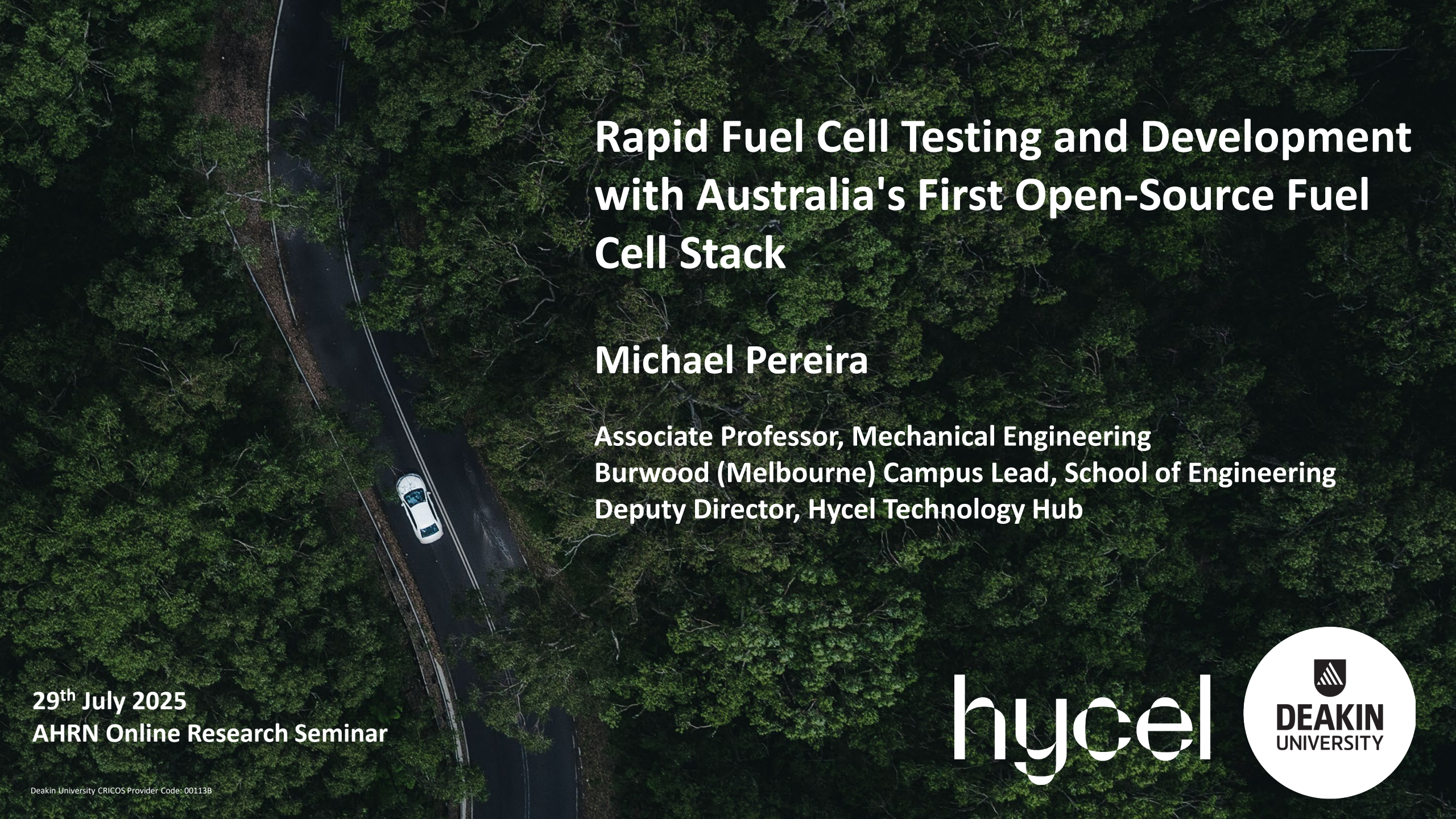


Rapid Fuel Cell Testing and Development with Australia's First Open-Source Fuel Cell Stack

Michael Pereira

Associate Professor, Mechanical Engineering
Burwood (Melbourne) Campus Lead, School of Engineering
Deputy Director, Hycel Technology Hub

29th July 2025
AHRN Online Research Seminar

hycel

DEAKIN UNIVERSITY

Overview of presentation

My aims for today:

Present the case for open-source fuel cell stacks for fuel cell R&D

Highlight how this can be used to enhance research translation and help to develop our local fuel cell industry

Provide a new concept for rapid fuel cell prototyping and testing with metallic bipolar plates

Raise awareness of our work for potential collaborators and partners

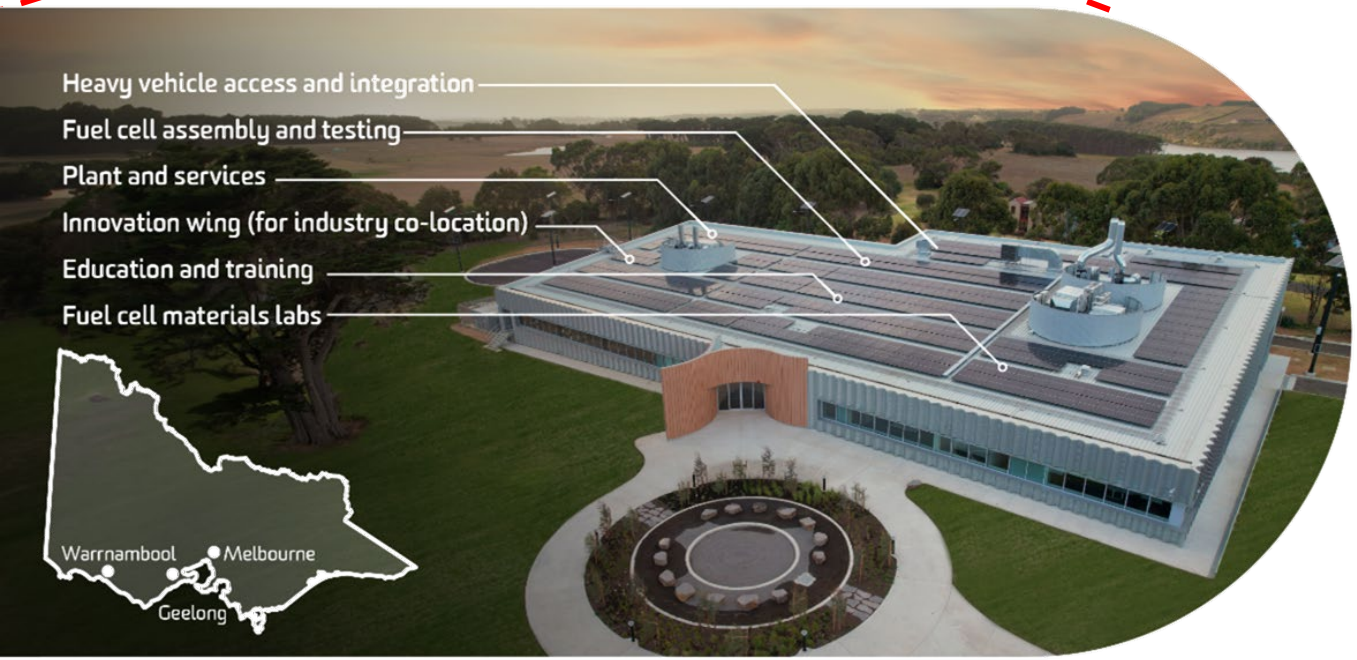
Presentation content:

1. Deakin's Hycel Technology Hub
2. Open-source fuel cells and fuel cell technology development
3. Open-source fuel cells with metallic bipolar plates

Presentation content

1. **Deakin's Hycel Technology Hub**
2. Open-source fuel cells and fuel cell technology development
3. Open-source fuel cells with metallic bipolar plates

What is Hycel?



AUD$24 million investment for new ~2200m^2 facility at Warrnambool, Victoria, Australia (co-funded State, Federal and Deakin).

Hycel is Deakin University's hydrogen hub with a **hands-on approach** to **real-world usage** in hydrogen.

From within Deakin, we bridge university, industry, and the community to drive the clean energy transition.

We focus on delivering **sector impact and uptake in hydrogen technology adoption**, with a strong focus on fuel cells, materials, education, and social licence.

The Hycel hub boasts nationally leading facilities for fuel cell R&D, testing and prototyping, propelling innovation and industry adoption of hydrogen technology in Australia.

Hycel: The Places and Faces

Warrnambool technology precinct

1. Hycel Technology Hub
2. Demonstration/validation space
3. Hycel future expansion zone
4. Hydrogen test beds “sandpit” (Future Fuels CRC)
5. Warrnambool Hydrogen Mobility Project (proposal)
6. On-site accommodation

The core Hycel team is part of the Faculty of Science, Engineering & Built Environment (SEBE)

Working with many researchers, educators and professional staff at other Divisions, Faculties and Institutes across Deakin

Hycel focus areas

Hydrogen technology adoption

Optimising fuel cells and energy systems to support a transition from fossil fuels to hydrogen in hard-to-abate transport and beyond.

Materials and Manufacturing

Optimising materials for production, storage, containment and purification, and green chemicals to support hydrogen distribution, usage and infrastructure.

Education

Developing hydrogen education and training pathways in the school, vocational, tertiary, and professional sectors to prepare Australia for the jobs of the future.

Social licence

Understanding and implementing best practice approaches to social licence that build awareness and acceptance of hydrogen's role in the transition to zero emissions energy.

Education

Aims:

- prepare a pipeline of hydrogen and clean energy workers for a safe, efficient domestic hydrogen industry;
- focus on short stackable training to upskill existing/professional workers;
- leverage lessons learned from mature international workforces.

Highlights (since 2021):

- developed primary and high school curriculum
- founded the National TAFE Hydrogen Network; membership on national forums
- secured funding for SWTAFE to develop hydrogen heavy vehicle training ($380k, Victorian Gov)
- delivering school outreach program at Hycel Technology Hub (800+ school, TAFE and uni students reached to date)
- **developed Australia's first hydrogen training for emergency responders (5000+ learners to date, stage 2 in development)**
- Rob McHenry, School of Eng: research with empirical evidence on the skills, knowledge and attributes required of engineers in hydrogen roles
- **developed 2 x Free Online Courses; 6 x CPD courses for engineers ($1.3m Commonwealth funding) (over 1,500 learners reached)**; scoping undergraduate and postgrad content
- co-coordinating 2025 proposal for Victorian Renewable Hydrogen Workers Centre with 7 academic partners, statewide
- Loren Tuck (Hycel Education, Training & Industry Coordinator): Awarded 2025 Churchill Fellowship to investigate international examples of hydrogen training

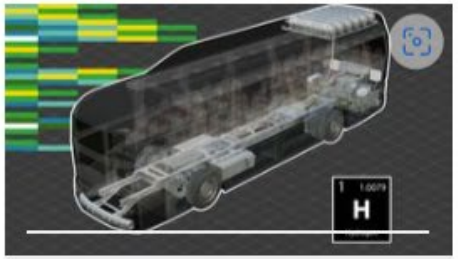
Education

Deakin University

The Role of Hydrogen in the Clean Energy Transition

Understand how hydrogen can help reduce carbon emissions to become a key player in the clean energy transition.

Go to course



Deakin University

Exploring Hydrogen Fuel Cell Systems and Balance of Plant (BOP)

Power a net zero future with expert insights and applications to hydrogen fuel cell systems and sustainable energy solutions.

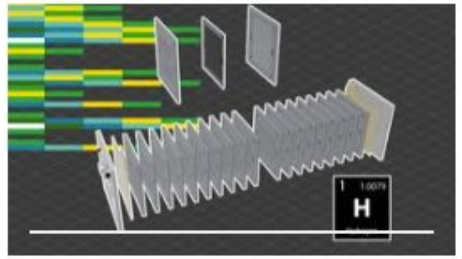
Go to course

Deakin University

Hydrogen in the Built Environment

Broaden your understanding of challenges and solutions to hydrogen projects in the real world.

Go to course



Deakin University

Hydrogen Engineering: Electrolyser Fundamentals

Gain essential knowledge about electrolysers for hydrogen engineering applications.

Go to course

Deakin University

Hydrogen Engineering: Handling Hydrogen for Engineers

Learn risk mitigation processes and safe management of hydrogen by exploring its physical and thermodynamic properties.

Go to course

Social licence

Aims:

- For Hycel and Deakin to lead hydrogen social licence in Australia
- To build social licence for Hycel and hydrogen in south west Victoria

Research

- Attitudes and perceptions of hydrogen
- Effective messages that support acceptance and awareness
- Tools for engagement that support best practice engagement
- Social licence mechanisms for community benefit

Activities

- Short course: The Clean Energy Transition: Developing a Social Licence for Hydrogen
- First Nations engagement: Hycel Technology Hub Indigenous design, ‘build it in don’t bolt it on’
- Engagement tools to ‘demonstrate to demystify’ hydrogen
- Outreach with 1500+ regional community members
- Hydrogen ambassador program to upskill community advocates

Social licence

The Clean Energy Transition: Developing a Social Licence for Hydrogen

Master hydrogen project advocacy and community engagement with Deakin University.

The Clean Energy Transition: Developing a Social Licence for Hydrogen

- 2 weeks
- 4 hours per week
- Digital certificate when eligible
- Open level

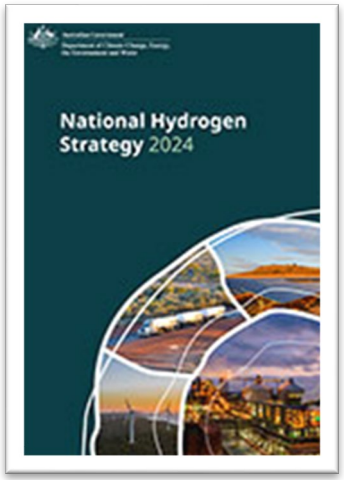
Join course

Find out more about how to join this course

Presentation content

1. Deakin's Hycel Technology Hub
2. **Open-source fuel cells and fuel cell technology development**
3. Open-source fuel cells with metallic bipolar plates

Why hydrogen? Why now?



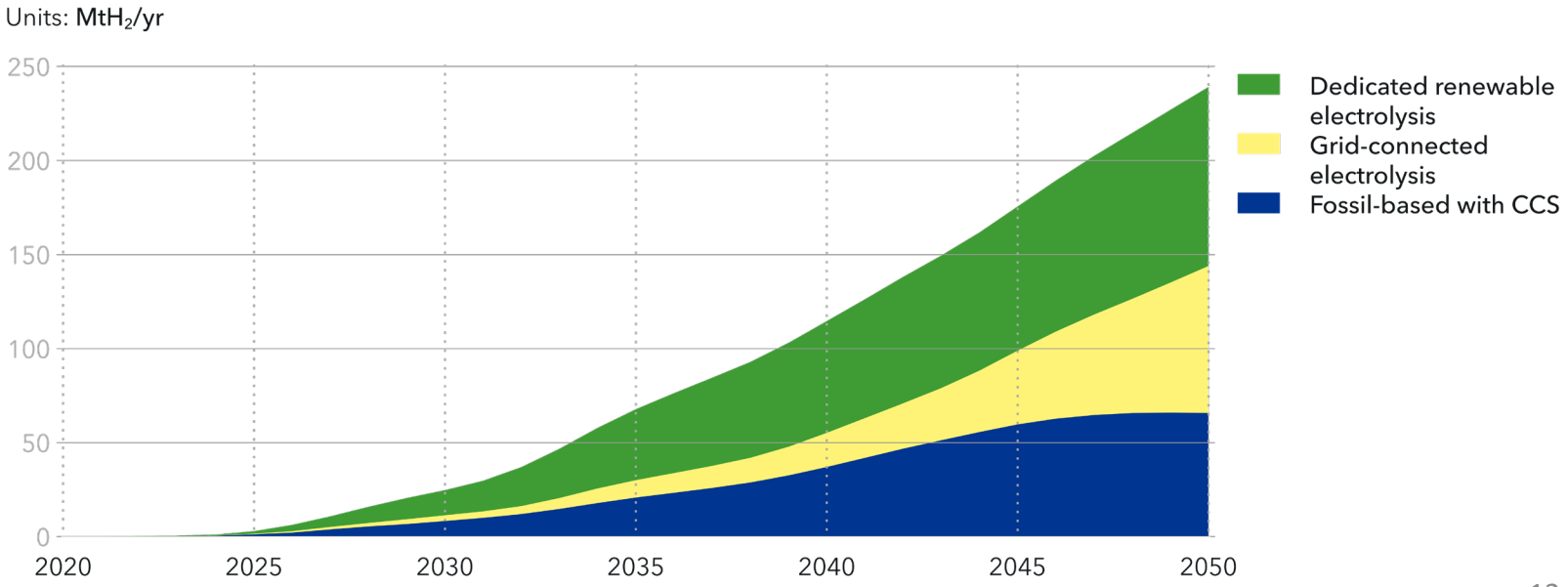
A competitive hydrogen will benefit Australia's communities and economy, enable our net zero transition, and position us as a major global player.

Hydrogen will play an essential complementary role to electrification in decarbonising the global economy, particularly in hard-to-abate sectors.

Transport was responsible for 21% of Australia's emissions in 2023.

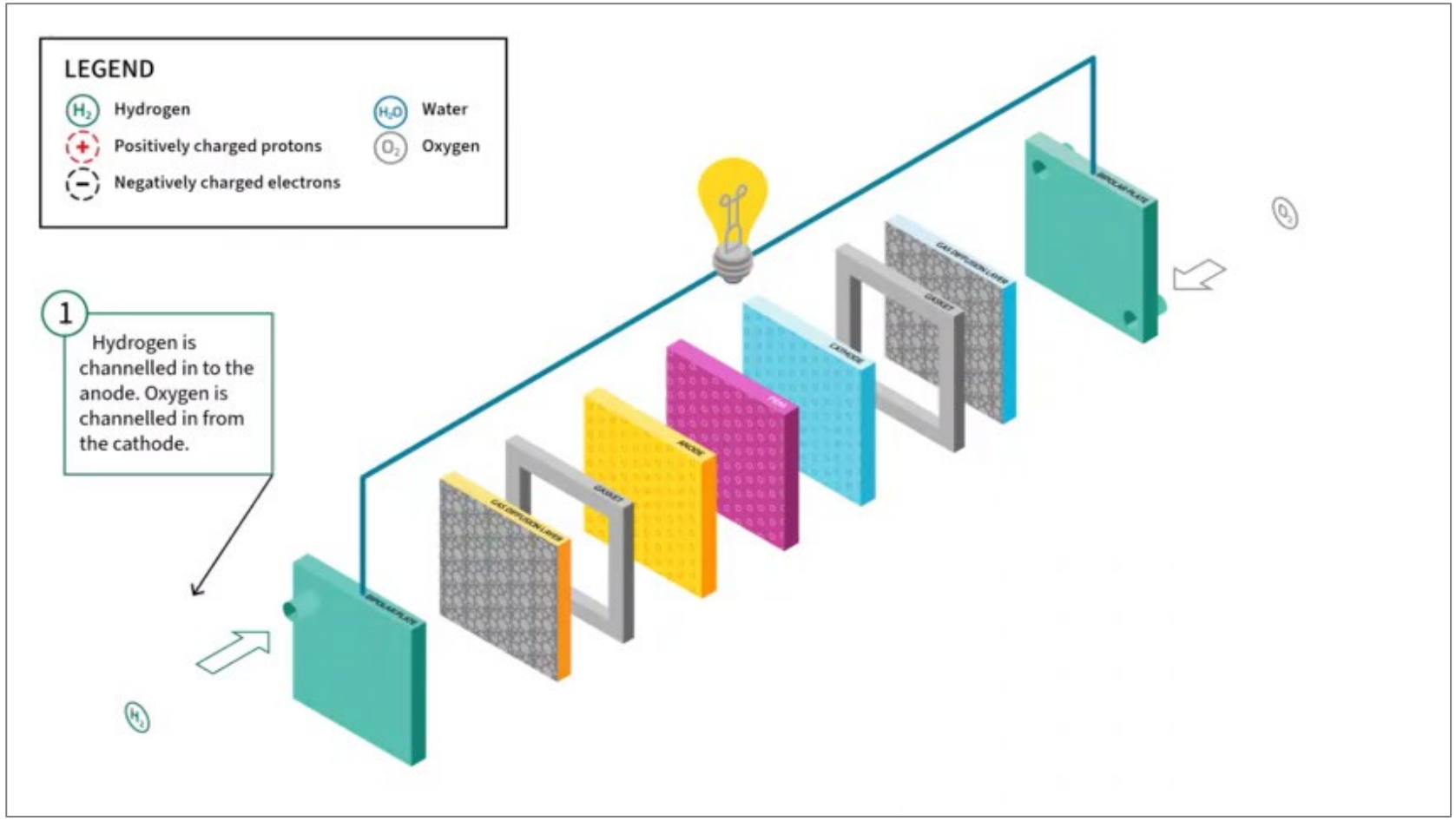
Australia's hydrogen project pipeline is significant: ~20% of the global total.

Global production of hydrogen and its derivatives for energy purposes by production route



Source:
enr.com/articles/54290-global-upswing-forecast-in-hydrogen-fueled-energy-production

What are hydrogen fuel cells?



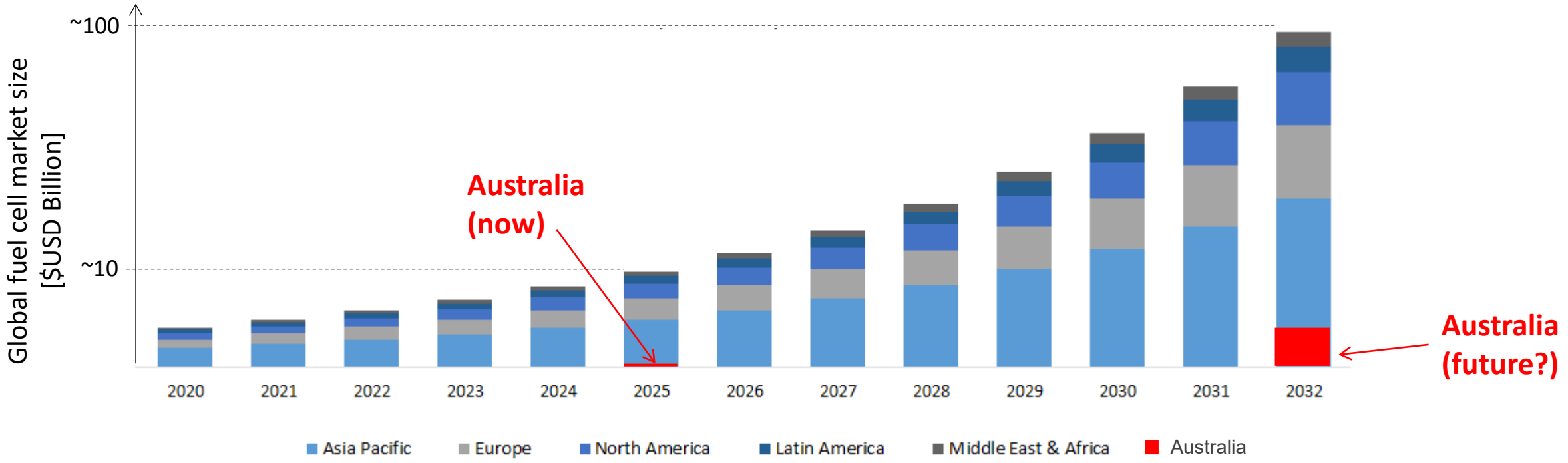
Convert the chemical energy of hydrogen into electricity, with water and heat as byproducts (zero CO_2 emissions).

Acts like a battery that never runs out, as long as it's supplied with fuel (H_2).

For transport, fuel cells will be applied for use cases with:
i) high vehicle utilisation,
ii) long distances,
iii) high loads, and
iv) all of the above (especially)

Source: futurelearn.com/courses/exploring-hydrogen-fuel-cell-systems-and-balance-of-plant

Aussie fuel cell industry



Source: polarismarketresearch.com/industry-analysis/fuel-cell-market

Good strengths in fuel cell (and electrolyser) research.
(Australia not good at translating Research > Technology > Trade)

Currently, in Australia the fuel cell industry (technology or manufacturing) is very small

But there is hope…

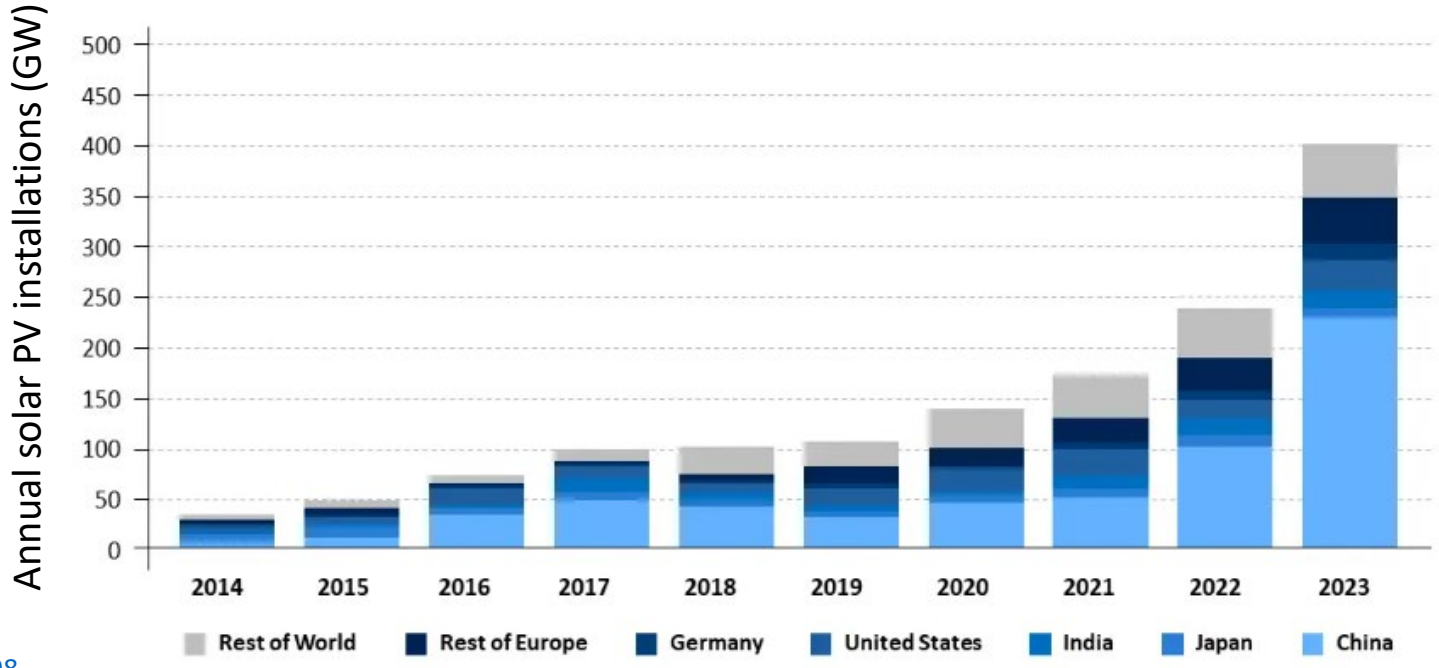
Do we risk missing the opportunity? (like solar PVs)

Australian technology has been the foundation for most of the solar panels used globally

Australia has the highest rate of rooftop solar adoption in the world (~40% of Australian households)

Yet only ~1% of the solar panels installed across the country are Australian made

What learnings can we apply for Australian hydrogen and fuel cell industries?



Source: researchnester.com/reports/solar-photovoltaic-market/6098

Learning from the Australian solar PV experience, applied to fuel cell industry

Similarities

High initial R&D and innovation

Focus on local manufacturing for supply chain resilience

Abundant renewable resources as a competitive advantage

Potential for export markets

Early stage of commercialization and scale-up

Challenges

Global competition

Cost competitiveness

Supply chain development

Rapid technological evolution

Market demand

Manufacturing complexity

Opportunities

- ✓ Leverage our strengths in research, renewable resources, and a growing focus on clean energy to build a hydrogen fuel cell manufacturing industry
- ✓ Need to (initially) focus on **niche/domestic markets**, **high-value components**, **developing local supply chains** that can integrate with a strong domestic hydrogen production and utilization strategy

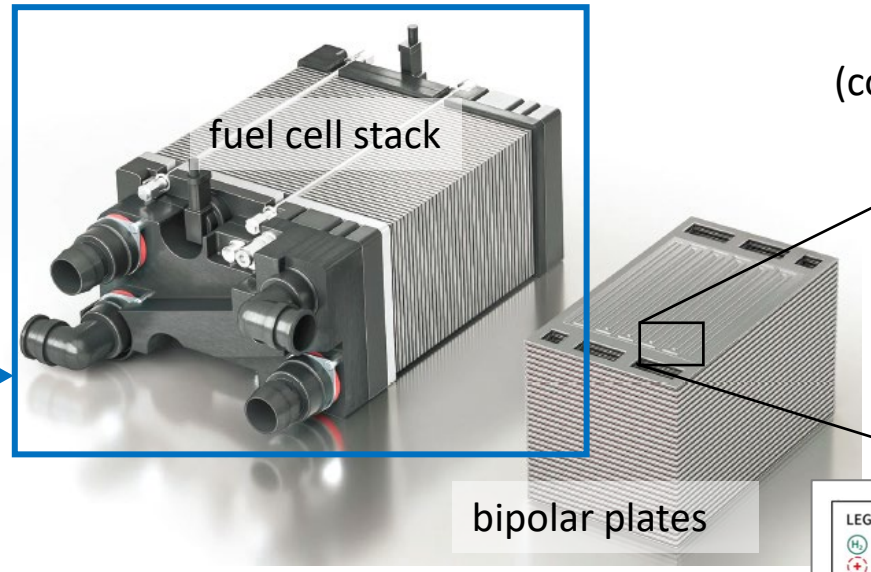
Large barriers to entry
(for domestic supply chains and niche markets)

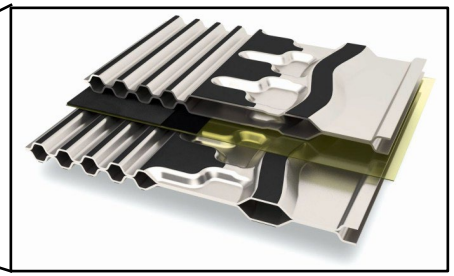
There are many **applications** for fuel cells

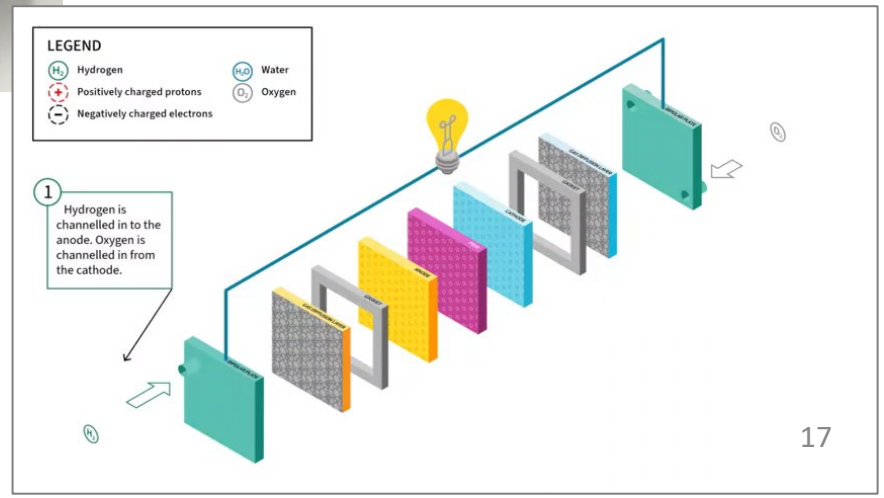
Each application has their own **fuel cell stack**

Each stack, and hence each of the components with each of the layers within each cell, has its **own requirements**

(cost, performance, size, material, weight)







How can new individual technology be developed and brought to market?

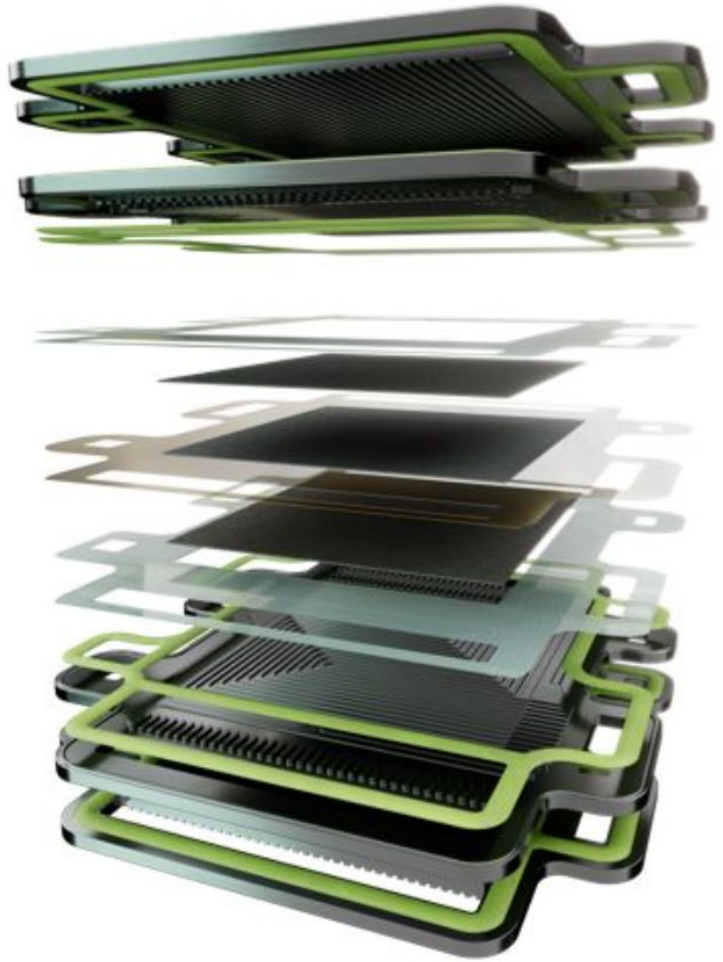
Open-source fuel cell stack

Industry-scale state-of-the-art stack

Open-source architecture, enabling new technology and components to be easily interchanged

Allow rapid development, testing and benchmarking

Is aligned with the focus on **niche/domestic markets**, **high-value components**, **developing local supply chains**



Source: hzwo.eu/open-source-plattformen/

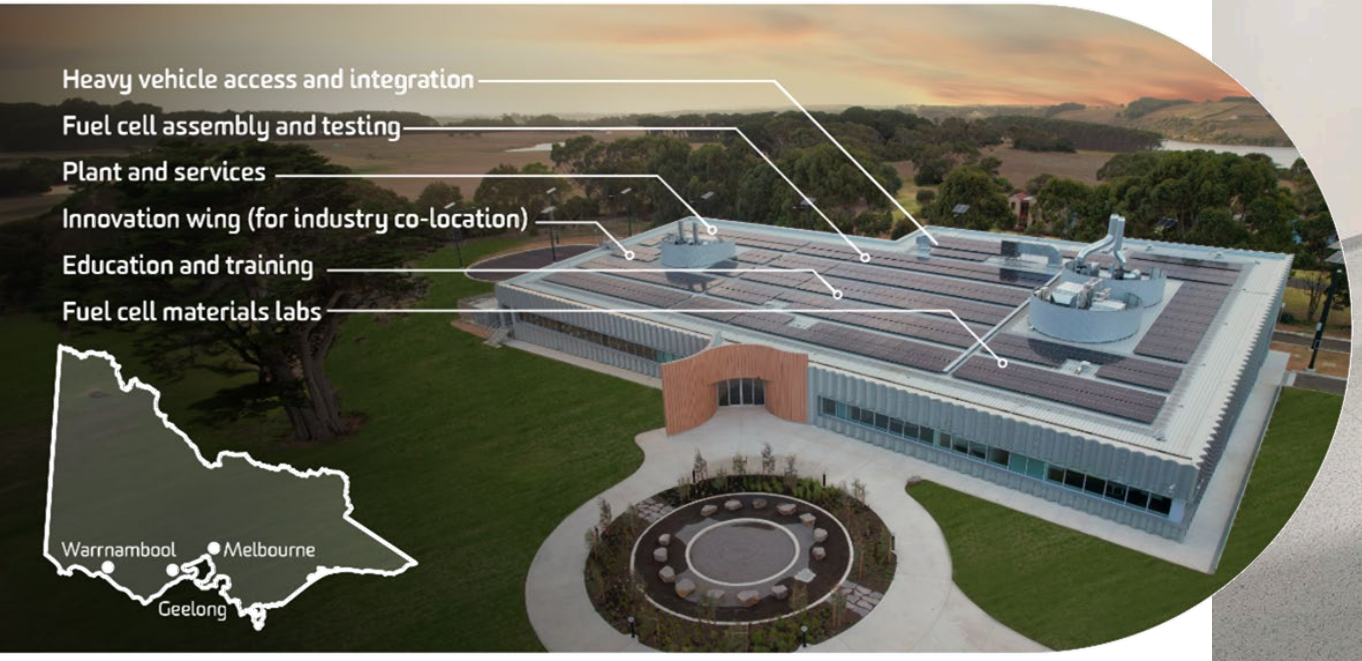
Open-source fuel cell stack

Source: hzwo.eu/open-source-plattformen/

Fuel cell stack performance testing

Also requires open access fuel cell testing capability.

Hycel has fuel cell testing capability from 5W (single cells), to 10kW (industry-scale short stacks)

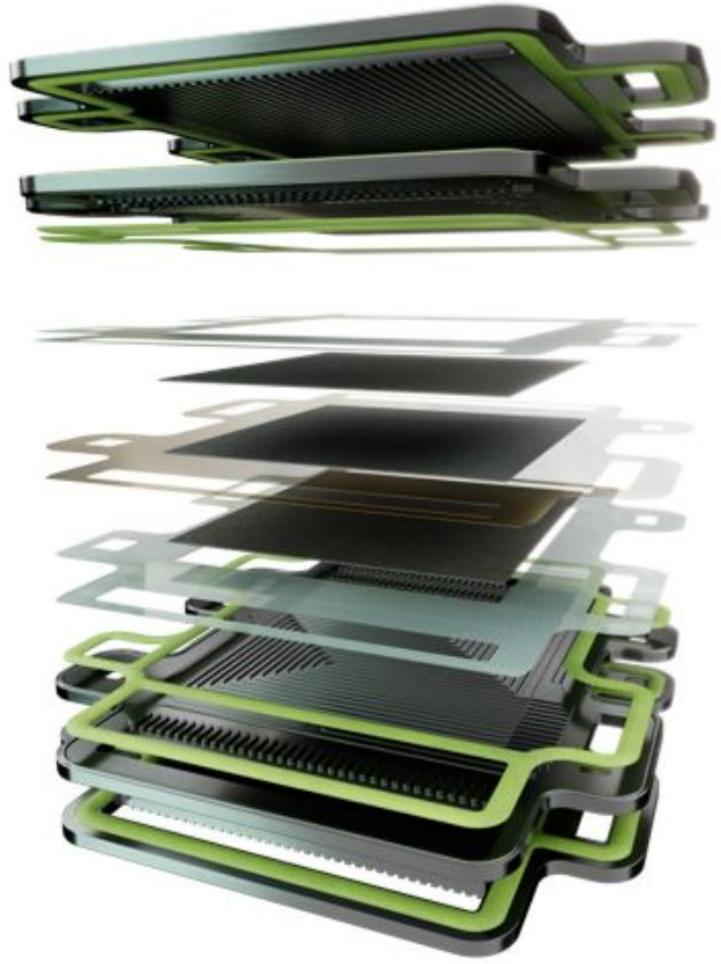


Fuel cell stack development with the OSS

All layers within the fuel cell and stack can be tested and compared with baseline data.

Strong interest in both **new materials** and **new manufacturing processes**.

- Membranes
- Catalysts
- Gas diffusion layers
- Microporous layers
- Bipolar plates and coatings
- Seals / gaskets



Source: hzwo.eu/open-source-plattformen/

Fuel cell development researchers

Working on both **new materials** and **new manufacturing processes**.

- Membranes
- Catalysts
- Gas diffusion layers
- Microporous layers
- Bipolar plates and coatings
- Seals / gaskets

Fuel cell testing and computer simulation

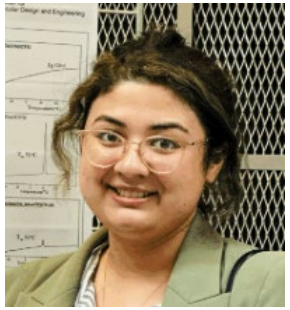
Hamish Edwards

Danny Bernstein

Membranes and catalysts

Prof Tiffany Walsh
Hycel Director

Dr Faezeh Makhlooghi Azad



Arpita George

Gas diffusion layers

A/Prof Wei Xu

Vahid Babalo

Bipolar plates (materials, manufacturing and computer simulation)

A/Prof Matthias Weiss
Sheet forming group leader

Dr Peng Zhang

Maziar Khademi

Deepansh Chourasiya

Presentation content

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3. **Open-source fuel cells with metallic bipolar plates**

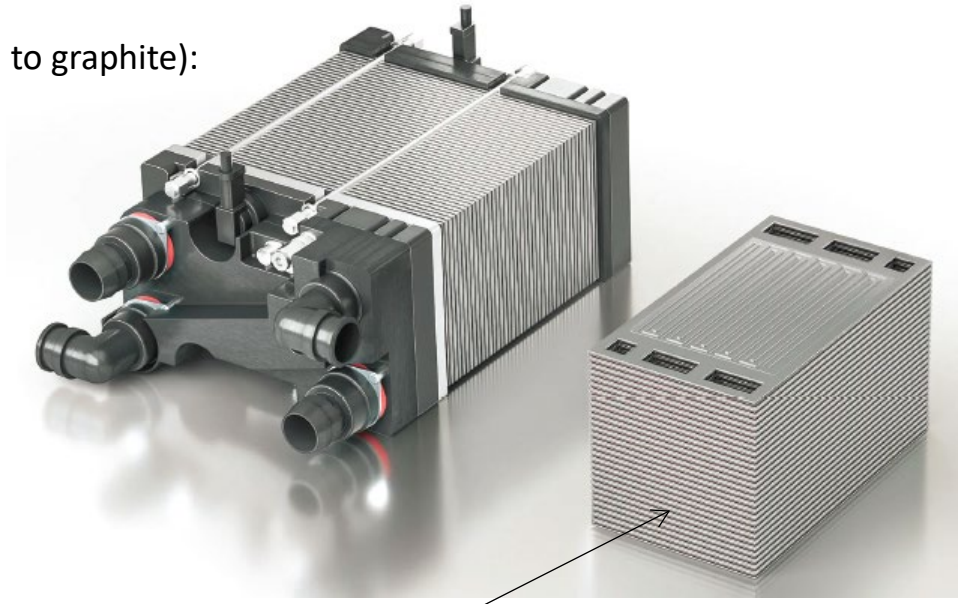
Open-source stack with metallic bipolar plates

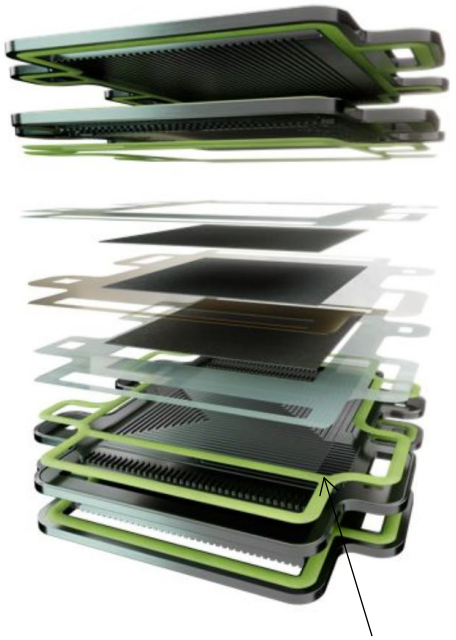
Advantages of metal bipolar plates (compared to graphite):

- cheaper
- lighter
- thinner

More suited to the applications relevant to Australian applications:

- Transport
- Defence
- Remote and back-up power





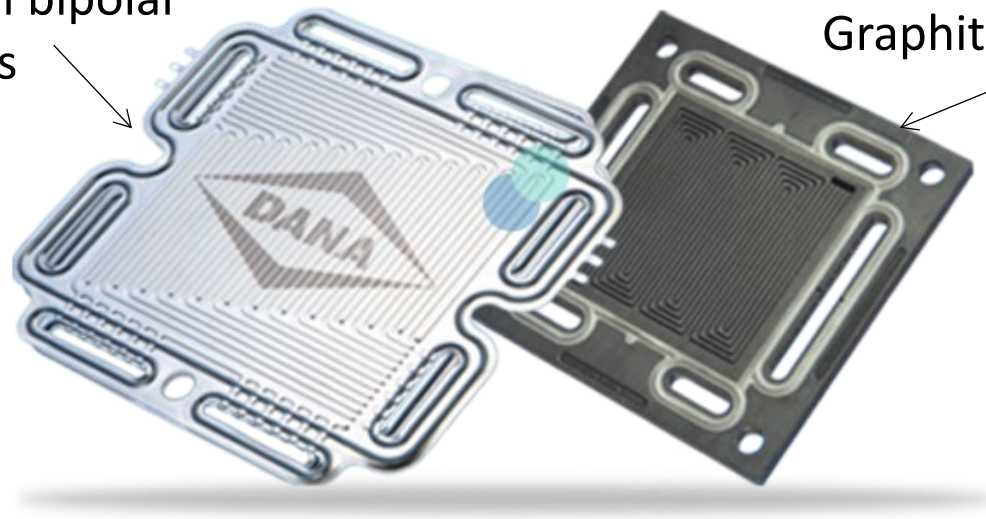
Metal bipolar plates

Graphite bipolar plates

Issues with metal bipolar plates:

- not suited for prototyping and small batch production
- sealing of cell is more difficult

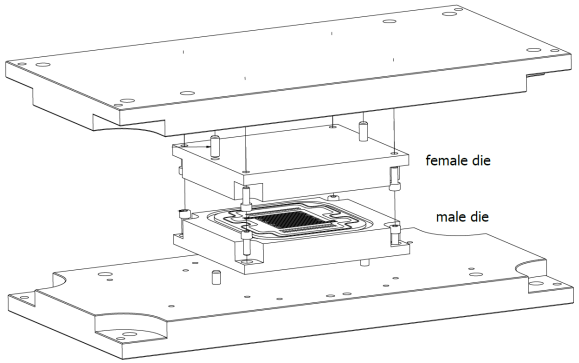
Our FEnEx CRC project has developed a metal bipolar plate solution for the open-source stack



Source: hydrogen-central.com/fuel-cell-bipolar-plates-technology-dana-inc-hannover-messe/

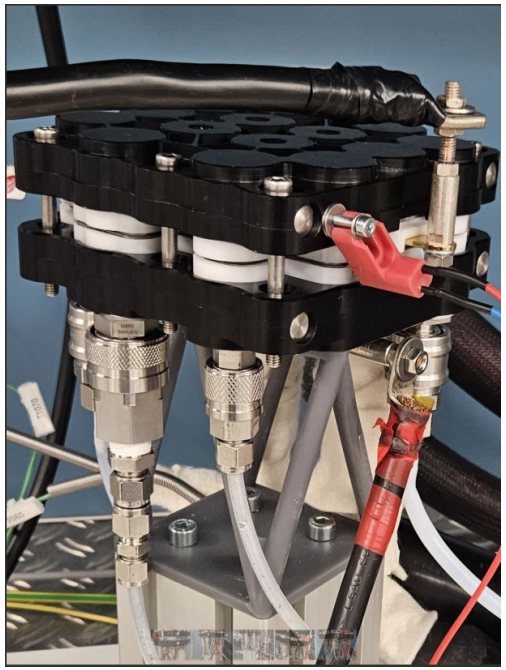
Open-source stack with metallic bipolar plates

Deakin designed and manufactured bipolar plates



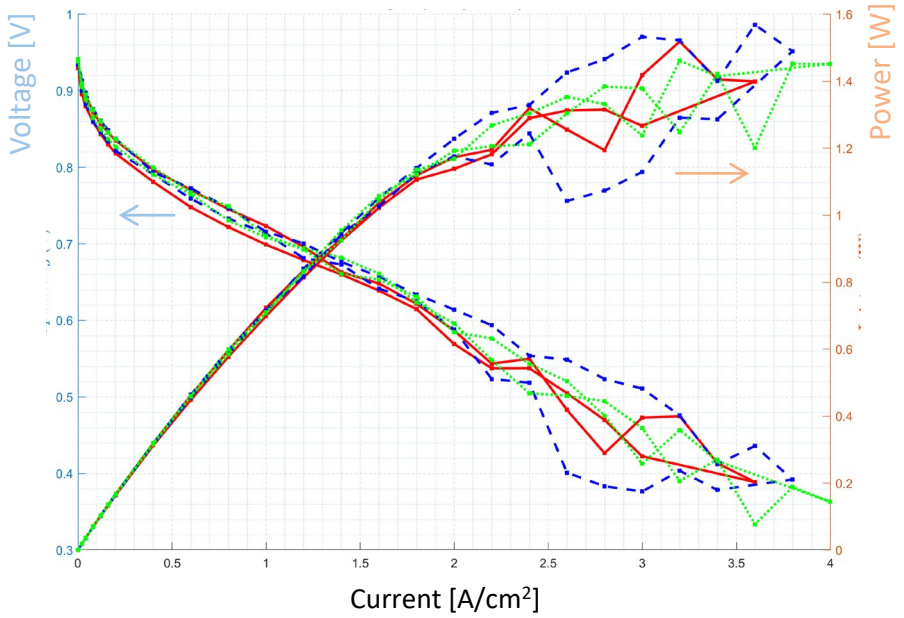
Anode and cathode plates with 50cm^2 active area

Implemented into open-source stack (world first)



Achieving good performance results (for single cells)

- Further development on stack is required



So what? What has the open-source stack enabled?

We have been able to quickly test our bipolar plate manufacturing method and materials in a fuel cell.

The results were quickly assessed and compared against baseline / reference data.

Limited time spent on designing / integrating with fuel cell stack – almost “plug and play”.

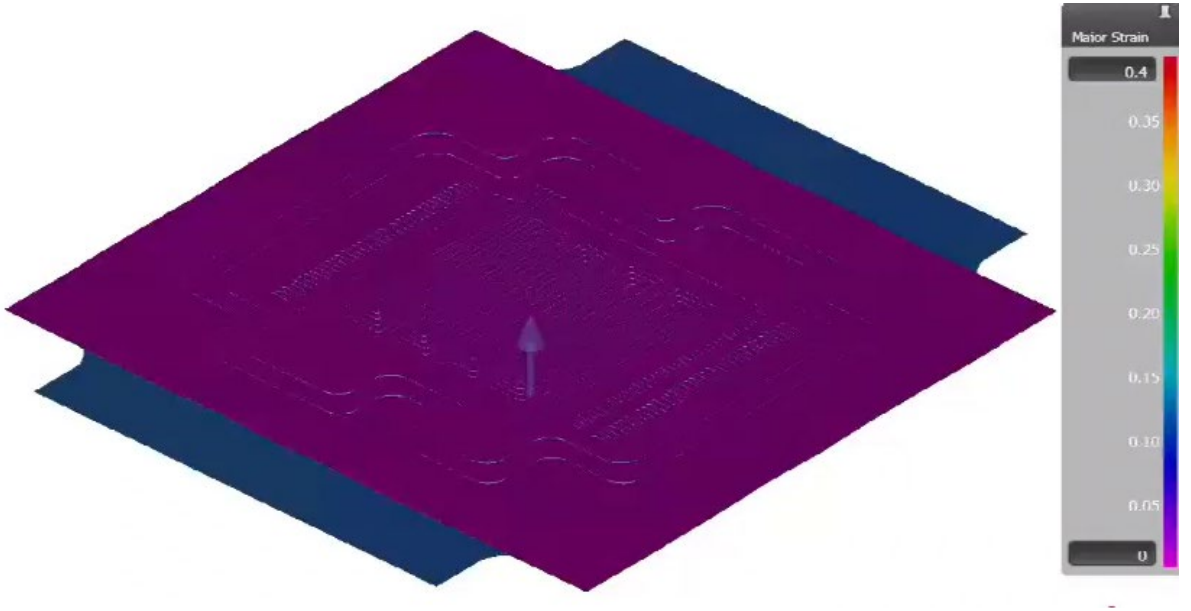
This can be applied to **any new materials, components, processes and operating conditions** within the stack (without requiring your own fuel cell and prototyping lab).

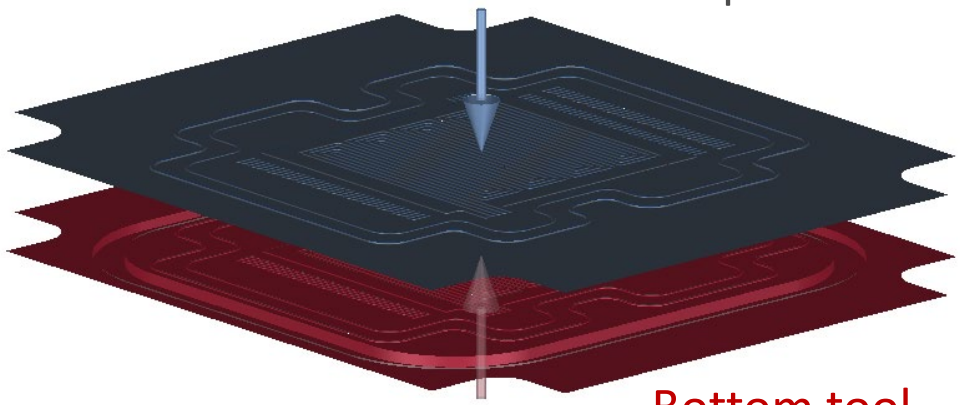
Next steps: Implement larger open-source stack at Hycel (100cm^2 and 300cm^2 active area).

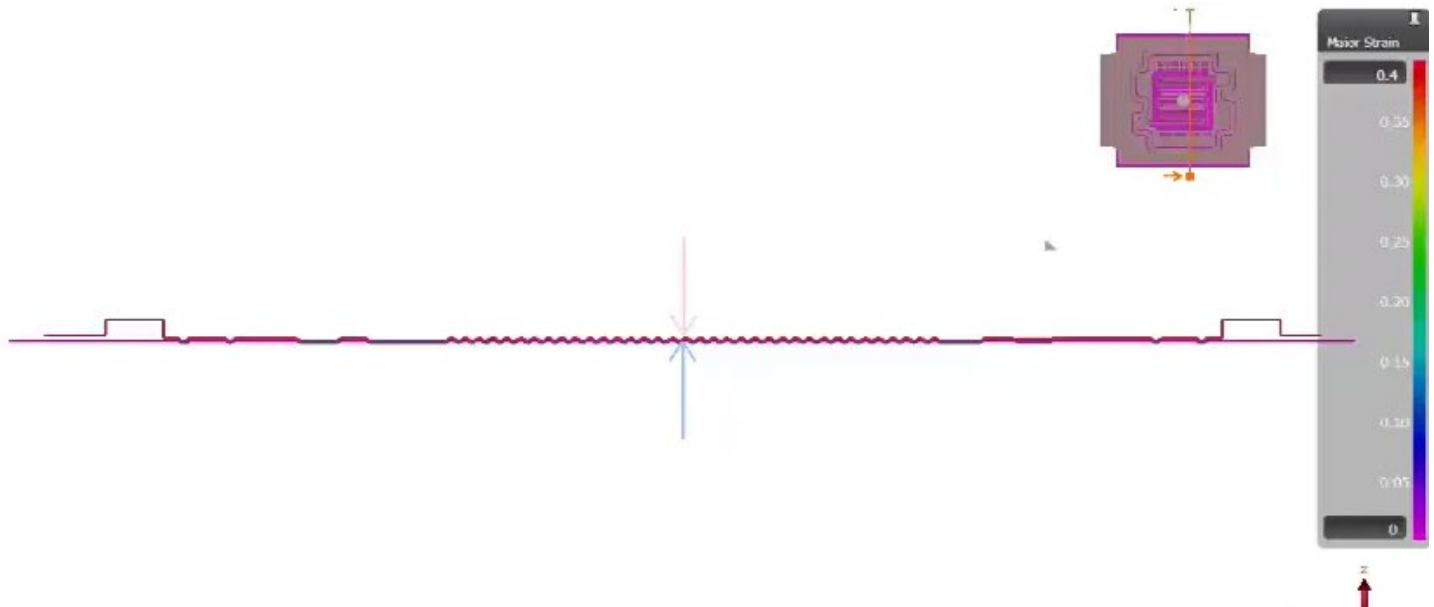
For metallic bipolar plates, joining the two half plates is an issue.

Metallic bipolar plate design and manufacture

- Computer simulation of the manufacturing process.
- Detailed analysis required to ensure the desired shape and accuracy can be achieved with the chosen materials.



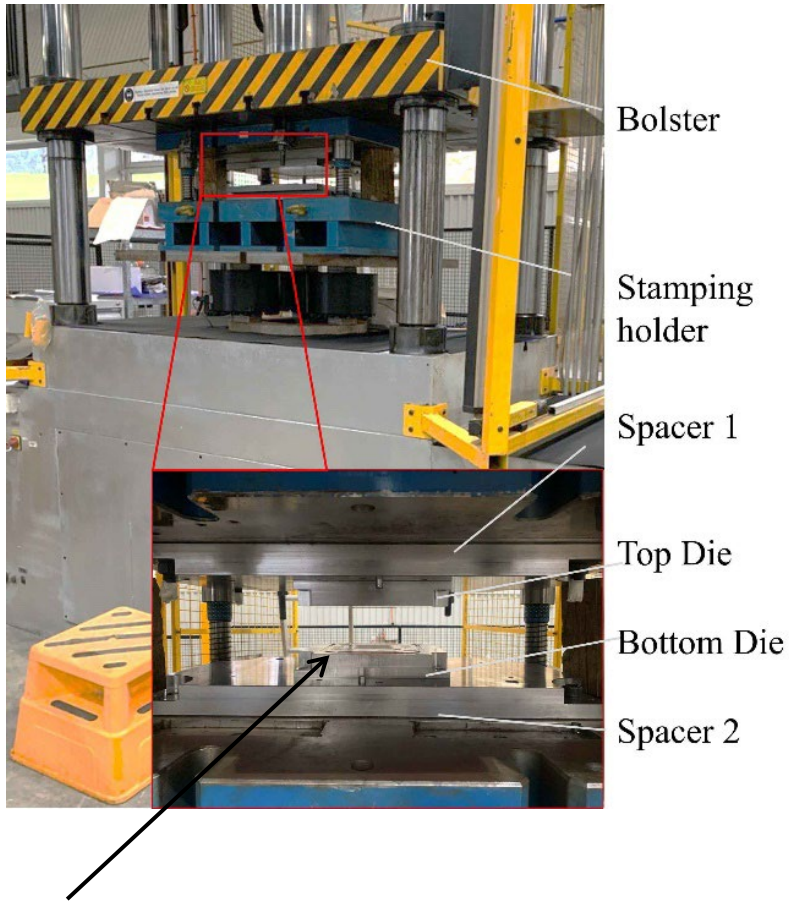




Metallic bipolar plate design and manufacture

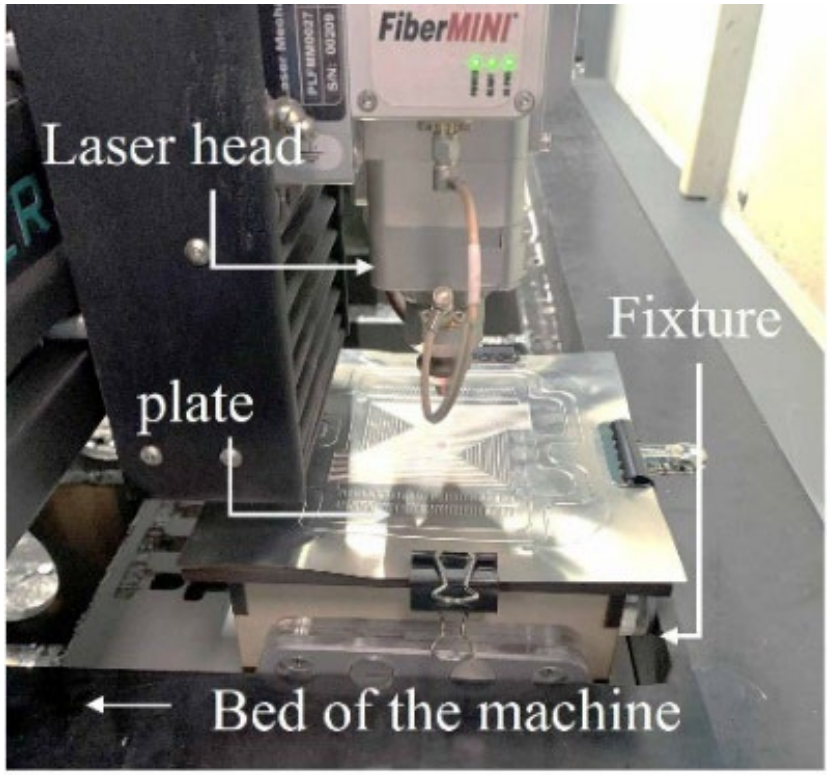
Manufacture of the bipolar plates at Deakin

"Micro" stamping – 250T press



Steel tooling was used for the stamping tools

Laser cutting – 2kW fibre laser



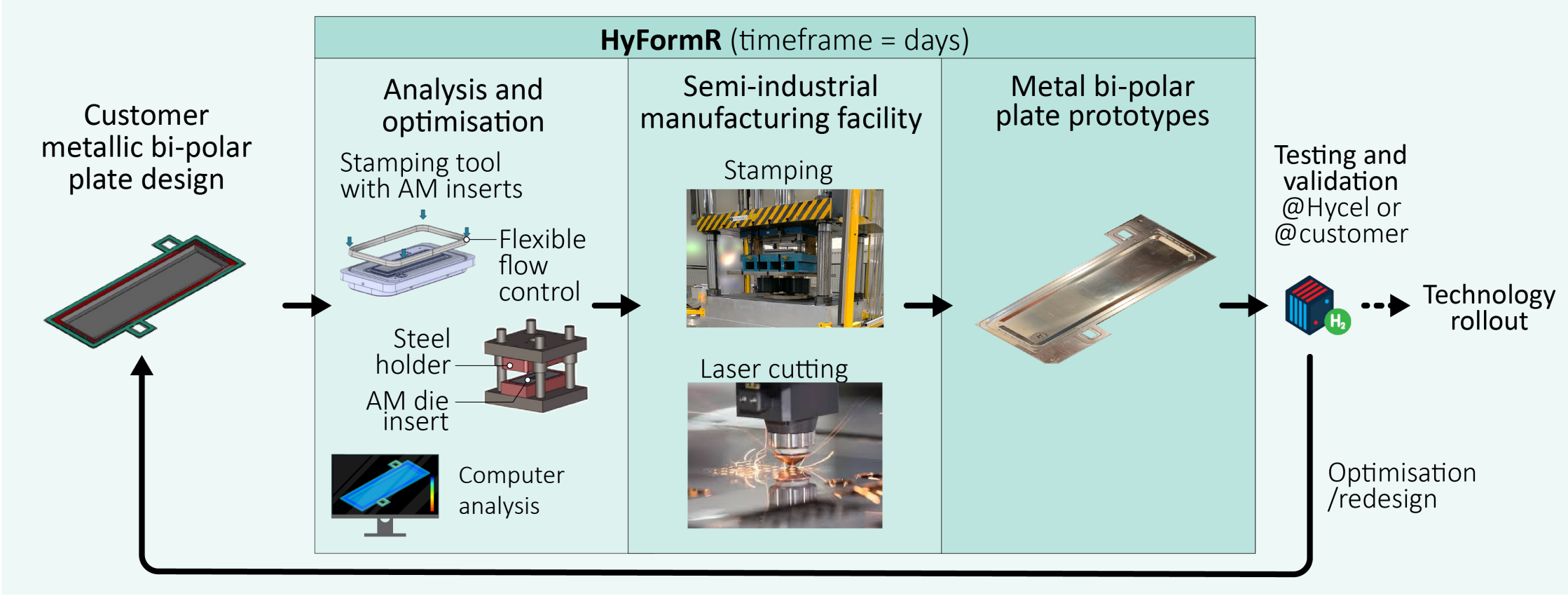
Final anode plates – 0.1mm thick titanium

Fuel cell rapid prototyping

Combining with rapid prototyping of individual layers within the cell, will **accelerate technology development**

Allows **rapid iteration and testing of new technologies** and concepts

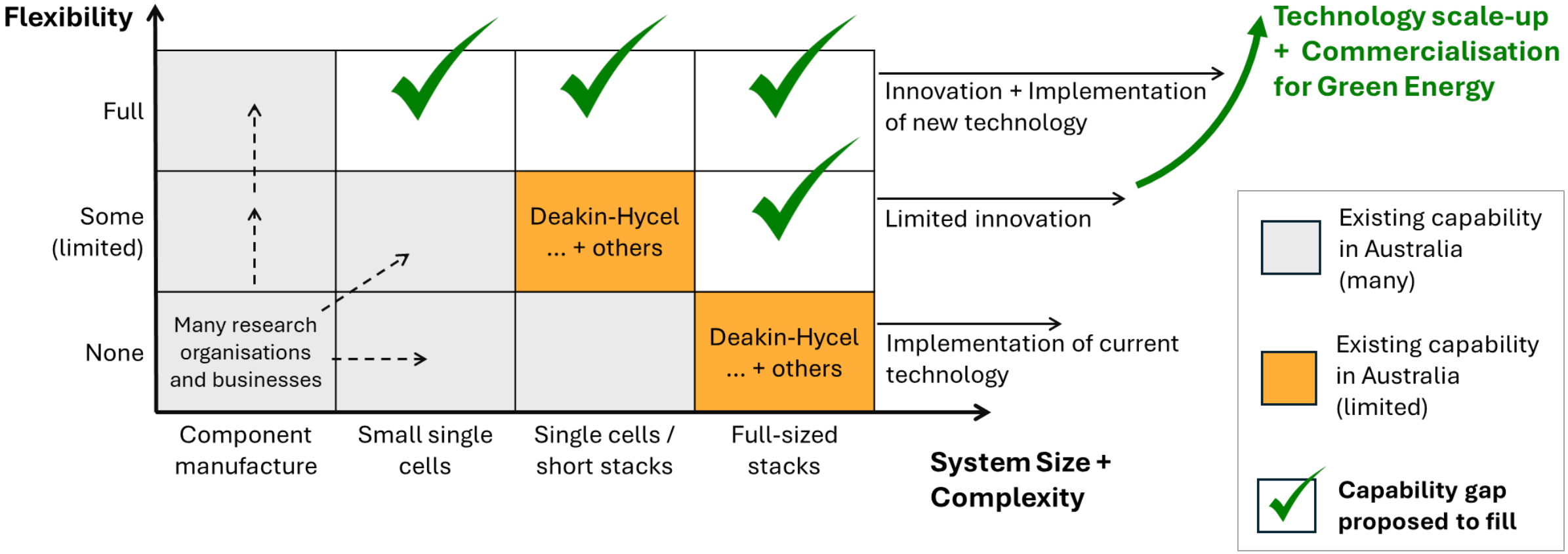
E.g. for metal bipolar plates: Deakin HyFormR technology reduces plate prototyping from months to days



Fuel cell rapid prototyping + rapid assembly

Requires specialised laser-welding facility to join the metal half plates

Provides further ability to rapidly assemble stacks



Summary

The fuel cell industry in Australia is small, despite some strong expertise in our research institutions.

We need to take action to ensure we can build a hydrogen fuel cell industry in Australia (don't miss the large opportunity).

Open-source fuel cell stacks provide a pathway to develop this industry, particularly translating research to technology.

Rapid prototyping and rapid assembly can further accelerate technology development.

Our capability / technology for bipolar plate manufacture is unique and can contribute to the technology development for the Australian fuel cell industry.

Hycel is open – please come and talk to us to explore opportunities ☺

Acknowledge funding and support from:

Australian Government
Department of Education

TECHNISCHE UNIVERSITÄT CHEMNITZ

HZwo

AUTOFORM
Forming Reality

FUTURE ENERGY EXPORTS
Cooperative Research Centre

THE UNIVERSITY OF WESTERN AUSTRALIA

VICTORIA
State Government
Energy, Environment and Climate Action

Thank you

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Please get in touch!

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