



Hydrogen cost and emissions analysis tools.

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FEnEx CRC Conference 2023

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Part 1: Hydrogen Pathways App

CRC Project: Paths to a sustainable hydrogen supply



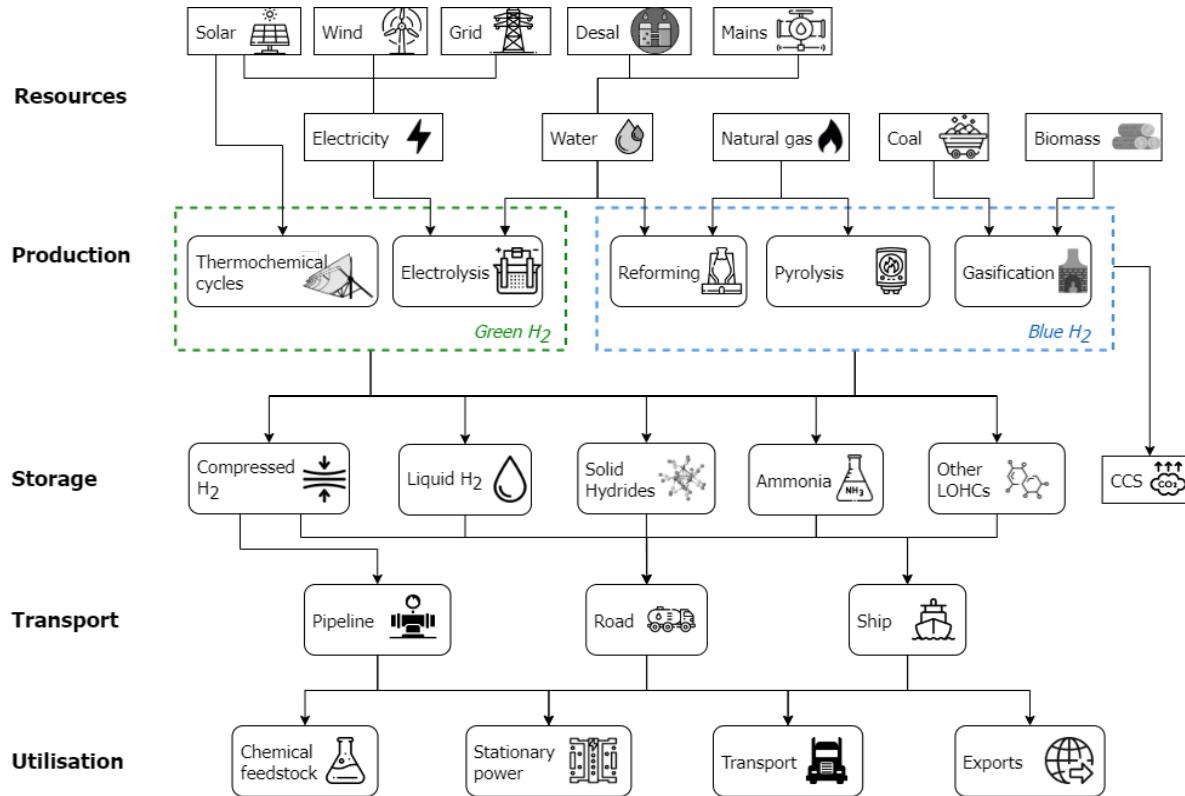
UWA
PERTH · AUSTRALIA

wood.



HORIZON
POWER

The Supply Chain



\$ Cost

CO₂ Emissions

Gears Technical Readiness

Current tools



HSC Tool	H2A	AusH2	HDSAM	HySupply	HyChain
<i>Organisation</i>	NREL	Geoscience Australia	Argonne National Laboratory	GlobH2E	ISPT
<i>Format</i>	Excel	Online app	Excel	Excel	Excel
<i>Economics</i>	✓	✓	✓	✓	✓
<i>Emissions</i>	✓	✗	✓	✓	✗
<i>Stages</i>	Production	Production	Storage & Transport	Production, Ammonia & Shipping	Production, Storage & Transport

What is needed?

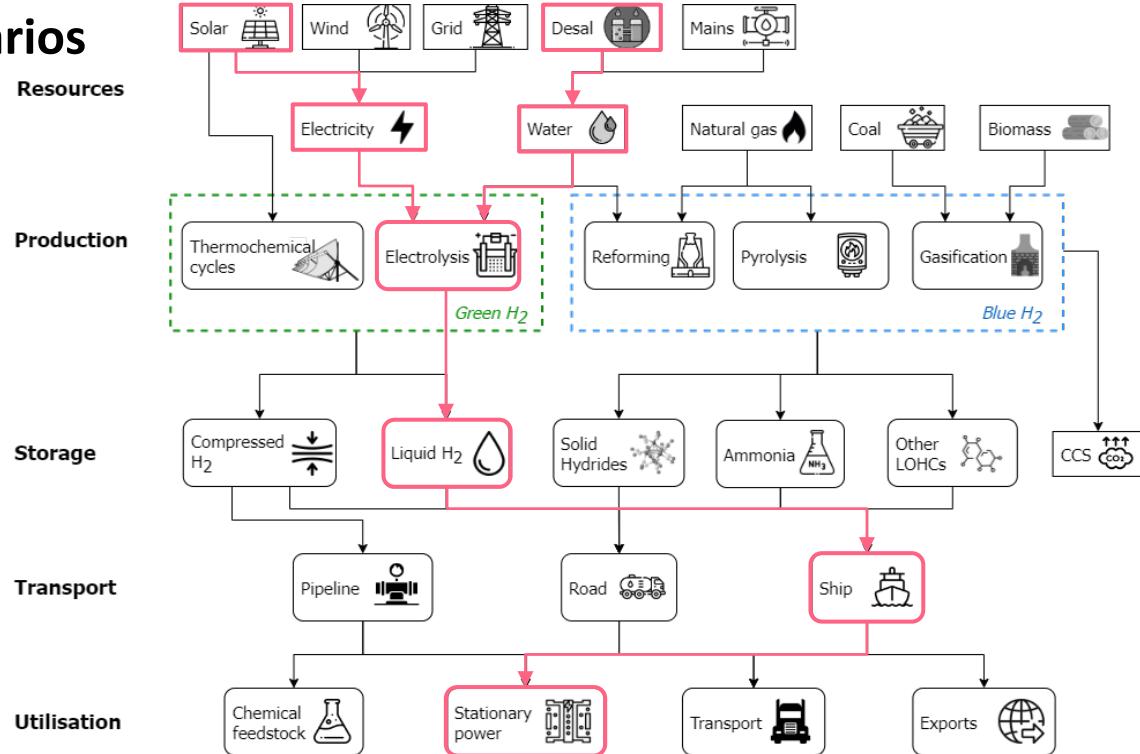
- Flexible & easy to use tool
- Economics & emissions (of all stages)
- Integration of all stages (including utilisation)

H₂Pathways – overview

Tool to evaluate H₂ scenarios



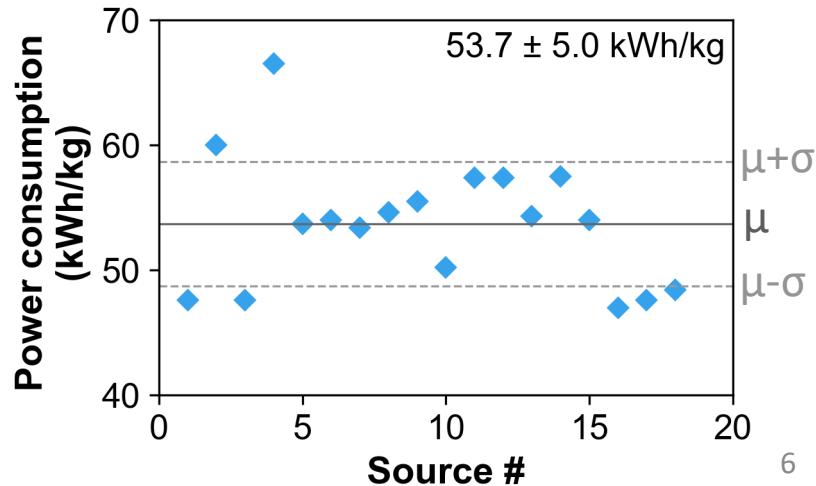
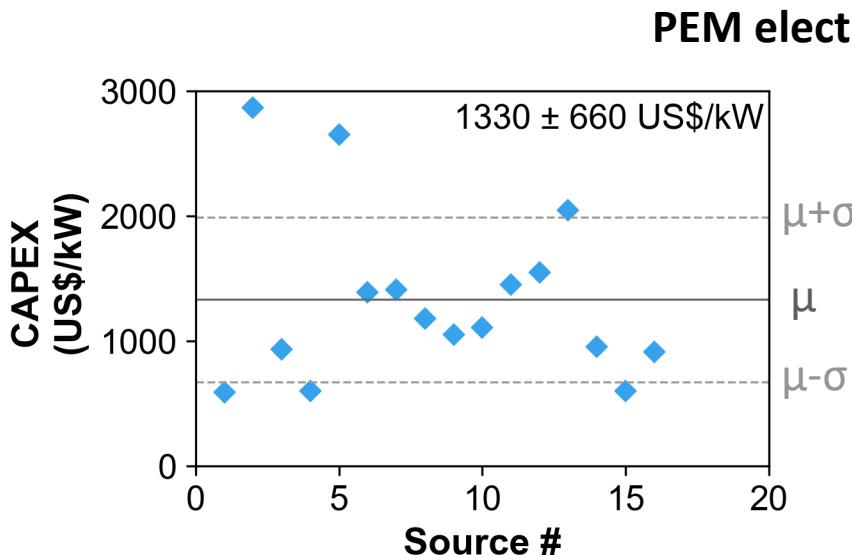
Web Application



Database

Upload and manage information on technologies, e.g. costs, usages

- Wide range of sources
- Clear details on source of data



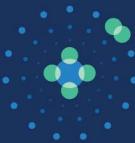
Scenario & module creation



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Scenario results

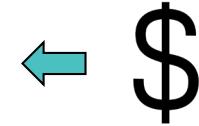
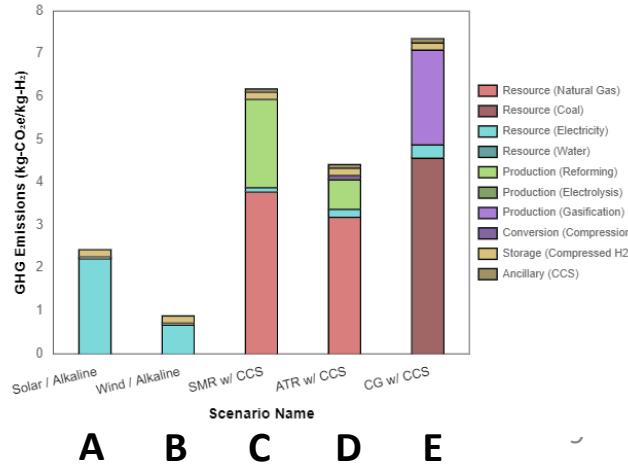
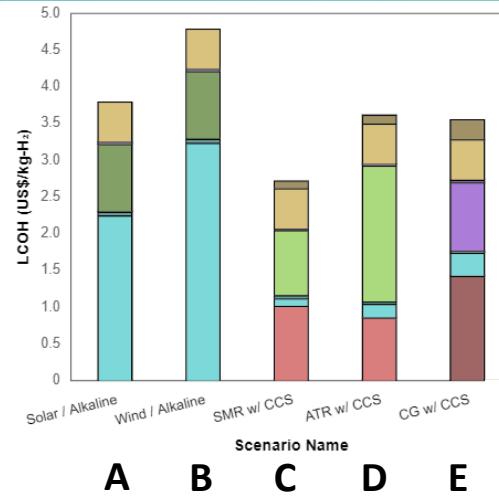
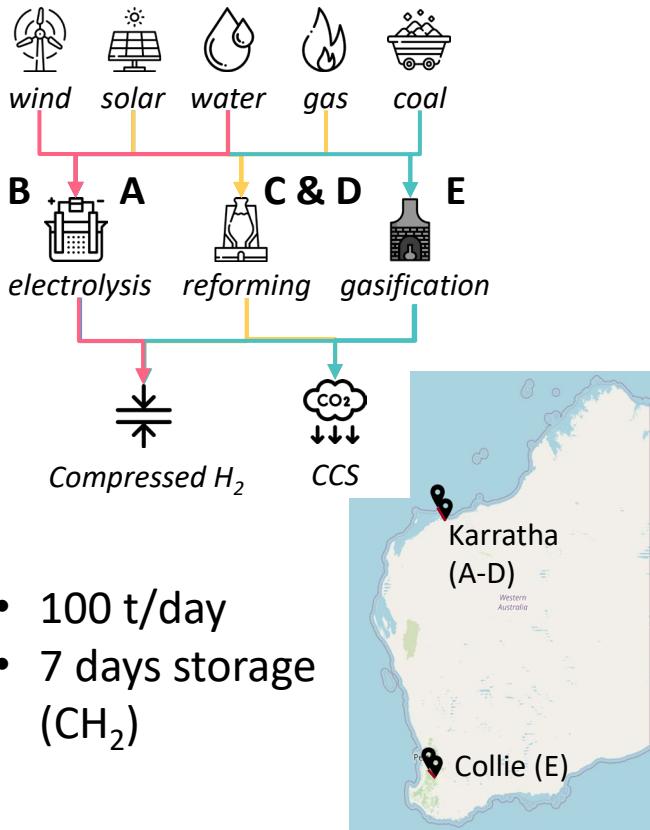


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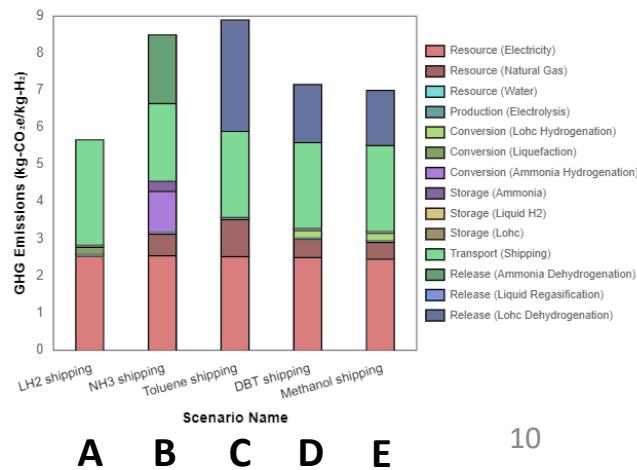
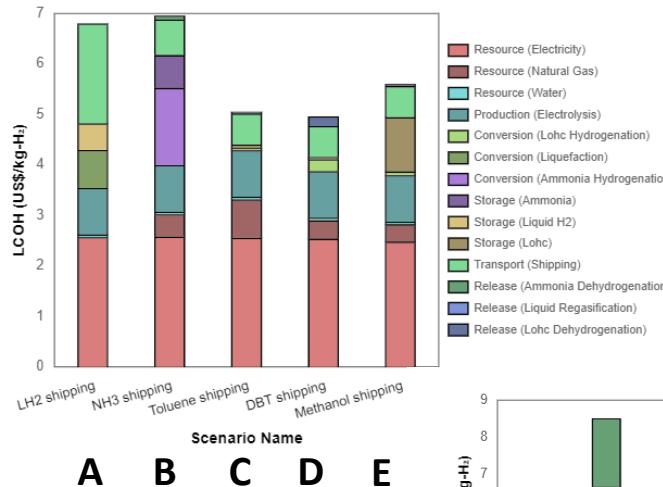
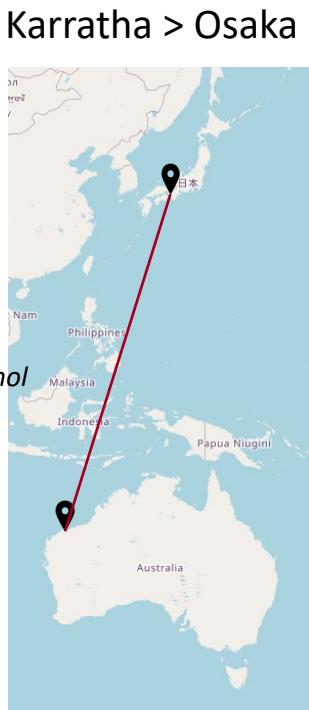
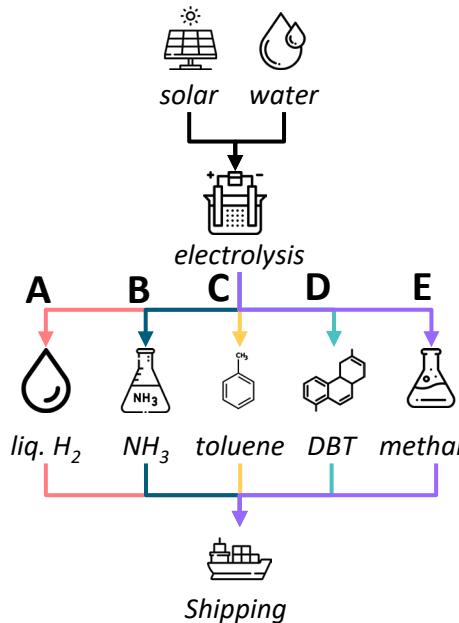


Comparison #1 – Production



A B C D E

Comparison #2 - Shipping



\$

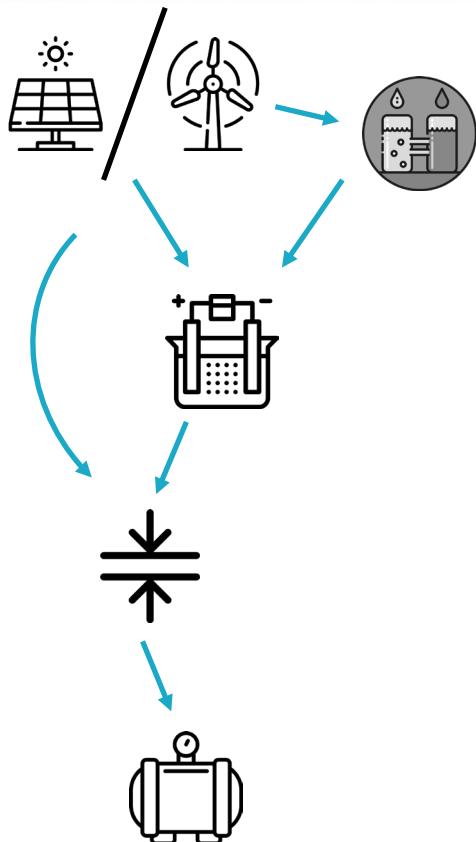


Part 2: Variable Renewable Energy Powered Electrolysis

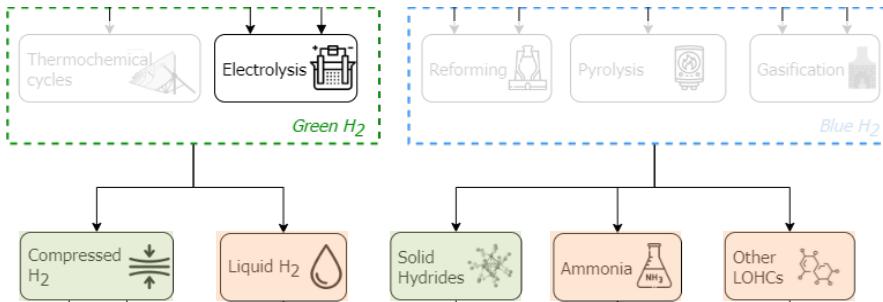
CRC Project: Bridging blue & green hydrogen



Hydrogen via Electrolysis



Electrolysis successors in supply chain

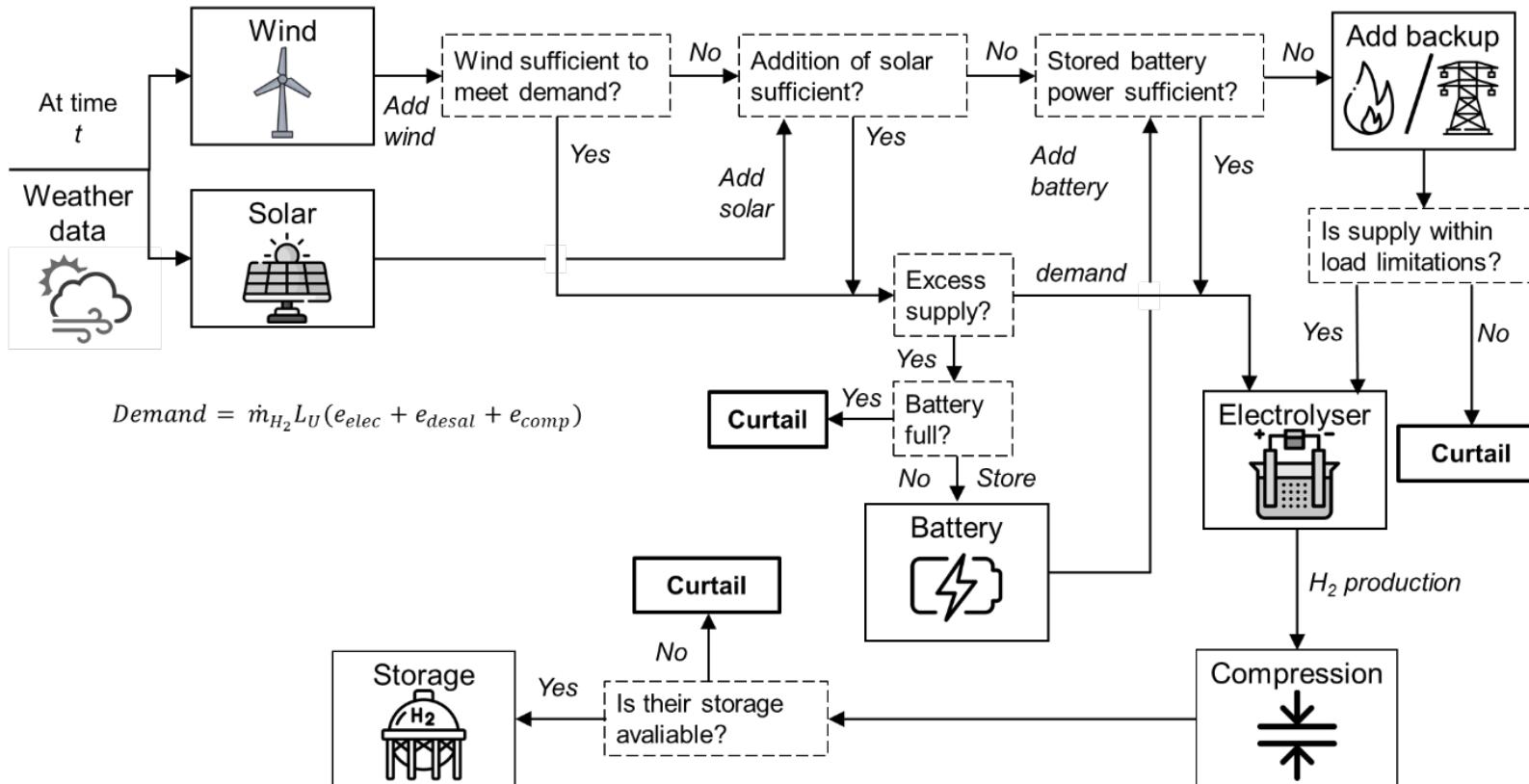


Robust to temporal variations? Yes / No

Producing “green hydrogen” (<4.3 kg-CO₂e/kg-H₂)

- What is the most cost-effective combination of solar & wind?
- What if I want H₂ 24/7?

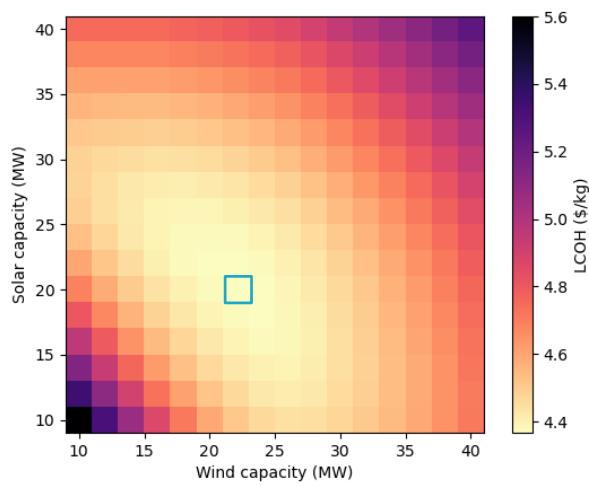
Modelling Algorithm



Another Scenario!

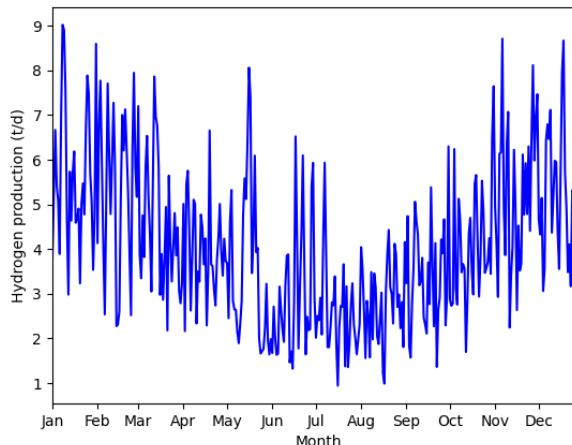


- Badgingarra (44% wind CF)
- 22 MW Alkaline electrolyser (10 tonne H₂/day)
- No backup/battery



Result

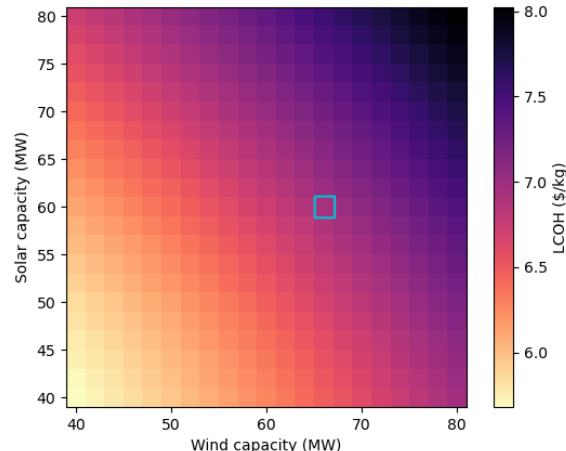
Solar Capacity	20 MW
Wind Capacity	22 MW
LCOH	4.4 \$/kg
C2G Emissions	1.4 kg-CO ₂ e/kg-H ₂
Capacity factor	41 %



Back to the scenario

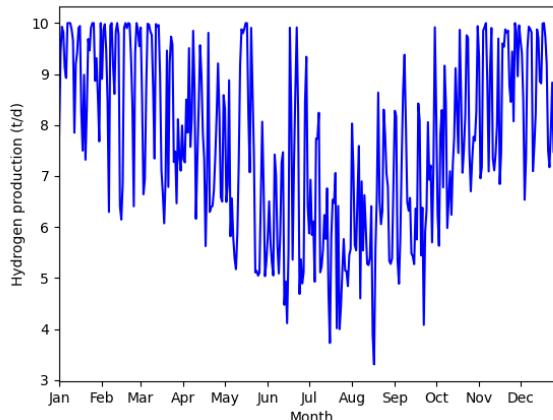


- 22 MW Alkaline electrolyser (10 tonne H₂/day)
- 22 MW / 88MWh battery
- >90 % capacity factor



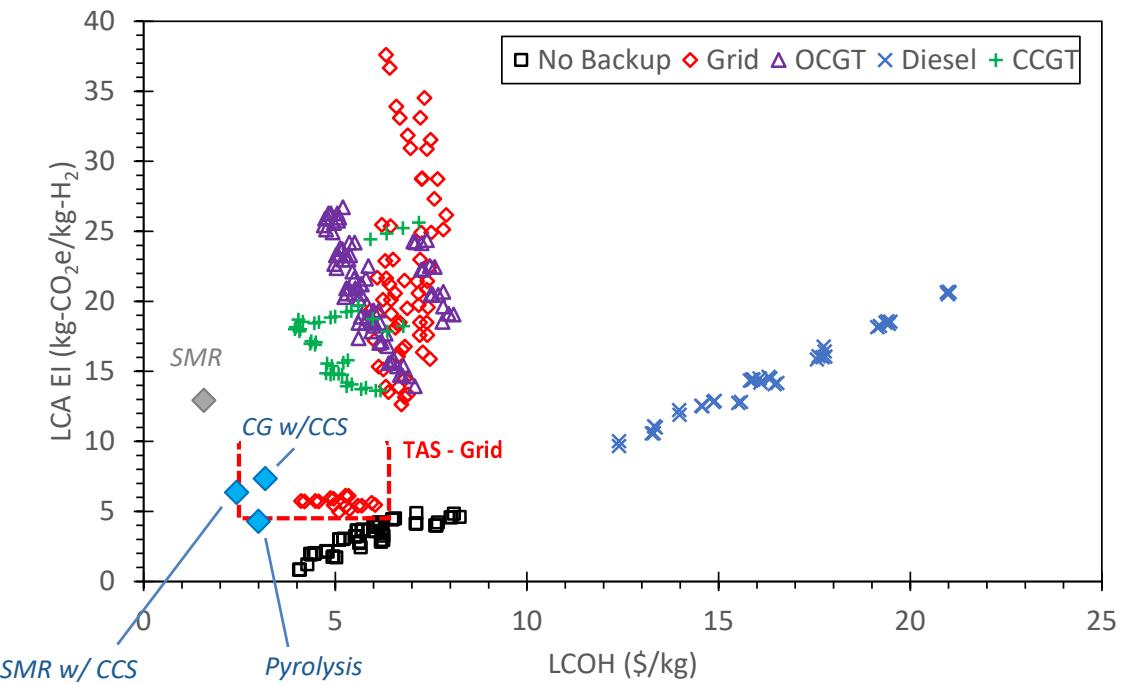
Result

Solar Capacity	60 MW
Wind Capacity	66 MW
LCOH	6.9 \$/kg
C2G Emissions	3.2 kg-CO ₂ e/kg-H ₂
Capacity factor	41 %



Results

5 x locations, 4 x electrolyser capacities



- Green hydrogen is expensive! (> \$4/kg)
- Require a “green grid” (e.g. TAS) for “green hydrogen”
- FF backup results in H₂ with > cost & > emissions than current SMR
- Capacity factor is critical

Model concept

Key design inputs

Solar capacity



Wind capacity



Battery capacity



Electrolyser capacity



Storage capacity



Electrolysis system model



Outputs

Cost



Emissions



Stability



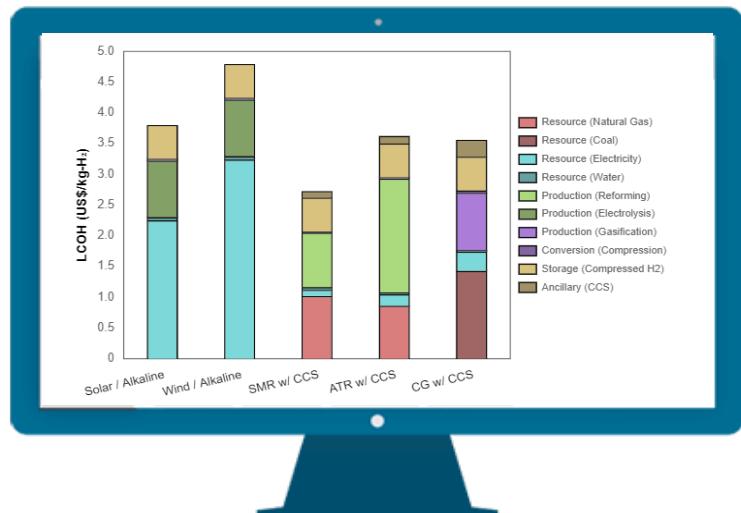
Risk



Conclusions

Demonstrated two hydrogen models for
technoeconomic & environmental evaluation:

- Hydrogen Pathways for full supply chain analysis
- Dynamic Electrolysis for temporal evaluation of
green hydrogen



Collaborators

UWA

Yuki Rhee

Fuyu Jiao

Saif Al Ghafri

Michael Johns

Eric May



H₂ Supply Chains



Blue/Green H₂

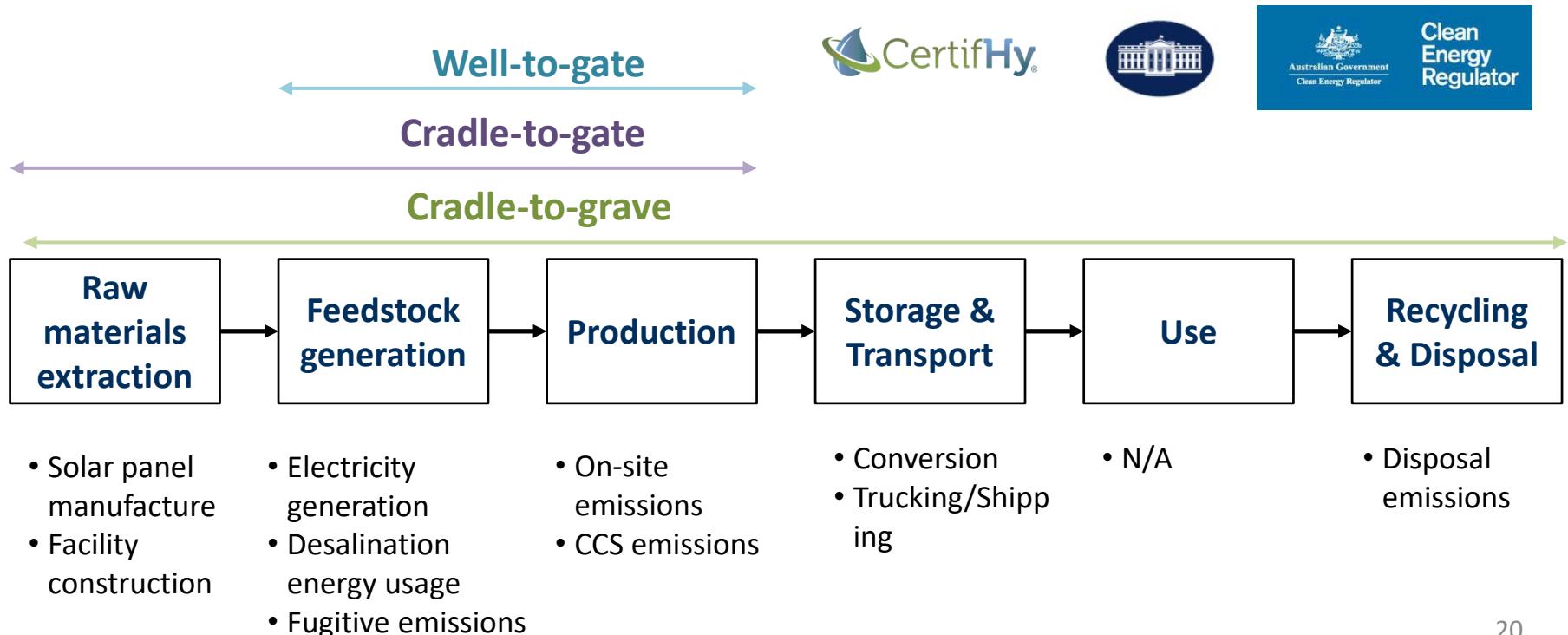


App available:

<https://h2pathways.azurewebsites.net/>

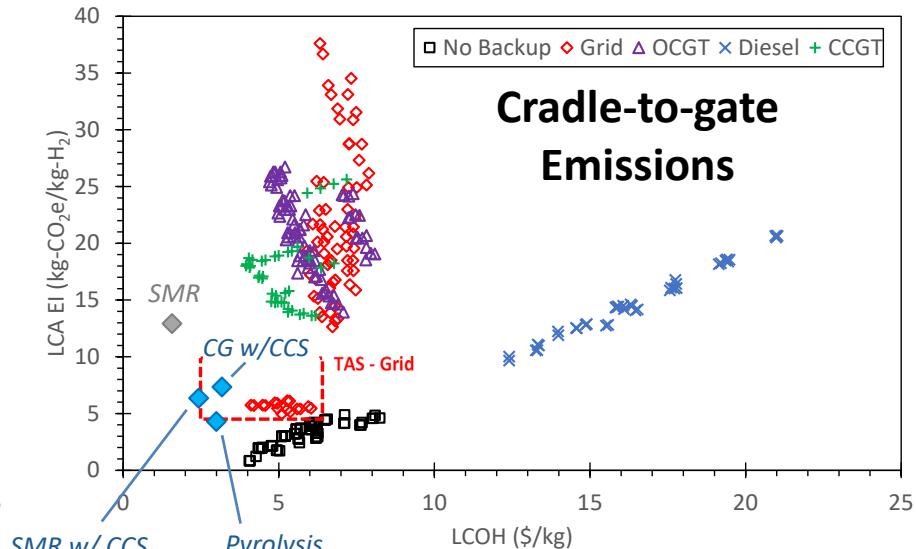
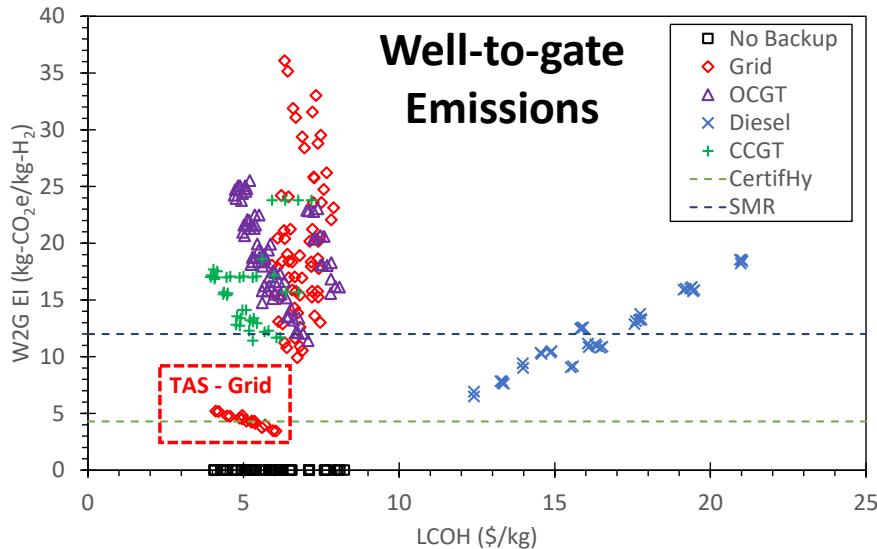
Emissions Analysis

Defining the life cycle emissions



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- Capacity factor is critical