Acknowledgement of country

I wish to acknowledge the Traditional Custodians and their Ancestors of the lands and waters across Australia on whose unceded lands I am living, studying and working. I respectfully acknowledge their Ancestors and Elders, past and present.


BIODIVERSITY LOSS
LOW RECOVERY
ADDITIVES
CONTAMINANTS
CONSUMPTIONS
EMERGING
UNSUSTAINABLE
MICROPLASTICS IN HUMANS
AGRICULTURAL PLASTICS
PROBLEMS
DISPOSAL
EPS
DISPOSAL
CONSUMPTIONS MICROPLASTICS
PVC TEXTILE SINGLE USE
FEW RECYCLING OPTIONS
MEDICAL PLASTICS MICROPLASTICS


INTERNATIONAL COLLABORATION
PVC RECYCLING
BIOPLASTICS
REDUCE
CHEMICAL RECYCLE
PLASTIC2PV
INITIATIVES
EARLY DETECTION
ANALYTICAL METHODS
TRACEABILITY
CIRCULARITY
REUSE
ESP RECYCLING
STANDARDS
ENZIDE
COMMUNITY
CLEANUP
MEDCYCLE
RECYCLE
AUTOMATED DEBRIS CLEANUP
MASS BALANCE
CONSUMER SENTIMENT
SOLUTIONS
ARTIFICIAL INTELLIGENCE
AI
PLASTIC2CONCRETE
RECOVERY
EDUCATION
COMPOSTABLE
TECHNOLOGIES
MATERIAL CIRCULARITY
SUSTAINABLE
DRONE
DATA
BIODEGRADABLE
MARINE DEBRIS REMOVAL
MICROALGAE BIOPLASTICS
BIODEGRADABLE MULCH
PUBLIC SENTIMENT
ALTERNATIVE MATERIALS

RMIT UNIVERSITY

CSIRO

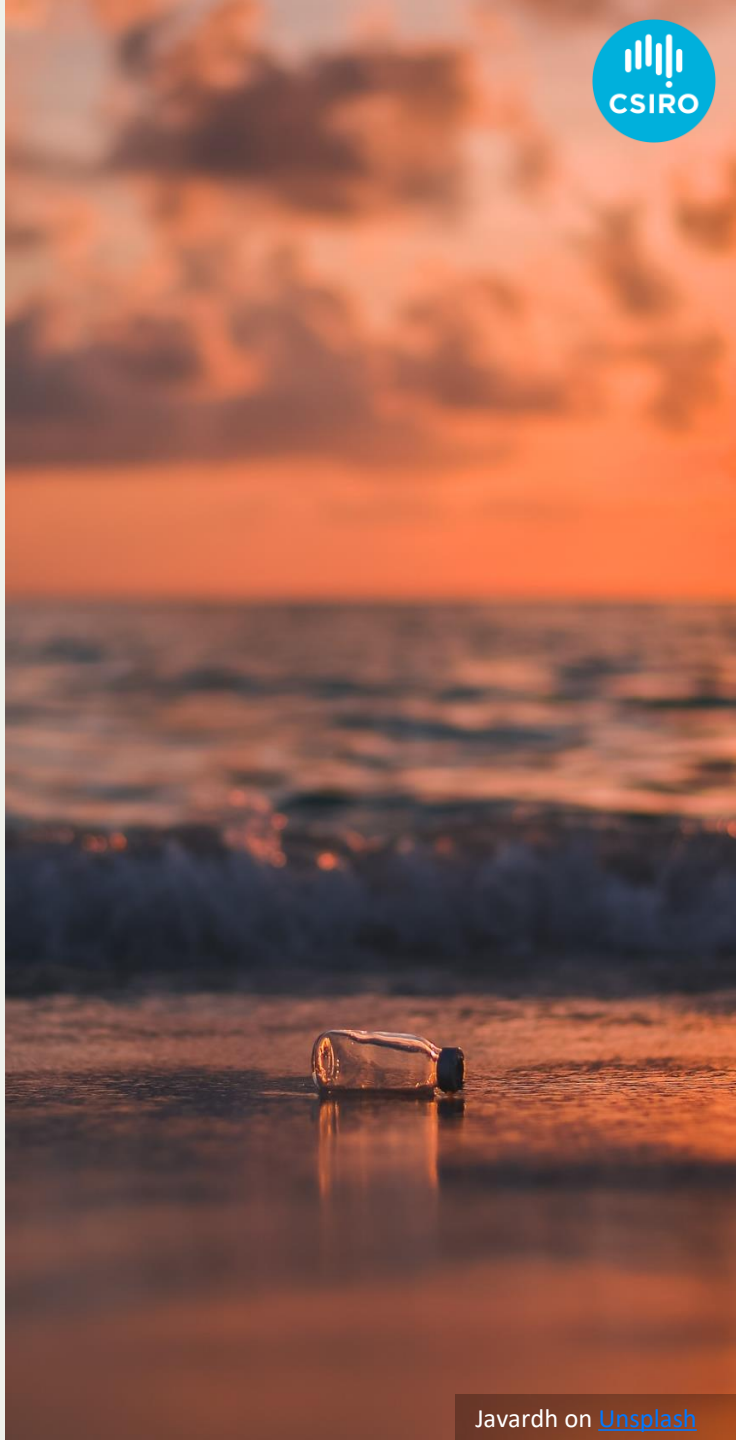
Life cycle assessment (LCA)

and its roles in the **plastic industry**

Ending Plastic Waste Symposium 2024

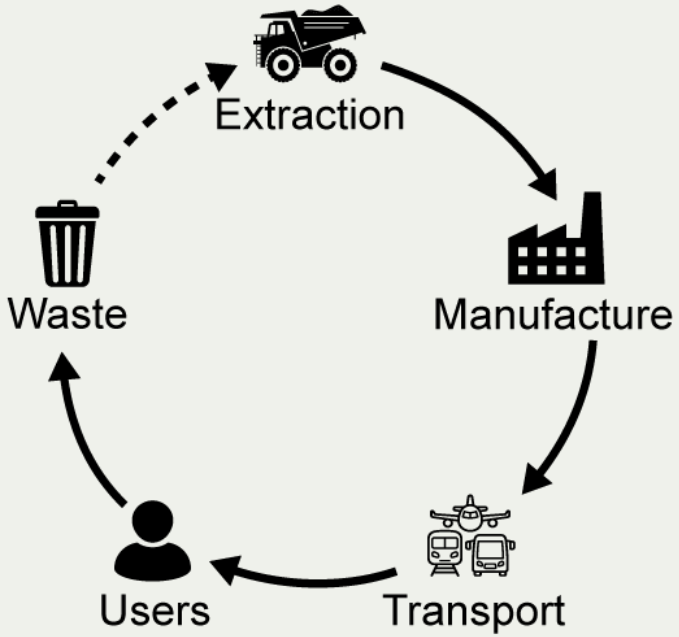
7th August 2024, Melbourne

Cao Ngọc Tú Xayachak (Tú)



Javardh on Unsplash

Life cycle of plastics



Life cycle assessments (LCAs) are comprehensive **environmental evaluations** that offer **holistic** and **quantitative** assessment of a product's environmental performance.

— EPD Australia 2024

WHY

LCA

MATTERS
IN THE

PLASTIC SECTOR

1 Decision-making

Material selection, waste management options, trade-off analysis

2 Supply chain management

Identify key contributors to emissions and wastes

3 R&D + Product development

New plastic-alternative materials (worth??)

4 Marketing & sales

Sustainability is a competitive edge

Enable good practices to be recognised

Access to global market

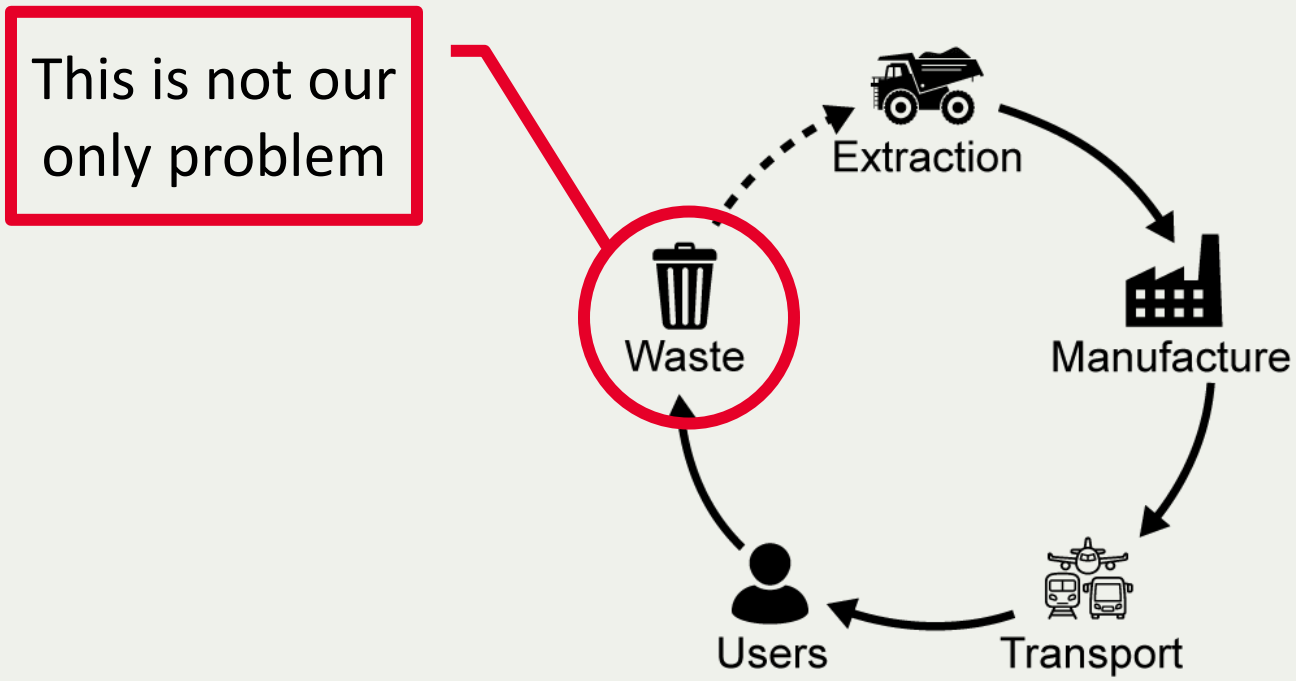
5 The story we tell matter

The plastic problem is more than just waste management

5 The story we tell matter

The plastic problem is more than just waste management

We can’t recycle our way to sustainability



1

A life cycle inventory **database** for **chemical recycling** of plastic waste

Pyrolysis, gasification, and depolymerisation

LCA research at

CSIRO

AND

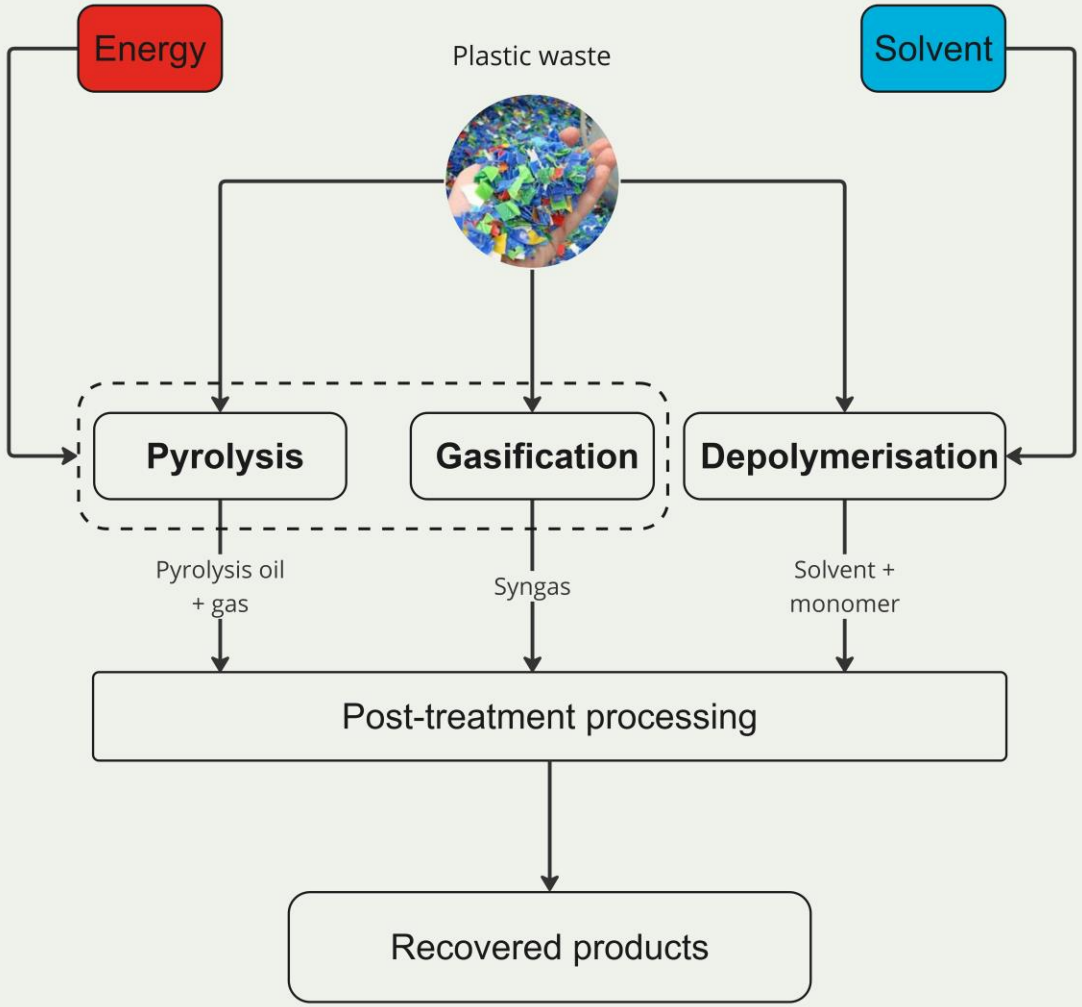
RMIT

A life cycle inventory **database** for **chemical recycling** of plastic waste

- Resistant to contaminants
- Energy and chemical solvent

Goals:

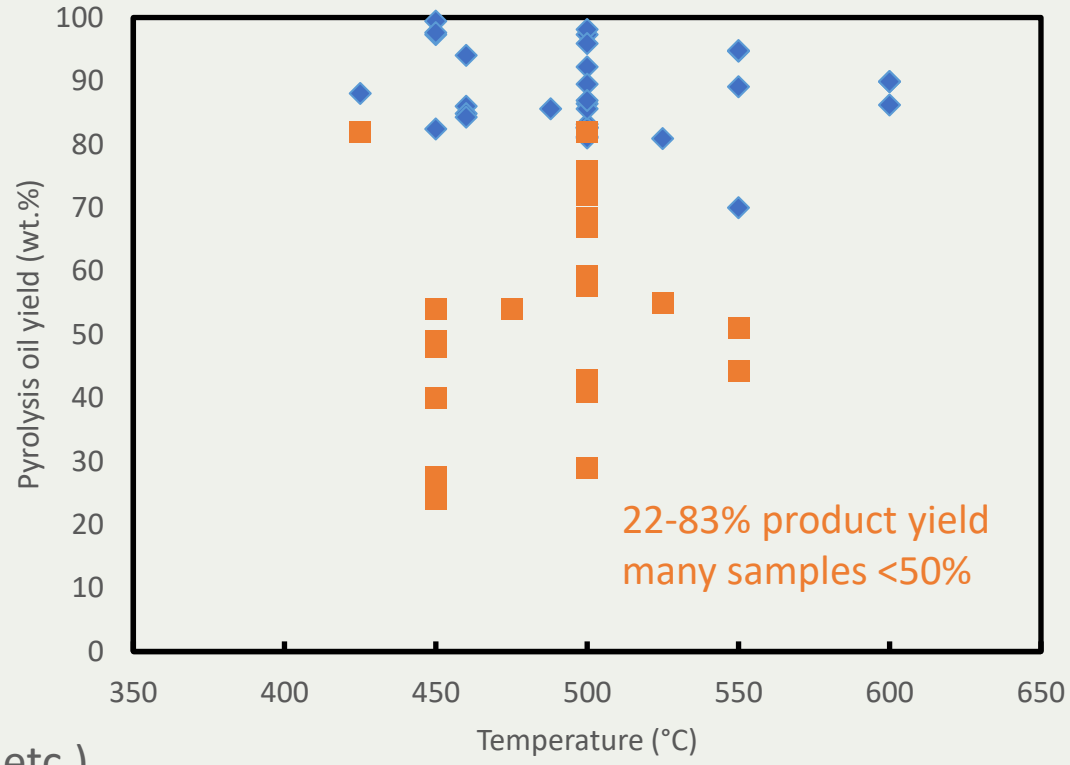
- Life cycle assessment of chemical recycling
- Editable, centralised database for future studies



A life cycle inventory **database** for **chemical recycling** of plastic waste

Lab plastics ≠ real-world plastics

- Lab plastics (◆)
  - ❖ No contaminants
  - ❖ No other polymers
  - ❖ No additives
  - → **Product yield: >80%**
- Real plastics (■)
  - ❖ Water
  - ❖ Oil residue
  - ❖ PVC
  - → **Product yield: 22-83%**



Xayachak et al. 2022

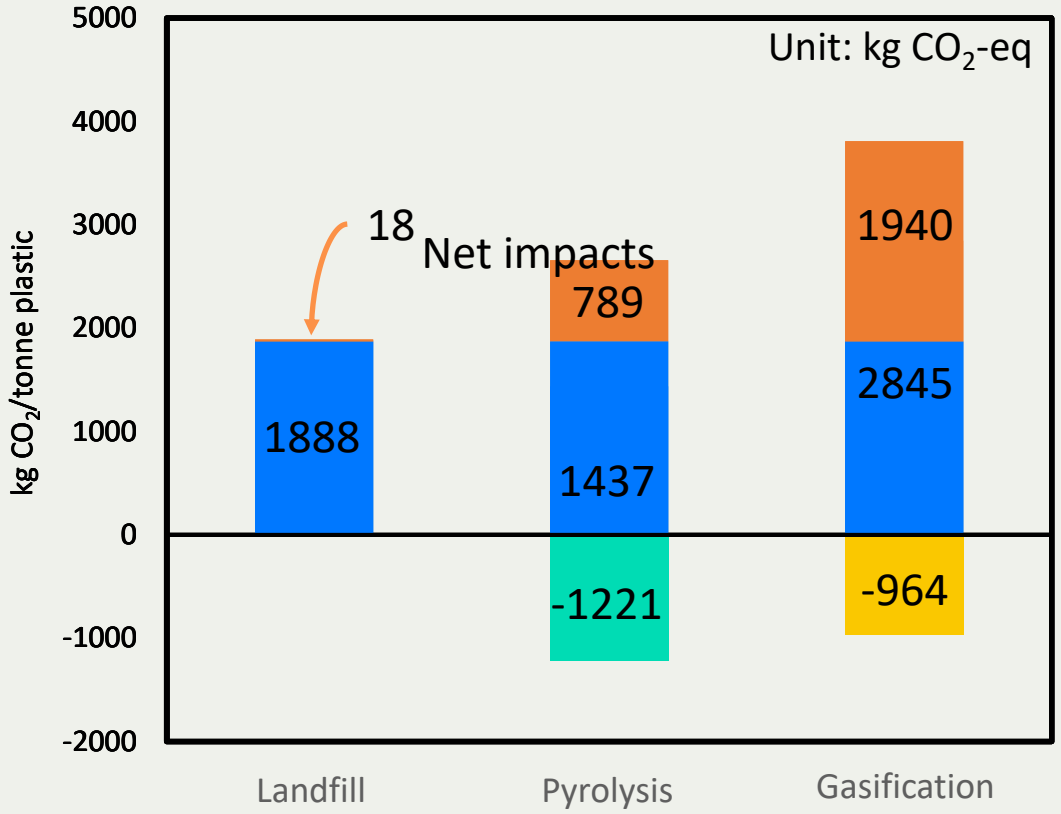
- Key data categories
  - ❖ Electricity & gas
  - ❖ Solvents (depolymerisation)
  - ❖ Nitrogen (pyrolysis)
  - ❖ Steam (gasification)
  - ❖ Emissions (CO_2, SO_2, NO_x, etc.)
  - ❖ Solid waste
  - ❖ Wastewater

A life cycle inventory **database** for **chemical recycling** of plastic waste

Comparative life cycle assessment

- **Landfill** vs **pyrolysis** vs **gasification**
- Baseline impacts: **1870 kg CO_2-eq**/tonne waste
- Add-on impacts: **waste management**
- Key contributors:
  - Energy (pyrolysis & gasification)
  - Steam (gasification)
- Crediting:
  - **Monomer recovery (pyrolysis)**
  - **Aromatic recovery (gasification)**

Xayachak et al. 2023



Other impacts (acidification potential, fossil fuel depletion potential, water use, etc.)
→ check linked publications

A life cycle inventory **database** for **chemical recycling** of plastic waste

Expanded polystyrene (EPS) pontoons

- **Landfill** vs **mechanical recycling** vs **depolymerisati**
- White spill:
  - 300+ flood-scattered pontoons
  - Remote beaches
  - Whole → bulky
  - Breakdown → hazards
- Inform local government

Hood et al. 2023

Xayachak et al. 2023b

LCA research at

CSIRO

AND

RMIT

1

A life cycle inventory **database** for **chemical recycling** of plastic waste

Pyrolysis, gasification, and depolymerisation

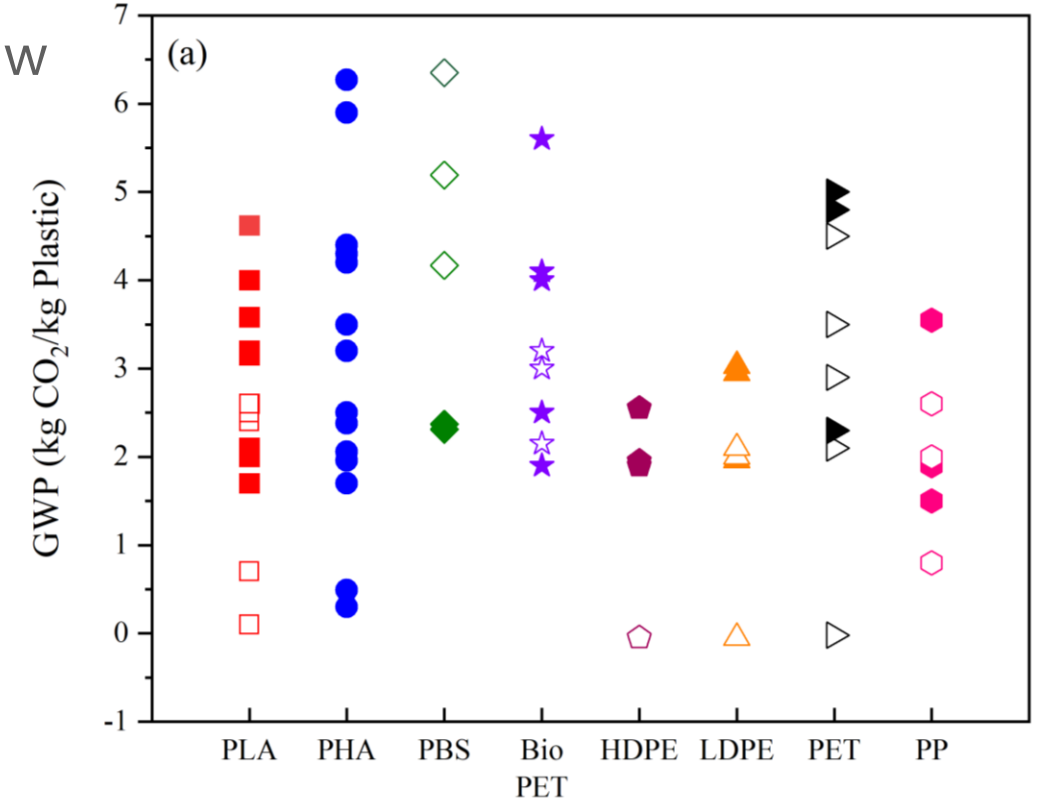
2

Life cycle assessment study of **bioplastics** in the context of Australia's circular economy

Life cycle assessment study of **bioplastics** in the context of Australia's circular economy

- Environmental impacts depend on the source of raw materials
- **Low:** climate change potential & fossil fuel depletion potential
- **High:** water & land use + ammonia emissions
- Fossil-based vs bio-based plastics (Fair???)
- Life cycle assessment for PLA made from sugarcane, algae, and other sources

Islam et al. 2024



Critiques

Current problems and research gaps in

LCA

1. ## Microplastics and plastic debris

No methodology and data for assessing their impacts

2. ## PFAS

LCA has limited data for ecotoxicity of PFAS → **Mostly omitted**

3. ## Site independence

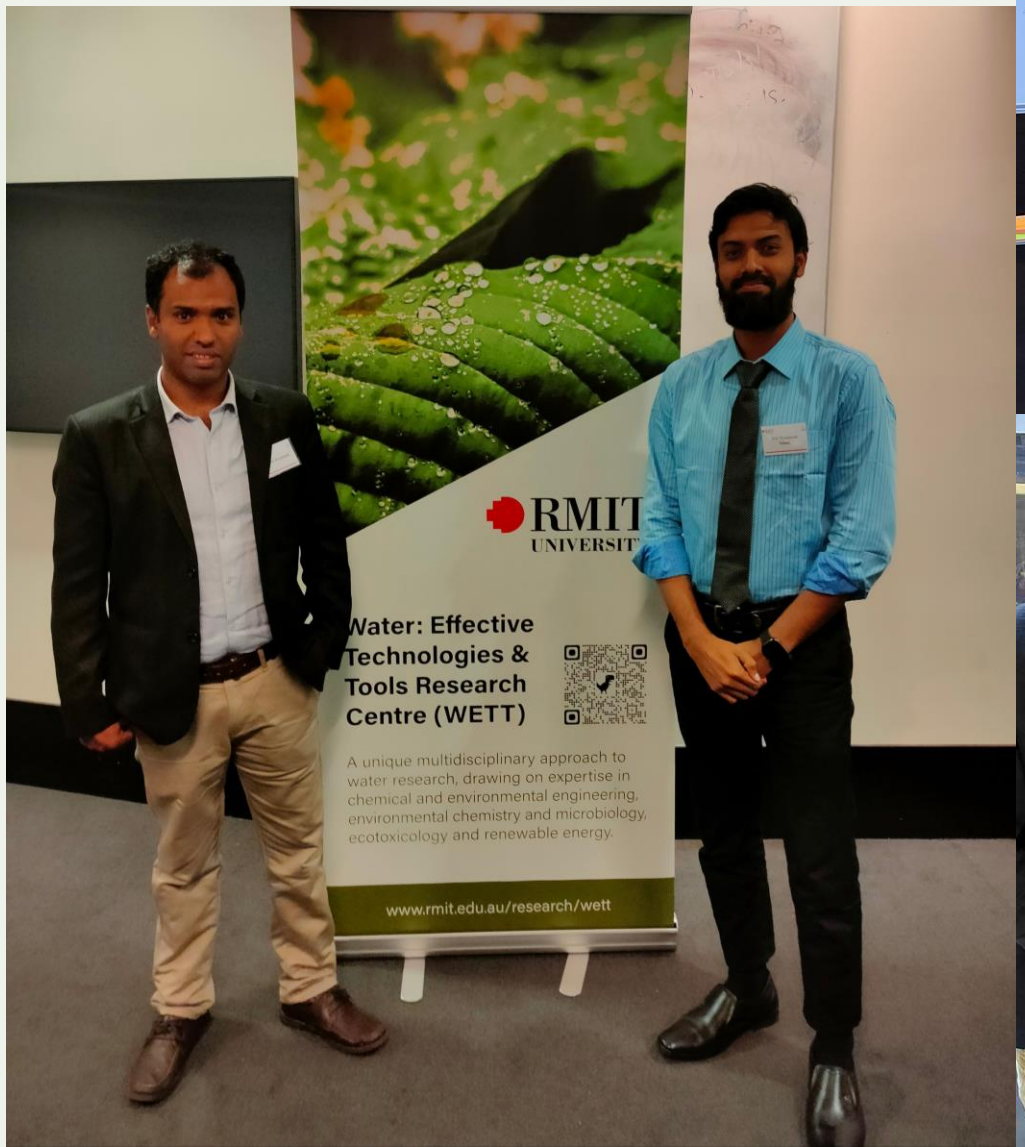
LCA emphasises global and regional effects over local ones
Many standards and regulations are not properly **regionalised**

4. ## Limited sensitivity analysis

5. ## Data scarcity

Not enough primary data

The Team


RMIT
UNIVERSITY
Water: Effective Technologies & Tools Research Centre (WETT)
A unique multidisciplinary approach to water research, drawing on expertise in chemical and environmental engineering, environmental chemistry and microbiology, ecotoxicology and renewable energy.
www.rmit.edu.au/research/wett


10
Breaking Down Plastic Waste: Assessing the Environmental Impact of Chemical Recycling Processes
RMIT
UNIVERSITY

Thank you for listening

Questions and feedback welcomed