Murdoch University | Harry Butler Institute

# Harry Butler Institute

## Annual Report 2024

Ngala kwop biddi.
Building a brighter future, together.

Carnaby's black cockatoo.
**Photo** Dannon Wu

# Harry Butler Institute

## Innovating for a sustainable future through collaborative research.

**Front cover: Plant research greenhouse experiment.**
**Photo** Dannon Wu



### Acknowledgment of Country

**The Harry Butler Institute acknowledges the Traditional Owners of Country throughout Australia. We pay our respects to Elders past and present.**

**Quenda.**
**Photo** Dannon Wu, HBI

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# Executive Director's report

**Prof Treena Burgess**
Executive Director,
Harry Butler Institute

**"At the heart of our vision, lies a commitment to expanding strategic partnerships that foster world-class research and drive real-world impact."**

**The year 2024 has been a significant period for the Harry Butler Institute at Murdoch University, one marked by enthusiasm, innovation, and an energetic drive that continues to attract growing interest from industry, government, and the wider community. As Executive Director, I am proud to share the progress we've made this year and the exciting path ahead.**

At the heart of our vision, lies a commitment to expanding strategic partnerships that foster world-class research and drive real-world impact. From conservation and ecological restoration to extractive metallurgy and infectious diseases, the Harry Butler Institute is delivering scientific excellence with a purpose, fuelled by curiosity, creativity, and collaboration.

We've seen the fruits of this vision in 2024 through a range of exciting initiatives. For example, our education programs took a leap forward with the launch of the WA Bug Barcode Blitz, a citizen science initiative engaging high school students across regional Western Australia to collect, discuss and DNA barcode local insects and spiders. We piloted a new wetlands science program with local schools, connecting students with our experts in snake-necked turtles, freshwater and feral fish, and mussels.

We brought global conversations to our doorstep, hosting a visit from polyphagous shot-hole borer expert from the University of California, Dr Shannon Lynch, and held a public lecture to share her knowledge with the wider community. We proudly watched as our PhD student and movement ecologist, Marie Windstein, interviewed the legendary Dr Jane Goodall during the Perth stop on her 'Reasons for Hope Tour'.

Our researchers broke new ground in terrestrial conservation, transforming lawns to woody meadows, bringing biodiversity and bushtucker to carbon farming in regional communities, and diving deep into the dietary habits of invasive foxes.

In our aquatic ecosystems, our research has revealed new insights into the taxonomy and threats to endangered species such as whale sharks and sawfishes. We have developed new tools to detect changes in ecosystem health and improve the resilience of freshwater ecosystems.

Through exciting new partnerships, our extractive metallurgy research team is taking sustainable metals recovery to new levels. They are utilising advanced technology, such as Flash Joule Heating (FJH) technology, to recover valuable materials from local ores and e-waste.

Within our Algae Research & Development group, we are taking a microscope to the science behind methane-lowering algae stock feeds, uncovering critical gaps in the research. The group's expertise was recognised on the international stage as we were announced to be the hosts for the 2027 International Society for Applied Phycology Conference.

In the events and communications space, we have stepped up our efforts to engage academia, industry and the public through our events and public lectures. We have hosted numerous conferences for industry and community partners in Murdoch University's state-of-the-art Boola Katitjin building, utilising our video team to live-stream events and create recordings.

## Lasting legacies

The year 2024 was a year of change as we saw inaugural Director of HBI, Professor Simon McKirdy, move on to a new role within the University, as Deputy Vice Chancellor of Global Engagement. Professor McKirdy maintains a strong connection with HBI as Professor Plant Pathology, continuing to mentor and supervise a number of research students and work closely with our team. Read more about Professor McKirdy's HBI legacy below.

Following Simon's departure, HBI Project Lead Susan Marie joined him at Global Engagement to take on the role as Director Strategic Partnerships. Susan had joined HBI after convening the first two successful Western Australian Biodiversity Conferences in 2021 and 2023, working closely with HBI. As Project Lead at HBI she used her unique skills to foster strong partnerships between academia, industry, and Indigenous communities in support of key projects such as the Harry Butler Science Centre. She emphasised Indigenous-led conservation and scientific solutions for environmental challenges and played a key role in formalising partnerships with like-minded international collaborators. Susan's achievements while at HBI have had a lasting impact on our business and our people.

Before the year ended, Andre deSouza, HBI's Manager of Operations felt the time was right to move on to a new challenge, taking up a new role as Director of Entrepreneurship within the University's College of Business. Andre had been at HBI since the Institute's inception, bringing to the role his expansive knowledge of business and industry, as well as his passion for marketing and tech-integrated solutions. His leadership has been central to fostering innovative research initiatives, particularly in leveraging emerging technologies such as artificial intelligence and drone technology to address ecological and environmental challenges. He has played an integral role in the establishment of the Harry Butler Institute and its reputation for fostering strong relationships with industry and sharing our achievements through outreach and communications.

Lastly, HBI saw two prominent Murdoch University professors take retirement in 2024: Professor Alan Lymbery and Professor Wendell Ela.

Professor Alan Lymbery had been a Professor of Parasitology in the School of Environmental and Conservation Sciences for nine years, teaching students about parasitology. He had also served as Director of the Centre for Sustainable Aquatic Ecosystems since the Centre's inception. Over his career, Professor Lymbery carved out a unique path in aquatic parasitology, combining the fields of disease ecology and conservation biology. He published more than 238 scientific articles with collaborators across the globe, as well as influential pieces in The Conversation. In retirement, he continues to mentor and support research students, working closely with the Centre for Sustainable Aquatic Ecosystems newly appointed Director, Professor Stephen Beatty.

Professor Wendell Ela had been inaugural Chair of Desalination and Water Treatment at Murdoch University and the Chief Scientific Officer of the National Centre of Excellence in Desalination Australia. His research focused on desalination technology development and implementation, as well as decentralised and off-grid water treatment systems and integrated water-renewable energy solutions for rural communities and agriculture. Although retired, he continues to contribute to key water research projects impacting rural communities.

## A bright future

Looking ahead, we are filled with optimism. As our Institute grows, so does our impact on sustainable and environmental research, both locally and internationally. We continue our work with communities, schools, and Aboriginal Elders and communities through the expansion of our citizen science and outreach programs, and the adoption of two-way knowledge. Our communications efforts expand our reach.

Following the success of our bids to host both the International Society for Applied Phycology (ISAP) 2027 Conference and the 5th International Congress on Biological Invasions (ICBI), we are embracing the opportunity to share our expertise, our research facilities and the beautiful city of Perth with global audiences.

**I'm immensely proud of what we've achieved in 2024, exemplifying our strengths in collaborative and innovative research that builds towards a sustainable future.**

As we continue work aligning with the United Nations Sustainable Development Goals, we recognise that there is more we can do. As an Institute, we are working to improve our engagement in two-way science, and providing equal access to outreach programs, while generally improving our communication. Together with our community, industry and government partners, we look forward to building on the momentum of 2024 and embracing the opportunities of the future.

**Prof Treena Burgess**
Executive Director,
Harry Butler Institute

# In recognition of Professor Simon McKirdy

**When Professor Simon McKirdy took on the role as the inaugural Pro-Vice Chancellor of the Harry Butler Institute (HBI) in 2017, he brought a wealth of experience in industry and government to an academic role.**

Over the next seven years he shaped a culture of collaboration both internally and externally, delivering research outcomes to address real-world problems through partnerships.

As Pro-Vice Chancellor, Simon built a research institute with a reputation for high-quality research and innovative management solutions in a wide range of areas related to environmental sustainability. The ethos of working collaboratively across industry, regulators and academia, upon which the institute was built, was inspired by its namesake, Harry Butler. The famed Western Australian environmental educator was a great inspiration to Simon.

Countless researchers, collaborators and students at Murdoch University and beyond, have benefited from Simon's leadership and expertise, particularly in the area of global biosecurity.

**Simon McKirdy.**
**Photo** Dannon Wu, HBI

The professional and academic team Simon nurtured is well placed to honour the Institute formed out of his vision, as Simon moves on to his new role as Deputy Vice Chancellor Global Engagement. HBI continues to benefit from his guidance and support as he maintains an active interest in the success of the institute and continues to support research outcomes in the Centre for Biosecurity and One Health.

# Our People

## Harry Butler Institute Leadership Team

### Executive Director

**Prof Treena Burgess**

### Business Director

**Andre deSouza**

## Centre Directors

Centre for
**Water Energy and Waste**

**A/Prof John Rubrecht**

Centre for
**Sustainable Aquatic Ecosystems**

**Prof Alan Lymbery**
Outgoing

**Prof Stephen Beatty**
Incoming

Centre for
**Terrestrial Ecosystem Science and Sustainability**

**Prof Trish Fleming**

Centre for
**Biosecurity and One Health**

**Prof Sam Abraham**

# Achievements and Impacts in 2024

**Broome sunset.**
**Photo** Dannon Wu, HBI

## SCIENTIFIC PUBLICATIONS

Total publications in 2024

**266***

Q1 outlets: **70.1%**

Top 10% of outlets: **17.9%**

Number of citations in top 10% journals by Citescore

2024

**42.9%**

2020–24

**42%**

* Published with HBI byline

## FIELD-WEIGHTED CITATION IMPACT

2024

**1.75**

2020–24

**1.73**

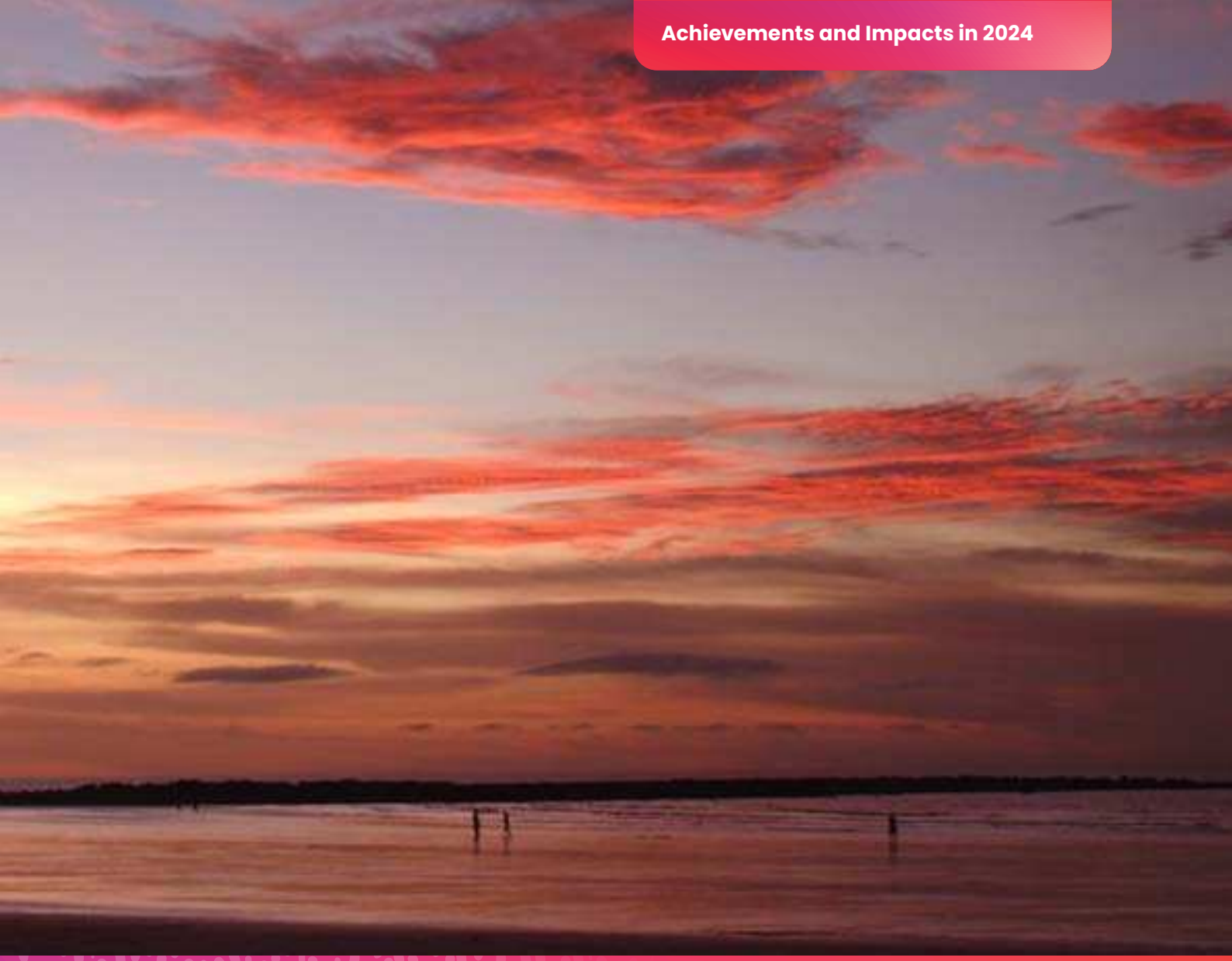
(usually done on a 5 year rolling average)

## NEW FUNDING AWARDS

2024

**$5,889,102**

(income to MU where Chief Investigator is in HBI)



## HIGHER DEGREE RESEARCH

**Load**

**237***

Equivalent Full-Time Student Load (EFTSL)

**Completions**

**68***

(based on best available data)

## RESEARCH OUTPUTS

Percentage of research outputs with international collaborators

**2020–24**

**65.1%**

## TOP COLLABORATING INSTITUTIONS

**2020–24**

University of Western Australia
United Arab Emirates University
Zagazig University
CSIRO
University of Melbourne
Statens Serum Institut
Curtin University
University of Queensland
University of Sydney
University of Tehran

* Supervised by staff who identify as HBI affiliated

# Our Research

**Plating metals samples in the lab.**
**Photo** Dannon Wu, HBI







# Centre for **Water, Energy and Waste**

**Associate Professor John Ruprecht**
Director

## About the Centre

**Supplies of water and energy are fundamental to modern life, as is the management of waste. The Centre for Water, Energy and Waste conducts research in these three related areas, ensuring human endeavours can coexist with biodiversity and sensitive ecosystems.**

# Seaweed might not be the answer to reducing methane from cows

**Grazing cattle produce some of the highest methane emissions in the world and researchers have been tasked with addressing the issue on a global scale. One of the solutions proposed is adding macroalgae (seaweed), such as *Asparagopsis*, to cattle feed to reduce the amount of methane cows produce when they digest it.**

**Ben Camer-Pesci**
**Photo** Dannon Wu, HBI

| Centre for **Water, Energy and Waste** | |
|---|---|
| **Focus** | Seaweed-Assisted Bioremediation |
| **Lead** | Prof Navid Moheimani |
| **Location** | Murdoch |


This solution has been heavily funded around the world and is touted as a feasible solution to the problem. While trials have shown that *Asparagopsis* can reduce up to 98 per cent of methane emissions from cattle, a Murdoch University research review indicates that it poses potentially serious threats to cows in its current state.

PhD candidate Ben Camer-Pesci was first drawn to this research by his concern for the natural environment, with *Asparagopsis* appearing to be a promising solution. However, once data collection began, Mr Camer-Pesci discovered some concerning statistics.

**"Upon reading further into the trials that had taken place, it became clear that the proposed technology was nowhere near a stage where it could be safely implemented," he said.**

"The motivation for this paper was driven by an urge to paint a clear picture of the current scientific standings of the technology, and to share this perspective with others."

During trials, there was evidence of ulceration, haemorrhaging and inflammation in cows' stomachs. Cows would refuse feed with higher *Asparagopsis* concentrations, or selectively avoid the *Asparagopsis*. In addition to this, milk production decreased and the milk that was being produced had higher levels of the chemical bromoform. Levels of bromoform remained under the maximum human intake with minimal exposure, and there was no evidence to suggest that the use of *Asparagopsis* could lead to concentrated human exposure. However, the review states that potential concentrated human exposure during processing of *Asparagopsis* biomass must be taken into consideration moving forward. Highly concentrated exposure to bromoform could lead to the slowing down of brain function and injury to the liver and kidney to both animals and humans.

Mr Camer-Pesci said that while *Asparagopsis* showed promise in reducing methane emissions, there had to be serious research and consideration before additional efforts and funding.

"I hope that research groups around the world will be able to work together to tackle the problems highlighted by the paper to clearly conclude whether or not this technology is worth further investment." Mr Camer-Pesci collaborated with researchers from the Algae R&D Centre throughout this project, including Professor Navid Moheimani, Associate Professor Mike van Keulen, Dr Damian Laird and Dr Ashiwin Vadiveloo.

This research supports the United Nations Sustainable Development Goal **12** and **13**.

# WaterSmart Farms Desalination Project

**The WaterSmart Farms Desalination project funded by Department of Primary Industries and Regional Development (DPIRD) and the Water Corporation is supporting circular agronomics for farmers through the roll-out of on-farm reverse osmosis desalinisation plants. The plants are a farm-scale version of the technology used to desalinate ocean water to supplement Perth's water supply. They process brackish groundwater into a suitable resource for livestock, crop agronomy and other agribusiness activities.**

| Centre for **Water, Energy and Waste** | |
|---|---|
| **Focus** | Watersmart Farms |
| **Lead** | A/Prof John Ruprecht |
| **Location** | Wheatbelt, WA |


HBI researchers, in partnership with the DPIRD and the Water Corporation are investigating optimal on-farm desalinisation technology and its application in the Wheatbelt of Western Australia.

The process of on-farm desalination involves installing a desalination unit, which comprises a tank, pump and reverse-osmosis processor. The desal units are powered by electricity from the grid, a generator, solar panels or hybrid systems. The brackish water is fed through a bore into the processor, producing fresh water and hypersaline reject water. The desalinated water produced is used mainly for crop spraying, livestock, gardening, household use and feedlot demands. The reject water is mostly disposed of through reinjection, evaporation basins, surface water disposal and holding dams.

**On-farm desalination unit.**
**Photo** A/P John Ruprecht, HBI MU

## Murdoch University is leading research into optimising the uptake, efficiency and sustainability of on-farm desalination in WA.

### Farm Scale Desalination

Researchers have assessed 31 farms sites across the WA Wheatbelt region to evaluate the technology, economics and systems, and options for the disposal of reverse osmosis (RO) reject water. They have explored factors such as reasons for using desalination, methods of application, as well as practical factors such as costs, operation and maintenance.

While the assessment is only, preliminary results have uncovered serval key findings:

- desalinated water is being used mainly for crop spraying, livestock, gardening, household use and feedlot demands.
- Disposal of reject water is mostly through reinjection, evaporation basins, surface water disposal and holding dams.
- Power sources for desalination ranged from grid, generator, solar or hybrid systems.

These findings reveal many opportunities for optimising the efficiency and sustainability of the process.

## Community Desalination

Desalination has also been implemented at a community scale to address the freshwater needs of communities in regional WA. Community desalination has three main objectives:

1. Focus on operation and maintenance costs, as well as reliability for two to three years continuous operation;
2. Determine the technical, economic and environmental viability for community uptake;
3. Engage Shires, agri-business, community, and surrounding stakeholders to build knowledge and local capability.

To date, four community desalination units have been installed in the south-west of WA. These are located in Merredin, Dumbleyung, Katanning and Wongutha/CAPS.

The **Merredin** system has produced over 6.9 ML, from January 2024 to May 2025 (17 months), producing on average around 95kL per week, depending on time of year. The desalination unit converts feed water of on average 20,000 mg/L TDS to a permeate salinity of below 100 mg/L TDS. Brine is disposed of in an evaporation basin.

The **Dumbleyung** system, production ranges from 4.7 to 10kL/day when operating from approximately 18,000 mg/L TDS feed water. Brine from this unit is also disposed via an evaporation basin.

The **Katanning** system is more efficient still, running at about 44% water recovery. It produces on average 24kL/day when operating from 9,000 mg/L TDS feed water. This system also disposes its brine via an evaporation basin.

The **Wongutha/CAPS** system is located near the Wongutha Christian Aboriginal Parent-Directed School and provides a consistent source of fresh water to the school community. This system is the most efficient, running at over 60% water recovery. It produces around 17 kL/day when operating from 6,400 mg/L TDS feed water. The desalination unit is powered by a solar system and the brine is disposed through a combination of saltbush irrigation and groundwater re-injection.

**Evaporation dam.**
**Photo** A/P John Ruprecht, HBI MU

## WaterSmart Farms Desalination Project *(cont.)*

### Reject Water Management

Additional research is underway which focuses on the rejected brine and what is currently being done to dispose of that water. The research has two main focuses, the first being the current situation and how the reject water is being disposed of, and the second will identify potential improvements to ensure the effects of the environment are kept to a minimum.

Currently, there are four main options for disposing of brine water:

1. Brine disposal — discharging to evaporation basins, dams, surface water systems or reinjecting to groundwater.
2. Brine minimisation — increasing overall system recovery and minimising the volume of brine requiring disposal.
3. Zero liquid discharge — reducing liquid discharge to zero.
4. Beneficial use of brine. Beneficial uses can include lithium extraction, metals mining, aquaculture (e.g., brine shrimp, algae, tilapia), and halophytes for animal feed, erosion control.

While evaporation dams are used for both community and on-farm desal, they have the greatest environmental footprint of all of the desal methods. More work can be done to increase the efficiency of desal systems, thereby reducing the overall volume of brine being produced. We are also working with researchers in lithium extraction and metals mining to investigate the practical use of brine in those processes. We look for forward to continuing this important research and sharing further results with scientific and agricultural communities.

For more information contact Professor John Ruprecht, **john.ruprecht@murdoch.edu.au**

This research supports the United Nations Sustainable Development Goals **6**, **9**, **11**, and **12**.

**FJH tech.**
**Photo** Jeff Fitlow, Rice University

# Flash Joule Heating technology brings new sustainable resource recovery opportunities

**The Harry Butler Institute is playing a central role in advancing Flash Joule Heating (FJH) technology to enable sustainable and eco-friendly metal recovery from both traditional ores and electronic waste. This cutting-edge method offers a transformative alternative to conventional extraction techniques by using intense, rapid electric pulses to release valuable metals without the use of toxic chemicals or high energy consumption.**

Centre for
**Terrestrial Ecosystem Science and Sustainability**

| | |
|---|---|
| **Focus** | Sustainable Resource Recovery |
| **Lead** | Prof Aleks Nikoloski |
| **Location** | Murdoch, WA |

In partnership with MTM Critical Metals, which holds exclusive global rights to FJH technology developed by Professor James Tour at Rice University, HBI researchers are working to optimise the technique for the recovery of critical metals such as rare earth elements, nickel, cobalt, and lithium. The collaboration has been formalised through a Memorandum of Understanding and aims to adapt the FJH process for use in Australian mining and urban recycling contexts. Notably, FJH uses between 80 to 500 times less energy than traditional smelting methods, produces results within seconds, and avoids the environmental hazards associated with chemical leaching or prolonged high-temperature processing.

HBI's extractive metallurgy team is refining the application of FJH to meet the unique challenges of local materials, including lithium-bearing spodumene from Western Australia and precious metals like gold, silver, and palladium from e-waste. In addition to recovering valuable resources, the technology also offers a solution for toxic metal removal. FJH can vaporise hazardous elements such as arsenic, mercury, and lead, rendering the remaining material safe for uses such as agriculture—lead levels in treated residue, for example, fall below 0.05 ppm.

A key focus of the project is its contribution to the circular economy. HBI is actively pursuing e-waste recycling as a solution to the global crisis of more than 60 million tonnes of discarded electronics generated each year. Urban mining pilot projects in Western Australia have already achieved promising gold recovery rates, with early tests showing yields of approximately 70 per cent.

Beyond technical research, HBI is also working to shape industry and policy outcomes. In collaboration with the Alcoa Foundation, the Institute is exploring how FJH might be applied to recover valuable metals from bauxite residue—commonly known as red mud—a major waste stream from aluminium production. This aligns with Western Australia's broader critical minerals strategy. HBI researchers are also engaging with the Department of Water and Environmental Regulation (DWER) and the Environmental Protection Authority (EPA) to develop regulatory frameworks that support the responsible adoption of FJH technologies.

**Looking ahead, the next phase includes scaling up the process for commercial deployment. A prototype FJH pilot plant is currently under testing in Western Australia.**

Research is also expanding into next-generation methods such as "Flash-within-Flash" (FWF) Joule Heating, a technique being developed at Rice University that enables the production of high-purity solid-state materials.

The Murdoch-MTM partnership positions Western Australia at the forefront of sustainable resource recovery. As global demand for critical minerals grows and pressure mounts to reduce the environmental footprint of mining, Flash Joule Heating offers a breakthrough technology. With HBI's leadership, this innovation has the potential to unlock untapped value in e-waste and mining tailings while delivering significant environmental and economic benefits.

This research supports the United Nations Sustainable Development Goals **11**, **12** and **17**.