

Centre for Policy Futures



Research Showcase

July 2, 2026

The **Queensland Decarbonisation Hub** is funded by the Queensland Government and partnered with Queensland's leading universities.



Acknowledgement of Country

The University of Queensland (UQ) acknowledges the Traditional Owners and their custodianship of the lands on which we meet.

We pay our respects to their Ancestors and their descendants, who continue cultural and spiritual connections to Country.

We recognise their valuable contributions to Australian and global society.

*The Brisbane River pattern from A Guidance Through Time
by Casey Coolwell and Kyra Mancktelow.*





Welcome and Opening Notes

Professor Greg Marston, Centre for Policy Futures

Dr Liz Fellows, Queensland Treasury

Dr Liz Young, Queensland Decarbonisation Hub



Session 1: Regional Dimensions of Queensland's Energy Transition

Chair: Dr Sarah McInnes, UQ

Presenters:

Dr Jeremy De Valck, CQU

Professor John Rolfe, CQU



Transitioning to Net Zero: Exploring Preferences and Regional Strategies for Decarbonisation in QLD

Dr. Jeremy De Valck (CQU)

Project Team: Hurriyet Babacan (JCU/CQU), Minh Ngoc Nguyen (CQU), John Rolfe (CQU), Jennifer McHugh (JCU), Lainie Poon (RDA Tropical North), Allan Dale (JCU)

Brisbane, 2 July 2026

Context: QLD's Energy Transition

- Most of Queensland's energy transition is taking place in **regional areas**, where lots of people currently work in industries related to fossil energies.
- **Workforce specialisation and local context differ across regions**, meaning that the transition might be felt differently. But how differently?
- We explore the likely impacts of the transition on **regional communities** especially, i.e.:
 - how people view the changes?
 - what support do they need in priority?
 - what energy policies do they prefer?
 - how to ensure a smooth transition?
- By **listening to regional voices**, this work aimed to help ensure that future decisions are fairer, better-informed, and supported by long-term social licence within local communities.



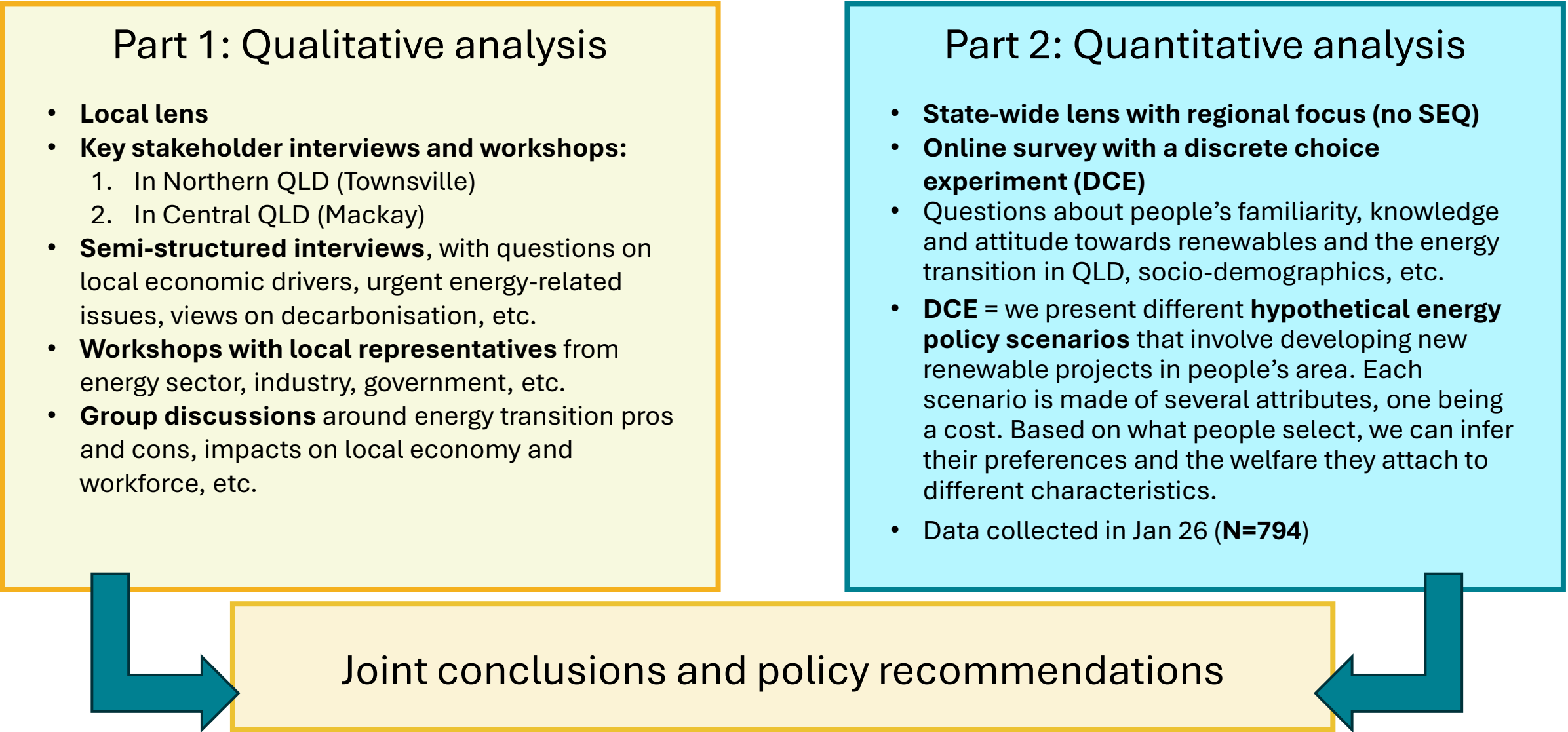
Data & Methods

Part 1: Qualitative analysis

- **Local lens**
- **Key stakeholder interviews and workshops:**
 1. In Northern QLD (Townsville)
 2. In Central QLD (Mackay)
- **Semi-structured interviews**, with questions on local economic drivers, urgent energy-related issues, views on decarbonisation, etc.
- **Workshops with local representatives** from energy sector, industry, government, etc.
- **Group discussions** around energy transition pros and cons, impacts on local economy and workforce, etc.

Part 2: Quantitative analysis

- **State-wide lens with regional focus (no SEQ)**
- **Online survey with a discrete choice experiment (DCE)**
- Questions about people's familiarity, knowledge and attitude towards renewables and the energy transition in QLD, socio-demographics, etc.
- **DCE** = we present different **hypothetical energy policy scenarios** that involve developing new renewable projects in people's area. Each scenario is made of several attributes, one being a cost. Based on what people select, we can infer their preferences and the welfare they attach to different characteristics.
- Data collected in Jan 26 (**N=794**)



Joint conclusions and policy recommendations

DCE Choice set: Example

Attributes	Solar energy expansion	Wind energy expansion	Mixed (solar/wind) expansion	OPT-OUT (no change)
Visual impact	No direct impact	 Substantial	 Moderate	No direct impact
New regional jobs within next 5 years (during construction & when in operation)	 Moderate +200/year (construction) +10/year (ongoing)	 Moderate +200/year (construction) +10/year (ongoing)	 Low <50/year (construction) +5/year (ongoing)	No significant change
Percentage of renewable energy consumed in region	 60% (+30%/year)	 No increase (currently 30%/year)	 50% (+20%/year)	 No increase (currently 30%/year)
Local community support	 High (>75%)	 Minimal (0-25%)	 Moderate (51-75%)	 Minimal (0-25%)
Fixed power bill increase (\$/household each quarter over 5 years)	\$100	\$5	\$25	\$0
Tick your preferred option:	☐	☐	☐	☐

Key insights: Interviews & workshops

1. The energy transition must deliver tangible regional benefits.

- Affordable and reliable energy is a top priority.
- Communities expect the transition to build on existing regional strengths to create local job opportunities.

2. Priorities differ between regions and stakeholder groups.

- Coal workers and associated industries show stronger resistance, especially in Central QLD.
- Northern QLD community members are generally supportive, but most households are worried about labour displacement and cost-of-living pressures.
- Traditional Owners are supportive if they feel their values are respected and the transition might visibly benefit them.

3. Workforce readiness is both a challenge and an opportunity.

- Skills shortages and labour retention across construction and operational phases of the transition remain key risks.
- But numerous conversion pathways towards emerging industries (e.g., critical minerals, SAFs, advanced manufacturing).

4. Social licence must be earned.

- Early engagement and transparent communication with local communities are essential to gaining and maintaining trust.

Key insights: Online Survey

- **Very positive feedback overall**
- Respondents seem to have a **good understanding** of the pros and cons of renewables.
- Many respondents **fear energy cost will rise**.
- Most respondents supported renewable energy, with **solar** a popular technology and wind attracting some concerns.
- Some felt that **other options** (e.g., hydrogen, nuclear) were not sufficiently considered.
- ~35% were opposed to at least one renewable energy solution.

Key insights: Choice Experiment

- **Preference heterogeneity:** 3 market segments: 1. “Supporters”: 61% of respondents would tolerate an increase in their energy bill to support decarbonisation. 2. “Opponents”: 30% of respondents are against it and would need to be compensated. 3. A third market segment (9%) had “Mixed views”.
- **Community support is key:** Most respondents feel that local communities are not sufficiently considered when developing new projects → common perception from both “Supporters” and “Opponents” to new renewable energy projects. Deserves great attention from policy-makers.
- **Net job creation is a unifying topic:** with both “Supporters” and “Opponents” preferring to see new employment opportunities in the regions. In practice, it is unsure if the energy transition will be able to result in net job creation in the long run, so it is essential that policy-makers collaborate with the industry to design transition pathways that minimise job losses.

Key policy implications

1. Secure local jobs

- Focus on **workforce continuity** (not ideology).
- **Build on existing regional skills** through partnerships with industry, unions and training providers.

2. Deliver early economic benefits

- Keep energy **affordable** and demonstrate tangible **local benefits**.
- Be transparent about costs and trade-offs to build trust.

3. Tailor the transition to regional needs

- Adopt **place-based strategies** that reflect local priorities.
- **Invest in regional industries, skills and infrastructure** to ensure communities benefit from the transition.



Who can use these findings?

- **QLD Government**
- **Local governments**
- **Industry bodies and resources sector employers**
- **Unions**
- **Renewable energy proponents**
- **TAFE/Training providers**



Scientific evidence for all departments delivering the transition in the regions.

To position themselves as credible advocates for their communities in transition negotiations.

- To better understand what their workers truly expect from that process.

- To understand the trade-offs their members are willing to accept when designing transition pathways.

To not underestimate the social licence challenge.

To know about the skills needed to ensure workforce continuity in the regions.

Where to from here?

- **Build the transition with communities, not around them**
 - Moving beyond consultation towards genuine partnerships and place-based decision-making.
- **Invest in people as much as infrastructure**
 - Support workforce transition through skills development, local employment and coordinated project delivery.
- **Share the benefits locally**
 - Ensure regional communities see tangible gains through affordable energy, local investment and fair benefit-sharing.
- **Keep learning as the transition unfolds**
 - Track how community attitudes evolve over time to inform adaptive, evidence-based policy.

The long-term success of Queensland's energy transition will depend not only on the infrastructure we deliver, but on the trust we build with regional communities.

Thank you very much for your attention!

Contact: j.devalck@cqu.edu.au

THEME 1 Project 1: Analysing workforce implications of renewable energy projects in regional Queensland

Professor John Rolfe & Dr Kalpana Pudasaini



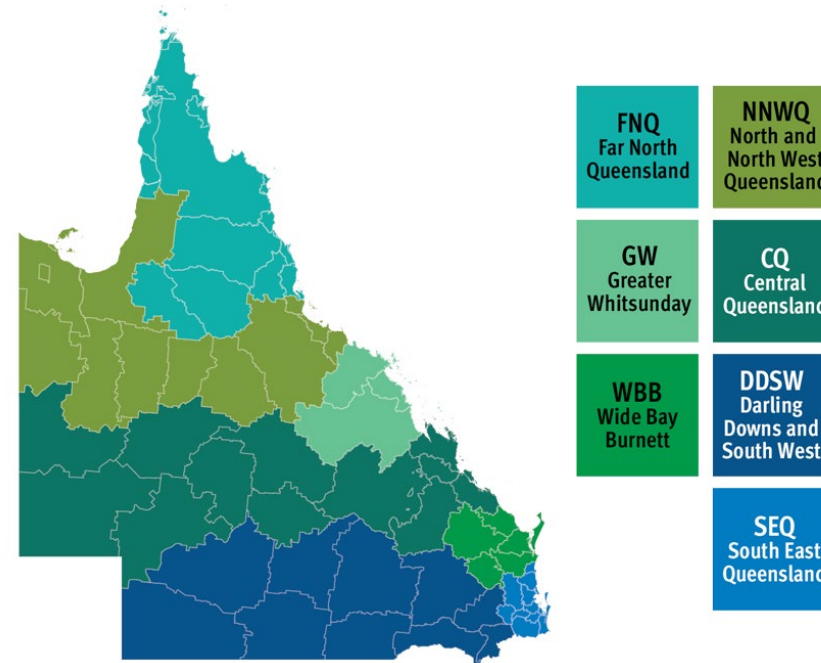
BE WHAT **YOU** WANT TO BE
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The issues being addressed

- Some big challenges relating to workforce during the transition towards decarbonisation in Qld:
 - What are the workforce implications in regions?
 - What will be the demand for local workers / skilled workers?
 - Are the workforce implications similar across wind and major solar (utility-scale solar) projects?
 - Where will projects be located?

What we did

1. Identified all the major solar and wind projects by region in Queensland,
 - including those that are completed, under construction or being planned.
2. Assembled the construction and operational workforce requirements for the projects
 - from available planning and approval documents
 - Identified project and workforce status at the 31st of March 2025
3. Regression analysis used to identify relationships
 - between the generating capacity of each project and the construction and operational workforce requirements, together with other factors.



Projects identified from two sources: Queensland Government Electricity generation Map & Renew Map platform



Potential growth of solar and wind energy sector in QLD

Previous QLD Govt target - produce 25,000 MW of energy from large scale wind and solar farm by 2035

- 2,882 MW from existing wind and grid solar farms (as of June 2022)
- 12, 200 MW from new wind generation
- 10,000 MW from new large scale solar farms
- These sectors may be major area of job growth in renewable energy sector

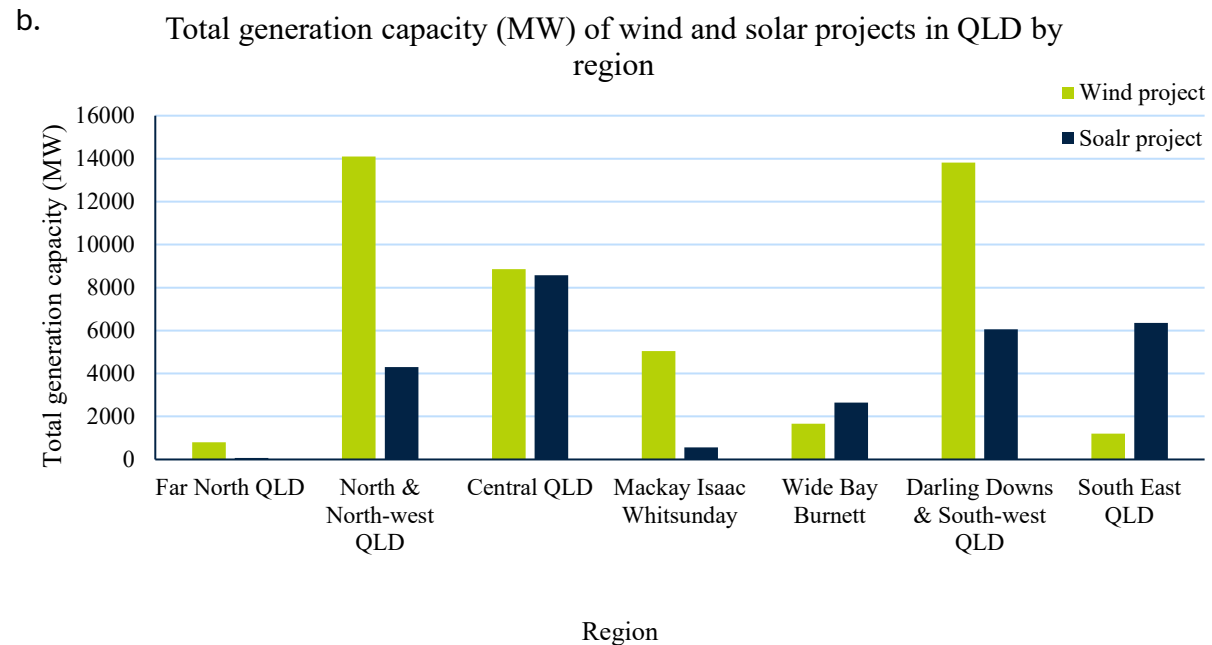
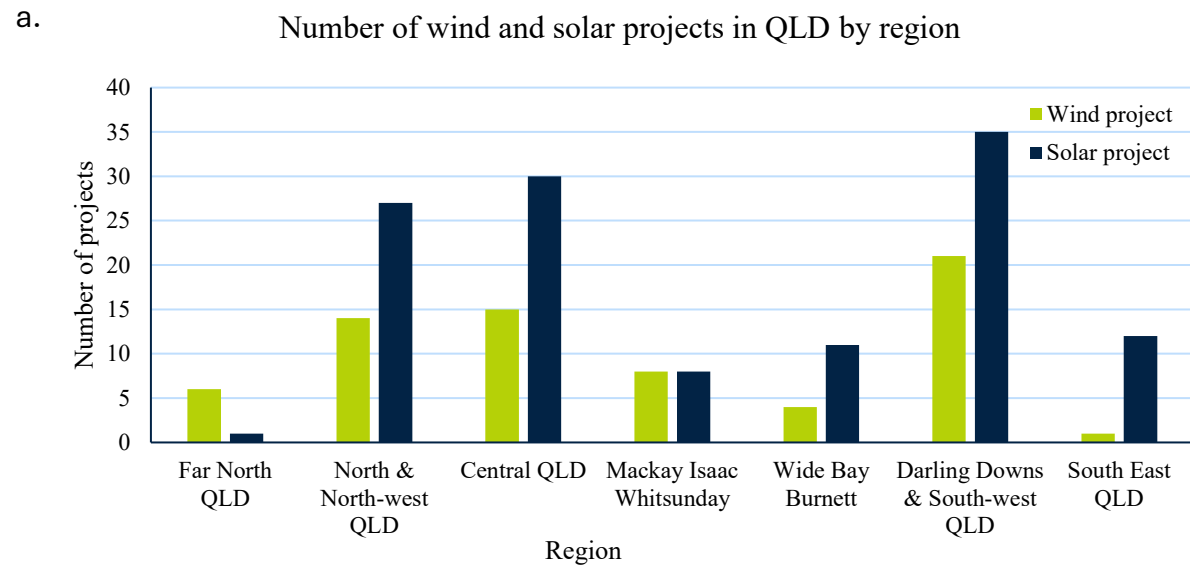
Coal and gas stations

- Currently produces 11,600 MW



Overview

- The full dataset included 69 wind projects and 124 large-scale solar projects
- But details on workforce requirements are missing for nearly half of projects



Results by project status

Total capacity if
everything was built
would be approximately:

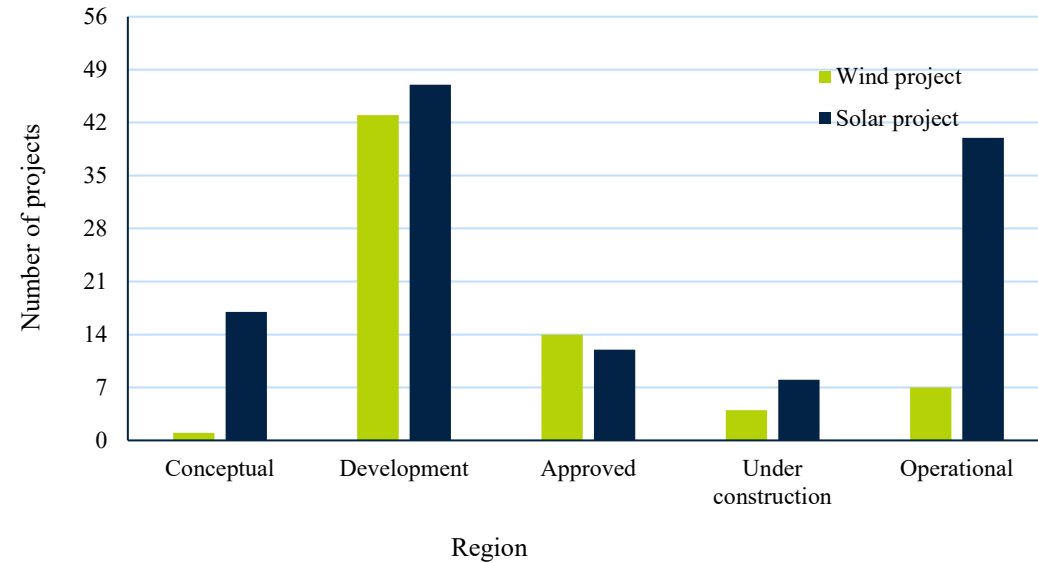
Solar 28,000GW

Wind 45,000GW

Not all projects will
proceed!

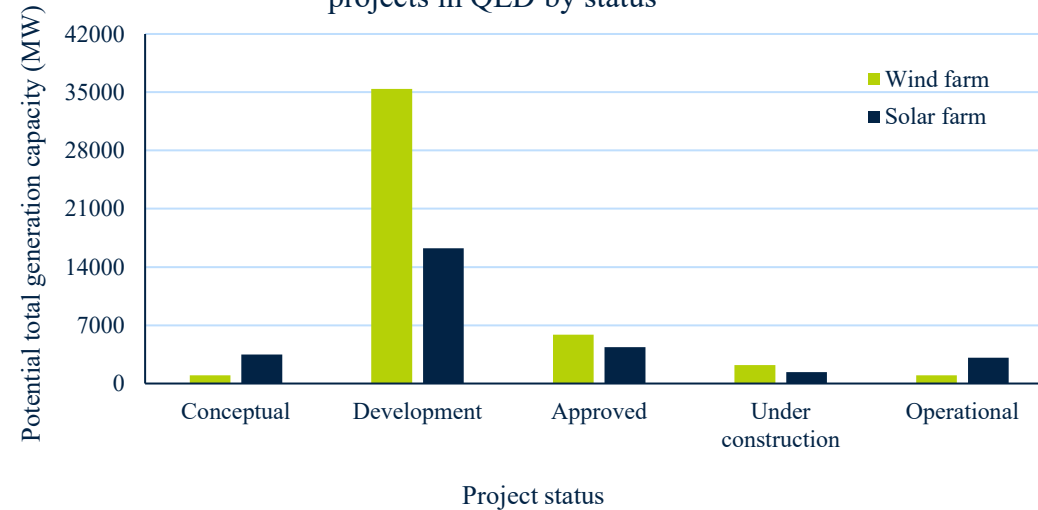
a.

Number of wind and solar projects in QLD by status



b.

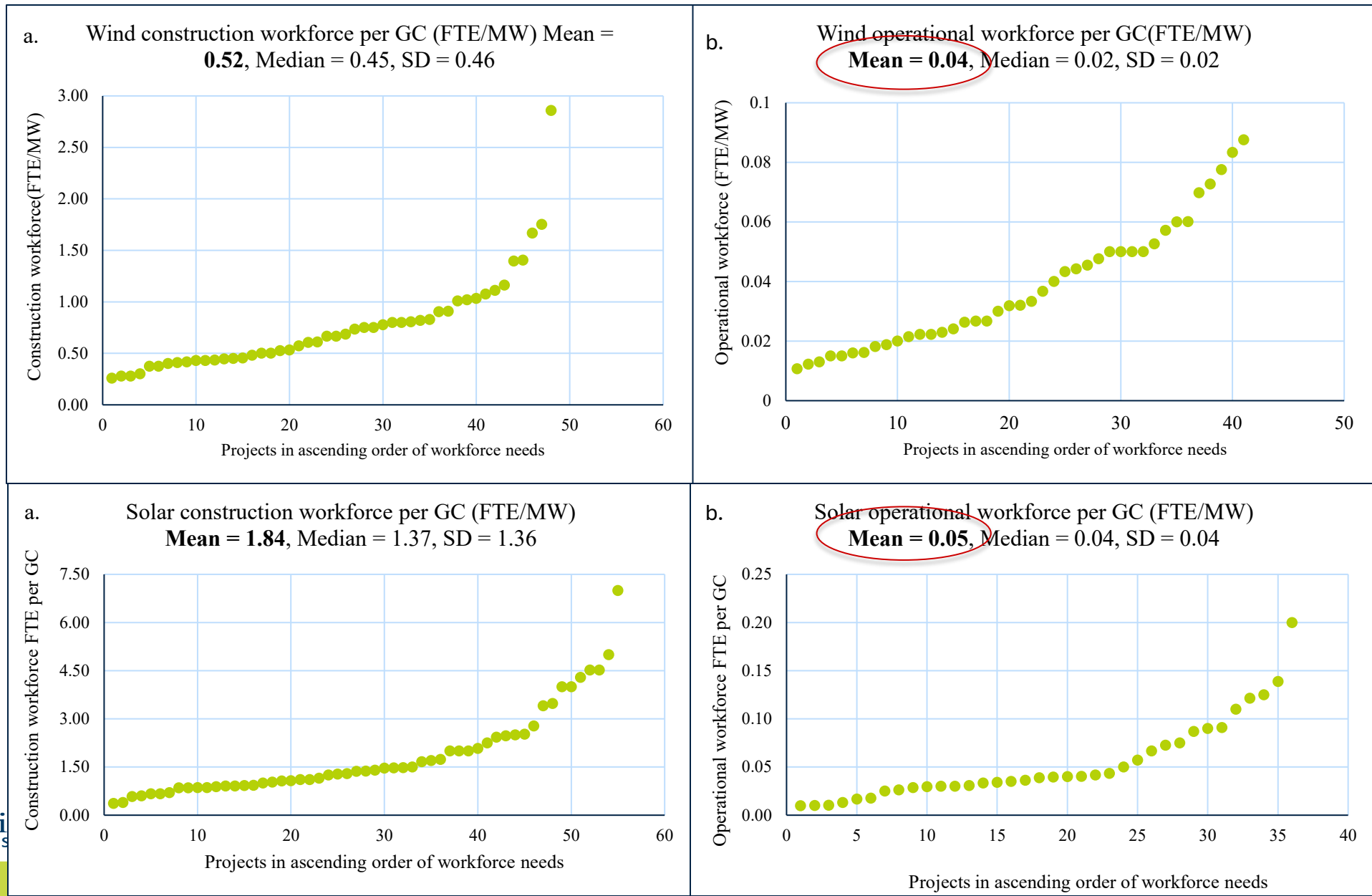
Potential total generation capacity (MW) of wind and solar projects in QLD by status



University
ALIA

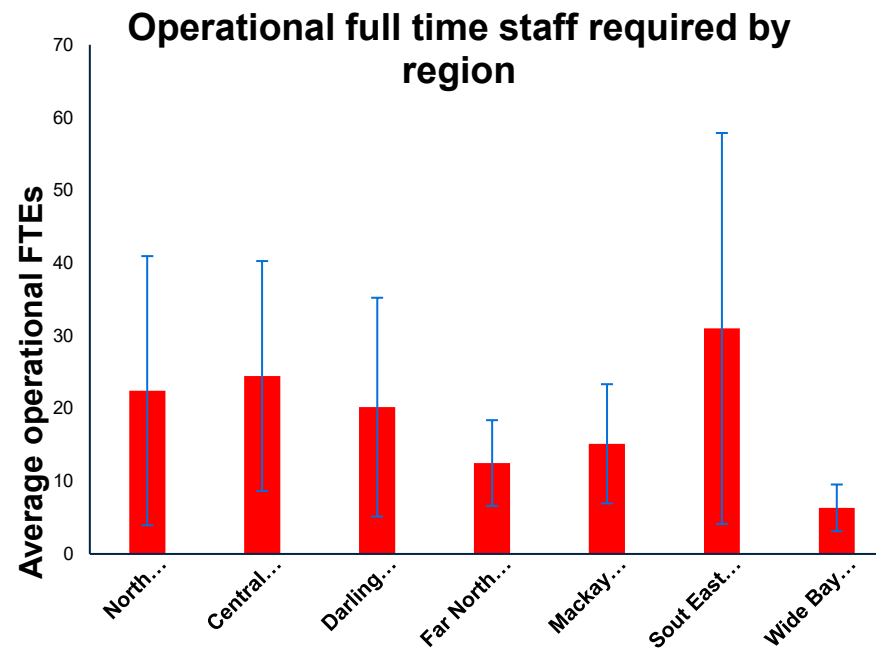
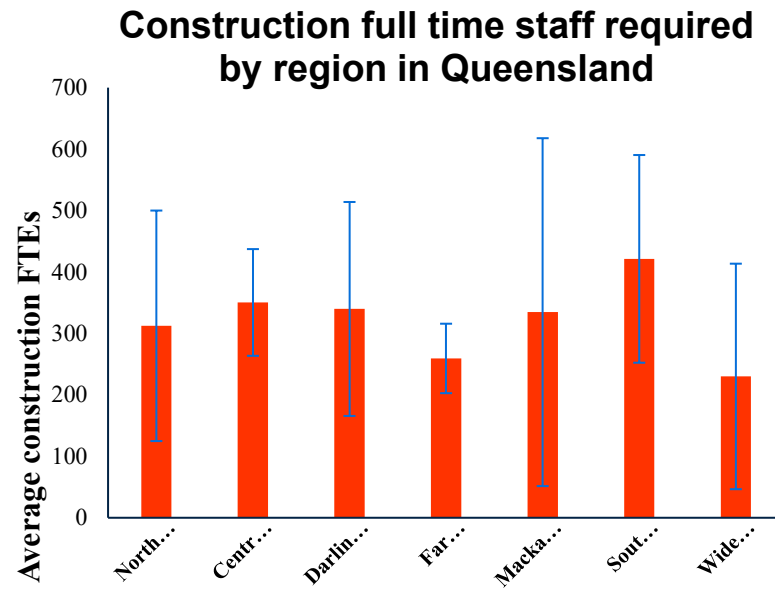
WANT TO BE
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Average workforce requirements per generating capacity



Results contd.

Are workforce requirements similar across regional areas in Queensland?

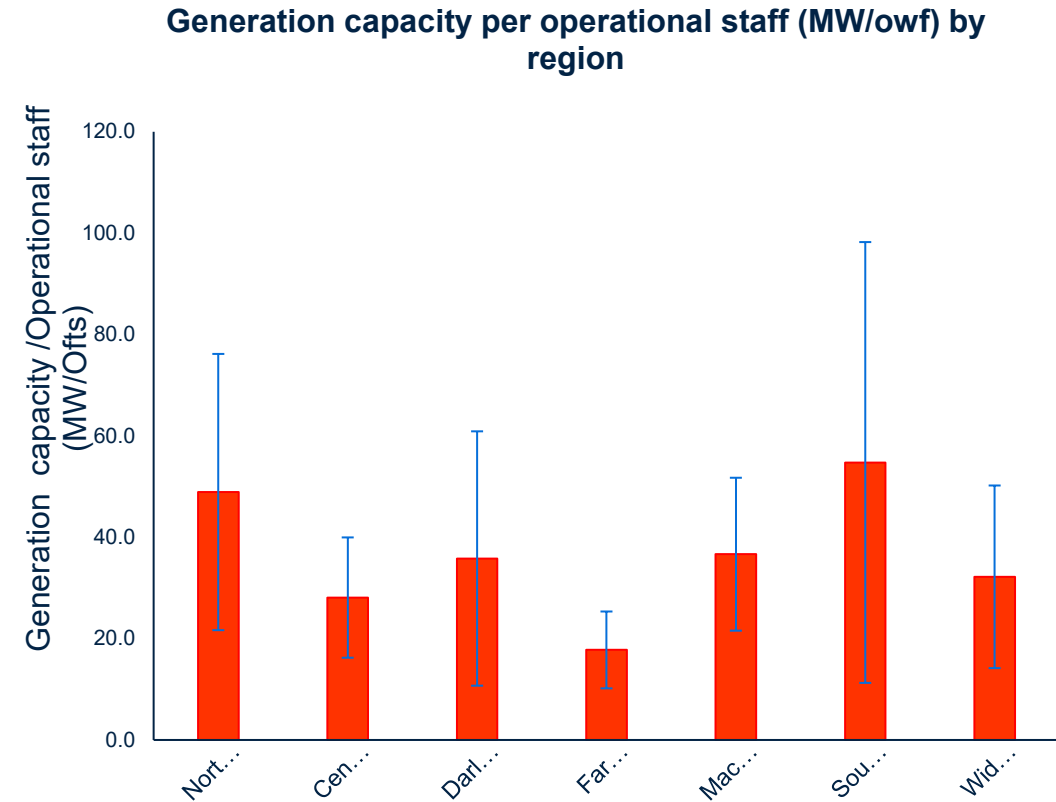
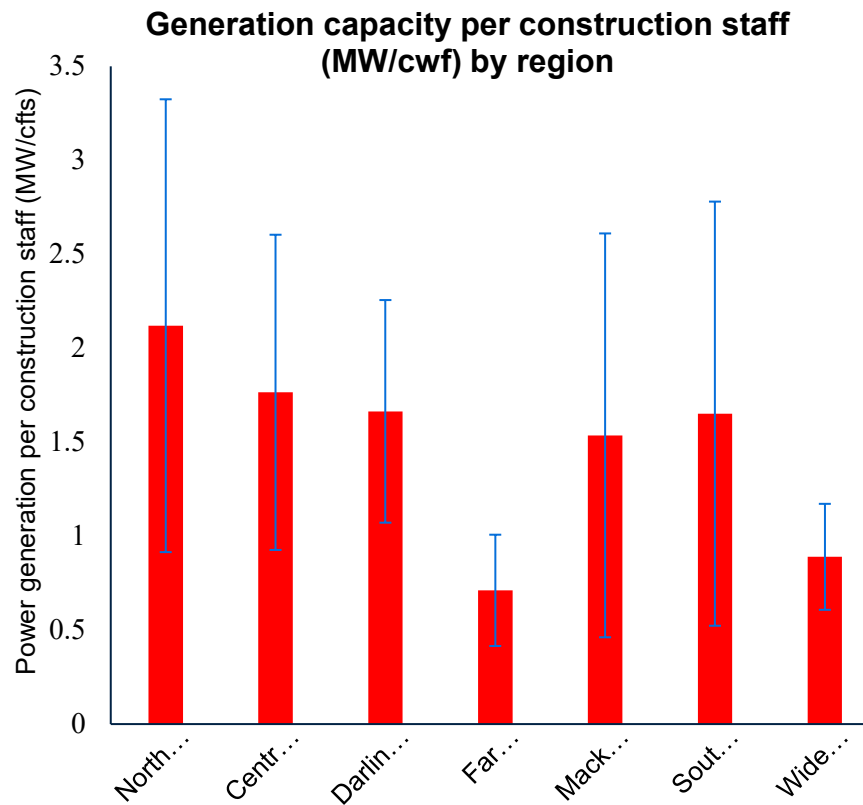


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RALIA

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Results contd.

Does generation capacity per construction and operational workforce vary across regions?



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Key outcomes and messages

- Data on employment is missing for roughly 50% of projects
 - Makes it very difficult to identify impacts on regions where projects will be situated
 - Suggests that many companies are not engaging well with regional communities
- We found that project scale (MW of capacity) is the key explanator of employment effects – with the relationship stronger for wind than utility-scale solar
 - Workforce requirements for construction per unit of generation capacity (MW) are more than double for solar than wind
 - But this may be an artifice of missing data about length of construction employment
 - But operational workforce requirements are similar at **0.05** and **0.04** units per MW of capacity between utility-scale solar and wind respectively.
 - Although requirements are much more variable than in coal generation
- We could not find any statistical differences in employment effects by regions in Qld or project status
 - Employment predictions are quite transferable across Qld
 - Employment factors seem to stable over time (project status)

Thank you





Session 2: Designing Renewable Systems for Environmental Sustainability

Chair: Professor Felicity Deane, QUT

Presenters:

Dr Adland Pradana, Griffith University

Distinguished Professor Lin Schwarzkopf, JCU



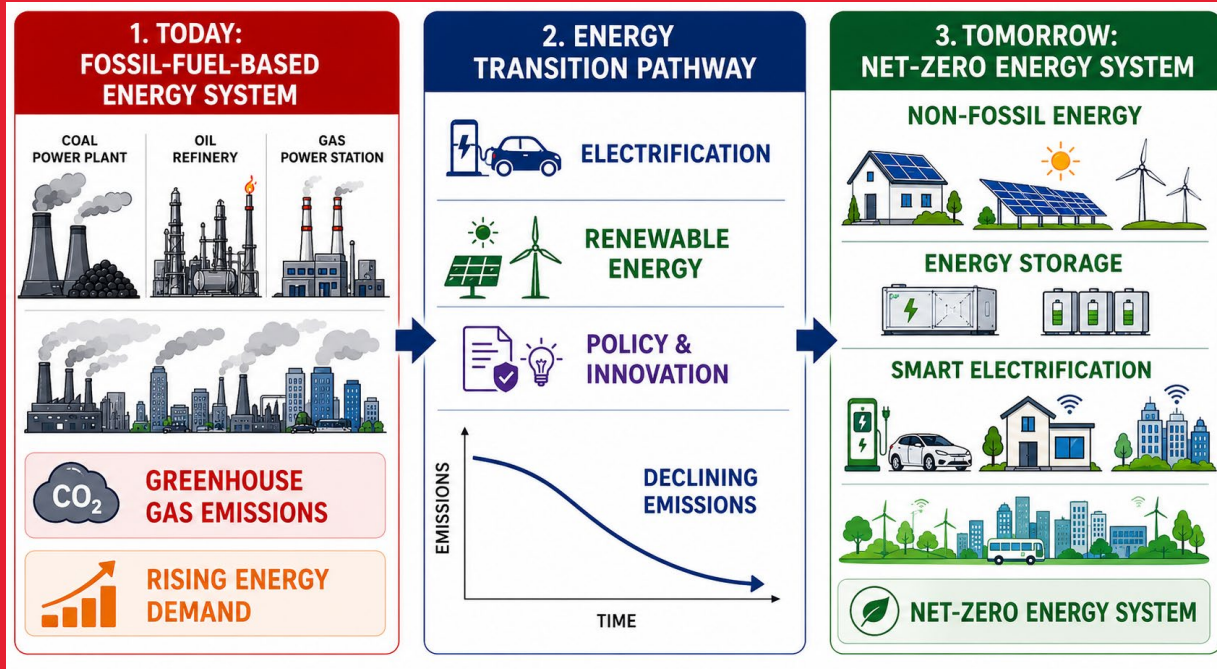
How Net-Zero Microgrids Could Support Queensland's Future Electricity System

Prof. Fuwen Yang

Dr. Moh Sanjari

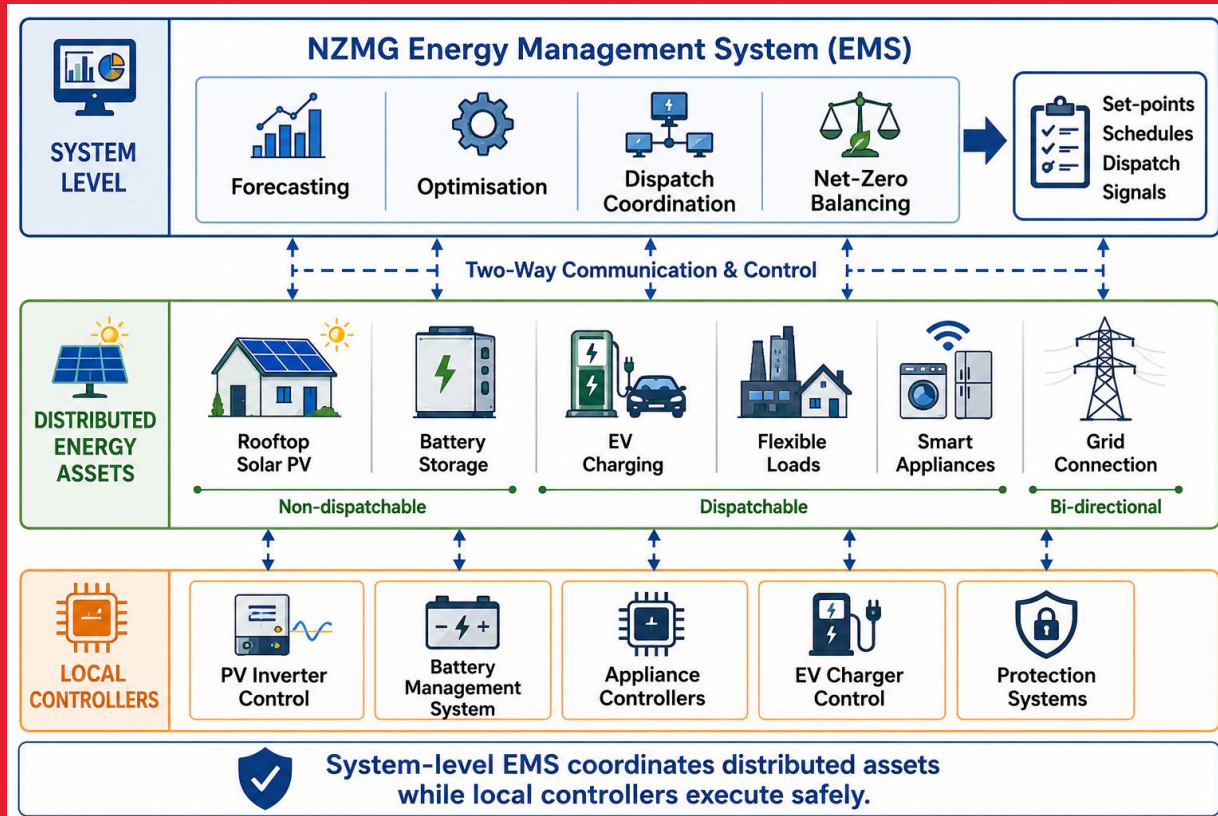
Dr. Adland Pradana

Why this research matters



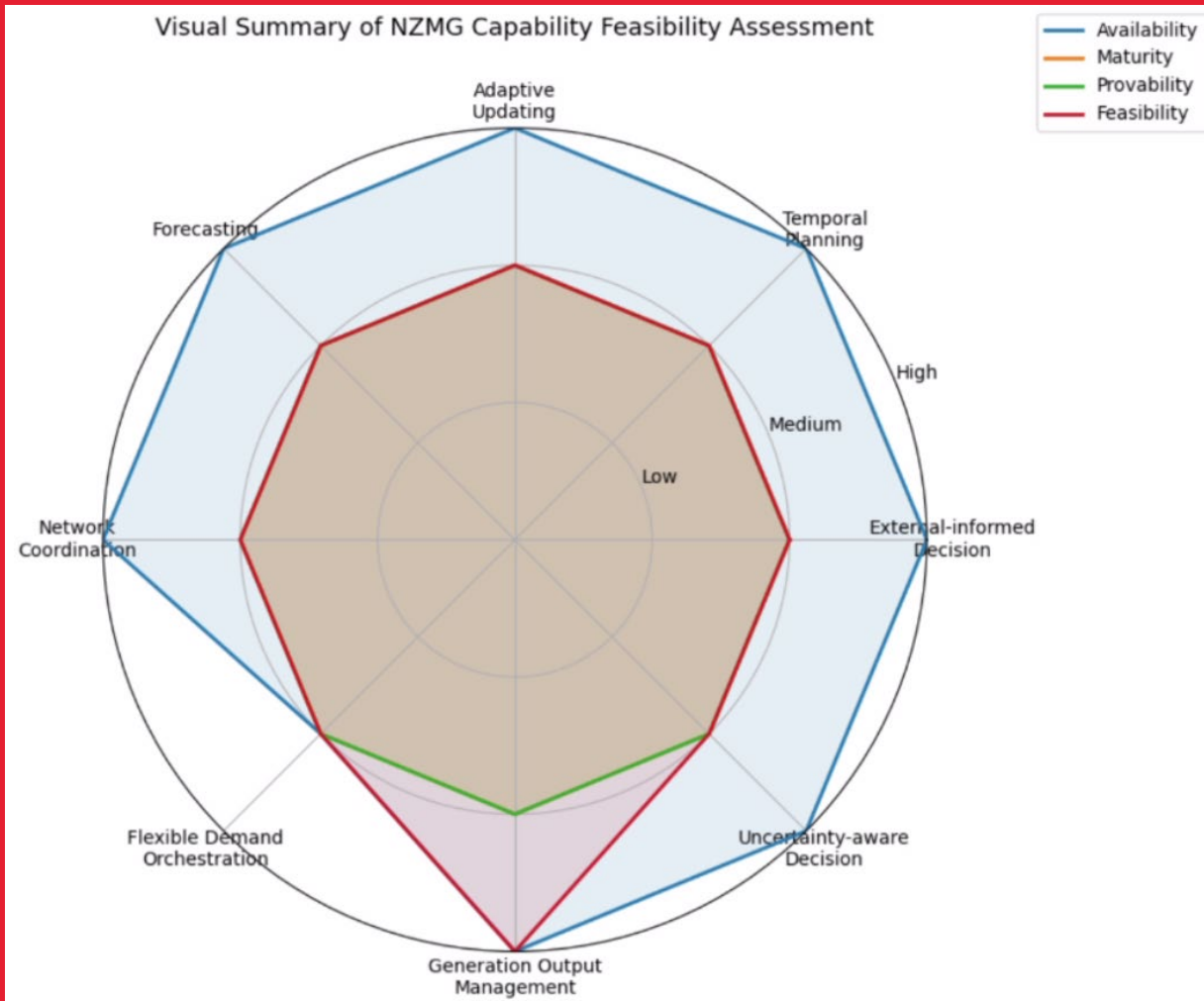
- Rapid growth of rooftop solar
- Renewable variability creates challenges
- Grids are not designed renewable
- NZMGs enable local coordination
- NZMGs improve resilience, flexibility, and integration

Key Findings



- Forecast-informed energy management can maintain net-zero over time
- Networked microgrids improve flexibility
- Uncertainty-aware control improves reliability
- Main challenge is coordination and control rather than hardware

Why the findings matter in practice



- Local coordination reduce pressure on networks
- NZMGs support renewable penetration and energy resilience
- Technologies are already available
- Pilot-scale validation is important
- Operational integration and regulatory support are key next steps

Who should pay attention

- Queensland Government and energy policymakers
- Distribution network service providers (DNSPs)
- Energy industry and technology providers
- Regional councils and community energy organizations
- Researchers and universities.

What could happen next

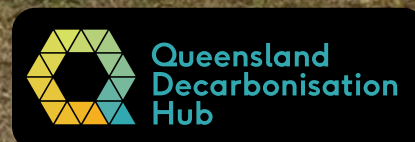
- Pilot projects
- Regulatory sandboxes
- Industry-government collaboration
- Real-world validation

Points to note

- Simulation-based
- Feasibility-focused
- Further validation required

An Outstanding Opportunity: Using Solar Farms for Biodiversity

Sebastian Hoefer, Eric Nordberg, Myles Menz, Lin Schwarzkopf



Co-authors



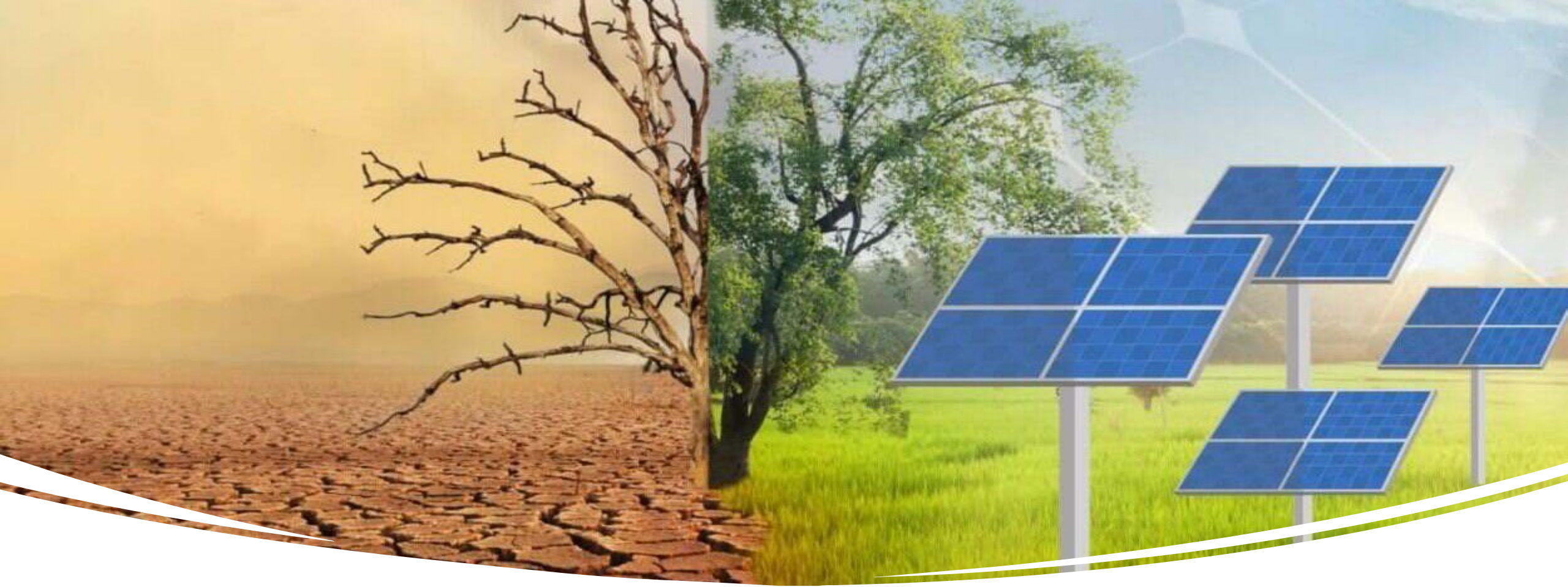
Eric Nordberg



Myles Menz



Sebastian Hoefer



Renewable energy is required to mitigate impacts of climate change

We will need to decarbonise to avoid the worst impacts of climate change



Queensland is leading Australia's solar revolution

- 50 operating large-scale solar farms
- More than 130 in the pipeline for development



Protest near Bundaberg

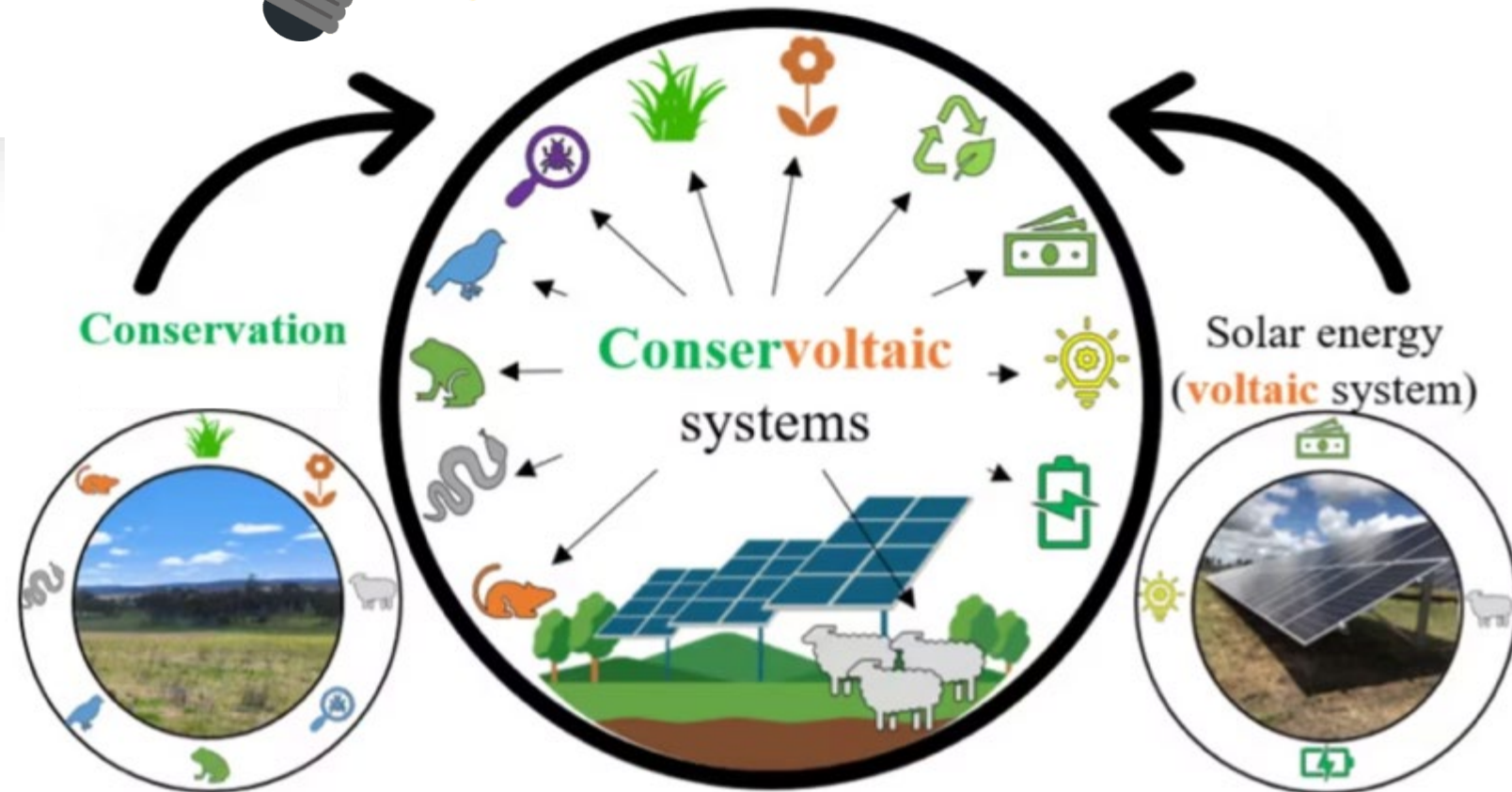
Not everyone is
thrilled about
this

- **Agricultural Displacement:** encroaching on grazing land, concerns about "trading food for energy"
- **Indigenous and Community Rights:** overlap with traditional indigenous lands leading to displacement disputes
- **Ecological:** alter natural landscapes affecting local biodiversity services and property values

We could make solar farms multi-use!



- Agrivoltaics – combine farming and solar farms
- “Conservoltaics”





Conservoltaics

Can we support biodiversity on solar farms?

May mitigate some community concerns



What kind of biodiversity do
solar farms support?

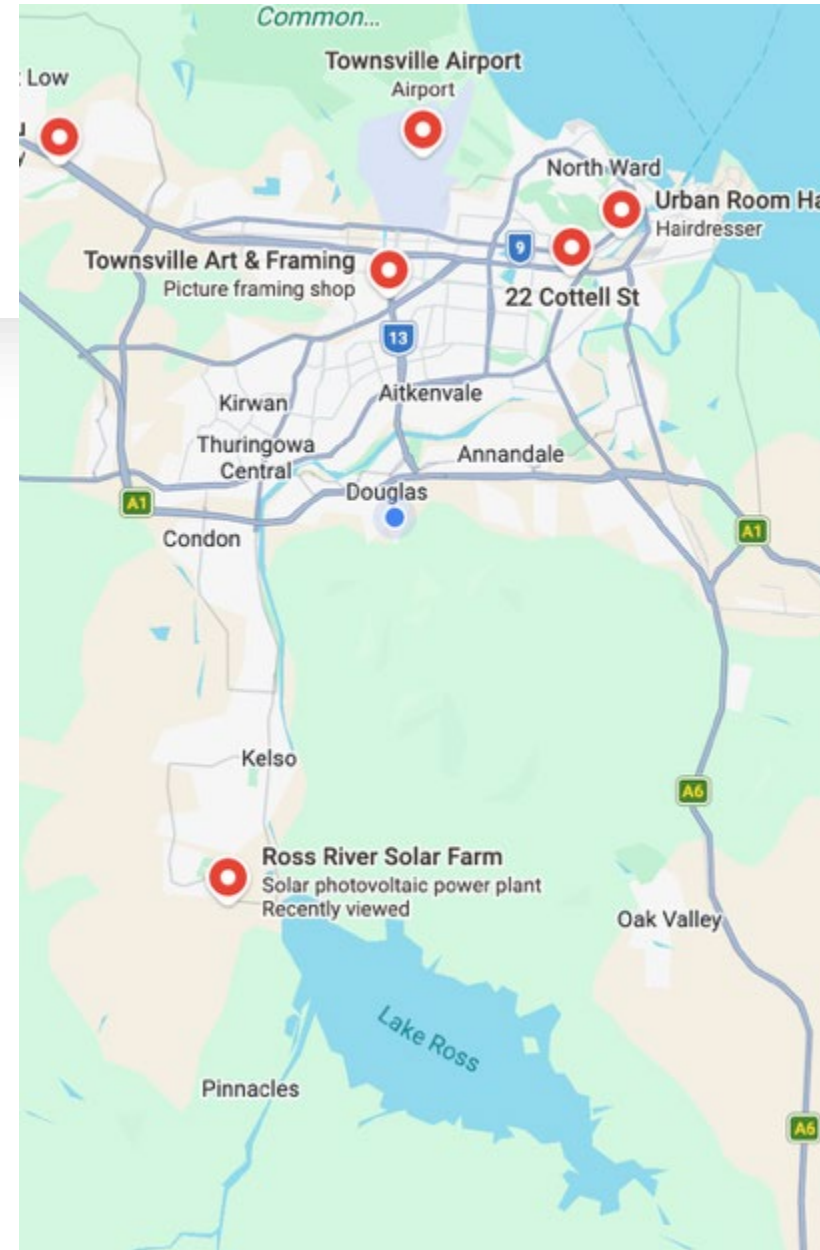
New question for Australia

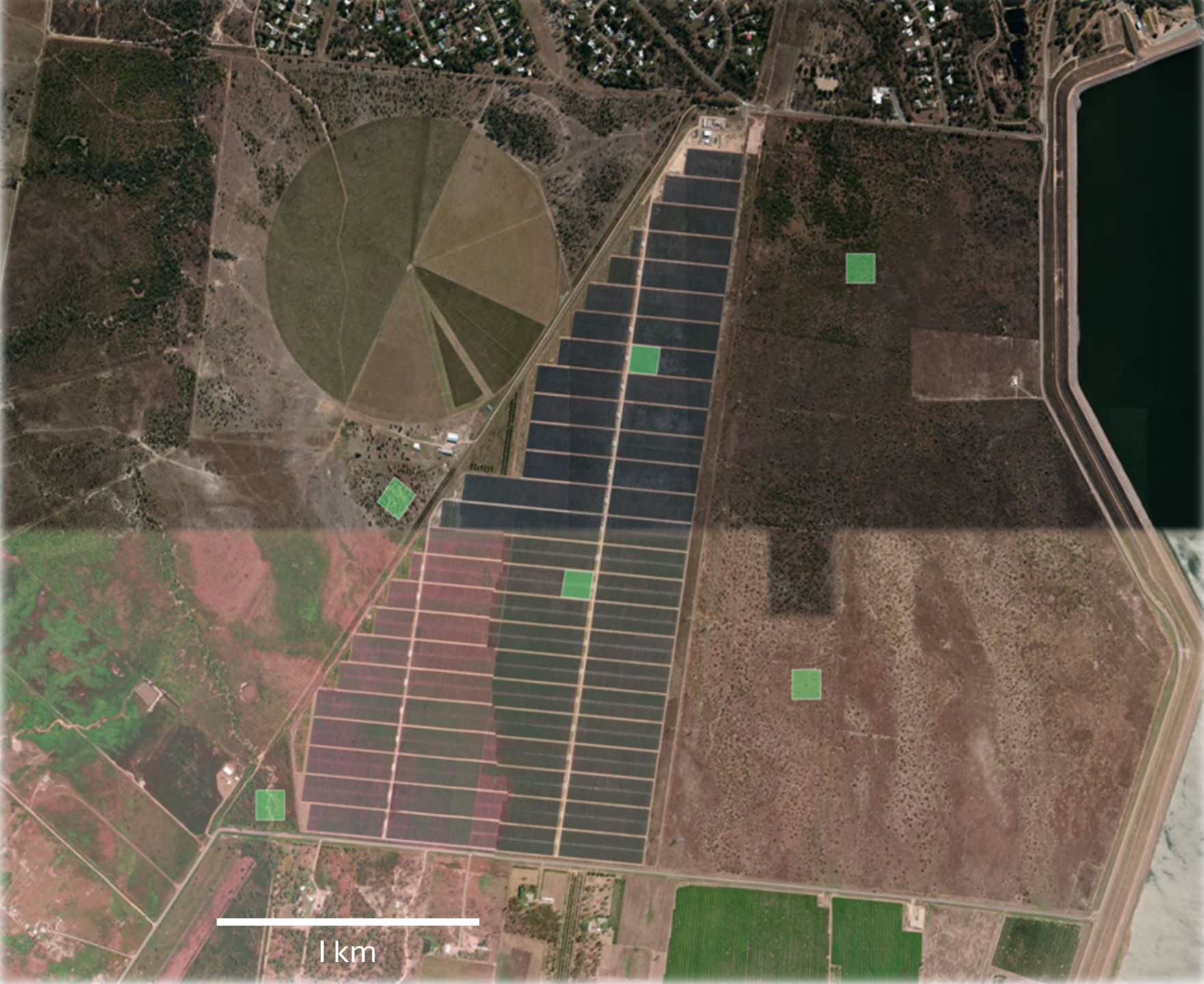


Ross River Solar Farm



ROSS RIVER
SOLAR FARM





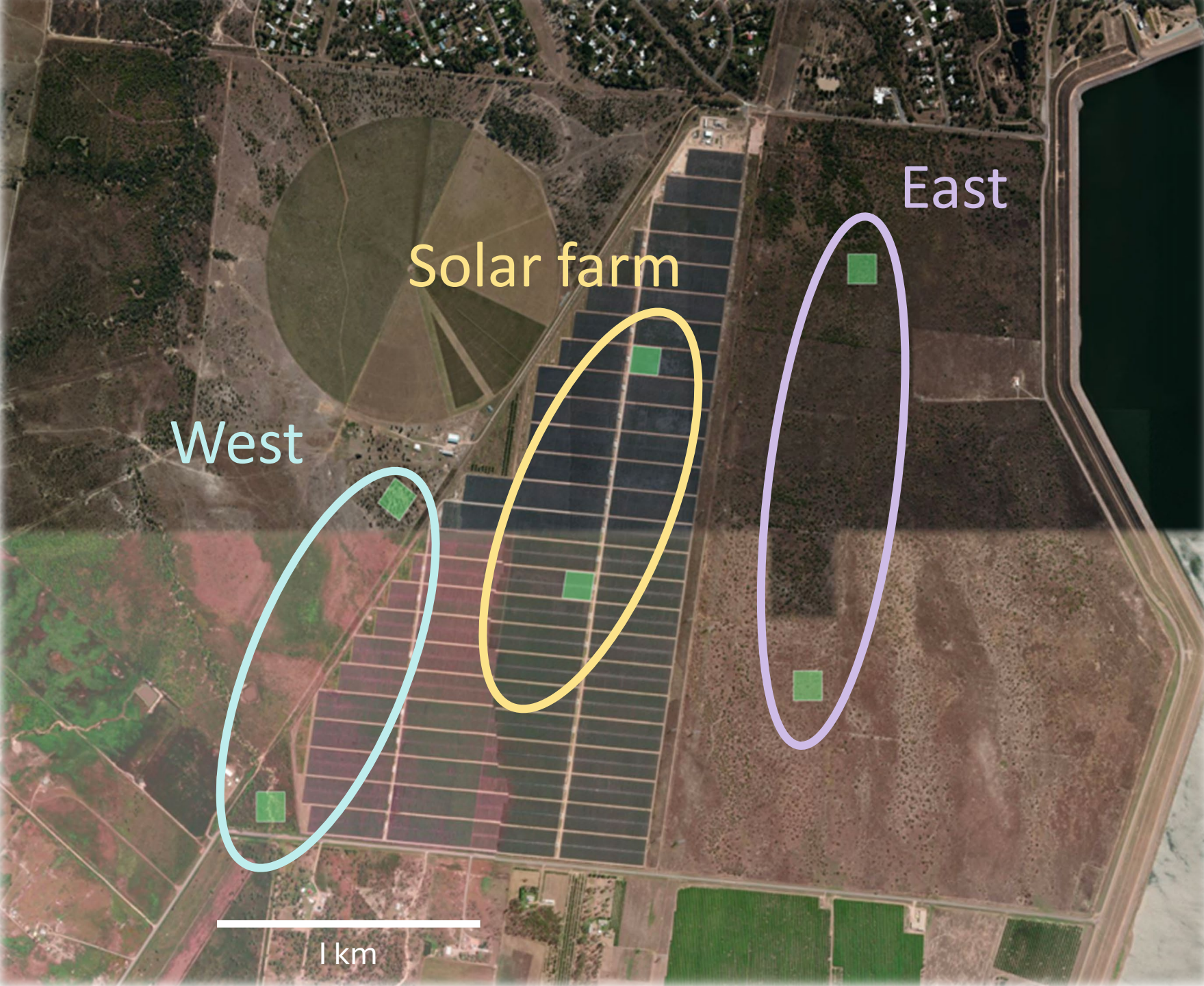
RRSF:

- 2016
- typical of brownfield solar farm
- Disused mango farm
- 202 ha

400,000 panels

148 MW

54,000 homes



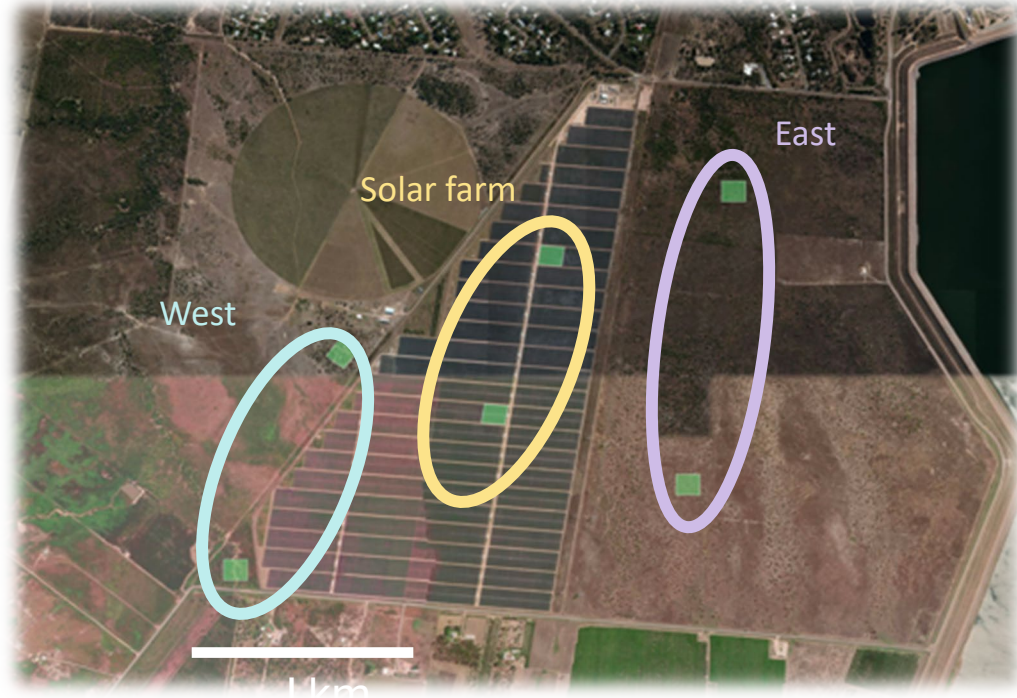
Compared 3 sites
East and West
were peri-urban
areas

Solar farm in the
middle

Western site = Grazed Farmland



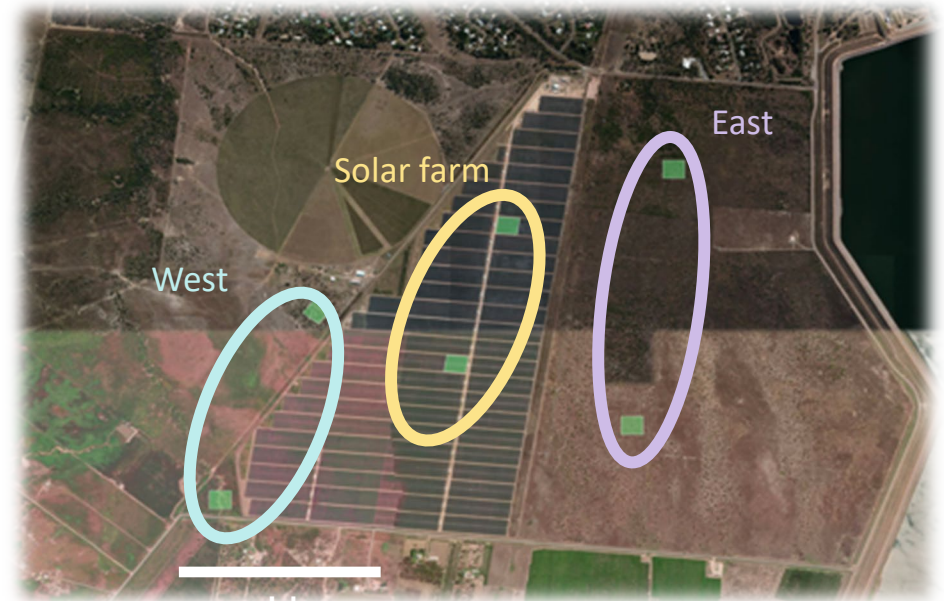
- Cattle grazing
- Remnant native vegetation with mature native trees
- Some weeds and Chinee apple (shrub)



Centre site = Solar farm



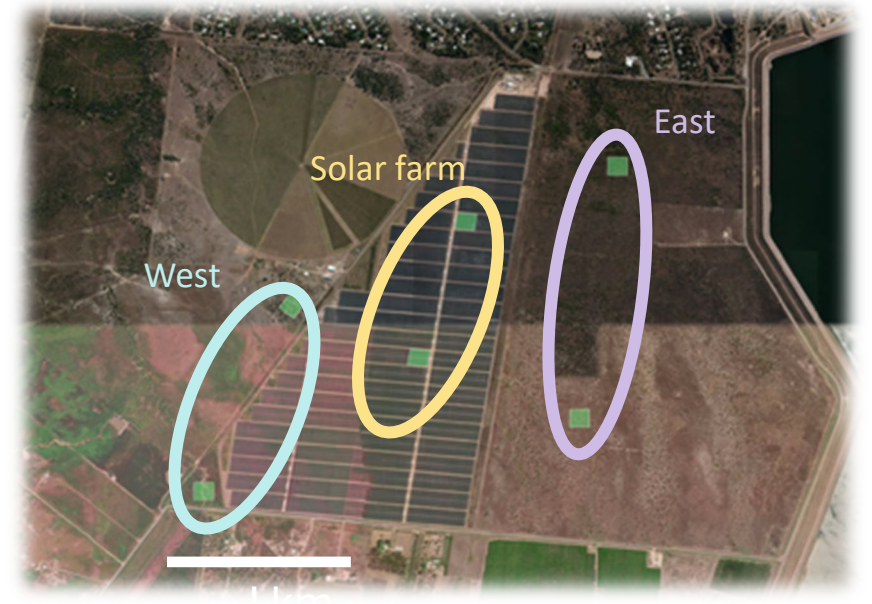
- Dominated by solar panel infrastructure
- Grasses and weeds below panels
- No mature native trees and little native vegetation

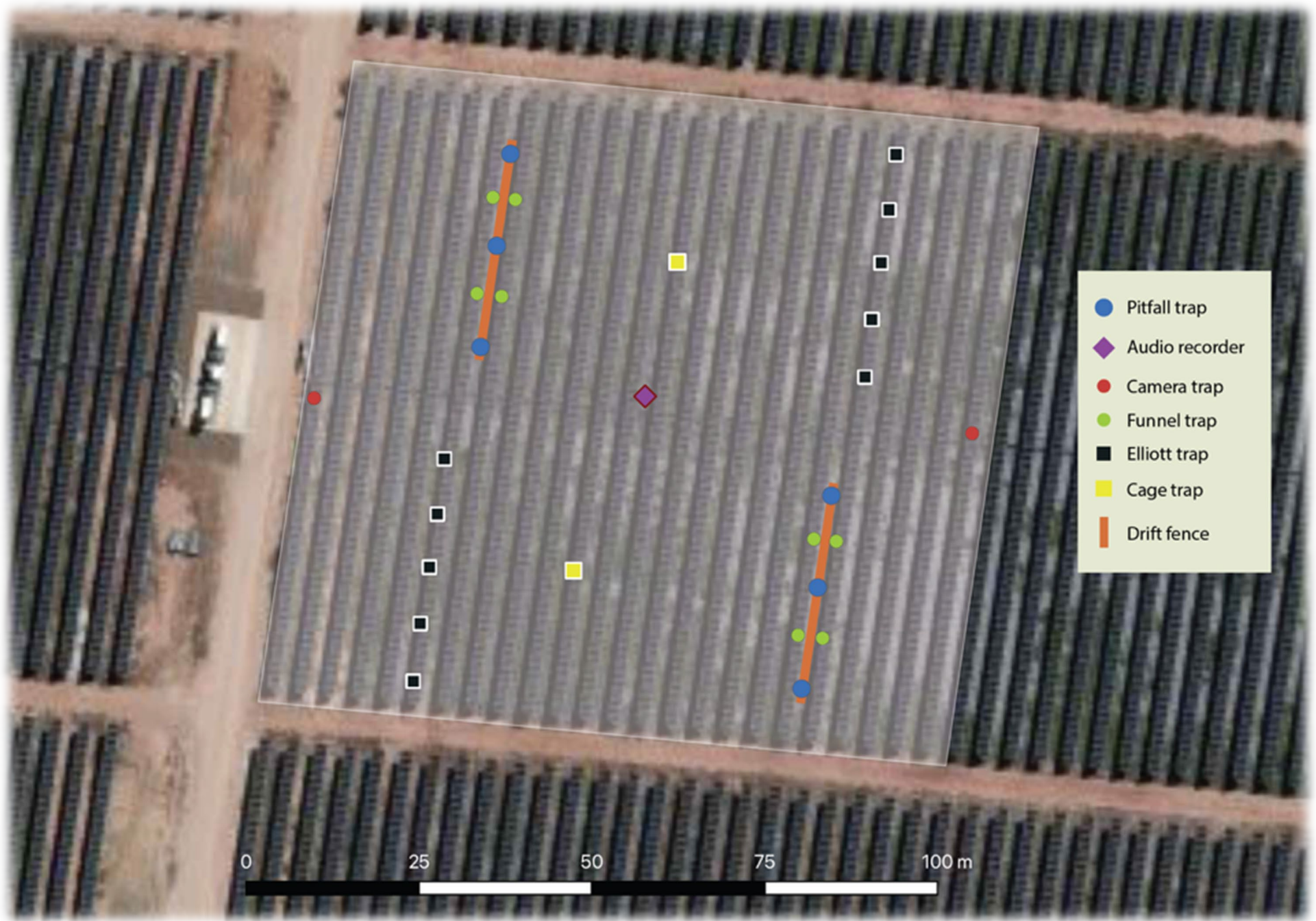


Eastern site = cleared easement



- Cleared for power lines
- Dominated by grassy weeds and Chinese apple
- No mature native trees and little native vegetation





Pit and funnel traps



Elliot traps



Cage Traps



Camera traps





Acoustic Recorder



Spotlighting



Birdwatching



Sweepnetting

Data

- 120 survey days
- >8,000 vertebrates (165 species) observed & identified
- >35,000 camera trap images collected & analysed
- >14,000 hours of audio collected & analysed
- >8,000 invertebrates identified



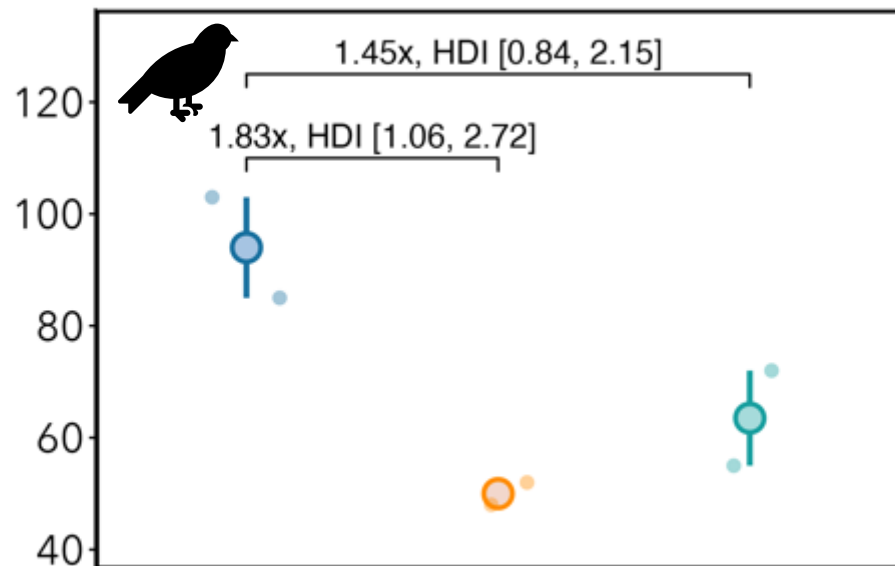
Some fauna farmland western site



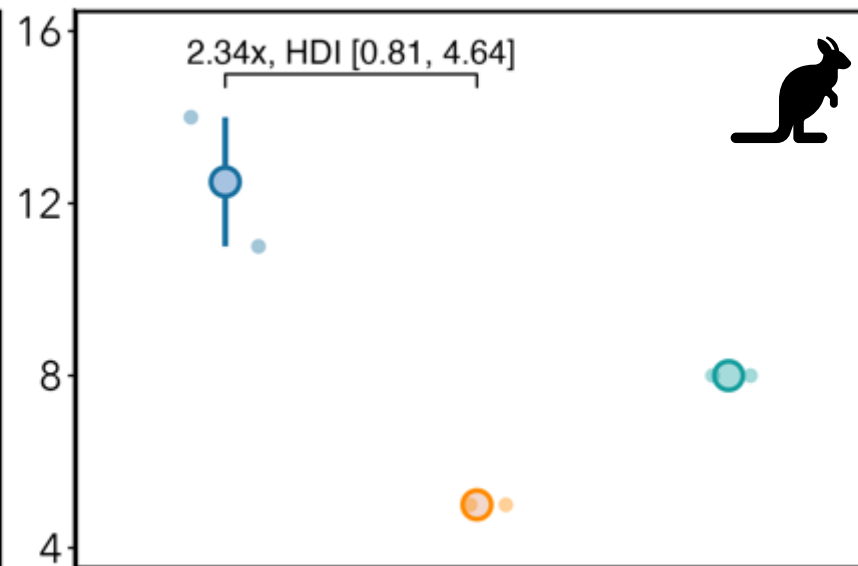
Some fauna easement eastern site



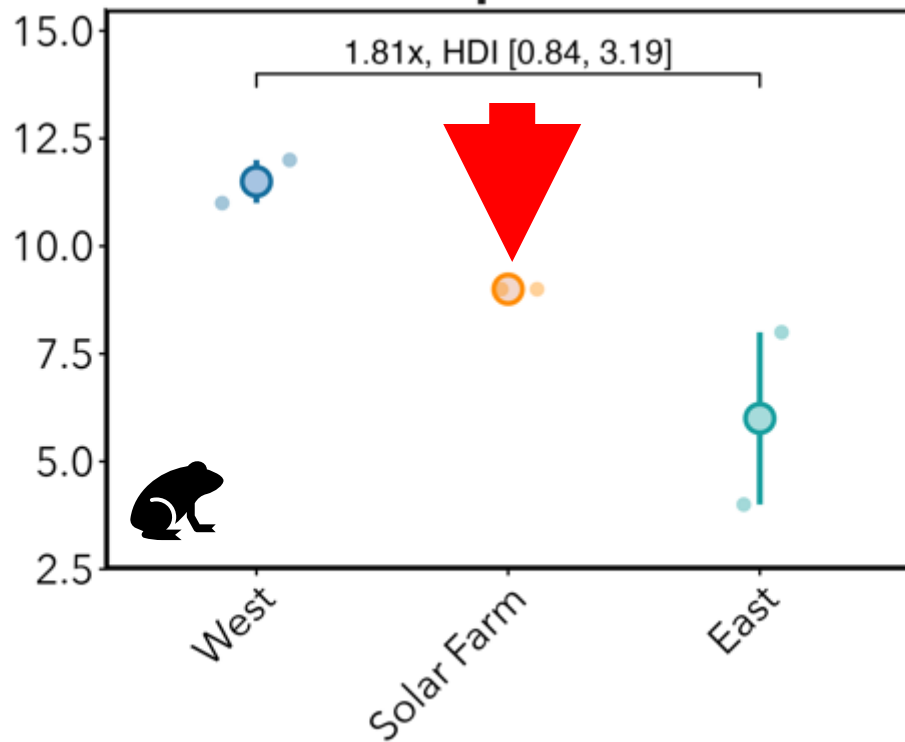
Aves



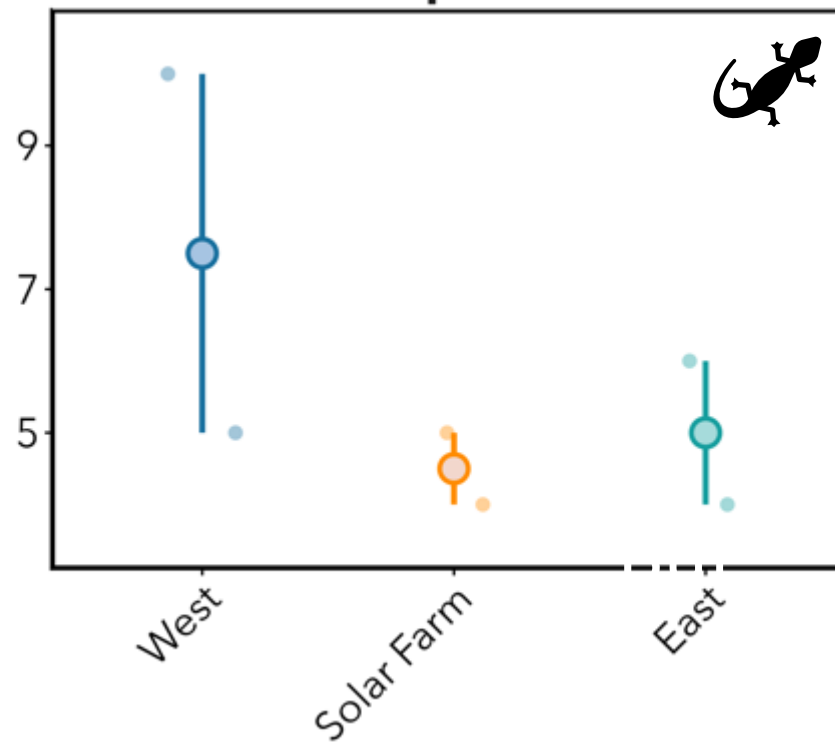
Mammalia



Amphibia



Reptilia



West Farmland:
Highest number
species

Solar farm & East:
Fewer species

Why more species in the farmland than solar farm & easement?

Farmland older than solar farm – biodiversity takes time to develop (10 years for solar farm)

Farmland had mature trees – trees support a range of biodiversity in 3 dimensions

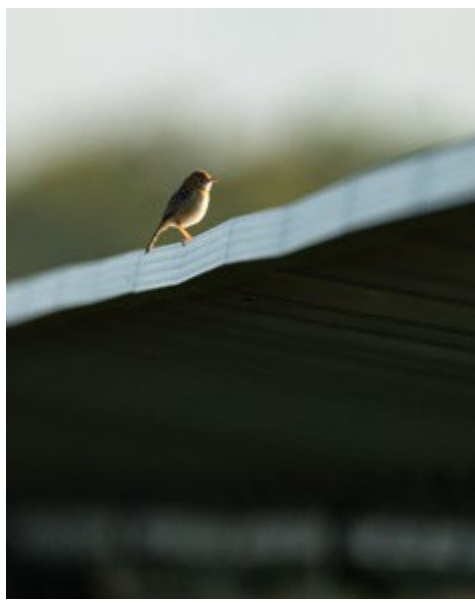
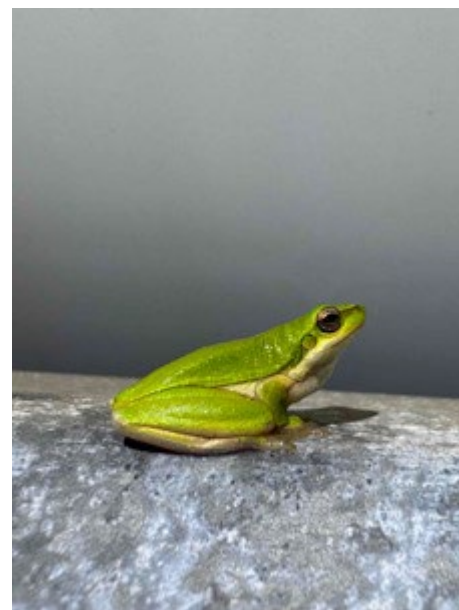
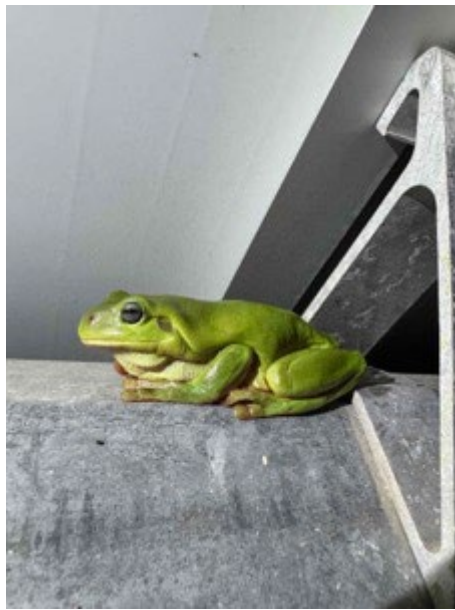
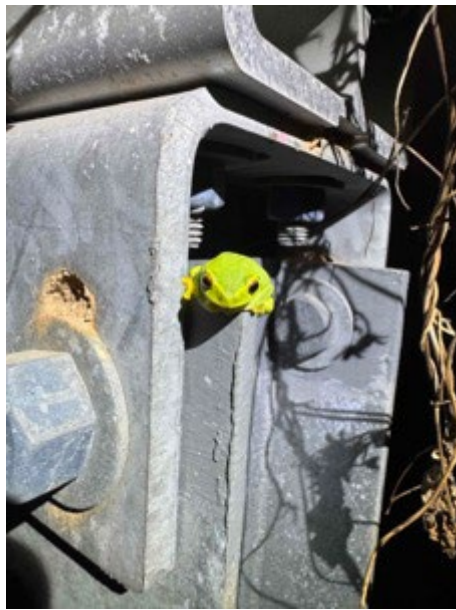
Farmland was least weedy – weeds reduce biodiversity

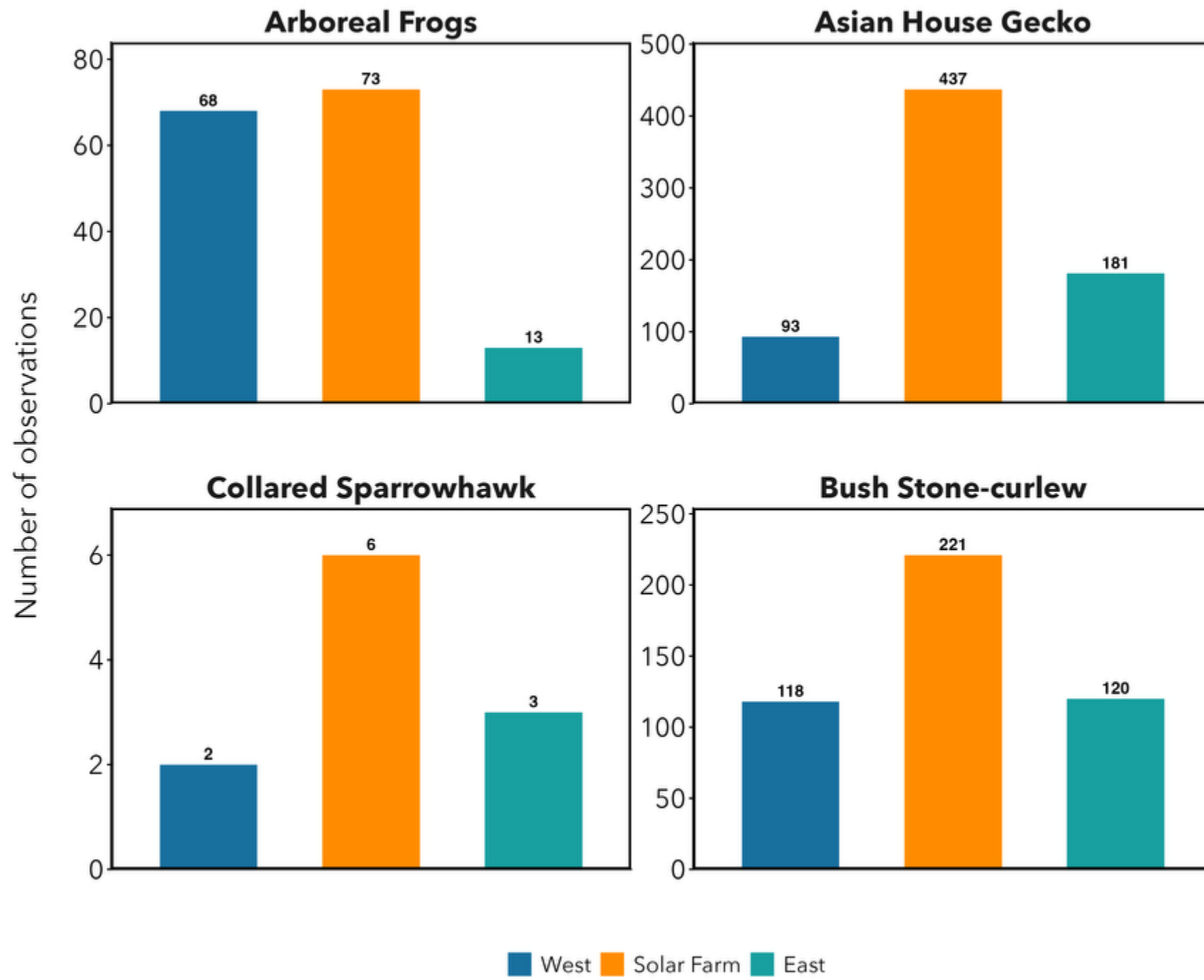
Solar farm is fenced: keeps out large mammals

Easement is and solar farm are mowed – reduced complexity



But animals do use solar farm infrastructure!





Solar farm
infrastructure
provides specific
functional
microhabitats which
benefit certain species

How might we enhance biodiversity on the solar farm?

- More vertical structures (mature trees around the edge, nesting hollows)
- Increasing ground-level complexity (coarse woody debris = logs, fine woody debris – leaf litter)
- Understory vegetation management (focus on native plants)
- Smart wildlife gates?



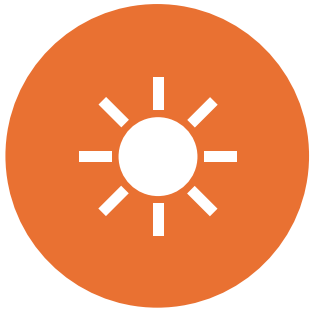
Key Message:

- Solar facility currently characterised by **low diversity**
- **BUT provides microhabitats for certain species and presents opportunities for enhancing biodiversity**

Renewable energy infrastructure *can co-exist* with nature and *offer added benefits* but improvements are needed to better support biodiversity



Who should pay attention?



SOLAR FARMS &
ENERGY PROVIDERS



REGULATORY BODIES,
GOVERNMENTS



CONSERVATIONISTS,
ENVIRONMENTALISTS



AN
OPPORTUNITY
FOR INCREASING
SOCIAL LICENSE



Future Work

Adaptive management to determine best approaches

Build on this study to look at larger areas and different regions

Derive general messages for enhancing biodiversity



Session 3: Difficult-to-Abate Land Sector Emissions: Measurement and Mitigation Approaches

Chair: Chris Norman, NRMQR

Presenters:

Dr Gareth Chalmers, UniSC

Dr Naoya Takeda, QUT





Maintaining environmental integrity of unique fire-resistant Qld peatlands - a nature-based solution to carbon capture and storage

Gareth Chalmers, Cathy Yule, Emily Philippov, Fern Adame, David Chittleborough, Clare Murphy & Allen Gontz

2 July 2026

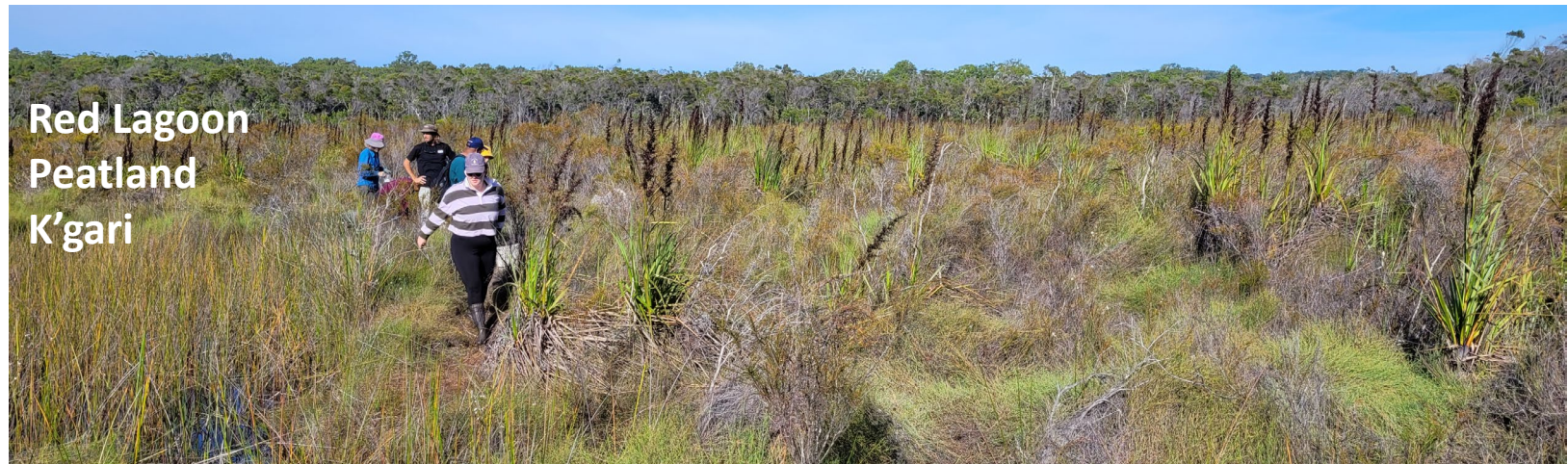
Acknowledgement

I begin by acknowledging the Kabi Kabi, Gubbi Gubbi, the Jinibara and Butchulla peoples as the traditional custodians of the lands and waters upon which our campuses are located.

I recognise these have always been places of learning, teaching and research. I pay my respect to Elders past, present and emerging.

Peatlands Importance to Decarbonisation

- Peatlands are only 3-4% of globe surface area BUT 30% of terrestrial organic carbon storage
- Storage over millennia (pasture C – decadal)
- Climate threat – convert carbon sink to carbon emitter
- SEQ peats; more understanding needed on:
 - C stored, GHG emissions & microbes, peat fire emissions, hydrological impacted by land use/climate change, nutrient flux impact

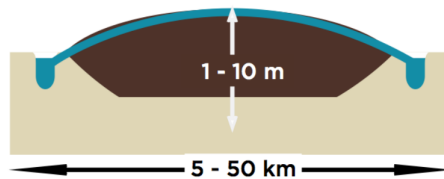


Peatlands Issue to Decarbonisation

From C Storage to C polluter

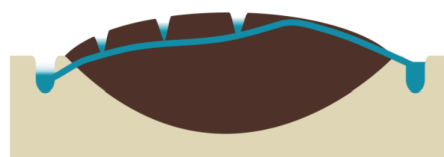
- Climate change or land use change
- Drying out or being flooded
 - Disrupts peat accumulation by vegetation change or oxidative decomposition
- Could lose C stored for millennia

Peatland drainage for Land Use Change – increase in aerobic microbes



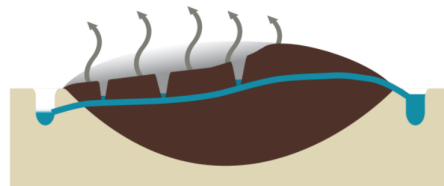
Natural situation:

- Water table close to surface
- Peat accumulation from vegetation over thousands of years



Drainage:

- Water tables lowered
- Peat surface subsidence and CO₂ emission starts



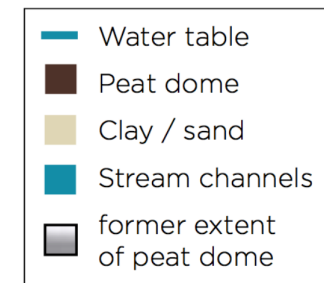
Continued drainage:

- Decomposition of dry peat: CO₂ emission
- High fire risk in dry peat: CO₂ emission
- Peat surface subsidence due to decomposition and shrinkage

Greenland, 2017 peat fires, permafrost melt, burn for weeks due to climate change

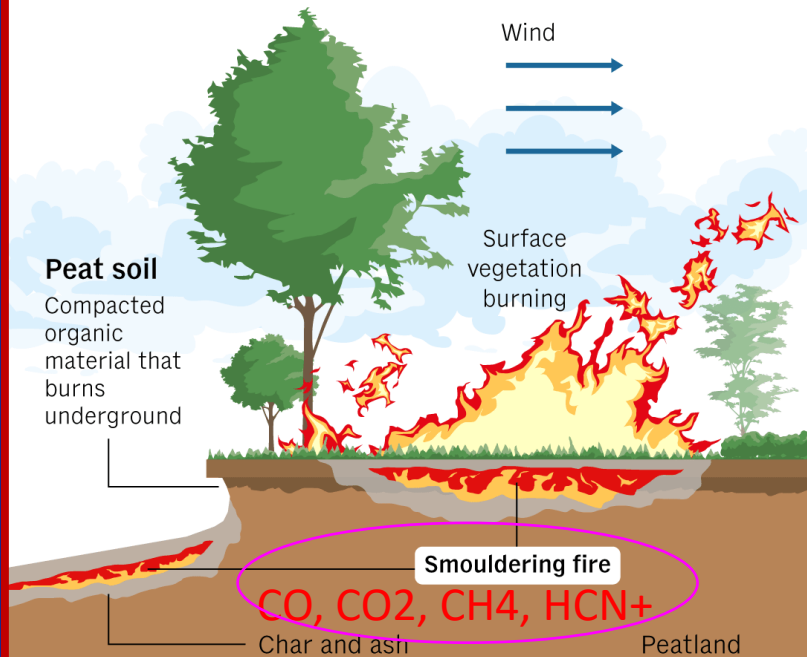


<https://nilu.com/2018/04/the-peat-fires-in-greenland-a-harbinger-of-accelerated-ice-melting/>



Issue for GHG & fire Emissions from Australian Peatlands

What is a peat fire?



Smouldering

Peat can burn below the surface for days or weeks

Source: Carbon Emissions From The Peat Fire Problem, Environmental Science and Pollution Research

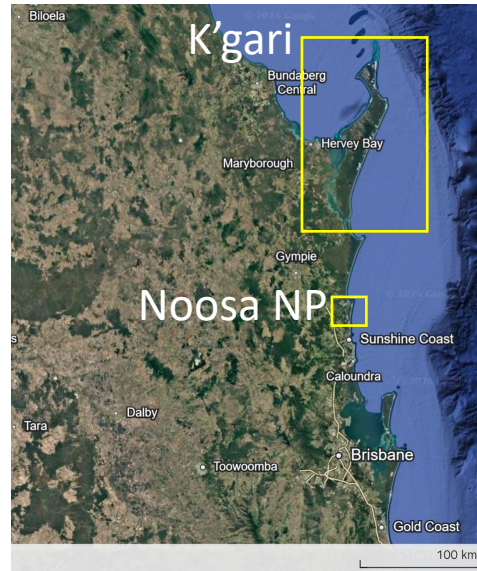
CNA GRAPHICS

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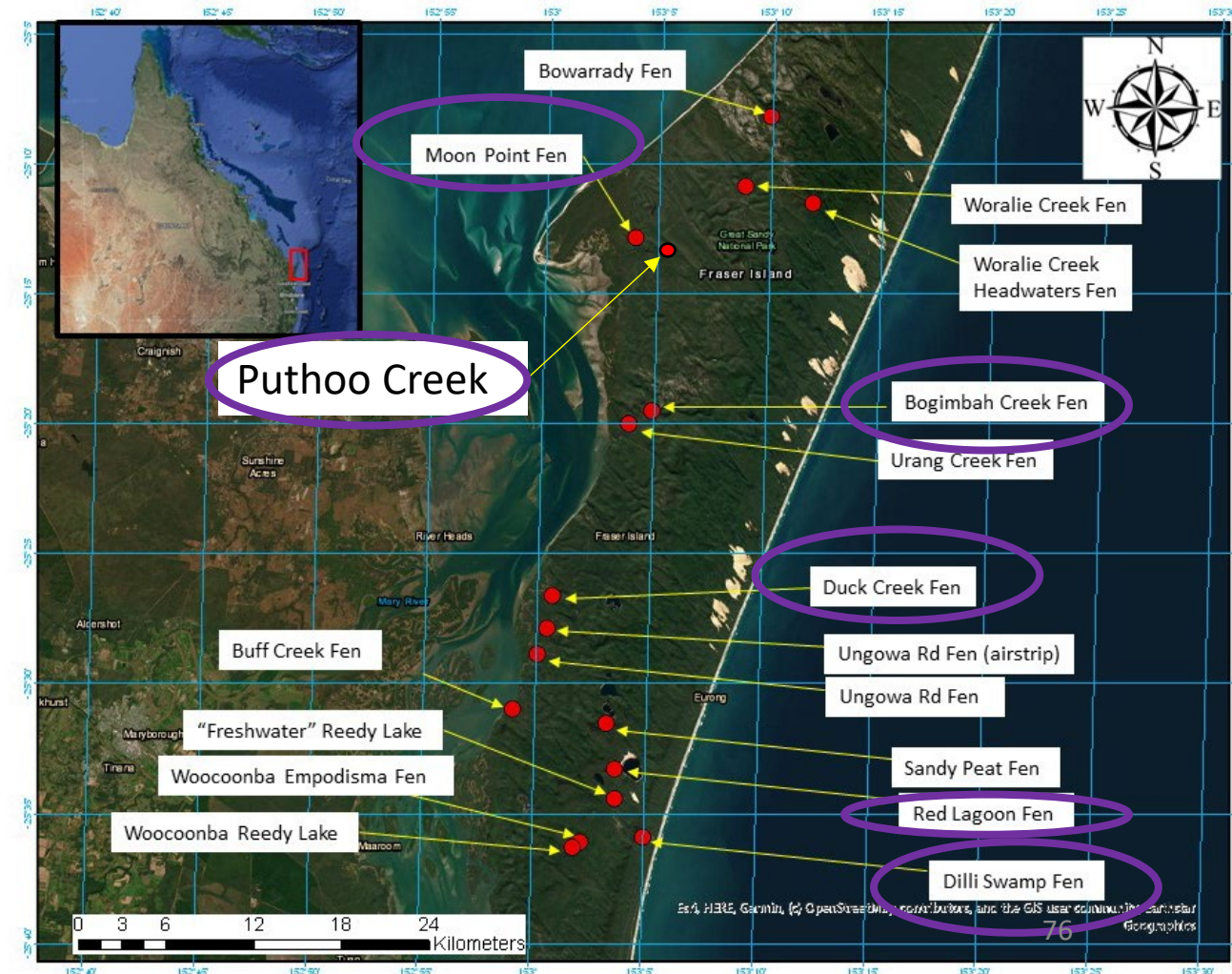


- Australia has less GHG emissions data compared to SE Asia or boreal systems
- Little evidence on what control GHG emissions for subtropical peatlands in SEQ
- Does wildfires in peatlands impact GHG emissions?
- Peat Fires: Aust. Standards based on forest fire
- Peat fires can have smouldering cooler fires with incomplete combustion
 - Resulting in high CO, hydrocarbon gases & hydrogen cyanide gas (HCN); > 100 trace gases (Hu & Rein, 2021)
- Need more data on what is in Australian peat fire emissions

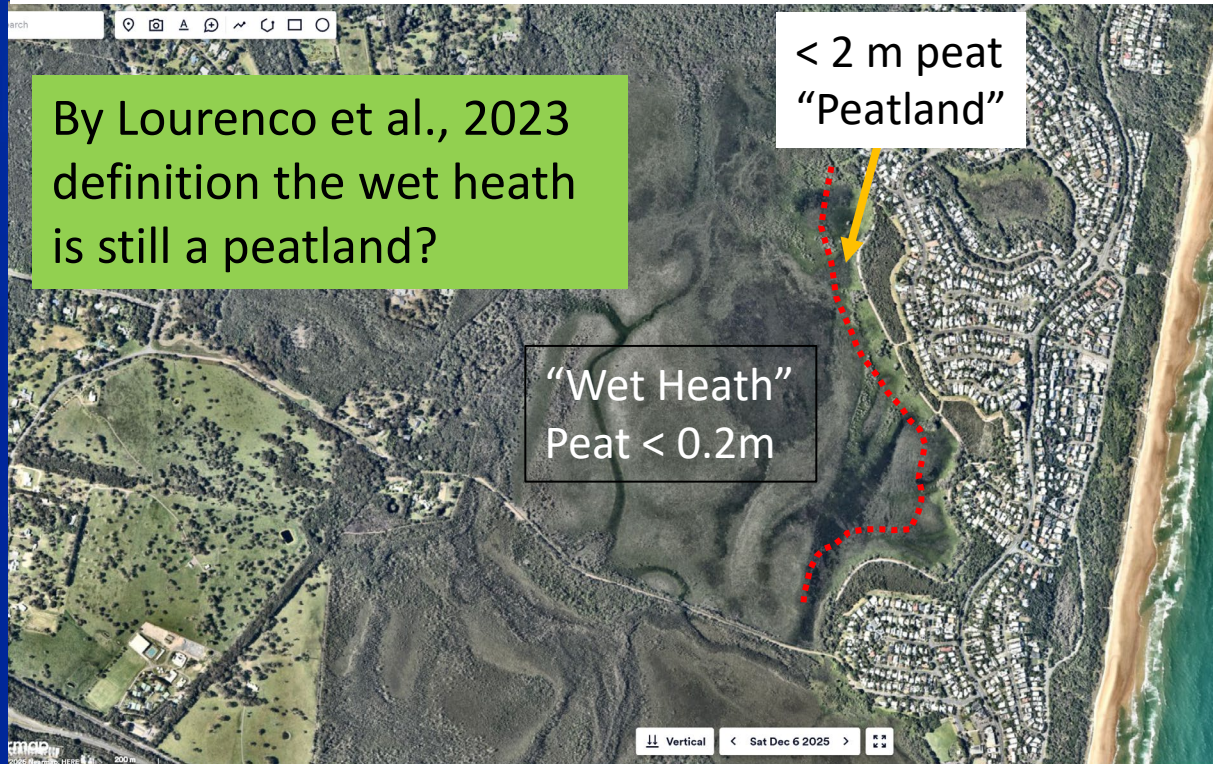
Project Study Areas



K'gari Peatland Sites

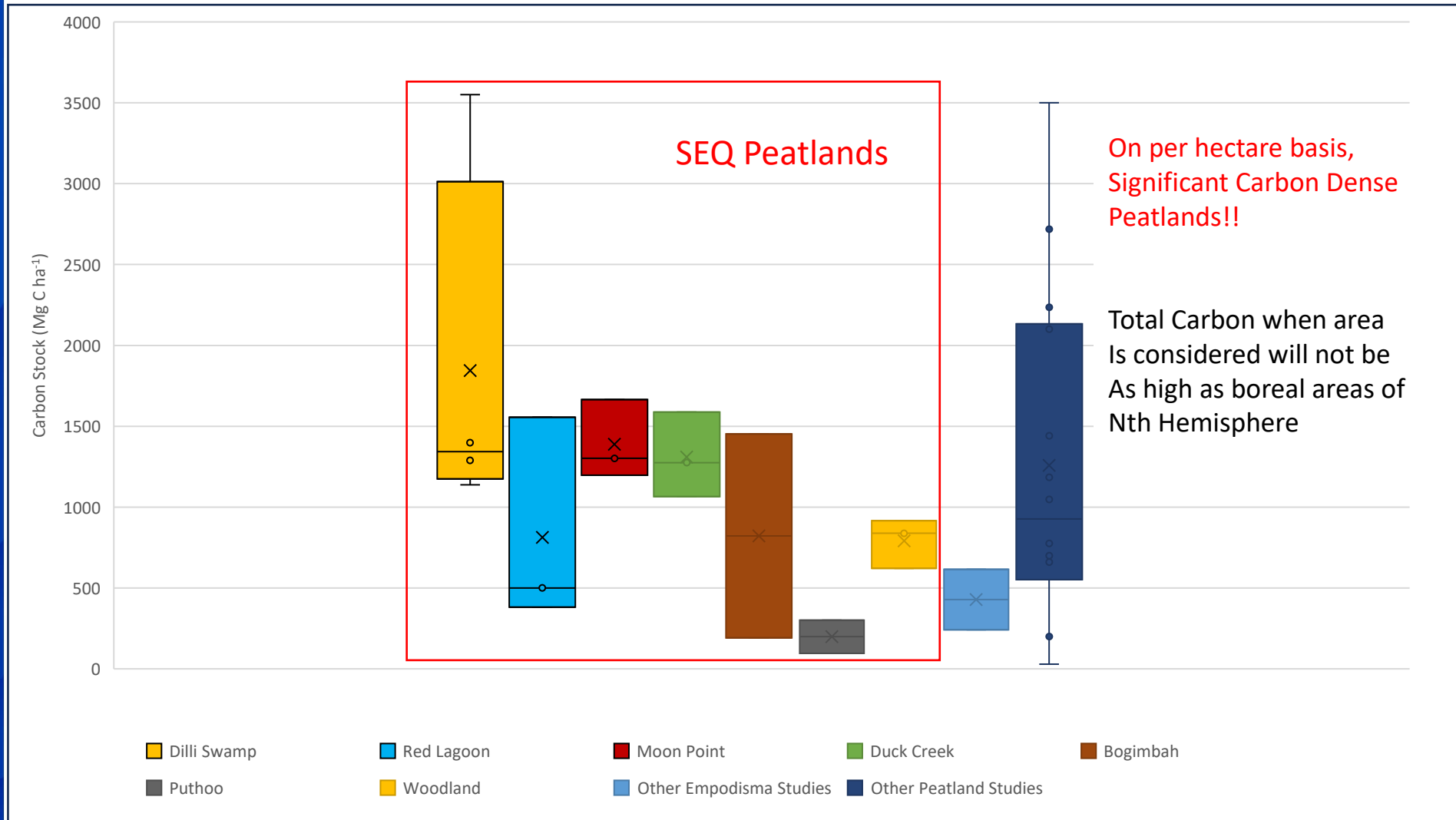


Noosa NP – Woodland Block, Peregrin Beach



How does SEQ peat compare to the world?

Carbon Storage Results – more than 2,500 tonnes per hectare



Significance of Carbon Storage

- Concentrated regional carbon stocks
 - Study area (~1,864 ha) stores:
 - ~2.45 million tonnes* of carbon
 - Equivalent to: ~4.85* million cars' annual emissions
 - ~AUD \$343* million (market price basis)
 - AUD \$6.68** billion (social cost of carbon)

*Caveat – these numbers are based on assumption that average peat depth is same, numbers are illustrative only

**ToI, 2023 - Social cost of carbon estimates have increased over time – Nature Paper.

Empodisma minus
Wire rush
Main peat former

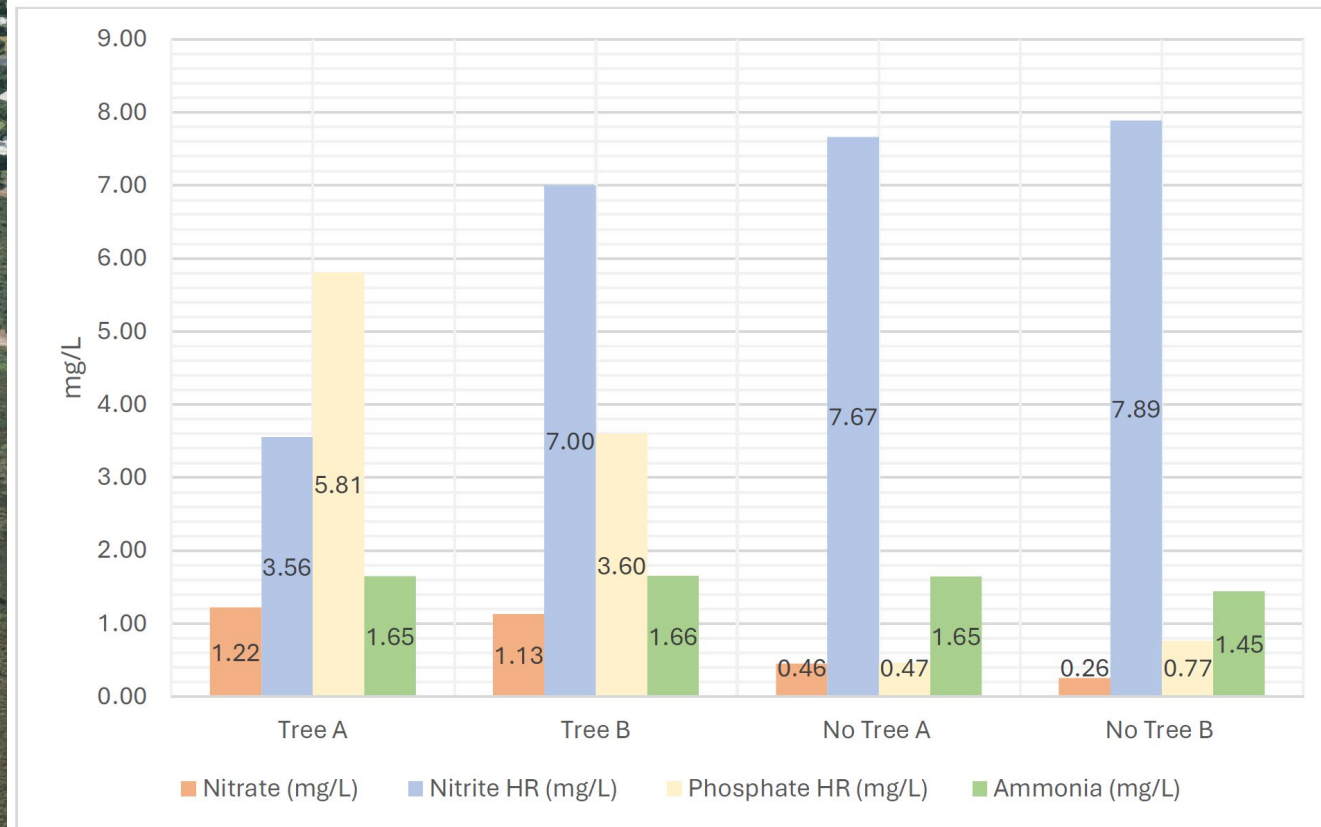
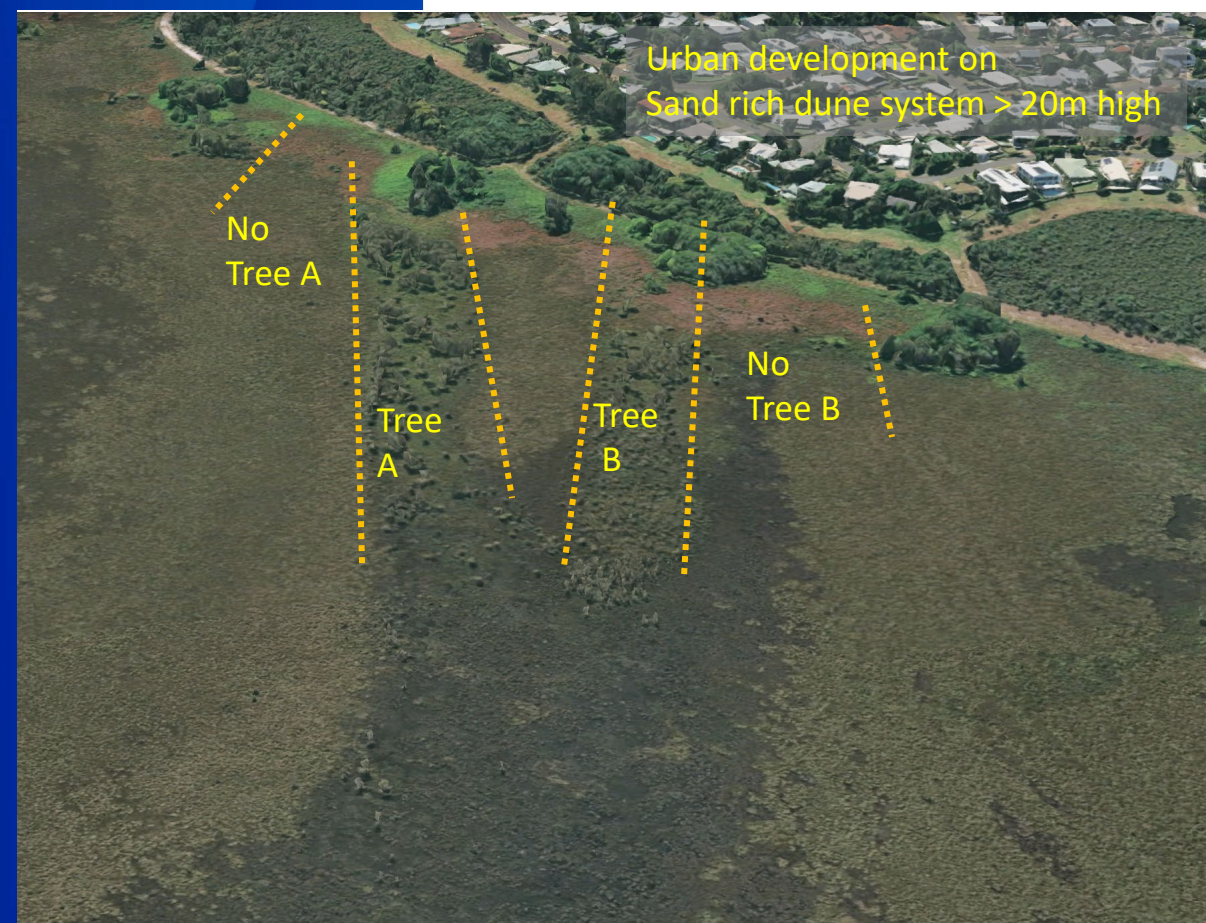


Duck Creek
Peatlands, K'gari



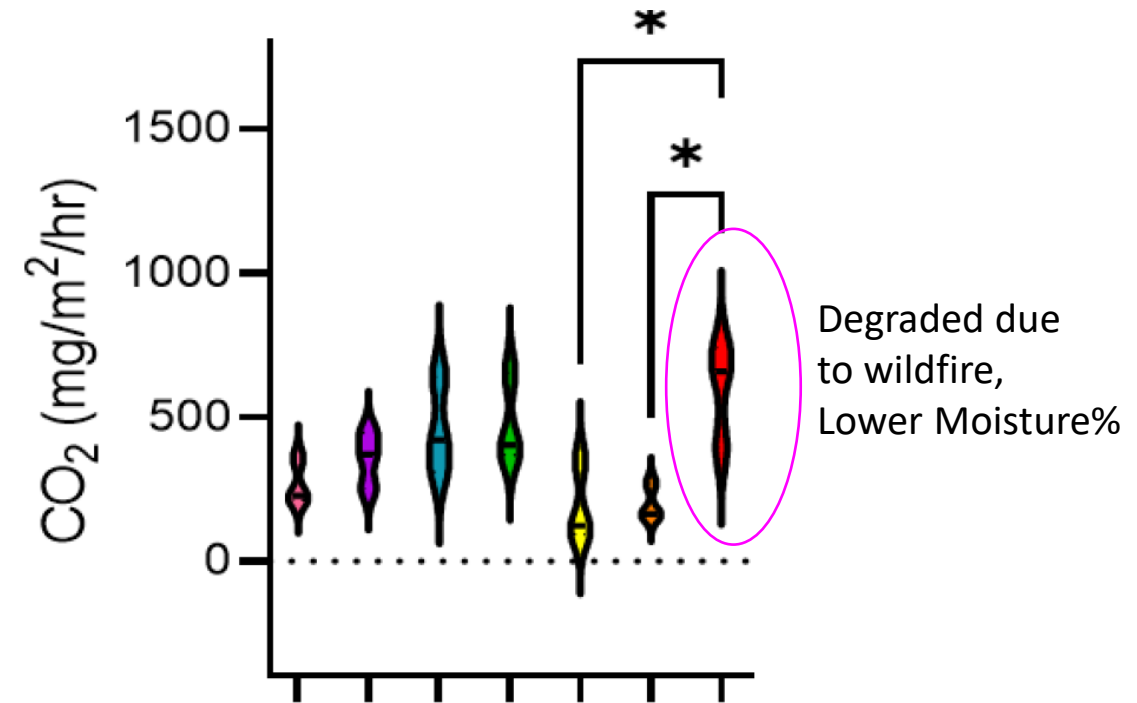
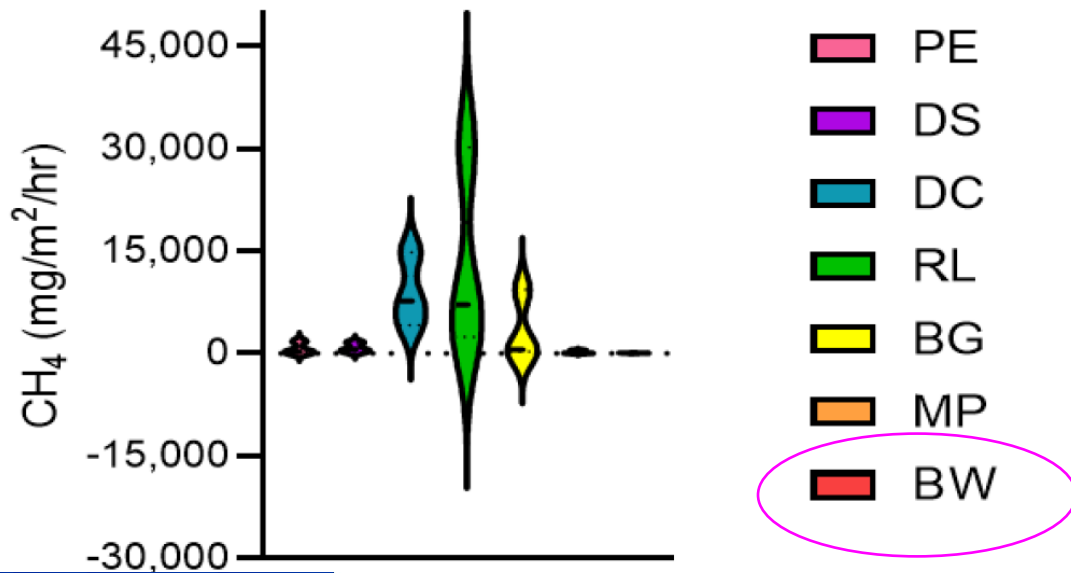
Nutrients in Woodlands Peatland

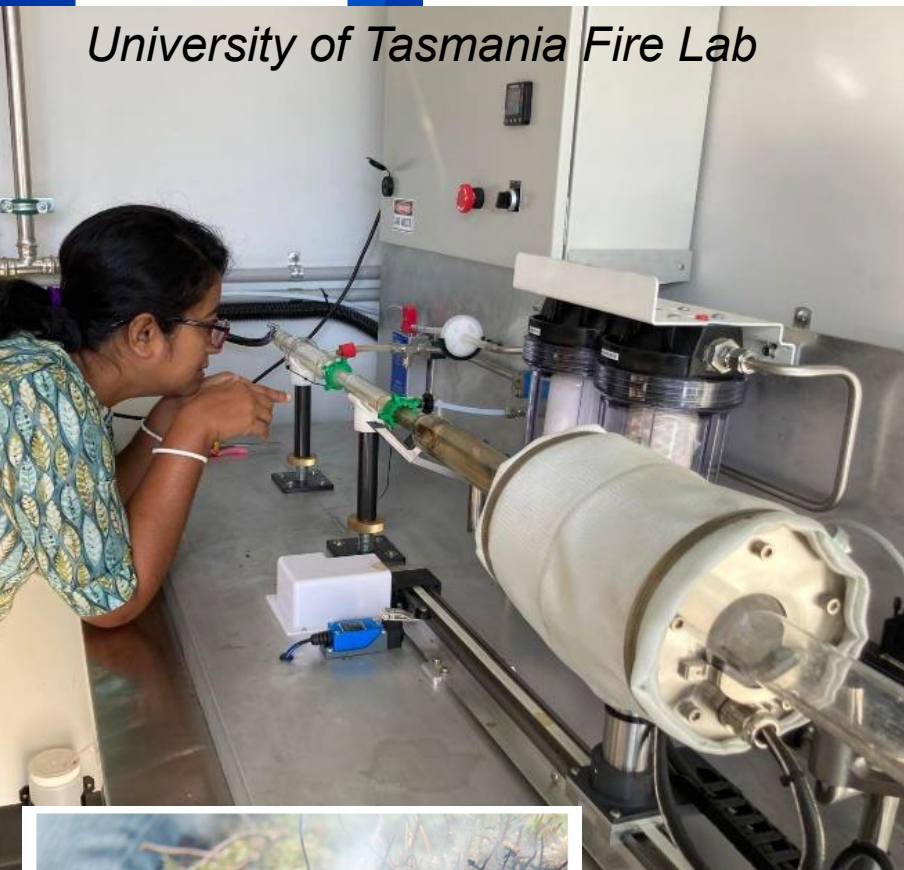
- Peat and heath lands are typically nutrient poor (e.g., Salmon et al., 2021)
- Up to 12x higher Phosphate levels in treed areas
- Phosphate entering through groundwater from adjacent urban area
- Higher nutrients may increase microbial activity – increase GHG emissions



GHG emissions

- 1) No significant difference between managed burn and most wildfire peatlands, nor pre- vs post-burn, except at severely degraded sites (e.g. Bowarrady).
- 2) Higher moisture content in peat give highest methane rates (Tyystjarvi et al., 2024)
- 3) Higher CO₂ rates in lower moisture peat, higher soil temp & bulk density (seen also by Boonman et al. 2022; Huang et al., 2021)





Peat Fire Emissions

- If peat fires become smouldering cooler fires:
 - Large quantities of aerosols ($PM_{2.5}$), CO , CH_4 & other hydrocarbons and trace HCN – hydrogen cyanide.
- Serious health implications – carcinogens, cardiovascular damage from $PM_{2.5}$ etc
- More data needed and normalised to C% of peatland
- The Hydrological Trifecta!
 - Stable high water table provides not only stability for carbon storage but also lowers CO_2 emissions & reduce potential of smouldering peat fires



Flaming

Smouldering

Why those findings matter in practice

- This project's findings can directly influence climate policy, land management & planning, fire management
- Australia is potentially undervaluing a major carbon asset
 - Some peatlands maybe not recognised in mapping, depths not known for a lot
 - Include more peatlands in carbon markets and climate policy
 - Better quantification of their emissions and sequestration rates
- Fire management
 - Managed cool burns are beneficial – no GHG differences seen
 - Severe wildfires with smouldering peat may cause irreversible damage, increased CO₂
- Firefighter safety and air quality
 - Peat fires produce potentially toxic emissions
 - Develop safety guidelines for fighting fires in/near peatland areas (e.g. Peregrine area)
- Focus on maintaining high water tables to preserve more carbon by preventing CO₂ release and/or deep peat fires
- Planning & environmental protection
 - Inclusion of peatlands in:
 - land-use planning & development

Who should pay attention and why

- Carbon storage
 - Who:
 - Environmental agencies, carbon market regulators, planners, and First Nations custodians.
 - Why:
 - Peatlands are very high carbon dense, but not all are included in carbon accounting, leaving them undervalued.
- Disturbance risks carbon loss and CO₂ release.
- First Nations management is key to maintaining peat integrity as their cultural burning has succeeded for millennia.
- Covered under broader wetlands - Ensure policies and planning protect and account for these particular carbon stores

Who should pay attention and why

- Greenhouse gas (GHG) emissions
 - Who:
 - Climate policymakers, scientists, and land managers.
 - Why:
 - Peatlands emit CH₄ naturally but shift to CO₂ when degraded.
- Emissions are driven mainly by peat condition (water, carbon, density), not just fire, but current data are limited.
- Significance: Manage water tables, avoid CO₂ increases, and improve GHG accounting.



Who should pay attention and why

- Fire emissions
 - Who:
 - Fire services, health and safety agencies, air quality authorities, and land managers.
 - Why:
 - Peat fires emit CO, CH₄, NMHCs, HCN, and PM_{2.5}, with high toxicity (notably HCN) and long-duration emissions.
 - Current standards are based on forest fires and do not capture peat-specific risks,
 - hydrological disturbance increases fire likelihood.
 - Significance: Require peat-specific safety standards, improved air quality modelling, and fire management that maintains high water tables to prevent smouldering fires.



Opportunities/next steps identified by the research

- Carbon storage

- Continue to map peatlands depths & carbon stocks
- Utilise new technology, ground penetrating radar on drone - easier subsurface mapping
- Protect and/or restore degraded sites to prevent long-term CO₂ loss
- Develop planning controls to avoid development impacts

- Greenhouse gas (GHG) emissions

- Conduct multi-year, multi-season monitoring across more sites to improve reliability of GHG data
- Use flux towers to determine net GHG balance at landscape scale

- Fire emissions

- Develop peat-specific firefighter safety standards and monitoring protocols
- Conduct field-based emission measurements to compare to lab studies
- Improve air quality modelling using Australian-specific emission factors
- Implement fire prevention strategies: maintain high water tables support managed/cultural burning to avoid deep smouldering fire



Flux tower
in
Canada



Drone-mounted
Mala GPR Over
Dilli Swamp

1st in Australia



Questions?





Centre for
Agriculture
and the
Bioeconomy

Making Low-Carbon Agriculture Verifiable: Reducing the Cost of Measuring On-Farm Emissions in Queensland

Naoya Takeda, David Rowlings, Michael Bell

QLD Decarbonisation Hub Research Showcase | 2nd July 2026

Decarbonisation of agri-food supply chain

- **Decarbonisation of agricultural supply chains** has been driven by international climate policies, regulatory disclosure requirements and corporate net-zero commitments.
- Agricultural industries are under increasing pressure to demonstrate and reduce greenhouse gas (GHG) emissions derived from their production for export markets, food manufacturers and supply chains.

Department of
Agriculture and Fisheries
Strategic Plan
2023–2027

Queensland Low Emissions
Agriculture Roadmap
2022–2032

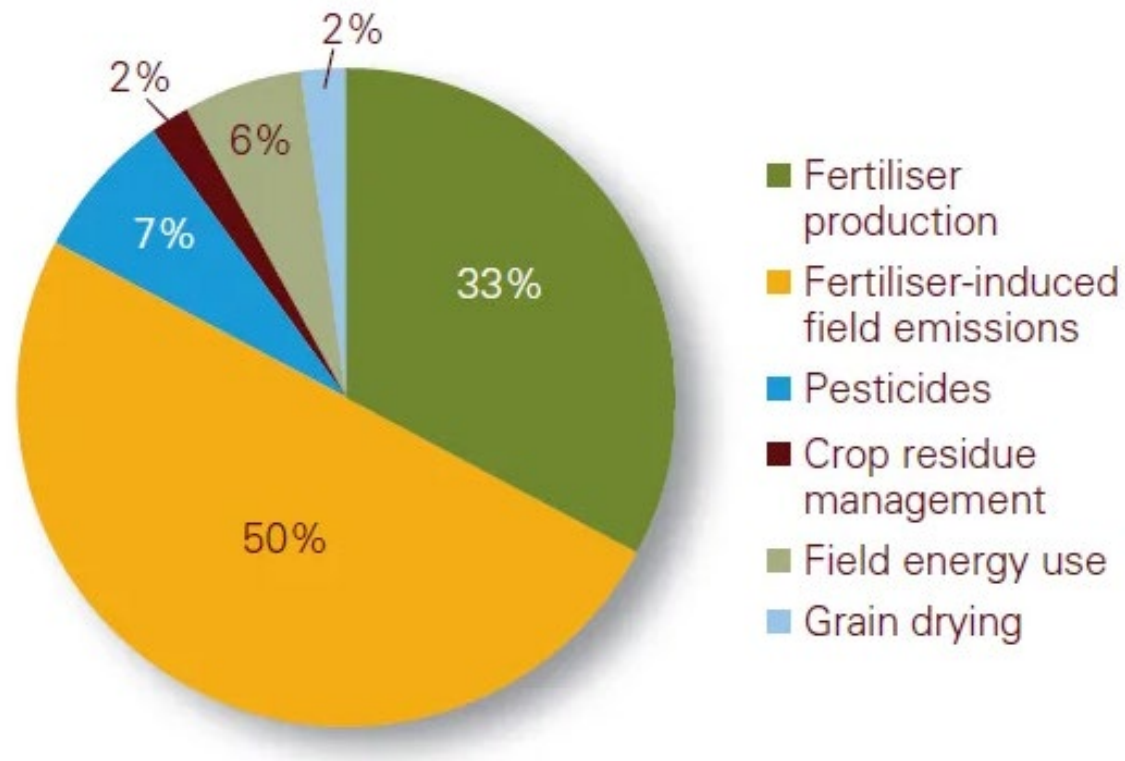
TCFD TASK FORCE ON
CLIMATE-RELATED
FINANCIAL
DISCLOSURES



➔ For QLD agri-food industries, this creates both a challenge and an opportunity for their global market access

On-farm nitrous oxide (N₂O) emissions

- In cropping systems, **on-farm nitrous oxide (N₂O) emissions** often account for **~50% of the carbon footprint**
- Scientific research has identified a range of farming practices that can reduce these emissions.



Source: Bayer Crop Science



Source: Cool Green Science

➔ N₂O reduction is a significant opportunity for supply-chain decarbonisation in the crop industries

Challenges towards credible on-farm N₂O reduction

- However, N₂O emissions are highly variable and difficult to evaluate the reduction in Measurement, Reporting and Verification (MRV) frameworks
- The current approaches to evaluate on-farm N₂O reduction:
 - High-frequency direct monitoring by deploying manual or automated GHG chamber systems
 - Fixed emission factors (EFs) only reflecting N input amounts and involving high uncertainty for specific cases



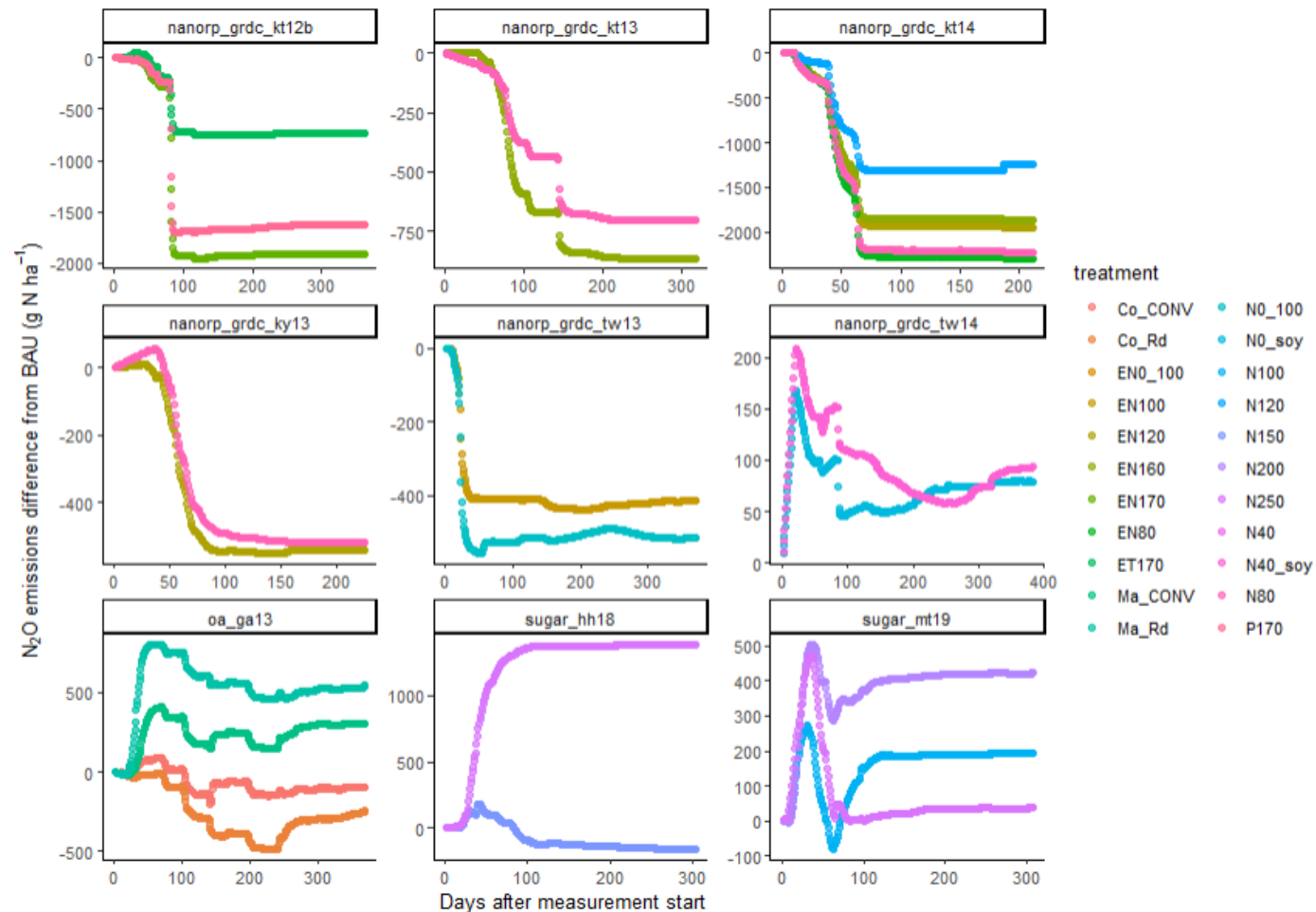
$$EF = \frac{[N_2O-N \text{ total}(+N)] - [N_2O-N \text{ total}(0N)] \times 100}{\text{Total N fertilizer applied}}$$

➔ Current MRV frameworks have a critical gap: too expensive and technical or lacking adaptability and credibility

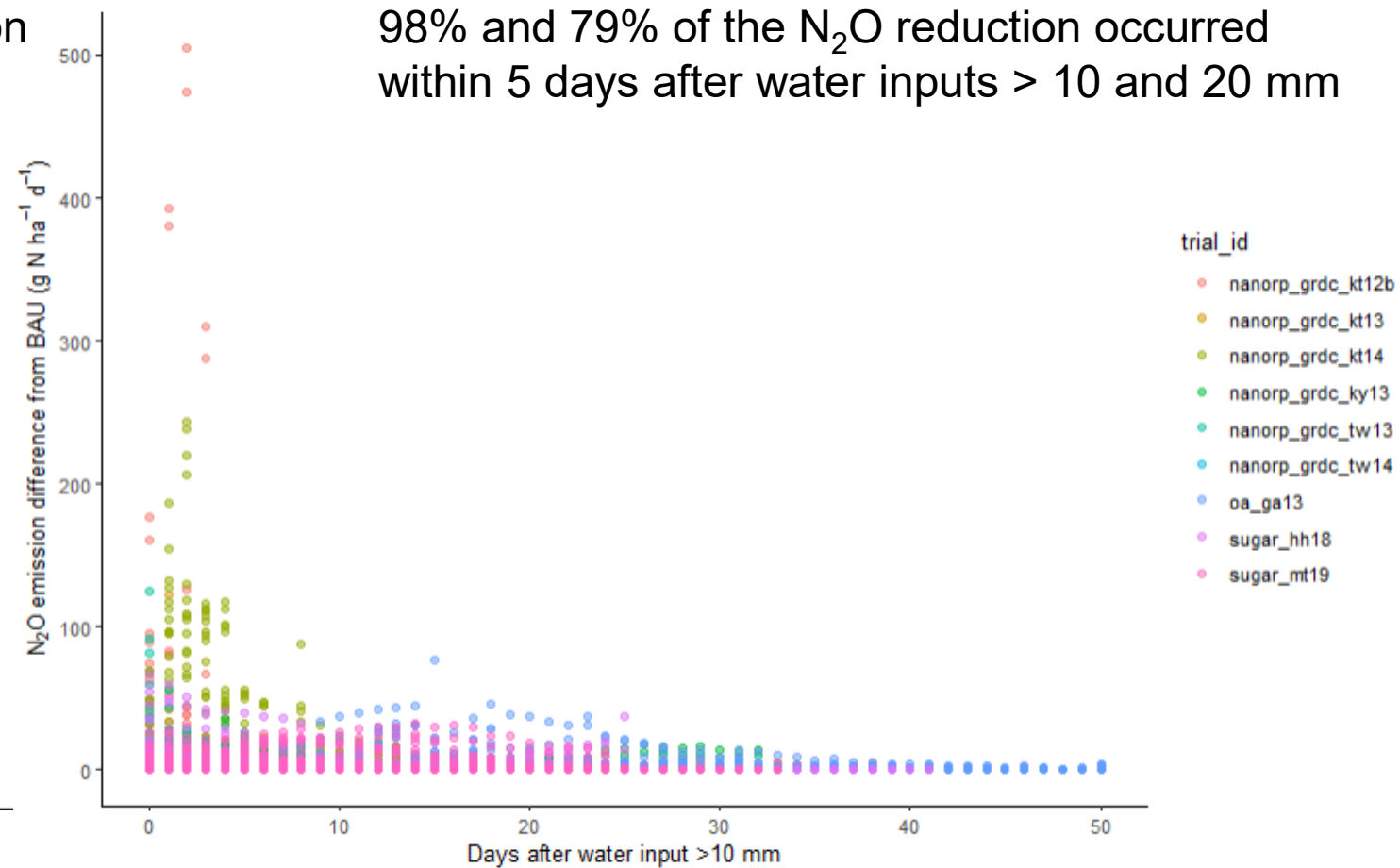
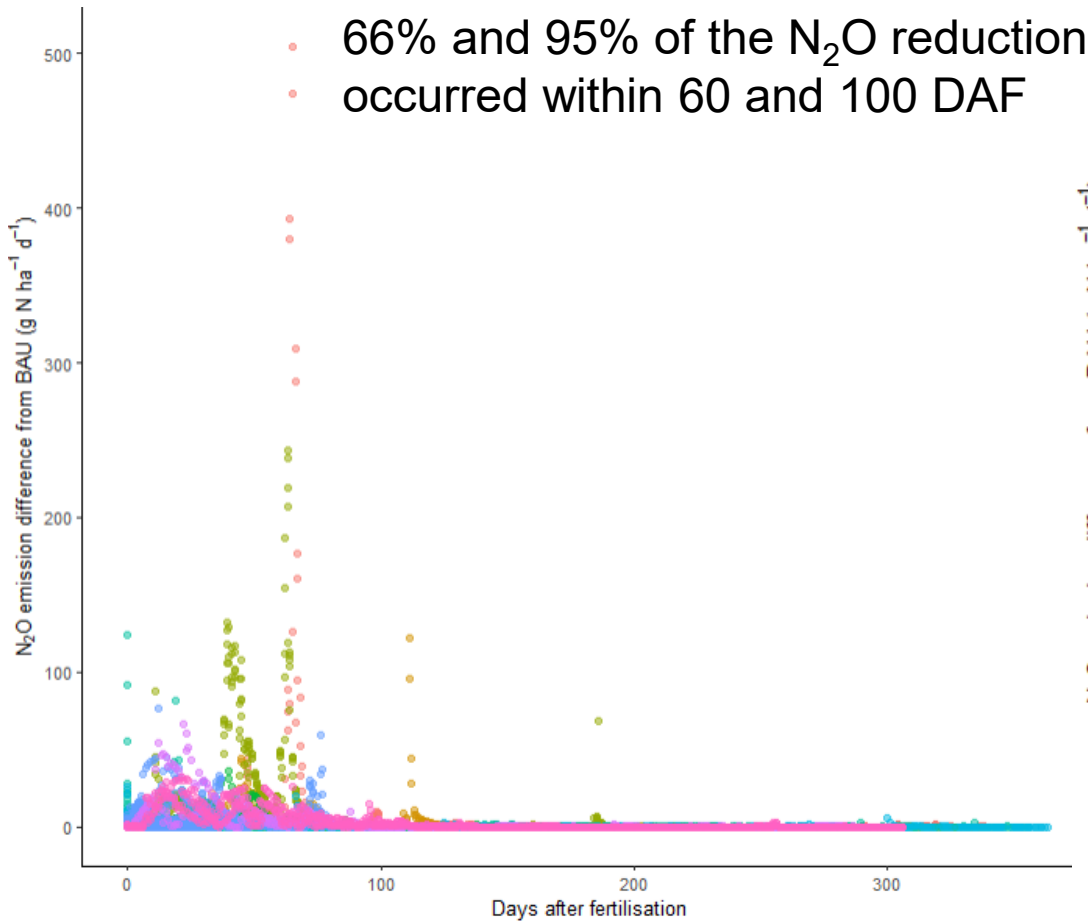
- This project examined how N₂O emissions can be measured more efficiently while maintaining scientific confidence in reported emission reductions.
- The aim was to develop practical approaches that reduce verification costs and support wider adoption of mitigation practices across Queensland.

Observed N₂O change from business-as-usual (BAU)

- N₂O data from 20 high-frequency GHG monitoring trials were collated, representing 102 site-season-treatment combinations across Queensland and Australian cropping systems
- The selected datasets showed the treatment effects on seasonal N₂O emissions ranging from 36 to 2291 g N ha⁻¹



Observed N₂O change from business-as-usual (BAU)

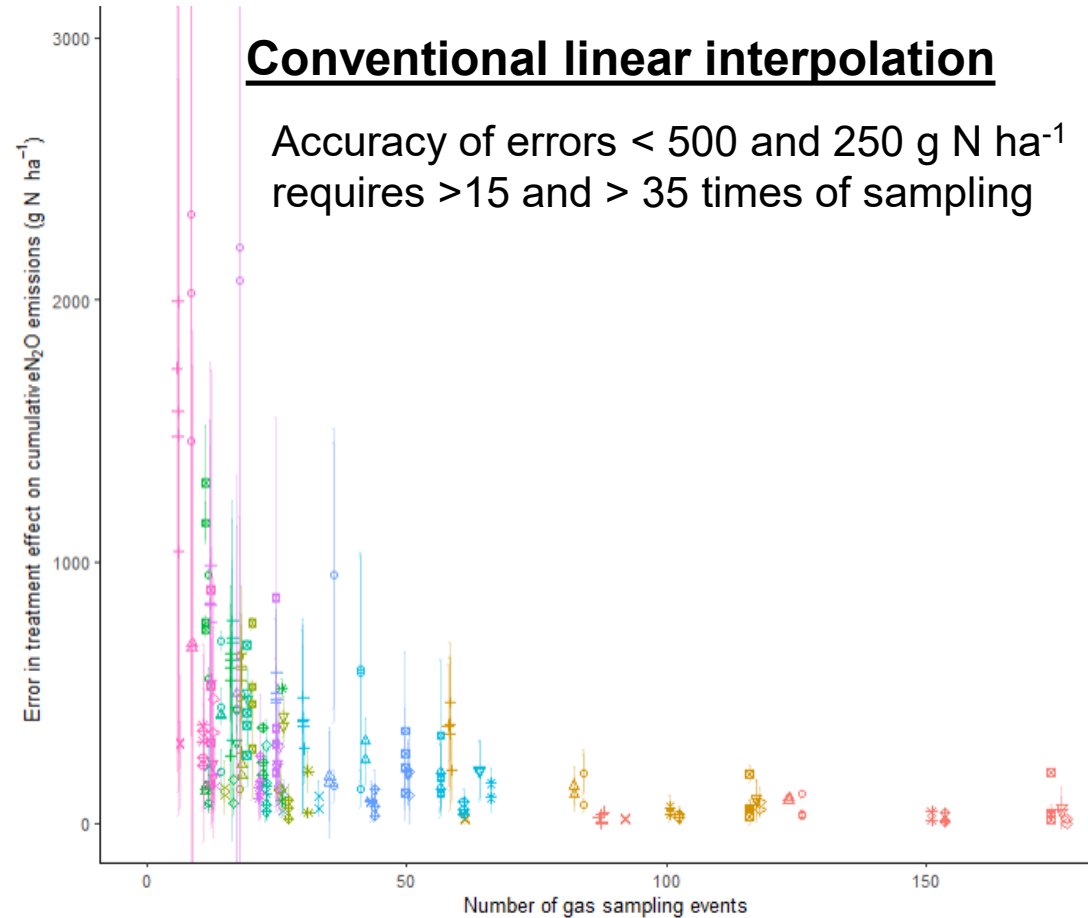


➔ Critical measurement timing is within 5 days of water inputs > 20 mm occurring <2 months after fertilisation

Gap-filling subsampled N₂O for seasonal estimates

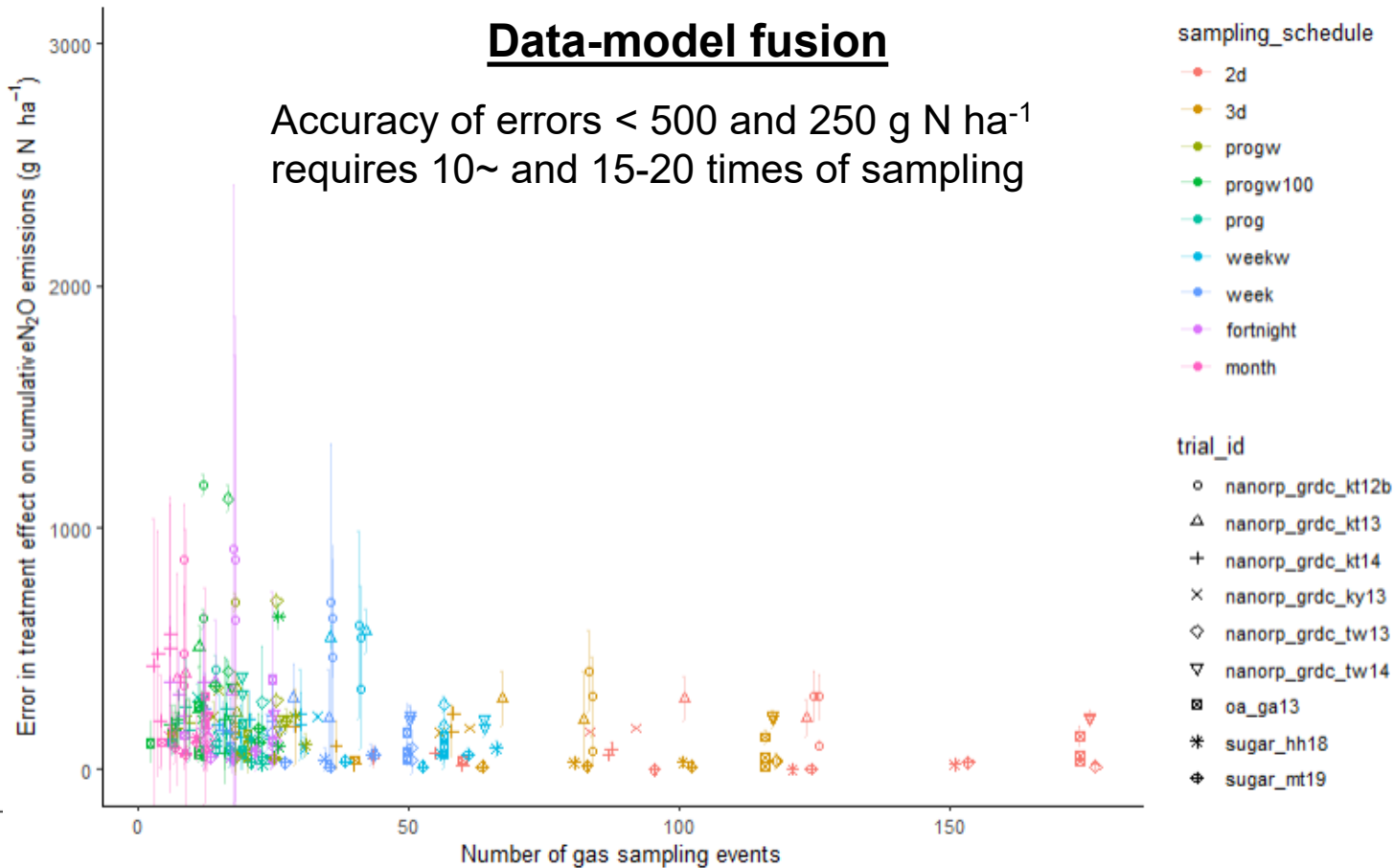
Conventional linear interpolation

Accuracy of errors < 500 and 250 g N ha⁻¹ requires >15 and > 35 times of sampling



Data-model fusion

Accuracy of errors < 500 and 250 g N ha⁻¹ requires 10~ and 15-20 times of sampling



- Conventional gas sampling schedules with linear interpolation require more than 30 sampling events per season to reliably quantify N₂O reduction.
- Combining strategically timed field measurements with process-based modelling and data-driven approaches can reduce the sampling requirement down to 15–20 events per season with similar accuracy.

Emission reduction potential in QLD cropping industries

Crop	N ₂ O EF (%)	N rate (kg N ha ⁻¹)	Direct N ₂ O (t CO ₂ eq ha ⁻¹)	Yield (t ha ⁻¹)	Area (1000 ha)	Production (kt)	Direct N ₂ O (t CO ₂ eq)	N ₂ O EF by EEF (%)	Direct N ₂ O by EEF (t CO ₂ eq)	N ₂ O EF by delay/split (%)	Direct N ₂ O by delay/split (t CO ₂ eq)
Wheat	0.566	70	0.170	2.22	898	1,998	152,633	0.15	40,884	0.28	76,316
Barley	0.563	70	0.169	2.59	179	464	30,263	0.15	8,106	0.28	15,132
Oats	0.563	50	0.121	1.08	36.9	40	4,456	0.15	1,194	0.28	2,228
Sorghum	0.566	100	0.243	3.68	435	1,601	105,624	0.15	28,292	0.28	52,812
Maize	0.59	150	0.380	4.78	19.8	94.7	7,517	0.16	2,014	0.30	3,759
Cotton	0.53	200	0.455	2.29	160	367	72,758	0.19	26,603	0.27	36,379
Sugarcane	1.77	180	1.367	13.6	330	4,500	451,042	1.20	305,791	0.89	225,521
Horticulture	0.63	210	0.568	20	40	800	22,703	0.15	5,493	0.32	11,351
Total (t CO ₂ eq)							846,997		418,376		423,498
Reduction (t CO ₂ eq)									428,621		423,498
Reduction (%)									50.6		50.0

- Proven mitigation practices, including enhanced efficiency fertilisers and improved fertiliser management, can reduce direct N₂O emissions by approximately 50% collectively across the cropping industries.
- Demonstrated N₂O mitigation potential of Queensland's major crops by 400 kt CO₂eq yr⁻¹, equating to ~50% of the current emissions and 6–26% reduction in the product carbon footprint.

Real-world significance of the findings

- A pathway to low-cost on-farm N₂O reduction verification, improving the feasibility of N₂O reduction MRV frameworks for commercial farming operations.
- Lower verification costs remove a key barrier to the adoption of proven emission reduction strategies- such as enhanced efficiency fertilisers and improved fertiliser management.
- More practical verification approaches allow producers, supply chains and governments to implement and evaluate these mitigation strategies with greater confidence.



Implications for each stakeholder

- **Queensland Government and policy agencies:** The findings promote decarbonisation and enhance market access of the agricultural industries in Queensland.
- **Agricultural industries and producer groups:** The work identifies lower-cost pathways to verify emission reductions and demonstrate sustainability credentials to customers and supply chains.
- **Food manufacturers, processors and exporters:** Verified reductions in product carbon footprint can support supply-chain decarbonisation commitments and product differentiation in global markets.
- **Carbon developers and methodology designers:** The findings provide evidence to support development of scalable verification approaches for agricultural emissions reduction projects.
- **Researchers and technology providers:** The project highlights opportunities to combine field monitoring, modelling and digital technologies to improve agricultural emissions accounting.

Next steps the research points towards

- Testing and refining the low-cost verification approach through commercial-scale demonstration projects across Queensland's major cropping industries.
- Continued expansion of the N₂O database to further improve verification accuracy and extend applicability across different regions, commodities and mitigation practices.

Over the longer term...

- Queensland could build a low-cost MRV framework for N₂O emission reduction that combines targeted field measurements, process-based modelling and existing scientific datasets.
- This would provide producers and supply chains with credible evidence of emission reductions, supporting wider adoption of mitigation practices and low-carbon commodity production.
- Scaling such low-carbon agricultural production advances decarbonisation and enhances the market access of the agricultural industries in Queensland.



Session 4: Carbon Sequestration and Alternative Carbon Pathways

Chair: Andrew Chamberlin, Queensland Farmer's Federation

Presenters:

Dr Mehdi Serati, UQ

Professor Mohan Jacob, JCU



Using Carbon-Reactive Aggregates to Reduce Emissions in Concrete Infrastructure

July 2026

Dr Mehdi Serati

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Harry Asche (Aurecon)
Ian van Wijk
Muhannad Al Kalbani (Oman Net Zero Centre)
Harald Hofmann (CSIRO)
Tom Ritchie (Hardie Pacific New Zealand)
David Purdy (Geological Survey of Queensland)



Concrete and shotcrete are fundamental to modern infrastructure worldwide



They underpin tunnelling, mining, transport, and urban development systems.



However, these materials are also a major contributor to global greenhouse gas emissions.



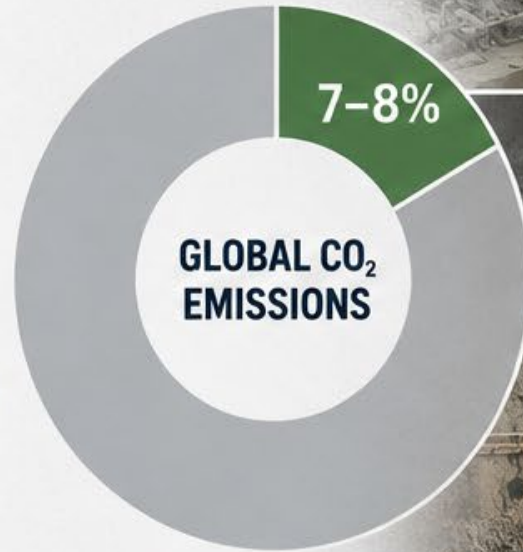
Cement production alone is responsible for approximately

7–8%

of global CO₂ emissions.



As global infrastructure demand continues to rise, reducing the carbon footprint of construction materials has become a pressing challenge for governments, industry, and international climate policy frameworks.



Cement production

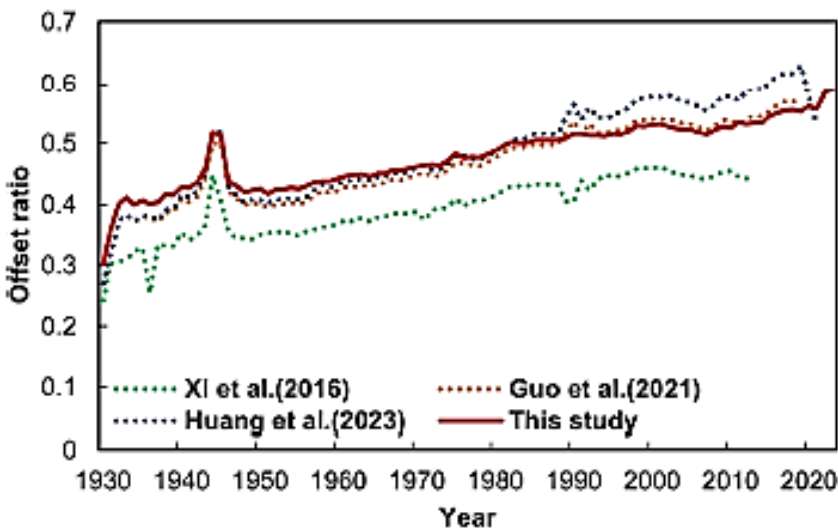


Background:

- Concrete and shotcrete naturally absorb CO2 from the air over time, similar to trees.
- This absorption process, known as the “sponge effect,” helps reduce carbon emissions.

Reference	Investigation Period	CO ₂ Emission (Gt)	CO ₂ Uptake (Gt)	Uptake Ratio (%)	Key Features
(Xi et al., 2016)	1930-2013	38.2	16.48	43%	Emission without including fossil fuel combustion Four-region
(Cao et al., 2020)	2014	2.995	0.615	20%	Physicochemical factors with a survival function rather than an average service life Ten-region
	2015-2100	270-390	80.4-116.4	30%	
(Huang et al., 2023)	1930-2021	41.55	22.9	55.1%	Using Fick's law to simplify the carbonation process Five-region
(Wu et al., 2024)	1930-2023	45.66	23.89	52.32%	Static model, similar to Huang and Xi's studies Five-region

- Uptake ratio from increasing
- Major contributor is from mortar, though with a lower cement content (~30%), but higher surface exposure to atmosphere
- Cao’s calculated result is significantly lower than the other: difference in modelling, which includes prediction on material efficiency, technology adoption, future cement production, also difference in number of regions

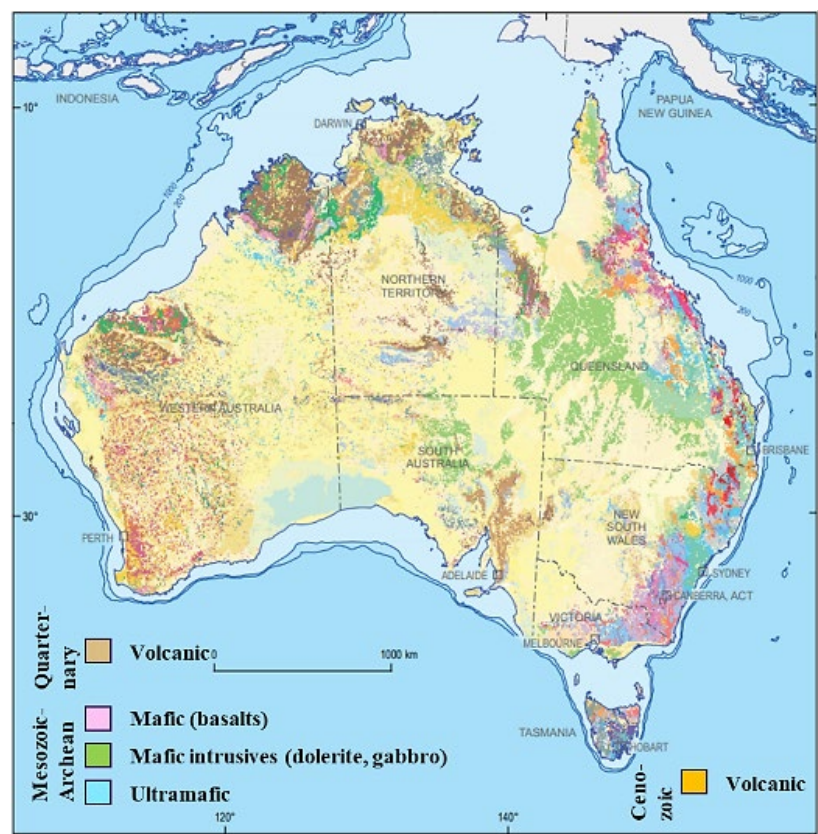


Background:

- At UQ Civil, we've been working on various waste recycling and carbon capture projects over the years, all backed by industry support.
- The Queensland Decarbonisation Hub is a collaborative initiative that unites Queensland's industrial, research and policy sectors to address the challenges and opportunities associated with decarbonisation.
- The project will study how mafic and ultramafic-based aggregates (natural or treated) affect CO₂ absorption.
- The research explores new ways to use Queensland's mafic and ultramafic rock formations in concrete and shotcrete production.

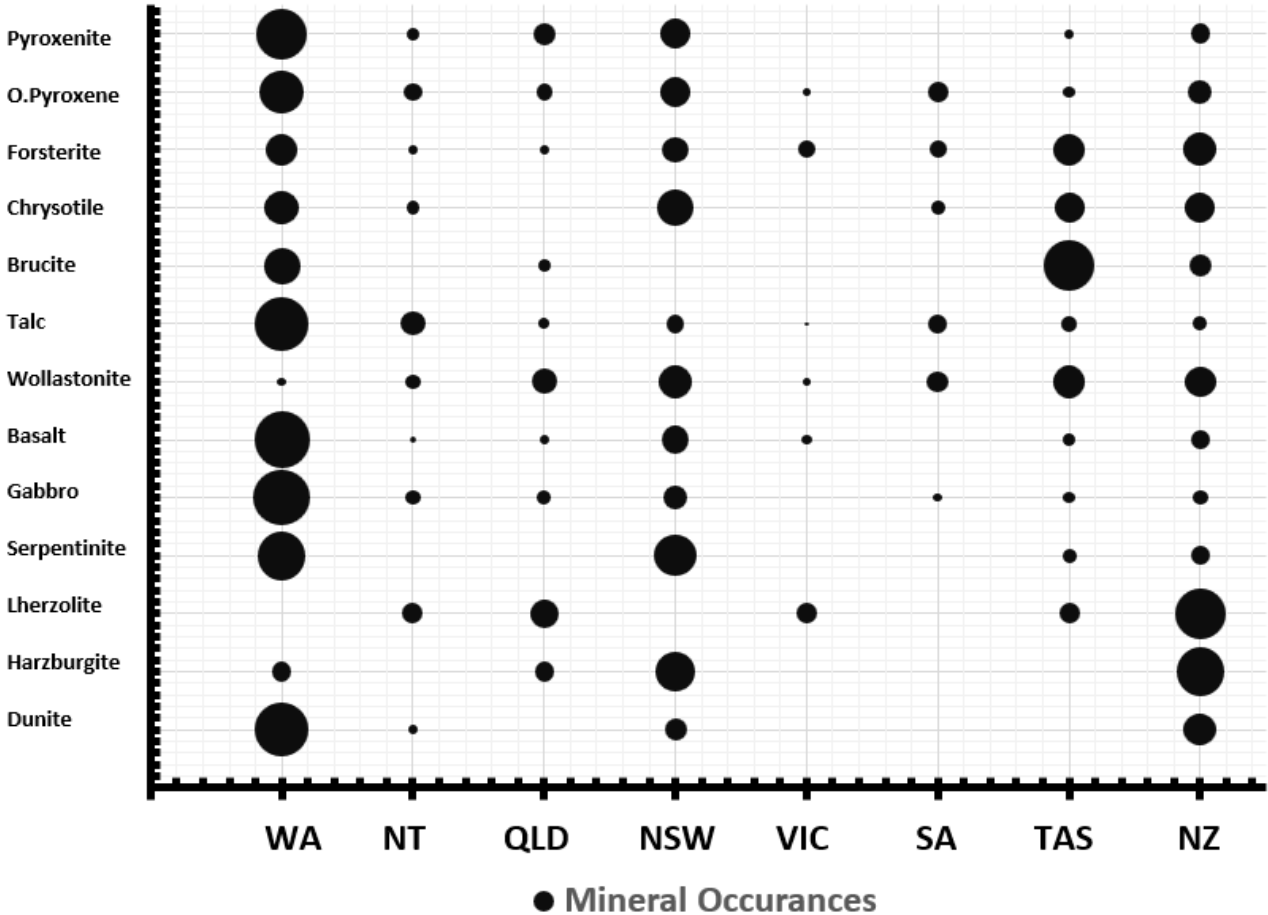


Background:



Australia contains widespread ultramafic and mafic rock occurrences, particularly across Western and South Australia. The Yilgarn Craton in Western Australia is a major example, hosting extensive Archean ultramafic–mafic intrusions and greenstone belts. Key areas include the Widgiemooltha, Kambalda–Widgiemooltha, and Norseman–Wiluna belts.

Al Kalbani, M. (2025). Characterizing multi-physics of enhanced carbon dioxide mineralization in ultramafic rock under in situ conditions.



Distribution of Mg- and Ca-rich minerals across Australia and New Zealand, with circle size representing the number of reported occurrences compiled from **Mindat.org**. Abbreviations: WA (Western Australia), NT (Northern Territory), QLD (Queensland), NSW (New South Wales), VIC (Victoria), SA (South Australia), TAS (Tasmania), NZ (New Zealand).

Aggregate Characterisation Experimental Plan

Test Name	Test description	Test Standard	Available lab	Status
Short Impact Load Cell (SILC)	Aggregate mechanical performance: tensile strength, fracture energy and stiffness	-	JKMRC	Completed
Scanning electron microscopy (SEM)	Microscopic study	-	SEES	Completed
Drop Shape analyser (DSA)	Aggregate wettability: measure through contact angle	-	UQ CMM	Completed
Shape analysis	Angularity and circularity using optical microscopy	-	UQ CMM	Completed
Thermal Conductivity	TPS	BS EN ISO 22007-2	UQ fire lab	Completed
X-ray diffraction (XRD)	Mineral Composition	-	UQ CMM	Completed
X-ray fluorescence (XRF)	Chemical composition	AS/NZ 2350.2	UQ fire lab	Completed
Thermal Analysis	TGA	-	UQ fire lab	Completed
Specific gravity	Measure through helium pycnometer	ASTM D4892	UQ geo lab	Completed
Carbon Absorption	SIP Measurement	-	UQ geo lab	Completed
SSD moisture content	Aggregate water absorption test	AS 1141.6.1	UQ geo lab	Completed
Density	Dry density, apparent particle density and SSD density	AS 1141.6.1	UQ geo lab	Completed
Particle size distribution	Aggregate grading curve	AS 1141.11.1	UQ geo lab	Completed

Test Name	Test description	Volume of each specimen (L)	No. of specimens	Total Volume (L)	Test age
Slump	Shotcrete consistency measurement through a standard slump	6	1	6	Fresh
Reverse Cone	Shotcrete flowability measurement through a standard slump	Use for slump			
Flow table	Specific test setup for shotcrete flowability and workability.				
Bleed & Density	Measuring the density and volume of bleed in batched shotcrete.	13.7	1	13.7	
Air content	Measuring through a standard air content meter.	7.0	1	7.0	
AVPV	Water absorption measured on one standard cylinder at each test age.	1.6	1	1.6	7, 28, 56
Beam end	Mixing with accelerator and moulded into shrinkage mould for testing.	1.6	3	6.0	3h, 5h
Core Strength	Compressive strength of cored specimen from mix with accelerator	8.0	1	8.0	28
UCS	Standard cylinder used to measure compressive strength.	1.6	9	14.1	7, 28, 56
Brazilian test	Standard Brazilian cyliner used.	5.3	3	15.9	7, 28, 56
Bulk resisitivity	3 standard cylinder used for each mix in long-term durability measurement.	1.6	3	4.7	As per standard
Carbonation	Carbonation rate analysed through measured depths - 5 cylinders required for each mix	1.6	7	11.0	As per standard
Drying shrinkage	Drying shrinkage measurement with standard shrinkage specimens	1.6	3	4.8	As per standard
ASR	ASR long-term measurment on three standard shrinkage specimens	1.6	3	6.0	As per standard
Creep	Long-term creep measurement. Six standard cylinders required.	1.6	5	7.9	As per standard



Dunite



Aggregate A



Aggregate B



Aggregate C

- Dunite extracted from Greenhills, New Zealand, supplied by Hardie Pacific
- Aggregates were proceeded with 20 mm standard crushing.
- Benchmark aggregates were selected from conventional shotcrete aggregates.

Oxides	Dunite	Aggregate A	Aggregate B	Aggregate C
SiO ₂	42.17	63.31	82.86	75.76
CaO	1.48	3.71	0.02	17.27
MgO	44.12	6.83	5.07	<0.01
Al ₂ O ₃	3.05	16.56	9.33	2.74
Fe ₂ O ₃	8.57	4.93	<0.01	2.99
K ₂ O	0.09	3.52	0.91	0.5
SO ₃	0.07	0.22	0.1	<0.01
TiO ₂	0.03	0.55	0.28	0.16
Cr ₂ O ₃	0.15	0.01	0.01	0.09
BaO	<0.01	0.06	0.04	0.04
ZrO ₂	<0.01	0.04	<0.01	0.04
MnO ₂	0.15	0.13	0.02	0.04
ZnO	<0.01	0.01	<0.01	0.02

- Dunite distinguishes the other aggregates in chemical composition, with main composition of magnesium, silicon oxide and sufficient content of ferric oxide.
- Test powder size <150 µm, same applied in XRD, TGA and TPS.

Parameters	Aggregate A	Dunite	Standard
Initial Moisture Content (%)	0.20	0.99	-
Specific Gravity	2.72	2.90	ASTM D5550
Water Absorption (%)	1.41	1.52	AS 1141.6.1
Apparent Density (t/m ³)	2.72	2.86	
Dry-basis Density (t/m ³)	2.62	2.74	
SSD Density (t/m ³)	2.65	2.78	

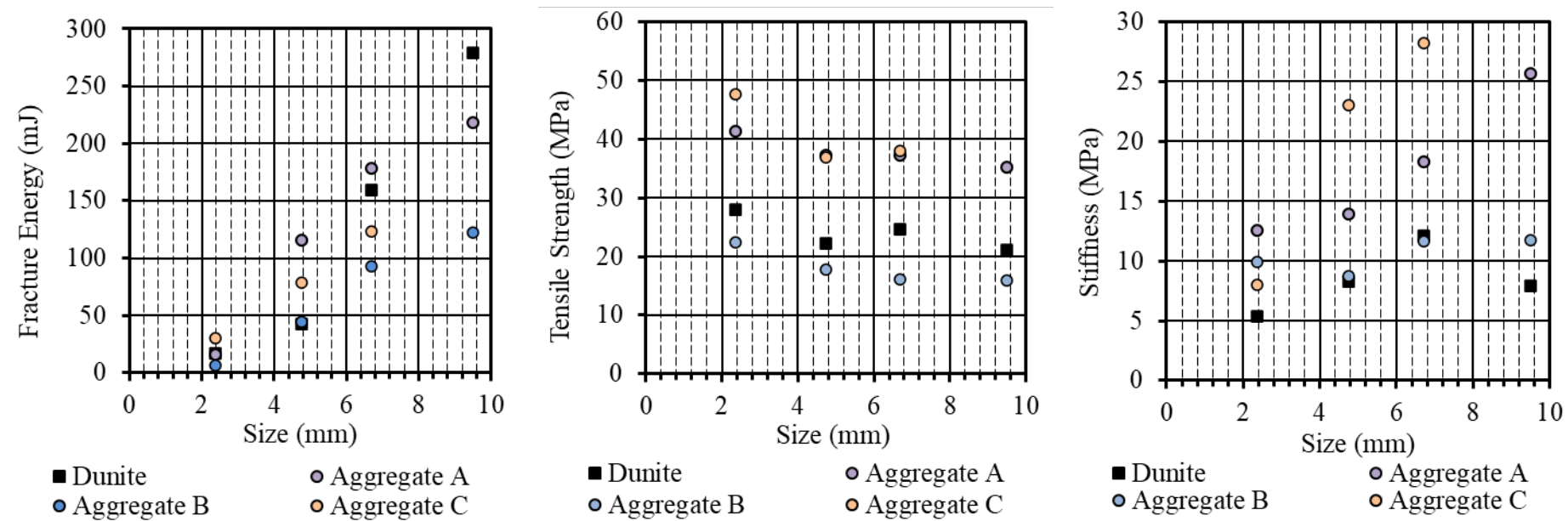
- Dunite obtained greater specific gravity due to greater content of Ca, Mg elements, while greywacke is with more Si elements (less atomic mass).
- Similar water absorption between two samples suggest similar water-permeable porosity.



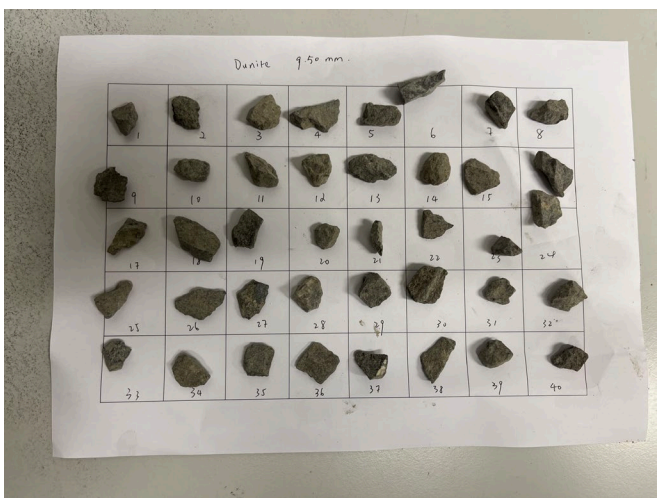
Aggregate in water



Ultramafic aggregate at SSD state



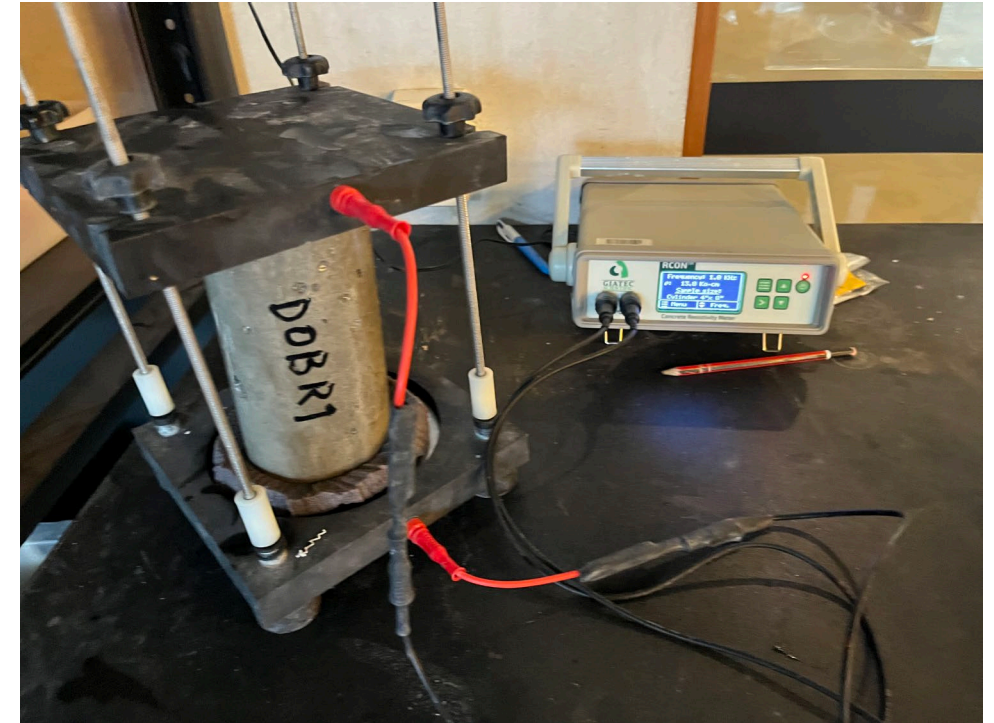
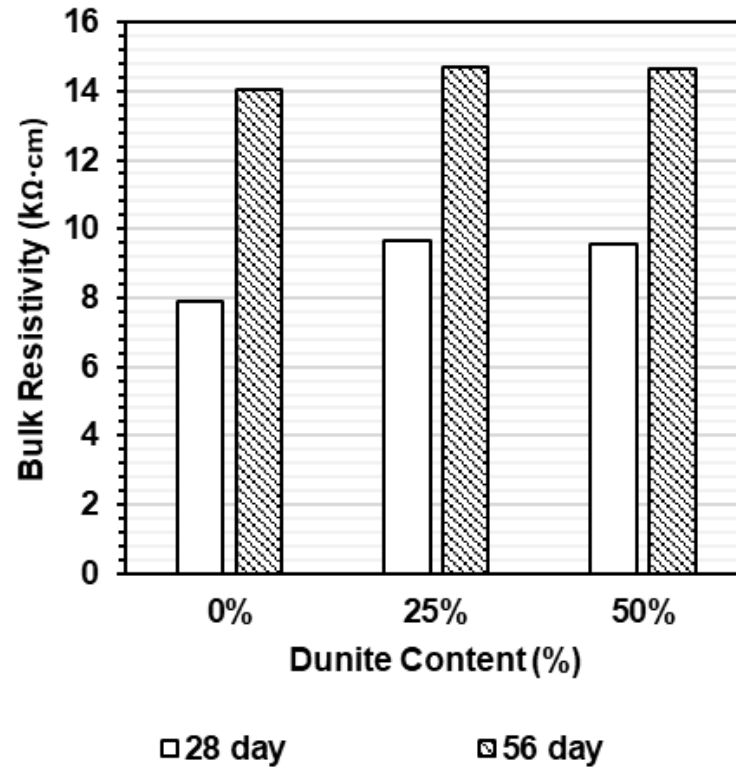
- Dunite demonstrates comparable mechanical performance among the aggregates
- Its tensile strength and stiffness are slightly below the average but maintain a fracture energy slightly above.
- This indicates its potential in slight reduction in concrete strength and stiffness but obtain greater fracture toughness.



Forty 9.5mm dunite aggregates for test



SILC test



- Samples are immersed in mixed hydroxide solution with calcium (Ca), potassium (K) and sodium (Na) for at least six days before testing (ASTM C1876).
- Slight enhance in bulk resistivity with dunite inclusion, suggesting better durability in ion penetration mitigation.



CO₂ gas cylinder



Water inlet and outlet



CO₂ connector



Hole for cable inlet

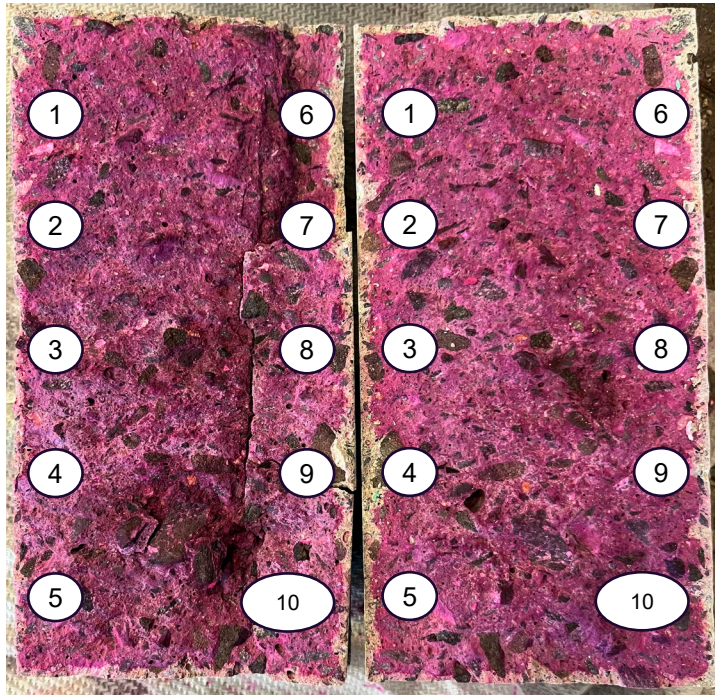


TEC carbonation chamber

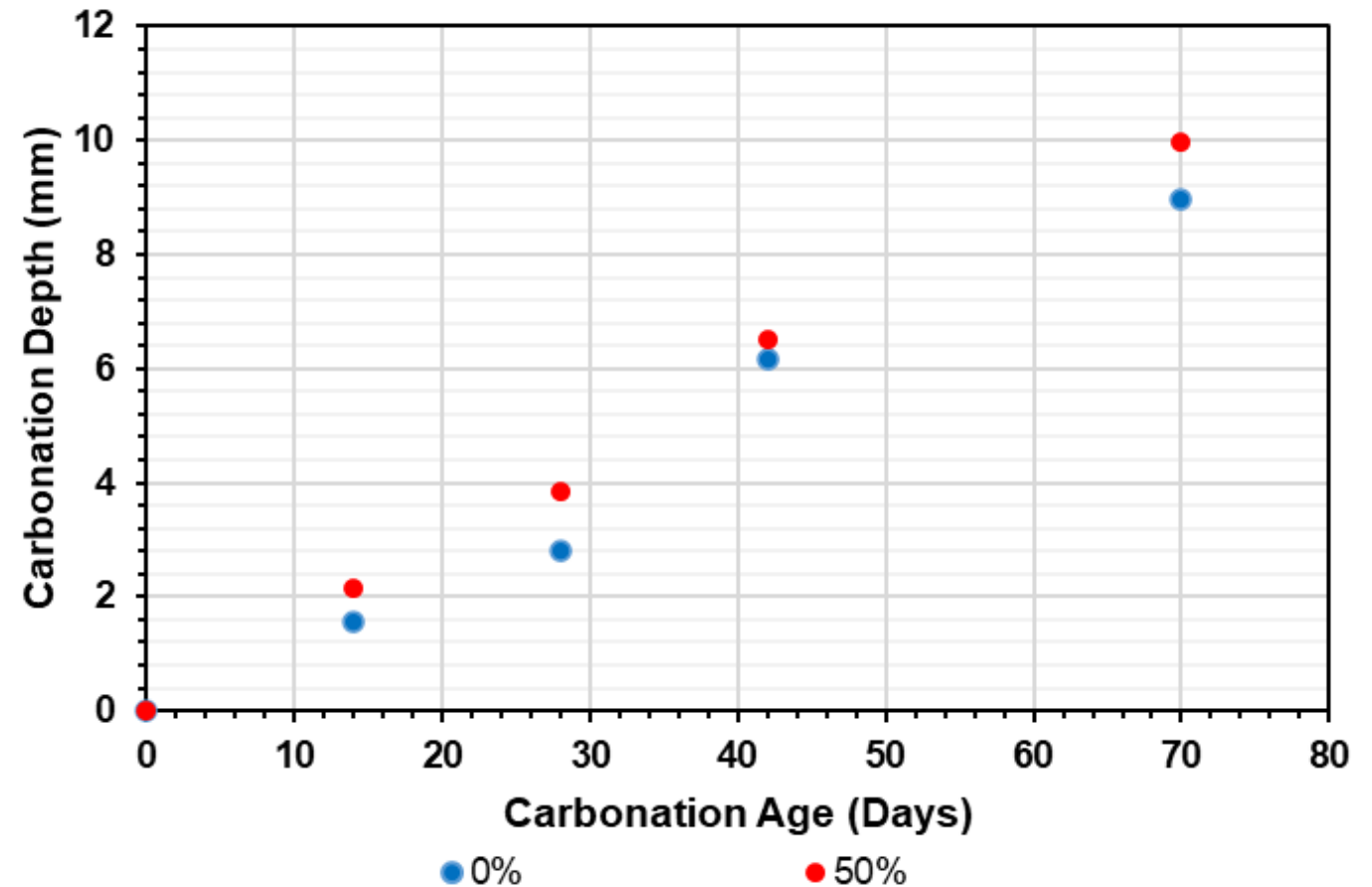


Reinforced racks

- Carbonation Chamber (Thermoline TEC humidtherm 460L)



Carbonation depth measurement



Carbonation depth (0% vs 50% dunite)

Significant increase dunite mix is observed across the carbonation process, but follows a similar trend, indicating that although ultramafic aggregates inclusion particularly accelerates the initiation of carbonation, but not accelerating the entire absorption rate.

- Dunite as an aggregate is similar to other conventional aggregates used in concrete and shotcrete production in terms of mechanical, thermal, morphological properties and moisture interactions. The main difference is in chemical and mineralogical as it is ultramafic aggregate, other aggregates are primarily siliceous.
- Shotcrete incorporating dunite aggregates demonstrates no significant adverse performance in its fresh performance, mechanical strength and durability-related properties.
- Carbonation to date has shown enhancement with its carbon absorption, but further evidence from microstructure is required. Furthermore, better distinguishment should be observed with accelerated CO₂ conditioning (higher temperature and CO₂ concentration)

Ultramafic aggregates allow concrete infrastructure to act not only as a structural system, but as a slowly active carbon sink - without sacrificing performance

Future work should focus on **field-scale validation**, detailed carbonation quantification, **fire resistance** evaluation, and upscaling under realistic curing and production conditions. These efforts will provide critical insights into the practical application of dunite as a CO₂-reactive aggregate, supporting the development of low-carbon construction materials and sustainable infrastructure.

Thank you

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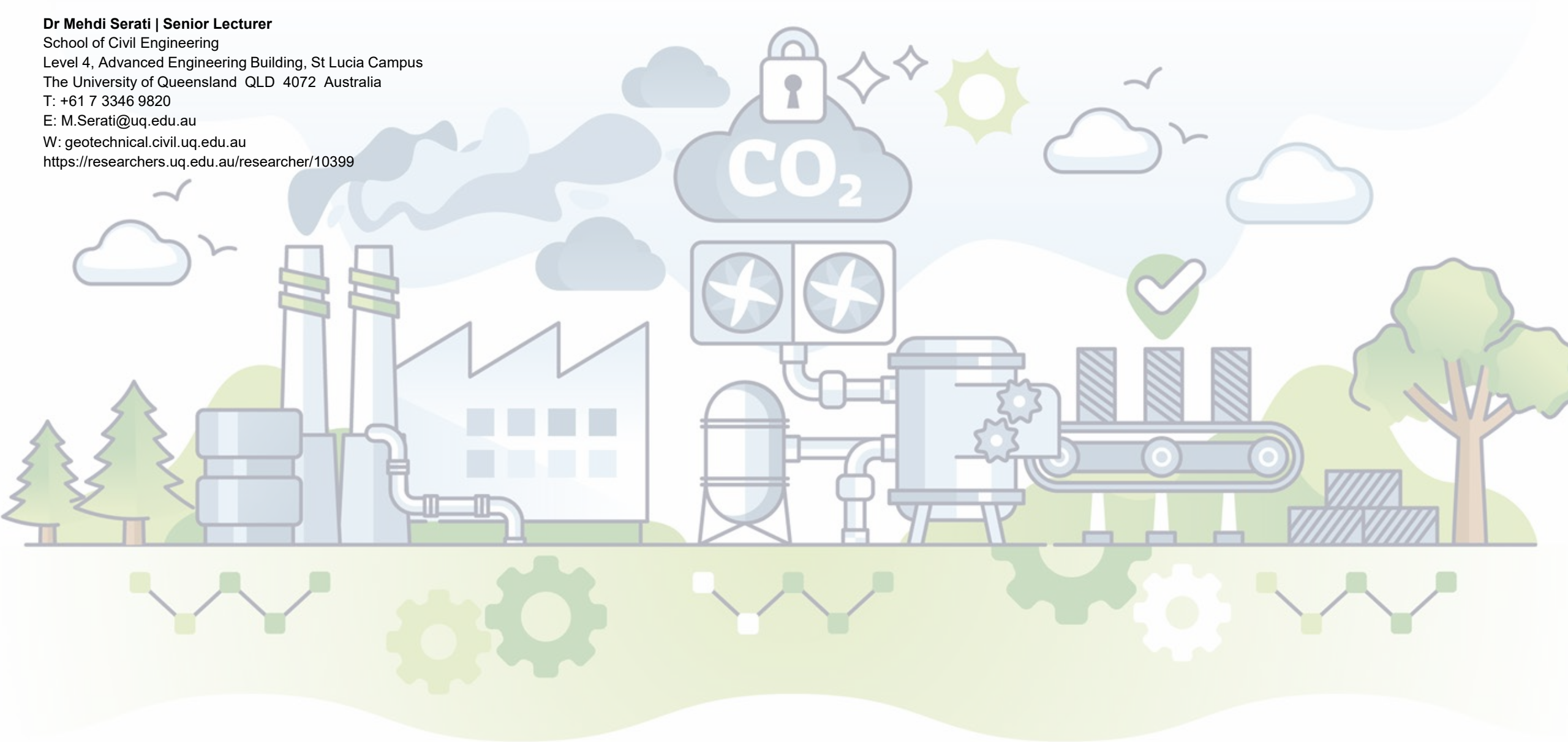
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<https://researchers.uq.edu.au/researcher/10399>



Microwave Assisted Pyrolysis of Hemp for Sustainable Biochar Production

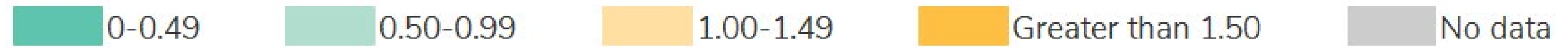
Prof. Mohan Jacob
Mrs Muliwana Arifudin
Prof. Graham Brodie
Dr Saeed Moarrefi
Dr Mahmood Sadat -Noori
James Cook University



Prof. David Rowlings
Queensland University of Technology

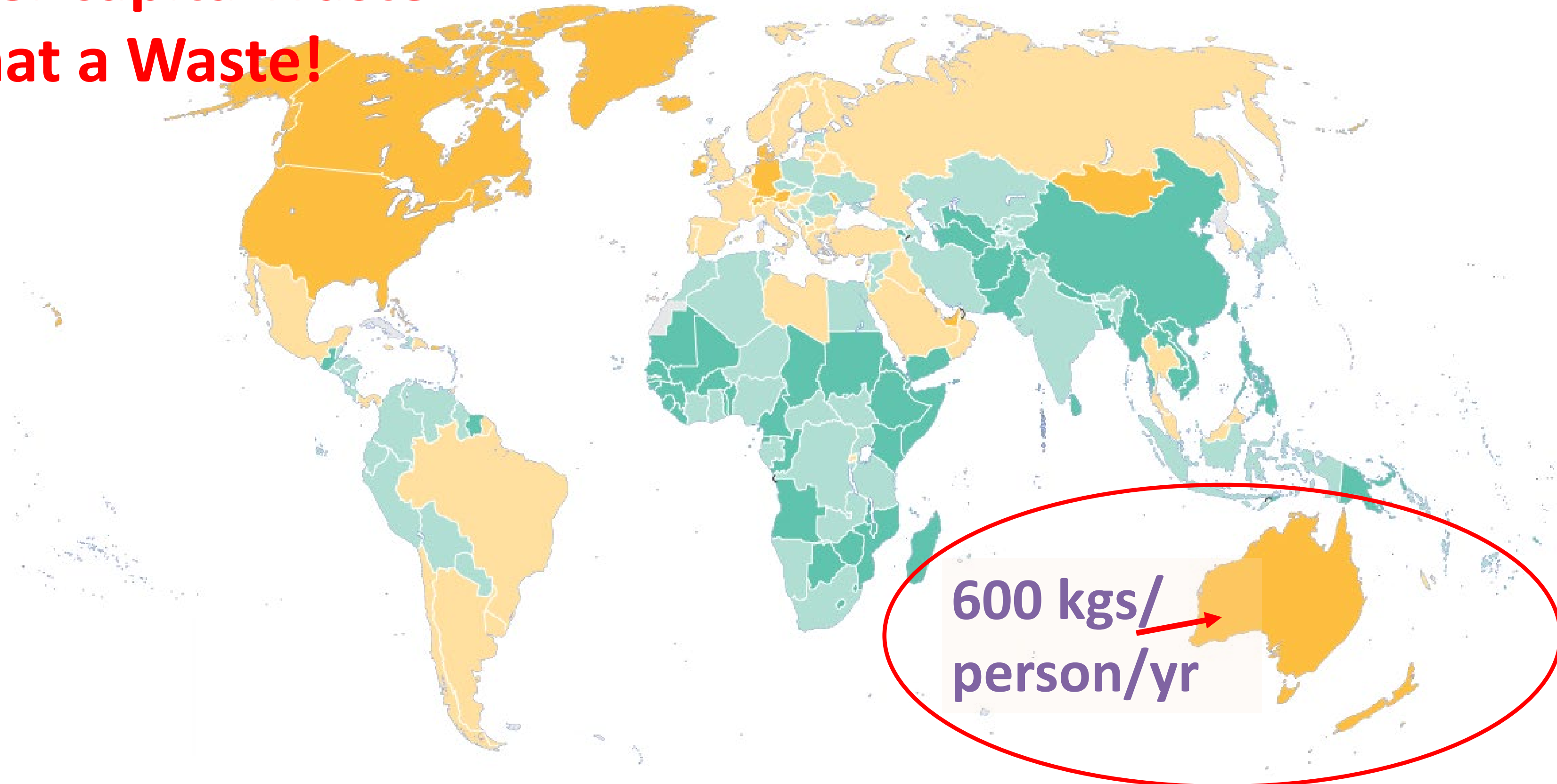
Industry Partners
➤ Wandarra
➤ Atlas Soil

Contact
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0406374570



Daily per capita Waste

What a Waste!



Hemp, Hemp products and waste

- **Fast-growing, high-yield crop:** Hemp produces large biomass in a short time, making it an efficient and reliable feedstock for many construction / building / furniture applications
- **Low-input and sustainable crop:** Hemp requires relatively low fertiliser, pesticide, and water inputs compared to many conventional crops.
- **Strong carbon sequestration potential:** Hemp captures significant amounts of CO₂ during growth
 - Hemp could be used in a myriad of applications

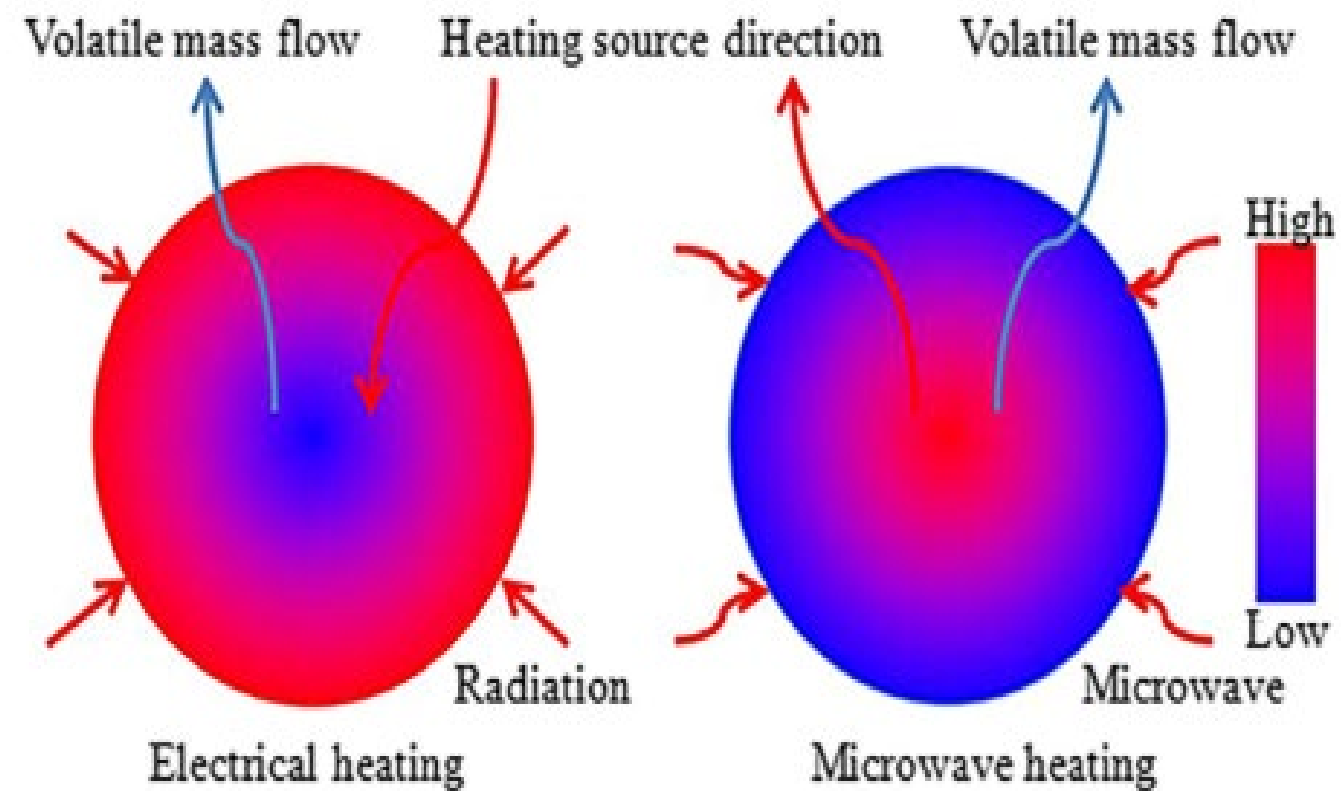


- Though most parts can be used, still lots of waste is also produced
- This may have potential use if converted into another form

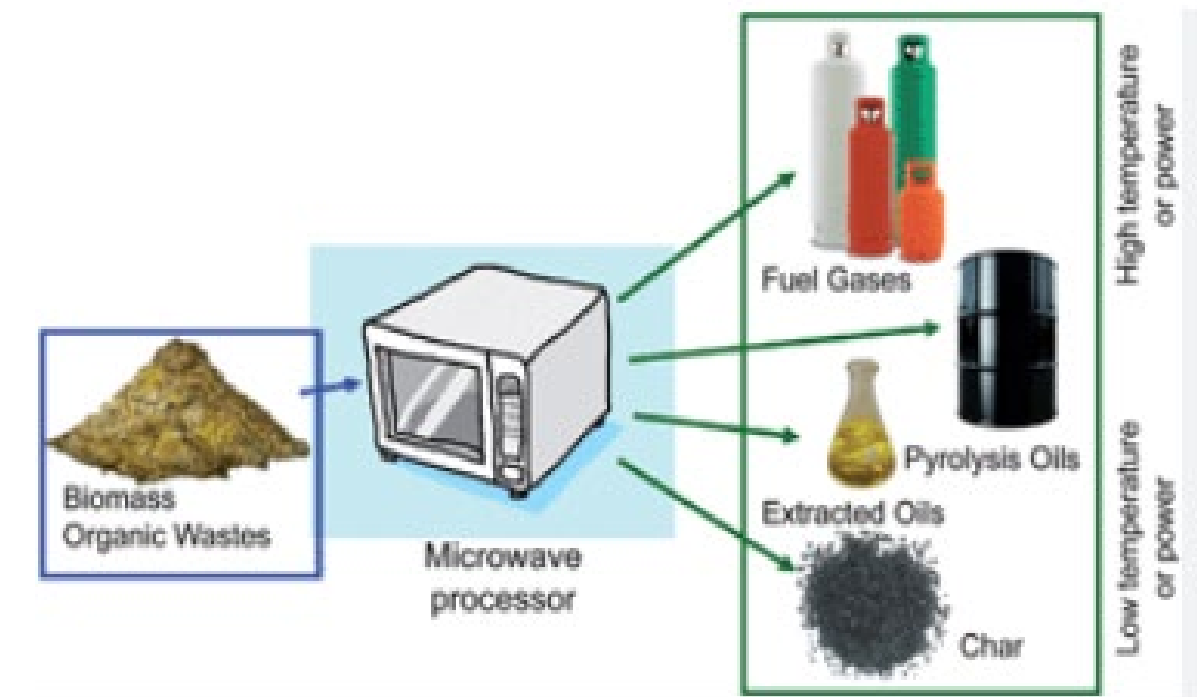


Thermochemical conversion

Conventional pyrolysis Vs MAP



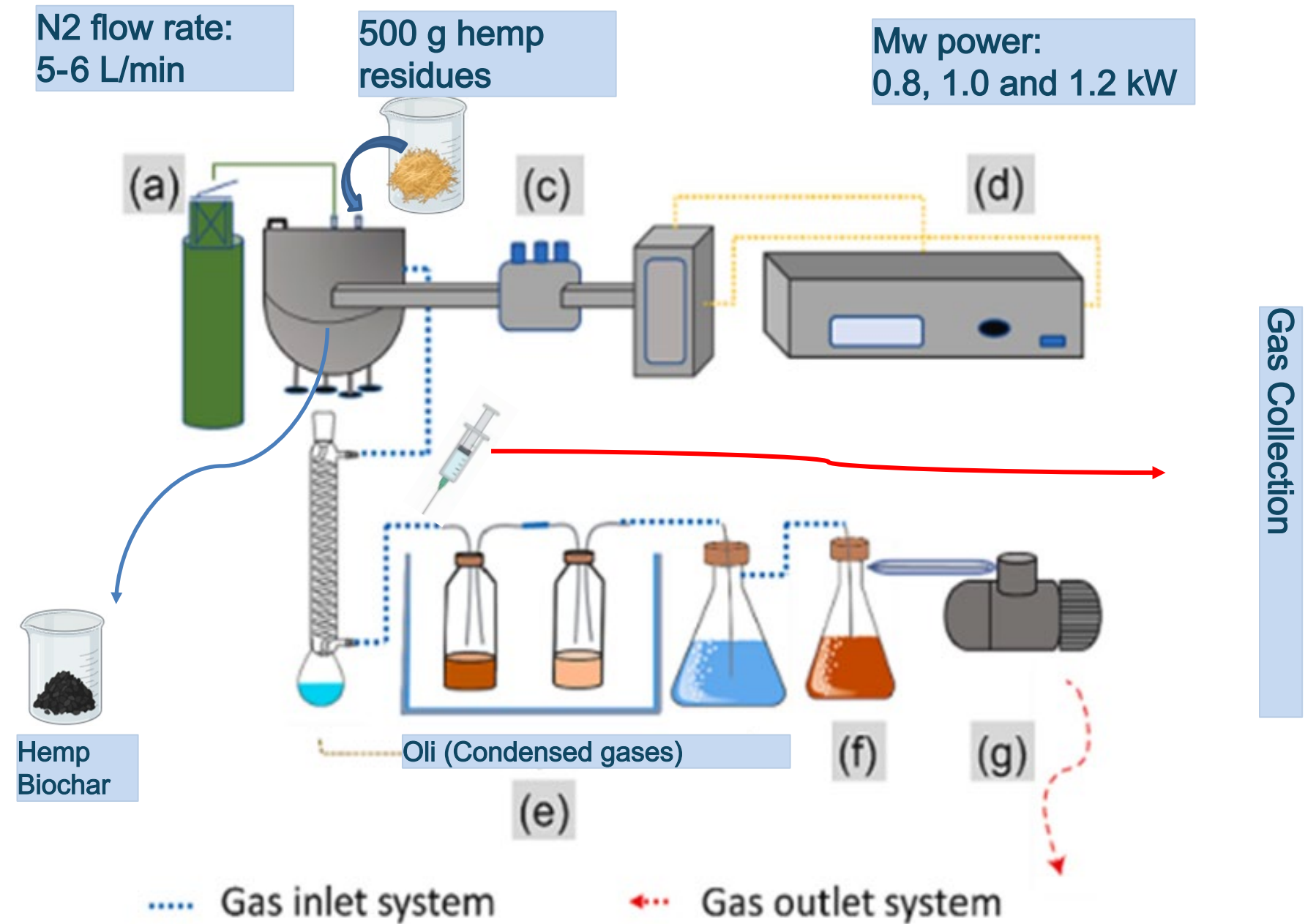
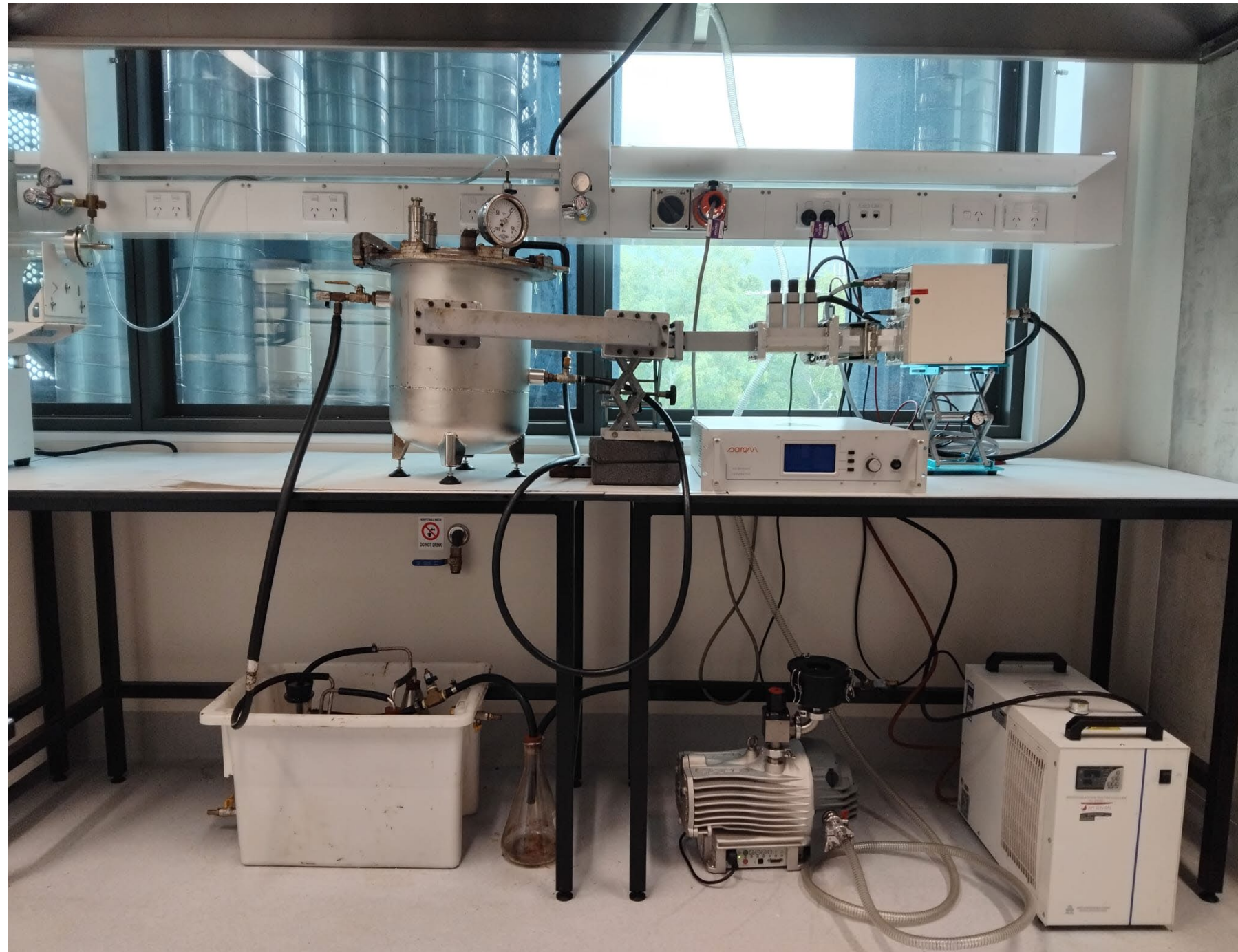
Microwave-assisted pyrolysis (MAP)



- More uniform heating
- Faster conversion
- Greater control over reaction condition

Biochar Production and Characterizations

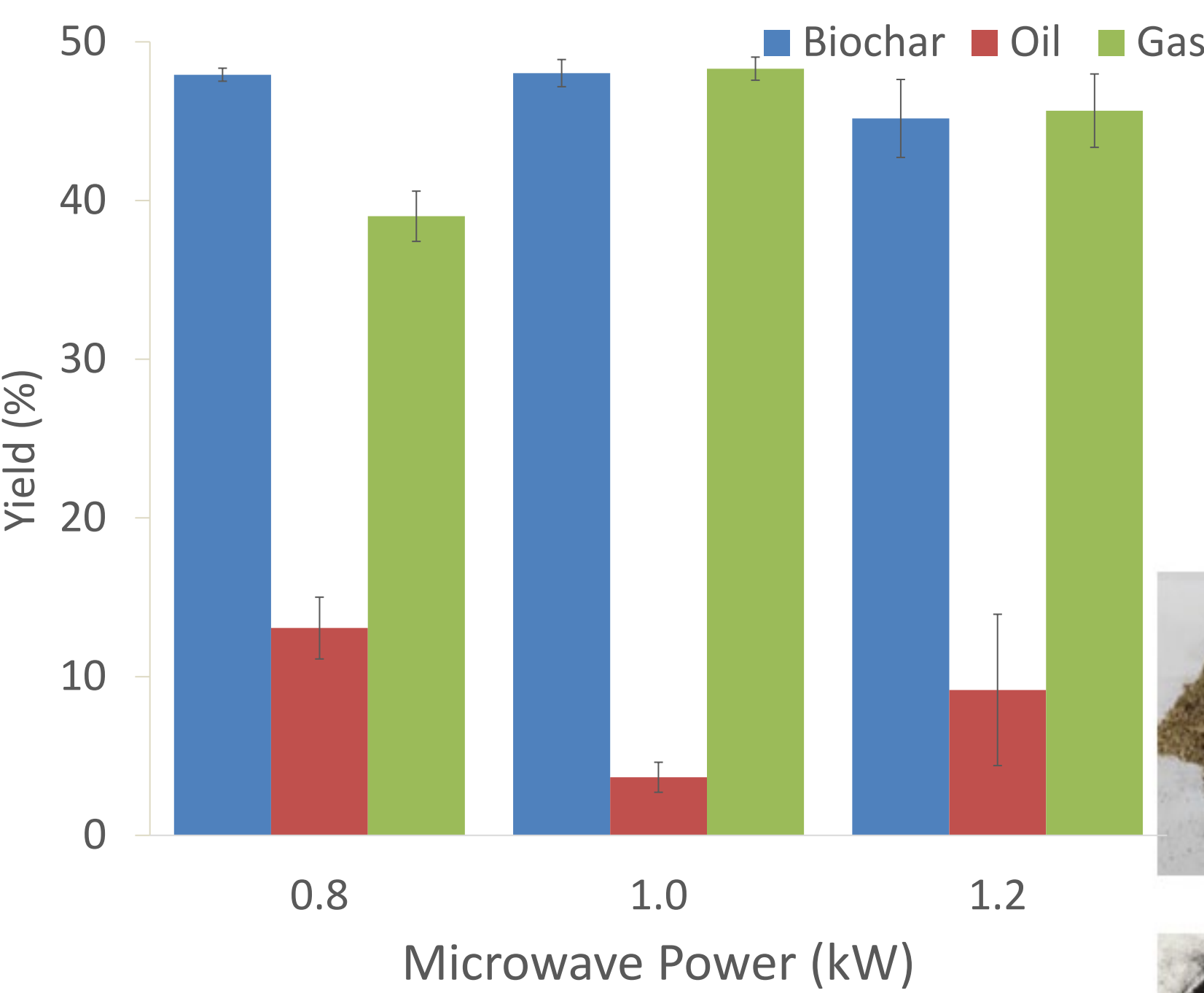
Microwave-assisted Pyrolysis



Characterizations:

1. Yield
2. density
3. Proximate analysis
4. Elemental analysis
5. Surface area and porosity
6. Functional group analysis
7. Surface morphology analysis

Byproducts Yield



Hemp Dust



Hemp Char 0.8 kW



Hemp Char 1.0 kW



Hemp Char 1.2 kW

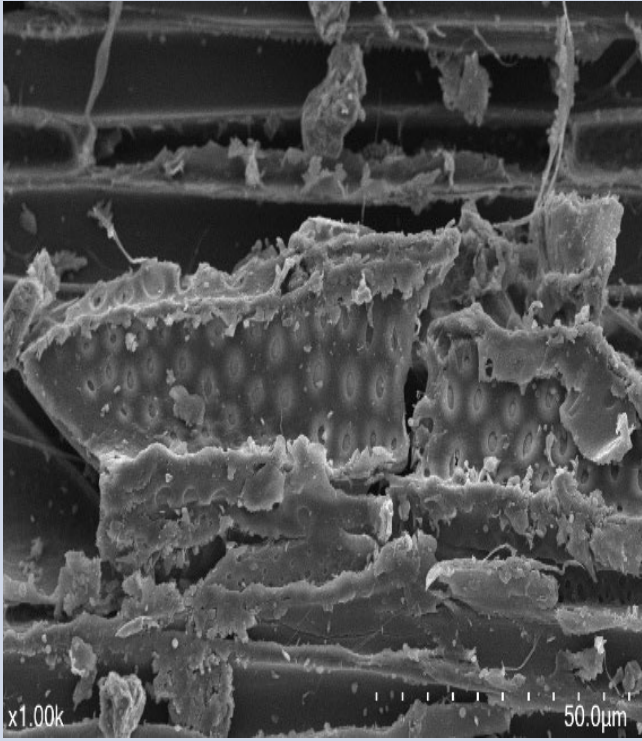
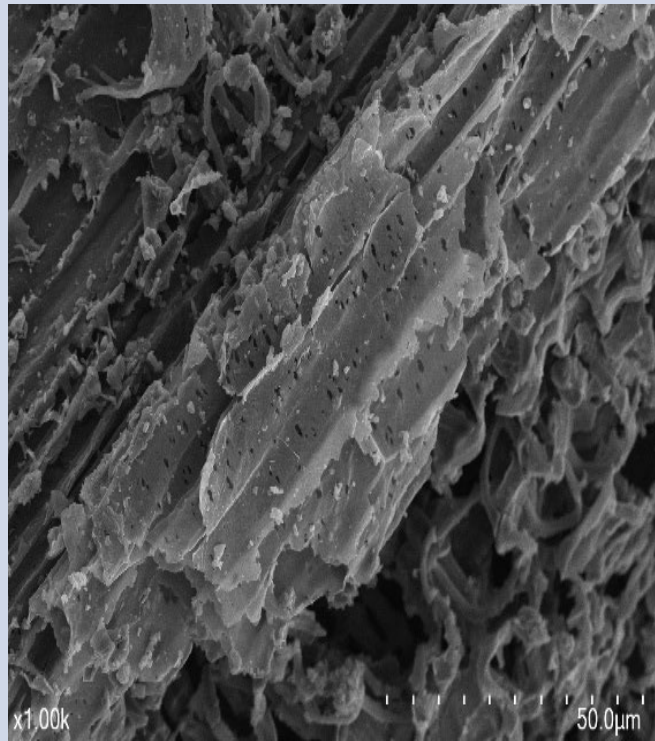
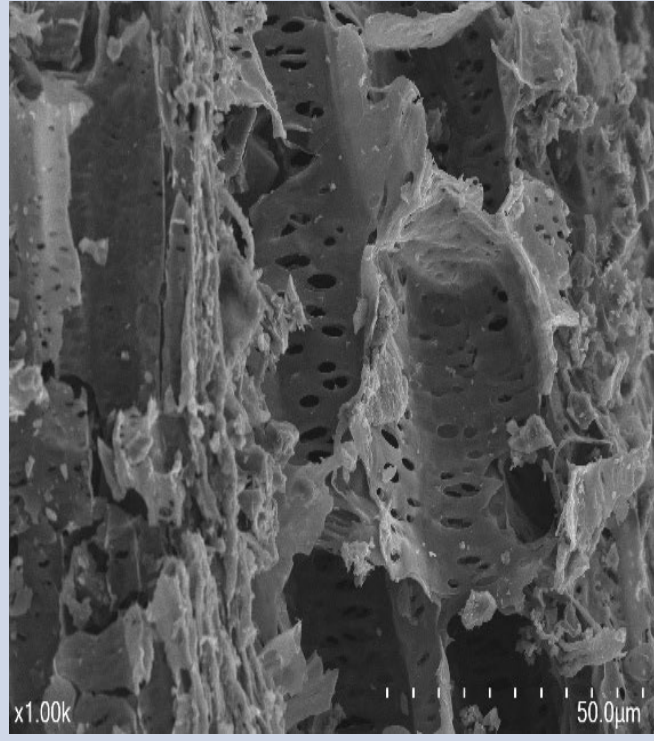
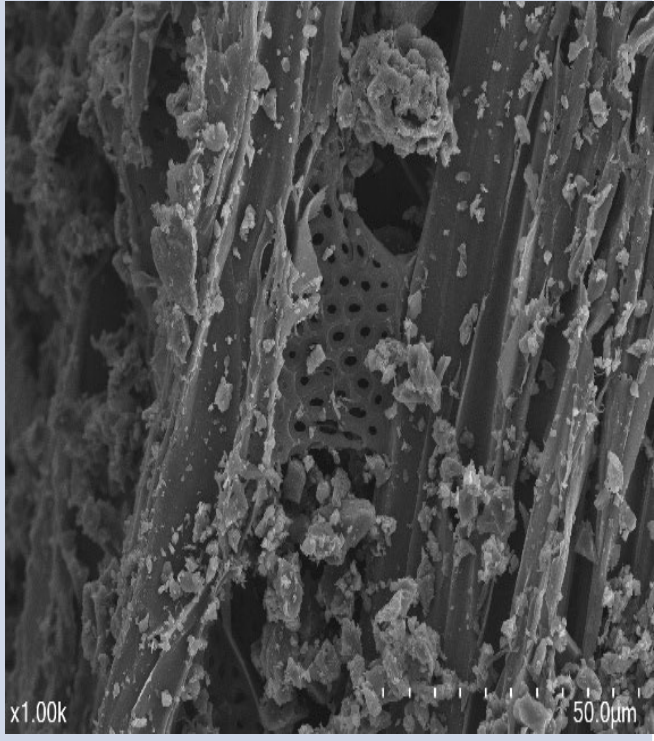
Hemp dust: Byproduct Yield

Char Characterisation

Physico-chemical properties

Properties	Hemp Dust	HC 0.8 kW	HC 1.0 kW	HC 1.2 kW
Density (g/cm ³)	1.5133	2.1848	2.1951	2.3697
Proximate analysis (%):				
Moisture content	8.75	1.401	1.130	1.225
Volatile matter	17.51	60.856	58.969	58.546
Ash	73.37	21.142	22.615	24.604
Fixed carbon	0.37	16.601	17.286	15.625
Ultimate Analysis (%):				
C	41.15	58.63	53.17	56.60
H	5.81	1.62	1.20	0.94
N	1.42	1.63	1.46	1.32
S	0.07	0.07	0.07	0.10
O	51.55	38.05	44.10	41.03

Structural properties

Characteristics	Hemp Dust	HC 0.8 kW	HC 1.0 kW	HC 1.2 kW
BET Surface Area (m ² /g)	1.04	128.15	138.01	149.63
Pore volume (cm ³ /g)	0.005	0.103	0.105	0.112
Surface morphology (SEM)				

- Substantial activation and pore development
- High surface area: essential parameter for soil water and nutrient holding capacities

Application rate of hemp biochar on seedling growth (pot experiment)

Radish: Seedling growth, measurement and analysis

Seedling growth and measurement



2 weeks

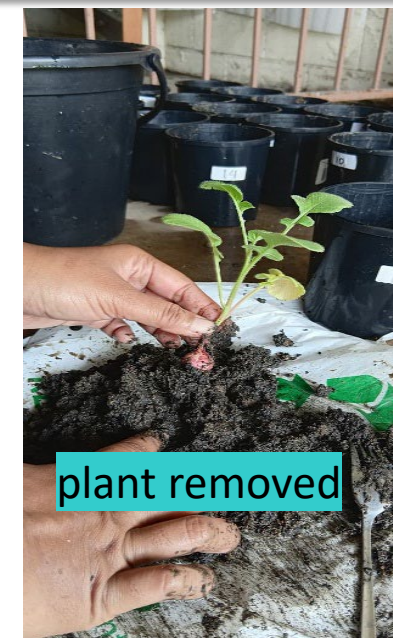


4 weeks



- 10 weeks
- Partial shade
- Daily watering

Harvest , measurement and analysis



plant removed



Plant washed



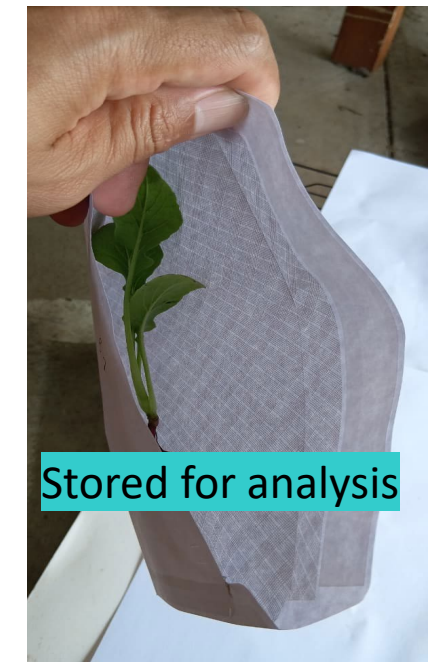
Plant measured



Plant measured

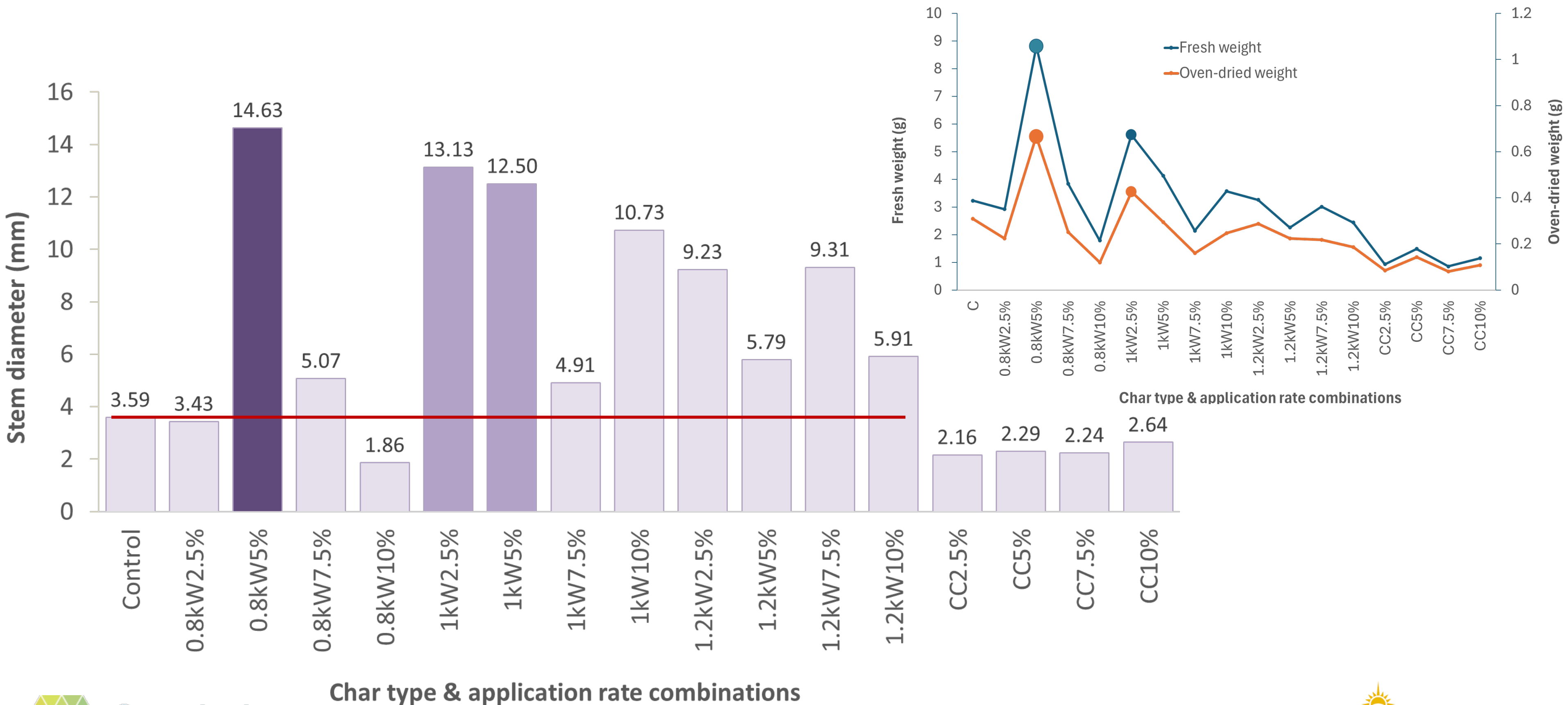


Plant weighed



Stored for analysis

Stem diameter & weight of seedlings



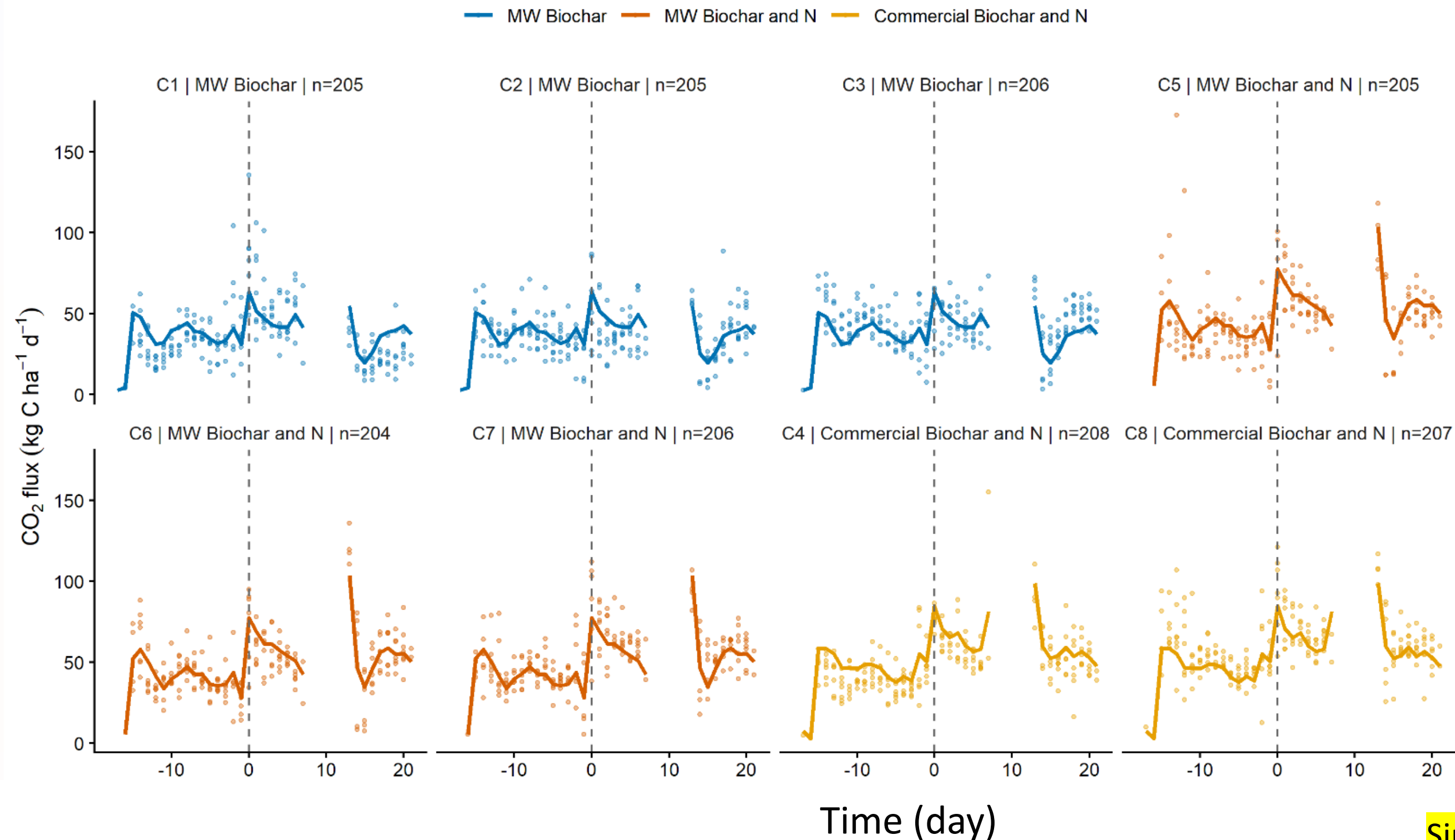
Application of hemp char: greenhouse gas fluxes from soil (field study)

Research site (QUT) and soil properties



Site:	
Name	QUT Samford Ecological Research Facility (SERF)
Biome	Subtropical
Latitude-Longitude	27.22S – 152.54 E
Annual precipitation	1101 mm
Mean annual temperature	20°C
Climate decomposition index	0.71
Soil:	
Type	Chromosol
Silt and clay (%)	30
Sand (%)	70
Total C (%)	1.5 (±0.13)
CEC (cmol/kg)	9
pH	5.4

CO₂ flux from automatic chamber



Treatment	g_c_ha_d
MW Biochar	39127.19
MW Biochar and N	52143.90
Commercial Biochar and N	50100.73

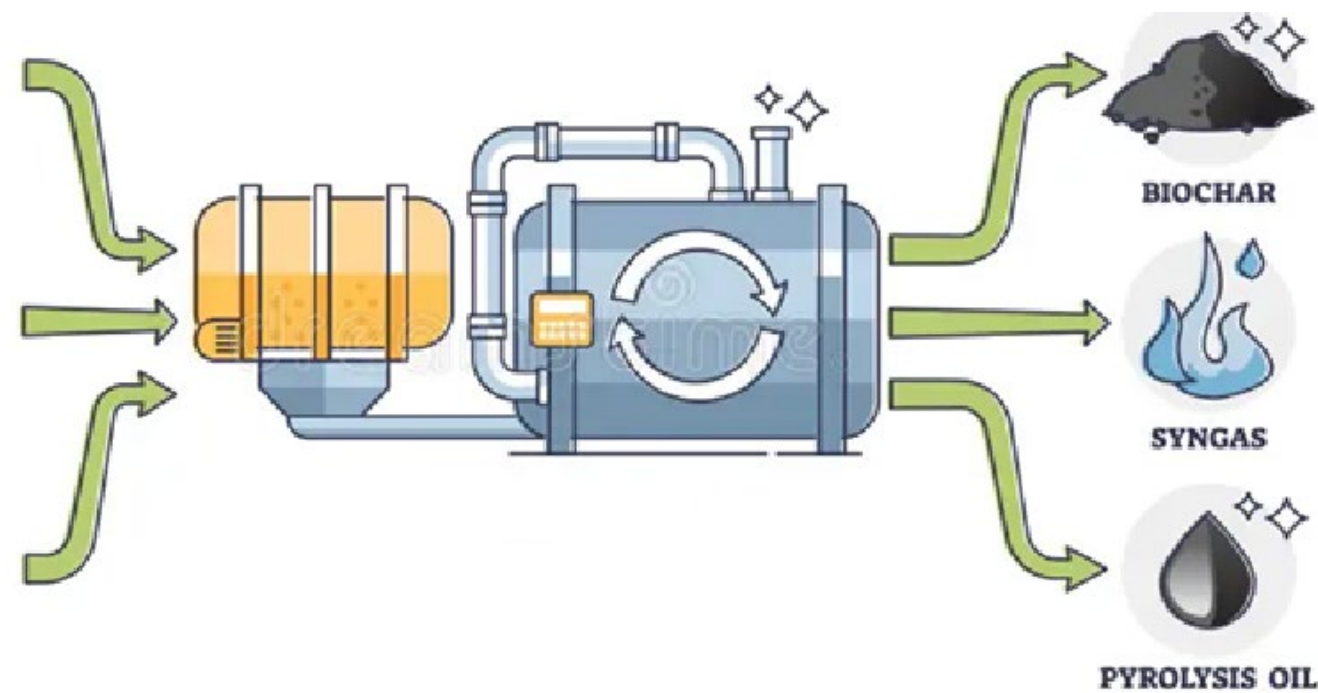
Typical CO₂ flux from soil is
60,000 to 80,000

Advantage is:

39,000 VS ~70,000

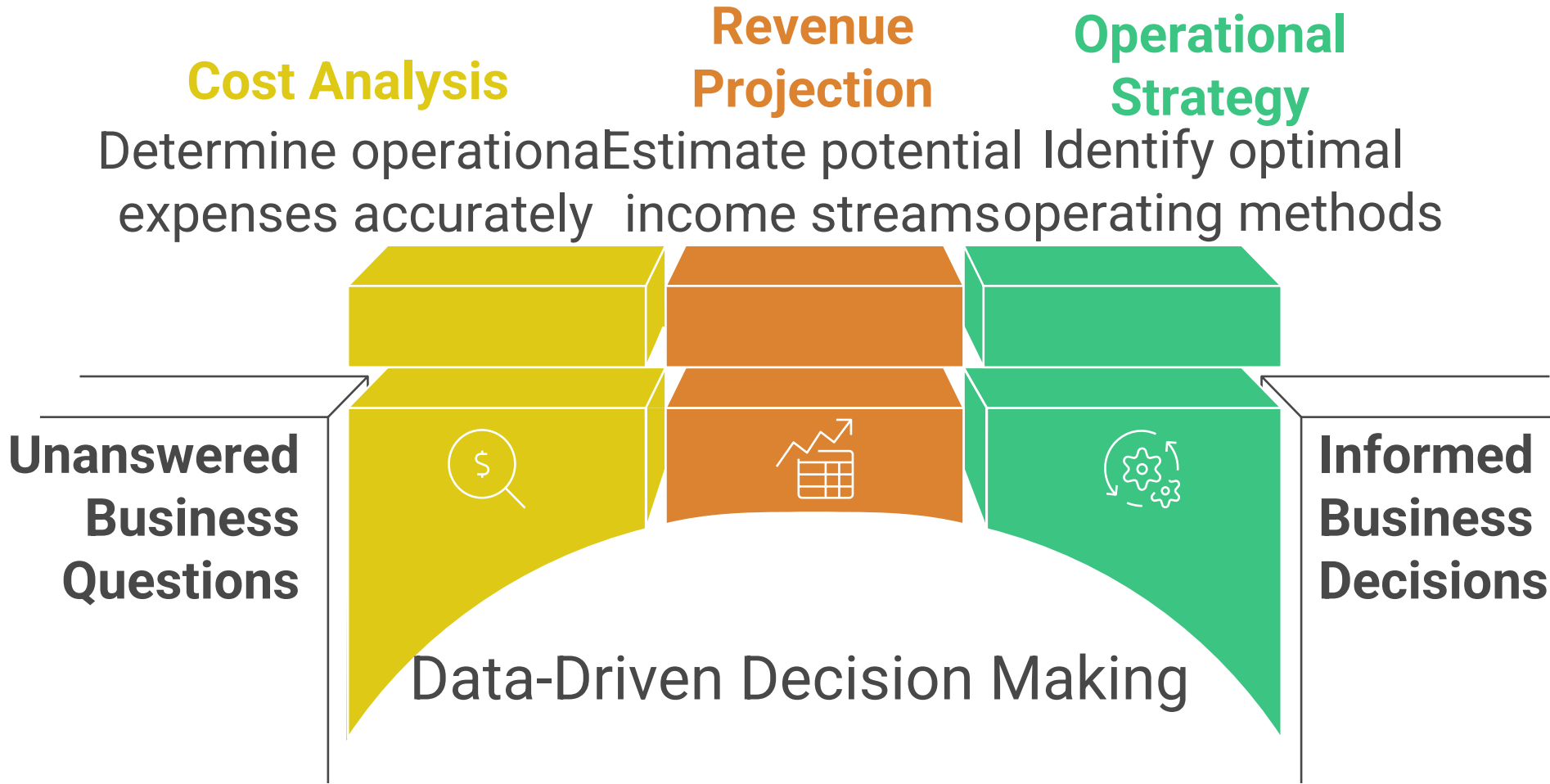
Similar advantages also for CH₄ and N₂O

Techno-Economic Calculations



Product	Yield (approx.)	Role
Biochar	46–48%	Primary revenue driver (70–85% of income)
Bio-oil	4–12%	Secondary revenue (10–20% of income)
Syngas	40–49%	Used on-site to offset electricity costs

Cost item	Share
⚡ Electricity	52%
🚚 Transport	27%
🌿 Feedstock	14%
👷 Labour	5%
Other (Utilities, Maintenance, Insurance, Investment, Tax)	1%

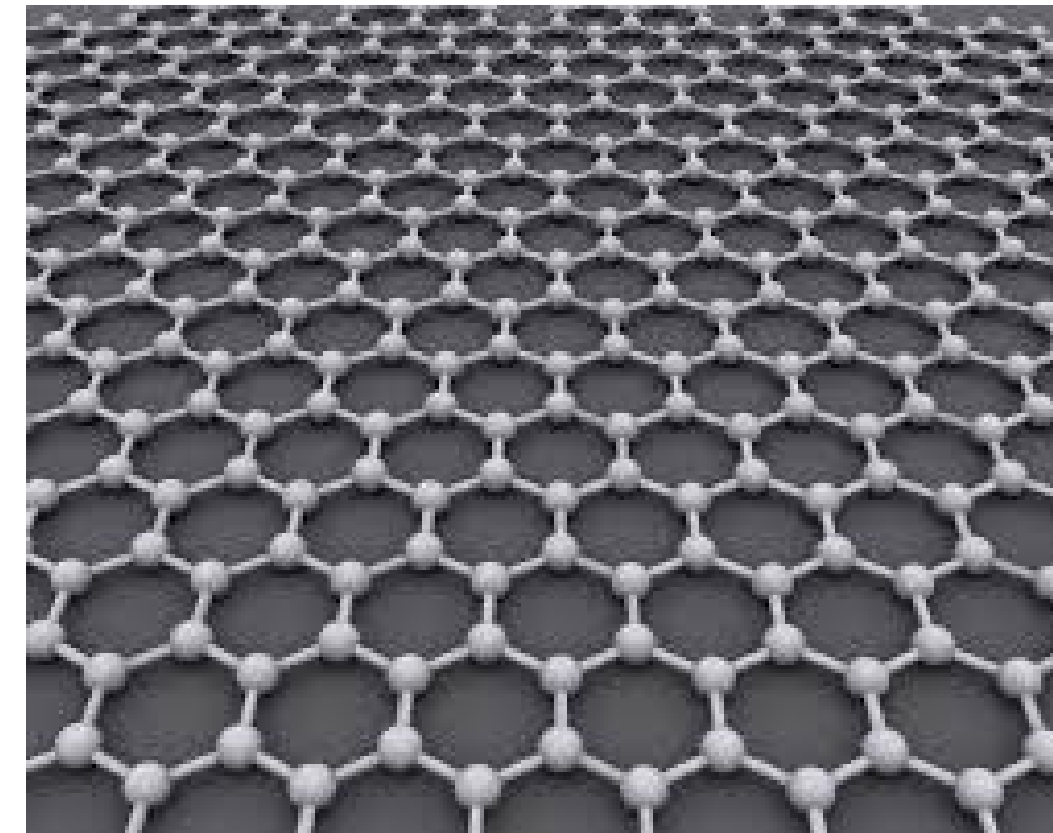


- All 3 scenarios are profitable — positive NPV, $PI > 1$
- 0.8 kW → most profitable, more emissions
- 1.0 kW → cleanest, but lower profit
- 1.2 kW → middle ground on both

What other applications for char?

Graphene

- Conversion of biochar into Graphene
- Single layer of Carbon atoms
- Extremely strong
- Flexible
- Transparent
- Highly conductive
- Expensive (\$1000 - \$20,000 / Kg – depends on quality)
- Many applications

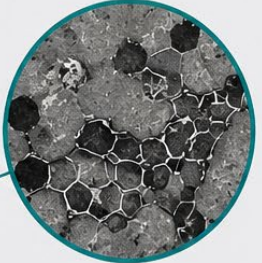


Waste to Biochar to Concrete



GRAPHENE MAKES CONCRETE STRONGER

Adding a small amount of graphene significantly improves the strength and durability of concrete.

WITHOUT GRAPHENE	GRAPHENE	WITH GRAPHENE
Lower strength and more cracking		Higher strength and fewer cracks
		
- Bridges microcracks and limits crack propagation - Improves bonding between cement particles - Enhances strength, toughness and durability - Effective at very low dosage (<0.1%)		 Graphene reinforces the internal structure for superior performance.
COMPRESSIVE STRENGTH ~ 25 MPa		COMPRESSIVE STRENGTH > 30% INCREASE ~ 33+ MPa

✓ STRONGER. TOUGHER. MORE DURABLE. WITH JUST A SMALL ADDITION OF GRAPHENE.

Antibacterial/ Coolant Coatings



Graphene antibacterial deodorant socks



Graphene antibacterial underwear



Graphene antibacterial cool POLO shirt

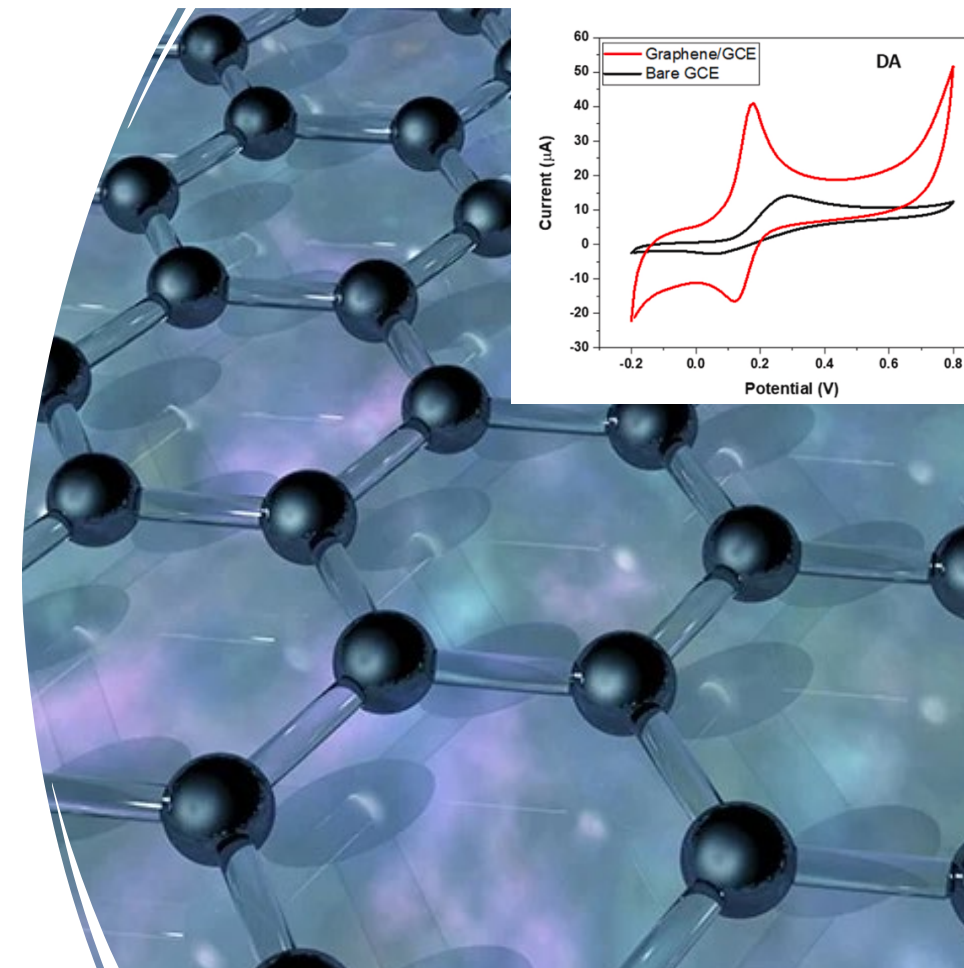


Giselle Bedding Double Mattress 35cm Euro Top with Graphene Cooling Comfort Medium Firm

<https://graphitecentral.com/graphene-textile-fabric>



<https://www.carbon-waters.com/en/graphene-shoes/>



Sensors/ Battery

What is Next!

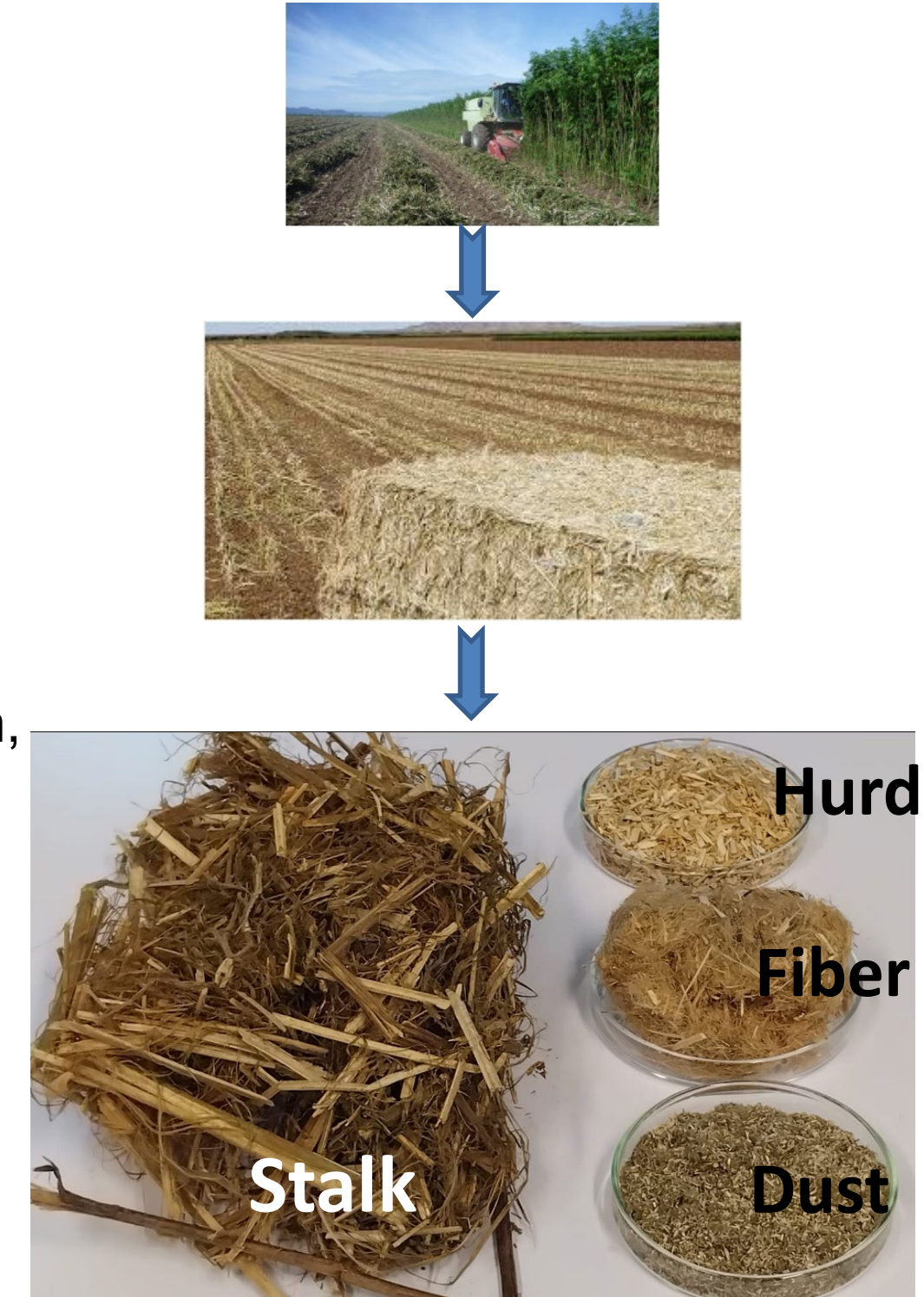
- Scaling up the technology
- Develop Deployable waste processing systems
- Try various organic and non-organic feedstock
- Production of renewable energy from other byproducts
- Utilise renewable energy for running the system
- Apply the char in real farm / lawn conditions
- Finding additional methods to improve the quality of carbon materials and produce high value nano carbon materials
- Improve the carbon sequestration and also include carbon credits in the calculations

Who should use (or adopt) the technology

- ✓ **Queensland Government and policy agencies:** To support circular economy initiatives, agricultural decarbonisation, carbon sequestration strategies, and regional economic development.
- ✓ **Agricultural producers and industry groups:** To identify new pathways for managing agricultural residues while improving soil productivity and farm sustainability.
- ✓ **Biochar producers and technology developers:** To support investment in scalable biochar production systems and regional processing facilities.
- ✓ **Carbon market developers and environmental agencies:** To evaluate opportunities for recognising biochar-based carbon sequestration within emerging carbon accounting frameworks.
- ✓ **Regional development organisations and local governments:** To explore waste-to-value opportunities that create economic and environmental benefits for regional Queensland.
- ✓ **Researchers and innovation providers:** To further optimise biochar production systems and evaluate performance across a broader range of crops, soils, and climatic conditions.

Key Outcomes/ Recommendations

- ✓ **Utilisation of agricultural residues:** Hemp by-products (stalks, hurds, dust) can be effectively valorised into biochar, reducing waste and could be used in for long-term carbon sequestration.
 - Potential for other waste streams
- ✓ **Emission reduction:** Biochar application can reduce soil greenhouse gas emissions, contributing to climate change mitigation.
 - Carbon sequestration, Carbon credits etc should be considered
- ✓ **Soil health improvement:** Hemp-derived biochar enhances soil structure, water retention, and nutrient availability, supporting sustainable agriculture.
- ✓ **Supports circular economy:** Converts biomass waste into a value-added product that benefits agriculture and closes resource loops.
 - Scaling up of the system as well as deployable systems
- ❖ **Multi-sector benefits:** Aligns agriculture, waste management, and climate strategies, making it a strong candidate for integrated decarbonisation solutions.





Thank you for your attention

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