International conference on

Circular Economy for Climate and Environment

CECE 2024

Abstract Booklet

29 Sep – 2 Oct 2024

Aerial Function Centre,
University of Technology Sydney

Ultimo, NSW, Australia

Welcome note from the conference chairs

Dear CECE 2024 delegates,

We warmly welcome you to the second International Conference on Circular Economy for Climate and Environment Conference (CECE 2024), hosted at the University of Technology Sydney (UTS).

Building upon the success of CECE 2023, this year's four-day event (September 29 - October 2) offers a unique platform for interdisciplinary discourse on circular economy applications across various sectors.

CECE 2024, 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, Circular Australia, Sydney Water, Food Recycle and IMM Consulting) and Gold Sponsor (Organic Crop Protectants or OCP) for supporting this event.

We look forward to welcoming you to CECE 2024 and wish you a productive and enriching conference experience.

Thank you.

CECE 2024 Chairs

Prof Hokyong Shon
UTS

Ms Lisa McLean,
Circular Australia

Mr Django Seccombe,
Sydney Water

A/Prof Sherub Phuntsho,
UTS

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Table of Contents

Contents

Conference Committees

Organizing committee

- Prof Hokyong Shon, UTS, Chair
- Lisa McLean, Circular Australia, Co-Chair
- Django Seccombe, Sydney Water, Co-Chair
- Associate Prof Sherub Phuntsho, UTS, Co-Chair
- Associate Prof Stefano Freguia, University of Melbourne
- Associate Prof Leonard Tijing, UTS, UT
- Dr Ibrahim El Saliby, ARC NiCE Hub, UTS
- Dr Li Gao, South-East Water
- Prof Mikel Duke, Victoria University
- Associate Prof Md Sayed Iftekhar, Griffith University
- Prof Sungyun Lee, Kyungpook National University, South Korea
- Dr Andrea Merenda, UTS
- Dr Veera Koskue, University of Melbourne
- Ms Louella Carr, Circular Australia
- Ms Weonjung Sohn (student, UTS)
- Ms Hanwei Yu (student, UTS)
- Ms Yeshi Choden, (student, UTS)
-

Scientific committee

- Prof Hadi Khabbaz, UTS/FEIT, Australia
- A/Prof Behzad Fatahi, UTS/FEIT, Australia
- Prof Qilin Wang, UTS/FEIT, Australia
- Prof Jason Prior, UTS/ISF, Australia
- Dr Amit Chanan, Water Authority Fiji

Conference executive team

- Prof Hokyong Shon, UTS
- A/P Sherub Phuntsho, UTS
- A/P Stefano Freguia, UOM
- A/P Leonard Tijing, UTS
- Dr Ibrahim El-Saliby, UTS

Student volunteers

- Mohsen Askari, UTS
- Mohammad mahbub Kabir, UTS
- Amirhossein Shafaghat, UTS
- Hanwei Yu, UTS
- Ghaiath Almustafa, UTS
- An Feng, UTS

Conference full programme

Scan for most updated programme

Day 1: Sunday 29 September 2024

2:00 PM	**Registration** CECE venue: Aerial Function Centre, UTS Building 10, Level 7, 235 Jones St, Ultimo, NSW 2007
5:00 – 8:00 PM	**Networking event with drinks**

Day 2: Monday 30 September 2024

7:30 AM	**Registration**		
8:30 AM	**Opening ceremony**		
9:00 AM	**Plenary Session 1: Circular economy and Climate change: The role of technology** Chair**: Lisa McLean**, Circular Australia		
	Engineering circular solutions for agriculture **Bernadette McCabe**, University of Southern Queensland, Australia		
	Designing knowledge infrastructure for a better city, with a circulation economy **Jaeweon Cho,** Ulsan National Institute of Science and Technology, South Korea		
	Revisiting Resource Recovery from Used Water in the Net-Zero Emissions Era **Liu Ye,** University of Queensland, Australia		
10:15 AM	**Panel discussion 1: Circular Economy in operations** Panellists: Jaeweon Cho (UNIST), Liu Ye (UQ), Bernadette McCabe (USQ), Melita Grant (Institute for Sustainable Futures, University of Technology Sydney), Liana Downey (Blueprint Institute) and Stefano Freguia (University of Melbourne) Moderator: **Lisa McLean**, Circular Australia		
11:00 AM	Morning tea break (with light breakfast)		
	Room 1 (Broadway)	**Room 2 (Jones)**	**Room 3 (Harris)**
11:30 AM	Session 1: Circular economy Chairs: Amit Chanan, Biplob Pramanik, RMIT	Session 2: Climate change Chairs: Thomas Gao, Yu-Jung Liu	**Workshop 1:** Circular Economy frameworks, standards and matrices Facilitator: Lisa McLean, Circular Australia
	Circular economy in Fiji Water (keynote) **Amit Chanan**, Water Authority of Fiji, Fiji	Tackling Climate and Environment Challenges with Science and Technology – The Approach by NSW Chief Scientist & Engineer Office (keynote) **Thomas Gao**, NSW Office of Chief Scientist & Engineers, Australia	
	The Role of Water Utilities in a Circular Economy **Phil Woods**, Taswater, Australia	Transitioning Beyond the Linear Material use Model in Construction **Maurice Lake**, Stonelake Group of companies, Australia	
	Tackling Unbalanced Development for Circular Economy in China **Haodong Gu**, Shanghai University, China	Agrivoltaics: assessing the suitability of innovative multi-land-use systems that integrate food, energy, and water outcomes for Australian agriculture **Angus Dunne**, Australian National University, Australia	
	Circular Economy Hub Options Analysis **Genevieve Daneel/Justin Franklin**, Sydney Water, WUS, Jacobs Australia	Extreme events enhanced by climate change and its impact on surface water quality and drinking water supply **A S M Mohiuddin**, Sydney Water/UTS, Australia	
	Machine learning for nutrient recovery in the smart city circular economy **Allan Soo**, University of Technology Sydney, Australia	Environmental impacts and energy consumption of electrode materials during electrochemical oxidation of ciprofloxacin **Yu-Jung Liu**, Taipei Medical University, Taiwan	
12:50 PM	Lunch break		

1:50 PM	**Session 3: Circular economy** Chairs: Liana Downey, Sanjay Kumarasingham	**Session 4: Water, Energy & environment** Chairs: Mufid Noufal, Mike Duke	**Session 5: Resource recovery** Chairs: Alicia An, June-Seok Choi
	Putting the economy in "circular economy" (keynote) **Liana Downey**, Blueprint Institute, Australia	Water efficiency: City of Sydney (keynote) **Mufid Noufal**, City of Sydney, Australia	Innovative Approaches in Membrane Distillation for Enhanced Ammonia Removal and Recovery from Wastewater Streams (keynote) **Alicia An**, Hong Kong University of Science and Technology (HKUST), Hongkong
	Reflections on leadership to value water (keynote) **Sanjay Kumarasingham**, Ganden Engineers and Project Managers, Australia	Applying the circular economy concept in the conversion of cyanobacterial nuisances into bio-based energy (keynote) **Mikel Duke**, Victoria University, Australia	Introduction and Future Plans of the Green Desalination Research Lab: A Crucial Step Towards Circular Economy (keynote) **June-Seok Choi**, Korean Institute of Civil Engineering and Building Technology, KICT, Korea
	What if companies drive corporate strategy with circular design principles? **Susan McHattie**, Nortoncrumlin, Australia	Effectiveness of grease interceptors in food service establishments for controlling fat, oil and grease deposition in the sewer system **Biplob Pramanik**, RMIT University, Australia	Malabar WRRF Biomethane Injection Project **Praby Sasson**, Sydney Water, Australia
	Reimagining cities with a circular economy lens **Valentina Petrone**, NSW Department of Communities and Justice, Australia	Valorization of liquid anaerobic digestate into N-P-K fertilizers by biological nitrification **Andrea Merenda**, University of Technology Sydney, Australia	Enhanced Energy Performance with Solid Digestate-Derived Biochar Adsorbent in Solid Recovered Fuel **Yu-Chieh Ting**, National Taiwan University, Taiwan
	Barriers to Economic Circularity in Australia **Ned Wales/Victoria Vega Garcia**, Bond University, Australia	Enhancing Nitrogen Removal Performance from Low C/N Municipal Wastewater through Anammox Self-Enrichment Using a Pilot-Scale Hybrid MABR System **Hsin-Chieh Lin**, National Taiwan University, Taiwan	Development of High-Value Bimetallic Catalysts from Metal-Contaminated Water **Hojung Rho**, University of Science and Technology, Korea
	Exploring the Influence of External Factors on Transparency in the Fashion Apparel Supply Chain in Asia-Pacific Region: A PESTEL Framework Analysis. **Chanuthi Rajapaksha,** Yokohama City University, Japan	Effects of surfactants on polyamide thin-film composite membranes fabricated by co-solvent assisted interfacial polymerization for the treatment of semiconductor wastewater **Jeonghoo Sim**, Myongji University, Korea	Agile Recycling Technology for Organics **Justin Frank**, Goterra, Australia
3:30 PM	Afternoon tea break		
4:00 PM	**Poster Session** (Chairs: Mikel Duke and Andrea Merenda)		**Workshop 2:** The Future of Renewable Technology Waste Management Facilitator: Kaveh Khalilpour (UTS) and Thomas Gao (NSW Office of the Chief Scientist and Engineers)
6 – 9 PM	Gala Dinner and Circular Award Ceremony		

Day 3: Tuesday 1 Oct 2024

8:00 AM	**Registration**		
9:00 AM	**Plenary session 2: Circular economy and climate change: issues** Chair: **Django Seccombe**, Sydney Water		
	Unlocking the circular economy as Greater Sydney grows: Sydney Water's approach **Roch Cheroux**, Sydney Water, Australia		
	Let's start at the beginning **David Bergmann**, Southeast Water, Australia		
	Driving the circular economy of nutrients through demand: the case of phosphorus **Dana Cordell**, Institute of Sustainable Futures, University of Technology Sydney, Australia		
10:15 AM	**Panel discussion 2: Circular economy and climate change: issues** Moderator: Django, Sydney Water Panellist: Roch Cheroux, Dana Cordell, David Bergmann, Amit Chanan (Water Authority of Fiji).		
11:00 AM	Tea break		
	Room 1 (Broadway)	**Room 2 (Jones)**	**Room 3 (Harris)**
11:30 AM	**Session 6: Resource recovery** Chairs: Dharma Hagare, Andrea Merenda	**Session 7: Environmental health & risks** Chairs: Stefano Freguia, Pema Dorji	**Workshop 3:** Retrofitting circularity into wastewater treatment plant Facilitator: Amit Chanan, Water Authority of Fiji **Workshop sponsored by IMM Consulting**
	Upcycling of Food Waste (keynote) **Dharma Hagare**, Western Sydney University, Australia	Medal-winners in the Olympics of urine technologies **Stefano Freguia**, University of Melbourne, Australia	
	Commercialisation of Food Waste to Animal Feed **Norm Boyle**, Food Recycle, Australia	Removal of PFAS from the landfill leachate (Invited speaker) **Pema Dorji**, Darwin City Council, Australia	
	Macroalgal Bioremediation - a fully circular and cost-effective solution to treat wastewater **Nicolas Neveux/Emma James**, Pacific Biotechnologies Australia Pty Ltd/Sydney Water, Australia	Human Health and Wellbeing Biomarkers in Untreated Wastewater **Jiaying Li**, University of Sydney, Australia	
	Resource Recovery from Challenging Hypersalline Solution Treatment by Membrane Distillation Crystallization **Youngkwon Choi**, Korea Institute of Civil Engineering and Building Technology, Korea	A review of the microbial health risks associated with the collection and processing of source-separated urine reused as fertilizer in agriculture **Johanna Engels**, Griffith University, Australia	
	Effect of hydraulic retention time on urine nitrification in pilot-scale activated carbon incorporated membrane bioreactor and application on hydroponics **Weonjung Sohn**, University of Technology Sydney, Australia	Pathogen regrowth in mesophilic AD after feeding pre-treated sludge **Junfu Li**, University of Queensland, Australia	
12:50 PM	**Lunch break**		
1:50 PM	**Session 8: Environmental Technologies** Chairs: Sungyun Lee, Wei Wei	**Session 9: Circular Economy/climate /environment/resource recovery** Chairs: Chia-Hung Hou, Saravanamuth Vigneswaran	**Workshop 4:** Nutrient recovery Facilitators: Stefano Freguia (University of Melbourne) and Sanjay Kumarasingham (Ganden Engineers and Project Managers)
	Machine Learning in the Circular Economy: Research Trend and Applications (keynote) **Sungyun Lee**, Kyungpook National University, Korea	Capacitive Deionization for Water Reclamation and Resource Recovery: Current Perspectives Aiming for Strategic Futures (keynote) **Chia-Hung Hou**, National Taiwan University, Taiwan	
	Biotechnology to convert biowastes into fossil fuel substitute	Recovery of Rare Earth Elements from Mining Wastewater using Functionalised	

	Wei Wei, University of Technology Sydney, Australia (Invited speaker)	Nanomaterials: a solution towards circular economy (keynote) **Saravanamuth Vigneswaran**, University of Technology Sydney, Australia	
	Direct Lithium Recovery from Synthetic Lithium-Ion Battery Leachate through Membrane Separation Processes **Tsai-Hsuan Chen**, National Taiwan University, Taiwan	Towards E-waste Circular Economy: The Impact of Contemporary Human Dimensions **Amila K.S.U Kankanamge**, Charles Darwin University	
	Interfacial and Structural Engineering in MOF-based Mixed Matrix Membranes **Tao Li**, University of Adelaide, Australia	Towards a Circular Economy and Net Zero Through Carbon Stewardship **Russ Martin/Craig Bagnall**, Global Product Stewardship Council and SEATA Group, Australia	
	Molecular-based artificial neural networks for selecting deep eutectic solvents for water treatment applications **Ghaiath Almustafa**, Khalifa University, UAE	Novel integrated process for the circular economy of green hydrogen and resources from brine **Mohammad Mahbub Kabir**, Noakhali Science and Technology University, Bangladesh	
3:10 PM	Afternoon tea break		
3:40 PM	**Closing ceremony** Best Presentation Award, CECE2025		

Day 4: Wednesday 2 Oct 2024

Technical tours 9:00 AM – 12:00 PM

Tour 1	Quakers Hill Water Recycling Plant
Tour 2	Malabar biomethane plant
Tour 3	Sircel Villawood (e-waste recycling and recovery)

Poster presentation
30 Sep 2024, 4:00 – 6:00 PM

Abstract #	Presenter	Poster Title
CECE24-P04	**Jonghun Lee**, Korea Institute of Civil Engineering and Building Technology, Korea	Research on Phased Application Technology of Semiconductor Industrial Wastewater Treatment for Circular Economy
CECE24-P05	**Hobin Jee**, Gyeongsang National University, Korea	Development of High-Performance a-GO/hBN-based Membrane for Organic Solvent Nanofiltration
CECE24-P06	**Ana Maria Caceres Ruiz**, Curtin University, Australia	Increasing Value Recovery from End-of-Life Tyres and Conveyor Belts in Australia: Insights from International Best Practices
CECE24-P07	**Kota Aizawa**, Tokyo University of Science, Japan	Preparation and properties of butene bridged silicon-based reverse osmosis membranes
CECE24-P08	**Niti Bhattarai**, University of Technology Sydney, Australia	Evaluating Urine-Based Microbially Induced Calcium-Carbonate Precipitation for Geotechnical Enhancement of Closed landfill Sites: Mechanical Properties and Microstructural Analysis
CECE24-P09	**Kazuki Yamamoto**, Tokyo University of Science, Japan	Development of sodium ion-selective nanofiltration membrane for wastewater treatment
CECE24-P10	**Tatsuya Iwashina**, Tokyo University of Science, Japan	Palladium recovery agents using azulene derivatives
CECE24-P11	**Yeshi Choden**, University of Technology Sydney, Australia	Optimization of Bromide selective composite electrode in membrane capacitive deionization.
CECE24-P12	**Amirhossein Shafaghat**, University of Technology Sydney, Australia	Sustainable Nutrient Recovery: Employing Membrane-Aerated Bioreactors for Effective Nitrification
CECE24-P13	**Nupur Khanna**, Icon Water, Australia	Spoil to Topsoil
CECE24-P14	**Mohsen Askari**, University of Technology Sydney	Sustainable Lithium Recovery: The Potential of Mexene Electrodes for Efficient Selective Extraction from Brine
CECE24-P15	**Minjeong Kim**, Myongji University, Korea	Evaluation of ANN, DNN, and RNN Algorithms for reverse osmosis-based shipboard seawater desalination
CECE24-P16	**Ana Maria Caceres Ruiz**, Curtin University, Australia	Implementing circular economy in regional Australia
CECE24-P19	**Xiaotong Cen/Min Zheng**, University of Queensland, Australia	Nanoscale zero-valent iron application in sewers: impact on sulfide and methane control and downstream wastewater treatment
CECE24-P24	**Juan Lucas**, Royal Botanic Garden Sydney, Australia	Anthroponics in a Circular Economy: Effect of urine fertiliser on the flowering and longevity of Pansy (Viola × wittrockiana)
CECE24-P26	**ChangKyoo Yoo**, Kyung Hee University, Korea	Schematic Evaluation on Sustainable Upgrading Technologies of Biogas-to-Hydrogen toward a Circular Economy
CECE24-P27	**Kangmin Chon**, Kangwon National University, Korea	One-step synthesis of magnetic biochars through co-pyrolysis of walnut shells and Fe-rich mine tails for adsorption capacity enhancement of polystyrene sulfonate microplastics
CECE24-S26	**I.B.P Adnyana**, Udayana University, Indonesia	Photothermal Characteristics Based Coffee Skin Activated Carbon on the Solar Interface Evaporation (SIE) for Seawater Purification of Remote Areas

Plenary Session 1: Circular economy and climate change: The role of technology

Plenary session Chair: **Lisa McLean**, Circular Australia

Engineering Circular Solutions for Agriculture

Bernadette MCCabe*

*Director | Centre for Agricultural Engineering (CAE) | P9 120

Bernadette.McCabe@unisq.edu.au

Brief bio of plenary/keynote speaker

Professor Bernadette McCabe is Director at the University of Southern Queensland's (UniSQ) Centre for Agricultural Engineering (CAE) and is the Research Program Leader for Energy and Bioresource Recycling. Bernadette is Australia's National Team Leader for the International Energy Agency (IEA) Bioenergy program Task 37: Energy from Biogas and is a member of the Australian Research Council (ARC) College of Experts.

Abstract

There is increasing pressure for the agriculture sector to move away from linear food production systems which rely on large raw material inputs and generates significant amounts of residues. This session will provide an overview of circular practices have developed to improve the sustainability of the agriculture sector both in Australia and overseas. It will provide background in closed-loop systems to optimise crop nutrient cycles and resource use, as well as avenues for agricultural waste to be recycled back into agricultural production. The presentation will highlight some examples, including using crop residues as livestock feed and developing new bio-based fertilisers, to producing biogas from livestock.

Designing knowledge infrastructure for a better city, with a circulation economy

Jaeweon Cho[1*]

[1]Ulsan National Institute of Science and Technology (UNIST)
*jaeweoncho@unist.ac.kr

Brief bio of plenary/keynote speaker

Jaeweon Cho is professor at Ulsan National Institute of Science and Technology (UNIST). He is environmental and semiotics engineering researcher. He teaches Science Humanities and Environmental Justice. He has directed the Convergence Research Center, named 'Science Walden', supported by National Research Foundation of Korea, with convergence of science and arts being focused, between 2015-2021. He proposed the feces Standard Money (fSM) in edge.org (edge.org/response-detail/26660) in 2016. He is one of founding members of North Korea Water Society under the ministry of Unification, Korea, since 2015, to discuss what should be done for Korean re-unification and on potential ways to collaborate to solve water issues in both Koreas, between two Koreas. He has been providing small water purification units being operated without electricity (named 'OngDalSaem'), to villages in various different countries. He is authors of books, “Honey Money: fSM a new money for a new society” (2020, art.earth, UK), of books in Korean, “Decision of the weak” (2024), “This is not a toilet” (2021), “Cyborg Thinks Sense Laboratory” (2022), and “Climate Change Humanities” (2015). He wrote columns in Seoul Newspaper, in “Eco-science of Jaeweon Cho” (2022-2023).

Abstract

Vegetarian does not eat meat in general, but ecologists may do as they are not directed by any concrete rules and beliefs. The two can get along but may have different environmental philosophies. Similarly, ecologists may have a wide view of eco-system under the capitalism, even Neo-liberalism, society, with wastes or used materials which suggest different views under the new paradigm of the digital ages.

Traditional infrastructures of waste have been accommodating various systems centering around the control tower, mostly governments or equivalent institutions or corporations being authorized. Two ends of types of the waste infrastructure system, as in the ideology, seems very different but actually similar in that they are operated and maintained by the centralized powers, through government versus capital. However, things in the digital times not yet but slowly start to change to come hopefully into a stage of singularity with means for not efficient but effective exchanges of value. Systems of waste are possible on the blockchain and shall be based on a different standard of value other than the legal tender; why not urine as a candidate for the standard of all other values? Otherwise, the legal tender money maintains its concrete position as in the present economy.

Wastes such as urine and feces are not easy to be “goods” as we believe it as being bad under the present system dealing with waste under the present infrastructure. But, from the conceptions of being bad, we, engineers, may have clues to transform into “Bads having a high value” as everyone dislikes it thus wants to be away from the bad, which creates a certain value in an ironical way. We have to consider this supposition of our being able to create new values which are not revealed yet but wait to be uncovered, and those can be integrated with values out of urine as fertilizer.

Economy of capitalism and even socialism is the system with signs of exchanging tools and means for which the legal tender currency is responsible, but newly emerging economy of waste being proposed to be circulated within a system can be implemented with a new currency among the community members, possibly token having information of wastes, such as urine, to be circulated by the participants or members of various communities being connected under certain solidarities, being different from the present legal tender currency having only the capability to be the standard of value. With the token with urine and other wastes being defined and characterized in that way, newly defined knowledge can be accumulated through the system of the token under the circulating economy, in turn formulating an infrastructure through which other knowledges are also to be generated in a circular way.

Revisiting Resource Recovery from Used Water in the Net-Zero Emissions Era

Liu Ye[1*]

[1]School of Chemical Engineering, Faculty of Engineering, Architecture and Information Technology, University of Queensland, QLD, Australia
*l.ye@uq.edu.au

Brief bio

Dr Liu Ye is a Professor at The University of Queensland (UQ) in the School of Chemical Engineering. Dr Ye’s research is focused on sustainable environmental engineering and is dedicated to finding innovative and practical solutions to tackle challenges in achieving net zero emissions, climate resilience, and sustainability. She is the Greenhouse Gas (GHG) research program leader at UQ urban water engineering. She has an established national and international leadership in the research field of net-zero emissions from urban wastewater systems. Prof Ye has been awarded over AU$10M competitive research funding and has a broad research collaboration within academia and industry.

Abstract

In the pursuit of a sustainable future, resource recovery from used water stands at the forefront of environmental innovation and circular economy. As we move toward a net-zero emissions world, it is crucial to revisit and reimagine the concepts, technologies and approaches proposed and developed on resource recovery from used water. This talk will discuss and share some perspectives on balancing valuable resources—such as energy, nutrients, and clean water— from wastewater, and minimizing greenhouse gas emissions. By integrating resource recovery and net-zero emission goals into water management practices, we can turn waste into a vital component of the circular economy, supporting global sustainability goals and ensuring a cleaner, greener future.

Panel discussion 1: Technology and circular economy

Panellists: Jaeweon Cho (UNIST, South Korea); Liu Ye (University of Queensland); Bernadette McCabe (University of Southern Queensland); Melita Grant (Institute of Sustainable Futures, UTS); Stefano Freguia (University of Melbourne); Jenni Phillipe (Aurecon); Liana Downey CEO (Blueprint Institute)

Moderator: Lisa McLean, Circular Australia

Plenary 2: Circular economy and climate change: issues

Plenary session Chair: Django Seccombe, Sydney Water

Unlocking the circular economy as Greater Sydney grows: Sydney Water's approach

Roch Cheroux

Sydney Water

Brief bio of plenary speaker

Roch is a key influencer in the water industry, with experience shaping and leading public and private corporations across Asia-Pacific region and Europe. Before joining Sydney Water, Roch was Chief Executive of South Australian Water Corporation (SA Water) where he led the transformation of South Australia's largest water utility, embedding changes to technology, culture and systems to improve the experience for its 1.6 million customers. Before joining SA Water, Roch was Chief Executive Officer of SUEZ for South East Asia and SUEZ-Degrémont Australia and New Zealand, Managing Director of United Utilities Asia and Pacific (TRILITY), and Chief Executive and Chair of Tallinn Water in Estonia. Roch holds formal qualifications in engineering and business management, and seeks to champion innovation, diversity and reconciliation in the workplace. Member of the Safety and Wellbeing, Planning and Infrastructure, and People, Culture and Remuneration, and Economic Regulation committees. Roch is active across the water industry and is currently Chair of Water Services Association of Australia and was previously a member of the Advisory Committee of the Australian Water Partnership. He is also a member of the French-Australian Chamber of Commerce Advisory Council. A dual French and Australian citizen, Roch holds formal qualifications in Engineering and Business Management, and seeks to champion innovation and workplace diversity in the organisations he leads.

Let's start at the beginning

David Bergmann[1*]

[1] South East Water, 101 Wells St, Frankston, VIC, 3199.

*david.bergmann@sew.com.au

Brief bio of plenary/keynote speaker

Dr David Bergmann is the Research, Development & Innovation Manager at South East Water providing solutions to over 1.8 million customers. With a PhD in Chemistry, and over 25 years experience in industry David has worked in R&D roles in chemicals, detergents, food, manufacturing, and now water and wastewater. Creating value from waste, making passive systems smart, use of alternative waters, urban cooling, and smart devices and sensors are areas of particular interest. In his current role David has delivered innovative solutions such as real time control of rainwater hot water systems, IoT vibration sensors for leak detection, and the scaling of pyrolysis technology for biosolids conversion. David is also a qualified Company Director and experienced Board Member. He is currently a Director on the Board of Water Research Australia, and serves on other industry sub-committees such as the Transforming Biosolids Centre and the OPTIMA Centre. David brings a diverse range of experience from a broad range of industries, from multinational corporations to regional utilities and not-for-profit organizations. He is passionate about positive change, innovation, and the delivery of solutions with impact.

Abstract

The urban water industry is in a face-off against population growth, urbanization, climate change, ageing assets and escalating customer expectations. From traditionally focusing on 'getting-the-basics-right' of supply, disposal, and a quarterly bill for the service - the focus of the water utility is shifting to a much broader 'healthy-water-for-life'. It is realising that it can make significant impacts inside and beyond its traditional boundaries. With the right partners and ecosystem, transformational outcomes become possible such as zero waste, resource recovery, negative emissions, food security, cooler cities, and healthier communities. The solutions that are arising in the industry focus on new and exciting areas such as IoT, digitalization, real-time monitoring and control, the circular economy, diversity of water sources, live condition assessment, and customer and community engagement. This is challenging an industry that prefers pipes, pumps, and valves. Developing and delivering these transformation

outcomes requires new research, new perspectives, new skill sets, multi-disciplinary partnerships, systems thinking, boldness, innovation, and the willingness to learn and progress. This presentation discusses the challenges and advances the Australian water industry is making, and the opportunities for research and industry partnerships to accelerate these transformational outcomes making our water more secure, our cities more liveable, and services more affordable.

Driving the circular economy of nutrients through demand: the case of phosphorus

Dana Cordell[1*]

[1]Institute for Sustainable Futures, University of Technology Sydney

*Dana.Cordell@uts.edu.au

Brief bio of plenary/keynote speaker

Dana Cordell is a Research Director and Associate Professor at UTS's Institute for Sustainable Futures, where she leads the Food Systems research group. She works with stakeholders across Australia, South Asia, UK and North America to co-identify how food systems can transform and circularise in response to a range of sustainability risks, from urban sprawl to climate change to the emerging global phosphorus challenge. Since co-founding the Global Phosphorus Research Initiative in 2008, Dana has been passionately dedicated to investigating measures that can ensure long-term availability and accessibility of phosphorus for future food security, while protecting the environment from nutrient pollution. Dana recently joined the UNEP-GEF uPcycle project led by UK CEH, which aims to accelerate the transition to a circular global phosphorus cycle to protect freshwater and coastal ecosystems. She currently co-leads the DFAT-funded PACSAN project which is modelling phosphorus and carbon emissions across Australia and China's food value chains, and, identifying priority measures to mitigate these together with a network of stakeholders across both countries. As a Chief Investigator in the ARC Research Hub 'Nutrients in a Circular Economy', Dana is investigating the governance and market barriers to scaling up circular nutrient value chains in the Australian food system. Dana provides expert advice to the UN and national governments as a global food and phosphorus security expert. Her internationally recognised phosphorus research was awarded one of Australia's top science prizes – a Eureka Prize.

Abstract

Recirculating organic by-products like food waste, wastewater and manure efficiently and at scale will be critical to future food security, energy security, climate resilience, water security and environmental health. Ultimately, we won't be able to live within the safe operating space of our planetary boundaries if we don't stop our wasteful and inefficient habits. Our food, waste, energy and water sectors are starting to transform towards circularity, driven by a diverse range of drivers, from net zero emissions targets to food waste policies to rising fertiliser prices and geopolitical risks. However, these sectors are often not transforming in a coordinated manner, risking unintended consequences like competition between end-uses, technology lock-in, preventing scalability, or failure to achieve key sustainability targets and causing rebound effects. For example, society's organic waste is being earmarked for the production of bioenergy, sustainable aviation fuels, biomaterials, and biofertilisers – but will there be enough organic waste to go around? Phosphorus flow analyses indicate that we will need to secure almost all the organic waste as fertiliser raw material to produce food alone. Drivers of recovery technologies and processes are also critical: for example, if organic waste recovery is optimised for low-emissions and maximising waste diversion from landfill in the short-term, the resultant product might not be in an appropriate fertiliser form that is bioavailable, safe, competitive and suitable for farmers and other end-users in the longer-term. This presentation identifies a pathway to navigate these tensions, to achieve co-existing sustainability goals and outlines what an integrated 10R circular economy for nutrients might look like in this context.

Panel discussion 2: Circular economy and climate change: issues Date: 1 Oct 2024

Panellist: Roch Cheroux (Sydney Water), Dana Cordell (ISF, UTS), David Bergmann (Southeast Water), Amit Chanan (Water Authority of Fiji).

Moderator: Django, Sydney Water

Session 1: Circular economy

Session Chairs: Amit Chanan and Biplob Pramanik

(Keynote) Circular economy in Fiji Water

Amit Chanan*

Water Authority of Fiji
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Brief bio of keynote speaker

Dr Amit Chanan is an experienced senior executive with a career spanning over two decades within the international water industry and infrastructure services. Amit is currently the Chief Executive Officer of the Water Authority of Fiji (WAF). Prior to this role, Amit was the Director City Projects and Property with The City of Sydney, Australia. Before that, Amit was the Chief Operating Officer of the New South Wales State Water Corporation. Amit is a Fellow of the Australian Institute of Engineers and recently recognised as the International Water Association or IWA Fellow. With a PhD in Engineering, Amit has strong academic interests and is currently an Adjunct Professor at the Faculty of Engineering, University of Technology Sydney. He is a member of the Editorial Board of UK's Institute of Civil Engineers' Journal of Municipal Engineering. Amit is a Member of the Advisory Board to UNESCO, Vice Chairman of the IWA's Specialist Group on Water Security and Safety Management and Board of Trustees for the WaterLinks.

Abstract

A keynote address that will take you on a journey of the outer space on the Spaceship Earth and bring you back to the beautiful islands of the blue Pacific Ocean.

The address will draw parallels between Dr Kenneth Boulding's 1966 work "Economics of the Coming Spaceship Earth" and the modern-day economics of the Small Island Developing States (SIDS) in the Pacific Ocean. Both Spaceship Earth and SIDS face constraints on natural resources, such as water, energy, and land. Both require self-sustaining systems, where waste is minimised, and resources are recycled. Vulnerability to external shocks is another parallel as susceptibility to climate change, economic fluctuations, and global crises threaten SIDS.

In his address Dr Chanan aims to inspire the experts to explore and develop practical solutions for a circular economy, that can assist SIDS to meet SDG 6 goals. For these small island countries in our neighbourhood, circular economy is not just a concept but arguably the only way to deal with challenges of safe sanitation, solid waste management and water security.

The Role of Water Utilities in a Circular Economy

Phil Woods[1]

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Brief bio of lead CI/presenter

Phil is a sustainability thought leader in energy, resource recovery, circular economy, and carbon management. Phil joined Tas Water as Sustainability and Climate Change Lead in January 2024, with a focus on implementing its renewable energy roadmap and developing resource recovery opportunities. Prior to that Phil was at GHD as Technical Director Sustainability, and before that, spent 16 years at Sydney Water, most recently as Strategic Planning Manager, Circular Economy and Resource Recovery.

Abstract

The circular economy is often talked about, but what does it really mean for water utilities? TasWater is looking at how we can turn today's sewage treatment plants into tomorrow's circular economy hubs, producing valuable water, energy and nutrients. New or major upgrades for wastewater treatment plants (WWTPs) don't happen very often so we need to seize the opportunities when they come. TasWater's Selfs Point Sewer Transformation project is one such opportunity. TasWater has developed a concept for Selfs Point WWTP as a Circular Economy Hub (CE Hub). Key features of the hub include: recycled water for either nearby industrial customers or going to irrigation an organics receival and processing facility to decontaminate organic waste streams and send them towards their highest value reuse anaerobic digesters to produce renewable bioenergy and biosolids for use as fertliser incorporating new and emerging technologies to maximise resource recovery value. As is often the case, there are tight timeframes for major projects. This can often see innovative approaches go no further than a concept on paper. It is not possible for the CE Hub concept to be developed within the required timeframe for the new Selfs Point WWTP. However, we are ensuring that some of the key foundations of the CE Hub are part of the Stage 1 design, including: high quality treated effluent that can be reused as is, or upgraded for a higher quality reuse, anaerobic digestion with available capacity for at least 10 years biogas cogeneration engine a tankered waste receival facility, with allowance for direct dosing to digesters Partnerships are fundamental to a circular economy and we are currently developing partnerships to progress the the CE Hub, building upon the foundations of Stage1. Selfs Point is the first of several potential TasWater CE hubs. Within the next 10 years there will be another major STP consolidation and upgrade for Launceston. We are following a similar approach there, firstly looking at how the project can most effectively contribute to TasWater's sustainability goals, ensuring that the basic building blocks for a resource recovery hub are factored into the design, and then working to build up to a circular economy hub for the region.

Tackling Unbalanced Development for Circular Economy in China

Haodong Gu [1*]

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Brief bio of lead CI/presenter

Dr. Haodong (Harry) GU received his PhD degree in Marketing from UNSW and was employed as a lecturer in the same university from 2013 before he joined Shanghai University in 2015, where Harry works till today as a lecturer, director of SILC International and associate director of Australian Studies Centre.

Abstract

In the 14th Five Year Plan of China, there is a section clearly stating that developing circular economy is one of the key strategies of China in the next five years, paving the road leading China to become an ecological civilization ultimately. The achievement of this aim, however, requires removals of obstacles such as unbalanced development in China. The current discussion intends to provide an overview of economic development in China with a focus on the comparison between urban and rural areas, explaining why rural development needs to be highlighted in parallel with urbanization and modernization, which happened to be the main themes in the past 40 years. Only when the flows of economic factors are allowed to move freely between cities and rural areas, the establishment of circular economy becomes possible.

Circular Economy Hub Options Analysis

Genevieve Daneel

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Brief bio of lead CI/presenter

Presenter: Genevieve Daneel Senior Associate Consultant, Jacobs

Genevieve is a senior associate consultant specialising in climate resilience and resource recovery. Genevieve's recent projects include working with the Victorian Government to advise on their circular economy policy, guiding NSW DCCEEW on Integrated Water Cycle Management in Greater Sydney and supporting Greater Melbourne's Water corporations on their adaptive planning approach to managing long term water security in the face of a changing climate.

Abstract

A partnership with Western Sydney University, Hawkesbury City Council and Sydney Water has been established to design a 'Circular Economy Hub' on the Western Sydney University campus as part of their agribusiness precinct. As part of this, Jacobs undertook an options analysis to review waste treatment technologies that would contribute energy/nutrients and in some occasions more specialised outputs (purified water) to the agribusiness precinct. Jacobs used their digital twin model 'Replica Planner' to simulate multiple options for treating varied resource streams (municipal solid waste, agribusiness waste, wastewater treatment outputs) with different waste treatment technologies. The different treatment technologies included anaerobic digestion, Pyrolysis, Supercritical Water Oxidation, and composting. These options were then assessed against a multicriteria analysis that was developed using the principals of circular economy. We propose to share the results of the MCA, as well as the regulatory review and cost benefit analysis undertaken to inform future prospects of developing circular economy hubs in Australia.

Machine learning for nutrient recovery in the smart city circular economy – A review

Allan Soo[1], Li Wang[2], Chen Wang[3], Ho Kyong Shon*

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Brief bio of lead CI/presenter

Allan Soo is a PhD candidate under Professor Hokoyng Shon with his thesis specialising in nutrient and resource circular economies within the wastewater treatment space. He completed his honours program in membrane desalination specialising in additive manufacturing membrane research, where he won the Alan Chappel Prize in 2021 for this capstone project to develop the "world's first ever 3D printed membrane for desalination" with superflux capabilities.

Abstract

Urbanisation is leading to a concentration of growing city populations that contribute significantly to economic growth, while becoming epicentres of waste generation, greenhouse gas emissions, and food consumption. Nutrient smart city circular economy is currently an understudied intersection of growing city populations of food consumers, nutrient recovery technologies, Internet of Things (IoT), and agriculture. Meanwhile, machine learning has exploded with popularity over the years, with many circular economy literatures examining its usefulness in its predictive qualities to support management, optimisation, and recovery of useful resources from organic waste. This review paper examines advancements in machine learning for macronutrient recovery in city organic waste systems for a circular economy. The use of ML will greatly improve the scalability, transparency, productivity and accuracy of nutrient: recovery technologies, logistics, dissemination, and reuse. ML can also be combined with hardware to automate tedious waste separation, recovery and agricultural tasks using drones, hydroponics and satellites. Meanwhile, crop yields, nutrient demand-supply efficiencies, food security, environmental soil monitoring, and prosumer involvement could all increase. However, ML applications for urine, anaerobic digestion and prosumer economics are lacking.

Session 2: Climate Change

Session chairs: Thomas Gao, Yu-Jung Liu

Tackling Climate and Environment Challenges with Science and Technology-The Approach by NSW Chief Scientist & Engineer Office (Keynote)

Thomas Gao

[1]NSW Chief Scientist & Engineer Office

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Brief bio of keynote speaker

Thomas Gao serves as a Manager, Policy Review and Committee with the NSW Chief Scientist & Engineer Office, a central agency that spearheads the state's innovation policies and programs. Thomas is a chemical engineer, certified project manager, and seasoned policy expert with over ten years of experience in leading strategies, grants program and expert advice services in the government and research sectors. He has played an instrumental role in advancing NSW's clean economy through his leadership in Power-to-X, decarbonisation and energy programs. Thomas holds a bachelor's degree in chemical engineering with First Class Honors from the University of New South Wales, a master's degree in Sustainable Energy from the University of Queensland, and a Diploma in Leadership and Management from the Australian Institute of Management.

Abstract

The NSW Chief Scientist & Engineer (OCSE) formally sits in the Premier's Department and has broad engagement across many NSW Government departments. OCSE has four functional arms, independent advice stream that delivering evidence-based scientific advice to government on a range of difficult challenges, research funding support stream that ensures NSW attracts and retains researchers and research infrastructure, industry development streams that brings academia, government and industry together to drive the commercialisation of research excellence and science outreach and education stream that gives the general public the opportunity to engage with science and scientists. OCSE's four functional streams interacts with each other, and broader policies and programs from NSW Government.

Today's presentation will take a deep dive into OCSE's decarbonisation projects to show how the state is tackling climate and decarbonisation challenges with science and technology. NSW Decarbonisation Innovation Studies are an important pillar of NSW Government's Net Zero Plan, it serves as a biennial review to identify priority areas that can drive the state's emissions reduction while generating economic benefits and new jobs. The 2020 and 2023 Study identifies a range of economic opportunities for NSW to focus on. One of the outcomes of the Study is the establishment of Decarbonisation Innovation Hub and three networks as a platform for innovation collaboration between government, industry and research. The Power-to-X Studies and Tool are good examples of how evidence-based analysis can support the growth of a new industry.

Transitioning Beyond the Linear Material use Model in Construction

Maurice Lake[1*]

[1]**Director – Stonelake Group of Companies**

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Brief bio of lead CI/presenter

Maurice Lake is the director the Stonelake Group of companies, and founder of the Buildonix® building technology. As a builder with over 35 years' experience in construction, Maurice has experienced firsthand the inefficiencies and poor environmental sustainability standards in construction, developing the Buildonix® technology in response to this issue.

Abstract

The construction industry, a cornerstone of modern infrastructure, is grappling with a crisis of sustainability. Predominantly operating on a single-use-to-landfill model, it contributes significantly to environmental degradation and resource depletion. Despite technological advancements in Building Information Modelling (BIM) and other areas, the sector has seen little fundamental evolution in its core methods and procedures over the past half-century. This presentation will explore the critical limitations of current construction practices, emphasising the industry's failure to transition away from wasteful, linear processes. I will then expand on the concept of a circular building economy as a transformative approach to address these issues. In this model, construction methodologies are fundamentally re-imagined, prioritising the design of building components for multiple life cycles. By integrating principles of reuse, recycling, and adaptability from the outset, the circular economy promises to revolutionise the industry. Through adaptive and dynamic re-use material re-use models, combined with an industry leading approach to components-based assembly, there is a capacity to realise significant increases in industry productivity and fundamental environmental benefits globally. This paradigm shift not only enhances sustainability but also promotes economic resilience and innovation in construction practices. The presentation aims to inspire stakeholders to rethink and redesign construction processes to align with a sustainable, circular future.

Agrivoltaics: assessing the suitability of innovative multi-land-use systems that integrate food, energy, and water outcomes for Australian agriculture

Angus Dunne[1 5] , Joseph Guillaume [1 2], Martin Amidy[1 3], Steven Crimp [1 4]

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[2]ANU, Institute for Water Futures
[3] ANU, Agrifood Innovation Institute
[4] ANU, Institute for Climate, Energy and Disaster Solutions
[5] Southern New South Wales Innovation Hub
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Brief bio of lead CI/presenter

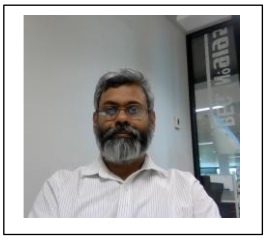
Angus Dunne is an Agro ecologist and currently working as a program manager for the SNSW Innovation Hub. Angus is a graduate of the ANU master's in science Agricultural Innovation (advanced).

Abstract

The integrated management of food, energy, and water systems will be essential to meet the demands of increasing populations and the shift to renewable energy. Agrivoltaics presents an opportunity to addresses, greenhouse gas (GHG) emissions, rising production costs, land competition, and, in a more limited way, water utilisation. This research assesses the suitability of agrivoltaics as a multi-land-use system in New South Wales (NSW), as a basis for expanding to all of Australia. The research includes (i) a systematic review of the available literature on agrivoltaics; (ii) the development of a set of future scenarios for agrivoltaics; and (iii) categorisation of uncertainties related to the adoption of agrivoltaics in Australia through roundtable focus groups, utilising the scenarios as a boundary object. The findings reveal that agrivoltaics appears suitable for NSW and that the most common categories of uncertainty for potential adopters of agrivoltaic systems were the construction and design of systems, managing multi-use systems, governance models, and economic information on agrivoltaics. The research identifies the need for agrivoltaic demonstration sites in Australia to generate meaningful information to make decisions. Additionally, a system of measurement for co-benefits can enable a metric to understand the wider benefit of multi land use systems.

Extreme events enhanced by climate change and its impact on surface water quality and drinking water supply

A S M Mohiuddin[1,2*], Saravanamuthu Vigneswaran[1]



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Brief bio of lead CI/presenter

ASM Mohiuddin is a chemical engineer, currently working as a Process Integration Manager at Sydney Water. He also currently carries out research works at the University of Technology Sydney as part of his PhD candidature. He is involved with numerous research and development trials on water treatment and advanced treatment technology selections at Sydney Water.

Abstract

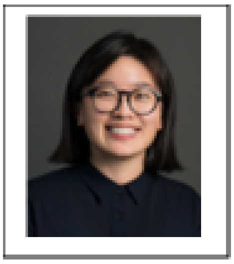
Climate change is creating more severe and intense weather events in Sydney, with a direct impact on the water quality and disruption in water supply services to the community. Sydney's drinking water catchment experienced several extreme events over the last six years. The events include a severe drought in 2018-19, followed by a significant bushfire in the largest Warragamba catchment in late 2019, a drought-breaking heavy rain in early 2020, and several major rain events and flooding over the last six years when most of the Dams in Sydney overflowed. Between 2021 and 2024 there were three intense rain events in Warragamba catchment, when in each event the volume of water entered the Warragamba Dam in three to five days was equivalent to the entire Sydney's drinking water demand for the full year. These extreme events resulted in substantial degradation of source raw water quality with a 50-100% increase in turbidity, true colour, and organics (dissolved and total organic carbon) (DOC, TOC). The poor raw water quality significantly impacted the treatment capability. Sydney's drinking water was at high risk due to the repeated extreme events and the potentially serious impact on the water supply to the five million population.

A suite of works was carried out to face the challenge of extreme events impacting water quality. For short-term impacts mitigation, the works included advanced optimisation of the water filtration plants by developing a Process Model integrating online data from Supervisory Control and Data Acquisition (SCADA) with the computerised model, pilot-scale trials for optimisation of water filtration, and testing & design of emergency pre-treatment by temporary sedimentation process upstream of full-scale water filtration. For long-term mitigation of weather events' impact on water quality, a holistic risk assessment was carried out for Sydney's drinking water, resulting in water filtration plant upgrades with advanced pre-treatment technologies currently being designed.

The short-term risk mitigation actions enabled to continue the supply of safe and clean drinking water, adapt to climate change impact, and avoid potential severe impacts on public health. The long-term actions will provide a robust water treatment resilient to weather events enhanced by climate change.

Environmental impacts and energy consumption of electrode materials during electrochemical oxidation of ciprofloxacin.

Yu-Jung Liu[1,*], Rou-Yu Jhu[1]



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Brief bio of lead CI/presenter

Dr. Yu-Jung Liu is an Assistant Professor in School of Public Health at Taipei Medical University. Her research interests include environmental electrochemistry, emerging contaminants, and environmental analysis. Her ongoing studies focus on environmental pollutant redox, including technology development for pharmaceutical elimination and energy-efficient wastewater treatment.

Abstract

This study examines the environmental impact and energy use of electrode materials during ciprofloxacin oxidation in a laboratory setting. The experiment found that the main environmental factors are material utilization and chemical use. The high impact is because of these chemicals' contribution to acidification and eutrophication. The study suggests that replacing these chemicals with more environmentally friendly alternatives or electrode configuration could significantly reduce the environmental impact of operation system. On the other hand, this study also considers the balance between treatment effectiveness and energy efficiency in pollutant degradation using electrochemical oxidation. Energy efficiency is a crucial factor for the economic viability of this technology. The research compared the effectiveness of different operational parameters on energy consumption, using G50 and E_{EO} as reference indicators. The study found that for dimensionally stable anode (DSA) electrode, adjusting the electrolyte concentration (NaCl) significantly improved G_{50}, indicating better energy efficiency. Similar trends were observed for E_{EO}, indicating lower energy consumption under the same conditions. A comparison of four electrodes revealed that boron-doped diamond electrode (BDD) exhibited the best energy efficiency (highest unit removal amount for G_{50} and lowest E_{EO}). This was followed by graphite felt, and DSA. This study also found that NaCl performed better energy efficiency than Na_2SO_4. Overall, the research highlights the importance of optimizing operational parameters and choosing suitable electrode materials or configuration to achieve both effective pollutant degradation and improved energy efficiency, ultimately making the technology more economically feasible.

Session 3: Circular Economy

Session Chairs: Liana Downey and Sanjay Kumarasingham

(Keynote) Putting the economy in “circular economy”

Liana Downey

CEO, Blueprint Institute
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Brief bio of keynote speaker

Liana Downey is the CEO of the Blueprint Institute, an independent think tank dedicated to helping Australia be more balanced, prosperous, resilient and sustainable. Downey is also a recognised thought-leader in the areas of the climate/energy transition, education and evidence-based policy development. Downey’s experience includes commercial advisory roles in agri-tech and energy infrastructure, Deputy Secretary for NSW Department of Education, and more than two decades as an advisor, as CEO of a boutique firm with offices here and New York and at McKinsey & company where she led the development of Australia’s first Greenhouse Gas Abatement Cost Curve. Downey was a special advisor to the Department of Prime Minister and Cabinet, taught public policy at Wagner’s Graduate School of Public Policy, holds an MBA from Stanford University (Arjay Miller Scholar), BSc (Math), BAStud, served as Chair and President of the Australian Conservation Foundation, and is the author of Mission Control: How Nonprofits and Governments Can Focus, Achieve More and Change the World (Routledge).

Abstract

The constraint on our ability to move towards more circular systems is not our capacity for innovation. The presentations in this conference will clearly demonstrate the ability of our best and brightest to rethink and redesign commercial and industries systems and processes to reduce and reusing waste. While the benefits from doing so are clear — the protection of delicate biodiversity and climate systems that we need to survive, our

broader macro-economic systems and processes make it harder, not easier, to create circular systems. So how might an economy be structured such that investment flows towards research in circular innovation? How might we reward people for reducing their consumption, rather than increasing their sales? What should we be asking of our governments to help us get there? This presentation considers the importance and benefits of bringing an economic and fiscal lens to circular economy research.

(Keynote) Water & Nutrient Management in Circular Economy

Sanjay Kumarasingham[1], Bhakti Devi[2]

[1]GANDEN Engineers & Project Managers, [2]OneWater Services
*Sanjay.Kumarasingham@ganden.com.au:

Brief bio of keynote speaker

- NSW Manager – GANDEN Engineers & Project Managers
- CEO Centre for Conscious Awareness (Registered Charity)
- Board Member – Youth in Transition Charitable Trust (Registered Charity)

Sanjay is a Charted PE, with over 25 years experience within the water industry. He consults through GANDEN. He has used his skills and knowledge in helping both private and public sectors on strategic projects which include energy generation through anaerobic digestion, biological nutrient removal, ultraviolet disinfection, beneficial use of biosolids, recycling water. He volunteers many community projects including providing food for homeless through the Sathya Sai Centre, youth suicide prevention and education in human values.

Abstract

As urbanisation occurs across the globe, there will be more people settling into towns and cities. There are over 81 cities globally with populations over 5 million and around 34 cities with populations over 10 million. Many city planning initiatives are looking at delivering on smart liveable city concepts.

Traditional linear model of economic growth has adversely impacted the natural resource base as it is built around growing the economy at the expense of natural resources. Hence, there is a growing movement of cities around the world are transitioning from linear economy to circular economy.

The circular economy (CE) is a transformative model that seeks to redefine economic growth by focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system. In the context of water and nutrient management, the circular economy framework offers a sustainable pathway to address global challenges like water scarcity, nutrient depletion, and environmental pollution.

This paper will explore the application of principles of CE to water & nutrient management while presenting case studies of how it is being done around the world.

What if companies drive corporate strategy with circular design principles?

Susan McHattie[1*]

[1]Susan McHattie is a practitioner who uses research and works with researchers when possible.
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Brief bio of lead CI/presenter

Susan McHattie is a consultant helping organisations transition to the new economy with clear ambition, implementation pathways, and accountability for action. She is focused on helping organisations bring transition and transition risk into strategy with purpose, people, customers and suppliers at the centre. She offers strategic services with a collaborative foundation built on years of experience in government, regional governance, community and industry settings. Susan is a practitioner who works with research, and enjoys working with researchers.

Abstract

Its time to put the circular economy in the centre of corporate strategy. The take up of net zero, circular and nature positive business models, products and services is increasing as a result of regulation, policy, system changing architecture and incentives. There is significant concern that the takeup may be compliance driven or market driven, leaving it superficial, rather than in the centre of corporate strategy. A hypothesis might be framed that placing shifts to the new economy at the centre of corporate strategy will deliver competitive advantage to those organisations and accelerate transition.

This presentation will explore the possible shape and benefits of research focused on this hypothesis.

- How does placing the new economy at the centre of corporate strategy achieve our transition targets and generate demand for the solutions presented in the conference program.
- Does placing the new economy at the centre of corporate strategy deliver competitive advantage and how is this shifting over time?

What other social shifts need to be in place to support this technical, economy transition

Reimagining cities with a circular economy lens

Valentina Petrone

Associate Director - WSP Australia Circular Economy Lead
Adjunct Associate Professor with the University of Sydney.
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Brief bio of lead CI/presenter

Valentina is WSP's Australia Circular Economy Lead and Adjunct Associate Professor with the University of Sydney. She has 16 years' experience in the property and construction industry, working across Europe and South-East Asia, providing design and advisory advice to Government and private clients.

Abstract

Cities play a key role in reducing environmental impacts as they account for more than 70% of global greenhouse gas emissions. On the other hand, cities contribute to more than 80% of global GDP and have a high concentration of resources, capital, data, and talent spread over a relatively small geographic area [1].nThis represents a unique opportunity for cities to shift toward a circular economy to respond to urban resource challenges and contribute to creating more sustainable, regenerative and inclusive cities. This shift will require a system thinking approach and collaboration across key stakeholders to co-design/redesign our cities and adopt new business models.In this context, Valentina Petrone will share opportunities and challenges of integrating circular economy principles and design strategies into every aspect of a city's design, construction and operations. She will also present key lessons learnt from Australian and international case studies to spark a conversation and identify a shared way forward.

Exploring the Transition to a Circular Economy in Australia: Barriers, Supply Chain, and Sustainable Design

Ned Wales[1*], Victoria Vega Garcia[2]

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Brief bio of lead CI/presenter

Dr. Wales is an Assistant Professor in Urban Planning at Bond University. With 35 years of experience in the land development industry across Australia and the United States, he has held leadership roles in urban planning, environmental management, and planning policy. He directs his consultancy firm, focusing on large urban development projects and research consultancy.

Abstract

This paper explores the role of government financial incentives and penalties in fostering the adoption of circular economy (CE) strategies across various industries. By examining the impact of grants, subsidies, tax breaks, and penalties for non-compliance, we highlight how these financial mechanisms can alleviate the high upfront costs associated with implementing circular practices. Additionally, the paper delves into policies supporting Australian products to compete with imports, emphasising the role of waste levies and Extended Producer Responsibility (EPR) in promoting sustainable waste management practices. State government waste levies, despite their substantial cost to local governments, are analysed for their potential to drive significant improvements in waste management by making disposal less attractive. Furthermore, the paper underscores the need for increased awareness about compostable and biodegradable packaging and addresses the insufficiency of current waste management infrastructure to support complex recycling needs. Through a comprehensive analysis, this study provides valuable insights and practical recommendations for policymakers and industry stakeholders to enhance the effectiveness of financial incentives and regulatory measures in advancing a circular economy.

Exploring the Influence of External Factors on Transparency in the Fashion Apparel Supply Chain in Asia-Pacific Region: A PESTEL Framework Analysis.

Chanuthi Rajapaksha[1]

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Brief bio of lead CI/presenter

Chanuthi Rajapaksha is a 2nd-year PhD candidate at Yokohama City University, Japan. She belongs to the Faculty of Urban, Culture, and Social Studies. Her research focuses on sustainable development, supply chain management, and corporate social responsibility within the fashion apparel industry. Chanuthi is passionate about understanding and addressing urban social issues.

Abstract

Exploring the Influence of External Factors on Transparency in the Fashion Apparel Supply Chain in Asia-Pacific Region: A PESTEL Framework Analysis.

The fashion apparel industry, a dynamic and global sector, faces increasing scrutiny for its environmental and social impacts. Despite advancements, significant challenges remain in achieving transparency, which is crucial for fostering a circular economy. In a circular economy, the supply chain plays a vital role. Transparency ensures

that all parties commit to sustainable practices, fostering innovation and collaboration. Openness about sourcing, production processes, and business practices builds trust among stakeholders and helps businesses meet regulatory requirements. The lack of transparency in the fashion supply chain leads to poor labour conditions, environmental degradation, and regulatory challenges. These issues hinder circularity by obstructing sustainable and ethical practices. Transparency is essential for identifying and addressing these problems, promoting a truly circular and sustainable fashion sector. This research investigates the external factors influencing transparency in the fashion clothing supply chain in the Asia-Pacific region using the PESTEL framework (Political, Economic, Social, Technological, Environmental, and Legal). The aim is to understand how these pressures affect transparency and provide actionable insights for stakeholders. The study begins with a literature review to identify and formulate hypotheses regarding PESTEL factors and transparency. A conceptual framework guides the empirical investigation. The research employs a mixed-methods approach, combining qualitative and quantitative methods. Data collection involves structured surveys & In-depth interviews with key stakeholders and experts in the industry. Additionally, secondary data analysis of reports, compliance documents, and case studies complements the primary data. Preliminary findings suggest that regulatory and technological factors are significant drivers of transparency efforts, while economic pressures and social expectations also play crucial roles. This research is particularly relevant for developing countries in the Asia-Pacific region, which are key players in the apparel sector. Enhanced transparency in these regions can improve labour conditions, reduce environmental impacts, and increase global consumer trust. The insights aim to inform policymakers, industry leaders, and advocacy groups, promoting ethical practices and sustainable growth.

Keywords: Transparency, Fashion Clothing Supply Chain, PESTEL, Sustainability, Asia-Pacific, Ethical Practices.

Session 4: water, Energy & environment

Session Chairs: Mikel Duke and Mufid Noufal

(Keynote) Water Efficiency City of Sydney

Mufid Noufal[1]

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mnoufal@cityofsydney.nsw.gov.au

Brief bio of keynote speaker

Mufid has over 27 years of experience in water and wastewater treatment. During his career, Mufid worked on the design, development of new technologies and products, construction and operation and maintenance of various water treatment applications. Mufid has a wealth of experience in biological treatment, membrane application and water reuse. Mufid worked in multiple countries, for small, large and government organisations. Mufid has a degree in chemical engineering, business management, project management, asset management, innovation, and design thinking. In his current role as a Water Systems manager, Mufid manages the City of Sydney's water strategy and drives the implementation plan, Mufid also manages multiple water recycling schemes as part of his role.

Abstract

The City of Sydney has made significant strides in improving water efficiency as part of its commitment to sustainability and environmental stewardship. This abstract provides an overview of the initiatives and strategies and frameworks implemented to optimise water usage across the City of Sydney operations. Key measures include the installation of smart water meters and data management, promotion of water-efficient equipment, fixtures and appliances, alternative water source from rainwater and stormwater. The city has also invested in rapid water leak rectification to reduce leakage. These efforts have resulted in a substantial reduction in water

consumption, contributing to the city's resilience against droughts and its goal of becoming a greener, more sustainable urban environment. The success of Sydney's water efficiency programs serves as a model for other cities aiming to balance urban growth with environmental preservation.

(Keynote) Applying the circular economy concept in the conversion of cyanobacterial nuisances into bio-based energy

Laryssa Gonçalves Pereira[1,2], Thomas Yeager[2], **Mikel Duke**[2*], Betina Kozlowsky-Suzuki[1,2,4]

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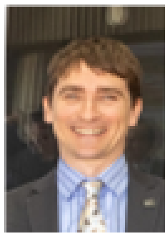

Brief bio of keynote speaker

Dr Mikel C Duke is Professor of Membrane Science at the Institute for Sustainable Industries and Liveable Cities at Victoria University. His research in the fields of gas separation, water treatment and membrane science have attracted $24.4M of funding and publications have >10,000 citations. He is an Editor of the journal Desalination (IF = 8.8), the former President of the World Association of Membrane Societies (https://www.wa-ms.org/) and the founding President of the Membrane Society of Australasia (https://www.membrane-australasia.org/).

Abstract

Cyanobacterial harmful blooms present a significant challenge in freshwaters worldwide, aggravated by climate change and increasing pollution of natural or constructed waterbodies. In this context, the circular economy concept can be applied by using cyanobacteria as a co-substrate in anaerobic co-digestion offering a promising and sustainable approach for both managing cyanobacterial nuisances and generating bio-based energy while recovering nutrients. This study aimed to investigate the use of cyanobacterial biomass from a bloom event as a co-substrate in anaerobic digestion with sewage sludge, being two major organic streams connected to sanitation and the water industry. Cyanobacterial biomass was harvested from a wastewater treatment plant during a bloom period when the community was dominated by the toxic species *Microcystis aeruginosa*. The biochemical methane potential (BMP) was assessed through batch experiments conducted over 43 days in a mesophilic regime (38 ºC) with a substrate/inoculum ratio of 1:2 (based on g VS). The total biogas yields were 357 mL/g VS for 100% sewage sludge (SS), 519 mL/g VS for 100% cyanobacteria-dominated bloom material (CYA), and 389 mL/g VS for the co-digestion of 25% CYA and 75% SS (1:3 ratio based on g VS). The average methane contents were 72% for SS, 76% for CYA, and 74% for the co-digestion. Our results indicate that the presence of cyanotoxins, i.e. microcystins, did not negatively affect anaerobic digestion. Moreover, a higher methane content was obtained from co-digestion compared with sewage sludge alone on a per VS basis. Therefore, this study aims to encourage further research on using cyanobacterial bloom material as a co-substrate in anaerobic digestion, as it can optimize biogas production in facilities that already use sewage sludge as a substrate. Furthermore, the residual microcystin concentration after anaerobic digestion highlights the need for additional studies on the toxicity and overall quality of the digestate, especially regarding its reuse in agriculture.

Effectiveness of grease interceptors in food service establishments for controlling fat, oil and grease deposition in the sewer system

Nilufa Sultana[1], Felicity Roddick[1], Li Gao[2], Biplob Kumar Pramanik[1]

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Brief bio of lead CI/presenter

Dr. Biplob Pramanik, a Senior Lecturer and ARC DECRA Fellow at RMIT University. Biplob's research focuses on fatberg management and resource recovery as well as development of a separation-based technological platform for removing emerging pollutants) from water and wastewater. To date, he has published over 130 articles in international peer-reviewed journals, amassing more than 5000 citations and an H-index of 40. Over the past 7 years, he has received over $4.0 million in research funding.

Abstract

The water industry worldwide experiences numerous sewer blockages each year, partially attributed to the accumulation of fat, oil and grease (FOG). Managing this issue involves various strategies, including the requirement for installation of grease interceptors (GIs) installation. However, the claimed efficacy of commercial GIs of eliminating 99 % of FOG has been questioned for many years because FOG deposit formation occurs despite food service establishments (FSEs) using GIs, therefore detailed understanding of FOG wastewater compositions and its removal by GIs is required. This study provides an insight into the key FOG components such as FOG particle size, metals and fatty acid (FA) profile in GI influent and effluent, and within the GI, at three different FSEs. Analysis of FAs identified substantial proportions of extra-long-chain FAs in the effluents, including arachidic (C20:0), behenic (C22:0), mead (C20:3), lignoceric (C24:0), and nervonic (C24:1) acids. In contrast, the household kitchen released palmitic (C16:0), oleic (C18:1) and linoleic (C18:2) acids. It was further observed that scums effectively remove the larger FOG particles, leaving only 10 % below 75.4 μm. Notably, FSEs which employed automatic dishwashers produced up to 80.4 % of particles ≤45 μm, whereas FSEs and household kitchen which used handwash sinks generated only 36.9 % and 26.3 % of particles ≤45 μm, respectively. This study demonstrated that the commercial GIs do not remove FOG entirely but clearly demonstrated that they discharge high concentrations of FOG with extra-long FFAs which were attributed to the occurrence of microbial activity and hydrolysis of triglycerides within the GI, potentially contributing to FOG deposition.

Valorization of liquid anaerobic digestate into N-P-K fertilizers by biological nitrification

Andrea Merenda[1]*, A.H. Shafaghat[1], Weonjung Sohn[1], Django Seccombe[2], Sherub Phuntsho[1], Ho Kyong Shon[1]

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Brief bio of lead CI/presenter

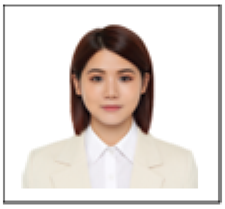
I am a postdoctoral researcher at the ARC Nutrients in a Circular Economy (NiCE) hub at the Faculty of Civil and Environmental Engineering, UTS. I graduated my PhD in 2019 (Deakin University). My research interests span green chemistry for biomass valorization, stimuli responsive materials for separation and energy, and membrane science.

Abstract

Climate change and population growth are promoting the implementation circular economy principles underpinned by a transition to renewable energy. The global fertiliser industry is responsible for more than 1% of annual CO_2 emissions since it largely relies on the mining of nutrients from dwindling feedstocks, and on the energy-intensive Haber-Bosch process. There is an urgent demand of circular economy approaches to build climate-resilient food supply chains, minimizing the utilisation of non-renewable resources and achieve net-zero emissions [1, 2]. Green fertilizers can be obtained from abundant, renewable feedstocks such as nutrient-rich wastewater [3]. Anaerobic digestion (AD) is a mature technology (>132,000 reactors worldwide) that produces green fuels from biomass while generating a nutrient-rich liquid fraction, named liquid anaerobic digestate (LAD). LAD holds great potential as a renewable carrier of nutrients and chemical energy for a circular bioeconomy owing to its abundancy (290-300 Mt y-1 worldwide), the high nutrient availability (100-600 kt y-1 in the EU27) and the presence of active biomolecules defined as biostimulants. In this study, LAD obtained from the Riverstone Sydney Water wastewater plant is valorized into liquid N-P-K fertiliser by biological nitrification, using a laboratory-scale membrane bioreactor (MBR) fitted with submerged UF membranes. The laboratory-scale, 4.5 L MBR was operated for 5 months at fixed pH and LMH of 6 and 4.5, respectively. Upon the acclimation of the nitrifying AOB and NOB bacteria, the LAD strength was progressively increased from 40 (10% v/v dilution) to 400 mg/L of NH_4^+ (full strength). UF-MBR afforded a 57% conversion of NH_4^+ into NO_3^- at steady state, with an HRT of 10 h and a TOC removal of 90%. A 0.2-0.2-0.1 N-P-K fertiliser was obtained and tested on the hydroponic growth of Basil (*Ocimum Basilicum*). This study will lay the foundation of a circular bioeconomy of nutrients whereby inexpensive and abundant waste, such as LAD, is valorised into value-added green fertilisers.

Enhancing Nitrogen Removal Performance from Low C/N Municipal Wastewater through Anammox Self-Enrichment Using a Pilot-Scale Hybrid MABR System

Hsin-Chieh Lin 1*, Chia-Hung Hou 1, Yu-Tzu Huang 2



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Brief bio of lead CI/presenter

Hsin-Chieh Lin is a Ph.D. candidate in Environmental Engineering at National Taiwan University, currently conducting research at the University of Technology Sydney. Her research interests focus on membrane aerated biofilm reactors (MABR), biological nitrogen removal processes, and the application of environmental biotechnology.

Abstract

Efficient nitrogen removal from low carbon-to-nitrogen (C/N) ratio wastewater is a significant challenge for conventional biological nitrogen removal systems, which often rely on external carbon sources and energy-intensive aeration. The anaerobic ammonium oxidation (Anammox) process presents a promising alternative, as it enables direct conversion of NH_3-N and NO_2^- into N_2 without the need for organic carbon. However, Anammox bacteria are slow-growing and traditionally difficult to cultivate, limiting their large-scale application. This study addresses these challenges by developing a pilot-scale hybrid membrane-aerated biofilm reactor (MABR) system, facilitating *in-situ* Anammox self-enrichment in municipal wastewater treatment with low C/N ratios (1.5-1.9). The MABR technology utilizes oxygen-permeable membranes that allow for counter-diffusional transfer of oxygen and substrates, creating distinct aerobic and anaerobic zones within the biofilm. This enables precise control over oxygen diffusion, which is critical for fostering Anammox activity while simultaneously suppressing nitrite-oxidizing bacteria (NOB) that compete for nitrite. By establishing these favourable microenvironments, MABR effectively supports multi-step nitrogen transformation processes, including partial nitrification, partial denitrification (PD), and Anammox, making it an ideal system for low C/N wastewater treatment. In this study, the system was tested under various operational conditions, including hydraulic retention time and sludge reflux ratios. Results demonstrated that Anammox bacteria, specifically *Candidatus Brocadia*, were enriched within the MABR biofilm, representing 6.91% of the microbial community. The system exhibited superior nitrogen removal efficiency, achieving a 3.9-fold improvement compared to

the traditional Modified Ludzack-Ettinger (MLE) process, without the need for external carbon sources. Moreover, the oxygen transfer efficiency (OTE) of the MABR was maintained at 40-60%, significantly outperforming conventional fine bubble diffusers (~25%). A life-cycle assessment (LCA) further demonstrated the sustainability benefits in the hybrid MABR system, showing a 57.7% reduction in greenhouse gas emissions compared to the MLE system, with 1 kg of total inorganic nitrogen (TIN) removal as the functional unit. By leveraging the advantages of in-situ Anammox self-enrichment, this hybrid MABR system offers a sustainable, energy-efficient solution for nitrogen removal in low C/N wastewater, paving the way for broader application in municipal wastewater treatment.

Effects of surfactants on polyamide thin-film composite membranes fabricated by co-solvent assisted interfacial polymerization for the treatment of semiconductor wastewater

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Brief bio of lead CI/presenter

Jeonghoo Sim is a Ph.D student from the Department of Environmental Engineering and Energy, Myongji University, Republic of Korea. Her research primarily focuses on the fabrication of reverse osmosis membrane for semiconductor wastewater treatment. She recently published a review of semiconductor wastewater treatment processes in Journal of Cleaner Production.

Abstract

The semiconductor industry is witnessing rapid growth due to the Fourth Industrial Revolution, but this has led to an increase in wastewater generation from manufacturing processes, containing harmful substances like TMAH, NMP, hydrogen fluoride, copper, and IPA. Reverse osmosis (RO) processes are being explored for semiconductor wastewater (SWW) treatment, targeting removal of TOC, SS, turbidity, PFOS, and other contaminants. However, there's a lack of research on RO membranes for SWW treatment. Interfacial polymerization (IP) is a common method for fabricating RO membranes, using m-phenylenediamine (MPD) and trimesoyl chloride (TMC) as monomers. Adding surfactants like sodium dodecyl sulfate (SDS) to the MPD solution facilitates effective control of the miscibility, termed co-solvent assisted interfacial polymerization (CAIP) [1][2]. In this study, PA composite membranes were fabricated using CAIP for semiconductor wastewater treatment, with a focus on evaluating the influence of surfactants on membrane properties and performance.

The porous supporting layers as supporting substrates were fabricated using PSf, N-Methyl-2-pyrrolidone (NMP), and lithium chloride on non-woven polyester fabric bases. To fabricate the TFC RO membrane, MPD aqueous solution and TMC organic solution were used during IP and CAIP on the supporting layers. For membrane characterization, SEM, FT-IR, and contact angle analyses were conducted, while salt rejection rate and analyses such as IC, LC-MS, and ICP were performed to evaluate membrane performance. This study aimed to understand the impact of surfactants on membrane properties and enhance the efficiency and sustainability of membrane-based treatment methods for semiconductor industrial wastewater. The CAIP membranes not only performed higher flux than IP membrane but also reached approximately 95% salt rejection. This study confirmed the feasibility of CAIP RO membranes for SWW treatment.

Acknowledgments

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (grant number: RS-2024-00335876).

Session 5: Resource Recovery

Session Chairs: Alicia Kyoungjin AN and June-Seok Choi

(Keynote) Innovative Approaches in Membrane Distillation for Enhanced Ammonia Removal and Recovery from Wastewater Streams

Alicia Kyoungjin AN

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[2] School of Energy and Environment, City University of Hong Kong, Hong Kong Special Administrative Region, China
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Brief bio of keynote speaker

Dr. Alicia An is a Professor in the Department of Chemical and Biological Engineering at the Hong Kong University of Science and Technology (HKUST). With 20 years of experience in membrane-based water treatment, she has published over 150 papers and has an h-index of 46 with an FWCI of 2.48. Her research focuses on emerging technologies such as Membrane Distillation (MD), Forward Osmosis, and hybrid Reverse Osmosis for removing emerging pollutants and resource recovery. Recognized among the top 2% of the world's most highly cited scientists in a report by Elsevier and Stanford University since 2020, Dr. An was awarded the "RGC Research Fellow" title in the Research Fellow Scheme (RFS) by HKRGC in 2022 and received the CityU Outstanding Research Award in 2023. She has secured over HK$50 million in research grant funding. Additionally, she serves as an Associate Editor for the journal Process Safety and Environmental Protection and is an Editorial Board member for Desalination and the Journal of Water Process Engineering.

Abstract

Efficient removal and recovery of ammonia nitrogen from wastewater is crucial for environmental protection and resource conservation. Ammonia, prevalent in wastewater due to agricultural runoff, industrial discharges, and municipal sources, poses significant environmental risks, such as eutrophication. Membrane distillation (MD) offers a sustainable solution by utilizing low-grade heat and ammonia's volatility for effective removal and recovery. Our research explores MD's applicability for ammonia recovery from sludge digestate, focusing on a specialized Nafion membrane with MWCNTs embedded within a PVDF-HFP nanofiber matrix. This structure enhances ammonia recovery and mechanical resilience, achieving a threefold increase in recovery compared to conventional membranes. We optimized operational parameters through experimental and modeling techniques, exploring configurations like Vacuum MD and DCMD with various membrane types.

Innovatively, we introduced an electrochemically assisted MD system using carboxylated MWCNTs on a hydrophobic PVDF membrane. This system eliminates chemical additives for pH adjustment by inducing hydroxide ion production, transforming ammonium ions into volatile ammonia. This method aligns with sustainability goals by offering a cost-effective solution for ammonia recovery. Our work extends to generating value-added products such as liquid ammonia, ammonia gas, or hydrogen, enhancing economic viability and aligning with sustainability principles. This research underscores the potential of innovative MD technologies to transform wastewater management, combining environmental protection with economic benefits for society and the planet.

(Keynote) Introduction and Future Plans of the Green Desalination Research Lab: A Crucial Step Towards Circular Economy

Joowan Lim [1], Linitho Suu [1, 2], Deokhwan Kim [1,2], Jonghun Lee [1], Hojung Rho [1,2], Saeromi Lee [1], Youngkwon Choi [1], Kwang-Duck Park [1], **June-Seok Choi [1,2*]**

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Brief bio of keynote speaker

Dr. June-Seok Choi is a Research fellow of Department of Environment Research at Korea Institute of Civil Engineering and Building Technology (KICT) in Republic of Korea and Representative Professor of KICT School at University of Science and Technology (UST) in Republic of Korea. He has (co)authored over 50 peer-reviewed international journal publications, primarily focusing on desalination technology.

Abstract

Globally, the issue of water scarcity is becoming increasingly severe due to the impacts of climate change, prompting various efforts to address this problem. Since the 1960s, seawater desalination processes have been developed, particularly in the Middle East, to tackle water scarcity, and this technology is now widely disseminated worldwide. However, the large volumes of concentrated brine produced by desalination processes pose new environmental challenges, leading to growing interest in utilizing this brine.

Additionally, the demand for advanced technologies and products is rising due to societal and lifestyle advancements, driving a sharp increase in the demand for critical resources. Given the limitations of existing land-based resources and the additional environmental issues associated with their extraction, there is increasing interest in new concepts of resource recovery.

The Green Desalination Research Lab aims to reduce the volume of concentrated brine generated from seawater desalination processes and recover valuable resources in the brine. The lab is conducting various studies related to resource recovery. This paper will introduce the technologies developed by the Green Desalination Research Lab and outline the future research directions.

Acknowledgements

This work was supported by Korea Institute of Civil Engineering and Building Technology (KICT) through International Matching Co-funding Research Program (No. 20240441).

Malabar WRRF and Biomethane Injection Project

Praby Sasson

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Brief bio of lead CI/presenter

Praby is the process controller at the Malabar Resource Recovery Facility (Sydney Water). Her role includes overseeing the processes involved in transforming waste materials into valuable resources, ensuring efficiency and compliance with environmental standards.

Abstract

Malabar Resource Recovery Facility produces biomethane as a coproduct of wastewater treatment, playing a crucial role in sustainable waste management. The facility processes sewage and industrial wastewater through a series of stages, beginning with screening and grit removal to eliminate large debris and solids. This initial treatment is followed by sedimentation tanks to remove further solid.

The captured solids undergo anaerobic digestion. This digestion process not only stabilises the organic material but also generates biogas, primarily composed of methane. The produced biomethane is a renewable energy source that can be used to power the facility or be injected into the gas grid.

The facility's approach to wastewater treatment and biomethane production exemplifies the principles of the circular economy, converting waste into a valuable resource. By effectively managing wastewater and harnessing its energy potential, the Malabar Resource Recovery Facility contributes to environmental sustainability while supporting local energy needs. This innovative process showcases how resource recovery can lead to significant benefits for both the community and the

Enhanced Energy Performance with Solid Digestate-Derived Biochar Adsorbent in Solid Recovered Fuel

Shao-Fu Tu[1], Yu-Ming Chu[1], Hsing-Cheng Hsi[1,2], Hwong-wen Ma[1], **Yu-Chieh Ting[1*]**

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[2]Advanced Research Center for Green Materials Sciences and Technology, National Taiwan University, Taipei, Taiwan

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Brief bio of lead CI/presenter

Yu-Chieh Ting currently works as an assistant professor in Graduate Institute of Environmental Engineering at National Taiwan University. His main research areas include the physicochemical and optical characteristics of air pollutants, the identification of pollution sources, the impact of air pollutants on human health, air quality, and climate. Additionally, he also explores the conversion of organic waste into energy, aiming to achieve a circular economy and net-zero carbon emissions.

Abstract

Anaerobic Digestion (AD) technology converts organic waste into biogas, aligning with circular economy principles. However, its byproduct, digestate, poses waste management challenges due to its variable composition and potential heavy metal contamination. This study investigates converting solid digestate into biochar for toluene adsorption and its utilization as Solid Recovered Fuel (SRF). We analyzed the physicochemical properties of biochars and conducted pyrolysis experiments on both unmodified and potassium carbonate-modified biochars at temperatures between 500 and 800 °C. The results indicate that biochar derived from digestate effectively adsorbs toluene, with adsorption capacities ranging from 81.63 mg/g to 963.94 mg/g post-modification. Furthermore, the calorific value of biochar, initially between 10.66 MJ/kg and 33.57 MJ/kg, increased by 5% to 33% after adsorption, meeting SRF criteria. This study highlights the dual benefits of biochar as a pollutant adsorbent and a low-carbon energy source. It offers an environmentally sustainable solution for managing solid digestate, addresses agricultural issues, and assists nearby industries in air pollution control, thereby promoting the circular economy and the sustainable development of agro-industrial symbiosis.

Development of High-Value Bimetallic Catalysts from Metal-Contaminated Water

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Brief bio of lead CI/presenter

Dr. Hojung Rho is a Senior Researcher of Department of Environment Research at Korea Institute of Civil Engineering and Building Technology (KICT) in Republic of Korea and Assistant Professor of Department of Civil and Environment Engineering at University of Science and Technology (UST) in Republic of Korea. He has (co)authored over 40 peer-reviewed international journal publications, primarily focusing on membrane and adsorption processes for physico-chemical water treatment and resource recovery

Abstract

Metal-contaminated water, notably with prevalent heavy metals, poses significant environmental and health threats, given its prevalent sourcing from industrial activities such as semiconductor production, electroplating operations, and mining. Despite the existence of numerous methods to extract metal ions from water, such as flocculation, ion exchange, chemical precipitation, electrocoagulation, membrane filtration, and adsorption, these processes often generate waste byproducts with negligible commercial value, emphasizing the increasing importance of finding beneficial uses for these "wastewaters". Previous studies showed that an up-cycled metal catalyst made from copper and palladium solution, known as Pd- Cu/γ-alumina, could be reused in processes that reduce nitrate levels. However, previous work didn't explain how the different forms (phases) of alumina – alpha and gamma - adsorb metals, or determine the best conditions for increasing the conversion of nitrates into nitrogen gas (N2 selectivity) using these catalysts. In this study, we elucidated the phase-dependent adsorption mechanisms of alpha and gamma alumina during the creation of Pd- Cu/γ-alumina bimetallic catalysts. Further, we carried out optimization experiments to generate a bimetallic catalyst with superior N2 selectivity, by finely tuning parameters such as temperature, pH, and amounts of metal adsorption. We conducted column tests under these optimal conditions, resulting in the synthesis of a variety of bimetallic catalysts. Subsequent nitrate reduction experiments allowed us to compare the N2 selectivity of the created bimetallic catalysts and pinpoint the copper to palladium concentration ratio that produced the highest N2 selectivity. This optimized procedure for crafting high-value bimetals exhibiting remarkable N2 selectivity (76%) suggests promising avenues for resource recovery strategies utilizing alumina.

Agile Recycling Technology for Organics

Justin Frank

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Brief bio of lead CI/presenter

As former Chief Strategy, Sustainability & Communications Officer at SUEZ Australia, Justin is a purpose driven circular economy leader with applied experience in the UK, Europe and Australia. Justin has joined Goterra as

Head of Strategy & Communications to help drive Goterra's innovative circular economy solutions and make a sustainable difference to the next generation's future.

Abstract

Food waste is directly responsible for 8% of global carbon emissions. One third of all food produced is lost or wasted (1.3 billion tonnes), costing the global economy c.$940 billion each year. In Australia, over five million tonnes of food goes to landfill from households and the commercial sector, costing the economy c.$20 billion a year. The highest volume of food organic wastes comes from households and businesses, often at low volumes. Managing these smaller volumes currently requires long distances and collection generally back to a central processing and management facility, which is inefficient and costly. Additional challenges with these waste streams are lack of uniformity and often high volumes of contamination that are unsuited to anaerobic digestion or composting. Goterra’s solution uses modular, autonomous infrastructure at the location where waste is generated; using maggots working in tandem with robotics. The solution is called Modular Infrastructure for Biological Services (MIBS). These MIBS (contained in modified 20 foot shipping containers) can be placed right where the waste is being produced. The MIBs accommodate colonies of black soldier flies (BSF) that quickly consume large quantities of organic waste and in doing so, turn it into two valuable commodities - a highly sustainable protein and soil enhancer. Value is created, organic materials are up-cycled back into the economy and transport miles are radically reduced.
Startups in the waste management sector learn from the relationships of their clients and stakeholders. How to liaise with councils, asset managers and waste management providers to unlock technology driven solutions to redesign waste management solutions. Engagement with the sector are pivotal to designing effective technology that solves real world problems. But what does it look like when these solutions emerge in the market? How do they interact and what are the implications for licensing and regulation? Exploring these themes from the Startups perspective, demonstrates the challenges faced by companies attempting to deliver technology into the market.

Session 6: Resource Recovery

Session chairs: Dharma Hagare, Andrea Merenda

(Keynote) Upcycling of Food Waste

Dharma Hagare[1]

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Brief bio of plenary/keynote speaker

Dr. Dharma Hagare, is a Senior Lecturer and researcher in the area of Sustainability Engineering at Western Sydney University. He is the leader of the Nutrient, Energy, Water and Materials Recycling Group (NEWMARG), which is focused on Circular Economy applications related to waste materials recycling. He has over 170 publications in international journals, conferences and book chapters. He has received over $3.4 million in research funding. Over the years, he has successfully supervised 14 PhD and 6 MPhil students to graduation. He has led as well as currently leading, several research projects which are funded by industries. His recent industry collaborators include Food Recycle, Global Renewables, Austral Bricks, several City Councils and other organisations. His pioneering work in food waste recycling has resulted in commercialisation opportunities for the industry partner. The technology that was concept tested is being implemented both nationally and internationally.

Also, he is leading the research activities related to Recycled Water for Irrigation (RWI). Towards this end, he has established a research group involving several researchers from Australia, India and USA.

He is also a co-leader and co-founder of the Australia India Water Centre (AIWC). AIWC is a consortium of 10 Australian and 15 Indian Universities and Government Departments. As part of AIWC activities, he is leading several research projects in spring rejuvenation and wastewater recycling. In addition, he is leading several capacity-building activities between Australian and Indian Universities.

Abstract

Food waste (FW) is highly biodegradable solid waste produced by residential, commercial, industrial and agricultural activities. In Australia, in 2020-21, about 4.7 million tonnes (Mt) of food waste was generated. Globally, in 2011, FAO estimated that a total of 1.3 billion tonnes/yr of food was wasted. In Australia, 3.9 Mt/yr (83%) of food waste was sent to landfill. Each tonne of food waste sent to landfill is estimated to contribute up to 3 tonnes of CO_2-e emission. FAO estimates that about 8-10% of global greenhouse gas emissions could be associated with the food that is wasted. Thus, wasting food is both a waste of resources as well as a significant contributor to greenhouse gas emissions.

The most desired method of reducing food waste is to prevent its generation in the first place. The next best is to use the food waste for producing varieties of animal feed. Recycling of food waste as animal feed is not new. It has been practised informally since the start of the domestication of animals. Recently, due to the adverse environmental impacts arising from the disposal of food waste in landfills, there is a move towards large scale recycling of food waste to produce animal feed.

The study reported here highlights the benefits of producing chicken feed from food waste. To promote the healthy growth of chickens it is important to maintain appropriate nutrients in the feed. Mainly the feed produced from food waste must meet the nutrient content in terms of protein, fat, energy content and cations such as calcium, magnesium, potassium and sodium. In addition, the feed must contain certain concentrations of amino acids to meet the nutrition requirements of the feed. It was found that it is possible to meet the nutrition requirements of the feed by mixing the different waste materials in appropriate portions. It was also found that under certain circumstances it could be challenging to meet the minimum protein content requirements. In such circumstances, it would be necessary to add virgin materials.

Overall, the study indicated that it is possible to produce balanced chicken feed by incorporating food waste and in commercial quantities. Also, the process can be economically justified as it can produce chicken feed that is less costly than the commercially sold feed.

Commercialisation of Waste to Animal Feed Process

Mr. Norm Boyle[1]

[1]Food Recycle Ltd, Bega, NSW
Email: Norm@normconsulting.com.au

Brief bio of plenary/keynote speaker
Norm Boyle is the founder of Food Recycle and the inventor of the patented technology. He has been the main drive behind building the company from the ground up, putting the team together and proving the science.
Norm has had experience across a broad range of industries including construction & engineering and spent a number of years in the USA working in licensing patented technologies. He is listed as the inventor on multiple patents and is now focussed solely on licencing the Food Recycle technology internationally.

Abstract
We live in a very strange world. A world where approximately one third of all produced food is wasted and is one of the world's most problematic wastes due to the greenhouse gas emissions that are generated as a result. At the same time millions of people around the globe go hungry as global populations stretch the world's food sources to their limits, this very same food that is a problem waste.
Traditionally the solutions around food waste have been better means to dispose of the waste, processing the waste into either nutrient rich composts or generating electricity through anaerobic digestion. The problems that have typically arisen with these solutions are the commercial viability of the businesses embracing them.
Enter the world of tomorrow and we have companies telling us that producing protein meal from black soldier fly larvae that eat the food waste is the future, yet not a single company in the world has been able to sustainably

produce nutritionally equivalent proteins that come close to the price of soy meal, the go-to protein used in animal feeds.
Prevention is always the ultimate goal, but often the hardest to achieve.
What if the solution was almost as simple as the problem sounds? We have too much food waste, and not enough food. What if we could use the food waste, at scale, to produce commercial animal feeds? There have been biosecurity barriers in the past that have restricted this as a solution, but we now have knowledge and technologies that can mitigate these barriers.
We would like to introduce you to the Food Recycle process, where we use food that has been wasted, for feed. A process that retains the original high value of the nutrients, and processes them into a biosecurity safe product that replicates a commercial feed's nutritional formulation. The best part about this process, is that the processing of the food waste is significantly less expensive than the value of the resulting feed. This makes for a truly sustainable solution, that in turn displaces new food needing to be used to make feeds.

Macroalgal Bioremediation- a Fully circular and cost-effective solution to treat wastewater

Emma James [1]*, Nicolas Neveux [2], Kevin Patrick [2], Django Seccombe [1]

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Brief bio of lead CI/presenter

Emma has been working in the water industry since the late 1990s, with a focus on environmental performance, natural treatment systems and benefits for communities from improved water management. Emma's role at Sydney Water has included trialling technologies to protect waterways and optimise circular economy outcomes.

Abstract

DRIVER
Bioavailable nutrients from treated wastewater threaten aquatic biodiversity in Australia. While advanced technologies can effectively treat wastewater, they are energy intensive and do not capture carbon or reuse nutrients. Nature-based technologies such as macroalgal bioremediation offer a compelling alternative to improve effluent quality and are simple, cost-effective, chemical free and typically carbon neutral. Macroalgal bioremediation solutions (e.g. RegenAquaTM) use native green macroalgae to capture nutrients, carbon dioxide, and other contaminants dissolved in wastewater to grow and deliver a continuous stream of high-quality biomass. This biomass can be converted into commercially viable products to promote a circular economic model.

CASE STUDY DETAIL
At the Picton Water Resource Recovery Facility (WRRF) in NSW, an algal trial has been operating since February 2023 to treat secondary effluent. The results from this trial show that macroalgal bioremediation is a simple, reliable, and effective technology. Nutrient concentrations were greatly reduced for nutrients, as well as other contaminants. TN and TP were typically reduced by 80-90%, and oxidised N, ammonia N, ortho P, and faecal coliforms were consistently reduced by over 99%.

Sustainability and Circularity are a key focus of the trial
Local algae species are used to ensure there is no risk of introducing a different algal strain to the local environment. The algae treatment reduces conditions that would be favourable for algae growth in downstream waterways. The lower concentrations of bioavailable nutrients are expected to provide protection for local waterway health.
This technology demonstrates the ability of macroalgae to transform waste nutrients into high quality biomass that can be continuously harvested. Reuse of the harvested algae at trial scale has been done simply with land application and composting. At a larger scale, this biomass provides a feedstock to produce organic fertilisers, liquid biostimulants or biochar, recycling key elements such as carbon, nitrogen, and phosphorus. Non-agricultural products such as bioplastics, biofuels and high value extracts provide alternative avenues for generating revenue from the harvested biomass, resulting in a fully circular solution.

The opportunity to reduce the energy and chemical use associated with traditional secondary treatment technologies is also being considered at the Picton facility.

Resource Recovery from Challenging Hypersalline Solution Treatment by Membrane Distillation Crystallization

Youngkwon Choi[1*], Joowan Lim, Linitho Suu, Jonghun Lee, Hojung Rho, June-Seok Choi

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Brief bio of lead CI/presenter

I am Youngkwon Choi, a senior researcher at Korea Institute of Civil Engineering and Building Technoloy in South Korea. I am working on the treatment of wastewater such as desalination plant brine and industrial wastewater, and the recovery of valuable resources from wastewater.

Abstract

As the water shortage problem caused by climate crisis spreads around the world, seawater desalination technology is in the spotlight as one of the ways to solve the water shortage problem, and the development of seawater desalination plant construction and seawater desalination technology is accelerated. RO-based seawater desalination shows a lower water recovery rate than conventional evaporation methods with an average recovery rate of 35-55%, and accordingly, the amount of brine (concentrated wastewater) generated is similar to or higher than that of fresh water produced. Most conventional concentrated water treatment methods such as marine discharge, surface water discharge, evaporation pond, and deep-well injection focus on the disposal of brine. However, due to the property of brine containing high salinity and various chemicals leading to the adverse effects on marine ecosystem, and the regulation on marine discharge of brine is strengthened, technologies and processes to utilize brine and to recovery the valuable resource from brine are being developed. In this study, strategies and technologies for reducing, utilizing, and resourcing brine were studied. The feasibility of advanced membrane distillation crystallization (MDC) process was investigated for recovering valuable resources from brine and reducing the negative effect of high concentration on water flux. Acknowledgement: Research for this paper was carried out under the KICT Research Program (project no. 20240441-001) funded by the Ministry of Science and ICT.

Effect of hydraulic retention time on urine nitrification in pilot-scale activated carbon incorporated membrane bioreactor (PAC-MBR) and application on hydroponics

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Brief bio of lead CI/presenter

Weonjung Sohn is currently a PhD candidate at University of Technology Sydney under Prof. Hokyong Shon's supervision. Her main research interests include biological nitrification process in membrane bioreactors for nutrients recovery in a circular economy from source separated urine. She is a Website and Social Media Manager of the ARC NiCE hub.

Abstract

Along with the increasing world population and agricultural demand, the continuous production of synthetic fertilisers would affect the resource availability due to the phosphorous extraction from mines as well as the fixation of atmospheric nitrogen. Source separation of urine can be an effective solution for nutrient recovery as a fertiliser within a circular economy framework, reducing a dependence on synthetic fertilisers. Powdered activated carbon (PAC)-incorporated ultrafiltration membrane bioreactor (UF-MBR) offers a promising technology for nitrifying ammonia into nitrate, stabilising pH, and adsorbing micropollutants by PAC, thereby producing NPK liquid fertiliser comparable to commercial fertilisers. However, long hydraulic retention time (HRT) of the MBR remains one of the major challenges of which reduces energy efficiency and increases footprint. A pilot-scale PAC-incorporated MBR for the source-separated urine treatment has been developed in a compact design MBR system. Previous studies adapted the pH-dosing mode for urine treating MBR of which the HRT depends on the nitrification rate. This study focused on investigating the effects of continuous feeding and subsequently fixed HRT in a pilot-scale PAC incorporated MBR system on the performance in terms of urine nitrification rate, and NH_4^- to NO_3^- conversion rate. Subsequently, the permeate produced at different HRTs with various NH_4^- to NO_3^- ratio was evaluated as a fertiliser for hydroponic plants, aiming to determine the optimal threshold of HRT in the MBR and conversion rate to be an effective urine fertilizer.

Session 7: Environmental Health and Risks

Session Chairs: Stefano Freguia and Pema Dorji

(Keynote) Medal-winners in the Olympics of urine technologies

Stefano Freguia[1,*]

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Brief bio of keynote speaker

Stefano Freguia is an Associate Professor at the Department of Chemical Engineering, University of Melbourne, where he leads a water technology research group. He obtained his PhD in 2008 from the University of Queensland, and later received a fellowship from the Japan Society for the Promotion of Science (JSPS) to undertake his post-doctoral studies at Kyoto University (2008-10). From 2010 to 2019 he was a researcher at the Australian Centre for Water and Environmental Biotechnology at the University of Queensland. Stefano's research focuses on the development of novel bio-electrochemical and hybrid biological/membrane processes to transform waste into resources, to promote a circular economy of water and nutrients and to improve society's water efficiency through technology.

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Abstract

Urine collection at the source provides an excellent opportunity towards the establishment of a circular economy of nutrients. Urine is ubiquitous, concentrated in nutrients (10 g/L nitrogen, 1 g/L phosphorus), and effective as such as a liquid fertiliser. It accounts for 80% of the nitrogen that escapes society via sewers and it contains sufficient macro- and micro-nutrients to support the growth of society's grain consumption. The limitations of urine are its unappealing organic chemical make-up (pharmaceuticals, hormones, pesticides) and its high transportation costs due to its 95% water content.
The Water Technology research group at the Department of Chemical Engineering, University of Melbourne has been busy for the past five years evaluating technologies for the concentration and purification of urine to meet market requirements for liquid fertilisers. In an Olympic-like competition in the urine-to-fertiliser discipline, we ran technology heats through extensive literature reviews. Many

existing technologies did not qualify for the finals due to various reasons, such as high energy consumption, low rates and poor suitability for decentralisation. The three technologies that were chosen for our experimental finals are: Microbial Electro-concentration (also know as Ugold Plus) Electrodialysis and Reverse Osmosis.

These technologies were all sub ected to testing with real human urine collected at the University of Melbourne through a custom-made urinal. All urine was pre-hydrolysed by storing it in tanks for a period of 3 weeks. The technologies were compared against a few critical criteria: specific energy consumption (kWh/kg N), nutrient recovery, nutrient flux (gN $m^{-2}d^{-1}$), micropollutant re ection and fouling propensity.

In this talk, the gold medallist of the urine-to-fertiliser technologies will be announced.

PFAS removal from landfill leachate

Pema Dor i

City of Darwin, Northern Territory.
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Brief bio of lead guest spea er

Dr. Pema Dor i is currently working as a Sr Coordinator Environment and Waste Services with City of Darwin. He manages environmental compliance at Shoal ay Waste Management Facility, which is the largest waste disposal and resource recovery facility in the Northern Territory. He also provides an oversight in the operation and performance of the leachate treatment plant.

Abstract

Per-and polyfluoroalkyl substances (PFAS), also commonly known as forever chemicals', are highly mobile in air, water and soil and persist in the environment for a very long time once released. PFAS refers to a group of more than 15,000 fluorinated synthetic chemicals, which are known to cause a wide range of diseases, including cancer. They are commonly used in firefighting foam and other industrial applications, and they are also widely used in many everyday household goods and appliances. Leachate generated in landfill contains PFAS, posing a significant management issue for waste management facilities around the world. Water and Carbon Group (WCG) is currently operating a PFAS removal system at Shoal ay Waste Management Facility, managed by City of Darwin. This presentation will provide an overview of Shoal ay Waste Management Facility and share knowledge about the award-winning leachate treatment plant, including innovative system for PFAS removal from landfill leachate.

nveiling Point Sources of Contaminants in Waste ater hrough rade Waste Profiling

iaying i[1],*, Chantal eane,[2,3] Jochen F. Mueller[2]

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Brief bio of lead CI/presenter

Dr Jiaying Li is a Research Fellow at the School of Civil Engineering at the University of Sydney. Her research focuses on wastewater-based epidemiology for chemical exposure, environment pollutants, and public health, as well as fate of contaminants of emerging concerns in urban water and wastewater systems.

Abstract

Effective wastewater management is essential for sustainable environmental practices, yet the sources of contaminants in wastewater remain unidentified, complicating efforts in source control. This study addresses this gap by systematically characterizing chemical contaminants in trade waste from a diverse array of industries and linking these profiles to industrial sources in catchments. In this study, we collected 264 trade waste samples from 132 industry customers across 53 distinct industry types, as classified by the Australian and New Zealand Standard Industrial Classification (ANZSIC). These samples were aggregated into industry-specific pools, including sectors such as Pharmaceutical Manufacturing, Polymer Manufacturing, Metal Manufacturing, and Waste Treatment and Disposal Services. We analysed these pools for >120 chemical analytes, including drugs, pharmaceuticals, pesticides, and PFASs by LC-MS/MS.

Our findings indicate substantial variability in chemical compositions and concentrations of contaminants among different trade waste types. Notably, waste from landfill operations exhibited particularly high concentrations of pesticides and PFASs, surpassing other industries by orders of magnitude (up to 10^4). Tade waste from the pharmaceutical sector showed significantly elevated levels of certain drugs and pesticides. PFOS that is commonly used for water-, stain, and grease-proof coatings shows higher levels in metal and pharmaceutical manufacturing trade waste, while leather manufacturing and printing service trade wastes are highly contaminated by PFBS. We also detected remarkably high concentrations of pesticides in polymer manufacturing waste streams. Specifically, we identified distinct chemical signatures, such as celecoxib in pharmaceutical manufacturing, PFHpS in metal manufacturing, and PFPeA and PFPeS in landfill leachates, which could serve as chemical fingerprints for source tracking.

This comprehensive profiling provides crucial insights into specific sources of contaminants entering wastewater, offering invaluable information for water utilities and regulators to implement more targeted source control measures. This benefits the generation of cleaner waste streams, contributing to the goals of sustainable environment and resources recovery.

A review of the microbial health risks associated with the collection and processing of source-separated urine reused as fertilizer in agriculture

Johanna Engels*, Md Sayed Iftekhar[2], Anne Roiko[1]

1 School of Pharmacy and Medical Sciences (Environmental Health), Griffith University, Queensland, Australia
2 Griffith Business School, Griffith University, Queensland, Australia
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Brief bio of lead presenter

My name is Johanna, and I am a Dutch/ German hydrologist specialized in water resource management. At Griffith University, my work focuses on assessing the microbial risk of urine-derived fertilizer that is processed from separated wastewater and applied in agriculture. For my research, I apply QMRA (quantitative microbial risk assessment).

Abstract

The diversion and reuse of human urine is an emerging technology that could pioneer the circular economy in the agricultural sector. Source separation of urine and nutrient recovery can supplant conventional fertilizer production with urine-derived fertilizer (UDF) that contains the recovered nutrients phosphorous and ammonia. In doing so, energy extensive ammonia production, which currently consumes 1.8% of the global energy, becomes obsolete. While urine-derived fertilizer could make a difference for global food banks, the developed technology has never been commercialized for bulk supply and public health regulators have expressed their concerns for microbial risks that are at present poorly understood. Only a small number of studies focused on microbial risks in human urine, because the pathogenic concerns arising from other wastewater streams have led to negligence of the subject matter. Following that, a systematic literature can support an evidence-based analysis on the risk scenarios proceeding from UDF application.

The objective of the systematic literature is to identify microbial risks, pathogens as much as risks of disease spread due to antimicrobial resistance, using the PRISMA guidelines. The paper will present the results following the review, but an initial scan of the literature shows that UDF raises different levels of concern depending on how their making has been contextualized. Broadly speaking, UDF is either derived through a highly mechanized treatment-train in industrialized countries or urine is diverted from the wastewater stream through rudimentary sanitation solutions commonly installed in developing nations and with the main goal to improve public health services in remote settlements.
The most common health outcomes in Australia are urinary tract- and kidney infections. In terms of transmission pathways, pathogens are either excreted through the urinary tract of infected individuals or through faecal cross-contamination that carry numerous pathogens. To ensure microbial safety, storage of collected urine is one of the control parameters to inactivate bacteria and viruses, however the exact duration is highly variable and influenced by temperature. Previous research outcomes have also suggested that viruses found in the urinary tract and also pharmaceutical compounds are stable in highly hydrolysed urine and could enter the environment through UDF application.

Pathogen regrowth in mesophilic AD after feeding pre-treated sludge

Li, J.[1], **Duan, H.[2]***, Jensen, P[1]., Batstone, D[1]. and Hu, S[1].

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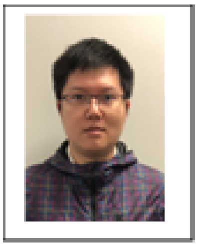


Brief bio of lead CI/presenter

Mr. Junfu Li is a third-year Ph.D student at the University of Queensland. He obtained his Master's degree in 2021 at Australian Centre for Water and Environmental Biotechnology (ACWEB), the University of Queensland. His research focuses on carbon and energy efficient sludge treatment technologies, anaerobic digestion intensification and sludge management.

Abstract

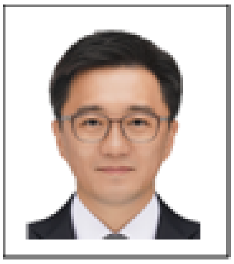
Anaerobic digestion (AD) is commonly utilized for resource recovery, generating biogas for energy and producing nutrient-rich digestate that can be used as fertilizer. The reuse of biosolids is integral to the circular economy; however, the presence of pathogens presents significant challenges to the safe and effective application of biosolids. It is generally accepted that pathogenic bacteria are reduced during the AD process to reach the class B level (MPN/gTS < 6 log units), however, it is still not able to be agricultural reused which required class A level (MPN/gTS < 3 log units). Moreover, there has been limited investigation into the regrowth of pathogens in AD reactors receiving pre-treated sludge. In reactors with sludge pre-treatments, including thermal hydrolysis process (THP), free nitrous acid (FNA), and microwaves, significant regrowth of Fecal Coliform was observed, with peak levels exceeding 8 log units, though stabilization times varied. Notably, after reaching peak levels, Fecal Coliform concentrations in reactors with microwave and THP eventually decreased. Conversely, reactors pre-treated with FNA stabilized at approximately 7.5 log units. Other pathogenic bacteria, such as Escherichia-Shigella and Legionella, demonstrated similar regrowth patterns, especially in reactors with FNA and THP pre-treatments, before ultimately declining. These findings suggest a pattern of pathogen regrowth followed by potential inactivation in AD systems receiving pre-treated sludge, as observed through long-term monitoring. Mechanistically, the initial regrowth may be driven by increased soluble chemical oxygen demand (sCOD) due to enhanced sludge digestibility. This study presents a novel discovery regarding the dynamic changes in pathogen levels in sludge AD reactor effluent, marking the first report of such observations.

Session 8: Environmental Technologies

Chairs: Sungyun Lee and Wei Wei

(Keynote) Machine Learning in the Circular Economy: Research Trend and Applications

Mita Nurhayati[1,2], **Sungyun Lee[1,3]***.



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Brief bio of lead CI/presenter

Sungyun Lee is an associate professor in the Department of Environmental and Safety Engineering at Kyungpook National University in Korea. He specializes in membrane processes and organic matter characterization. Recently, his research has focused on the application of machine learning in environmental engineering.

Abstract

Machine learning (ML) is being increasingly applied across various research fields such as healthcare, autonomous driving, finance, marketing, and image processing. In recent years, its application in the circular economy has also significantly grown, though it is still less prevalent compared to these other areas. This study aims to review the current research trends and applications of ML in the circular economy, specifically focusing on environmental technologies such as membrane technology, environmental sensors, and environmental treatment processes. ML has shown promising results in predicting pollutant removal in membrane technology, enhancing the efficiency and effectiveness of filtration systems. In the field of environmental sensors, ML algorithms are employed for accurate monitoring, enabling more precise and cost-effective real-time analysis. Furthermore, in environmental treatment processes, ML is utilized to optimize wastewater treatment, improve resource recovery, and achieve significant energy savings. Despite these advancements, the application of ML in circular economy faces several limitations, such as data gaps, performance evaluation, and interpretation challenges. This study will present potential strategies to overcome these challenges, including the integration of mathematical modeling and enhanced collaboration between environmental scientists and data scientists.

Biotechnology to convert biowaste into fossil fuel substitute

Lan Wu[1], **Wei Wei[1]***

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University of Technology Sydney
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Brief bio of lead CI/presenter

Three sentences or 50 words max along with a small photo should be included.
The bio shall be used by the session chairs to briefly introduce the speakers.
Do need not write very long bio but just include who you are, your affiliation and your roles.
Dr Wei Wei is a Lecturer & ARC DECRA Fellow from School of Civil and Environmental Engineering in UTS, and Australian Museum Eureka Prizes Finalist in 2024. She has developed a sustainable bioenergy network to fully explore the potential of biowastes as valuable energy resources.

Abstract

The Abstract should be 350 words maximum. Figures and Tables are not necessary.
The typical carbon-rich biowaste, like sewage sludge and food waste, holds great potential to be the renewable energy resources. An innovative and highly marketable biotechnology was developed to convert these biowastes into fossil fuel substitute, namely, medium-chain fatty acids (MCFAs), in a self-sufficient and cost-effective manner. A cheap and readily commercialized yeast was inoculated into the anaerobic fermentation smartly to enhance MCFAs production with internal-supplied electron acceptor (EA) and electron donor (ED). The enriching organisms involved in ethanol supply and chain elongation jointly promoted biowaste-derived MCFAs productions. The enhanced abundance and transcriptional activity of genes related to key enzymes, such as alcohol dehydrogenase and acetaldehyde dehydrogenase, affirmed the robust capacity for the self-sustained production of MCFAs. This is indicative of an effective metabolic network established between yeast and anaerobic microorganisms within this innovative biowaste fermentation framework. This biotechnology does not require major changes to the design and operation of existing anaerobic fermentation infrastructure. Instead, the utilization of biowaste was enlarged through producing high-value MCFAs while waiving the cost of external ED by using inexpensive cheap yeast.

Direct Lithium Recovery from Synthetic Lithium-Ion Battery Leachate through Integrated Membrane Separation Processes

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Brief bio of lead CI/presenter

Dr. Chen is a postdoctoral researcher in Environmental Engineering at National Taiwan University. Her research specializes in electrochemical and membrane separation technologies, including redox-flow battery desalination and membrane distillation. She is dedicated to developing tailored water treatment solutions for environmental applications, such as wastewater reclamation and resource recovery.

Abstract

The increasing demand for lithium-ion batteries (LIBs), driven by the expansion of energy storage solutions and the electric vehicle industry, necessitates the development of efficient recycling strategies due to the limited lifespan of these batteries. Traditional hydrometallurgical methods often yield low lithium recovery efficiencies due to their multistep separation processes. To address this challenge, the present study introduces a novel approach for direct lithium separation from LIB leachate utilizing a hybrid membrane separation process, specifically flow-electrode capacitive deionization (FCDI) combined with membrane distillation (MD). In the FCDI process, Li^+ ions were selectively separated from Co^{2+}, Ni^{2+}, and Mn^{2+} ions in synthetic LIB leachate via a monovalent cation-exchange membrane (CEM) and concentrated in the cathodic flow-electrode under an applied voltage of 1.6 V. After 2-day selective enrichment, the Li^+ concentration in the cathodic flow-electrode reached 677.7 mg/L, with negligible uptake of Co^{2+}, Ni^{2+}, and Mn^{2+} ions. The highly Li-enriched catholyte was then filtered to remove the carbon electrode and introduced into the feed chamber of the MD cell. The MD process further concentrated the Li^+ solution by removing 70% of the water at a temperature difference of 40°C, resulting in a final Li^+ concentration of 1750.8 mg/L. Subsequent chemical precipitation using CO_2(g) transformed the recovered lithium ions into Li_2CO_3, achieving a precipitate purity of 97.5%. X-ray diffraction analysis confirmed the identity of the Li_2CO_3 precipitate with diffraction peaks matching the standard pattern. This study demonstrates a sustainable approach for lithium recovery from LIB leachate through a hybrid FCDI-MD process, offering a promising solution for efficient lithium recycling and environmental conservation.

Interfacial and Structural Engineering in MOF-based Mixed Matrix Membranes

Tao Li*

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Brief bio of lead CI/presenter

Dr. Tao Li led an independent research group at ShanghaiTech University from 2015 to 2023 before starting his Lecturer position at the University of Adelaide in 2024. His research focuses on the construction of well-defined porous composite materials to address pressing energy and environmental challenges.

Abstract

Metal-Organic Framework (MOF)-based mixed matrix membranes (MMMs) represent a promising material platform for the development of high-performance gas separation membranes. However, rational design of MMMs requires the knowledge and ability to predict the interfacial compatibility, modify the interface, and manipulate the spatial distribution of MOF crystals within the membrane. This talk will present our recent effort to address each of these three challenges. I will first demonstrate various synthetic strategies that we developed to decorate the MOF surfaces with different condensation polymers. These surface-modified MOF particles can simultaneously enhance MOF-polymer interfacial interaction, suppress defect formation, and improve particle dispersibility in a polymer matrix. Then, I will present our approach to achieve a percolated network of MOF particles in a MMM at low MOF loading through controlled phase separation in the polymer matrix. Finally, I will discuss how to utilize polymer phase separation to predict and sort MOF-polymer interfacial compatibility.

Molecular-based artificial neural networks for selecting deep eutectic solvents for water treatment applications

Narjis E. Awaja[a], **Ghaiath Almustafa**[a,c], Ahmad S. Darwish[a,b], Tarek Lemaoui[b], Fawzi Banat[a,b], Hassan A. Arafat[a,b,*], Inas AlNashef[a,b,*]

[a] Chemical Engineering Department, Khalifa University, P.O. Box 127788, Abu Dhabi, United Arab Emirates
[b] Research & Innovation Center for Graphene And 2D Materials (RIC 2D), Khalifa University, P.O. 127788, Abu Dhabi, United Arab Emirates.
[c] Dubai Electricity and Water Authority, DEWA R&D Centre, Dubai P.O. Box 564, United Arab Emirates.

Brief bio of lead CI/presenter

Ghaiath Almustafa, a researcher in the field of water treatment using Green Solvents. Had multiple roles in UAE as a research engineer at Khalifa University Abu Dhabi, an R&D Engineer at Dubai electricity & Water Authority. Recently joined the fleet of UTS as a PhD candidate with Prof. Ho Kyong Shon's research group.

Abstract

Computational methods for predicting a solvent's performance in a given application, and for selecting an adequate solvent for that application, are becoming increasingly essential for separation processes. In this context, this article presents a first-of-a-kind machine learning tool based on guided molecular design of solvents to predict the performance of various solvent systems in the solvent extraction process. The tool was demonstrated herein for the extraction of aqueous boron, through the selection of neoteric solvents from a dataset that spans different types of solvents (molecular solvents, deep eutectic solvents (DESs) and ionic liquids). The model was developed by first obtaining the COSMO-RS-based molecular descriptors (σ-profiles) for each solvent system and using them as input parameters to an Artificial Neural Network (ANN), in addition to other operational parameters (e.g., pH, temperature, ion concentration, and A/O ratio), while extraction efficiency as the output. The results showed that the optimal ANN configuration (59–20-15–1) exhibited remarkable predictability for boron extraction with an R2 of 0.988 and 0.977 for the training and testing sets, respectively. The model was used to investigate different solvent systems of which six new DESs were successfully synthesized, experimentally tested,

and characterized across different properties such as density, viscosity, and leachability. The combination of Decanol and 2,2,4- trimethyl-1,3-pentanediol exhibited appreciable properties and high experimental extraction efficiency of 97.22%. The experimentally validated model demonstrates the effectiveness of molecular-based descriptors and machine learning for predicting the extraction capabilities of solvents in aqueous media and allows further exploration of new solvent systems based on their extraction performance at different operational conditions. This proof-of-concept approach can be effectively adopted to predict the extraction behaviour of different solvent systems towards target contaminants in aqueous environments, thereby supporting both the design of separation processes and solvent screening for future applications.

Session 9: Circular Economy/Climate Change/environment/resource recovery

Chairs: Chia-Hung Hou and S. Vigneswaran

(Keynote) Capacitive Deionization for Water Reclamation and Resource Recovery: Current Perspectives Aiming for Strategic Futures

Chia-Hung Hou 1*, Jui-Yao Chang[1,*], Yu-Tzu Huang[2]

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[2]Department of Chemical Engineering, Chung-Yuan Christian University,
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*Speaker's email: chiahunghou@ntu.edu.tw

Brief bio of lead CI/presenter

Dr. Chia-Hung Hou is a professor in the Graduate Institute of Environmental Engineering, National Taiwan University. His research focuses on electrochemical and membrane separation, water reuse and desalination. He has held positions in the committee members of the International Working Group for CDI&E and the IWA Membrane Technology Specialist Group.

Abstract

In response to zero liquid discharge policies, industries are increasingly adopting advanced technologies for water resource recovery from wastewater, aiming to enhance efficiency throughout the water cycle in their facilities. Recently, significant research efforts have focused on developing advanced water treatment technologies with low energy requirement and high ion selectivity. Notably, capacitive deionization (CDI) and membrane capacitive deionization (MCDI) are emerging as promising ion separation processes for efficient water reclamation and selective resource recovery. Over the past few years, we have successfully scaled up MCDI stacks for pilot-scale technology demonstration. For example, MCDI has been effectively demonstrated in various applications, including the reclamation of wastewater treatment plant effluent, water softening for cooling tower blowdown water, and water recycling in wet scrubbing system. Additionally, to achieve high-performance resource recovery (e.g., ammonia), selective electrodes have been integrated into the CDI system. For example, nickel hexacyanoferrate (NiHCF) has shown a strong affinity for ammonia intercalation. The incorporation of the NiHCF electrode in the CDI system has demonstrated high selectivity for ammonia, with selectivity coefficients of 9.5 for NH_4^+/Ca^{2+} and 4.9 for NH_4^+/Na^+. This highlights the potential of CDI combined with NiHCF to effectively target and recover ammonia from wastewater. After the selective separation of ammonia, MCDI can further concentrate the resource by optimizing operating protocols, enabling the ammonium concentration in wastewater to increase from 500 mg/L to 5000 mg/L. This concentrated ammonia can then be processed using ammonia stripping technology with high energy efficiency to produce an ammonia solution (6–25%) for subsequent use. Overall, this presentation showcases advancements in water reclamation and resource recovery through CDI/MCDI technology, contributing to the achievement of net-zero emissions.

(Keynote) Recovery of Rare Earth Elements from Mining Wastewater using Functionalised Nanomaterials: a solution towards circular economy

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Brief bio of lead CI/presenter

Prof. S. Vigneswaran is an Emeritus Professor at the University of Technology, Sydney (UTS) and Research Professor at Norwegian University of Life Sciences (NMBU). Prior to it, he was Distinguished Professor and Professor for 30 years. He is a Distinguished Fellow of the International Water Association (IWA).

Abstract

Rare earth elements (REEs) have become a strategic resource extensively used in renewable energy technologies and modern electronic devices. Depletion of natural REE-bearing mineral deposits has made selective recovery of REEs from alternative sources crucial in meeting the rising global demand. The successful adoption and widespread implementation of innovative acid mine drainage treatment and resource recovery methods hinge on their capacity to demonstrate enhanced performance, economic viability, and environmental sustainability compared to conventional approaches.

While functionalised chromium frame work (Cr-MIL-PMIDA) exhibit excellent properties for selective recovery of REE, there are practical challenges associated with its production cost and potential susceptibility to chromium leaching, making it less attractive for large applications. To address these challenges, a highly stable, cost effective, novel SBA15-NH2-PMIDA material was then synthesized for the first time. Eu adsorption tests revealed that SBA15-NH2-PMIDA reached equilibrium within two hours and showed superior adsorption capacity of 86.21 mg/g at optimum pH 4.8. Selective adsorption tests were also carried out with real AMD collected from an abandoned mining site in northern Norway. The novel adsorbent selectively recovered over 80% of Eu from pH adjusted real AMD at an optimum dosage of 0.8g/l. A sequential adsorption study showed economic recovery of Eu and copper.

SBA15-NH2-PMIDA managed to retain over 90% of adsorption capacity over 10 regeneration cycles, making it an economically viable adsorbent for industrial scale applications. A cost-benefit analysis was then undertaken to quantify the advantages of employing SBA15-NH-PMIDA material. The study disclosed that 193.2 g of EuCl3 with 99% purity can be recovered by treating 1000 m3 of AMD. This approach leads to simultaneous water recycle and valuable resources recovery leading to circular economy.

Towards E-waste Circular Economy: The Impact of Contemporary Human Dimensions

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Brief bio of lead CI/presenter

Amila Kasun Sampath Udage Kankanamge is a PhD candidate at Charles Darwin University, Northern Territory, Australia. His research interests include sustainable solutions, circular economy transitions, waste management, and urban mining. He has published with reputable publishers including Palgrave Macmillan. Before joining Charles Darwin University, he worked in the service industry for five years.

Abstract

Purpose – Despite significant efforts, the circularity of electronic waste (e-waste) remains inefficient in developing countries. The existing literature on the circular economy (CE) primarily focuses on technological solutions, environmental considerations, business models, and health aspects to promote circular systems globally. However, it largely overlooks human dimensions. As a result, human behaviour often leads to e-waste being discarded in open environments, water bodies, and landfills without effective utilization, posing significant threats to ecosystems and society. This study aims to explore the impact of human dimensions on the e-waste circular economy.

Methodology/Approach – The study employs a case study approach to comprehensively examine the human dimensions influencing e-waste circularity in Sri Lanka. The study concluded with 46 semi-structured interviews, achieving theoretical saturation. Two focus group discussions were conducted to clarify further, extend, and challenge the data collected from the interviews. The study employs thematic content analysis to triangulate data from interviews and focus group discussions.

Findings – The study results found that knowledge, values, attitudes, and practices are critical human dimensions that challenge e-waste generators, operators, and end-users to break paradigms and manage complex ecosystems to promote circularity in the e-waste urban mining industry. In light of this, the study proposed a five-dimensional integrated framework essential for managing the complex ecosystem required to promote Sri Lanka's e-waste urban mining industry. Further, the findings emphasized that changes in the human mindset of e-waste generators, operators, and end-users are essential in developing countries to facilitate a more balanced transition to a circular economy, closing material loops in e-waste flow.

Originality/Value – This study is the first to examine the human dimensions influencing e-waste circularity in developing countries. It bridges the knowledge gap by proposing a five-dimensional integrated framework encompassing knowledge, skills, values, attitudes, and practices. Furthermore, the study addresses the theory-practice gap by guiding industry practitioners and policymakers in extending the application of human aspects to support a broader transition toward circular economy practices alongside environmental, technological, health, and economic factors.

Keywords: e-waste, urban mining, human dimensions, circular economy, developing countries

Towards a Circular Economy and Net Zero Through Carbon Stewardship

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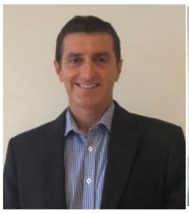


Brief bio of lead CI/presenter

Russ Martin is CEO of the Global Product Stewardship Council and CEO of consultancy MS2. Craig Bagnall is a Director of SEATA Group and Principal Consultant of Catalyst Environmental Management. Both have substantial experience in biochar and circular carbon, including leading development of the world's first biochar industry roadmap.

Abstract

Carbonisation of biomass via pyrolysis and gasification to produce biochar, syngas and other bioproducts can help Australia address all three principles of a circular economy: eliminating waste and pollution, circulating products and materials at their highest value, and regenerating nature, whilst concurrently providing urgent climate action. Appropriate funding, policy and regulatory support for stronger uptake has the potential to deliver a broad range of benefits for Australia, including:

- upcycling large amounts of carbon-based wastes currently being landfilled, openburned or otherwise under-utilised into valuable solid, liquid and gas products;
- providing scalable, affordable carbon dioxide removal (CDR, or 'drawdown') *and* emissions reduction with renewable bioenergy.
- reducing risk of high-intensity bushfires, and reduced backburning and slash-pile

burning;
• contributing to land restoration, and reducing land degradation and biodiversity loss
• safely managing problematic feedstocks, including emerging contaminants and other pollutants of concern (e.g. PFAS, microplastics) through thermal deconstruction
• encourage economic development, especially in regional areas

- Circular economy
- Climate change: impacts mitigation and adaptation
- Water, energy, and environment
- Resource recovery from wastes
- Environmental pollution
- Environmental Technologies
- Bioresource
- Environmental health and risk

and economic resilience against climate change impacts
(e.g. drought resilience)
• enhance stewardship for aligned industries and local businesses, including agriculture, transport, steel, forestry, wine, water, built environment and others
• enhancing community engagement and social license to operate

Additionally, 'problematic' wastes, such as biosolids, can be co-fed with other biowastes to create a higher quality biochar, better carbon credit value, and improved mass and energy balance to reduce CAPEX and OPEX. Globally, pyrolysis / gasification of biosolids has demonstrated that it can safely deconstruct PFAS and microplastics, with at least three European EPAs approving biochar use in agriculture. This facilitates continued recovery of critical P-rich organics into regenerative fertilisers that can help minimise reliance on expensive synthetic fossil-based fertilisers. Sustainable biomass (including native species) grown on marginal and degraded land (including mine rehabilitation) has recently been successfully trialled, and could additionally contribute to an even more circular and regenerative approach, benefiting local communities and restoring degraded soils and avoid competition with land needed for food production. This presentation will address these opportunities for optimising their benefits including appropriate industry strategies, policy support and regulatory improvements, and creating community engagement / social license.

Novel integrated process for the circular economy of green hydrogen and resources from brine

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Brief bio of lead CI/presenter

Mohammad Mahbub Kabir is currently working as a PhD candidate at the School of Civil & Environmental Engineering, Faculty of Engineering & Information Technology, University of Technology Sydney (UTS), Australia. He has been awarded one of the most prestigious UTS president scholarships (UTSP) & International research scholarship (IRS) for pursuing his PhD at UTS. Before joining UTS, he worked as an assistant professor in the environmental science and disaster management department at Noakhali Science & Technology University, Bangladesh.

Abstract

This paper investigated the circularity of green hydrogen and resources from brine employing an innovative and integrated approach based on the principles of alkaline water electrolysis (AWEL) techniques. The typical AWEL process needs to be used a highly alkaline liquid electrolyte solution to increase the ion conduction of the feed solution. The subsequent impacts include corrosion of electrodes and side reactions due to the complicated properties of brine or other impure water. Although engineered catalysts solved the corrosion problems to some extent and indirect brine electrolysis using pre-treatment processes, which required additional maintenance and energy consumption, ultimately made the brine electrolysis non-feasible in terms of techno-economic and environmental considerations. Based on the challenges, this paper proposed a novel brine electrolysis system based on solid electrolytes. The core strategies incorporate an on-site brine treatment process, utilizing a self-driven phase transition technique. We employed an aquaphobic membrane, which acts as a membrane distillation (MD) process supporting the gas pathway interface, which is both water-resistant and breathable. Additionally, we introduced an array of polyvinyl alcohol and tetraethylammonium hydroxide (TEAOH)-based hydrogels with different concentrations of potassium hydroxide (KOH) that functioned as a self-wetted electrolyte (SWE). This design facilitates the partial dispersion of water vapor, while completely preventing the intrusion of brine and contaminated ions. The PVA-TEAOH-KOH 30 wt% hydrogel provides the highest ion conductivity of 91.38 $mScm^{-1}$, having an excellent single-cell performance with a current density of 375 mA/cm^{-2}. The long-term brine electrolysis up to 48 h evidently showed satisfactory performance with 6 times concentrated brine. Thus, the produced hydrogen can be used as an energy source, while concentrated brine could serve as a potential resource, ensuring a circular system of energy and resource recovery.

Workshops

Workshop 1: Circular Economy frameworks, standards and matrices. Facilitator: Lisa McLean (Circular Australia).

Workshop 2: The Future of Renewable Technology Waste Management. Facilitators: Kaveh Khalilpour (UTS) and Thomas Gao (NSW Office of the Chief Scientist and Engineer).

Workshop 3: Retrofitting circularity into wastewater treatment plant. Facilitator: Amit Chanan (Water Authority of Fiji). Workshop sponsored by IMM Consulting.

Workshop 4: Nutrient recovery Facilitators: Stefano Freguia (University of Melbourne) and Sanjay Kumarasingham (Ganden Engineers and Project Managers).

Poster Session/Workshop (display)

Chairs: Mikel Duke and Andrea Merenda

Research on Phased Application Technology of Semiconductor Industrial Wastewater Treatment for Circular Economy

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Brief bio of lead CI/presenter

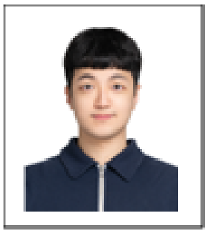
Jonghun Lee is a postdoctoral researcher at KICT and is conducting research on recovering valuable resources from seawater concentrate and industrial wastewater.

Abstract

The semiconductor market has been experiencing explosive growth recently, particularly in South Korea, Taiwan, and the United States, driven by the Fourth Industrial Revolution. Semiconductor manufacturing processes use large amounts of ultrapure water for cleaning, resulting in significant volumes of wastewater containing organic and inorganic contaminants. As the demand for semiconductors increases, the need for industrial water is increasing, but as usable water resources become increasingly scarce due to climate change, the number of water resources that can be used for industrial water is decreasing. Additionally, improperly treated discharge water released into rivers can cause environmental and ecological problems in the surrounding areas. Therefore, there is growing interest in the proper treatment and recycling of semiconductor wastewater. To address water scarcity issues, wastewater from semiconductor manufacturing processes is treated and partially reused for landscaping and cooling systems. Despite these efforts, a significant amount of treated water is still discharged into rivers. To increase water reuse, it is necessary to convert treated water into high-purity industrial water that can be used as a source for ultrapure water in the processes. Current treatment facilities struggle to remove specific contaminants such as urea and tetramethylammonium hydroxide, making it difficult to directly reuse treated water as high purity industrial water. Therefore, it is necessary to develop advanced wastewater reuse technologies capable of effectively removing these specific contaminants for the reuse of semiconductor wastewater as high-purity industrial water. This study aims to evaluate the feasibility of using treated semiconductor wastewater as high purity industrial water by treating actual semiconductor wastewater through a process comprising coagulation-flocculation, DMF, UF, and two-stage RO. The treatment efficiency of specific contaminants in each process will be analysed. Additionally, the study introduce a phased approach to the utilization of treated semiconductor wastewater, suggesting methods for resource circulation and water reuse to enhance water resource management.

Development of High-Performance a-GO/hBN-based Membrane for Organic Solvent Nanofiltration

Hobin Jee 1*, Seunghyun Song 1, Kunli Goh 2 and Euntae Yang 1



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Brief bio of lead CI/presenter

He obtained a master's degree from the Department of Marine Environmental Engineering at Gyeongsang National University and is studying for a Ph.D. Previously, he mainly studied water treatment membranes and gas separation membranes, and now he is researching organic solvent nanofiltration (OSN) membranes.

Abstract

The usage of organic solvents has significantly increased as various industrial fields such as pharmaceuticals, dyes, and pigments have expanded and developed. One of the major problems in these industrial fields is the generation of large amounts of waste organic solvents such as ethanol, butanol, and others. Proper treatment or recovery before discharging these waste organic solvents is required because of their toxicity and the cost-cutting aspect [1]. Additionally, waste organic solvents, in particular, in the pharmaceutical sector, often contain high-value gradients such as active pharmaceutical ingredients (API).

Diverse retrieval techniques have been invented and applied to recover organic solvents. Traditional retrieval techniques such as distillation, rotary vacuum evaporation, and pervaporation use heat energy to separate organic solvents from waste [2, 3]. However, heat sources are costly. Also, during these recovery processes, they may alter the molecular structure of high-value materials. Therefore, organic solvent nanofiltration (OSN) has been spotlighted thanks to its cost-effectiveness and non-involvement of phase conversion and heat energy. However, for OSN, commercial polymeric nanofiltration membranes cannot be employed due to their vulnerability to harsh organic solvents. Therefore, novel NF membranes possessing excellent chemical resistance and high performance are in demand for OSN membranes. In this study, graphene oxide (GO) [4] and hexagonal boron nitride (hBN) [5], 2-dimensional nanomaterials with outstanding chemical stability, were chosen to fabricate a highly solvent-resistable NF membrane for high-performance organic solvent recovery. For the membrane fabrication, hBN was obtained by exfoliating high-concentrated boron nitride solution in isopropyl alcohol under ultrasonication for 48 hours, followed by centrifugation to obtain hBN nanosheets. The ratio of 0.2mg of GO and 45mg of hBN was selected by ratio optimization and the final ratio. The membrane was fabricated using a vacuum-assisted filtration method onto a commercial nylon ultrafiltration membrane and stored in a desiccator. Before membrane operation, the GO/hBN membrane was thermally annealed in a vacuum oven at 135 °C for 1 hour to anneal the surface and structure of the membrane.As a result, the annealed GO/hBN (a-GO/hBN) membrane showed high selectivity for acetone-based organic dye solution with methylene blue (MB) and methyl orange (MO). The rejection rates of the a-GO/hBN membrane are 94.63%, and 83.33%, respectively. In the case of acetone permeability, the a-GO/hBN membrane could reach over 1000 LMH/bar. This impressive performance of the a-GO/hBN membrane suggests a novel approach to combining nanomaterials for OSN.

Acknowledgments

This work is sponsored by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (NRF-2020R1C1C1013172, No. RS-2023-00219497, & RS-2023-00217317) and the Korea Institute for Advanced of Technology (KIAT) grant funded by the Korean Government (MOTIE) (P0017310, Human Resource Development Program for Industrial Innovation(global)).

Increasing Value Recovery from End-of-Life Tyres and Conveyor Belts in Australia: Insights from International Best Practices

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Brief bio of lead CI/presenter

Ana Maria is a sustainability and circular economy scholar with a background in chemical engineering. She holds a master's degree in environmental sciences from Curtin University, Perth, Australia. She is pursuing a PhD on implementing regional circular economy in Australia at Curtin University, where she also works as an academic.

Abstract

As part of the Australian Government's National Environmental Science Program Sustainable Communities and Waste Hub, CSIRO and Curtin University reviewed a set of best practice case studies for overcoming barriers and increasing value recovery from end-of-life tyres (EOLTs) and conveyor belts in Australia. The review encompassed product stewardship schemes in Canada, Chile, several European countries, and New Zealand; recycling enablers like waste classifications and quality standards; technologies for value recovery from EOLTs and conveyor belts; end markets for tyre-derived products, and strategies for communicating with Indigenous communities. Key recommendations included making the Australian voluntary tyre stewardship scheme compulsory or at least co-regulatory, introducing a recycling fee as part of the price of new tyres and conveyor belts, and banning landfilling and on-site disposal of EOLTs and conveyor belts. Currently, classification systems for EOLTs vary across Australia, and waste conveyor belts are not classified as controlled waste in Australia, leading to inadequate monitoring and lack of data on arisings, transport, and the fate of waste conveyor belts. The stewardship scheme could also be extended to include rubbery conveyor belts. Enablers critical to the successful development of recycling technologies and market pathways include consistent waste classifications, quality standards, traceability, and enhanced collaboration across the value chain. Recycling hubs or ecosystems would allow tyre recyclers and industries that consume tyre-derived products and fuels to co-exist. Supporting these facilities allows for technology development and conversion of rubber waste into valuable products, promoting circularity. However, to foster circular economy solutions effectively, it is crucial to maximize the material value of EOLTs and prioritize waste hierarchy in product markets. End-markets need to be created or reinforced in Australia for retreading, upcycling, recycling of EOLTs and conveyor belts. Reverse logistics will likely play a crucial role in managing rubber waste, potentially facilitated through the adoption of Industry 4.0 (advanced information technologies and robotics) technologies. Prioritising and investing in technologies should be aligned with circular economy principles. This will be enabled through holistic value chain assessments such as value retention models, cost/benefit comparisons, life cycle assessments, and material circularity indicators.

Preparation and properties of butene bridged silicon-based reverse osmosis membranes

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Brief bio of lead CI/presenter

Kota Aizawa received his Bachelor's Degree from Tokyo University of Science in 2024 under the supervision of Prof. Takahiro Gunji (Tokyo University of Science). Currently, he is a Master student in Tokyo University of Science.

Abstract

Water treatment using reverse osmosis membranes is a major seawater desalination technology. Recently, reverse osmosis membranes using organically bridged alkoxysilanes have attracted attention due to their heat and chlorine resistances. Among them, BTESE2 and BTESE3 having ethenediyl and ethynediyl groups, respectively, have been reported to show high water permeance. In this study, we synthesized alkoxysilanes having butenediyl and butynediyl groups (BTESB2 and BTESB3), respectively, with increasing carbon numbers and evaluated their reverse osmosis properties. The reverse osmosis membrane with BTESB2 showed desalination performance with a water permeance of 1.2 × 10^{-13} $m^3/(m^2$ Pa s) and a salt rejection of 98 %, while the water permeance was lower than that of BTESE2. This is due to the flexible molecular chains and the decrease of the molecular sieving property for water permeance.

Evaluating Urine-Based Microbially Induced Calcium-Carbonate Precipitation for Geotechnical Enhancement of Closed landfill Sites: Mechanical Properties and Microstructural Analysis

Niti Bhattarai[1*], Behzad Fatahi[2], Hadi Khabbaz[3], Lam Nguyen[4]

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Brief bio of lead CI/presenter

Presenter- Niti Bhattarai, a PhD student at School of Civil and Environmental Engineering at UTS, is deeply committed to exploring sustainable construction practices. Her research integrates circular economy with a ground improvement technique, reflecting her dedication to eco-friendly solutions for a more resilient and environmentally conscious future.

Abstract

Evaluating Urine-Based Microbially Induced Calcium-Carbonate Precipitation for Geotechnical Enhancement of Closed landfill Sites: Mechanical Properties and Microstructural Analysis

The utilization of urine-based bio-cementation presents a promising avenue for sustainable improvement of weak geomaterials. This bio-geotechnical approach leverages urine and soil-indigenous bacteria to precipitate calcium carbonate ($CaCO_3$), thereby enhancing the mechanical strength of materials such as crushed rock, weak soils, and closed landfills. This study addresses the current knowledge gap regarding the application of Microbially Induced Calcium Carbonate Precipitation (MICP) using source-separated urine instead of commercial urea for the treatment of closed landfills. Two landfill samples were treated with commercial urea, and two were treated with urine. The study investigates the feasibility of using urine by comparing the strength characteristics of these treatments, treatment extent, stimulation strategies, and improvements in soil stiffness and strength. Initial treatments established the indigenous microorganisms, followed by the cementation treatments across all samples. Monitoring during treatments included urea and ammonium concentrations, soil permeability, and shear wave velocities. Triaxial tests incorporating embedded bender elements were conducted on the MICP-treated landfill samples under constant confining pressure of 100 kPa. Further experimentation involved varying calcium chloride ($CaCl_2$) concentrations resulting in specimens with varying $CaCO_3$ content. Triaxial test results demonstrated increased soil strength even at small $CaCO_3$ content. Subsequent analysis utilized Scanning Electron Microscopy (SEM) and Energy Dispersive X- ray Spectroscopy (EDS) to access $CaCO_3$ morphology and spatial distributions at the microscale. This study presents compelling evidence of the efficacy of urine-based bio-cementation in enhancing the engineering properties of closed landfill sites, underscoring its potential as a sustainable solution in ground improvement practices.

Development of sodium ion-selective nanofiltration membrane for wastewater treatment

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Brief bio of lead CI/presenter

Dr. Kazuki Yamamoto is a Junior Associate Professor at Tokyo University of Science. He received Dr. Eng. in 2017 from Hiroshima University. After working at Hiroshima University as a Project Researcher, he became an Assistant Professor at Tokyo University of Science in 2017 and a Junior Associate Professor in 2022.

Abstract

In order to recycle nitrogen, phosphorus, and potassium, which are produced by environmentally hazardous methods and are threatened with depletion, research is underway to recover these ionic components in human wastewater and use them as liquid fertilizer for plants. However, sodium and chloride ions in treated wastewater can cause salt damage to plants, so a technology is needed to selectively remove these sodium chloride ions. In this study, crown ether, which is known to interact with sodium and potassium ions, was added to polyamide nanofiltration membranes to develop a membrane that permeates sodium ions while suppressing the permeation of potassium ions. Water permeation tests of the membranes were conducted using model aqueous solutions containing NaCl and KCl.

Palladium recovery agents using azulene derivatives

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Brief bio of lead CI/presenter

Tatsuya Iwashina received his Bachelor's and Master's Degrees from Tokyo University of Science in 2021 and 2023, respectively, under the supervision of Prof. Takahiro Gunji (Tokyo University of Science). Currently, he is a Ph.D. student at Tokyo University of Science.

Abstract

Azulene is known as a unique molecule which shows bule color and emission from the second excited state. Recently, the synthesis of polymers having an azulene moiety and their pharmacological activities have attracted attention. However, there are few reports for metal complexes having azulenes as ligand and their application. Therefore, we surveyed the reaction of diethyl 2-aminoazulene-1,3-dicarboxylate (**DEAA**) with metal sources and extended to the application as a palladium recovery agent.

We found that **DEAA** complex was formed only when palladium was used as a metal source. Hence, **DEAA** was found to coordinate selectively to palladium. **DEAA-MPTMS** was synthesized by thiol-ene reaction using **DEAA** and 3-mercaptopropyl(trimethoxy)silane (**MPTMS**). Free-standing film was prepared by casting a tetrahydrofuran (THF) solution of polysiloxane and **DEAA-MPTMS** to be coloured in yellow. Then, colour of the film was changed

to orange when the film was immersed in the THF solution of palladium acetate. The result indicated that the composite films are expected to use as a palladium recovery agent.

Optimization of Bromide selective composite electrode in membrane capacitive deionization.

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Brief bio of lead CI/presenter

Yeshi Choden is currently pursuing her PhD in Civil and Environmental Engineering at the University of Technology, Sydney (UTS). Yeshi's academic journey began with her completion of a master's degree in Environmental Engineering, specializing in solid and wastewater engineering from IIT, India. Yeshi served as a lecturer in Royal University of Bhutan. Currently, Yeshi's doctoral research primarily focuses on nutrient (bromide ion) recovery from wastewater with a profound commitment to sustainability and circular economy principles.

Abstract

Bromine is a valuable yet depleting resource that is essential for various industrial applications, including flame retardants, clear brine fluids for oil extraction, and zinc-bromine batteries for energy storage etc. Seawater represents a vast and largely untapped source of bromine, accounting for 99% of the total bromine storage on Earth. Developing cost-effective and environmentally friendly technologies to recover bromine from seawater and other aqueous sources is crucial for meeting the escalating demand while mitigating environmental impacts. To address this, the study proposes utilising electrochemical process such as membrane capacitive deionization (MCDI) with highly selective materials for Br^- extractions that will contribute to revolutionizing the Bromine extraction process contributing to circular economy practices in the desalination industry. In our study adsorbent materials like Purolite resin Bromide Plus/9218 are explored as potential components for developing a bromine-selective composite electrode (Br-SCE) in membrane capacitive deionization (MCDI) systems. Optimization of electrode was performed based on ratio of adsorbent:conductive materials : binder and performance was analysed, Results of Bromide Plus/9218 based Br-SCE demonstrate that by effectively incorporating these resins into the composite electrode, the removal efficiency of bromide ions (Br-) is significantly enhanced, achieving up to 50-70 % reduction in overall conductivity, 65% removal Br- ions and selectivity of <2 over competing in comparison to bare activated carbon electrodes influence by the combined effect of electrostatic attraction and ion exchange. Our research aims to contribute in revolutionizing the Bromine extraction process contributing to circular economy practices in the desalination industry.

Sustainable Nutrient Recovery: Employing Membrane-Aerated Bioreactors for Effective Nitrification

Amirhossein Shafaghat*[1], Andrea Merenda[1], Django Seccombe[2], Sherub Phuntsho[1], Ho Kyong Shon[1]

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Brief bio of lead CI/presenter

Amirhossein Shafaghat is a PhD researcher at the University of Technology Sydney and a member of the ARC NiCE Hub. He is working on the subject of the circular economy using membrane-aerated bioreactors.

Abstract

Environmental pollution and the increasing demand for food necessitate sustainable approaches to biofertilizer production. One promising strategy to address these challenges is the circular economy concept, which aims to close the loop on key nutrients. Among various technological solutions, activated sludge bioreactors have shown significant potential, particularly in treating nutrient-rich wastewater such as liquid anaerobic digestate (LAD),

which is the liquid fraction recovered from digestate dewatering. This study, conducted at the University of Technology laboratory, focuses on enhancing the nitrification process within biological processes by employing a novel aeration system design, specifically a membrane aerated bioreactor (MABR).

In this study, real LAD sourced from the Sydney Water Riverstone wastewater treatment plant was nitrified in a lab-scale MABR reactor to obtain liquid N-P-K fertilizers. A lab-scale MABR system was utilized to evaluate the impact of the aeration system design and pH maintenance on the nitrification process. To optimize conditions for nitrification, various process parameters were assessed through batch experiments. The research investigates nitrification rates at different pH levels using different dilutions of LAD as feed.

Initially, 10 times diluted LAD in a continuous feed mode with pH control was assessed in terms of NH_4 conversion and nitrification (NH_4 to NO_3) percentage. The results revealed that the MABR system achieved a 70% NH_4 conversion rate within just two days. Nitrification % achieved 62% after three weeks with the pH set at 6.2, without any NO_2 accumulation. The average hydraulic retention time (HRT) was approximately 8 hours, indicating a fast nitrification process compared to the urine-MBR system. This shows that the MABR has great potential to produce NH_4/ NO_3 biofertilizer without any chemical addition. When compared to a urine-MBR system, the MABR demonstrated a 12% higher nitrification percentage.

Additionally, the study will assess less diluted LAD at different pH levels and oxygen dosages to determine the optimal conditions. Moreover, the energy and cost-effectiveness of the MABR compared to conventional MBR systems will be studied. The findings are expected to provide insights into optimizing the nitrification process for enhanced biofertilizer production. This research contributes to sustainability practices and supports the broader framework of the circular economy.

Spoil to Topsoil

Nupur Khanna

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Brief bio of lead CI/presenter

Nupur Khanna is Icon Water's Sustainability and Resource Recovery Coordinator. Responsible for identifying, developing, and managing circular economy programs and sustainability practices within the business, she brings with her eight years' experience in supply chain, social impact and sustainability management and holds a Masters in Environment and Sustainability.

Abstract

Icon Water's Soil to Topsoil project is an innovative and industry-first initiative that repurposes waste streams from water, wastewater, and maintenance operations as byproducts to make a topsoil product for superior rehabilitation. This project is an extension of the existing spoil reuse initiative as part of Icon Water's No Opportunity Wasted program, and in line with the Circular Economy Plan to advance the organisation's efforts to manage, engage and reduce resource use and waste generation.Icon Water, like other water utilities, generates ~2,000 tonnes per annum of water treatment solids (or alum sludge) and sends it to landfill due to limited knowledge on how to reuse the material, plus buys topsoil for excavation restoration activities. The Soil to Topsoil initiative developed to produce a topsoil product combines four different product streams generated by Icon Water and the ACT Government: soil from the organisation's network maintenance activities; water treatment solids from water treatment plants; Agri-ash from biosolids heat treatment; along with compost made from food organics and garden organics collected from green waste bins across Canberra.

The trial consisted of sowing multiple plot mixes containing different proportions of the materials with a grass seed mix compliant with the region's grassing specification. Measures were taken to replicate routine maintenance and operation conditions to ensure results are in accordance with on-ground conditions. A combination of analytical tests and visual monitoring was carried out to determine which soil mix encouraged faster plant growth, fewer weeds, and ability to withstand Canberra's extreme climatic conditions for improved resilience.

In addition to achieving multiple environmental and financial benefits this project also presents a chance to showcase to other industries scalable potential reuse opportunities for by-products such as water treatment solids

to be upcycled and reused rather than the material being treated as a waste stream. All in all, helping drive innovation, reframing the water utility sector as resource recovery enterprises and contributing towards a collaborative circular economy.

Based on the successful results of the trial Icon Water is now working with ACT Environmental Protection Authority to gain approval to make this part of business-as-usual operations.

Sustainable Lithium Recovery: The Potential of Mexene Electrodes for Efficient Selective Extraction from Brine

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Brief bio of lead CI/presenter

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

Abstract

The rapid rise in global demand for lithium (Li) resources, driven by the proliferation of lithium-ion batteries in electric vehicles, underscores the critical need for sustainable lithium extraction methods. Traditional mining of lithium from ores, such as those found in Australia, poses significant environmental challenges. In contrast, extracting lithium from brine offers a more sustainable alternative, aligning with the principles of circular economy and resource recovery. This method not only reduces environmental impact but also leverages naturally occurring lithium in saltwater, providing a more efficient resource recovery process. Our research focuses on capacitive deionization (CDI), a highly efficient and cost-effective electrochemical technology for extracting lithium from natural sources like brine and seawater. By developing advanced Hybrid CDI (HCDI) electrodes using MXene-based materials, we aim to enhance the selectivity and efficiency of lithium extraction. MXene, with its unique properties, has emerged as a promising material for lithium-ion batteries and capacitors. Our approach involves designing MXene-based electrodes, such as pure MXene and MXene@SnO_2 nanoparticle electrodes, which significantly enhance active sites for electrochemical reactions. This improvement facilitates better electron/ion transport pathways and creates numerous channels for the reversible insertion and extraction of Li^+ ions during the CDI process. The MXene@ SnO_2 structure, characterized by active and stable surface facets, enables rapid ion transport, exhibits high capacity, superior selectivity, and enhanced adsorption capabilities when used as a cathode material in HCDI systems. Our experimental results demonstrate that these electrodes achieve remarkable Li^+ electrosorption selectivity and capacity, even in the presence of competing ions such as K^+ and Na^+ in aqueous solutions. Additionally, the electrodes exhibit robust cyclic stability, retaining over 95% of their initial electrosorption capacity after 10 cycles. Our study advances the development of MXene-based electrode materials for HCDI applications and highlights their potential to meet the growing global demand for lithium resources essential for clean energy technologies.

Evaluation of ANN, DNN, and RNN Algorithms for reverse osmosis-based shipboard seawater desalination

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Brief bio of lead CI/presenter

Minjeong Kim is a master's student in Environmental Engineering and Energy at Myongji University.
She is currently learning to use various analytical instruments and will handle LC-MS/MS. With these instruments, she will analyze PFAS in semiconductor wastewater to study the behavior of PFAS and find solutions for treating this wastewater.

Abstract

Global climate change has accelerated worldwide due to industrial development along with population growth, which causes water shortages. It led to a need for sustainable water infrastructure and management. Seawater desalination technologies have been developing as an alternative water resource. The shipboard desalination process was an infrastructure that could produce and supply fresh water to isolated regions such as island areas suffering water shortages. Moreover, the shipboard desalination process can be used for emergencies by moving and managing it. It was necessary to minimize the volume and load of reverse osmosis process equipment, considering the volume and weight of the marine mobile seawater desalination plant.

Artificial neural network (ANN) was an algorithm that learned patterns from data and improved over time, achieving higher accuracy as the neural network processed more data. In terms of price predictions, the ANN algorithm model was utilized. On the other hand, deep neural network (DNN) aims to find the optimal equation by continuously adjusting weights based on a linear formula, and it learns autonomously to make flexible predictions for various situations. Another method, recurrent neural network (RNN) utilizes a simple structure with weight updated for repetitive learning. This study aimed to implement the algorithm that provided the most accurate predictions via these three models.

This study used the LG Q+ design software database to extract target values, including the minimum number of vessels and membrane module quantity, based on input values (production, raw water concentration, recovery rate, temperature, membrane module type) for the training and test sets. Furthermore, the performance of the model was assessed by employing the coefficient of determination (R-squared, R2) and the root mean squared error (Root Mean Squared Error, RMSE).

Acknowledgments

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (grant number: RS-2024-00335876).

Implementing circular economy in regional Australia

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Brief bio of lead CI/presenter

Ana Maria is a sustainability and circular economy scholar with a master's in climate and environmental emergency from Curtin University, Perth, Australia. She is currently doing her PhD on Implementing circular economy in regional Australia at Curtin University where she works as an academic.

Abstract

Regional settings play a vital role in the transition to a circular economy. While successful global and national circular economies heavily rely on functional regional circular economies (RCE), there is limited knowledge on how to implement them. The study focuses on reviewing the literature to start unpacking what a regional circular economy should be and do, and to define the main research gaps and priority areas in the context of regional Australia. A CE is a path to sustainability and to regeneration by narrowing, slowing and closing loops and by

efficient resource utilisation. While the bulk of records analysed belonged to regional areas in Europe and China, where most research on this domain has been conducted, this study focuses on the regional Australia context.

Four main aspects stand out when implementing RCE. Firstly, the operational application of CE. This includes resource-oriented CE tactics and strategies which can be applied by using various R-frameworks (i.e. reduce, reuse, recycle) or by undertaking industrial symbiosis practices. Secondly, context-based approaches are essential in devising regional development strategies and making the most of endogenous resources. There is no such thing as a one-size-fits-all RCE model as its design relies upon the distinctive specificities of regions (i.e. geography, social, political aspects) and upon considering locally available resources to optimise biological and technical cycles. Thirdly, assessing RCE performance is key to track and identify priority areas and effects of regional CE interventions. Lastly, governing RCE was identified as a key aspect in the RCE transition. Moving from linear models requires fundamental changes supported and driven by new governance models viz. network governance.

A key contribution of this study is the development of an original method that provides a quantitative assessment of the existing literature gaps. This can help in research prioritisation as well as in identifying connections among gaps. Key gaps identified in the implementation of RCE in Australia include the primary sector, material and resource sufficiency and efficiency, circular bioeconomy, and place-based approaches, among others.

Nanoscale zero-valent iron application in sewers: impact on sulfide and methane control and downstream wastewater treatment

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Brief bio of lead CI/presenter

Xiaotong received her Bachelor degree with Honours Class I in Environmental Engineering from University of New South Wales in 2020. She then started her PhD at the University of Queensland in 2021 where her research focuses on integrated chemical management in urban wastewater systems.

Abstract

The production and build-up of hydrogen sulfide and methane in sewers are major concerns due to their contribution to odour, corrosion and greenhouse gas emissions. While nanoscale zero-valent iron (nZVI) is an emerging material known for its high particle reactivity and potential to disrupt biofilms and suspended biomass, its application in sewer systems remains underexplored. In this study, we investigated the effectiveness of nZVI for controlling sulfide and methane in sewers, as well as its downstream effects on wastewater treatment. Two continuous flow laboratory-scale reactor systems were used, comprising sewer reactors and sequencing batch reactors (SBRs). The long-term results revealed that, during the nZVI dosing cycle of experimental sewer reactors (50 mg Fe/L dosing for 6 h followed by three 6-h cycles off), the effluent contained a reduced sulfide concentration by 8.5 ±0.5 mg S/L (84.4±5.8%) and methane concentration by 16.6 ± 1.9 mg COD/L (42.2 ± 4.1%), as well as an increased sulfate concentration by 3.0 ±0.5 mg S/L (105.0 ±19.4%), compared to the control. In addition to sulfide precipitation, batch experiments showed that first addition of nZVI inhibited sulfate-reducing and methanogenic activities by 58% and 27%, respectively. Even in the cycle without nZVI dosing, the inhibitory effect was comparable. After three months of nZVI addition, sulfate-reducing bacteria recovered to only 28% lower activity compared to the control, while the reduction ratio of methanogenic activity increased slightly. Furthermore, approximately 40% of the dosed nZVI entered downstream wastewater treatment. This reduced the phosphorous concentration in the experimental SBR effluent by 2.1 ± 0.2 mg P/L (37.3±4.0%), improved sludge settleability by 22.9 ±4.0%, and enhanced sludge dewaterability by 35.3 ±4.6%, compared to the control. The results suggest that intermittent addition of nZVI in sewers can precipitate sulfide and suppress microbial activities responsible for sulfide and methane production without causing cytotoxic effects. Additionally, the downstream benefits make nZVI a potential approach to integrated urban wastewater management.

Anthroponics in a Circular Economy: Effect of urine fertiliser on the flowering and longevity of Pansy (Viola × wittrockiana)

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Brief bio of lead presenter

Juan Lucas is a Nursery horticulturist at the Royal Botanic Garden Sydney, Australia. He is currently managing experiments on the end-use of fertilisers from human urine, focusing on understanding the effect of fertiliser application in contrast with commercial fertilisers.

Abstract

Human urine contains essential elements necessary for plant growth and biomass production, making it a valuable resource. There is a growing trend towards converting urine into fertilisers using various processes and technologies. The recovery of nutrients from human urine plays a critical role in promoting circular economy principles, aiming to create sustainable loops by utilising ornamental plants or urban farming to mitigate waste and environmental pollution. UTS has achieved success in converting human urine into plant fertiliser using the UrVal technology, resulting in the production of UrVal fertiliser. In light of this, our experiment aims to investigate the effects of UrVal fertiliser on plant growth compared to a commercial fertiliser.

Urine fertiliser (UrVal) performance was compared with a commercial fertiliser solution (Cal-Mg Finisher, ICL) as nutrient solutions tailored for Pansy (Viola × wittrockiana). Two different growing media were used for the experiment Coco chips, and Peat/Perlite P500 (1:1). The experiment layout was a completely randomised design with 5 replications per treatment combination. The experiment was carried out at the Royal Botanic Garden Sydney – Nursery to test our hypotheses on plant performance and growth.

On weekly basis, data was collected on plant height, plant diameter, and number of flowers for the period of the experiment. At the end of the experiment, leaves of each plant were collected to assess fresh biomass. To measure the dry biomass, leaves samples were placed in paper bags in a Memmert GmbH oven (Model 400, Germany) at 100 ℃ for 24 hours and then weighted again. Similar growth patterns were recorded between fertiliser treatments showing the importance of recovering nutrients and reusing them to grow Pansy.

Schematic Evaluation on Sustainable Upgrading Technologies of Biogas-to-Hydrogen toward a Circular Economy

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Brief bio of lead CI/presenter

ChangKyoo Yoo, Professor, Dept. Environment Sci. and Eng., Kyung Hee University, Korea, (current) Dept. Chair, (former) Director of Environmental Informatics Program, (former) Leader of Environment-Safety Institute, Samsung Electronics.

Abstract

Sustainable economic development is a significant and urgent issue across various sectors including energy and industries to avoid global climate change. To accelerate sustainable and circular economy, hydrogen utilization is promising approach in various sectors to substitute fossil-fired energy resources. Hydrogen production can be categorized as grey, blue, and green hydrogen; among them, grey hydrogen is major production method including as byproduct from petrochemical industry. This grey hydrogen production emitted lost of anthropogenic greenhouse gases (GHGs) such as carbon dioxide (CO_2). Hence, low or non-CO_2 emitted hydrogen production methods should be developed and implemented towards sustainable and circular economy, and in this context, biogas upgradation-based hydrogen production can be a solution to transit from grey to blue or green hydrogen production. Biogas can be easily generated from various biomass including wastewater through anaerobic digestion (AD). For this, improvement of methane (CH_4) purity is a critical point for biogas upgradation. This study focuses onto develop schematic evaluation on sustainable biogas upgradation technologies towards circular economy, based on techno-economic analysis (TEA) and life-cycle assessments (LCA). First of all, diverse composition of biogas were collected; then, various biogas upgradation systems including waster scrubbing and methanation processes were modeled using Aspen Plus. Based on the developed models, TEA and LCA were conducted to figure out the best available technology for improvement of CH_4 purity in economic and environmental aspects. The results represented that waster scrubbing process showed the superior performance to improve the CH_4 purity while removing more than 95% of CO_2 in the biogas. Integrating with the wastewater treatment plant (WWTP), only 1.8% of water reclaimed from the WWTP's effluent is feasible to remove 95% of CO_2 in biogas. Accordingly, this research indicated that the the biogas upgradation system is sustainable technologies towards water and hydrogen circular economy. Acknowledgments: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. 2021R1A2C2007838).

One-step synthesis of magnetic biochars through co-pyrolysis of walnut shells and Fe-rich mine tails for adsorption capacity enhancement of polystyrene sulfonate microplastics

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Brief bio of lead CI/presenter

Dr. Kangmin Chon is Associate Professor of Department of Environmental Engineering at Kangwon National University in Republic of Korea and leads the Sustainable Environmental Technology (SETL) Laboratory. He has (co)authored over 97 peer-reviewed international journal publications and also serves as an Editor in Desalination and Water Treatment (Elsevier).

Abstract

Polystyrene sulfonate microplastics (PSMPs) known to be highly mobile in aquatic ecosystems and consequently offer potential threats on human health and aquatic organisms. In this study, Fe-rich mine tails has been utilized as an additive to improve the adsorption capacity of walnut shell biochars (WSB) for PSMPs in aqueous phases. To provide deeper insights into the effects of microplastic sizes on the adsorption of PSMPs onto pristine WSB and magnetic WSB produced via co-pyrolysis of walnut shells and Fe-rich mine tails (FMTs), physicochemical characteristics of pristine WSB and magnetic WSB were comprehensively analyzed and directly correlated to the changes in the adsorption behaviors and mechanisms of PSMPs with 3 different molecular weights (MW; 210 – 32,000 Da) toward WSB via incorporation of Fe-rich mine tails (FMTs). Fe-WSB was more efficient for the adsorption of PSMPs (adsorption capacity (Q_e) of Fe-WSB = 0.77–6.75 mg g^{-1}) than WSB (Q_e = 0.27–0.79 mg g^{-1}). The R^2 values calculated from the adsorption kinetics and isotherms indicated that chemisorption plays a fundamental role in the adsorption of PSMPs toward pristine WSB and magnetic-WSB in aqueous phases. Moreover, the adsorption of $PSMP_{210}$ (MW = 210 Da), $PSMP_{10K}$ (MW = 10,000 Da), and $PSMP_{32K}$ (MW = 32,000 Da) toward pristine WSB and magnetic WSB proceeded exothermically and their Q_e values proportionally decreased with increasing the temperatures as van der Waals forces became weaker at high temperatures. The X-ray photoelectron spectra of pristine WSB and magnetic WSB before and after the adsorption of PSMPs support the conclusion that the incorporation of FMTs on WSB surfaces could facilitate electrostatic interactions, pore-filling effects, π-π and H-bond interactions mainly governing the adsorption of PSMPs in aqueous phases.

Photothermal Characteristics Based Coffee Skin Activated Carbon on the Solar Interface Evaporation (SIE) for Seawater Purification of Remote Areas

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Brief bio of lead CI/presenter

Prof. I.D.G Ary Subagia ST., MT., PhD is a lecturer in the mechanical engineering study program at Udayana University. He is head of the material engineering laboratory, Head center for technology and materials, also Head of the Research group for engineering systems and Materials renewable at Udayana University.

Abstract

Reducing water sources suitable for consumption is a problem that must be addressed immediately. Seawater is an alternative water source, but it needs to be purified before it can be consumed. Desalination technology is used for this purpose, which involves separation methods. To create cheap, environmentally friendly, and sustainable desalination technology, solar energy absorption systems have been carried out by researchers. In this technique, we are trying to conduct agricultural residue such as coffee skins, to create photo-thermal sheets. The photo-thermal is placed on the water surfaces of the desalination system. This method is called solar interface evaporation (SIE). Synthesis and characterization of coffee skin waste carbon were conducted using H_3PO_4 activator. Carbon is activated at temperatures 400 C, 500 C, and 600 C, respectively. This work aims to create innovations in photo-thermal by using natural material as solar thermal absorption for water evaporates in the purified seawater process in remote areas. The result shows that coffee skin waste after the process increases the number of pores and has a high absorption capacity for solar energy. It influences the evaporation rates of water. So the material is suitable for photo-thermal sheets in desalination systems in remote areas.

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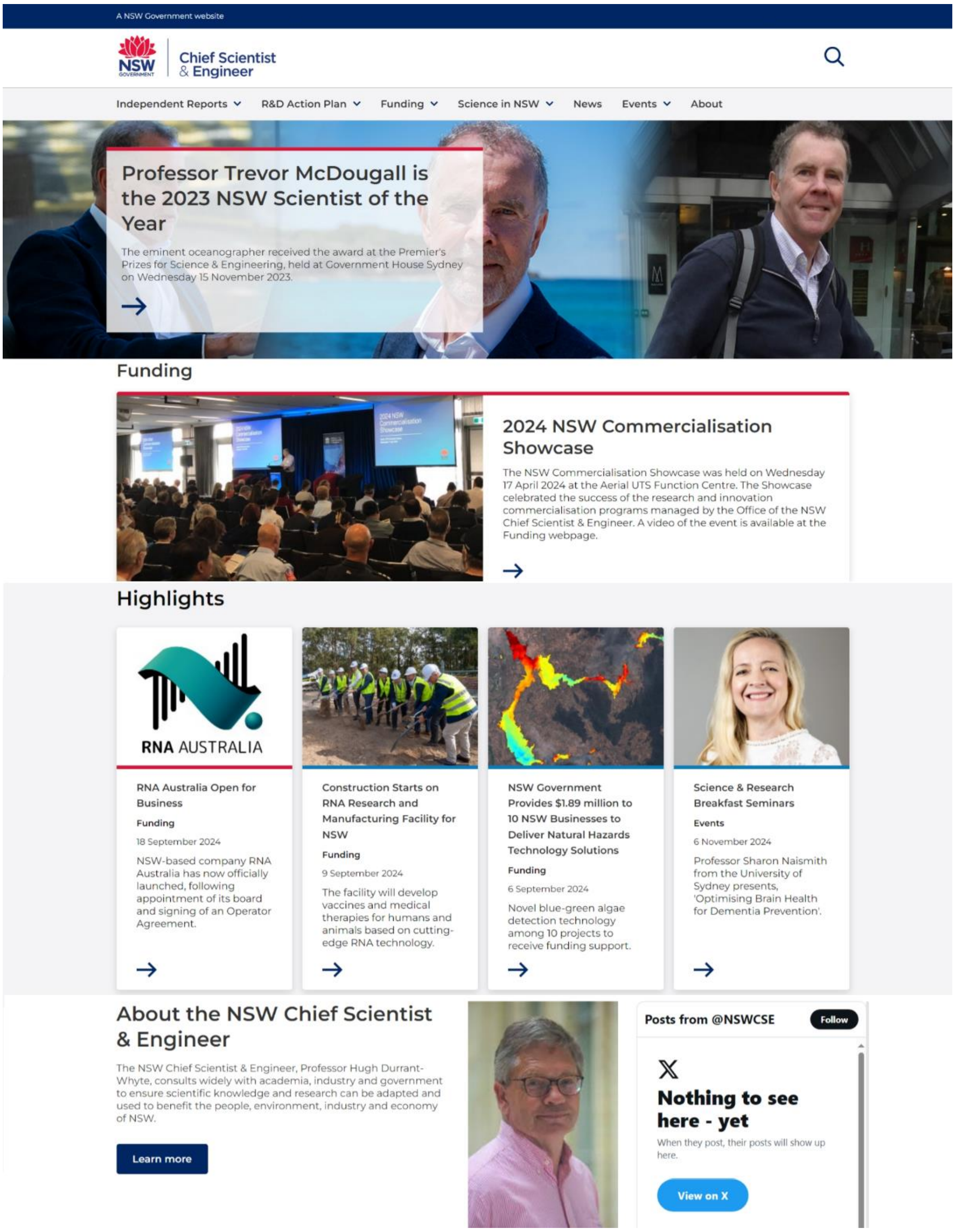

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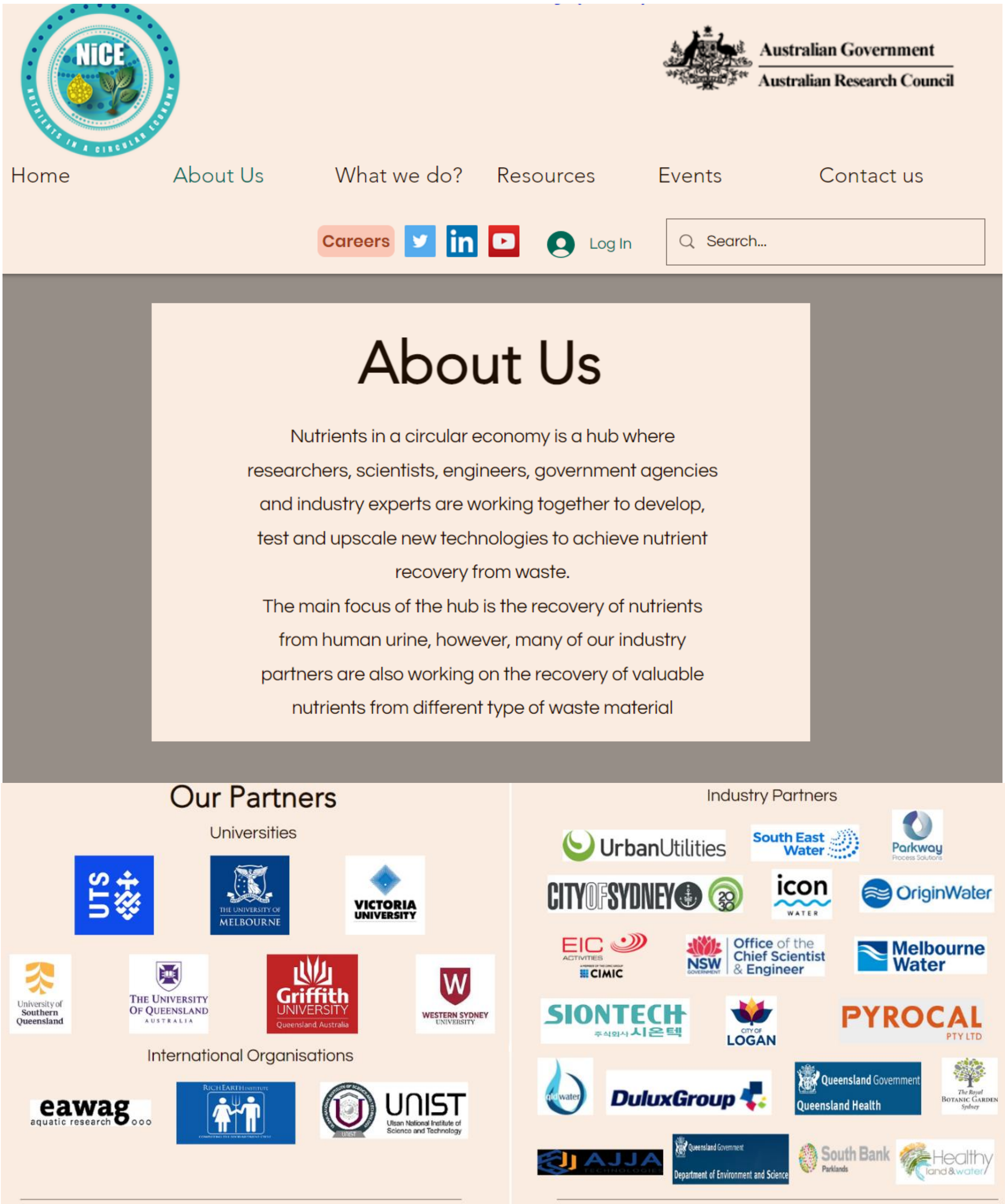

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About us

Circular Australia is an independent, national peak not-for-profit body working to transition Australians, governments and businesses to a circular economy by 2030. Our expertise, programs and partnerships drive change, measure impact and accelerate the circular economy transition.

Our mission is to lead and inspire others to implement circular actions to accelerate the circular economy in Australia.

CEO message

The circular economy is here, and we need to get ready. Businesses and governments are leading the way with big changes that will make our planet more sustainable and resilient.

Companies and researchers are designing out waste by making products that last and can be repaired. Next-generation infrastructure and services are allowing people to generate energy and water locally, reducing costs and creating an abundance of sustainable resources that can be shared. People are also sharing mobility, saving money and carbon.

Circular Australia is on a mission to remove barriers to the circular economy future by partnering with business, government, researchers and people.

Join Australia's leading organisations dedicated to building the circular economy. Circular Australia works with businesses, government agencies, not-for-profits, researchers and finance & investment organisations to build an Australian circular economy.

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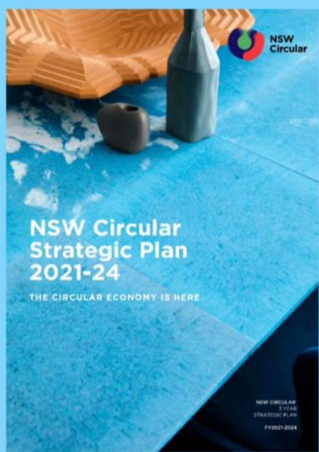
Our strategic plan

Circular Australia is in the early stages of its transition from NSW Circular and an updated Strategic Plan will be released in FY22-23.



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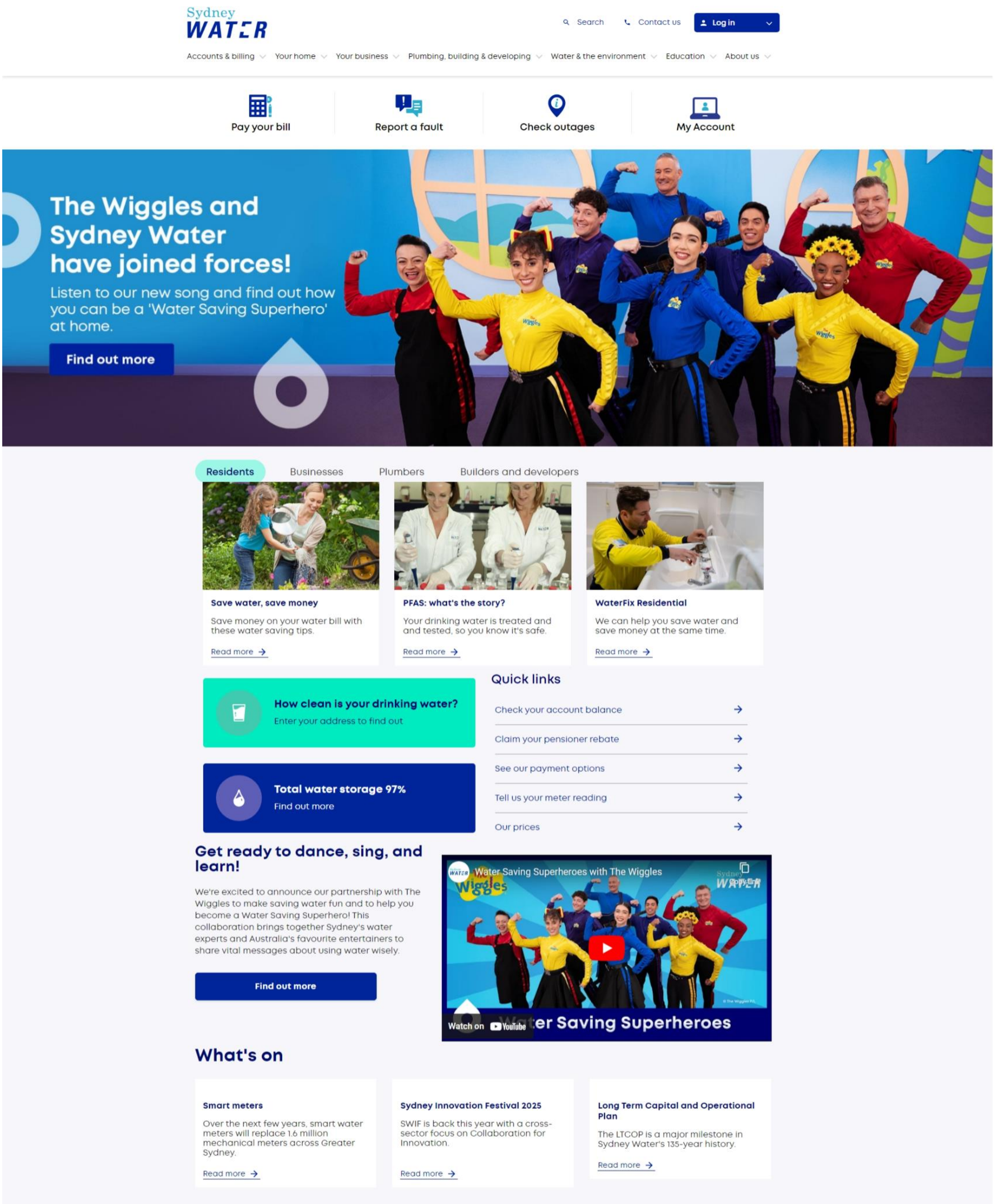

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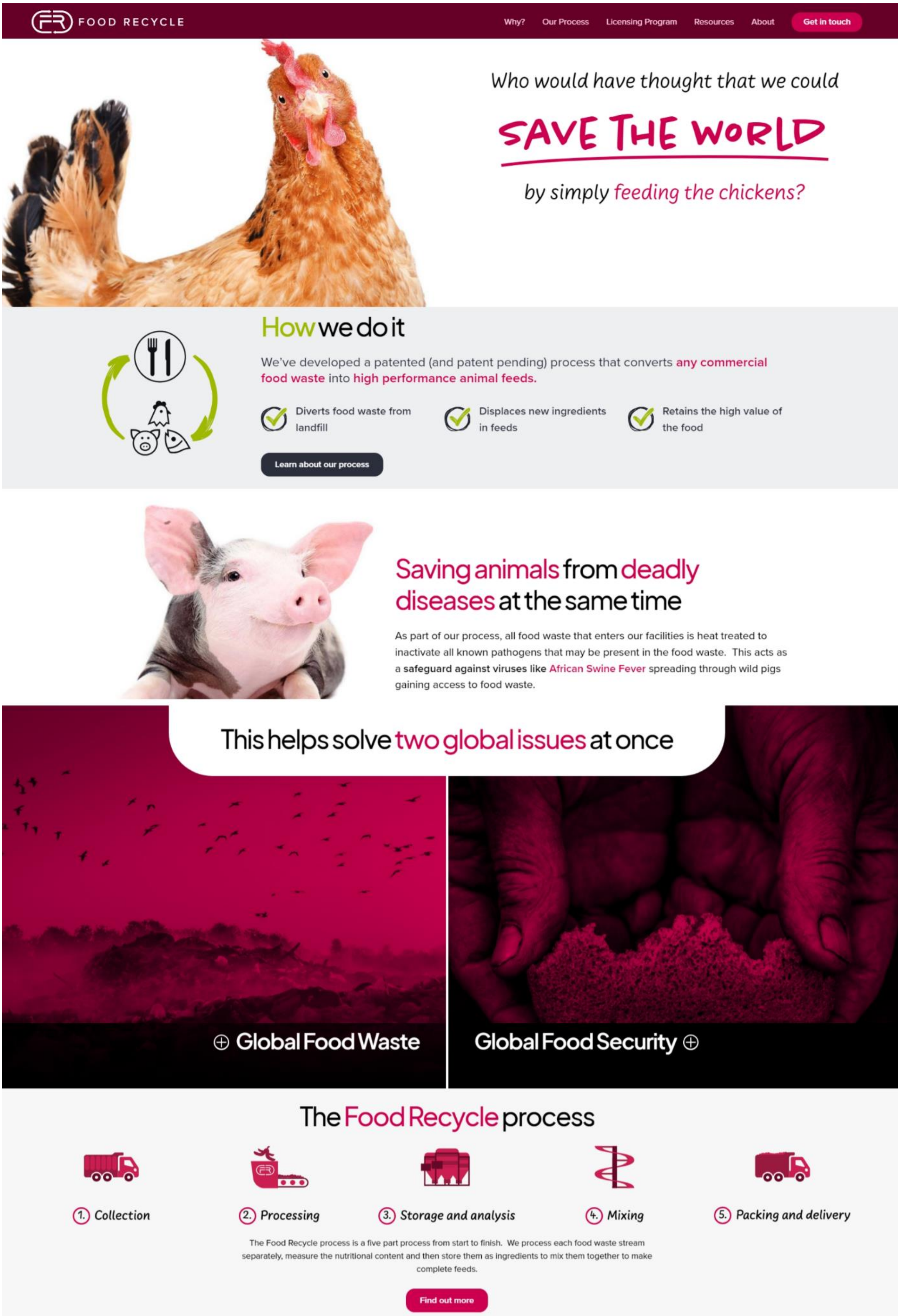

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2017 - Dec 2018 · 2 yrs
Fiji

Provision of subject matter expertise to the Water Authority of Fiji through the Urban Water Supply and Wastewater Management Package Capacity Building Contract: Asian Development Bank Contract CS0 ...see more

Sydney Water
18 yrs 1 mo
Sydney, Australia

- **Head of Developer and Business Customer Services**
  2016 - 2017 · 1 yr

  Management of developer interactions and the relationship between Sydney Water and its 200,000 non-residential customers. Functional responsibility for developer interactions, trade waste management, c ...see more

- **Project Manager, Operating Model**
  2015 - 2016 · 1 yr

  Development of an overall operating model based on Sydney Water's business model. Management of strategy consultants to deliver outcomes on time, cost and quality. ... ...see more

- **Manager Business Customers**
  2003 - 2015 · 12 yrs

  Responsible for developing the relationship between Sydney Water and its 200,000 non-residential customers. Functional responsibility for trade waste management, customer demand management, asset protecti ...see more

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