterisation standard and worked with industry, government, councils and international research organisations on research translation, commercialisation and place-based recycling solutions.

Abstract
The environmental value of circular economy technologies is not secured by waste diversion alone. It depends on the selectivity, energy demand and emissions of transformation; the safety and performance of recovered products; and whether processes remain robust when moved from laboratory batches to variable industrial feedstocks. This presentation examines the SMaRT Centre's science of microrecycling as a source-to-product platform and considers the technical, environmental and system-level requirements for scaling circular manufacturing [4].

At industrial scale, Green Steel™ Polymer Injection Technology (PIT) uses waste tyres as sources of in situ carbon and hydrogen in electric arc furnace steelmaking, reducing reliance on conventional coal and coke while supporting furnace efficiency [1,2]. Modular MICROfactories™ extend this approach to difficult non-metallic streams, transforming waste plastics, textiles and glass into durable Green Ceramics™ for the built environment [3]. These pathways show that scale-up requires waste chemistry, process control, manufacturing specifications and reliable product markets to be designed together.

Selective thermal transformation further enables critical materials to be recovered or directly remanufactured into higher-value products. From spent Li-ion batteries, thermal disengagement preserved valuable copper and aluminium foils, followed by selective recovery of high purity cobalt [5]. In a Green Chemistry study, waste coffee powder supplied renewable carbon and reducing gases to recover lithium and cobalt and regenerate electrochemically active $LiCoO_2$ [6]. Mixed black mass from Ni-MH, Li-ion and alkaline batteries was also converted in a single step into NICOM 622, a Ni-Co-Mn-based superalloy, demonstrating a direct route from mixed critical-metal inventories to engineered alloy feedstock [7]. Complementary research selectively recovered La, Ce, Nd and Pr oxides from end-of-life Ni-MH batteries and repurposed rare-earth-containing phases in functional electrochemical materials [8,9].

Circularity also requires designing performance into waste-derived materials. Recent Advanced Science research transformed discarded compact discs into renewable carbon electrodes and showed that configurational defects influence initial ion storage, while the in-plane size of nanolayered microdomains governs longer-term stability differently in Li-ion and Na-ion systems [10]. Across these pathways, upscaling challenges include feedstock variability, thermal and mass-transfer uniformity, off-gas and contaminant control, energy intensity, product qualification, capital requirements, logistics and secure end markets. Integrating multiscale characterisation, process monitoring, life-cycle and techno-economic assessment, and industry validation is therefore essential. Circular-economy scale-up succeeds when waste chemistry, environmental safeguards and manufacturing performance are engineered together, enabling local supply chains for green metals, ceramics and energy materials.

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Powering a sustainable circular battery value chain to accelerate Australia's decarbonisation and resilience

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Brief bio of speaker

Katharine has served as CEO of the Association for the Battery Recycling & Reuse Industry (ABRI) for the past five years – a role she greatly enjoys. She draws on her considerable expertise in shaping strategy and influencing public policy to help elevate the industry's profile and advance greater safety and sustainability. Driven by her enthusiasm for the battery circular economy, Katharine enjoys working collaboratively with industry partners to promote an innovative growth sector grounded in best practices. Prior to her role at ABRI, she held high-level government positions in fields such as energy, resources, planning, water, infrastructure, and the environment, where she successfully delivered outcomes in complex domains.

Abstract
This presentation examines how Australia can strengthen its role in the global clean energy transition by developing a sovereign, circular battery value chain. As demand for critical minerals and low-carbon technologies accelerates, Australia has an opportunity to move beyond raw materials extraction toward sustainable local manufacturing, advanced metallurgical processing of battery materials. The session will explore how regulatory reform, technological innovation, and cross-sector collaboration can address current weaknesses in the battery circular economy while reducing lifecycle emissions and improving supply chain resilience. By outlining a strategic roadmap for policymakers, industry leaders, and researchers, the presentation argues that Australia can become a trusted supplier of recycled battery materials and a leader in responsible clean energy manufacturing.

Closing the Loop on Water: Membrane Technologies for a More Circular and Climate-Resilient Economy

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Brief bio of speaker
Dr Geoffrey Johnston-Hall is an R&D Manager for DuPont, where he leads research and development in membrane materials, products, manufacturing processes and water-treatment systems. He has more than 20 years of industrial research and development experience and a track record of translating membrane technologies from scientific concepts into commercial products and practical treatment solutions.
His work has covered microfiltration, ultrafiltration, membrane bioreactors, membrane contactors and specialised separation technologies. In recent years, his focus has been on developing reliable, lower-energy and lower-chemical-demand membrane technologies for drinking-water treatment, wastewater treatment, water reuse and desalination pretreatment. He works with multidisciplinary teams, customers and research partners across Australia, Asia, Europe and the Americas to address challenges including water quality, treatment efficiency, system durability, infrastructure renewal and resource recovery.
Geoffrey has contributed to the development and commercialisation of membrane filtration products, including technologies for improving treatment capacity, reducing land and resource requirements, and extending the productive life of water-treatment infrastructure. His current interests include circular water systems, low-energy wastewater treatment, membrane lifecycle management, and the recovery and reuse of materials from end-of-life membranes.
He holds a PhD in Polymer Chemistry from the University of Queensland (UQ), an MBA from the University of New South Wales (UNSW), and a Bachelor of Applied Science in Materials Science from the University of Technology Sydney (UTS). He has also served the Membrane Society of Australasia in executive and non-executive director roles.

Abstract
Water is inherently circular, yet many modern water systems continue to operate linearly: water is extracted, treated, used once and discharged. Water-treatment infrastructure can follow a similarly linear pathway, in which assets are constructed, operated for a defined service life and ultimately replaced or discarded. Climate variability, population growth, ageing infrastructure, carbon emissions and increasingly stringent water-quality requirements are creating an urgent need to rethink how water-treatment systems are designed, installed, operated, upgraded and managed throughout their lifecycle.
This presentation will examine how advances in membrane technology can support the transition from linear water-treatment practices to a more circular and climate-resilient model. It will present circular water as more than wastewater reuse. A comprehensive circular approach must recover water at a quality appropriate for its next use, reduce the energy, chemicals, land and infrastructure required for treatment, extend and maximise the productive life of existing assets, and address the materials remaining at the end of a product's useful life.
Examples from DuPont will illustrate several complementary technology pathways. Membrane bioreactor (MBR) and ultrafiltration (UF) systems provide robust separation platforms that support high-quality municipal and industrial water reuse while enabling compact, modular and long-lived treatment systems. Modular designs can allow treatment capacity to be increased or upgraded within constrained sites and enable infrastructure to expand progressively as demand grows. Advances in aeration, membrane configuration, hydraulic distribution and backwash operation are also improving treatment efficiency and reducing water, energy and chemical consumption.
The presentation will consider the role of high-recovery treatment technologies in industrial wastewater reuse and minimum-liquid-discharge (MLD) treatment trains. Increasing water recovery can reduce freshwater demand and decrease the volume of concentrated wastewater requiring energy-intensive thermal treatment. Digital assessment tools can complement these technologies by helping decision makers compare water, energy and emissions implications during process selection.
Circularity must also encompass the physical infrastructure and materials used to provide water services. Examples of membrane-system rehabilitation will demonstrate how long-lived treatment plants can be upgraded by retaining

valuable infrastructure while replacing or modernising selected components. Emerging research into the recovery and purification of polymers from end-of-life ultrafiltration membranes will illustrate both the potential and the remaining technical and commercial challenges associated with closing the material loop.
Circular water systems require the coordinated design of technology, infrastructure, validation approaches, regulation and business models. By treating wastewater as a resource, existing assets as valuable capital, and end-of-life materials as potential feedstocks, the water sector can make a practical contribution to circular-economy, climate-resilience and resource-efficiency objectives.

Keynote: Placed-based approaches towards a circular bioeconomy

Pablo Juliano

Bio (100-200 words)
Dr Pablo Juliano Otero is a Principal Research Scientist at CSIRO Agriculture and Food and former Group Leader of Food Processing and Supply Chains. A food engineer with a PhD and MBA, he has more than 20 years' experience translating research into industrial, policy and regional outcomes. His work spans food processing, circular bioeconomy, food-waste reduction, resource valorisation and place-based food-system transformation. Pablo contributed to Australia's National Food Waste Strategy and Baseline and has led multidisciplinary research programmes with government, industry and academic partners.

Abstract
Food loss and waste are increasingly recognised as important resources for the circular bioeconomy. However, circularity strategies have often focused on diverting materials from landfill into animal feed, compost, energy or other bioproducts, without first considering how their nutritional, economic and functional value might be retained at the highest practicable level. National material-flow estimates and annual tonnages can also obscure the importance of material quality and variability, seasonality, location, remaining useful life, infrastructure and existing uses. This keynote will examine how food-waste circularity is being addressed through strategies, research and collaborative programmes in Australia and Europe, and how place-based approaches can connect national ambitions with the resources, capabilities, markets and actors of particular regions.
The presentation will consider what mapping of food and organic material flows and current circularity indicators reveal about progress, drawing on Australian national and sector initiatives, developments in France, and European programmes such as WASTELESS. Selected Australian and international examples, including lessons from earlier dairy-sector transitions, will illustrate how initiatives are moving from measuring and monitoring food loss and waste towards selecting and implementing interventions. The presentation will discuss decision tools that help compare options for prevention, redistribution and transformation, while recognising that a technically feasible pathway alone does not constitute an implementable circular solution. Place-based decisions must also account for when and where materials arise, their current and competing uses, appropriate products and processes, facility scale and location, logistics, markets, environmental and economic performance, and the roles and readiness of participating actors. Future opportunities lie in connecting these tools and evidence within coordinated regional systems that can identify viable configurations for retaining food and material value, strengthening supply-chain resilience and delivering climate, environmental and socioeconomic outcomes.

Synchronising Circular Construction Data: AI-Assisted, Cross-Platform Carbon Assurance

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Brief bio of speaker

A/Professor Jupp is an academic leader in digital engineering at the University of Technology Sydney. Her research focuses on information management, Common Data Environments, data governance, and digital assurance across complex infrastructure and facilities lifecycles. She works closely with government and industry partners to examine how digital engineering can improve project delivery, asset information quality, embodied-carbon reporting and circular construction outcomes. Her current research investigates cross-platform CDE synchronisation and AI-assisted assurance methods for improving the reliability, traceability and decision value of project data in major Australian infrastructure delivery ecosystems.

Abstract

Circular construction policy increasingly depends on the ability of infrastructure projects to measure, report and assure embodied carbon, recycled content, material provenance, and circularity outcomes. Yet major Australian infrastructure projects are delivered through highly fragmented digital ecosystems, where models, drawings, specifications, schedules, quantities, design reviews, approval records and carbon-relevant metadata are distributed across multiple Common Data Environments, organisations, disciplines and contractual interfaces. This fragmentation creates hidden uncertainty in circular construction reporting.
Carbon and circularity calculations may appear precise at the point of reporting, while the underlying project data remains incomplete, duplicated, inconsistently classified, poorly synchronised or disconnected from the current design and construction baseline.

This paper investigates cross-platform CDE synchronisation as an enabling layer for circular construction data governance and carbon assurance. Drawing on synchronisation data from a live Australian transport infrastructure project, the study examines the scale, quality and circularity-readiness of project information moving across the delivery ecosystem. The analysis quantifies synchronisation transactions, connected platforms, information containers, metadata fields, revision histories and approval-status records. It then assesses the extent to which project records contain the minimum information required to support reliable embodied-carbon and circular material calculations, including material type, quantity, unit of measurement, asset or package classification, design status, revision lineage, specification linkage and evidence of recycled content or product provenance.

The paper further evaluates how AI-assisted anomaly detection can be used to identify missing, inconsistent or unverifiable data that may affect embodied-carbon and circularity reporting. Potential anomaly classes include incomplete material classifications, inconsistent units, duplicated records, superseded revisions used in calculations, mismatched quantities, unlinked model and document records, recycled-content claims without supporting evidence, and material substitutions that are not reflected in updated carbon calculations. By analysing

With these data-quality risks within ordinary project delivery workflows, the research demonstrates that circular construction failures often emerge well before formal sustainability reporting occurs.

The contribution of the paper is twofold. First, it provides empirical evidence of the information-management conditions that shape the reliability of circular construction and embodied-carbon reporting in major infrastructure delivery. Second, it develops an evidence-based framework for circular carbon assurance, showing how the synchronisation of data across CDEs and AI-assisted checking can improve traceability, data confidence and decision-usefulness across fragmented project environments. The findings are relevant to infrastructure clients, delivery partners, digital engineering teams and sustainability practitioners seeking to scale circular construction practice beyond isolated calculations and towards continuous, auditable and project-integrated assurance.

Purified Recycled Water for drinking water customers of data centres?

Stuart Khan

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Brief bio of speaker
Stuart Khan is Professor and Head of School of Civil Engineering at the University of Sydney. He has received funding for over 40 major competitive research projects from Australian, US and European funding agencies. He has published over 200 peer reviewed journal articles on issues relating to water quality and treatment, including drinking water, wastewater, recreational water, environmental water systems, water recycling and desalination.

Stuart is a Fellow of scientific and engineering institutions, including Engineers Australia (FIEAust), The Academy of Technological Sciences and Engineering (FTSE), The Royal Society of Chemistry (FRSC), The Royal Society of NSW (FRSN), and is also an International Water Association IWA Fellow.

Abstract
Australia's urban water supplies are entering a period of increasing uncertainty. Climate change, population growth and recurring drought are placing greater pressure on water systems that remain heavily dependent on rainfall. The experience of the 2017–2020 drought demonstrated the consequences of this vulnerability, with numerous Australian communities approaching or reaching critical water shortages. Greater Sydney is particularly exposed: compared with several other Australian capitals, it has a relatively low proportion of rainfall-independent water supply.

Purified recycled water (PRW) has emerged as an important component of long-term water security planning. The 2022 Greater Sydney Water Strategy identifies purified recycled water alongside desalination as a potential new rainfall-independent supply, while the Lower Hunter Water Security Plan identifies a future purified recycled water drinking scheme as a major supply augmentation. Australian experience already demonstrates the technical feasibility of potable reuse at scale, including Perth’s groundwater replenishment scheme and Queensland’s Western Corridor Recycled Water Scheme.
However, a rapidly emerging competing demand raises an important question about how this valuable resource should be allocated. The NSW Government’s 2026 Data Centre Guidelines state that where water is required for data-centre cooling, recycled water should be prioritised, with the intention of shifting demand away from drinking water and encouraging investment in new rainfall-independent supplies. For water-intensive cooling systems, the guidelines envisage 100% recycled water use or an agreed transition to rainfall-independent water.
On one level, this policy is logical: high-quality drinking water should not be unnecessarily consumed for industrial cooling. But it creates a deeper water-security question. Recycled water derived from municipal wastewater is a relatively constant, rainfall-independent resource. That characteristic makes it particularly valuable during drought, - precisely when conventional drinking water supplies are under greatest stress. Allocating increasing quantities of recycled water to data centres may therefore provide those facilities with highly drought-resilient water supplies while reducing the same resource's availability to improve drought resilience for the wider community.
This presentation examines the evolution of recycled water in Australia, from non-potable urban and industrial reuse to large-scale potable reuse, and considers the implications of rapidly growing data-centre demand. It argues that decisions about recycled water should extend beyond the apparently straightforward hierarchy of “drinking water for people, recycled water for industry”. The opportunity cost of allocating rainfall-independent water must also be considered. As Australia prepares for future droughts, governments and water utilities need a transparent framework for determining where recycled water delivers the greatest public value and, ultimately, whose drought resilience we are prioritising.

Two-dimensional Nanosheets as Membrane Building Blocks for Species Separations

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Brief bio of speaker

Nicholas Ze-Xian Low presently holds the position of National Foreign Expert and Jiangsu Distinguished Professor at the National Engineering Research Center for Special Separation Membrane at Nanjing Tech University. Additionally, he serves as an Adjunct Senior Research Fellow in the Department of Chemical and Biological Engineering at Monash University. Prior to joining Nanjing Tech, Low co-founded and served as the CEO of 2D Water, a Melbourne-based spin-out from Monash University focusing on the research commercialization of graphene-based desalination technology. Low is committed to advancing energy-efficient composite separation membranes based on advanced materials, addressing industrial challenges across decarbonization, desalination, and resource recovery. Notably, his work has received funding from prestigious grants such as National Natural Science Foundation of China (NSFC) Foreign Scholar Research Fund, General Program, Jiangsu Provincial Key R&D Program, an open project of Suzhou Laboratory, and a Yangtze River Delta Innovation Alliance proof-of-concept project, among other domestic and international projects. He has published over 120 papers in reputable peer-reviewed journals, including Nat. Rev. Mater., Nat. Synth., Nat. Commun., Chem. Rev., Adv. Funct. Mater., ACS Nano, Angew. Chem., CEJ, AIChE, IECR, and JMS. His contributions to research have been acknowledged through various awards, such as the FYA Young Social Pioneer Award, I&ECR Class of Influential Researchers, Rising Stars in Desalination, ARC Hub Excellence Award, RINENG Young Investigator Award, JWPE Trailblazer Award, and Stanford/Elsevier Top 2% Scientists.

Abstract
Two-dimensional analogues, such as graphene oxide, boron nitride (BN) nanosheets, and MXene, have been studied extensively for their potential to develop functional membranes with superior ion and molecular separation capabilities attributed to their Angstrom-scale channels, customizable channel wall properties, and remarkably low transport resistance. Among these analogues, BN nanosheets, comprising multiple layers of hexagonal planes formed by alternating B and N atoms interconnected through robust B−N covalent (sp2) bonds, have been widely investigated due to their higher thermal conductivity, mechanical robustness, and resistance to oxidation and harsh chemical environments. Owing to these distinctive characteristics, BN nanosheets have found applications in energy storage, insulation, waterproof coatings, electrocatalysis, gas and ion separation, and water purification. Similarly, MXene. Similarly, MXene, a family of two-dimensional transition metal carbides, nitrides, or carbonitrides, offers metallic conductivity, mechanical flexibility, and readily functionalizable surfaces via abundant terminal groups, allowing precise control over channel chemistry and interlayer spacing. These features render MXene nanosheets highly

attractive for fabricating membranes with tunable selectivity, high permeance, and enhanced fouling resistance in separation applications.
In this presentation, we discuss techniques for synthesizing BN nanosheets and MXene and leveraging them as building blocks to fabricate nanocomposite membranes with enhanced separation efficiency, particularly in gas separation, nanofiltration, reverse osmosis, and salinity gradient harvesting. We present several scalable exfoliation techniques for the large-scale production of BN and MXene nanosheets, along with their functionalized variants. Additionally, we explore contemporary approaches for crafting membranes with heterostructures that exhibit novel properties.1-5 The fabrication techniques and membrane design strategies discussed herein hold significant promise for advancing membrane-based separation processes, offering avenues for more efficient and sustainable separation technologies.

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Material Flow Structures and Quantitative Targets for a Decarbonised Circular Economy

Keisuke Nansai

Director, Material Cycle Division, National Institute for Environmental Studies, Japan

Abstract
Japan enacted the Basic Act on the Promotion of a Sound Material-Cycle Society in 2000, marking the beginning of its policy efforts to build a circular society. Between 2000 and 2022, the input of natural resources into the Japanese economy decreased by 40%, while the use of recycled resources increased slightly. Over the same 22-year period, Japan also reduced its greenhouse gas emissions by approximately 15%. However, reduction targets and policy measures for material flows and greenhouse gas emissions have largely been discussed separately.

Given the limited time remaining until 2050, the target year for achieving a net-zero society, it is essential to set quantitative targets and design measures based on a clear understanding of the material flow structures required in such a society. This is particularly important for materials, for which technological decarbonisation is often more difficult than it is for electricity. This presentation will provide an overview of the interrelationship between material use and greenhouse gas emissions in Japan, focusing on plastics and minerals, and will discuss the systemic transformation of material flows required to achieve a decarbonised circular economy.

Nutrients in a Circular Economy

Sherub Phuntsho and Ho Kyong Shon

RC industry research hub for Nutrients in a Circular Economy, Centre for Technology in Water and Wastewater, School of Civil, Environmental, and Sociotechnical Engineering, University of Technology Sydney
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Brief bio of speaker

Dr Sherub Phuntsho is an Associate Professor at the School of Civil and Environmental Engineering, Faculty of Engineering and Information Technology (FEIT), University of Technology Sydney (UTS). He is a core member of the Centre for Technology in Water and Wastewater (CTWW) and a globally recognized expert in membrane technologies, water and wastewater treatment, desalination, nutrient circular economy, onsite sanitation and humanitarian engineering. Dr Phuntsho holds a PhD in Environmental Engineering and a Master of Engineering from UTS, and a Bachelor of Civil Engineering from SVRCET (now SVNIT), Surat, Gujarat in India. Prior to his academic career, he served in various capacities with the Royal Government of Bhutan from 2001 to 2008, where he led national initiatives in urban waste management and infrastructure development under the DANIDA funded Environment and Urban Sector Programme Support project.

He is an editorial board member and subject editor of the Process Safety and Environmental Protection and Membranes) and serves as a subject editor and guest editor for special issues in these journals. Dr Phuntsho actively engages in community and professional service. He served as the President of the Sydney Bhutanese Community Association (2017-2024) and Vice President of Kharchu Centre Australia (2017-22024). He has also served as a co-chair and organizing committee member for several international conferences, including CECE 2024, IFOS, and IMSTEC.

Abstract

Modern agriculture relies on a linear fertiliser economy based on finite phosphate reserves and energy-intensive nitrogen production. While synthetic fertilisers have enabled global food security, they also contribute to greenhouse gas emissions, nutrient pollution, eutrophication, biodiversity loss, and fertiliser supply vulnerabilities. Human urine represents an underutilised resource for closing this nutrient loop. Although it constitutes only about 1% of domestic wastewater volume, it contributes up to 70% of the nitrogen and 50% of the phosphorus of the wastewater, making it an ideal target for nutrient recovery through separation at source.

Here at the University of Technology Sydney, we have developed innovative technologies to convert source-separated urine into safe, concentrated fertiliser products. This work resulted in the Urval (Urine is Valuable) technology platform, which combines biological nitrification and advanced membrane processes to stabilise nutrients, reduce odour, and produce transportable circular fertilisers.

The research progressed from laboratory proof-of-concept studies using synthetic and real urine to pilot-scale validation, process optimisation, techno-economic assessment, and commercial translation. Various concentration technologies, including forward osmosis, membrane distillation, electrodialysis, and membrane capacitive deionisation, were evaluated to improve nutrient recovery and reduce storage and transport costs.

Pilot-scale systems operating at UTS demonstrated the technical feasibility of treating source-separated urine under realistic conditions. The resulting fertiliser products showed promising performance in hydroponic cultivation, comparable to conventional nutrient solutions. Lifecycle and economic assessments also identified substantial environmental benefits, including reduced nutrient loads to wastewater treatment plants, lower treatment costs, and increased treatment capacity.

A key challenge remains the slow biological nitrification of urine due to high ammonia concentrations and salinity, which increases treatment time and costs. Ongoing studies focus on improving nitrification rates, removing pharmaceutical residues, and developing alternative nutrient recovery pathways. The research has culminated in the establishment of NiCE GreenTech for commercialisation, with applications now expanding beyond urine to include nutrient recovery from liquid anaerobic digestate. Together, these advances demonstrate a practical pathway towards nutrient security, sustainable sanitation, climate resilience, and a circular nutrient economy.

Breaking Australia's Lithium Refining Competitiveness Cycle: Industrial, Technical, and Policy Barriers to Value-Added Processing

Amir Razmjou

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Brief bio of speaker
Associate Professor Amir Razmjou is a leading researcher in membrane science, surface engineering, and critical mineral extraction at Edith Cowan University, where he leads the Mineral Recovery Research Centre (MRRC) and serves as a Board Director of the Membrane Society of Australasia. His work spans lithium, rubidium, high-purity alumina, iron, and gallium extraction, with strong expertise in membrane technology and desalination. He has published more than 240 peer-reviewed articles (h-index 67, over 15744 citations) and secured more than $35.9 million in research funding, including over $24.6 million as lead Chief Investigator. He has supervised more than 40 HDR students and serves on the editorial boards of leading journals including Desalination, Journal of Water Process Engineering, and Desalination and Water Treatment. Amir is consistently ranked among the Stanford/Elsevier World's Top 2% of Scientists and, according to 2025 ScholarGPS lifetime analytics, is placed within the top 0.34% of scholars globally. His excellence has been recognised through major awards, including the Australian Water Association WA Water Professional of the Year (2025), the ECU Vice-Chancellor's Excellence in Research Award (2024), the WA FHRI Fund Innovation Fellowship (2023), the Membrane Society of Australasia Industry Innovation Award (2023), and the UTS Chancellor's Research Fellowship (2021).

Abstract
Australia is the world's largest producer of spodumene concentrate and a major supplier of lithium feedstock to global battery supply chains. Despite this strong upstream position, Australia has struggled to establish a globally competitive lithium refining industry. Existing explanations often focus on labour costs, energy prices, environmental regulations, or policy settings, but these factors alone do not explain the systemic nature of industrial competitiveness. This paper proposes a systems-level framework based on 23 factors across three interconnected domains: (i) cost disadvantage, (ii) process efficiency gaps, and (iii) limited industrial integration. Together, these create a self-reinforcing "negative competitiveness loop" where high costs restrict scale, limited scale reduces learning and optimisation, and lower efficiency further increases costs. The framework also identifies gaps in waste management, by-product recovery, and resource circularity as contributors to reduced competitiveness.
The analysis argues that competitiveness depends on dynamic interactions between scale, learning, integration, supply-chain maturity, process optimisation, and waste valorisation. China's refining dominance is examined through this lens, highlighting the benefits of industrial clustering, downstream integration, and coordinated manufacturing ecosystems.
The paper proposes pathways to break the competitiveness loop, including industrial clustering, advanced separation technologies, integrated waste-management systems, by-product utilisation, and coordinated policy support. It concludes that Australia's opportunity may lie not in replicating conventional refining models, but in developing next-generation technologies that reduce energy use, waste generation, and impurity management costs while maximising resource recovery and circular-economy value.

Australia's Cable Recycling Crisis and the Path to Circular PVC Recovery

Josh Robinson

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Brief bio of speaker

Josh Robinson is the founder and Managing Director of JR Hammer, a Melbourne-based industrial recycling company transforming how Australia handles cable, metal, and PVC waste. When working in the field, Josh identified critical gaps in Australia's cable recycling infrastructure for the electrical and construction industry. He saw firsthand how traditional scrap merchants only recycle the metal and throw the rest of the by-product (plastic cable insulation) away, only to end up in landfill. After completing his Certificate III in Electrotechnology, Josh co-founded SRS Metals in 2013, achieving 400% turnover growth within four years through operational innovation. In 2018, driven by the conviction that waste is unnecessary, unintelligent, unsustainable, and uncommercial, he established JR Hammer to close the loop on electrical cable waste recycling. JR Hammer now operates Victoria's largest cable processing facility, with advanced European machinery processing up to 2.5 tonnes per hour and achieving recovery rates over 90%, double the industry standard (less than 50%). The company recently expanded into Heidelberg, acquiring a second factory to scale its operations. These certified recycling services help electrical contractors and construction, energy, and demolition companies to meet ESG targets while unlocking tangible value from waste streams. Josh's commitment to innovation extends beyond current operations. As co-inventor of Australia's first operational Solar PV recycling facility and Head of Recycling at Lotus Energy Recycling, he tackled emerging waste challenges in renewable energy infrastructure. In 2024, JR Hammer was federally funded for R&D collaborations with CSIRO, RMIT, BYGEN, Welvic, and the Vinyl Council of Australia to develop groundbreaking dissolution technologies to recover near-virgin PVC resin from complex waste streams, directly addressing Australia's PVC recycling crisis. Recognised as a 2025 finalist for the Smart Energy Council's Excellence in Stewardship award, Josh's vision is to expand circular cable recycling nationwide, fundamentally shifting how Australia's electrical industry approaches resource recovery and environmental responsibility.

Abstract

Australia generates substantial quantities of electrical cable waste from construction, infrastructure upgrades, telecommunications, and renewable energy installations. Globally, electrical and electronic waste exceeds **50 million tonnes annually**, with cables representing a significant fraction of this stream. In Australia, thousands of tonnes of cable waste are generated each year from building demolition, electrical upgrades, and infrastructure replacement. However, the national recycling system remains largely focused on **metal recovery**, where copper and aluminium are extracted while the polymer insulation-primarily **poly (vinyl chloride) (PVC)**-is commonly sent to landfill or incineration. As a result, only **around 2% of Australia's PVC production is currently recycled**, leading to the loss of valuable polymer resources and contributing to environmental pollution. PVC insulation constitutes a major portion of cable mass and contains stabilisers, plasticisers, and additives that provide desirable mechanical and electrical properties. Conventional cable recycling technologies rely on mechanical shredding and density separation methods that prioritise metal recovery but degrade polymer quality, rendering recovered PVC unsuitable for high-performance

applications. Thermal routes such as incineration or pyrolysis destroy the polymer structure and raise environmental concerns due to emissions and potential release of hazardous compounds. These limitations create a substantial gap between the growing volume of cable insulation waste and the ability to reintroduce PVC into **high-value manufacturing cycles** such as new cable production or construction materials.

To address this challenge, a **selective dissolution approach using tailored ionic liquid (IL) solvents** is investigated for recovering high-quality PVC from cable waste streams. Ionic liquids possess tunable polarity, high thermal stability, and negligible vapour pressure, making them promising solvents for polymer separation processes. In this approach, granulated cable waste is contacted with a selectively designed ionic liquid under controlled temperature and residence time conditions. The solvent preferentially dissolves the **PVC insulation layer**, while metallic components such as copper and aluminium remain unaffected and can be separated through simple physical processes. The dissolved polymer is subsequently recovered via controlled precipitation, enabling PVC recovery while preserving molecular structure and important formulation additives.

Research activities are undertaken through collaboration between **RMIT University and CSIRO** to integrate fundamental materials research with scalable processing concepts. RMIT focuses on developing and optimising ionic-liquid solvent systems for efficient PVC dissolution and recovery, while CSIRO supports advanced materials characterisation and contributes to the design of scalable processing strategies suitable for industrial cable recycling systems. Laboratory studies using representative cable waste streams demonstrate selective dissolution and recovery of PVC with **repeatable dissolution precipitation cycles**. The recovered polymer retains key chemical and thermal characteristics comparable to high-quality PVC materials, indicating minimal degradation during processing. Solvent recycling studies further show that the ionic liquid can be reused across multiple cycles without loss of performance, supporting the feasibility of closed-loop operation.

By enabling selective recovery of high-quality PVC, ionic-liquid-based processing offers a pathway to transform cable recycling from a metal-centric practice into a **comprehensive materials recovery strategy.** This approach could significantly improve PVC circularity within Australia's electrical and construction sectors, reduce landfill disposal of cable insulation waste, and support national waste reduction and circular supply chains.

The deal before the deal

Django Seccombe

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Brief bio of speaker
Django is an environmental engineer and change broker, committed to unlocking new enterprise and creating a more circular and sustainable economy.
Django's experience spans operations, planning, project development, strategy and policy development in the water and bioenergy sector. He splits his time between establishing and embedding circular economy practice in Sydney Water and developing cross industry circular economy projects in the private sector. His projects cut across water, energy, food and waste systems.

Abstract
Recovering nutrients from organic waste streams at meaningful scale is increasingly technically achievable. The technology exists. The case for closing the loop on phosphorus, nitrogen, and organic carbon is well established. What remains stubbornly difficult is building the commercial ecosystem that makes it actually happen — and in Australia, this gap between vision and execution is wider than most practitioners want to admit.
This presentation draws on two contrasting projects to examine what it takes to move from concept to contract. The first is Sydney Water's Upper South Creek Circular Economy Zone — an eco-industrial precinct in Western Sydney where the speaker has led a multi-year collaboration between Sydney Water and regional councils to aggregate biosolids and food and garden organics to the scale required for advanced processing and nutrient recovery. The second is the Goodness Grown Bioenergy Hub in northern Victoria — a rural project converting dairy manure and food processing waste into biogas for heating a 20-hectare glasshouse tomato operation and fertiliser for local agriculture.
The two projects share a common architecture but differ sharply in context, feedstock mix, and the nature of the partnerships required. Together they reveal a consistent truth: circular economy projects that recover nutrients only work when every party in the feedstock chain sees enough shared value to commit — and building that shared value requires a level of commercial honesty that does not come naturally to institutions more accustomed to procurement than to partnership.

This presentation is not about the technology or the vision. It is about the sequence of difficult conversations, the funding pathways that work and the ones that do not, the procurement structures that preserve flexibility, the offtake agreements that hold, and why embedding innovation into the business model from day one determines whether a project can capture upside as markets mature. It offers a practitioner's account of how to architect those ecosystems: what does it actually take, who you need, when you need them, how to sequence the relationships and build enough buy-in to see partners persist through the hard parts.

Beneficial Reuse and Disposal Options for CSG Brine

Prashant Srivastava

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Brief bio of speaker
Dr Prashant Srivastava is a Senior Research Scientist at CSIRO, Australia, with extensive expertise in environmental chemistry, soil science, waste valorisation and circular economy solutions. His research spans coal seam gas (CSG) brine management, resource recovery and the environmental assessment and remediation of emerging contaminants, including PFAS, microplastics and tyre-derived chemicals. He leads multidisciplinary research that integrates advanced analytical science, environmental risk assessment and innovative resource management approaches to address complex environmental challenges. Working at the interface of science, industry and government, Dr Srivastava translates research into evidence-based strategies and practical solutions that advance sustainable resource management and circular economy outcomes.

Abstract
Hypersaline brine generated from coal seam gas (CSG) operations represents one of the most persistent environmental and operational challenges associated with produced water management. Following reverse osmosis treatment, large volumes of concentrated brine remain, creating long-term issues related to salt accumulation, storage, disposal, environmental risk and social licence. This research examined technically feasible, environmentally responsible and economically viable pathways for the beneficial reuse, management and disposal of CSG brine, with the aim of supporting more sustainable and circular approaches to salt and waste management in the resources sector.
The work brought together brine characterisation and techno-economic assessment to evaluate both established and emerging brine management options. Representative CSG brines were assessed for major ions, trace elements and other constituents that influence treatment performance, reuse potential and environmental risk. A broad suite of technologies and pathways was considered, including salt recovery, crystallisation, secure encapsulation, resource recovery, energy generation and storage applications, microalgae cultivation, and acid mine drainage neutralisation. Each option was evaluated against technical performance, regulatory requirements, infrastructure needs, environmental implications, cost and suitability under different brine chemistries and site conditions.
The findings show that there is no single universal solution for CSG brine management. Feasibility is strongly controlled by brine composition, including salinity, scaling potential, trace element concentrations and temporal variability. Conventional approaches such as crystallisation and secure encapsulation remain technically robust, but may carry significant economic and long-term liability considerations. In contrast, beneficial reuse and resource recovery options offer promising opportunities where brine chemistry, market demand, infrastructure and regulatory settings are favourable. Emerging applications also show considerable potential, although further pilot-scale validation is required before broader implementation.

Bhutan For Life: An Innovative Conservation Financing Mechanism for Climate Resilience and Sustainable Development

Pema Wangda

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Brief bio of speaker

Dr. Pema Wangda is a conservation and sustainable development leader with over two decades of experience in biodiversity conservation, protected area management, watershed management, and innovative conservation financing. He has held senior leadership positions within the Royal Government of Bhutan, where he has contributed to national policies and programs that promote environmental sustainability, biodiversity conservation, and climate resilience. Dr. Wangda has played a pivotal role in the implementation of *Bhutan for Life (BFL)*, one of the world's pioneering conservation financing initiatives and the first of its kind in Asia. Designed to secure the long-term financial sustainability of Bhutan's protected area system, the initiative has strengthened conservation management, institutional capacity, and partnerships among government agencies, local communities, development partners, and international organizations. His expertise encompasses conservation finance, protected area governance, ecosystem restoration, landscape-level planning, and results-based management. A strong advocate for nature-based solutions and sustainable development, Dr. Wangda has represented Bhutan at the regional and global forums, sharing the country's experiences in conservation finance, ecosystem resilience, and biodiversity conservation. He has authored and co-authored scientific publications in international, regional, and national journals on biodiversity conservation, natural resource management, and environmental sustainability.

Dr. Wangda is committed to advancing innovative policies and partnerships that integrate conservation with sustainable economic development and community well-being. He believes that pioneering initiatives such as *Bhutan for Life* offer valuable lessons for countries worldwide and can inspire scalable, long-term solutions that strengthen biodiversity conservation, enhance climate resilience, and contribute to a more sustainable future for generations to come.

Abstract

Climate change, biodiversity loss, and increasing pressure on natural resources demand innovative financing approaches that simultaneously deliver environmental, social, and economic benefits. Nature-based Solutions (NbS) are increasingly recognized as cost-effective strategies for climate adaptation, mitigation, and sustainable development, yet their implementation is often constrained by fragmented and short-term financing. Bhutan For Life (BFL) represents a pioneering Project Finance for Permanence (PFP) model that addresses this challenge by providing long-term, performance-based financing to secure the sustainable management of Bhutan's protected area system. Bhutan maintained over 70% of its land under forest cover and maintains more than half of its total area under network of protected areas and biological corridors, making it one of the world's most intact mountain ecosystems. These landscapes function as critical natural infrastructure, providing carbon sequestration, watershed protection, biodiversity conservation, disaster risk reduction, and climate resilience for both upstream ecosystems and downstream communities across the Eastern Himalayas. Sustaining these ecosystem services requires predictable financing that extends beyond conventional project cycles. The presentation examines Bhutan For Life as an innovative conservation financing mechanism that integrates biodiversity conservation, climate resilience, and sustainable development through long-term financial sustainability. By linking donor investments to clearly defined conservation milestones and progressively increasing national financing commitments, BFL creates a durable pathway toward self-sustaining protected area management. The programme strengthens protected area governance, ecological monitoring, habitat restoration, climate-smart management planning, human-wildlife conflict mitigation, and community-based livelihood initiatives that enhance both ecological integrity and local resilience. Beyond biodiversity conservation, Bhutan For Life demonstrates how conservation finance can serve as an effective climate finance instrument. Healthy forests and watersheds enhance climate adaptation by regulating water supplies, reducing erosion and flood risks, stabilizing mountain landscapes, and supporting resilient agriculture and hydropower systems. At the same time, conserving Bhutan's carbon-rich forests contributes to global climate mitigation while helping the country maintain its status as one of the world's few carbon-negative nations. These investments directly support Bhutan's Nationally Determined Contributions (NDCs), the Kunming-Montreal Global Biodiversity Framework, the Paris Agreement, and multiple Sustainable Development Goals. The Bhutan For Life model also aligns with circular economy principles by investing in the long-term maintenance and regeneration of natural capital rather than the depletion of ecosystem assets. By treating protected landscapes as renewable ecological infrastructure that continuously generates ecosystem services and socio-economic benefits, the programme demonstrates how innovative finance can create resilient, self-reinforcing systems for sustainable development. As countries seek scalable mechanisms to finance Nature-based Solutions under accelerating climate change, Bhutan For Life offers a globally relevant model that integrates conservation finance, climate resilience, and landscape-scale ecosystem management. Its experience provides practical lessons for governments, conservation organizations, and development partners seeking to build financially sustainable, climate-resilient protected area systems that deliver lasting benefits for people, nature, and future generations.

Water, Data Centres, Mining and the Circular Economy

Dr. Dallas Wilkinson[1*]

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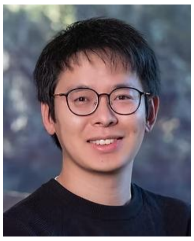
Brief bio of speaker
Dr. Dallas Wilkinson is an accomplished leader with over 35 years of extensive international experience in the Mining Equipment, Technology, and Services (METS) sector. His career spans senior executive and board roles across R&D, technology management, manufacturing, operations, sales, marketing, safety, strategy, intellectual property, and business turnarounds. With extensive global expertise, Dallas is known for driving technology adoption and advancing industry innovation worldwide. A strong advocate for the Australian METS sector, Dallas serves as Chair of Austmine, championing industry innovation and collaboration. He is also the Founder and Managing Director of Enhanced Performance Business Advisory (EPBA), providing transformative strategies for technology commercialization, business growth, and leadership excellence. Through EPBA, he helps organizations accelerate technology adoption, unlock growth, navigate complex business challenges and build resilient leadership teams.
Dallas is Co-Chair of the Licensing Executives Society (LES) Chemical, Energy, Environmental, and Materials (CEEM) Committee and its Industry Advisory Board, is President -elect LES ANZ, and serves on multiple private boards and chairs several advisory boards across the METS and Oil & Gas sectors. A passionate coach and mentor, Dallas is dedicated to developing the next generation of industry professionals. His qualifications include a PhD in Chemistry, an MBA in Technology Management, and recognition as a Graduate of the Australian Institute of Company Directors (GAICD).

Abstract
The rapid expansion of artificial intelligence and data centres is creating a new infrastructure challenge involving energy, mined materials and water. Although the digital economy may appear largely invisible, it depends on extensive physical infrastructure and substantial natural resources. A 100 MW artificial intelligence data centre may require approximately 3,000 to 5,000 tonnes of copper within its power, cooling and communications systems. Depending on its location and cooling technology, the same facility may directly consume approximately one to five million litres of water each day. Its indirect water footprint through electricity generation can approach 11 million litres per day, depending on the energy source and local electricity mix.
Copper provides a useful illustration of the scale of material demand, but data centres also need steel, aluminium, silicon, lithium, nickel, rare earth elements and other materials required to provide the electricity generation, transmission, storage and backup systems supporting each facility. Material and water footprints of the digital economy therefore extend far beyond the physical boundaries of the data centre.
Meeting growing demand for the minerals and metals required by digitalisation, electrification and artificial intelligence will require both increased primary production and greater recovery of secondary resources. However, many mineral deposits are located in water-constrained regions, while declining ore grades can increase the quantities of water and energy required for each tonne of material produced. The technologies supporting a digital and lower-carbon economy may therefore place additional pressure on water, energy and natural resources.
Many mining materials are recyclable, but materials incorporated into data centres, buildings and electricity networks may remain in productive use for decades before becoming available for recovery. Circularity is therefore essential, but recycling alone cannot satisfy immediate growth in demand. Circular-economy strategies must also reduce resource consumption, extend asset life, recover value from waste and keep water and materials in productive use for longer.
Innovation will be critical to resolving these competing demands. Sensors can continuously measure water flows, water quality, energy consumption, equipment condition and environmental performance. Reliable communications infrastructure can connect these sensors across complex and remote operations. Integrated platforms and control rooms can bring operational and environmental information together. Artificial intelligence, machine learning, predictive analytics and digital twins can then identify patterns, forecast emerging problems, optimise processes and support real-time control of water (and other fluids), energy and production systems.
Practical examples will demonstrate how Australian mining equipment, technology and services innovation can enable this transition e.g. long-range Wi-Fi and mine IoT technologies provide the connectivity required to monitor and manage people, equipment and environmental performance across complex and remote operations. Examples will illustrate how innovation can improve performance across the mining lifecycle.
The central proposition is that a circular digital economy cannot be achieved by considering data centres, mining, water and recycling independently. We must be able to measure then manage, connect before optimising, and innovate before scaling. The objective is a connected system in which technology, data, intellectual property and commercial collaboration enable water, materials, equipment and land to remain productive for longer.

Integrated Process Development and Reactor Optimisation for High-Efficiency Recycling of End-of-Life Photovoltaic Modules



Yuting Zhuo*

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Brief bio of speaker
Dr Yuting Zhuo is a Lecturer in the School of Chemical Engineering at the University of New South Wales (UNSW), Australia. His research focuses on sustainable process engineering, including photovoltaic recycling, critical material recovery, metallurgical decarbonisation, and reactor design. By integrating experimental research with computational modelling and process optimisation, he develops scalable technologies that support the circular economy and the transition to low-carbon manufacturing. Dr Zhuo collaborates extensively with industry through projects funded by the Australian Research Council (ARC), ARENA, and NSW EPA, etc.

Abstract
Massive photovoltaic (PV) modules will be decommissioned and must be properly recycled, but current recycling methods cannot recover valuable materials such as silver and silicon from end-of-life PV panels in an economically feasible manner. In this study, a highly efficient recycling process is developed, featuring a novel sieving aids technology for high-efficiency separation of solar cells and glass, integrated with upstream pyrolysis for delamination and downstream chemical leaching for silver recovery. The results indicate that over 96.3 wt.% of the chip-like PV cell particles can be separated from the debris mixture under the optimised sieving conditions using the new sieving aids technology, compared with only 31.7% using conventional sieving methods. The separated PV cell particles are subsequently leached using 4 M nitric acid at 40 °C for 30 min, achieving a silver recovery efficiency exceeding 98.9%. Furthermore, numerical simulations were performed to redesign and optimise the pyrolysis, sieving, and leaching reactors, providing improved process understanding, enhanced reactor performance, and a scalable engineering basis for future pilot-scale and industrial implementation. This study presents an integrated and scalable recycling strategy for the efficient recovery of valuable materials from end-of-life PV modules.

Invited Speakers

Closing the Loop: Circular Economy in Minerals Processing

Salwan Al-Assafi

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Brief bio of speaker
Dr. Salwan Al-Assafi is the Research Portfolio Manager – Critical Minerals and Alternative Use of Tailings and Waste at the Minerals Research Institute of Western Australia (MRIWA), where he leads research strategy and industry partnerships across the critical minerals value chain. He holds a PhD in Materials Science and Engineering and brings over 20 years of experience in research and innovation leadership, spanning materials science, decarbonisation, and circular economy initiatives. Dr. Al-Assafi is actively engaged with several Cooperative Research Centres and maintains strong research partnerships with leading Australian universities, contributing to the advancement of critical minerals research and international collaboration.

Abstract
The transition to a low-carbon future is placing unprecedented demand on critical minerals, at the same time as legacy processing waste and tailings represent an underutilised secondary resource base. This keynote explores how circular economy principles can be embedded into minerals processing strategy, drawing on work underway at the Minerals Research Institute of Western Australia (MRIWA).
Two complementary circular pathways will be examined. The first is waste valorisation: reprocessing streams such as delithiated beta spodumene (DBS) for use in construction materials, turning a disposal liability into a value-adding product. The second is critical metals recovery from these same secondary sources, extending resource life beyond the original processing step. Together, these approaches illustrate how circularity can be applied not as a single technology but as a portfolio of pathways spanning materials substitution, resource recovery, and value-chain redesign.
The talk will also touch on the role of international research collaboration in accelerating this shift, referencing MRIWA's engagement with international research organisations working on tailings valorisation and critical minerals

recovery. The aim is to offer a practical, portfolio-level view of how research institutes can de-risk and accelerate circular economy adoption in minerals processing, balancing technical feasibility and commercial pathways.

From Circular Concrete to Circular Mining: Developing low carbon concrete mix designs from Australia's diverse mine wastes

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Brief bio of speaker

Martin Anda is an environmental engineer with over 30 years of experience in the energy, water and resource recovery sectors since completing a Bachelor of Engineering (Mechanical) degree at The University of Western Australia. He completed a PhD at Murdoch University and became Director of the UNEP Environmental Technology Centre, before launching the Environmental Engineering undergraduate and masters programs. Martin is Theme Leader Circular Economy in the university's Harry Butler Institute and Research Fellow in the Indo-Pacific Research Centre where he manages postgraduate researchers on a range of renewable energy, water and waste management related projects. His current projects include commercialisation of low-carbon geopolymer concrete manufacturing in Western Australia and Indonesia and green hydrogen for industrial process heat.

Abstract

Sustainability and carbon emissions in civil infrastructure projects are multifaceted, and require holistic planning, innovative technologies, and strategic management to mitigate environmental impacts. The challenge lies in balancing infrastructure development with environmental sustainability, particularly in reducing greenhouse gas emissions associated with construction and maintenance activities. Infrastructure projects, particularly in transport (roads, carparks, marinas, airports), contribute significantly to carbon emissions, both directly and indirectly. Direct emissions arise from the use of fossil fuels in construction equipment, while indirect emissions are associated with the production of construction materials (Moore, 2022), for example, the Portland cement used in concrete.

Construction of infrastructures with traditional materials poses significant challenges, primarily due to the environmental impact of Ordinary Portland Cement (OPC), which is the world's single largest source of carbon emissions. OPC production is highly energy-intensive and accounts for approximately 10% of global CO2 emissions (Fadi, 2023).

The use of alternative materials in the making of concrete, both in SCMs and new binder systems like geopolymer, offers a promising solution to these challenges. For example, geopolymers produced from industrial by-products like fly ash, smelter slags, or bauxite residue, can significantly reduce the carbon footprint associated with infrastructure development while maintaining comparable or superior durability to OPC-based concrete (Moore, 2022). Their lower embodied energy, excellent resistance to chemical and thermal degradation, and ability to incorporate waste materials make them highly suitable for sustainable construction, particularly in marine and local transport infrastructure where durability and environmental performance are critical (Andrew, 2018). Jamieson et al. estimate the emissions from producing geopolymer concrete to be 10–40% less than that of OPC (Ricciotti et al., 2025).

This paper will report on what may be called "circular concrete" formulations made from recovered mine wastes and industrial by-products for application in specific transport infrastructure projects across Western Australia. It will explain how the demand from civil infrastructure projects for low carbon concrete can drive the mining industries towards more sustainable practices and circularity through the case study of Suvo kaolin mine at Pittong, Victoria where a new metakaolin SCM product has been developed from its mine process tailings.

The paper seeks to demonstrate how circular design and material reuse can enhance performance, resilience, and sustainability.

Pilot scale recovery of nutrients from human urine: challenges and perspectives

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Brief bio of speaker
Dr. Andrea Merenda is a Research Fellow at the Institute for Sustainable Industries & Liveable Cities, Victoria University, and former Postdoctoral researcher at the ARC Nutrients for a Circular Economy hub (NiCE), UTS. He received his PhD from Deakin University in 2019. Dr Merenda specializes in the design and synthesis of functional materials and their integration in membrane separation technologies and chemical reactors for green chemistry, circular economy and water remediation. He has authored and co-authored 63 research papers and 2 book chapters since 2016. Dr. Merenda is also Associate Editor of the Journal of Water Process Engineering (JWPE) and Board Director of the Membrane Society of Australasia (MSA).

Abstract
Modern agriculture has relied for decades on inexpensive, high-emission (responsible for ~2% of global CO2 emissions) synthetic fertilisers obtained from finite, dwindling fossil feedstocks to meet the global demand for food. Despite the abundancy of natural resources locally available, Australia imports half of the local demand of synthetic fertilisers (2023 import: $ 4.2 billion). Membrane bioreactors that combine the sanitation of human urine with the recovery of nutrients offer a promising strategy to produce renewable fertilisers for sustainable agriculture. Nonetheless, membrane bioreactors in field applications can be disrupted by challenging environmental conditions that affect sensitive autotrophic nitrifiers, such as acidic pH and oxygen competition mechanisms. To overcome these challenges, this study investigated the performance of a pilot-scale membrane bioreactor in the recovery of nutrients from human urine via biological nitrification at low pH (5.75-5.8) and high mixed liquor suspended solids (15.3 ± 0.2 g·L-1) under fixed dissolved oxygen concentration (4.5 ± 0.5 mg·L-1). The membrane bioreactor exhibited excellent stability under such operating envelope, achieving a maximum nitrification rate of 26.8 ± 4.4 mgN·gMLVSS-1·d-1 while removing up to 89% of TOC, in-line with the performance of our sister pilot-scale reactor operated under conventional conditions. Taxonomic and metagenomic analysis revealed that the *Candidatus Nitrosoglobus* outcompeted Nitrosomonas during operation with full strength-urine, while the *Nitrospira* genus dominated the NOB community. Biological nitrification conducted under adverse conditions correlated with a high NOB:AOB ratio of 9.9 at steady state, which was reflected by a predicted prevalence of nitrite oxidoreductase genes and the onset of a plausible nitrite loop. The nutrient-rich solution obtained from the bioreactor permeates, containing essential macronutrients and proteinic-rich organic fractions stemming from biological transformations in the bioreactor, was tested on the hydroponic growth of Dactylis glomerata. The urine-derived nutrient solutions afforded a similar performance to a commercial hydroponic fertiliser in terms of biomass yield, demonstrating that membrane bioreactors can efficiently transform human waste into a value-added product under a broad range of conditions. This study paves the way for the upscale and operation of membrane bioreactors for the recovery of nutrients from human urine in field applications, unlocking new circular economy opportunities for waste management utilities.

All other speakers

#1 Material Revaluation Through Circular Design: Insights from Healthcare Plastics, Deconstructed Timber and Single¯Use Products

Angelique Milojevic* and Berto Pandolfo

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Brief bio of speaker
Berto Pandolfo is an industrial designer and Associate Professor in Product Design at UTS. Trained in Australia and Italy, he combines practice-led research with both emerging and traditional methods to develop new approaches to product design. His work explores material processes, the meaning and complexity of objects, and the strategic role of design-led innovation in strengthening manufacturing capability. His designs have been featured in leading local and international design journals and exhibited at global design events. He has contributed to numerous university–industry collaborations, applying his research to batch production, commercialisation, and more sustainable object-making practices. Berto is the project lead on Achieving Circularity: Development of a sustainable and scalable model to recycle and reduce the cost of polypropylene waste in hospitals, a major research initiative advancing circular practices in healthcare.

Abstract
This paper examines how design-led approaches can meaningfully reduce waste across three distinct material streams: healthcare plastics, timber from deconstructed dwellings, and single-use consumer products. Through an analysis of circularity initiatives undertaken in hospitals, flood-affected regional communities, and university-based materials laboratories, the study identifies shared principles and cross-sector opportunities to design out waste at multiple scales. In the healthcare context, the Achieving Circularity project demonstrates the potential to recover large volumes of single-use polypropylene sterilisation wraps, surgical drapes, gowns, and masks, and remanufacture them into new high-value products using technologies trialled in New South Wales hospitals. At a materials and community scale, the Northern Rivers Circular Timber Pilot highlights how replacing demolition with deconstruction enables the recovery of premium hardwoods from flood-damaged homes, supporting their repurposing into new objects, furniture and community infrastructure. The project illustrates how maker engagement and local knowledge can extend material lifecycles while restoring social and cultural value.
At the product scale, a university-led initiative on polystyrene coffee cup lids demonstrates how small-format plastics can be transformed into durable objects through shredding, extrusion and robotic 3D printing. These processes provide a replicable model for localised, closed-loop manufacturing. Collectively, these case studies show that designing out waste requires reimagining materials as assets, embedding circular practices into existing systems, and fostering collaboration across designers, industry, government, and communities. The paper argues that cross-sector design interventions can transform waste into valuable circular products, contributing to more environmentally safe and socially sustainable futures.

#2 Circular Resource Recovery: Functionalized Glass Resins for Selective Extraction from Seawater and Brines

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Brief bio of speaker
I am a chemical engineer with PhD from the University of Palermo, Italy (2024), where my research was focused on advancing sustainable desalination and brine valorisation technologies at both laboratory and pilot scale. In collaboration with leading European institutions, including UPC-BarcelonaTech (ES), TU Delft (NL) and AAU (DK), I have investigated novel Minimum Liquid Discharge (MLD) routes for valuable resource recovery. A key aspect of my work has been the recovery of high value minerals, particularly magnesium, to enable more circular and environmentally responsible water treatment systems. I contributed to two major EU funded projects, ***Zero Brine*** and ***Water Mining***, where I played an active role in demonstrating real-world applications of resource recovery. During Water Mining, I was responsible for the construction, operation, and experimental validation of a large-scale demonstration plant in Lampedusa, Italy, designed to recover multiple resources from seawater while producing key chemicals internally. Beyond MLD processes, my research has also explored novel materials for enhanced

nanofiltration performance. I have developed next generation membranes and adsorbent materials that enable highly selective magnesium recovery from seawater/brines. This work earned the ***First Miriam Balaban Innovation Award*** at the 2023 European Desalination Society Conference and led to a patent with ACWA Power. Currently, I am a Postdoctoral Researcher at Aalborg University, working on several brine valorisation projects. In 2025, I received the ***Young Water Professional of Denmark Award*** from IWA and DWF (Danish Water Forum) for my contribution in the Danish water sector. In addition, I recently secured the prestigious **1.5 million DKK InnoExplorer grant** to upscale my new technology MagNaGLASS, a recyclable glass-based adsorbent for high selective magnesium recovery. I am deeply committed to reshaping the future of desalination by developing sustainable, high-performance and versatile materials that can enhance brine valorisation and unlock new economic value.

Abstract
Magnesium is a strategically important element with essential roles in renewable energy technologies, lightweight manufacturing, and water treatment. Yet, its global supply is increasingly vulnerable due to the depletion of land-based deposits and heavy dependence on geographically concentrated production routes. Recognizing this risk, the European Union has classified magnesium as a Critical Raw Material, underscoring the urgent need for sustainable and circular recovery pathways. Seawater and industrial brines represent vast, underutilized reservoirs of magnesium and align strongly with circular economy principles—particularly when valorising desalination waste streams. However, extracting magnesium efficiently from these complex matrices remains challenging due to competing ions such as calcium, sulphate, and bicarbonate, which limit selectivity and reduce product purity. Existing technologies, including polymeric ion-exchange resins and membrane systems, often lack the thermal stability, durability, and ion discrimination required for large-scale, sustainable resource recovery. To address these limitations, we introduce a new class of functionalized, ion-exchangeable glass composites engineered for rapid and highly selective magnesium recovery from seawater and waste brine [1]. The materials are produced by blending a ZIF-62-derived metal–organic framework (MOF) glass with sodium phosphate glass, followed by controlled heat treatment and water activation. This process embeds exchangeable alkali ions and surface-anchored phosphate groups directly into a mechanically robust, mouldable inorganic–organic glass network. Surface characterization confirms successful phosphate grafting which underpins selective capture and fast ion transport. The optimized composite exhibits high capacity and ultrafast uptake under realistic conditions. In natural seawater from three locations—the Red Sea, Mediterranean Sea, and Baltic Sea—the material recovers 9.6, 8.2, and 7.4 mg g^{-1} of Mg^{2+}, respectively, within 10 minutes. Despite lithium's trace abundance, the composite also captures 3.1, 2.8, and 2.1 mg g^{-1} of Li^{+} in the same time frame, highlighting multi-ion valorisation potential. Under identical test conditions, a commercial cation-exchange resin (Dowex 50W X8, Na^{+} form) removes only 3.6–3.1 mg g^{-1} Mg^{2+} and 0.5–0.3 mg g^{-1} Li^{+}, even after 3 hours, demonstrating both higher capacity and more than an order-of-magnitude faster kinetics for the glass composite. Selectivity strengthens as solution complexity increases. While Ca^{2+} can marginally outcompete Mg^{2+} in single-salt tests, the composite displays a marked preference for Mg^{2+} in binary (Ca^{2+}/Mg^{2+}), ternary ($Na^{+}/Ca^{2+}/Mg^{2+}$), and synthetic seawater systems. Mechanistically, uptake is governed by a dual mode: ~72% via $Na^{+}\leftrightarrow Mg^{2+}$ ion exchange and ~28% via interactions with phosphate functional groups and pore surfaces. The adsorption follows Langmuir behaviour (monolayer binding) with pseudo-second-order kinetics, consistent with chemisorption-dominated processes. The material is regenerable using simple NaCl brine and retains ~80% of its initial capacity after six sorption–desorption cycles. Processing temperatures of ~350–450 °C enable shaping into beads, granules, or self-standing membranes, facilitating scalable integration into desalination and brine-mining. By converting seawater and desalination brines into sources of strategic magnesium and lithium, this platform advances circular mineral supply, reduces dependency on high-impact terrestrial mining, and supports climate-aligned manufacturing. The approach is tuneable across MOF-glass chemistries and alkali domains, offering a versatile framework for selective resource recovery at the water–materials nexus.

#4 Recycling medical plastic

Emilie Gauthier[1,2], Peter Halley[1,2]

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Brief bio of speaker
Emilie Gauthier is a polymer engineering researcher specialising in sustainable materials, biopolymers, and the circularity of plastics. Her research focuses on the structure–property relationships, degradation mechanisms, and end-of-life pathways of synthetic and bio-based polymers. She has expertise in polymer formulation, processing, and characterisation, with work examining crystallinity development, thermal transitions, and degradation behaviour, and how these factors influence mechanical performance and recyclability.
She leads projects investigating the mechanical recycling behaviour of high-volume medical plastics, such as polypropylene (PP) and polyethylene terephthalate (PET). Her work integrates analytical techniques such as DSC,

TGA, FTIR, and tensile/impact testing to quantify material ageing and to develop data driven strategies for improving polymer recovery and end of life performance in healthcare settings.
Emilie's research bridges fundamental polymer science with applied sustainability challenges, generating field-ready material insights that support the transition toward circular manufacturing and improved plastics performance across their full lifecycle.

Abstract

Medical plastic waste is generated in substantial quantities across healthcare facilities worldwide, driven by the widespread use of single use devices, sterile packaging, and disposable consumables. A large proportion of this waste stream consists of high-quality thermoplastics, particularly polypropylene (PP), which is valued for its chemical resistance, low density, and suitability for sterilisation. Despite its material quality and recyclability, most medical PP is currently landfilled or incinerated due to concerns around contamination, inconsistent segregation practices, and limited evidence demonstrating the feasibility of high-quality recycling. Advancing circular economy strategies in healthcare therefore requires robust data on how thermomechanical recycling affects the processability and performance of PP recovered from clinical settings.

This study investigates the effects of thermo-mechanical recycling on the processability and material properties of PP incorporating varying amounts of regrind derived from medical plastic waste. Blends containing different proportions of medical grade regrind were successfully extruded without compatibilisers, stabilisers, or other processing aids, demonstrating good melt flow and stability during processing. Mechanical testing revealed that the incorporation of medical grade regrinds maintained favourable material properties. These results indicate that clean medical plastic waste can be effectively reprocessed and reintegrated into new material applications.
Overall, this research highlights the potential of mechanical recycling as a viable and sustainable pathway for valorising single use medical plastics, supporting both environmental objectives and resource efficiency goals within the healthcare sector.

#5 Physics-Informed Generative AI for Resilient Decentralized Water Quality Management

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Brief bio of speaker

Gyuri Kim is an integrated M.S./Ph.D. student at Myongji University, Republic of Korea. Her research focuses on seawater desalination, reverse osmosis (RO) membrane systems, and machine learning-based water treatment processes. She is particularly interested in compact and energy-efficient desalination systems for a small-scale desalination system and remote applications. Her recent research includes predicting membrane performance and energy consumption in small-scale RO systems using real seawater data. She has also received a presentation award for her research presentation from the Korean Society of Environmental Engineers.

Abstract

Small-scale decentralized water treatment facilities are pivotal for regional water circularity, yet they remain inherently vulnerable to operational uncertainties due to limited sensor infrastructure and technical manpower. These systems frequently exhibit volatile water quality fluctuations, while the intermittent and sparse nature of monitoring data severely limits the efficacy of conventional data-driven predictive models. To bridge this "data gap," this study proposes a novel hybrid modeling framework that synergizes generative data augmentation with physics-based constraints. A Conditional Tabular Generative Adversarial Network (CTGAN) was employed to synthesize high-fidelity datasets, which were rigorously validated for statistical consistency with real-world variation patterns. This augmented data served as the foundation for a Recurrent Neural Network (RNN) to capture complex temporal dynamics, further integrated within a Physics-Informed Machine Learning (PI-ML) architecture to ensure both predictive robustness and physical interpretability. The proposed framework functions as a proactive decision-support tool, enabling early detection of abnormal events and providing operational guidance under climate-related stresses such as heatwaves and droughts. This work demonstrates a transformative pathway for "Circular AI" to empower decentralized water infrastructure toward higher reliability and resilience.

#6 Optimizing Cleaning Strategies for Fouled Reverse Osmosis Membranes in Industrial Wastewater ZLD Processes

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Brief bio of speaker
Minseo Kim is a Master's candidate at Myongji University, where she researches advanced membrane processes for industrial wastewater treatment. Her expertise lies in the investigation of RO fouling mechanisms and the development of strategic mitigation and cleaning solutions for Zero Liquid Discharge (ZLD) systems. Her work is centered on improving the operational stability of membrane processes dealing with complex, high-strength industrial effluents.

Abstract
Zero Liquid Discharge (ZLD) processes are widely applied in industrial wastewater treatment to enhance water reuse and minimize environmental discharge. In these systems, reverse osmosis (RO) membranes play a crucial role in achieving high-efficiency separation of dissolved contaminants. However, membrane fouling remains a major operational challenge, leading to permeability decline, reduced treatment efficiency, and increased operational costs. This study investigates the fouling mechanisms of RO membranes in ZLD processes treating industrial wastewater. Particular attention was given to the influence of key wastewater constituents, including organic matter, inorganic salts, and trace metals. Experimental results showed that the accumulation of these substances on membrane surfaces results in both physical and chemical fouling, which progressively reduces water permeability and overall membrane performance. Among the identified factors, high concentrations of inorganic salts and dissolved organic compounds were found to be the primary contributors to membrane flux decline during long-term operation.
To mitigate fouling effects, various membrane cleaning strategies were examined, including the optimization of cleaning cycles and the evaluation of different cleaning agents. A comparative analysis of biological, chemical, and physical fouling mechanisms indicated that cleaning approaches tailored to the dominant fouling type significantly improve membrane recovery and operational stability. These findings highlight the importance of effective pre-treatment, regular chemical cleaning, and proactive monitoring strategies for maintaining long-term performance and efficiency in RO-based ZLD wastewater treatment systems.

#7 Low sludge metal-free Electro-Fenton treatment with nitrogen-doped rGO for semiconductor wastewater reuse

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Brief bio of speaker
Dr. Lee is a postdoctoral researcher in environmental engineering at Myongji University, Republic of Korea, where he focuses on advanced water treatment technologies for semiconductor wastewater reuse. His research centers on the development of metal-free electro-Fenton systems using nitrogen-doped reduced graphene oxide (N-rGO) as cathode materials to enable selective hydrogen peroxide generation, minimize sludge formation, and improve the sustainability of advanced oxidation processes. Building on his doctoral work on nitrogen-doped carbon-based catalysts, he systematically investigates the roles of pyridinic and graphitic nitrogen sites in tuning the two-electron oxygen reduction reaction and enhancing reactive oxygen species production for organic contaminant degradation.

Abstract
This study presents a sustainable metal-free electro-Fenton system employing nitrogen-doped reduced graphene oxide (rGO) as an efficient cathode material for organic pollutant removal in semiconductor wastewater reuse. The research aims to overcome the inherent limitations of conventional Fenton reaction based advanced oxidation processes, which suffer from excessive sludge generation, metal ion leaching, and high operational costs. Nitrogen-doped rGO was synthesized via solvothermal reduction of graphene oxide using N,N-dimethylformamide (DMF), followed by thermal nitrogen doping with dicyandiamide, resulting in the formation of pyridinic-, pyrrolic-, and graphitic-N functional groups within the graphene lattice. Optimizing the thermal treatment at 500°C enhanced the ratio of pyridinic- to graphitic-N species, achieving a 95.8% selectivity for the two-electron oxygen reduction reaction

(ORR) toward hydrogen peroxide (H_2O_2) generation. Electrochemical characterization revealed that pyridinic-N functioned as the primary active site for selective H_2O_2 formation, while graphitic-N contributed to electron transfer and overall conductivity, ensuring efficient charge transport during the reaction.
This improved structural stability enhanced the catalyst's performance in oxygen reduction and ion transport. The degradation of Reactive Red 141 achieved 57% removal efficiency under optimized conditions (pH 3, 160 mA, 25°C), following pseudo-first-order kinetics mediated by multiple reactive oxygen species (hydroxyl radicals, superoxide radicals, and singlet oxygen). When applied to real semiconductor wastewater, the nitrogen-doped rGO-based system achieved 31% total organic carbon (TOC) removal while generating 6-10 times less sludge than conventional iron-based Fenton treatment. This drastic reduction in sludge formation minimizes secondary contamination and mitigates membrane fouling in downstream filtration systems, ultimately lowering long-term operational and maintenance costs.
Although the cathode exhibited gradual performance decline over multiple cycles (from 63 % in the first run to 7 % after five cycles) due to organic adsorption and surface passivation, the system maintained high H_2O_2 selectivity and structural stability. These findings demonstrate the feasibility of using nitrogen-functionalized graphene materials as metal-free cathode in advanced oxidation processes. The developed nitrogen-doped rGO-based electro-Fenton process offers an environmentally compatible and economically viable pathway for replacing conventional metal-based AOP in semiconductor wastewater reuse, contributing to sustainable water resource management and reduced environmental footprint in industrial oxidation processes.

#8 Comparative Evaluation of Commercial Nanofiltration Membranes for Selective Ion Fractionation in SWRO Brine

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Brief bio of speaker
Hae Kang Cho is a M.S student at Myongji University, Republic of Korea. He researches evaluating the separation performance of nanofiltration (NF) membranes for monovalent and divalent ions in SWRO concentrate. His research proposal aims to develop processes for the selective recovery of valuable ions from concentrated streams, particularly from seawater and semiconductor wastewater.

Abstract
Seawater reverse osmosis (SWRO) desalination generates a highly concentrated brine stream containing elevated levels of sodium (Na^+), chloride (Cl^-), magnesium (Mg^{2+}), calcium (Ca^{2+}), and sulfate (SO_4^{2-}), which limits further recovery and increases environmental discharge concerns. To enhance overall system recovery and enable selective ion management, nanofiltration (NF) was investigated as a post-treatment process for SWRO concentrate fraction. This study aimed to comparatively evaluate the ion separation performance of commercial NF membranes under controlled SWRO concentrate conditions. Fifteen commercially available NF membranes were assessed under identical operating parameters. Experiments were conducted using on-site collected seawater and prepared synthetic solutions, with SWRO concentrate produced using an SWRO unit at approximately 50% recovery. Membrane performance was analyzed in terms of permeate flux behavior, individual ion rejection, and average divalent ion removal efficiency. Ion concentrations in feed and permeate streams were quantified using ion chromatography (IC) and inductively coupled plasma (ICP) analysis. The evaluated membranes exhibited distinct separation characteristics. Several membranes demonstrated preferential rejection of divalent ions, particularly SO_4^{2-} and Mg^{2+}, achieving removal efficiencies of up to approximately 70%, while allowing relatively higher passage of monovalent ions. Divalent selectivity was maintained under SWRO concentrate conditions corresponding to ~50% recovery. Comparative analysis enabled the identification of membranes combining stable flux performance with enhanced divalent ion selectivity.
These results demonstrated the technical feasibility of integrating commercial NF membranes into high-recovery desalination systems for selective ion fractionation. This study provides a foundational framework for **selective ion fractionation**, suggesting that optimized NF configurations can significantly enhance resource circularity and process efficiency in high-recovery desalination systems.

#9 Fabrication of Polyketone Electrospun Nanofiber Membranes for the Removal of Metal Oxides in Drinking Water Treatment

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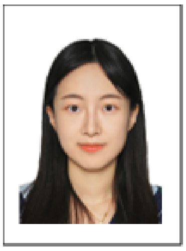
Brief bio of speaker
Hyeonjoo Lee is a M.S. student at Myongji University, Republic of Korea. My research filed is a fabrication of ion exchange membrane using electrospinning technique.

Abstract
Metal oxide particles such as manganese oxides (MnO_2) and iron oxides (FeO_2) are generated during drinking water treatment processes, which can increase turbidity in water and cause membrane fouling and reduced efficiency in downstream filtration processes. Various separation technologies have been applied to remove these fine particles; however, conventional filtration materials still show limitations in terms of selectivity and structural stability. In this context, electrospun nanofiber membranes, which can form a high specific surface area, high porosity, and interconnected pore structures, are attracting attention as next-generation filtration materials.
In this study, electrospun polyketone nanofiber membranes were fabricated and their characteristics were evaluated for the removal of metal oxide particles generated in drinking water treatment processes. Polyketone is known as a polymer with excellent chemical stability and mechanical strength and is easily functionalized, indicating high applicability as a membrane material. Accordingly, polyketone was dissolved in an appropriate solvent, and nanofiber-structured membranes were fabricated through an electrospinning process. The physicochemical properties of the fabricated membranes were then analyzed.
Fourier transform infrared spectroscopy (FTIR) analysis was performed to identify the chemical structure and functional groups of the membranes, and contact angle measurements were conducted to evaluate surface hydrophilicity. In addition, porosity analysis and permeability tests were carried out to evaluate the pore characteristics and filtration-related properties of the membranes.
This study aimed to analyze the structural and surface properties of polyketone electrospun nanofiber membranes and to evaluate their applicability as membrane materials for the removal of metal oxide particles in drinking water treatment processes.

Acknowledgement: This work was supported by Korea Environment Industry & Technology Institute(KEITI) through Digital Desalination and Brine Resource Recovery Technology Development Project, funded by Korea Ministry of Environment(MOE) (grant number : RS-2025-02032971)

#11 Bioaugmentation Strategies for Mitigating Nitrite Accumulation in Urine Nitrification Systems



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Brief bio of speaker
Lu Fu joined the NiCE Hub as a PhD candidate in 2024 and is currently pursuing her PhD at the University of Queensland (UQ), under the supervision of Prof. Liu Ye. Prior to commencing her PhD, she obtained an MSc degree in Environmental Engineering from Chongqing University, China. Her research interests primarily focus on GHG mitigation and nutrient recovery within the wastewater sector, with an emphasis on improving the environmental sustainability of biological wastewater treatment processes. Her PhD research investigates the mechanisms of nitrous oxide (N_2O) emissions in high-strength wastewater treatment systems and explores strategies to mitigate these emissions.

Abstract
Sustainable nutrient management is pivotal for reducing the carbon footprint of wastewater systems, yet the interactions between operational strategies, microbial processes, and greenhouse gas (GHG) emissions remains insufficiently understood. This work presents insights from both controlled laboratory experiments and full-scale wastewater treatment plant investigations, focusing on high-strength wastewater treatment processes.
At the laboratory scale, we investigated urine nitrification as a promising strategy for decentralized nitrogen recovery. Source-separated urine represents a typical high-strength wastewater rich in nitrogen and offers significant potential for resource recovery as fertilizers. However, conventional urine nitrification is often hindered by pH decline during

the process, which suppresses nitrite-oxidizing bacteria (NOB) and leads to nitrite accumulation. Elevated nitrite concentrations can destabilize the system and increase the risk of nitrous oxide (N_2O) generation, a potent GHG. To overcome this limitation, acid-tolerant NOB were cultivated and introduced into low-pH urine nitrification systems. These adapted organisms demonstrated the ability to sustain nitrification under acidic conditions, minimizing nitrite accumulation and improving process stability.
Complementing the laboratory studies, full-scale investigations were conducted at the Luggage Point wastewater treatment plant in Queensland, Australia, where a sidestream partial nitritation/anammox (PN/A) process is employed to treat high-strength anaerobic digestion (AD) liquor. Through the evaluation of energy recovery and direct GHG emissions, mechanistic modelling was applied to develop integrated mitigation strategies for reducing N_2O emissions. Together, these studies illustrate the multifaceted nature of sustainable nutrient management and highlights opportunities for integrated solutions that not only meet regulatory and resource recovery goals but also contribute to climate change mitigation.

#12 Time-Resolved Carbon Transformation and Nutrient Assimilation During Phototrophic Treatment of Fuel Synthesis Wastewater Using Purple Non-Sulfur Bacteria

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Brief bio of speaker

Dr. Sultan Shaikh is an environmental biotechnologist specializing in wastewater valorisation, microbial resource recovery, and sustainable bioprocess engineering. He is currently a Postdoctoral Researcher at Hamad Bin Khalifa University (HBKU), Qatar, where he develops scalable microbial systems for converting industrial wastewater into valuable bioproducts such as single-cell protein and bioplastics using purple non-sulfur bacteria (PNSB). His research integrates environmental biotechnology, photobioreactor design, and circular bioeconomy strategies. Dr. Shaikh completed his PhD in Sustainable Environment at HBKU in 2023, focusing on biofilm photobioreactors for treating fuel-synthesis wastewater and recovering microbial bioproducts. He subsequently conducted postdoctoral research at Texas A&M University at Qatar, working on advanced microfluidic systems and volumetric imaging techniques to study pore-scale environmental processes. His research portfolio includes more than 10 peer-reviewed publications, with several first-author articles in leading journals such as Journal of Chemical Technology & Biotechnology, Biochemical Engineering Journal, and Biotechnology Reports. His work has contributed to multiple research projects funded by the Qatar National Research Fund, focusing on sustainable wastewater treatment, microbial protein production, and circular bioeconomy technologies. Beyond research, Dr. Shaikh is the Founder and CEO of Tekgen Technical Institute, which provides professional training in sustainability and environmental management. He actively engages in academic mentoring, serves as a peer reviewer for international journals, and participates in professional organizations related to environmental engineering and sustainability. His current research aims to advance microbial biotechnologies for circular water systems and sustainable production of alternative proteins from industrial waste streams, contributing to global efforts in environmental sustainability and resource recovery.

Abstract

Introduction: Fuel synthesis wastewater (FSW) generated during industrial fuel processing contains high concentrations of volatile fatty acids (VFAs) and biodegradable organic compounds that represent both a pollution challenge and a potential carbon resource. Purple non-sulfur bacteria (PNSB) offer a promising approach for phototrophic wastewater treatment and resource recovery through their unique anoxygenic photosynthesis capabilities, enabling simultaneous organic removal and biomass production (Shaikh et al., 2023).

Objectives: This study aimed to: (1) evaluate the performance of mixed-culture PNSB systems for treating VFA-rich fuel synthesis wastewater under phototrophic conditions, (2) interpret time-resolved transformation pathways of organic intermediates during treatment, (3) quantify removal efficiencies for organic carbon and nitrogen, and (4) characterize carbon fate through tracking of VFA consumption, biomass accumulation, and inorganic carbon generation.

Methodology: The untreated FSW exhibited high organic strength with COD of 3910 ± 2.8 mg/L and NPOC of 1029 ± 12 mg/L. VFAs dominated the organic fraction: acetate (394 ± 2.4 mg/L), formate (333

± 0.9 mg/L), and propionate (54 ± 0.1 mg/L), while total nitrogen was low (3.17 ± 0.28 mg/L), indicating carbon-rich, nitrogen-limited conditions. Wastewater was supplemented with ATCC 2728 medium nutrients including KH_2PO_4 (3.03 g/L), NH_4Cl (3.03 g/L), $NaHCO_3$ (4.29 g/L), trace minerals and vitamins (10 mL/L each). A mixed PNSB culture enriched from coastal seawater and freshwater pond samples served as inoculum. Batch cultivation was conducted for 18 days in a 2 L photobioreactor (1.6 L working volume) illuminated by 200 W white LED with red filter (1380 lux) at 20°C with continuous mixing. Growth was monitored via optical density at 420 nm. COD, VFAs, anions, total nitrogen, inorganic carbon, and NPOC were measured using standard methods in duplicate.

Results and Discussion: COD decreased from 3418 ± 110 mg/L to 1248 ± 17 mg/L (63.5% removal) and NPOC declined from 888 mg/L to 283 mg/L (68% removal), demonstrating effective organic carbon removal. Optical density increased from 0.1 to 2.35 by day 12, indicating rapid microbial proliferation followed by culture stabilization. Formate reached non-detectable levels by day 15 while acetate, propionate, butyrate, and valerate were completely consumed during early cultivation, confirming VFAs as primary carbon and electron donors for phototrophic metabolism. Total nitrogen decreased from 87 mg/L to below 3 mg/L (97% removal), indicating strong nitrogen assimilation into microbial biomass. Notably, inorganic carbon increased from 340 mg/L to over 450 mg/L (32% increase) and carbonate concentrations nearly doubled. This concurrent increase in inorganic carbon alongside organic carbon removal reveals a dual carbon transformation pathway: biomass synthesis and partial mineralization to bicarbonate/carbonate. This finding has important implications for carbon accounting in PNSB systems and suggests opportunities for coupled CO_2 capture or alkalinity generation in industrial wastewater treatment applications.

Conclusion and Future Directions: This study demonstrates that mixed-culture PNSB systems can effectively treat VFA-rich FSW, achieving substantial organic carbon removal, near-complete nitrogen assimilation, and revealing critical carbon transformation mechanisms. Future research should focus on biomass characterization, process optimization, and techno-economic assessment for industrial-scale implementation.

References: Shaikh, S., Rashid, N., Onwusogh, U., McKay, G., Mackey, H.R., 2023. Effect of nutrients deficiency on biofilm formation and single cell protein production with a purple non-sulphur bacteria enriched culture. Biofilms 5, 1–8.

#15 Valuing sand for mineral circularity: A review of valuation frameworks as critical enabler for the transition toward sustainable materials

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Brief bio of speaker

Madhu Ardhanari is a joint PhD candidate at the Global Centre for Mineral Security and the Camborne School of Mines (University of Exeter). Her research focuses on scaling ore-sand sustainably and systemically towards a low-carbon future. Ore-sand is a mineral co-/by-product that encourages total resource use from mining value chains, with the potential to reduce burden on natural sand sources such as oceans and rivers. Sand (and aggregates) are the world's most extracted solid material. Her research interests include rethinking resource extractivism, labour rights and ecosystem conservation as part of achieving a just transition.

A sustainability and futures practitioner, Madhu has over a decade of experience coaching businesses and facilitating multi-stakeholder collaborations towards systemic leadership in the face of climate breakdown and social inequalities. She has extensive work experience in areas such as sustainable value chains and livelihoods, and radical decarbonisation.

Madhu is also a Next Generation Foresight Practitioners Fellow and a Senior Atlantic Fellow for Social and Economic Equity. Her Masters dissertation on land reclamation, sand use and resource inequalities in Southeast Asia won the 2021 LSE Saw Swee Hock Southeast Asia Centre UK Postgraduate Dissertation Prize.

Abstract

Total resource recovery and mineral coproduction is a potential goal in mining circularity, where all minerals recovered are responsibly utilised, and no mineral is regarded as 'waste' - thereby minimising unnecessary extraction. Valuation is a key instrument for designing towards mineral coproduction and care, as the way minerals are valued determines the economic and social feasibility of upscaling coproduction in mining projects.

This paper focuses on the valuation shifts needed to transition away from natural sand extraction towards ore-sand, a more resource efficient circular economy alternative. Abundant and cheap to produce, sand, along with aggregates,

is the second most exploited material globally, and its irresponsible extraction has resulted in profound environmental and social destruction. In parallel, more mining projects are being commissioned to meet material needs for a renewable energy transition and urban infrastructure expansion. Only a small fraction of the material excavated is considered 'valuable' ore, with the large majority being classified as waste. The currently unused bulk material fraction can be processed into human-made sand (ore-sand), a companion product to metallic ore minerals and an alternative to primary sand extraction. If produced responsibly at scale, ore-sand could drastically reduce mine waste and minimise the socio-environmental impacts of natural sand extraction. The paper's aim is to understand how value and valuation frameworks can be designed to influence real decision-making towards implementing ore-sand at the firm, value chain and societal levels. We investigate the mismatch between commercial and public valuations of sand, affecting ore-sand uptake. How can the full value of ore-sand be understood and communicated in shifting the cost-benefit analysis of mining projects to improve the uptake of ore-sand as a substitute for natural sand?
The paper employs a hybrid methodology of expert opinion, supplemented by systematic reviews across the Scopus and Web of Science platforms to understand patterns and trends in valuation frameworks spanning firm, value chain and societal contexts used to ascribe value to mineral resources.
Our findings highlight a mismatch between how companies and societies value mineral resources. Furthermore, the role of minerals within a just operating space (i.e. within ecological limits while meeting societal needs) is not well represented in existing valuation frameworks. We propose a synthesised valuation approach that reconciles these challenges. Applying this framework to ore-sand, we aim to explore how valuation processes can be redesigned to inform decision making to catalyse the transition from natural sand to ore-sand at scale. This work contributes to developing a shared understanding of sand as a valuable resource within the context of mineral circularity and offers a potential approach to operationalise this both within individual firms and in policymaking at the societal level.

#16 Thermoeconomic Performance and Renewability Assessment of a Corn Stover Biorefinery Producing PLA, Succinic Acid, Xylitol, Adhesive, and Electricity

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Brief bio of speaker

Reza Hessampour is a PhD candidate in the School of Mechanical, Medical and Process Engineering at Queensland University of Technology (QUT), Australia. His doctoral research focuses on the optimization of bioresources, technologies, and market pathways for bioplastics, with a particular emphasis on the integrated design and sustainability assessment of advanced biorefinery systems for polylactic acid (PLA) and other value-added bio-based products.

His research sits at the intersection of circular bioeconomy, process systems engineering, and sustainability science, encompassing life cycle assessment, techno-economic analysis, exergy and exergoeconomic evaluation, and broader environmental systems modelling. Prior to commencing his PhD, he completed both MSc and BSc degrees in Biosystem Engineering in Iran, where he developed a strong foundation in agricultural systems analysis, machinery modelling, and sustainability evaluation.

Reza has authored and co-authored scholarly publications spanning bioplastics, agricultural production systems, life cycle assessment, exergy, environmental performance, and resource-efficiency analysis, with work published in journals including *Science of the Total Environment*, *Information Processing in Agriculture*, *Agronomy*, and the *Journal of the Saudi Society of Agricultural Sciences*. He is also advancing several research outputs on integrated multi-product biorefineries and sustainability assessment frameworks for next-generation bio-based materials.

Beyond his research, he has contributed as a journal reviewer and has engaged in international academic collaborations across Australia, Malaysia, Italy, Poland, Turkey, and the Czech Republic. His work is driven by a commitment to developing rigorous, systems-oriented solutions that support the transition to low-carbon materials, resource-efficient industrial processes, and a more sustainable circular economy.

Abstract

This study applies an integrated exergy and exergoeconomic framework to assess thermodynamic performance and cost-formation mechanisms in a corn stover biorefinery co-producing polylactic acid (PLA), succinic acid, xylitol, lignin-based adhesive, and electricity. Four process scenarios were simulated in Aspen Plus and Excel and evaluated through system-level and unit-operation diagnostics. Universal exergy efficiencies range from 44.46-64.17%, while

functional exergy efficiencies span 26.90-47.75%, demonstrating strong sensitivity to co-product selection and downstream separation intensity. Scenarios incorporating adhesive production exhibit the highest universal efficiency (up to 64.17%), whereas electricity-integrated scenarioss show lower performance due to combustion-driven losses. Normalized exergy destruction further differentiates pathways, with the adhesive-succinic acid configuration achieving the lowest value (0.56 GJ/GJ product) and the xylitol-electricity scenarios the highest (1.25 GJ/GJ product). Exergy destruction is dominated by separation-intensive processes, notably enzymatic hydrolysis (8.06 GJ/FU), lactic-acid purification (4.87 GJ/FU), electricity generation (11.78 GJ/FU), and the relevant co-product recovery steps, succinic acid fermentation and purification (15.53 GJ/FU) or xylitol fermentation (10.45 GJ/FU). Exergoeconomic analysis shows that cost escalation is driven primarily by purification units, with SA purification (642.60 USD/GJ) and xylitol purification (958.86 USD/GJ) emerging as major cost hotspots. Adhesive upgrading shifts cost formation toward investment-dominated behavior, particularly in AD activation and methylation. Overall, the results highlight that co-product strategy and separation intensity govern both thermodynamic and economic performance. Key improvement opportunities include reducing utility demand in purification steps, enhancing heat integration, and optimising capital-intensive adhesive operations.

#19 Circular Economy and Net-Zero Emissions: Carbon Capture and Utilization Using Waste Calcium Silicate Boards

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Brief bio of speaker
Latest biography (Limit 300 words).
Assistant Professor, Cheng-Han Lee, is from the Department of Resources Engineering and the Center for Resilience and Intelligence on Sustainable Energy Research (RiSER), National Cheng Kung University. He obtained his Ph.D. from National Cheng Kung University in January 2024 and started serving as an Assistant Professor in August 2024. His research field primarily focuses on the development of Resource Circulation, Circular Economy, Extractive Metallurgy, Green Innovation, and Net-Zero Emissions techniques using waste. In addition to elements recycling from waste, high-value techniques are used to directly convert waste into usable materials, achieving the goal of resource reutilization. The elements separated and recycled from waste can also be applied to various industries through high-value techniques, enhancing the economic efficiency of resource circulation. Carbon capture and utilization (Net-Zero Emissions technique) is implemented directly from waste or using elements/materials recycled from waste. This will enhance the value of each element/material to the application while directly contributing to Net-Zero Emissions.
https://scholar.google.com/citations?user=Dsu_BpwAAAAJ&hl=zh-TW&oi=sra
https://www.researchgate.net/profile/Cheng-Han-Lee-3

Abstract
Driven by the continuous rise in atmospheric CO_2 concentrations, which intensifies the greenhouse effect and climate change, many countries have committed under the Paris Agreement to reduce greenhouse gas emissions by 45% by 2030 and to achieve Net-Zero Emissions by 2050. To meet these targets, substantial research has been devoted to developing carbon capture, utilization, and storage (CCUS) technologies. Among these, carbon capture and utilization through alkaline waste materials has attracted increasing attention because it can convert CO_2 into carbonate products. This research investigates the use of waste calcium silicate board, a construction and demolition waste, for mineral carbonation, thereby creating additional recycling pathways for the approximately 17,000 metric tons of waste calcium silicate board generated annually in Taiwan. The experimental work consists of two main parts. The first involves high-temperature solid-gas mineral carbonation of waste calcium silicate board. Under optimal reaction temperature, reaction time, and CO_2 flow rate, the process aims to maximize CO_2 capture while producing high-purity $CaCO_3$ and SiO_2. Because high-temperature solid–gas mineral carbonation may involve excessive energy consumption, the second part of the project focuses on indirect carbonation. In this approach, waste calcium silicate board is first leached with various organic and inorganic acids to dissolve calcium ions into the leaching solution and separate them from silica. CO_2 is then introduced into the leachate, and $CaCO_3$ is subsequently precipitated by adjusting the experimental parameters. Given the wide range of industrial applications of both $CaCO_3$ and SiO_2, comprehensive product characterization was also conducted to evaluate the potential industrial uses of the carbonation products, thereby integrating circular economy principles with net-zero carbon strategies. The experimental results show that, during high-temperature solid–gas mineral carbonation, each gram of calcium silicate board can capture approximately 0.3 g of CO_2, while the purities of the resulting $CaCO_3$ and SiO_2 both exceed 99%.

In the indirect carbonation process, hydrochloric acid and formic acid were identified as the most effective leaching agents. In addition, a multistage CO_2 capture process further enhanced both CO_2 capture and $CaCO_3$ precipitation. As no previous study has explored CCU technologies for waste calcium silicate board, this project helps clarify the reaction mechanisms and the effects of key parameters in its mineral carbonation process. It also provides a basis for promoting suitable CCU applications for construction waste in the future, thereby reducing CO_2 emissions and improving economic value.

#20 When Do Electric Vehicles Really Reduce Emissions?

Ling L

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Brief bio of speaker

Ling Li is a PhD student pursuing Economics at the University of Auckland in New Zealand. She is an economist of energy, climate policy, and sustainability transitions, and is specifically interested in interactions between transport electrification and electricity system decarbonization. Her work at present is the study of the joint effect of the adoption of electric vehicles and the proportion of renewable energy on electricity-associated CO2 emissions, which applies dynamic panel and threshold model methods to determine the circumstances in which electrification is most effective to help reduce emissions. Her research generally focuses on the dynamics of energy transition, integration of renewable energy, and the policy framework that is required to facilitate low-carbon growth.

Abstract

The decarbonization of transportation requires electric vehicles (EVs) to reach global carbon neutrality targets. EVs offer climate benefits through their power from electricity, yet these benefits directly relate to the amount of carbon in the energy supply. EV expansion produces minimal emission reduction effects when power grids rely on fossil fuel-based power generation. Introducing RE technologies into power networks enhances EVs' prospects to reduce their emissions. Despite general promotion efforts, only limited academic research exists regarding the systematic analysis of how EVs and renewable electricity generation strategies interact and create nonlinear effects in the market. This study investigates how changes in renewable energy sources affect electricity-sector CO_2 emissions from EV adoption in 30 Chinese provinces during 2017-2021. The study uses fixed effects (FE), dynamic system GMM, and dynamic panel threshold regression models to understand direct effects and conditional effects while studying adjusted electricity-based CO_2 emissions.The adoption of EVs demonstrates a positive relationship with electricity emissions, whereas using renewable energy has negative associations. Statistics show that the coefficients become insignificant when using static modeling approaches. Dynamic Generalized Method of Moment analysis establishes that adopting EVs increases pollution emissions, yet renewable energy reduces emissions. Threshold regression shows how EV adoption diminishes electricity-based CO_2 emissions only beyond the national renewable energy ratio is greater than 44% on average. These experimental results support the synergy hypothesis by proving that electric vehicle decarbonization depends on electrical grid composition. The study shows that clean mobility initiatives support renewable energy transitions because these two transitions work together as complementary solutions. Effective policy development requires coordinated efforts between EV deployment and renewable energy systems.

#21 Preparation of Green Biomass-based Lithium Ion-Imprinted Polymers (Green Li-IIPs) and Highly Selective Adsorption Application in Desalination Brine

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Brief bio of speaker

Yi-An Wei is currently pursuing a Master's degree in the Department of Resources Engineering at National Cheng Kung University (NCKU), Taiwan, where she also received her Bachelor's degree. Her research expertise primarily focuses on hydrometallurgy, resource regeneration from spent batteries, and the sustainable utilization of industrial byproducts, including the preparation of non-fired, permeable bricks from textile waste. Dedicated to advancing circular economy technologies and green chemistry, Yi-An Wei is currently developing green biomass-based ion-imprinted polymers for lithium extraction from desalination brine. Recently, she published a significant study under the guidance of her advisor, Cheng-Han Lee, on the regeneration of critical metals from spent sodium-ion batteries in the *Journal of Industrial and Engineering Chemistry* (Q1, IF 6.0) in October 2025.

Abstract

With the rapid growth of the global energy transition and the electric-vehicle industry, lithium has become a critical strategic resource. Conventional lithium supply largely relies on extraction from salt lakes and ores. However, these resources are geographically concentrated, require long development timelines, and may impose substantial environmental burdens. Accordingly, developing alternative lithium sources and improving recovery efficiency are increasingly important. Meanwhile, seawater desalination generates high-salinity brine. If discharged directly back into the marine environment, this brine can exert ecological stress and pose potential pollution risks due to salinity and temperature gradients, as well as residual treatment chemicals or trace metal ions. Therefore, desalination brine should not be regarded merely as a waste stream requiring disposal, but rather as a resource stream with potential for beneficial utilization. Existing mainstream Li separation technologies from desalination brine, such as ion-exchange resins, membrane separation, and solvent extraction, while somewhat effective, are severely limited by poor ion selectivity, membrane fouling, high energy consumption, and third-phase emulsions. In contrast, ion-imprinted polymers (IIPs) feature an exclusive "lock-and-key effect," significantly enhancing the specific selectivity for target ions. Nevertheless, the synthesis of traditional IIPs heavily relies on highly toxic chemicals, including methacrylic acid (MAA), ethylene glycol dimethacrylate (EGDMA), diphenylcarbazide (DPC), 2,2'-Azobis(2-methylpropionitrile) (AIBN), and volatile organic solvents (VOCs). These substances not only cause severe secondary environmental pollution but also drastically limit their potential for industrialization. To overcome the environmental constraints of traditional toxic IIPs, this study aims to develop a completely non-toxic, highly sustainable novel lithium-ion-imprinted polymer (Green Li-IIPs). The natural marine biomass polymer chitosan is used as the functional monomer, with citric acid serving as both the cross-linker and ligand, and lithium chloride (LiCl) as the template ion. The fabrication process is carried out without chemical initiators or toxic solvents, and a stable three-dimensional polymeric network is constructed via direct physical thermal cross-linking at 120 ℃ for 2 hours. Experimental results now indicate that the novel biomass-based Li-IIPs maintain excellent physical morphology and structural stability under adsorption and acid desorption, with no dissolution or disintegration observed. The expected adsorption and desorption efficiencies for lithium ions in desalination brine can reach above 80% and 90%, respectively, with high ion selectivity. This study not only develops a novel Li-IIP but also transforms pollution burdens into resource value by mitigating the environmental impacts associated with brine discharge. In addition, it can reduce reliance on conventional lithium mining at the supply-chain level, thereby enhancing the diversity and security of lithium sources. Overall, integrating lithium recovery from desalination brine with desalination systems can simultaneously achieve pollution reduction, resource circularity, and the sustainable supply of critical materials, underscoring its clear environmental and strategic significance.

#23 Development of a Buffer-free Alkali-producing Bioelectrochemical System for Mitigating Coastal Acidification

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Brief bio of speaker
Water-Energy Nexus / Waste to Resources

Abstract
Coastal regions worldwide are increasingly threatened by the combined pressures of wastewater discharges and progressive ocean acidification. Livestock operations located near estuaries and shorelines generate effluents rich in organic matter, ammonium, and dissolved salts. When released into receiving waters, these effluents not only drive eutrophication and oxygen depletion but may also exacerbate local acidification hotspots by reducing alkalinity

buffering capacity. As global atmospheric CO2 concentrations continue to rise, the ocean absorbs more CO2, leading to the formation of carbonic acid and long-term declines in seawater pH. Consequently, there is an urgent need for decentralized technologies that both treat saline effluents and restore alkalinity to support coastal water resilience.

Microbial electrochemical systems (MES) represent a promising nature-based engineering strategy for resource recovery. However, conventional MES configurations rely heavily on phosphate buffer solutions (PBS) to counteract anode acidification, limiting real-world deployment. Moreover, cathodic OH^- production in MES typically proceeds slowly under high ionic-strength conditions. To overcome these limitations, this study develops a salt-tolerant, PBS-free alkalinity-producing bioelectrochemical system (APBES) capable of simultaneously removing pollutants from synthetic livestock effluent and generating alkalinity that may support coastal acid-neutralizing capacity. The system consists of an anode chamber fed with synthetic livestock effluent and a cathode chamber containing NaCl solutions of varying salinity (1%, 2.5%, and 5%). These chambers are separated by a cation exchange membrane to facilitate selective ion transport. Five electrochemical conditions were examined: open circuit (with and without aeration), a 10-Ω external resistor, and controlled potentials of +0.3 V and +0.6 V. Measurements of pH, electrical conductivity (EC), temperature, and current were taken at 0, 12, 24, and 48 h under triplicate trials.

Preliminary results reveal three key findings. First, even without PBS supplementation, the APBES maintained stable or slightly increasing anode pH, contradicting the typical acidification observed in conventional MES. This suggests that Na^+ migration from the cathode helped offset proton accumulation, providing indirect support for the proposed Na^+-driven electro-neutrality mechanism. Second, cathodic alkalinity generation was strongly enhanced by salinity, with 5% NaCl achieving the highest OH^- production due to reduced internal resistance and improved ionic conductivity. Under a 10-Ω external load, the cathode exhibited the fastest pH rise among all electrochemical modes, indicating efficient electron utilization and favorable ion transport. Third, although applied potentials (+0.3 V and +0.6 V) did not significantly change final pH at 48 h, they markedly accelerated early-stage OH^- formation, which is critical for designing rapid-startup systems intended for real wastewater treatment. These outcomes highlight the feasibility of a buffer-free alkalinity platform that can generate substantial alkalinity directly from saline livestock effluents. Such alkalinity could, in principle, be used to compensate for localized acidification and enhance carbonate system buffering. By transforming a pollution source into an alkalinity resource, the APBES aligns with global efforts to strengthen nearshore ecosystem resilience under accelerating ocean acidification.

#24 Adaptive Reuse: a key circular design strategy for urban regeneration

Valentina Petrone

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Brief bio of speaker

Valentina Petrone is a circular economy expert and sustainability educator. With a background in architecture and extensive experience in the design and construction industry across different parts of the world, Valentina has been instrumental in shaping policies and strategies that drive circular practices in urban development. Valentina has been awarded the title of Adjunct Associate Professor by the University of Sydney in recognition of her significant contributions to the circular economy in the built environment and her commitment to education. She is also a regular contributor to several industry leading conferences.

Abstract

The built environment presents a significant opportunity to shift from a linear approach to a circular economy, contributing to making urban areas more liveable, resilient and sustainable. Adaptive Reuse is one of the most critical design strategies for achieving circular economy outcomes in the built environment, promoting urban regeneration and community revitalisation. It involves uplifting and repurposing existing assets and infrastructure rather than demolishing them.

In this presentation, Valentina will share best practice projects from Australia and overseas to showcase the key benefits and practical insights on Adaptive Reuse, including:

Environmental and economic benefits, such as reduced use of raw materials and associated water and energy consumption, cost savings from materials reuse and avoided demolition waste, and conservation of embodied carbon
Cultural conservation and identity, achieved by preserving historical and heritage-listed buildings
Urban regeneration outcomes, including the transformation of unused assets into functional spaces, reducing urban sprawl, and promoting community participation and local employment growth

This presentation will encourage and challenge all stakeholders to rethink the way we value our existing assets and infrastructure, transform the way we design by advocating for adaptive reuse, and play our role in the broader transition towards a more circular and resilient economy.

#27 Mechanical recycling of polyhydroxyalkanoates via reactive extrusion with chain extenders

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Brief bio of speaker

Alia Gallet--Pandellé is a third-year PhD candidate in Chemical Engineering at The University of Queensland, in the ARC Training Centre for Bioplastics and Biocomposites. She completed a double degree master's program between the INSA Lyon (France) and Tohoku University Japan, with a focus on material science and engineering and environmental studies. During her master studies, she developed strong material characterisation skills to investigate structure-property relationships and conducted biodegradation experiments in a simulated industrial compost environment.

Her current research focuses on the development of sustainable and viable biodegradable products based on polyhydroxyalkanoates (PHAs). She investigates strategies to address current limitation to their commercial uptake, including enhancing mechanical properties through stretching, improving mechanical recyclability via reactive extrusion and evaluating the biodegradation behaviour of modified PHAs.

Abstract

Mechanical recycling is considered the most favourable end-of-life option for bioplastics, including biodegradable polyhydroxyalkanoates (PHAs), as it enables material recovery in a closed-loop process that supports circularity and reduces demand for virgin feedstock.
However, reprocessing of pure PHAs by extrusion leads to thermal degradation, resulting in significant molecular weight loss and deterioration in mechanical properties, which limits their practical recyclability.

This works explores strategies to extend the reprocessing lifetime of PHAs through reactive extrusion using chain extenders. Two representative materials, poly(3-hydroxybutyrate-*co*-3-hydroxyvalerate (PHBV, 1 mol% 3HV), and poly(3-hydroxybutyrate-*co*-4-hydroxybutyrate) (P3HB4HB, 15 mol% 4HB), were subjected to multiple reprocessing cycles (extrusion–griding–drying–re-extrusion). The recyclate was characterised after each cycle to: (i) assess the extent of thermal degradation through molecular weight, thermal and mechanical properties; (ii) quantify the functional end groups formed; and (iii) determine the number of reprocessing cycles before properties fell below a critical threshold.

Based on the nature and proportion of end groups formed during thermal degradation, suitable chain extenders are selected and incorporated from the second reprocessing cycle onwards. The effectiveness of this approach is evaluated by monitoring the evolution of molecular weight, thermal properties and mechanical performance across successive cycles.

The aim of this work is to demonstrate that reactive extrusion can mitigate thermal degradation and to increase the number of viable reprocessing cycles for PHAs. By improving the mechanical recyclability of these materials, this work is intended to support the commercial uptake of PHAs and their integration into circular material systems.

#28 Upscaling urine-to-fertiliser treatment systems

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Brief bio of speaker

Dr Veera Koskue obtained her doctorate in Environmental Engineering in Finland in 2022. She currently works as a Postdoctoral Research Fellow at the Department of Chemical Engineering at the University of Melbourne, Australia. Veera is experienced in resource recovery from various wastewater streams and the design and operation of different (bio)electrochemical systems. She currently focuses on scaling up and commercialising innovative ways to recycle nutrients from human urine into fertiliser products.

Abstract

Human urine is a concentrated waste stream that contains key nutrients used as fertilisers in agriculture, namely nitrogen, phosphorus and potassium at concentrations up to 8.6 g_N L^{-1}, 0.5 g_P L^{-1}, and 2.4 g_K L^{-1}, respectively [1]. At the same time, urine only contributes to ca. 1% of municipal wastewater volume [2]. Therefore, diverting urine from other wastewater at the source and treating it separately opens interesting opportunities for nutrient recycling.

However, untreated urine is still >95% water and contains harmful micropollutants, including pharmaceutical residues. It would therefore be unfeasible and unsafe to use untreated urine directly as fertiliser. Different electrochemical technologies that utilise ion-exchange membranes (IEMs), such as electrodialysis (ED) and bioelectroconcentration (BEC), have emerged as promising urine-to-fertiliser treatment technologies. The IEMs used in these systems allow the concentration of ionic ammonium nitrogen (NH_4^+), phosphate phosphorus (HPO_4^{2-}) and potassium (K^+) by up to 5-fold into a liquid fertiliser, while largely retaining micropollutants in the reject stream. Both ED and BEC have been demonstrated to be highly suitable for nutrient recovery from urine in laboratory scale, reaching nitrogen recovery efficiencies up to >80% [1,3].

Our current work is focusing on upscaling these two nutrient recovery technologies from laboratory scale – treating ca. 2 L of urine per day – to pilot scale, treating up to 100 L of urine per day. Partnered with Composting Toilet Systems (Victoria, Australia), we have access to and the capacity to treat thousands of litres of urine collected from music festivals into liquid fertiliser annually. Preliminary glasshouse cultivation tests with ryegrass indicate that urine-derived fertilisers obtain comparable performance with commercial alternatives despite the high concentrations of salts and ammonia. Work is also on-going to ensure the safety of the generated liquid fertiliser by comprehensively assessing the fate of a large suite of licit and illicit drugs and antibiotics in the nutrient recovery systems.

#29 Machine learning-guided discovery of deep eutectic solvents for lithium extraction

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Brief bio of speaker
Ghaiath Almustafa is a researcher and currently an HDR candidate at the University of Technology Sydney (UTS) working in the resource recovery group of Prof. Ho Kyong Shon, working is at the forefront of green solvent design and sustainable process engineering. His work focus is on the development and application of deep eutectic solvents (DESs) as environmentally benign alternatives to conventional organic solvents, with a particular emphasis on resource recovery and separation technologies.

After completing his MSc at Masdar Institute – Khalifa University, he worked as a research engineer at the centre of membranes and Advanced Water technologies on topics spanning the extraction of critical elements from aqueous systems, including boron and lithium, as well as the recycling of lithium-ion batteries. Later, he joined the R&D Centre at Dubai Electricity & Water authority (DEWA), upgrading his bench-scale experience to pilot- and industrial-scale water treatment systems.
Almustafa's research is characterized by a strong integration of experimental design and computational screening, enabling the rational selection of solvent systems for high-efficiency separations. Through this work, he aims to bridge fundamental chemistry with scalable engineering solutions, helping to redefine how materials are recovered and reused in a resource-constrained world.

Abstract
The accelerating global energy transition is driving unprecedented demand for lithium, the cornerstone of high-performance battery technologies underpinning the decarbonised economy. Meeting this demand requires separation processes that are simultaneously selective, scalable, and environmentally favourable, yet conventional organophosphorus and ionic-liquid extractants used in solvent extraction (SX) satisfy only a subset of these criteria. Although deep eutectic solvents (DES) offer a tunable, low-toxicity alternative, however, the combinatorial design space spanned by hydrogen-bond donor and acceptor pairings, mole-fraction compositions, and diluent choices is prohibitively large to navigate experimentally, motivating a surrogate-assisted approach.
Herein, we describe an integrated computational–experimental framework that couples COSMO-RS molecular descriptors with an optimised multilayer perceptron ensemble to accelerate DES discovery. The ensemble was trained on curated SX data from the literature, achieving coefficients of determination of $R^2 = 0.986$ on training and $R^2 = 0.949$ on held-out test data, and was subsequently recalibrated through semi-supervised incorporation of manually selected experimental runs targeting high-uncertainty regions of the design space.
Experimental validation under representative brine conditions confirmed the predicted performance envelope, and the recalibrated surrogate was subsequently used to guide the design of previously untested binary and ternary DES formulations, yielding up to threefold enhancement in Li^+/Mg^{2+} relative to benchmark systems. This computational approach reframes DES discovery for hydrometallurgical separations and provides a deployable design guide for academic and industrial practitioners to rationally develop environmentally favourable extractants, accelerating the translation of DES-based hydrometallurgy from bench-scale curiosity to a practical route for securing critical mineral supply.

#30 Techno-Economic Assessment of Mainstream Biogas Upgrading Technologies: Benchmarking for Next-Generation Biological Solutions

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Brief bio of speaker
Menglin(Elin) Xie is a PhD candidate in Environmental Engineering at the University of New South Wales (UNSW), where her research focuses on iron-based biotechnology for biogas upgrading — a novel, low-waste approach to renewable energy purification. Her PhD project employs an innovative, patented iron-based bioprocess where iron-reducing bacteria and aeration work in a closed loop to continuously remove CO_2 from biogas — enriching methane content without external chemicals, offering a promising low-waste, in-situ upgrading solution.
Elin holds an MSc in Environmental Sciences from ETH Zürich and a BEng in Environmental Engineering from the Harbin Institute of Technology. Her master's thesis and internship at Eawag (Swiss Federal Institute of Aquatic Science and Technology) investigated microbial functional groups in Aerobic Granular Sludge (AGS) formation. As an R&D Engineer at a private environmental firm in Guangdong, she developed AGS granulation strategies, analysed microbial community dynamics, and co-invented two filed patents — a modular electrocatalytic hydrolysis-acidification reactor and a high-density bioreactor for sewage treatment.
Her research interests span microbiology, carbon neutrality, net-zero strategies, and wastewater treatment technologies, reflecting a commitment to bridging environmental science with practical sustainability outcomes. Having studied and worked across China, Switzerland, and Australia, Elin brings a broad international perspective to her research in environmental engineering

Abstract
The Abstract should not exceed 500 words. Figures are not necessary. Upgrading raw biogas to pipeline-quality biomethane (greater than 95% CH_4) is a critical step in realising biogas's full potential within the circular bioenergy economy. Several physicochemical technologies have reached commercial maturity for this purpose, including High-

Pressure Water Scrubbing (HPWS), Amine Scrubbing (AS), Pressure Swing Adsorption (PSA), and Membrane Permeation (MP). While each is technically effective, their environmental footprints and economic profiles differ considerably, and they hardly emerge as universally optimal across all performance dimensions.

This study systematically reviews these four mainstream biogas upgrading technologies and conducts a comparative techno-economic analysis based on published process data and operational parameters. Key indicators assessed include capital expenditure, operating costs, energy consumption, CH_4 recovery efficiency, and methane losses, complemented by qualitative evaluation of environmental performance drawn from life cycle perspectives. The analysis reveals meaningful trade-offs across technologies. AS consistently delivers the strongest environmental profile, largely due to its minimal methane slip and lower electricity demand, though its dependence on thermal regeneration introduces substantial heat energy requirements and chemical management costs. HPWS remains the most widely deployed technology globally, offering straightforward operation and reasonable economics at scale, but its relatively high water consumption and methane losses present operational and environmental drawbacks. PSA avoids chemical inputs entirely yet requires energy-intensive pressure cycling and additional off-gas treatment to meet emission standards, adding operational complexity and cost. MP presents a mechanically simple and chemically clean solution, while demanding the highest compression energy input and is sensitive to trace contaminants in raw biogas. Across all technologies, scale plays a decisive role in economic viability: Larger plants consistently achieve lower specific costs and shorter payback periods, which presents a structural challenge for small and decentralised biogas installations. This techno-economic comparison highlights that while all mainstream technologies are commercially proven, each carries inherent limitations in either energy intensity, chemical consumption, or operational complexity that constrain their suitability across diverse deployment contexts.

These gaps point toward the need for fundamentally different upgrading strategies. An innovative iron-based biological process, in which iron-reducing bacteria drive CO_2 removal via ferrous carbonate precipitation within a self-regenerating iron cycle. This represents a promising biogas upgrading solution, by operating without external chemicals, pressurised scrubbing, or thermal regeneration. Such a process could address the key limitations of existing technologies identified in this review, offering a low-waste, energy-lean pathway to biomethane production with strong potential for decentralised and resource-constrained deployment.

#31 Impact of pH on microbial community dynamics and electrochemical performance in urine-fed bioelectroconcentration systems

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Brief bio of speaker

Vania Méndez earned a Bachelor's degree in Renewable Energy Engineering in Mexico in 2025 and is currently pursuing a Master of Philosophy (MPhil) at the University of Melbourne, Australia.

Her research centres on nutrient recovery from human urine through bioelectrochemical systems. Her interests include sustainability and waste valorisation, with a particular emphasis on transforming waste into valuable resources. She has prior experience in resource recovery and waste valorisation processes.

Abstract

Hydrolysed human urine is a highly concentrated stream containing most of the nitrogen, phosphorus, and potassium excreted by humans, despite accounting for only approximately 1% of domestic wastewater volume [1][2]. Bioelectrochemical systems (BES) offer a low-energy approach for nutrient recovery by coupling microbial activity with electrochemical processes [3]. Among these, bioelectroconcentration (BEC) enables the transport of ionic species such as ammonium across ion-exchange membranes to produce concentrated fertiliser streams [4].

In these systems, nitrogen recovery is governed by the ammonium/ammonia (NH_4^+/NH_3, pKa = 9.25) equilibrium, which is strongly influenced by pH and affects both nitrogen speciation and microbial activity [5][6]. Lower pH favours the protonated ammonium form (NH_4^+), which is more readily transported across membranes, enhancing nutrient recovery [7]. However, pH also plays a critical role in shaping microbial community structure and function, and deviations from optimal conditions may negatively affect microbial activity and electrochemical performance [8]. The high pH (~9) and strong buffering capacity of hydrolysed urine stabilise microbial activity, but simultaneously limit the ability to adjust pH to conditions that favour ammonium transport.

During bioanode operation, proton release contributes to pH dynamics, and previous studies have shown that bioanodes in bioelectrochemical systems (BES) typically operate at pH values above 8 [7]. To investigate whether lower pH would improve nitrogen recovery, this study first attempted to control the bioanode pH using the natural buffering capacity of hydrolysed urine by adjusting the hydraulic retention time (HRT) via intermittent feeding. This strategy, however, resulted in only temporary pH decreases. Over time, the system became unstable, with pH increasing and current generation declining.

To decouple the urine feeding rate from bioanode pH and thereby eliminate the effect of potential nutrient limitations on bioanode performance, the anode pH was controlled by adjusting the acid

dosage. The anode pH of two reactors was gradually decreased from 8.2 to 7.5 and held at 7.5 for two months, while a control reactor was maintained at pH 8.2. Changes in microbial community composition and current generation were monitored to examine their relationship and understand their impact on nitrogen recovery from human urine.

#32 Circular material flows in water sector

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Brief bio of speaker

Strategy & Sustainability Senior Advisor - Circular Economy and Resource Recovery, Sydney Water

Her expertise is in system thinking, productivity, energy efficiency, Net Zero carbon emissions and Circular Economy. Glenda has extensive experience creating shared value solutions in the private sector and now in the public sector, specifically local government, OEH/DPIE/NSW Treasury OECC and Sydney Water. At NSW Office of Energy and Climate Change, she scoped and led the design of the national Vehicle Emissions Star Rating and NSW Vehicle Emission offset scheme. She is leading the development and implementation of Sydney Water's Circular Economy strategic plan.

Abstract

Circular Economy is an accepted framework however there remains lack of understanding of our current circular position at an organisational level and ability to identify opportunities to improve our performance. The water industry is one of the most circular sectors, as custodians of water, materials, and energy. Sydney Water is Australia's largest water utility, supplying water, wastewater, and stormwater services to over 5.4 million people across Sydney, the Illawarra, and the Blue Mountains. There have been 3 ISO standards released related to Circular Economy: ISO 59000 Series. These support organisation in implementing a transition towards a circular economy.

Newly released ISO 59020:2024 Measuring and assessing circularity performance has been applied to our current dataset of material flow to create circularity performance analysis and system maps. For the first time, it brings together our performance covering water, solids and nutrients, electricity and carbon, chemicals, oil and grease across our network of operation. This work summarises the major resource flows through our operations to quantify and spatially understand where our resources are being consumed and disposed of, to allow us to estimate our current level of circularity – ie how we contribute to the circular economy. This will help educate people on where our resources flow, enabling us to set future targets and programs for our circular economy. This paper explores this material flow, and context for our current performance. It also examines the application of ISO standards in transitioning toward a circular economy in terms of engagement and decision making.

#33 Blending Biosolids with Garden Organics: A Pathway to Safer Biochar for Land Application

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Brief bio of speaker

Nusrat is an early-career researcher with a background in Environmental and Chemical Engineering, specializing in sustainable waste-to-resource technologies. Her research focuses on converting organic waste into circular economy products such as biochar, activated carbon, and digestate, with practical applications in water treatment and land management. Nusrat has developed strong practical expertise through a range of multidisciplinary research projects. She combines a strong technical foundation with hands-on research experience and contributes thoughtfully to projects aimed at enhancing environmental sustainability and circularity of resources.

Abstract

Australian water utilities are exploring practical options to recover value from biosolids as volumes rise, management costs increase, and regulatory expectations shift toward material circularity. Given its carbon-rich composition, biosolids represent a suitable feedstock for thermochemical conversion into biochar through pyrolysis. Biochar is a demonstrated soil improver, enhancing soil structure, water holding capacity, and nutrient composition. However, concerns around potential contaminants such as trace metals and PFAS, and also the absence of national biochar standards continue to limit the application of biosolid-derived biochar as a viable soil amendment. Garden organics (GO) represent a significant portion of municipal solid waste, particularly in Victoria, as councils expand food and garden organics collections. The lignocellulosic structure of GO means that mixing it with biosolids prior to thermochemical conversion should impart desirable physicochemical properties to the resulting biochar, as well as potentially reducing the overall contaminant profile as compared to 100 % biosolids-derived biochar.

This study investigates whether blending biosolids with garden organics prior to pyrolysis can produce a biochar with a reduced contaminant profile and a greater compliance with the Queensland End of Waste (EOW) code, the only biochar regulation currently available in Australia. Biochar produced from 100 % biosolids and from 50:50 blends were compared for surface characteristics, water holding capacity, total metal concentrations, metal leachability, and PFAS concentrations. The mixed-feedstock biochar showed higher surface area and porosity, contributing to improved water holding capacity. Notably, one of the 50:50 blend sample met EOW limits for leaching of metals, but the 100 % biosolids-derived biochar exceeded EOW thresholds for Cd, although leaching results showed low metal mobility and limited risk for soil application. Results showed PFAS concentrations below guideline values for all biochar samples. Overall, co-pyrolysis of biosolids with GO offers improved compliance outcomes, demonstrating a practical pathway to produce safer biochar for land application while supporting circular economy principles.

#34 Circularising Hydrogen Export Systems: Economic Advantages of Reusing Dehydrogenated Carriers

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Brief bio of speaker

Aditiya Harjon is a researcher specialising in hydrogen energy systems, techno-economic analysis, and industrial decarbonisation. He received his PhD under the Australian Government's International Research Training Program (IRTP). He obtained an M.Phil. from The University of Melbourne and a B.Eng. (Hons., top 1%) from Universiti Tenaga Nasional, Malaysia.

His work focuses on the economic feasibility and large-scale deployment of hydrogen carriers and sustainable energy value chains, with research track records spanning Australia and Asia. Adit has held multiple academic and research leadership roles, including lecturer, research project officer, laboratory head, and founder of an energy research centre in Jakarta. He has actively contributed to cross-sector collaborations with leading academic and industry partners, including The University of Tokyo, PETRONAS, Boron Molecular Melbourne, and Clean Power Indonesia. Adit has contributed to multiple energy transition, hydrogen, and alternative fuel studies, with expertise in techno-economic modelling, feasibility assessments, and decarbonisation through strategy and policy recommendations. His research has been recognised through various academic awards and publications, particularly in techno-economic analysis, hydrogen energy systems, alternative fuels, and low-carbon technologies.

Abstract

Hydrogen is widely recognised as a promising low-emission energy carrier for supporting global decarbonisation. However, large-scale hydrogen deployment remains constrained by storage and transportation challenges arising from its physical characteristics. Hydrogen must either be maintained at extremely high pressure in gaseous form or stored at cryogenic temperatures as a liquid, both of which require energy-intensive infrastructure and specialised handling systems. These limitations have accelerated interest in hydrogen carrier technologies as an alternative to enable international hydrogen trade.

Hydrogen carriers offer several advantages by enabling hydrogen transport under more manageable operating conditions while leveraging existing fuel and chemical logistics infrastructure. Beyond simplifying transportation and storage requirements, hydrogen carriers also create circular economy opportunities by enabling the reuse of dehydrogenated carriers after hydrogen release at the import destination. Rather than treating the spent carrier as a single-use medium, the dehydrogenated compound can be recirculated back to the exporting country for re-hydrogenation and subsequent reuse within the supply chain.

This study investigates the economic feasibility and circularity benefits of reusable hydrogen carrier systems through a techno-economic analysis framework developed for large-scale hydrogen export between Malaysia and Japan in collaboration with PETRONAS. The analysis compares circular and linear supply chain configurations using the levelised cost of hydrogen (LCOH) as the primary economic indicator. Two liquid organic hydrogen carrier (LOHC) systems are evaluated: toluene/methylcyclohexane (MCH) and dibenzyltoluene (DBT)/perhydro-dibenzyltoluene (H18-DBT).

The results demonstrate that incorporating carrier recirculation within a circular supply chain framework substantially reduces recurring operational costs, with carrier replenishment costs approximately 50 times lower than in linear systems that require continuous fresh carrier procurement. The findings further reveal that economies of scale progressively reduce the relative contribution of shipping costs to the overall cost of hydrogen supply. However, hydrogenation costs become increasingly dominant at larger production scales, particularly for carrier systems involving high-value materials such as DBT. This economic behaviour highlights the sensitivity of large-scale hydrogen export systems to carrier market prices and hydrogenation energy requirements.

Overall, this study demonstrates that circular hydrogen carrier recirculation frameworks can significantly improve the economic performance and resource efficiency of international hydrogen supply chains. The findings reinforce the importance of integrating circular economy principles into future hydrogen trade infrastructure to support cost-effective, sustainable global hydrogen ecosystems.

#36 The role of thermal treatment in a circular economy using PFAS as the example

Nathan Weber[1*], Edwin Banks[1], Nathan Garner[1], Sibel Kaya[2], Phuong Thao Nguyen[2], Jerome Dunne[2], John Lucas[2], Tai Truong[2], John Mackie[3], Michael Stockenhuber[1] and Eric Kennedy[1].

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Brief bio of speaker

Dr Nathan Weber is a Chancellor's Research Fellow at the University of Technology Sydney, specialising in the thermal treatment technologies for per- and polyfluoroalkyl substances (PFAS). Nathan recently relocated from Raleigh, North Carolina, USA, where he spent two years as an Oak Ridge Institute for Science and Education (ORISE) Fellow based at the United States Environmental Protection Agency. Nathan earned his PhD in Chemical Engineering from the University of Newcastle, Australia, and brings a blend of research and technical expertise to tackle the challenges posed by these persistent environmental pollutants. Nathan's work is instrumental in developing effective strategies for PFAS remediation, contributing to the broader field of environmental science and remediation.

Abstract

Thermal treatment plays an important role in supporting a circular economy through the destruction of hazardous contaminants and remediation of contaminated waste streams and soils. Without effective treatment technologies, persistent contaminants may continue to cycle through reuse and recycling pathways, leading to further

environmental contamination. In addition, many thermal treatment systems are designed to recover energy and reduce landfill disposal. However, concerns remain regarding the suitability of thermal treatment for emerging contaminants such as per- and polyfluoroalkyl substances (PFAS).
This presentation describes the results of laboratory- and commercial-scale investigations to evaluate the environmental performance of thermal treatment technologies for PFAS destruction. Laboratory studies utilized quantum chemical simulations, bench-scale furnace experiments, Fourier-transform infrared spectroscopy (FTIR), and Gas Chromatography/Mass Spectrometry (GC/MS) analysis to investigate PFAS decomposition pathways and identify byproducts known as products of incomplete destruction (PIDs). The studies demonstrated that inappropriate operating conditions can result in the formation of undesirable fluorinated byproducts, including compounds such as C_2F_6.
Building on the laboratory findings, field investigations at commercial-scale thermal treatment facilities, including soil thermal desorption systems in Australia and hazardous waste incinerators in the United States, were used to evaluate real-world performance. Results indicate the importance of using correct measurements methods such as other test method (OTM)-45 and OTM-50 and that properly designed and operated thermal treatment systems can achieve effective PFAS destruction while minimizing hazardous emissions and environmental impacts.
The findings highlight that thermal treatment can play a critical role in enabling circular economy strategies for contaminated waste streams, but continued monitoring and scientific evaluation are necessary as new emerging contaminants are identified.

#37 Transforming mining waste into sustainable construction: A critical mineral tailings data repository for low-carbon concrete production

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Brief bio of speaker

I am Amitha Varghese, a graduate of Information Technology. I am currently undertaking research at Murdoch University on sustainable construction materials and circular economy approaches for mine tailings utilisation.

Abstract

Global mining operations generate a substantial volume of waste materials once the valuable metals have been extracted. These waste materials are disposed of in landfills or large ponds known as tailings storage facilities, TSF's. The long-term storage of theses tailings poses significant environmental challenges, including toxic tailings, dam failures, and air pollution. It is essential to find sustainable alternatives for managing tailings.
The construction industry is one of the top contributors of global carbon emissions. Concrete, the most widely used construction material globally, generates 0.8–0.9 tonnes of CO_2 per tonne of Ordinary Portland Cement (OPC). This makes it the single largest source of carbon emissions worldwide contributing approximately 8% of global emissions. Critical mineral tailings often contain significant amounts of alumino-silicates that can used as geopolymer precursors or supplementary cementitious material (SCMs) for the production of low carbon concrete.
As the global demand for critical minerals increases in support of the energy transition, large volumes of critical minerals tailings are generated. These tailings have the potential for the recovery of minerals and reuse for low carbon concrete. There is no centralised system for critical mineral tailings repurposing possibilities.
In this research study, we design and develop a repository of detailed information on critical mineral tailings that supports sustainable construction practices. The data repository will contain tailing properties; geographic locations and the regulations related to policy for repurposing. The repository will incorporate concentrations of aluminium silicate as well as amorphous aluminium silicate for use in low carbon concrete production. The information about the mine tailings is spread across the mining companies' repositories, laboratories and research publications. Our data repository will bring all necessary information into one organised repository. It will be easy to identify and find supplementary materials for low carbon concrete from tailings and will provide information on mineral recovery from each tailing with the access protocols. The repository can be useful for mining companies, concrete producers, and determination of carbon credits. Mining companies can use it to characterise their waste streams toward sustainability commitments. Concrete producers can identify and source low-carbon supplementary cementitious materials with verified data and regulation required to access these materials and use the repository to help with determination of – carbon credits due to them.
This repository will help in the recovery of valuable minerals from mine waste and reduce carbon emissions in construction. By consolidating essential information into a single platform, it promotes circular economy principles and supports a more sustainable future for both the mining and construction industries.

#38 Development of a Design of Experiments to Assess the Mechanical Durability of 3D-Printed Recycled Polymers for Structural Applications

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Brief bio of speaker
Alireza Boostan is a Senior Structural Engineer with over 25 years of international experience in the construction and energy sectors. Currently a PhD Candidate at the University of Wollongong, their research investigates the mechanical characterization and long-term durability of 3D-printed recycled polymers. By establishing a reliable technical foundation for these materials, they provide the engineering validation necessary to transition recycled polymers into functional structural applications.

Abstract
The transition to a circular economy for plastics relies on the ability to transform plastic waste into durable, functional components. While 3D printing (Additive Manufacturing) offers significant advantages over traditional injection moulding in terms of design freedom, reduced waste, and the elimination of expensive tooling and moulding, its industrial adoption for recycled materials is hindered by concerns over long-term durability. Unlike the isotropic properties typical of injection-moulded parts, 3D-printed components exhibit mechanical anisotropy that must be characterized to ensure safety and reliability in load-bearing roles.
This research supports a circular framework for plastics by evaluating the structural durability of recycled polymers. To move beyond mere prototyping and into industrial application, a design of experiments was completed to assess durability properties. The investigation includes Charpy impact testing for energy absorption, Shore D hardness for surface integrity, creep testing for deformation limits under constant stress, and fatigue testing for cyclic loading resistance to ensure long-term structural reliability.
To understand failure modes, the methodology incorporates fractography using Scanning Electron Microscopy (SEM), alongside Fourier-transform infrared spectroscopy (FTIR), differential scanning calorimetry (DSC), and thermogravimetric analysis (TGA) to characterize the recycled plastic feedstock, which can vary significantly between batches.
This allows for a direct comparison of how the thermal history and degradation of recycled resins affect inter-layer bonding compared to virgin counterparts. By establishing these performance baselines, this work provides the industry with the technical data required to substitute virgin plastics with 3D-printed recycled plastics. The application of the proposed methodology has been demonstrated by comparing the mechanical durability characteristics of FDM-printed specimens with virgin PP and FGF-printed specimens from recycled PP.

#40 Environmental Degradation of 3D-Printed Thermoplastics: Establishing Baselines for a Circular Plastics Economy

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Brief bio of speaker
Azra is a PhD candidate and researcher within the School of Engineering at the University of Wollongong. Her research focuses on the intersection of advanced manufacturing and environmental sustainability, specifically investigating the degradation behaviour of 3D-printed plastics. In addition to her primary research, Azra is an active member of the academic community at UOW, serving as a tutor. She is dedicated to translating complex engineering principles into actionable knowledge for undergraduate students, fostering the next generation of engineers.

Abstract
Fused granular fabrication (FGF)-based 3D printing offers a transformative pathway for the circular economy by enabling the decentralized, onsite upcycling of plastic waste into functional goods. However, achieving true circularity requires a robust understanding of the environmental degradation profiles of common printing materials, such as Polylactic Acid (PLA), Polyethylene Terephthalate Glycol (PETG), Polycarbonate (PC), and Polypropylene (PP), when subjected to real-world conditions. Establishing these degradation baselines is critical for developing appropriate policies to enforce targeted collection and recycling protocols. Furthermore, this data equips micro-recyclers with the essential knowledge needed to sort, assess, and prioritize different types of end-of-life thermoplastics for 3D printing-based upcycling.

This study investigates the environmental degradation of FDM-printed specimens of PLA, PETG, PP, and PC over a comprehensive six-month period. To simulate realistic environmental exposures, the specimens were subjected to three distinct weathering conditions: ultraviolet A (UVA) radiation, UVA combined with seawater, and UVA combined with river water. The performance and resilience of these 3D-printed plastics are evaluated and compared against published degradation data for traditional injection and compression moulded plastics.
By evaluating the comparative degradation behaviours across different manufacturing methods and environmental exposures, this research highlights critical variances in long-term material resilience. The preliminary insights presented aim to guide sustainable recovery strategies, inform future material selection, and support the broader implementation of circular frameworks for upcycled plastics.

#41 PHREEQC-XGBoost Hybrid Modeling of Mineral Carbonation from Seawater Desalination Brine considering Inhibition effects of Antiscalants

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Brief bio of speaker
Juyeon Yu is a researcher at CJK with a master's degree. She is currently engaged in R&D projects related to water treatment, desalination brine treatment, and brine resource recovery. Her main research interests include high-salinity wastewater treatment and sustainable resource recovery technologies.

Abstract
As seawater desalination expands to address global water scarcity, sequential mineral carbonation-precipitation processes have emerged as a promising technology for recovering magnesium and calcium from brine while simultaneously sequestering carbon dioxide. However, residual antiscalants from upstream reverse osmosis processes inhibit nucleation and crystal growth, causing significant discrepancies between precipitation prediction models and actual recovery yields. This study proposes a hybrid modeling framework coupling PHREEQC dynamic modeling with XGBoost machine learning to quantify these kinetic inhibition effects. First, theoretical recovery rates of $Mg(OH)_2$ and $CaCO_3$ were calculated using the Pitzer database, and experimental recovery data were obtained through precipitation tests using synthetic desalination brine under various antiscalant concentrations. A kinetic correction factor, defined as the ratio of measured to predicted recovery, was then modeled via XGBoost as a function of pH, temperature, and antiscalant concentration. The developed XGBoost model achieved high performance with an RMSE below 0.03 and an R^2 above 0.95, effectively correcting the overestimation inherent in standalone PHREEQC models. These findings are expected to serve as a critical foundation for optimizing the design and establishing operational control algorithms for desalination brine resource recovery processes.

#42 Development of Spinel HTO@MXene Electrodes for Efficient Lithium Recovery from Complex Brines

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Brief bio of speaker
Mohsen is currently pursuing a PhD in Civil and Environmental Engineering at the University of Technology Sydney, focusing on Lithium recovery from brines within the context of circular economy under the guidance of Prof. Hokyong Shon.

Abstract
The growing demand for sustainable lithium recovery from low-grade brines has accelerated the development of advanced electrode materials for capacitive deionisation (CDI). Herein, a multifunctional HTO@MXene composite electrode was developed by integrating spinel-type hydrogen titanium oxide (HTO) with conductive $Ti_3C_2T_x$ MXene to enhance lithium adsorption kinetics, ion transport, and cycling stability. The conductive and hydrophilic MXene framework improved active-site accessibility, accelerated charge transfer, and reduced mass-transfer resistance, thereby overcoming the kinetic limitations of conventional lithium-ion sieves. The effects of feed concentration, solution pH, and applied voltage on adsorption capacity and adsorption efficiency were systematically investigated.

Feed concentration was identified as a dominant parameter, with higher Li^+ concentrations enhancing adsorption capacity through stronger diffusion driving forces and improved mass transfer, although excessive concentrations could induce active-site saturation. Solution pH significantly influenced electrode performance, with optimal adsorption achieved under alkaline conditions (pH 10–12) due to enhanced surface deprotonation and stronger electrostatic interactions with Li^+ ions. The applied voltage also showed strong nonlinearity, with optimal performance observed near 1.0–1.1 V, while higher voltages led to deterioration due to Faradaic side reactions and possible electrode degradation. The HTO@MXene electrode demonstrated enhanced lithium uptake, faster adsorption–desorption kinetics, and high selectivity toward Li^+ over competing Na^+ and Mg^{2+} ions in binary and ternary solutions. In simulated desalination brine, the composite electrode-maintained Li selectivity values above ≈100 throughout repeated cycling, highlighting its excellent operational stability. The lithium adsorption rate increased progressively from ≈5–31% during cycles 1–5 to ≈97% by cycle 8, indicating gradual electrode activation and improved ion accessibility during cycling. MXene incorporation further promoted rapid Li^+ intercalation and efficient charge transfer, while the spinel-type HTO structure provided a stable host framework for sustained lithium accommodation. These findings demonstrate the synergistic benefits of combining HTO with MXene for selective, stable lithium recovery, providing a promising strategy for next-generation CDI systems to extract lithium from complex saline resources.

#44 GO-ZIF-67 Quaternized Polycarbazole Membranes for High-Performance Alkaline Electrolysis

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Brief bio of speaker
Yeshi Choden is a PhD candidate in Civil and Environmental Engineering at the University of Technology Sydney (UTS), where her doctoral research centres on nanomaterial-based membrane fabrication for anion exchange membranes in alkaline water electrolysis. She holds a Master's degree in Environmental Engineering from IIT, India, with a specialization in solid and wastewater engineering. Prior to her doctoral studies, Yeshi served as a lecturer at the Royal University of Bhutan, bringing both academic rigour and practical teaching experience to her research career.

Abstract
Anion exchange membrane water electrolysis (AEMWE) is a promising route to green hydrogen. Still, its progress remains constrained by the limited hydroxide (OH^-) conductivity and the alkaline instability of conventional anion exchange membranes (AEMs). Here, a series of nanocomposite AEMs was developed by incorporating zeolitic imidazolate framework-67 (ZIF-67) into a TMA-quaternized polycarbazole (QPC) matrix, exploiting the rigid, ether-free carbazole backbone to provide intrinsic resistance to nucleophilic backbone degradation. ZIF-67 was loaded from 1 to 5 wt.%, and at the optimal loading a ternary membrane was further reinforced with graphene oxide (QPC-GO/ZIF67), in which the GO sheets anchor and uniformly disperse the ZIF-67 particles. The composite membranes exhibited markedly enhanced charge density and hydration relative to pristine QPC, with the ion exchange capacity rising from 2.0 to 4.3 meq g^{-1} for QPC-GO/ZIF67, while the rigid backbone constrained swelling to moderate levels. Mechanically, the tensile strength increased from 24 MPa (pristine) to 36 MPa for QPC-ZIF67-5, accompanied by an unusual concurrent gain in elongation at break, indicative of uniform, non-agglomerating filler dispersion. The composite membranes also showed improved thermal robustness and substantially reduced ionic resistance, achieving OH^- conductivities at 80 °C of up to 130 mS cm^{-1} for QPC-GO/ZIF67, against 92 mS cm^{-1} for pristine QPC. After 1000 h of immersion in 1 M KOH at 60 °C, the QPC-GO/ZIF67 membrane retained 97.8 % of its initial conductivity, compared with only 93 % for the pristine membrane. In single-cell AEMWE testing in 1 M KOH at 60 °C, the composite membranes delivered higher current densities at the 2.0 V cut-off, reaching 500 mA cm^{-2} for QPC-GO/ZIF67 versus 390 mA cm^{-2} for pristine QPC. The QPC-GO/ZIF67 cell further sustained 200 h of continuous operation at 0.7 A cm^{-2} with a voltage decay rate of only 0.10 mV h^{-1}. These results demonstrate that combining a chemically resilient ether-free polycarbazole backbone with a GO-dispersed ZIF-67 filler offers a synergistic and scalable strategy for developing high-performance, durable AEMs for green hydrogen production.

#46 Catalytic Upcycling of Mixed Plastic Waste toward Circular Resource Recovery

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Brief bio of speaker

Arshad Ali is an accomplished engineer with a B.Tech and M.Tech in Mechanical Engineering. He is currently pursuing a Cotutelle Ph.D. jointly at the Department of Chemical Engineering, BITS Pilani, India, and the Department of Chemical and Environmental Engineering, RMIT University, Australia. His research focuses on developing innovative waste-to-energy strategies, specifically converting plastic waste into pyrolysis-derived plastic oil for use as an alternative transportation fuel, addressing the critical fuel challenges faced by developing countries like India. His work aims to explore and optimize pathways for converting plastic and biomass waste into sustainable energy sources, with an emphasis on enhancing energy efficiency and environmental sustainability. His research holds significant potential to mitigate the environmental impact of plastic waste while contributing to energy security in India and Australia. He has published 17 + papers in reputed journals, i.e., Renewable and Sustainable Energy Reviews, Journal of Analytical and Applied Pyrolysis, ACS OEGA, Biomass Conversion and Biorefineries, and Bioenergy Research.

Abstract

The increasing accumulation of mixed plastic waste and the limitations of conventional mechanical recycling have intensified the need for sustainable thermochemical recycling technologies that support circular resource recovery. In this study, catalytic upcycling of mixed plastic waste (low-density polyethylene, LDPE; high-density polyethylene, HDPE; polypropylene, PP; polystyrene, PS; polyvinyl chloride, PVC; and polyethylene terephthalate, PET) was investigated using a two-stage catalytic pyrolysis process to enhance oil yield and improve hydrocarbon selectivity toward fuel-grade products. Catalytic vapor-phase upgrading was performed using activated biochar catalysts under optimized operating conditions. The influence of catalyst loading, catalyst activation, and staged reaction temperatures on product distribution and hydrocarbon composition was systematically evaluated. The two-stage catalytic pyrolysis system achieved a maximum oil yield of 91 wt% at 450 °C, whereas the highest light oil (BTEX) fraction (57 wt%) was obtained at $T1 = 450$ °C and $T2 = 550$ °C using HCAT-assisted catalytic upgrading. Furthermore, catalysts substantially improved gasoline-range hydrocarbon formation, with 5% HCAT catalyst loading producing the maximum fuel-grade hydrocarbon composition (84%) compared to higher catalyst loadings. The enhanced selectivity toward lighter hydrocarbons was primarily attributed to the synergistic role of mesoporous structure and Brønsted acid sites. The results demonstrated that low concentrations of PVC promoted early dehydrochlorination, generating acidic HCl species that catalyzed secondary cracking reactions, while PET-derived heteroatoms stabilized olefin radicals, promoting recombination and crosslinking reactions leading to heavier hydrocarbons and char formation. Vapor-phase upgrading was predominantly governed by β-scission, isomerization, and aromatization reactions, resulting in a significant reduction of olefin concentration by more than 50 wt%. Overall, the findings demonstrate the strong potential of catalytic vapor-phase upgrading for converting mixed plastic waste into valuable fuel-grade hydrocarbons, providing a promising pathway toward sustainable circular plastics and advanced feedstock recycling technologies.

#49 Harnessing Electroconductivity in Membranes for Microbial Fuel Cells and Resource Recovery

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Brief bio of speaker

Dr. Swatantra Pratap Singh is Professor-In-Charge for the Gogri Hub for Membrane Translational Research and Convenor for the Centre of Excellence on Membrane Technologies for Desalination, Brine Management and Water Recycling (DeSaltM) at IIT Bombay, supported by the DST, India. He is an Associate Professor at the Indian Institute of Technology Bombay, in the Department of Environmental Science and Engineering, and leads the interdisciplinary Environmental Nanotechnology Lab (ENano). He received his Ph.D. and M.Tech from the Indian Institute of Technology Kanpur, India, in Environmental Engineering, and was a postdoctoral scholar at the Zuckerberg Institute of Water Research, Ben-Gurion University of the Negev, Israel. He was awarded the INAE Young Engineer Award (2020), ISEES Young Scientists Award (2020), DST-SYST (2020), European Membrane Society Young Associates (2020), and IITB Early Research Achiever Award (2021). Most recently, he has been awarded the Professor Krithi Ramamritham Award for Creative Research 2022, the 2023 award, and the INSA Young Associates 2024 award. His current research focuses on the water-health-energy nexus for desalination and wastewater treatment by membrane technology.

Abstract

Laser-induced graphene (LIG) has gained significant attention due to its chemical-free fabrication process, enabling the direct conversion of various substrates, from commercial polymers to waste organic materials like cloth, paper, and food, into graphene electrodes. This versatility allows for the development of cost-effective, recyclable materials for flexible electronics and environmental applications. The porous structure of LIG has shown great potential in electrochemical sensing for medical diagnostics, food safety, and environmental monitoring. In membrane-based desalination, wastewater recycling, and microbial fuel cell biofouling, the trade-off between selectivity and permeability remains a key challenge. Electroconductive membranes offer a promising solution for mitigating biofouling while optimizing performance. LIG, fabricated using a 10.6 µm CO_2 laser, enables a single-step, chemical-free conversion of polyethersulfone (PES) membranes into LIG-based filters. Further surface modifications transform these filters into ultrafiltration (UF) and TFC composite membranes, ion-exchange membranes, and membrane electrode assemblies with exceptional catalytic and anti-biofouling properties. The catalytic mechanisms of doped LIG membranes arise from the intrinsic properties of graphene, the 3D porous texture, and heteroatom doping, which enhance performance. These laser-printed membranes hold immense potential for energy and resource recovery, as well as environmental applications, offering a scalable and sustainable approach to water treatment.

#53 Engineering Pristine Biochar Adsorbents: An Activation-Free Strategy for Tuning Pore Architecture for Targeted Pollutant Removal

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Brief bio of speaker

Dr. Ojima Zechariah Wada is a Post-Doctoral Researcher at the Qatar Environment and Energy Research Institute (QEERI), Hamad Bin Khalifa University, Doha, Qatar. He holds a PhD in Sustainable Environment f rom Hamad Bin Khalifa University, a Master of Public Health in Environmental Sciences f rom the University of Ibadan, Nigeria, and a NEBOSH certification in Occupational Health and Safety.His research spans environmental biotechnology, circular economy systems, and advanced materials for water treatment, with a current focus on engineering biochar adsorbents f rom food and biomass waste streams for the selective removal of emerging contaminants including PFAS, pharmaceuticals, and dyes. His work on activation-free pyrolysis strategies for tuning biochar pore architecture represents a cost-effective and scalable approach to pristine adsorbent design, particularly relevant to resource-scarce and arid-region contexts. Dr. Wada has authored over 30 peer-reviewed publications (H-index: 23; ~3,000 citations), lead innovator for a US patent on a circular bioprocess for industrial wastewater valorisation and has presented his research at international conferences across Africa, Europe, and Asia. Beyond the laboratory, Dr. Wada is the founder of Global Eco -Oasis Sustainable Initiative, an NGO advancing WASH access and SDG 6 implementation in underserved Nigerian communities, reflecting his commitment to translating science into real-world impact across the Global South.

Abstract

Developing cost-effective and sustainable adsorbents with tailored properties is crucial for addressing environmental contamination. In this research, we demonstrate a simple, activation-free pyrolysis strategy to engineer biochar pore architecture by strategically selecting cellulosic precursors. We systematically compared the structural evolution of biochars derived from pure cellulose (C) and cellulose acetate (CA) via pyrolysis from 300°C to 600°C. A clear divergence in material properties was observed. Cellulose acetate pyrolysis generated hierarchical micro-/mesoporous carbons, achieving a high surface area of 626 m²/g (CA-600-2hr) and significant mesopore volumes (54%). In contrast, pure cellulose pyrolysis produced predominantly microporous carbons, reaching a high micropore volume (~88%) and a surface area of 590 m²/g (C-600-2hr). This structural tuning was validated in targeted applications. The microporous C-600-2hr showed superior performance for small-molecule pollutants, excelling in Methylene Blue (MB) adsorption (q_m = 38 mg/g) and CO_2 capture (2.1 mmol/g), attributed to its compatible pore dimensions and strong π-π interactions. Notably, the hierarchical CA-600-2hr, despite its larger total surface area, performed poorly for both MB and CO_2, confirming that specific pore architecture is more critical than bulk surface area for these small molecules. Conversely, this same hierarchical structure was superior for the bulky Rhodamine B (RhB) molecule (q_m = 48 mg/g), where its open mesoporous network mitigated diffusion limitations observed with C-600-2hr. This work confirms that activation-free tuning can be achieved by altering pyrolysis conditions and precursor selection, providing a powerful tool for designing adsorbents with customized functionalities.

#54 Development of a Nutrient-Rich Liquid Fertilizer through Combined Membrane Bioreactor and Membrane Contactor Treatment

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Brief bio of speaker

Amirhossein Shafaghat is a PhD candidate in Environmental Engineering at the University of Technology Sydney (UTS), Australia. His research focuses on nutrient recovery from source-separated human urine and the development of sustainable technologies that support circular economy and resource recovery initiatives. His current work investigates the production of value-added fertilizers from hydrolysed urine using advanced membrane technologies, including membrane bioreactors (MBRs), membrane-aerated biofilm reactors (MABRs), and membrane contactors (MCs). His research aims to recover and transform nutrients from urine into safe and effective liquid fertilizers while reducing reliance on energy-intensive synthetic fertilizer production. Through this work, he seeks to demonstrate the potential of decentralized urine treatment systems to contribute to sustainable sanitation, nutrient recycling, and environmental protection. He has authored numerous peer-reviewed publications in leading international journals and has presented his research at international conferences. His research interests include nutrient recovery, membrane-based treatment technologies, sustainable fertilizer production, circular sanitation systems, and the valorisation of human urine as a renewable resource.

Abstract

Source-separated human urine contains the majority of the nitrogen excreted by humans and represents a concentrated nutrient stream with significant potential for resource recovery. However, conventional urine treatment technologies often focus on either nutrient removal or the production of a single fertilizer product, limiting overall nutrient recovery and valorisation. This study investigated an integrated membrane contactor–membrane bioreactor (MC–MBR) system designed to maximize nitrogen recovery from hydrolysed urine while producing value-added liquid fertilizers in line with circular economy principles.

The proposed process consisted of two sequential stages. In the first stage, hydrolysed urine containing 4.5 ± 0.2 g N/L at pH 9.1 ± 0.1 was treated using a membrane contactor to recover ammonia as ammonium sulfate fertilizer. The effects of sulfuric acid concentration (0.1, 0.3, and 0.5 M H_2SO_4) and recirculation flow rate (100, 130, and 150 mL/min) were evaluated. Acid concentration significantly influenced recovery performance, with 0.1 M H_2SO_4 showing acid exhaustion after 2 h of operation, as indicated by an increase in acid pH from 1 to approximately 6. Increasing the acid concentration from 0.3 to 0.5 M did not provide additional benefits. Likewise, increasing the flow rate above 130 mL/min resulted in negligible improvement in nitrogen recovery. Consequently, 0.3 M H_2SO_4 and a flow rate of 130 mL/min were selected as the optimal operating conditions for the proposed system.

Under these conditions, treating 2 L of urine with 500 mL of acid achieved ammonia removal efficiency of 42% and nitrogen recovery efficiency of 89%, generating a concentrated ammonium sulfate fertilizer stream. Following ammonia extraction, the residual urine exhibited a reduced pH of approximately 8.2 and a nitrogen concentration of

approximately 3 g N/L, making it more suitable for biological nitrification. In the second stage, the residual urine was treated in a membrane bioreactor to convert ammonium into nitrate and produce a mixed NH_4^+/NO_3^- liquid fertilizer. The MBR achieved a nitrification efficiency of 45% and a nitrification rate of 320 mg N/L·d at a hydraulic retention time of approximately 4 days. This represented a reduction of approximately 3 days compared with conventional standalone MBR treatment of urine with similar nitrogen concentrations. Furthermore, the integrated MC-MBR configuration reduced specific energy consumption (kWh/kg.$N_{recovered}$) by approximately 73% relative to the standalone MBR process.
The results demonstrate that sequential ammonia recovery and biological nitrification can be successfully integrated to generate two marketable fertilizer products from a single urine stream while improving process efficiency. The proposed MC-MBR system offers a promising pathway for decentralized nutrient recovery, sustainable fertilizer production, and transitioning wastewater treatment to resource recovery within circular sanitation systems.

#55 Molecular Insights into the Chemical Recycling of Polyolefin Plastics

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Brief bio of speaker
Martina is a Scientia Senior Lecturer in the School of Chemistry at UNSW Sydney. Martina is originally from Torino (Italy), where she completed both her bachelor's and master's degrees in Chemistry. She then moved to Princeton University (United States) where she earned a PhD in Chemistry in 2017 under the mentorship of Professor Emily Carter. During her time at Princeton, Martina used computational chemistry to investigate catalysts for CO2 conversion. After the completion of her PhD, Martina joined Columbia University (United States) as a Columbia Science Fellow. In this role, Martina was part of a team of scientists teaching the first-year undergraduate course "Frontiers of Science" and conducted research on novel functional materials in the group of Professor David Reichman. Following this experience, Martina moved to Australia to continue her research and teaching career at the University of Sydney, where she was awarded a University of Sydney Fellowship to work on computational modelling of metal-organic frameworks. In 2020, Martina joined the School of Chemistry at UNSW as a Scientia Lecturer. In this role, she works with her students to investigate molecules and materials for sustainability applications using computational methods. Martina was promoted to Senior Lecturer in 2023. Martina’s research impact has been recognised by awards such as the Rita Cornforth lectureship from the Royal Australian Chemical Institute (2024) and a DECRA fellowship from the Australian Research Council (2025 round).

Abstract
Developing efficient technologies for the conversion of polyolefin plastic waste into high-value products, including feedstocks for the production of new virgin-like plastics, is a critical milestone toward achieving plastic circularity. Advanced chemical recycling strategies that use catalysts to convert the polyolefin waste via pyrolysis or hydrogenolysis are a promising route. However, they typically lead to wide product distributions, including excessive methane formation, that hamper the efficiency of the process. Molecular-level insights into the conversion mechanism are needed to design better catalysts that lead to narrow product distributions centred around the most desirable products. My research group uses computational methods to gain such insights and aid the development of new catalysts for catalytic advanced recycling of polyolefins.
In this contribution, I will focus on two recent systems we have been working on. First, I will present our work on ruthenium-catalysed hydrogenolysis of polyolefin plastic waste. In this work, we used periodic density functional theory (DFT) to determine the surface coverage of atomic hydrogen under operating conditions for different facets of ruthenium as well as the plastic polymer cleavage mechanism. Furthermore, we have used classical molecular dynamics (MD) to study how the polymer interacts with the catalyst surface in the presence of hydrogen and how the hydrogen can diffuse through the polymer melt and reach the surface to participate in the cleavage mechanism.
In the second part of my contribution, I will focus on our recent efforts to study the interaction of polyolefins with porous metal–organic framework-based catalysts for pyrolytic recycling, with particular emphasis on UiO-66, which has been shown to improve product distributions. To this end, we use classical MD simulations to investigate how variations in chain length and branching influence preferential interactions with different pores, as well as the diffusion of polymers and their resulting fragments within the MOF.

#56 Beyond Disposal: Computational Insights into Hydrogenolysis of Polyolefin Plastic Waste

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Brief bio of speaker

I am Sohaib Umer a final-year PhD student in the Lessio Group at the University of New South Wales (UNSW), Sydney. I study a range of sustainability-relevant catalytic reactions over metal-based catalysts through computational methods. My aim is to uncover atomic-level insights that can guide the rational design of next-generation catalysts.

Currently, I am working on one of the pressing environmental challenges of our time, plastic waste. My work explores the viability of chemical reactions to break down plastic polymers into valuable products such as fuels, contributing to the development of a truly circular economy for plastics. I employ rigorous theoretical frameworks combined with newly developed machine learned interatomic potentials (MLIPs) to bridge the gap between fundamental computational discovery and practical, scalable solutions for plastic waste upcycling.

I completed my Master's degree from the Ulsan National Institute of Science and Technology (UNIST), South Korea, where I built a strong foundation in quantum chemical methods and surface science. During my studies, I have developed a deep interest in harnessing computational approaches as a tool to address pressing environmental challenges, from greenhouse gases like CO_2 to persistent plastic waste. This commitment to reimagining waste as a resource has since become the defining motivation behind all of my research.

Abstract
Increased consumption of single use plastics has led to a substantial rise in the accumulation of plastic waste. Consequently, the conversion of post-consumer plastic waste into valuable resources like fuel or monomers that can be turned into new plastic products has attracted significant attention.[1] Several techniques have been proposed for transforming the waste plastic items, however, the majority of these are energy intensive and suffer from low control over the product selectivity.[2]

Catalytic hydrogenolysis is one promising technology that can break the C-C bond in polyolefins such as polyethylene (PE) to produce small molecules that could be used as fuels.[3] Recently, catalysts based on supported ruthenium (Ru) nanoparticles have been identified as promising candidates for the depolymerization of PE via hydrogenolysis. However, their reactivity and selectivity are strongly influenced by the catalyst design, particularly by the nature of the support material. Supports play a significant role in lowering the activation barriers for the C-C cleavage and determining the selectivity of the process. As a consequence, an in-depth knowledge of the chemistry of the support material and its interactions with the nanoparticles is crucial for designing an efficient and selective catalytic material.

In this work, we employed density functional theory (DFT) combined with machine learned interatomic potentials (MLIP) to investigate how typical metal oxide (MO_2) supports affect Ru-catalysed polyolefin hydrogenolysis. We investigated how the support affects the electronic state of Ru, H-coverage on Ru cluster, and H-spillover (hydrogen diffusion from Ru to the support) and how these in turn affect the reactivity of the polymer. We used butane as a representative model of PE to capture the chemistry of polymer without compromising the computational efficiency and we focus on the first step of the hydrogenolysis process, i.e., PE adsorption at the catalyst surface. Our results indicate that changing the support material affects the factors mentioned above, which in turn governs the butane adsorption. Overall, this study provides insights into metal-support interactions and their impact on the activity of the hydrogenolysis reaction, offering guidance for the rational design of new catalytic systems to convert plastic waste into value added products.

#57 Computational Insights into Plastic Polyolefin Pyrolysis catalysed by UiO-66

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Brief bio of speaker

Christine Yu is a PhD candidate in Computational Chemistry at UNSW Sydney under the supervision of Dr Martina Lessio. Christine's research uses classical molecular dynamics and density functional theory to investigate the interaction between polyolefins and MOF catalysts for advanced recycling via pyrolysis. She aims to develop computational insights that enable more rational catalyst design to support the circular economy for plastics.

Christine completed a Bachelor of Science (First Class Honours) in Green Chemical Science at the University of Auckland. Prior to commencing her PhD, she gained industry experience as a Quality Control Technician, developing expertise in analytical testing, quality assurance, and data management. Driven by a passion for the environment and sustainability, she is now pursuing a PhD, honing her skills to help achieve a more sustainable future.

Abstract

Plastic waste, particularly single-use plastics, which are predominantly made of polyolefins, poses significant environmental problems, primarily due to their strong and chemically inert backbone (C-C). Currently, we generate 225 million tons of plastic waste, exceeding the limit at which we can manage it efficiently.[1] The concept of a plastic circular economy provides an excellent way to put plastic waste back into the cycle to regenerate plastic products. This concept increases the value of plastic waste while reducing its environmental footprint. Chemical recycling addresses the limitations of mechanical recycling, particularly its inability to produce higher-grade plastics, such as those needed in medical and food packaging applications.The most mature chemical recycling method is pyrolysis. Pyrolysis occurs at high temperatures (400-600 ˚C) in the absence of oxygen. This method can convert diverse plastic waste streams into valuable liquid and gaseous fuels and potentially higher-value plastics.[2] Catalysts are often employed to enhance product selectivity and decrease unwanted byproducts. Recent attempts have utilised metal-organic frameworks (MOF) as pyrolytic catalysts. In particular, UiO-66 with missing linker defects has demonstrated improved distribution and yields of pyrolysis products derived from polyolefin waste.[3] The mechanism of plastic breakdown has been confirmed by previous Density Functional Theory (DFT) calculations; however, the interactions between the polymer and catalyst remain poorly understood owing to experimental limitations, such as high temperatures and a lack of real-time monitoring. This project uses computational techniques, specifically classical Molecular Dynamics (MD), to investigate the kinetics and thermodynamic properties of polymers upon entering and interacting with the catalytic defective UiO-66. Preliminary molecular dynamics simulations reveal distinctive pore preferences depending on hydrocarbon chain length: hexane (C_6H_{14}) preferentially occupies tetrahedral pores, while eicosane ($C_{20}H_{42}$) shows greater affinity for defect sites within the defective UiO-66 framework. These results suggest that the inherent pore-size distribution in the missing-linker defect UiO-66 may be a tunable variable for controlling product selectivity in polyolefin pyrolysis, motivating further thermodynamic analyses to quantify these preferences and interactions. The insights from these studies will ultimately lead to more rational pyrolytic catalyst designs for selective product distribution, supporting the plastic circular economy.

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#59 SOFT PLASTICS AND THE CONSUMPTION CRISIS:Insights from a case study on sachets in the PhilippineS

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Brief bio of speaker

KC brings senior leadership experience from 27 years in the consumer products industry at Procter & Gamble, spanning multiple geographies and businesses across manufacturing, supply chain engineering, and innovation management. He has worked on product and packaging platforms, specializing in technology innovation, supply network design, and sustainability strategy. He also has experience collaborating with technical institutions, government agencies, and industry networks. KC is passionate about organizational development and has been involved in training, coaching, and mentoring early-career professionals. He is an avid diver and photographer, keen to learn more about marine ecosystems and how to protect them. KC holds a Master's degree in Environmental Engineering from Purdue University and is currently pursuing his PhD at the Institute for Sustainable Futures at UTS. His research explores management strategies for soft plastics in Australia and the region to facilitate meaningful policy design and a transition away from linear systems.

Abstract

The Philippines is a major contributor to ocean plastic debris[1]. Of the estimated 2.7 million tons of plastic waste generated each year in the Philippines, about 0.54 million tons enter the oceans[2], a figure projected to reach 9 million tons by 2040 if current practices continue[3]. A significant share of this debris is soft plastics, particularly LDPE, LLDPE, and multi-layer flexible packaging, such as single-use sachets, which dominate the local consumer market[4]. Additionally, it has been reported that the nation consumes nearly 34 billion plastic bags and 60 billion sachets annually[5], emphasizing the scale of the challenge. Soft plastics have been especially problematic due to low collection rates and high environmental leakage[2], increased risk of microplastic fragmentation, and their contribution to clogged waterways and localized flooding[1].

This literature review examines the impacts of soft plastics in the Philippines, especially single-use sachets, and their opportunities. Sachets have become the prevalent purchase format in the Philippines, shaped by the longstanding '*tingi*' culture of buying goods in small quantities when needed and to manage limited cash flow[6]. This practice is predominant among low-income communities that also experience disproportionate exposure to the health and environmental impacts of plastic waste. While public support for reform is strong, with seven in ten Filipinos favoring plastic bag bans and half supporting sachet restrictions[5], there has been little progress, and national and local policy implementation remains fragmented and insufficient[3].

This review examines the emergence of multi-layer sachets in the early 2000s and how the indigenous 'tingi' practice has been transformed by market forces into a dependence on disposable plastics. It evaluates existing regulatory approaches that largely emphasize collection, recycling, and leakage prevention, while offering limited attention to reduction, refill, and reuse. It argues that meaningful progress requires not only improved waste management infrastructure but also systemic changes to curb plastic consumption. Finally, it explores control opportunities grounded in community participation that can contribute to a more socially responsive, sustainable solution to the Philippines' escalating plastic crisis.

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#60 Governing the circular nutrient economy: A case study of international urine-derived fertiliser networks

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Brief bio of speaker
Jordan Roods is an ARC NiCE Hub PhD Candidate who is conducting research on the governance of the circular nutrient economy, which he is exploring through international case study research on urine-derived fertiliser networks. A core focus of Jordan's research is to investigate how the circular nutrient economy could be more effectively governed to improve outcomes for the natural environment. While 'regenerating nature' is the third principle of the circular economy, there has been limited engagement with how this could be achieved in practice. Jordan is advancing the call for an 'earth-centred' governance framework that reprioritises nature in circular economy discourse.

Abstract

Ensuring global food security, whilst simultaneously addressing the widespread environmental issues caused by fragmented local and global nutrient cycles, is one of the defining sustainability challenges of our time. Nested within the sanitation, agriculture and food production systems, a circular nutrient economy aims to minimise the loss of the essential macro- and micro-nutrients out of the system, whilst also recovering and reusing them in higher-value products, such as urine-derived fertilisers, to support food security and environmental health. The co-benefits are wide-ranging: improved soil health, reduced water pollution, and new economic opportunities for farmers and agribusinesses.While technological innovation has advanced nutrient recovery considerably, a critical and underexplored challenge lies in how the circular nutrient economy is governed. Effective governance is necessary to ensure that solutions can be implemented safely, equitably, and at scale. Yet the governance landscape remains largely fragmented, and the specific drivers and barriers operating across the nutrient value chain are poorly understood.This presentation reports on the findings from international case study research of urine-derived fertiliser networks in the USA, Europe, and South Africa, mapping both the formal and informal governance structures that exist across these unique nutrient value chains. Initial findings indicate that actors across the value chain face a complex array of governance challenges, including regulatory uncertainty, limited institutional coordination, and barriers to market entry. A further finding that emerged is the need for an earth-centred approach to governing the circular nutrient economy to balance human governance systems with the needs of the living ecosystems they depend upon.The presentation concludes by reflecting on what these international experiences mean for Australia, with its own unique governance challenges and bioregions. Navigating this landscape will require targeted policy reform, cross-sector collaboration, and greater integration of circular economy principles into existing regulatory frameworks.

#63 Policy and regulatory pathways for circular and low-carbon healthcare in Indonesia

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Sri Astuti Thamrin is the leader of the Applied Statistics and Data Science Research Group at Hasanuddin University. She has spent over twenty years developing statistical approaches to Indonesia's most pressing public health challenges. With a PhD from Queensland University of Technology, she has become particularly known for her work on dengue fever surveillance in Makassar, where she leads nationally funded research using spatial survival models to track disease patterns. Professor Thamrin's research portfolio spans from traditional epidemiological studies of non-infectious diseases to machine learning applications that predict obesity using Indonesia's national health survey data. During the COVID-19 pandemic, she examined human mobility patterns through an Australia Indonesia Centre collaboration. Beyond her research, Professor Thamrin has served as Vice Chair of the Statistics Society Forum and holds membership in the International Statistical Institute. Her contributions to clinical biostatistics earned her recognition from the International Society for Clinical Biostatistics in 2018. Professor Thamrin continues to bridge statistical theory and practical public health applications in Indonesia's evolving healthcare landscape.

Introduction & Objectives

Healthcare facilities are energy-intensive public services with a substantial climate footprint, yet policy pathways for their low-carbon and resource-efficient transition remain underdeveloped in many emerging economies (Hu et al., 2022; Karliner et al., 2020). In Indonesia, national commitments on decarbonisation and renewable energy are advancing, but their application to healthcare facilities remains fragmented across the health, energy, environment, and finance sectors (Resosudarmo et al., 2023; Sambodo et al., 2022). This study examines whether Indonesia's policy and financing framework is sufficiently aligned to support circular and low-carbon transitions in healthcare facilities, with attention to energy efficiency, renewable energy adoption, resource efficiency, green procurement, and sustainable waste management.

Methods

The study combines a structured review of 18 national and provincial policy documents with qualitative evidence from focus group discussions involving approximately 20–25 stakeholders in Gorontalo and North Sulawesi. Documents were coded using qualitative content analysis to assess policy coherence, financing provisions, and implementation barriers, while focus group data were analysed thematically and triangulated with the policy review. This design captures both regulatory architecture and implementation challenges in a decentralised governance setting, consistent with policy-mix and multi-level governance approaches used in transition studies (Li & Taeihagh, 2020; Rogge & Song, 2023; Zepa & Hoffmann, 2023).

Results & Discussion

The most significant finding is that Indonesia shows relatively strong vertical alignment from national to regional planning, but weak horizontal integration across health, energy, and finance. Existing regulations provide a broad enabling basis for renewable energy, environmental health, and sustainable finance, yet healthcare facilities are not explicitly positioned as priority actors within the energy transition. No dedicated financing pathway currently supports healthcare decarbonisation. Stakeholder evidence further indicates barriers in project bankability, procurement rules, emissions data, local fiscal capacity, and institutional capability. These findings suggest that the main constraint is not policy absence, but the lack of a coherent, sector-specific implementation framework. This interpretation aligns with wider evidence that healthcare decarbonisation depends on governance, metrics, and implementation capacity as much as on technology(Eckelman et al., 2024; Karliner et al., 2021; Smith et al., 2025). It also reflects the broader difficulty of renewable energy procurement and transition governance in Indonesia (Gamalliel & Fuady, 2024; Halimatussadiah et al., 2024).

Conclusions

Indonesia’s healthcare transition challenge is primarily one of policy integration rather than policy absence. Future work should develop sector-specific implementation pathways, including green procurement guidance, measurable sustainability indicators, and blended financing models for healthcare facilities.

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#66 **Preventive Environmental Impact Based on Local Wisdom in Indigenous Communities in West Sulawesi, Indonesia**

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Brief bio of speaker

Tuti Bahfiarti is a permanent lecturer, researcher, and writer of the Department of Communication Science, Faculty of Social and Political Sciences, Hasanuddin University. Consistent scientific qualifications in Communication Science studies in programs (Bachelor, Master, Doctoral). Interest in research on environmental communication issues. Has worked as a consultant program manager in research studies on Social Mapping, Corporate Social Responsibility, and Community Development Programs based on the environment since 2013 in the Sulawesi, Papua, and Maluku regions. CSR Program of PT Pertamina Persero Region VII and VIII. Consistent in the field of publication, author of books in reputable national and international journals, and speaker in various regular activities in government institutions. Supervisor of student research programs (Bachelor, Master, Doctoral) in the communication science expertise specification.

Abstract

Environmental impact is a pressing issue in Indonesia. Preventive efforts are a strategic step towards sustainability and preventing damage to forest ecosystems in West Sulawesi. Indigenous communities possess a rich tradition based on local wisdom in maintaining forest ecosystems. The challenges of increasingly rapid modernization and globalization have caused indigenous communities to face challenges in transferring local values to the younger generation. Therefore, indigenous communities strengthen traditions based on local wisdom in various aspects of life, including efforts to maintain harmony with nature through environmental conservation. In indigenous communities, forests are not only an economic resource but also an integral part of spirituality and cultural identity. This study uses a qualitative approach with in-depth interviews and non-participatory observation methods. This study explores forms of local traditions, such as traditional rituals in the life practices of indigenous communities dependent on forest commodities. The results show that indigenous communities integrate traditional values through traditional rituals, such as oral communication in the form of stories and traditional advice passed down from generation to generation. These traditional values aim to maintain social and spiritual harmony and protect forest ecosystems as a source of life. The implication of this research is to increase the involvement of the younger generation in maintaining sustainable forest ecosystems. Local wisdom values are cultural assets capable of providing solutions to social and environmental sustainability issues. Indigenous communities serve as role models in maintaining traditions in the era of globalization. This research can also provide guidance and direction for the government in formulating policies based on local wisdom so that damage and impacts to ecosystems can be prevented early.

Keywords: Environmental Impact; Local Wisdom; Indigenous Communities; West Sulawesi; Traditional Values.

#68 Plastic, Wildlife, and Communities: Addressing Plastic Pollution in Indonesia's Coastal Communities

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Brief bio of speaker

Nurul Ichsani is a lecturer in the Department of Communication at Hasanuddin University (Universitas Hasanuddin/UNHAS), Makassar, South Sulawesi, Indonesia, where she has taught since 2015. She holds a Bachelor of Social Sciences and a Master of Communication Studies.
Her primary research focus is media studies, including social media, television, and film. She explores topics related to government policy's impact on democracy, community, and women. Nurul Ichsani believes media has the power to influence people and drive change.
Notably, in 2009, she produced a television program covering pollution issues in Makassar, Indonesia, demonstrating her commitment to using media for social awareness.

Abstract

Indonesia ranks among the world's largest producers of plastic waste and simultaneously hosts exceptional biodiversity, making plastic pollution a critical conservation and socio-environmental challenge. Bulukumba, South Sulawesi, faces pervasive plastic contamination that affects both marine and terrestrial ecosystems, including local populations of Macaca spp. This study explores local community perceptions of plastic pollution and their understanding of its impacts on Macaca, with the aim of informing community-driven conservation strategies that benefit wildlife and people.
Using a qualitative approach, we conducted in-depth, semi-structured interviews with three stakeholder groups: residents of coastal and inland communities, representatives of local government, and owners/managers of hotels and villas operating in Bulukumba. Purposive and snowball sampling ensured diverse perspectives across age, occupation, and proximity to Macaca habitats. Interview topics included awareness of plastic sources and pathways, observed environmental and wildlife impacts, existing waste practices, and openness to mitigation strategies. Interviews were audio-recorded, transcribed, and analyzed to identify dominant patterns and divergent views.
The analysis revealed several findings. Awareness of plastic pollution was high, but knowledge about specific ecological pathways and long-term effects on wildlife varied widely. Many community members reported frequent sightings of Macaca foraging among plastic debris and anecdotal instances of entanglement or ingestion. Hotel and villa operators expressed concern over waste management's effects on tourism appeal yet cited infrastructural and economic barriers to improved practices. Local government officials acknowledged regulatory gaps and resource constraints but showed openness to collaborative solutions.

These results indicate strong potential for leveraging existing concern and local knowledge to co-develop targeted conservation actions—such as community-led waste collection, educational campaigns linking plastic risks to Macaca health, and partnerships with the hospitality sector to reduce single-use plastics. The study underscores the value of integrating local perceptions into policy design to ensure culturally appropriate, feasible, and sustainable interventions. By centering stakeholders' views, conservation initiatives can more effectively address plastic pollution while supporting both biodiversity protection and community wellbeing in Bulukumba.

#70 Utilising pre-farm gate organics to build regional circular bioeconomy

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Brief bio of speaker

Dr Melita Jazbec is a Research Director at the UTS Institute for Sustainable Futures, specialising in resource, energy and water systems with a focus on circular economy transitions and sustainable waste management. With a background in chemical engineering and a PhD in chemical kinetics and computational fluid dynamics, her work applies spatial modelling, systems analysis and techno-economic assessment to resource recovery and circular bioeconomy development.

She leads multidisciplinary projects informing policy, strategy and infrastructure planning across government and industry. Her recent work includes national-scale analysis of organic waste flows to identify hotspots and support the feasibility of circular economy interventions in agriculture, fisheries and forestry.
Melita has extensive experience in resource recovery, waste strategy development, and circular economy implementation, and contributes to national advisory initiatives including Circular Australia, MECLA and NABERS.

Abstract
Recent research funded by AgriFutures and its partners has defined what a successful circular economy could look like for Australian agriculture, fisheries, and forestry. The study also examined cross-sectoral opportunities for utilising organic waste residues generated by the agricultural sector, considering economic, regulatory, and implementation aspects, while maintaining a technology-agnostic approach.
This presentation provides analysis that supports data-driven decision-making for the siting and feasibility of large-scale circular economy interventions, such as energy and nutrient recovery. It is based on spatial modelling analysis of pre-farm gate organic wastes across Australia at a fine spatial resolution to identify hotspots where resource concentrations are highest. These insights have practical applications for stakeholders seeking economically viable deployment of circular economy initiatives, including bioenergy projects. An illustrative case study demonstrates how availability maps and hotspot data, combined with financial analysis, can inform the evaluation of potential circular economy measures.
Pre-farm gate organic residues – including manures, crop residues, and harvest losses – represent an underutilised resource with significant potential to deliver environmental and economic benefits when recovered through appropriate technologies. The data generated in this study supports decision-making and the identification circular economy opportunities for the sectors. A high-resolution spatial modelling approach was developed by disaggregating low-resolution organic residue generation estimates to a higher spatial resolution, using land use classification data from the Australian Land Use and Management (ALUM) dataset. The analysis considered four residue types – animal wastes, green material, product losses and sludges – across thirteen agricultural, horticultural, dairy and livestock production industries across Australia.
This approach delivers high resolution spatial datasets characterising the availability of organic residues across Australia. Hotspots of concentrated available residues indicate areas with strong potential for financial and technically viable deployment of circular economy initiatives and resource recovery infrastructure. These spatial concentration of residues often occur in areas on the periphery of urban and population centres, highlighting opportunities for circular economy investment, and guiding infrastructure planning to build Australia's circular bioeconomy.
Griffith, New South Wales is presented as a case study to illustrate how spatial data analysis can support feasibility assessment, including estimating the electricity generation potential of anaerobic digestion using locally available manures. For this case study, a financial analysis is conducted comparing two business models: (1) on-farm utilisation of organic residues to generate energy and capture nutrients and (2) establishing a cooperative circular economy hub able to capture and process energy, heat, nutrients. Additional benefits, such as carbon credits, are also considered.
Finally, the Griffth Case Study, outlines the approvals required to process organic wastes on-farm or within a circular economy hub. Establishing new circular economy projects for organic residues – legally classified as waste – faces regulatory hurdles that vary across jurisdictions and require navigation through multiple government agencies, permits and compliance processes.

#74 Forward osmosis for concentrating lithium-enriched brine: From system design to salt diffusion control

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Brief bio of speaker
Shucheng Mo is a Ph.D. candidate at ShanghaiTech University. His research centers on process design and mass-transfer modeling of membrane systems, with a focus on hollow fiber membranes, forward osmosis, and nanofiltration. His works have published in Desalination.

Abstract
Forward osmosis (FO) utilizes concentrated salt-lake brine as a draw solution (DS), offering a low-carbon technology for extracting water from lithium-enriched brine. However, scaling from membrane modules to industrial systems poses significant trial-and-error costs in time and investment. Furthermore, existing system designs often overlook bi-directional salt diffusion, which critically impacts lithium purity and recovery. This study bridges these gaps by developing a comprehensive model that integrates membrane characteristics, system design, and salt diffusion effects for industrial-scale FO concentration.

A system-level mathematical model was developed for hollow fiber (HF) FO modules targeting a typical industrial output of 10k tons of Li_2CO_3. Utilizing a master curve of water flux versus feed concentration, the model systematically investigated key parameters: concentration polarization along the module, membrane structural parameter (S), crossflow velocity, DS concentration, flow directions (co- and counter-current), and specific membrane rejections. A $LiCl$-$MgCl_2$ mixture was specifically used to simulate and analyze bi-directional salt diffusion dynamics.
At the module scale, the structural parameter (S) is the primary determinant of the required membrane area, while crossflow velocity has a minor but non-negligible impact. At the system scale, a multi-stage design (e. g., 3 stages) effectively reduces the number of required modules and DS flow while maximizing DS osmotic pressure utilization. Regarding salt diffusion, the counter-current mode significantly outperforms the co-current mode in enhancing lithium purity and recovery. High-rejection FO membranes are essential, as Mg^{2+} rejection dictates lithium purity, while Li^+ rejection governs recovery. Contrary to conventional intuition, a lower concentration ratio is optimal; further concentration at high feed concentrations drastically increases salt flux. For realistic membrane rejections (Li^+: 97.1%, Mg^{2+}: 99.6%), the model achieves 99% lithium purity and 94% recovery at a 5 g/L feed concentration.
The proposed model successfully bridges HF FO membrane properties with industrial system design. By simultaneously optimizing hydraulic performance and bi-directional salt diffusion, it serves as a practical and reliable tool for FO membrane selection and process optimization. This methodology not only facilitates the low-carbon extraction of lithium from salt-lake brines but also holds broad applicability for other multi-salt FO systems utilizing HF membranes.

#76 Waste Polymer to Purpose-Built Materials: A Machine-Learning Framework for Mapping Upcycling Routes

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Brief bio of speaker

Pooria Pasbakhsh is a Research Fellow and Technical Manager at the University of Melbourne, working at the intersection of materials science, sustainable construction, and research commercialisation. His current portfolio spans CRC-P industry partnerships covering industrial hemp composite production, lithium-ion battery recycling, material characterisation and machine-learning-driven prediction of material properties for low-carbon construction materials. His background combines academic research leadership with technical experience in advanced materials characterisation, giving him a practical, industry-facing perspective on translating waste and secondary materials into functional, high-performance products. He is a member of the CECE Scientific Advisory Committee.

Abstract

Plastic waste valorisation has matured rapidly, and post-consumer and post-industrial waste polymers are now demonstrated feedstocks for a wide range of purpose-built materials, separation and filtration media, construction composites, carbon and catalytic materials, and electrodes for energy storage, produced via mechanical reprocessing, solvent-based recovery, pyrolysis, and functional post-polymerisation modification. This body of work is substantial and increasingly well synthesised, including recent comprehensive reviews mapping waste polymer chemistry to functional material classes across multiple application domains. What remains largely unaddressed is a predictive, decision-support layer that sits across this landscape: given a waste polymer stream's characterisation profile (structural, morphological, thermal, mechanical), which processing route and which downstream application offer the best technical and economic fit? This review synthesises the published literature mapping waste polymer type, upcycling route, and resulting functional material class and performance, and proposes a machine-learning framework trained on reported characterisation and performance data to predict, across candidate applications, the best-fit upcycling pathway for a given waste stream ahead of physical trial-and-error. Rather than proposing a single new material or process, the contribution is methodological: a reusable, characterisation-driven tool that reduces the qualification cost currently limiting industrial uptake of waste-derived materials for higher-value, purpose-built applications. We discuss implications for de-risking capital allocation, decentralised manufacturing, and standardisation of waste-material characterisation reporting, positioning the work toward industrial translation rather than materials discovery alone.

#77 Space-efficient nutrient recovery from source-separated hydrolysed urine using GAC pretreatment coupled with an integrated submerged membrane aeration–filtration system

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Brief bio of speaker

Dr Hsin-Chieh Lin is an environmental engineer specialising in membrane-based biological treatment, nitrogen transformation and nutrient recovery. She completed her PhD in Environmental Engineering at National Taiwan University, where her research focused on hybrid membrane-aerated biofilm reactor (MABR) systems for energy-efficient nitrogen removal from wastewater and life-cycle assessment. She is currently a Visiting Fellow and researcher at the University of Technology Sydney, investigating integrated membrane-aerated submerged membrane bioreactor system for stabilising and recovering nutrients from source-separated urine and other nutrient-rich streams.

Abstract

Source-separated human urine represents a concentrated and readily recoverable source of nitrogen and other essential plant nutrients, yet its direct reuse is constrained by urea hydrolysis, high ammonium concentrations, residual biodegradable organic matter, odour, and the risk of nutrient loss during storage and handling. Although urine constitutes only a small fraction of domestic wastewater volume, it carries a disproportionate nutrient load; recovering it separately can reduce downstream treatment demand and dependence on energy-intensive synthetic fertilisers.

Biological nitrification can stabilise urine-derived nitrogen by converting volatile ammonium into oxidised nitrogen; however, conventional suspended-growth systems generally require long hydraulic retention time (HRT) to retain slow-growing nitrifiers, resulting in large reactor footprints and limiting decentralised application. To address these limitations, this study developed a compact two-stage nutrient-recovery system comprising an upflow GAC-packed bed followed by an integrated membrane-aerated biofilm and submerged-filtration bioreactor. The upflow GAC-packed bed was designed to attenuate the organic loading before biological nitrogen conversion, thereby creating more favourable conditions for nitrification in the downstream unit. The integrated membrane-aerated submerged membrane bioreactor (MAsBR) was subsequently employed to intensify nitrification within a compact reactor volume, enabling nutrient recovery from high-strength hydrolysed urine at a shorter HRT than conventional urine-fed biological treatment systems. In the MAsBR, gas-permeable membranes supplied oxygen directly and without bubbles to an attached biofilm, enabling efficient oxygen utilisation and retention of slow-growing nitrifiers, whereas submerged filtration membranes retained suspended biomass and produced a clarified nutrient-rich permeate.

The system was operated continuously and progressively acclimated to increasing urine strengths, from tenfold to twofold dilution, with pH controlled under mildly acidic conditions to support nitrification and limit ammonia volatilisation. Treatment performance was evaluated using concentration profiles of chemical oxygen demand (COD), ammonium, nitrite, nitrate and total nitrogen across the treatment train, together with nitrogen transformation. Preliminary results demonstrated a stepwise decrease in COD across the GAC pretreatment and MAsBR, while the integrated reactor sustained ammonium conversion as the urine concentration increased. At elevated ammonium concentrations, 38–47% of the influent ammonium was converted at an HRT of approximately 20 h, producing a clarified permeate containing both ammonium and oxidised nitrogen forms while avoiding the intentional removal of valuable nitrogen. By combining biofilm-based nitrifier retention, membrane-mediated oxygen delivery and membrane-based solids separation, the MAsBR increased the volumetric capacity of biological urine treatment.

Overall, the integration of membrane-aerated biofilm nitrification and submerged membrane filtration enabled biological nitrogen stabilisation and solids separation within a compact treatment unit, while the upstream GAC-packed bed provided complementary organic matter attenuation. The proposed system advances source-separated urine management from pollutant removal towards resource-oriented treatment and provides a scalable platform for producing clarified urine-derived nutrient solutions with reduced reactor volume and increased treatment throughput. This approach supports decentralised resource recovery from urine, reduces nutrient loading on centralised wastewater treatment plants, and promotes circular nutrient management through the potential agricultural reuse of the recovered nutrients.

#79 Transforming Lithium Refining By-products into Circular Economy Resources

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Dr John Moursounidis, Manager Research and Innovation, ChemCentre
Dr John Moursounidis is Manager Research and Innovation at ChemCentre, where he leads research programs and collaborations that apply analytical science to public health, environmental safety, sustainable industry development and essential scientific infrastructure. Since joining ChemCentre in 2021, John has drawn on more than 30 years of experience in R&D management, leadership and general management across the pharmaceutical, fine chemical, consumer healthcare and food industries.
A key focus of John’s work is supporting Western Australia’s transition to a more circular economy. He leads and supports research that helps government, industry and research partners improve resource recovery, characterise waste and by-product streams, reduce environmental risk and identify higher-value uses for materials generated by mining, minerals refining, primary industry and environmental management activities. His work connects scientific capability with practical decision-making, helping translate complex chemistry and analytical data into evidence that can support sustainable policy, regulation and industry practice.
John also oversees multi-year collaborative projects that bring together government agencies, universities and industry partners to address challenges in critical minerals, environmental monitoring, circular materials and sustainable industrial development. He holds a PhD in Organic Chemistry from the University of Western Australia and completed postdoctoral research at Indiana University in the United States.

Abstract
Transforming Lithium Refining By-products into Circular Economy Resources
Western Australia's lithium refining industry generates substantial quantities of delithiated beta spodumene by-product (DBS), creating both a management challenge and an opportunity to improve resource efficiency. Approximately 8 to 11 tonnes of DBS are produced for every tonne of lithium hydroxide manufactured, with disposal representing a significant cost to industry. The DBS Program is a collaborative government, industry and research initiative that seeks to transform this by-product into a valuable resource for construction and infrastructure applications.
The program is developing the scientific, environmental, human health and engineering evidence required to support beneficial reuse pathways for DBS, alongside standards development, field trials and regulatory engagement. By replacing virgin quarry materials in selected applications, DBS has the potential to reduce waste, conserve natural resources, lower infrastructure costs and strengthen the sustainability of Western Australia's critical minerals sector. This paper presents the program's evidence-based approach to enabling circular economy outcomes and highlights how industrial by-products can be transformed into valuable secondary resources that support both economic growth and environmental sustainability.

Keywords: Circular economy, lithium refining, delithiated beta spodumene (DBS), beneficial reuse, critical minerals, sustainable infrastructure.

#80 Where to next for circular bioeconomy?

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Brief bio of speaker
Dr Maja Arsic is a Research Scientist in the Agrifood Systems Program, CSIRO Agriculture & Food. She is passionate about developing pathways to accelerate sustainable transitions in agrifood systems, with a focus on the circular bioeconomy by working across the science-policy interface through roles such as advisor for the UN Food & Agriculture Organization’s Livestock Environmental Assessment Partnership, and Science & Technology Australia STEM Ambassador. She works on embedding circularity in the food system and in emerging bioeconomy industries such as low carbon liquid fuels, and for shaping sustainable bioeconomy pathways for agriculture by 2050. Dr. Arsic currently works with a range of stakeholders and sectors, including aquaculture, water, bioenergy, and livestock industries, to design and deliver pathways towards achieving circularity at local, regional and international scales.

Abstract

The growing awareness of linear production, consumption and waste models is prompting exploration of circular economy and bioeconomy models. The ‘circular bioeconomy’ sits at the nexus of these concepts and is critically important for sustainable agrifood systems, which plays roles such as producing biologically based materials and services, and converting “wasted” organic resource streams into safe and sustainable bioresources. As growing demand for bioresources may lead to interacting and competing demands across food security, bioenergy, and net zero priorities, circular bioeconomy research can play a key role in navigating trade-offs and developing pathways that seek to deliver multiple benefits for finite bioresources. This presentation will provide new insights into the current circular bioeconomy research landscape for agrifood systems from energy, food system, and circularity perspectives. By reflecting on recent regional research spanning Australia and New Zealand and emerging policy drivers across this space, this presentation highlights critical advances needed to shift circular bioeconomy research efforts to deliver real-world solutions in an increasingly competitive world for bioresources.

All poster presenters

#50 Recovery from Human Urine for Fertilizer Production: *A Systematic Review and Conceptual Process Assessment*

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Brief bio of speaker
Kaicheng Zhang is a Master of Engineering student in Environmental Engineering at the University of Technology Sydney, Australia. His current research focuses on nutrient recovery from source-separated human urine and the development of circular fertilizer production strategies within urban circular economy frameworks. He is particularly interested in how decentralised sanitation, source separation and resource recovery can be integrated into existing water and wastewater infrastructure.
He completed his Bachelor of Science with honours in Environmental Science and Earth Sciences at the University of Toronto, where he received broad training in environmental chemistry, hydrology, soil science and solid waste management. During his undergraduate studies, he became involved in research on converting municipal solid waste incineration fly ash into value-added materials and co-authored a journal article on waste-to-resource technologies. These experiences provided him with a foundation in experimental design, data analysis and the translation of laboratory findings into practical engineering insights.
In his current master’s project, he is conducting a systematic review and conceptual assessment of nutrient recovery processes for human urine, including struvite precipitation, ammonia stripping-acid absorption and membrane-based configurations. By synthesising reported performance data and constructing simplified mass balance and process scenarios, he aims to compare different process routes in terms of nutrient recovery efficiency, resource demand and potential climate benefits. His broader research interests include circular economy for water and nutrients, resource recovery from human excreta and wastewater, and the techno-economic and environmental assessment of emerging treatment processes. He plans to continue working on sustainable sanitation, circular resource systems and evidence-based engineering design through future research and collaboration.

Abstract
The transition from a linear nutrient disposal paradigm to a circular resource recovery model is a central challenge in environmental engineering, particularly for nitrogen and phosphorus management. Human urine, although comprising only about 1% of municipal wastewater volume, contributes roughly 80% of nitrogen, 50-56% of phosphorus and 63% of potassium in domestic sewage, making source-separated urine one of the most concentrated and accessible entry points for closing anthropogenic nutrient cycles. This study provides a comprehensive, integrated review of technologies and system configurations for recovering nitrogen, phosphorus and potassium from source-separated human urine for fertilizer production.

The physicochemical composition of fresh and stored urine is synthesised from a broad body of literature, and quantitative comparisons with commercial fertilizer specifications are established to assess nutrient concentration, plant availability and impurity profiles. Core nutrient recovery processes are critically evaluated, including struvite precipitation for phosphorus with reported removal efficiencies typically in the range of 80-99%, ammonia stripping-acid absorption and bipolar membrane electrodialysis for nitrogen with 85-97% recovery, and membrane-based concentration and separation processes - forward osmosis, electrodialysis and membrane distillation - for nutrient enrichment and water reclamation. The review also analyses the behaviour and removal of micropollutants such as pharmaceuticals and hormones along these treatment trains, and compiles agronomic evidence from greenhouse and field trials demonstrating that urine-derived fertilizers can achieve crop yields comparable to conventional synthetic inputs under calibrated application rates.
Technical-economic assessments reported in the literature indicate that urine collection and logistics frequently account for approximately 40-60% of total system costs, while life cycle assessment studies consistently suggest potential 20-50% reductions in global warming potential relative to conventional fertilizer pathways, depending on electricity mix and system boundaries. Integrated multi-product treatment trains achieving simultaneous N, P and K recovery are compared with single-nutrient alternatives, highlighting trade-offs between recovery efficiency, energy demand, chemical consumption and product quality. Major research gaps are identified in long-term technical-economic data, harmonised life cycle assessment methodologies and regulatory frameworks for micropollutant residues in urine-derived fertilizers. Overall, the evidence positions urine-based fertilizers as technically viable and environmentally promising components of circular nutrient management, while underscoring that implementation depends on infrastructure investment, public acceptance and policies that recognise recovered nutrients as products rather than waste.

#62 Rethinking the Life Cycle of Plastics: Polyethylene Upcycling

Madeleine Miyamoto[1] and Martina Lessio[1]

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Brief bio of Madeleine

Madeleine is a first-year PhD student in the School of Chemistry at the University of New South Wales (UNSW) under the supervision of Dr Martina Lessio. She specialises in polymer and computational chemistry and is passionate about environmental sustainability. Her research focuses on upcycling polyethylene, one of the most widely used and environmentally persistent plastics. Through molecular dynamics simulations, her work aims to better understand polymer behaviour at a molecular level and to improve the development of chemical recycling strategies.

A key motivation underlining Madeleine's research is the transition towards a circular economy. This interest extends beyond academic research, with an ongoing commitment to learning about recycling technology, materials innovation, and industry practices. By combining computational approaches with polymer chemistry, Madeleine seeks to contribute fundamental insights that can support practical, scalable solutions to plastic waste.

Originally from the United States, Madeleine holds a Bachelor of Science in Biochemistry from the University of California, Santa Barbara (UCSB). During her undergraduate studies, her academic interests were concentrated on polymer chemistry and computational biochemistry, providing a strong interdisciplinary foundation.

Outside of academic research, Madeleine maintains an active lifestyle and enjoys surfing and rock climbing. She also has a personal interest in regenerative agriculture and sustainable food systems, reflecting a broader commitment to closing the loop. Together, these academic and personal interests shape a research trajectory driven by curiosity, interdisciplinary thinking, and a desire to contribute meaningfully to a more sustainable future.

Abstract

Plastic waste is accumulating at an exponential rate, posing a growing environmental and economic challenge worldwide. At the same time, limitations in current recycling technologies— such as low efficiency, material degradation, and poor scalability— are hindering meaningful progress toward a circular economy. The wide variety of plastics, or polymers, used in daily life requires equally diverse and tailored recycling strategies. Among these, polyolefins such as polyethylene and polypropylene are produced at the greatest scale and are the most

environmentally persistent. Polyolefins consist of long hydrocarbon chains containing strong inert carbon-carbon bonds. The strength provides exceptional durability, however results in a significant challenge for recycling.

Catalytic hydrogenolysis is a viable and promising alternative to upcycle polyolefin by converting it into medium-length hydrocarbons that can be used as high-value fuels [1]. The process operates by cleaving the carbon-carbon backbone of polyolefins with a transition-metal catalyst and hydrogen gas. Optimisation of this process is required to reduce methane formation, a greenhouse gas, and improve selectivity towards high-value fuels.

To address these limitations, molecular dynamics (MD) simulations will be employed to investigate polymer-catalyst interactions. By elucidating these interactions at the molecular level, we gain mechanistic insights that can be leveraged to tune product selectivity.

Hydrogen gas is a key reactant in the cleavage of carbon-carbon bonds and is essential for the formation of saturated hydrocarbons. Despite the critical role of hydrogen, most molecular computational models have neglected it thus far. In this work, we focus on the role of hydrogen as it affects the reaction and selectivity. A previous study shows that hydrogen gas adsorbs onto the catalytic surface, disassociating into atomic hydrogen [2].
Hydrogenating the surface typically precedes the introduction of melted polymer in experimental procedures.

This work develops a new model to represent the interactions between the polymer and the hydrogenated surface. Additionally, we use the model to investigate how the reaction proceeds as additional hydrogen gas is added into the system, as it is consumed throughout the reaction. Overall, this study provides insights into critical, unexplored aspects of catalytic hydrogenolysis, offering guidance for the design of new hydrogenolysis systems to efficiently convert plastic waste to high-value fuels.

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#67 Anthroponics: Nutrients recovery from urine and their use as fertiliser on mini green walls

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Brief bio of lead presenter

Dr. Ibrahim El Saliby is a research manager with a wealth of experience in managing and maintaining research projects in nutrient recycling, wastewater treatment and reuse, and plant propagation and production for plant science and conservation. Dr. El Saliby holds a Doctor of Philosophy in Environmental Engineering from the University of Technology Sydney, a Master of Science in Plant Sciences from the American University of Beirut and a Diploma of Agricultural Engineering from the Lebanese University.

Abstract

This study investigates the use of recovered nutrients from human urine as a sustainable fertiliser solution for plant growth in mini green walls, aiming to support circular economy principles and reduce environmental pollution. Human urine is rich in essential nutrients vital for biomass production, making it a promising alternative to conventional fertilisers. The University of Technology Sydney (UTS) has developed the UrVal technology which successfully recycles essential nutrients, enabling nutrient loop closure and waste reduction. The UrVal technology

converts urine into UrVal fertiliser, whose performance is here compared with a commercial fertiliser (Cal-Mg grower, ICL) and a control (no fertiliser) in supporting plant growth.

The experimental setup involves mini green walls constructed using the G-Sky Versa Wall system with 117 individual pots arranged in a 13-column by 9-row grid. Three identical walls, MGW1, MGW2, and MGW3, located in the Royal Botanic Gardens Nursery, were assigned distinct treatments: control (no fertiliser), Cal-Mg grower at 200 ppm nitrogen, and UrVal fertiliser at 200 ppm nitrogen. The study included three plant species: Heuchera sp., Alternanthera Red Ruby, and Syngonium sp., with 40 plants per species distributed across the walls. A recirculating hydroponic system facilitated nutrient and water delivery, with continuous monitoring and adjustments to pH (maintained between 6.5 and 6.8) and electrical conductivity (EC) to ensure optimal growing conditions.

Over an 8-week period from November 2025 to January 2026, plant growth was monitored biweekly by measuring plant height, while fresh and dry biomass of shoots were assessed at the conclusion of the experiment. The results revealed that plants treated with UrVal fertiliser showed comparable growth performance to those receiving the commercial fertiliser and considerably better growth than the control group. For example, Alternanthera treated with UrVal achieved fresh leaf weight of 40.58 g and dry leaf weight of 4.64 g, closely matching the results with Cal-Mg grower (39.60 g and 4.20 g) and significantly surpassing the control (13.46 g and 2.22 g). Plant height measurements similarly demonstrated that UrVal-treated plants exhibited sustained growth increases consistent with commercial fertiliser treatments across all assessed species.

This study confirms the feasibility of using human urine-derived fertilisers in ornamental horticulture, particularly in urban applications such as mini green walls, offering an environmentally sustainable alternative to synthetic fertilisers. The findings provide strong evidence supporting nutrient recovery from human waste as a component of sustainable urban agriculture and circular economy strategies.

#72 Mechanical performance and structural stability of waste PC and HDPE during repeated direct hot-press recycling

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Brief bio of speaker

Abstract

The growing accumulation of plastic waste and the need for sustainable resource recovery have increased interest in recycling technologies that can reuse engineering thermoplastics while maintaining functional performance. Hot-press recycling offers a simple and energy-efficient alternative to conventional recycling methods by converting shredded plastic waste directly into reusable products without extensive reprocessing. Successive thermal processing cycles however, can induce morphological, interfacial, and structural changes that influence the long-term performance of recycled polymers.

This study investigated the effects of repeated hot-press recycling on the mechanical, thermal, and chemical characteristics of waste polycarbonate (PC) and high-density polyethylene (HDPE), with particular emphasis on the evolution of structure-property relationships during successive recycling. Unprocessed waste PC and HDPE flakes (as-received materials) were processed into sheets under optimised hot-press conditions and subsequently reprocessed through two successive cycles of shredding and hot-press recycling. Mechanical performance was evaluated using tensile, flexural, and Charpy impact testing, while thermal and chemical behaviours were characterised using Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), and Fourier Transform Infrared Spectroscopy (FTIR). As-received and recycled materials were systematically compared to determine the influence of repeated hot-press processing.

Results demonstrated that repeated recycling significantly influenced the mechanical properties of both polymers. For PC, flexural strength decreased from 87.9 MPa in the as-received material to 54.3 MPa after the first cycle and 22.5 MPa after the second cycle. This reduction is attributed to the high sensitivity of flexural loading to recycled morphology, where interfacial boundaries between consolidated flakes, surface imperfections, and localised defects act as stress concentration sites that promote premature crack initiation. In contrast, PC tensile strength increased after the first recycling, which is associated with improved flake consolidation, enhanced interfacial contact, and

relaxation of residual stresses during hot pressing. Further recycling, however, resulted in tensile degradation due to the accumulation of microstructural defects and progressive thermal damage. HDPE exhibited a continuous reduction in tensile and flexural strength with increasing number of cycles, indicating greater susceptibility to cumulative structural deterioration during repeated processing.

Despite the changes in mechanical behaviour, thermal and chemical analyses demonstrated that the fundamental polymer characteristics were largely preserved. DSC showed that the glass transition temperature of PC remained approximately 145 °C throughout all recycling stages, whereas HDPE exhibited only minor variations in melting and crystallisation behaviour. TGA confirmed comparable thermal stability between as-received and recycled samples, while FTIR analysis revealed no significant changes in chemical functionality.

These findings demonstrate that repeated hot-press recycling primarily influences the mechanical integrity of recycled PC and HDPE through morphology-driven defect evolution rather than significant chemical transformation. The contrasting tensile and flexural responses highlight the importance of evaluating multiple loading modes when assessing the performance of recycled polymers and provide new insights into the applicability and limitations of direct hot-press recycling for the recovery of engineering thermoplastic waste.

#75 Competitive co-assembly for high-performance LbL nanofiltration

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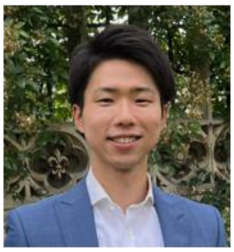
Brief bio of speaker
Quan Yuan is a first-year Ph.D. candidate at the Shanghai Advanced Research Institute, Chinese Academy of Sciences. Her research interests include polyelectrolyte multilayer assembly, nanofiltration membranes for selective ion separation and micropollutant removal. She has published in *Water Research* and *Desalination*.

Abstract
Layer-by-layer (LbL) nanofiltration (NF) membranes provide a versatile platform for ion separation owing to their tunable pore structures and charge characteristics. However, achieving simultaneously high permeance, excellent Li^+/Mg^{2+} selectivity ($S_{Li/Mg}$) and saline stability remains challenging, particularly for lithium extraction from salt-lake brines. Conventional poly(sodium 4-styrenesulfonate) (PSS)/poly(allylamine hydrochloride) (PAH) and PSS/poly(diallyldimethylammonium chloride) (PDADMAC) systems offer complementary advantages but are subject to an intrinsic permeance-selectivity-stability trade-off.
Herein, we propose a co-assembly strategy using PAH and PDADMAC as mixed polycations (Pol^+) to construct PSS/Pol^+ LbL NF membranes. In a chaotropic KBr environment, enhanced chain mobility promotes competitive assembly between Pol^+. Benefiting from its smaller aggregate size, higher diffusion capability and additional hydrogen bonding interactions with PSS, PAH exhibits preferential adsorption during assembly, resulting in its selective enrichment within the polyelectrolyte multilayers (PEMs). This competitive co-assembly enables precise regulation of PEM thickness, pore structure and charge characteristics.
The mixed Pol^+ strategy effectively mitigated the conventional permeance-selectivity-stability trade-off. Introducing only 1% PAH resulted in a water permeance of 10.8 LMH/bar, while increasing the PAH fraction to 15% enhanced saline stability, increasing the critical salt concentration to 1.5 M and achieving a $S_{Li/Mg}$ of 124. Moreover, pH modulation of the mixed Pol^+ solution served as a switch to regulate PAH protonation and competitive assembly behavior, allowing the predominant Pol^+ and the resulting membrane properties to be tuned, with an optimized $S_{Li/Mg}$ of 355.
This work reveals the competitive co-assembly behavior of mixed Pol^+ and provides a composition- and pH-controlled assembly regulation strategy for designing high-performance, salt-stable LbL NF membranes for lithium extraction from complex brines.

#78 Takuma Does the circular economy address material poverty?

Takuma Watari



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Brief bio of speaker

I am a Senior Researcher in the Material Cycles Division at the National Institute for Environmental Studies, Japan. I lead the Provisioning Systems Group, where we study how societies can provide essential energy and material services within planetary boundaries. I also hold an Adjunct Fellow position at the Institute for Sustainable Futures, University of Technology Sydney. Previously, I worked at the University of Cambridge (2022-2023) and Leiden University (2024-2026). I received my PhD from the University of Tokyo in 2021, where I won the Dean's Award and became the first student in the department to complete the PhD program within a two-year timeframe.

Abstract
Circular economy strategies are increasingly framed as tools for national security, resilience, and industrial competitiveness. This geopolitical turn may secure materials for affluent economies and firms while doing little for people with the least access. Just as energy justice is rooted in 'energy poverty', we propose that circular justice should be anchored in 'material poverty'. In this framing, justice in the circular economy is assessed by whether it expands access to essential material services for people with the least access. We call for a collective effort to better understand not only how many tonnes of materials are extracted, accumulated, or circulated, but also which material services are delivered, who can access them, and who remains deprived.

#41 PHREEQC-XGBoost Hybrid Modeling of Mineral Carbonation from Seawater Desalination Brine considering Inhibition effects of Antiscalants

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Brief bio of speaker
Juyeon Yu is a researcher at CJK with a master's degree. She is currently engaged in R&D projects related to water treatment, desalination brine treatment, and brine resource recovery. Her main research interests include high-salinity wastewater treatment and sustainable resource recovery technologies.

Abstract
As seawater desalination expands to address global water scarcity, sequential mineral carbonation-precipitation processes have emerged as a promising technology for recovering magnesium and calcium from brine while simultaneously sequestering carbon dioxide. However, residual antiscalants from upstream reverse osmosis processes inhibit nucleation and crystal growth, causing significant discrepancies between precipitation prediction models and actual recovery yields. This study proposes a hybrid modeling framework coupling PHREEQC dynamic modeling with XGBoost machine learning to quantify these kinetic inhibition effects. First, theoretical recovery rates of $Mg(OH)_2$ and $CaCO_3$ were calculated using the Pitzer database, and experimental recovery data were obtained through precipitation tests using synthetic desalination brine under various antiscalant concentrations. A kinetic correction factor, defined as the ratio of measured to predicted recovery, was then modeled via XGBoost as a function of pH, temperature, and antiscalant concentration. The developed XGBoost model achieved high performance with an RMSE below 0.03 and an R^2 above 0.95, effectively correcting the overestimation inherent in standalone PHREEQC models. These findings are expected to serve as a critical foundation for optimizing the design and establishing operational control algorithms for desalination brine resource recovery processes.

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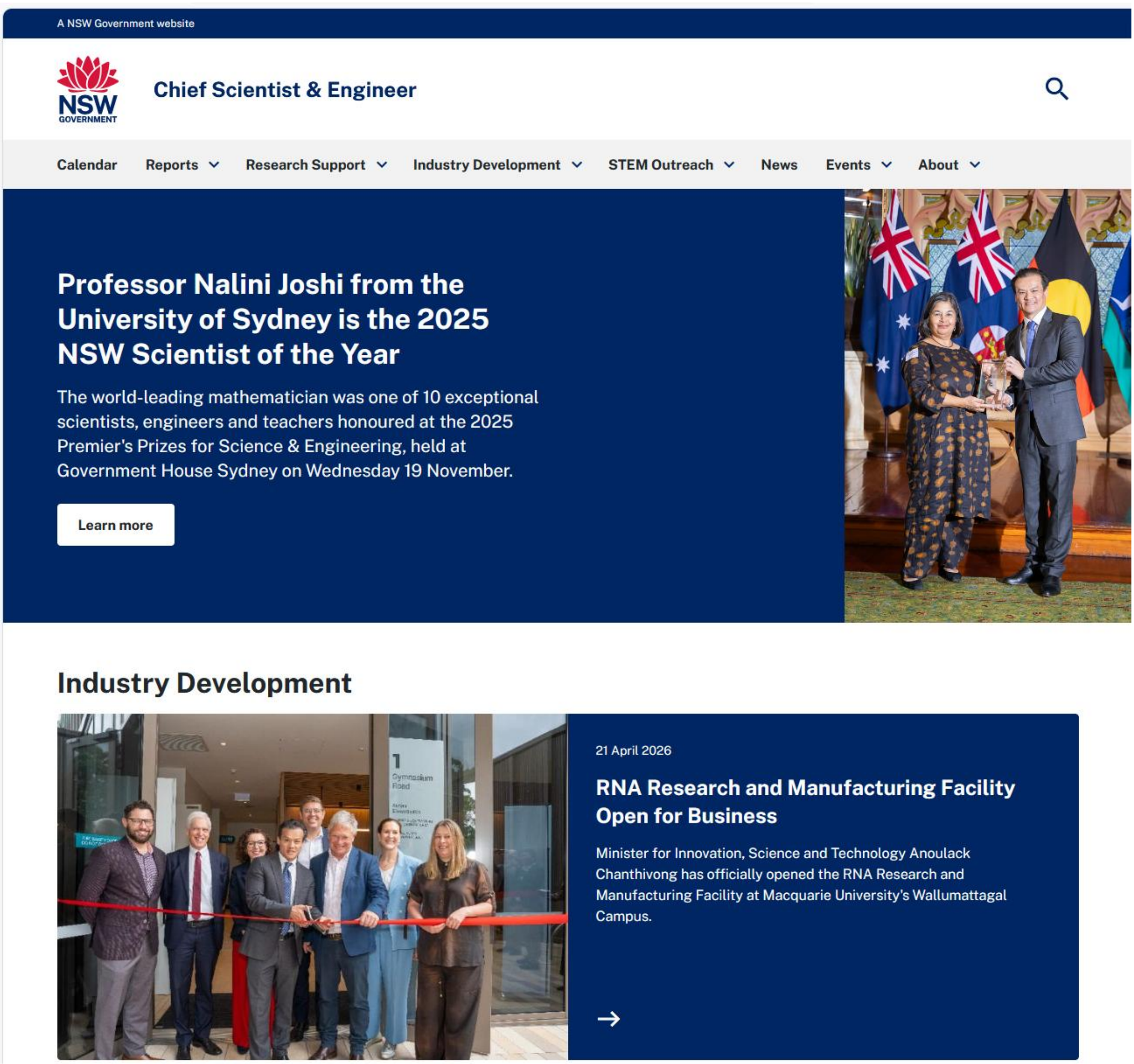

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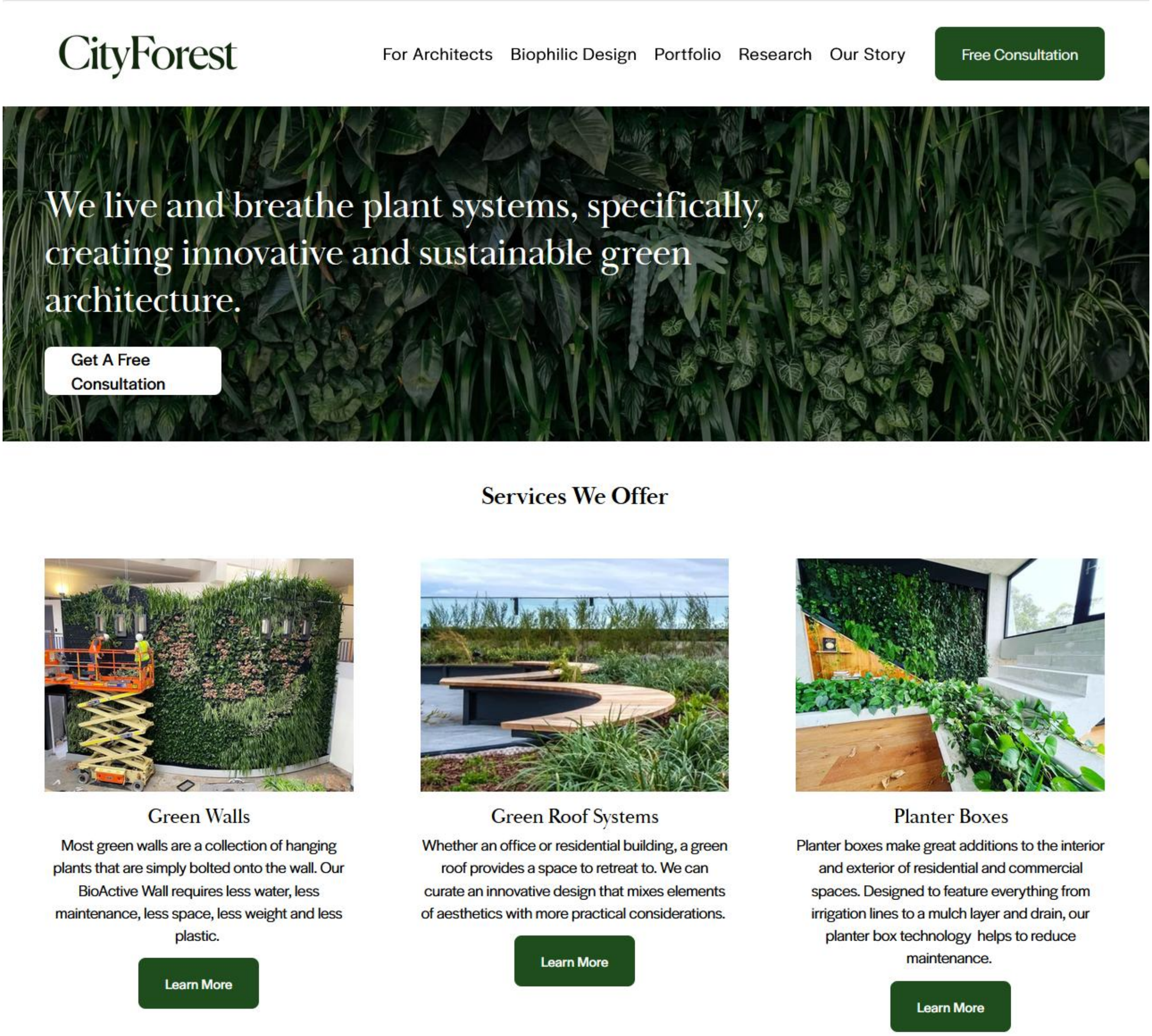

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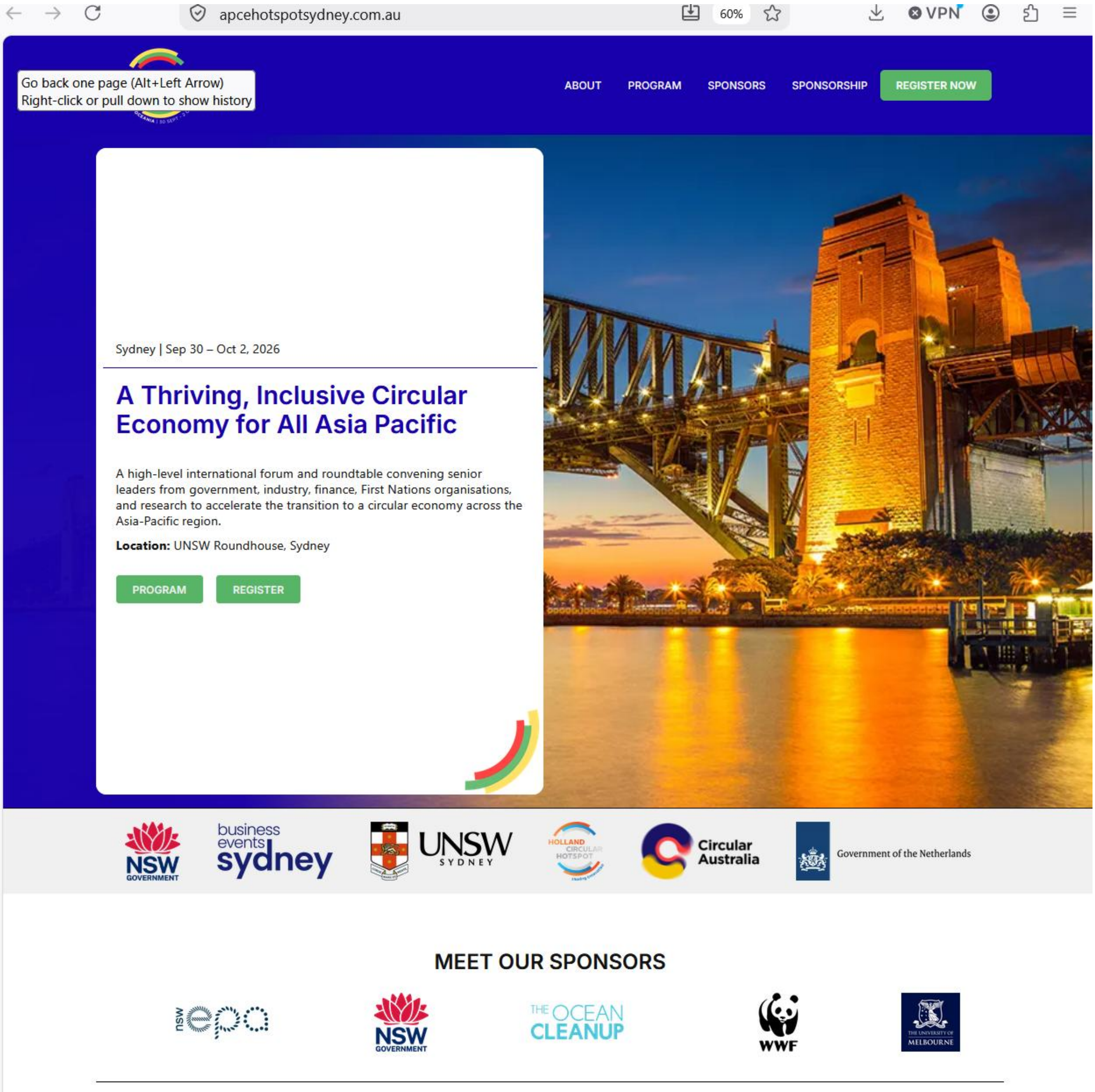

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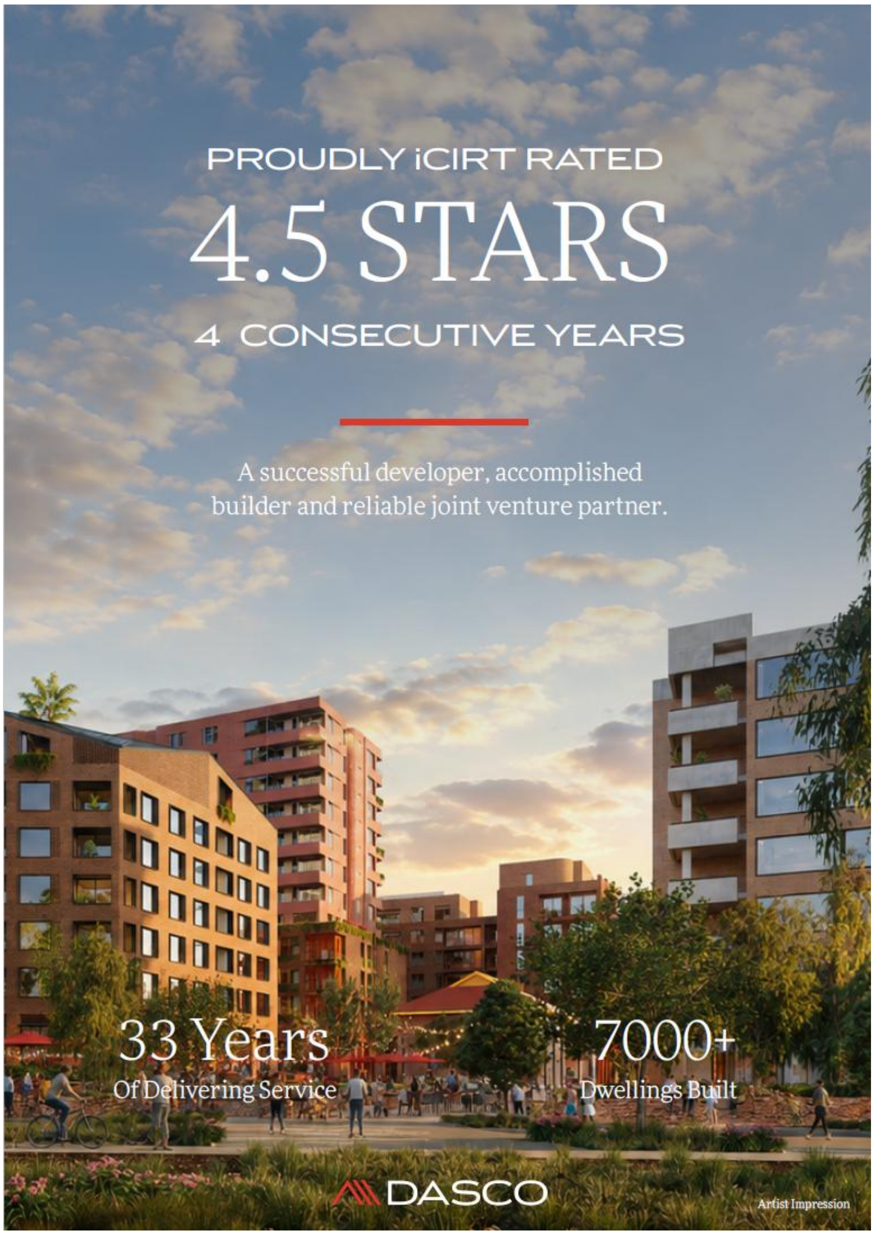

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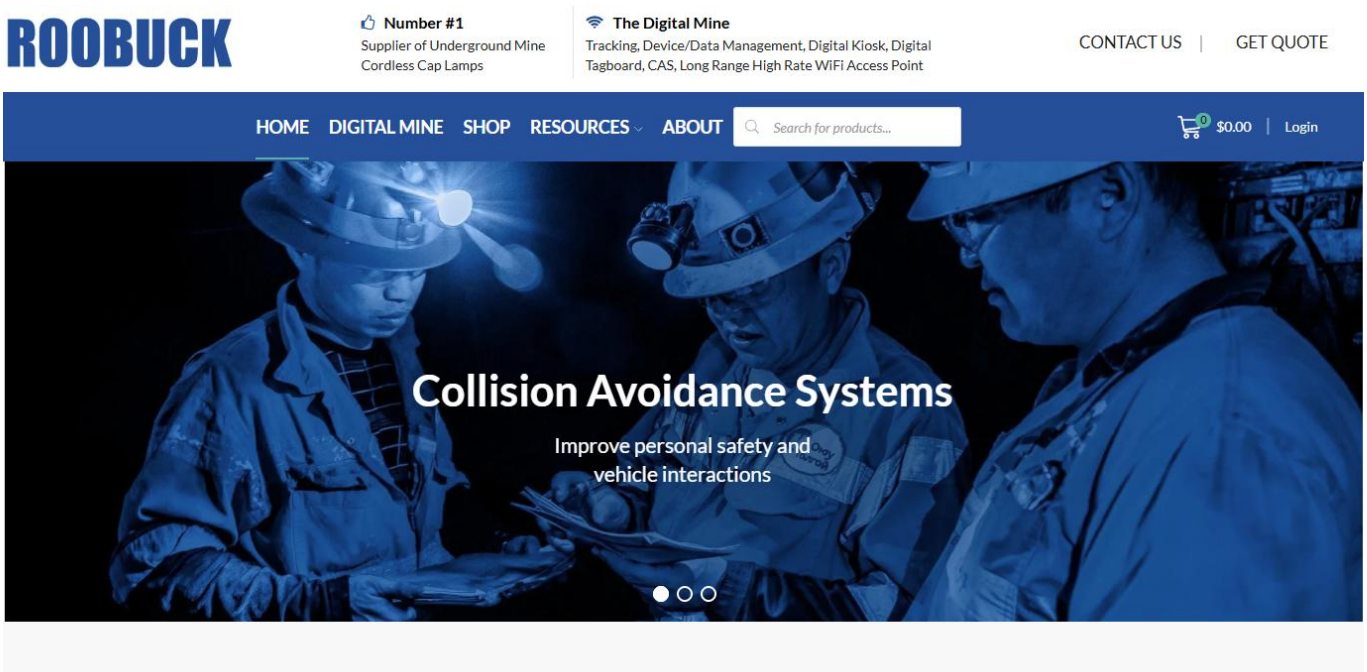

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