Education – F-12 Schools and the Hydrogen Future

Australian Hydrogen Council Webinar –
Jobs & Skills in Hydrogen

Dr Seamus Delaney

Senior Lecturer, School of Education,
Deakin University

s.delaney@deakin.edu.au
@delaneysw

DEAKIN UNIVERSITY

Acknowledgement of Country

I wish to begin by acknowledging the Wurundjeri people of the Kulin nations, the Traditional Owners of the land on which I join you from today.

I recognise their continuing connection to land, waters and culture. I pay respect to their Elders past, present and emerging.

Old Walter Tjampitjinpa, Pintupi people

https://searchthecollection.nga.gov.au/object/16739?uniqueId=16739

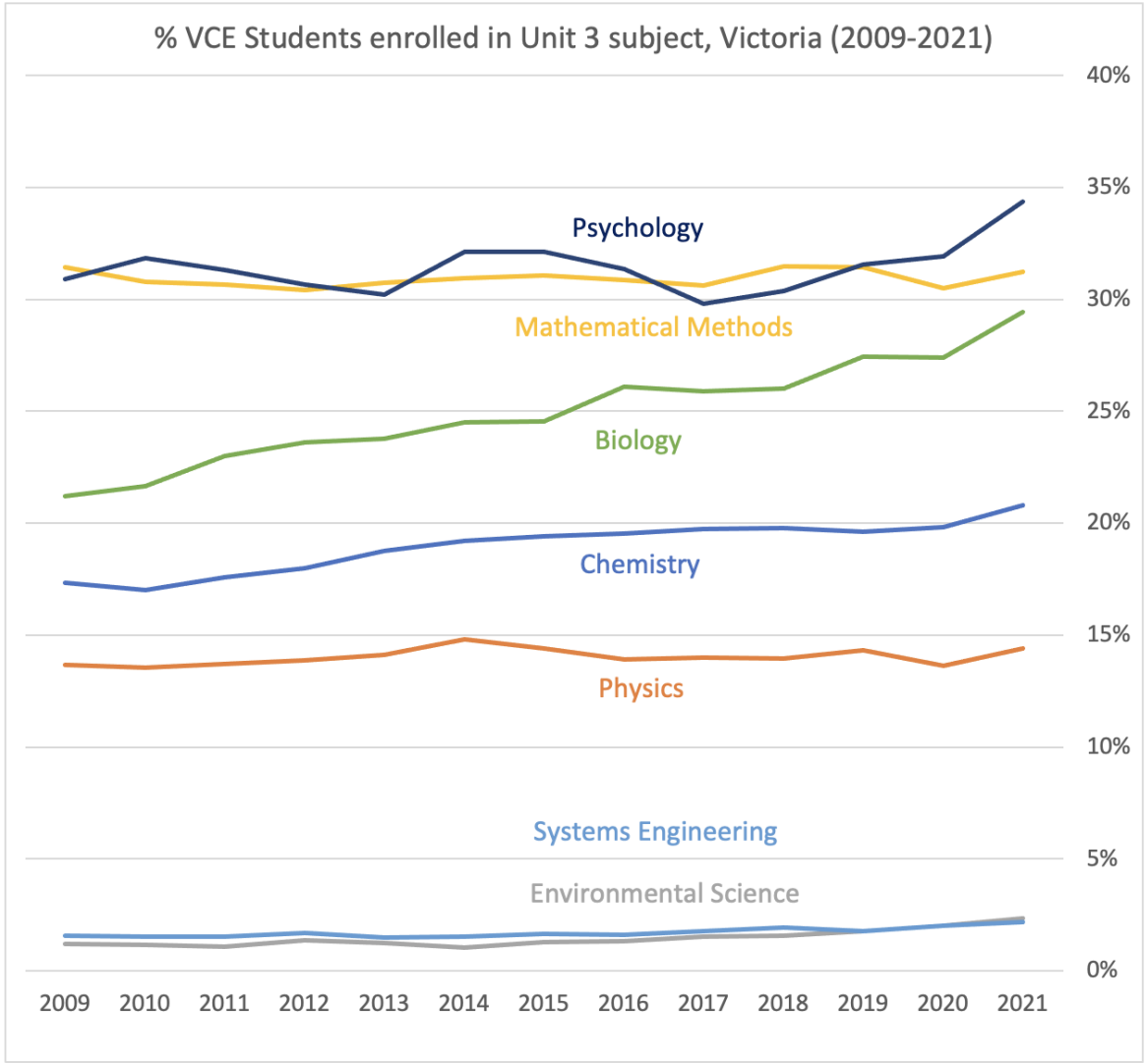
Where does the Jobs mindset begin? How far back should we go?

Senior secondary (years 10-12)?

3-10 years from a 'H_2 job'

Chemistry – only curriculum mention of:

- Hydrogen
- Fuel cells



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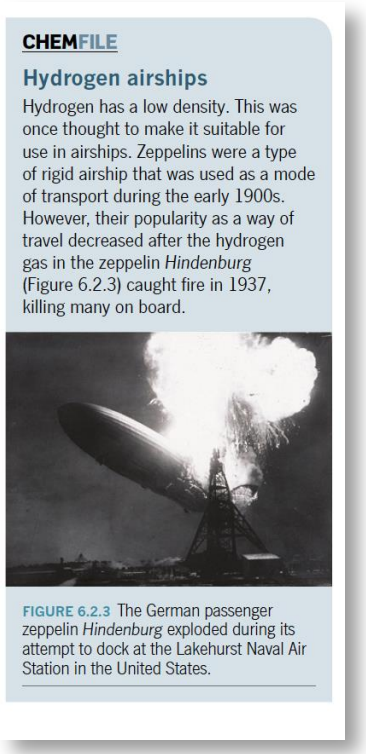
Quick sidenote… Chemistry textbooks still have *somewhat* out-of-context mention of Hindenberg disaster in bonding chapter

Commons et al. (2016) *Heinemann Chemistry 1 Student Book*, 5th Ed, Pearson Australia, China, p. 146.

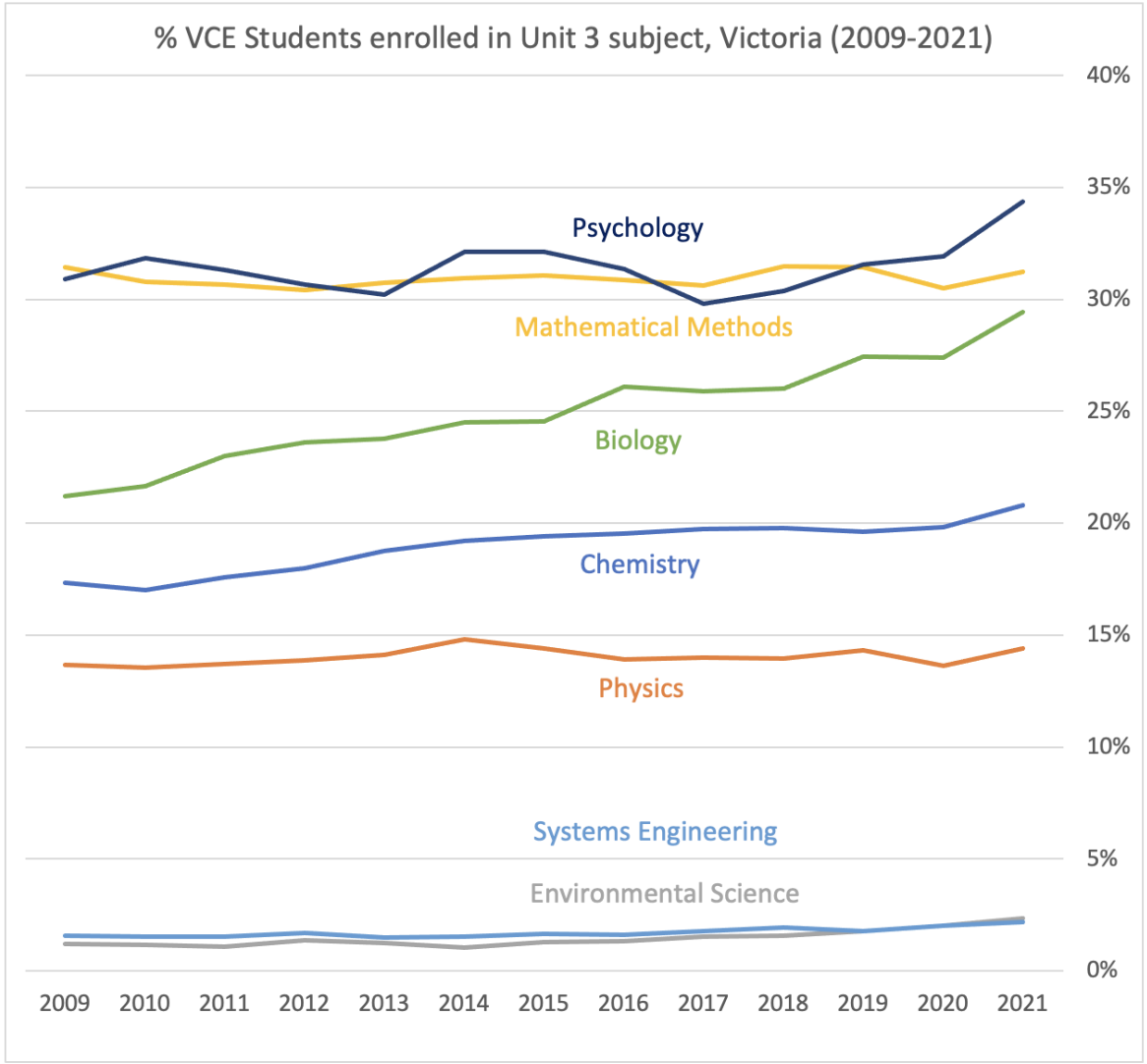


CHEMFILE

Hydrogen airships

Hydrogen has a low density. This was once thought to make it suitable for use in airships. Zeppelins were a type of rigid airship that was used as a mode of transport during the early 1900s. However, their popularity as a way of travel decreased after the hydrogen gas in the zeppelin *Hindenburg* (Figure 6.2.3) caught fire in 1937, killing many on board.

FIGURE 6.2.3 The German passenger zeppelin *Hindenburg* exploded during its attempt to dock at the Lakehurst Naval Air Station in the United States.



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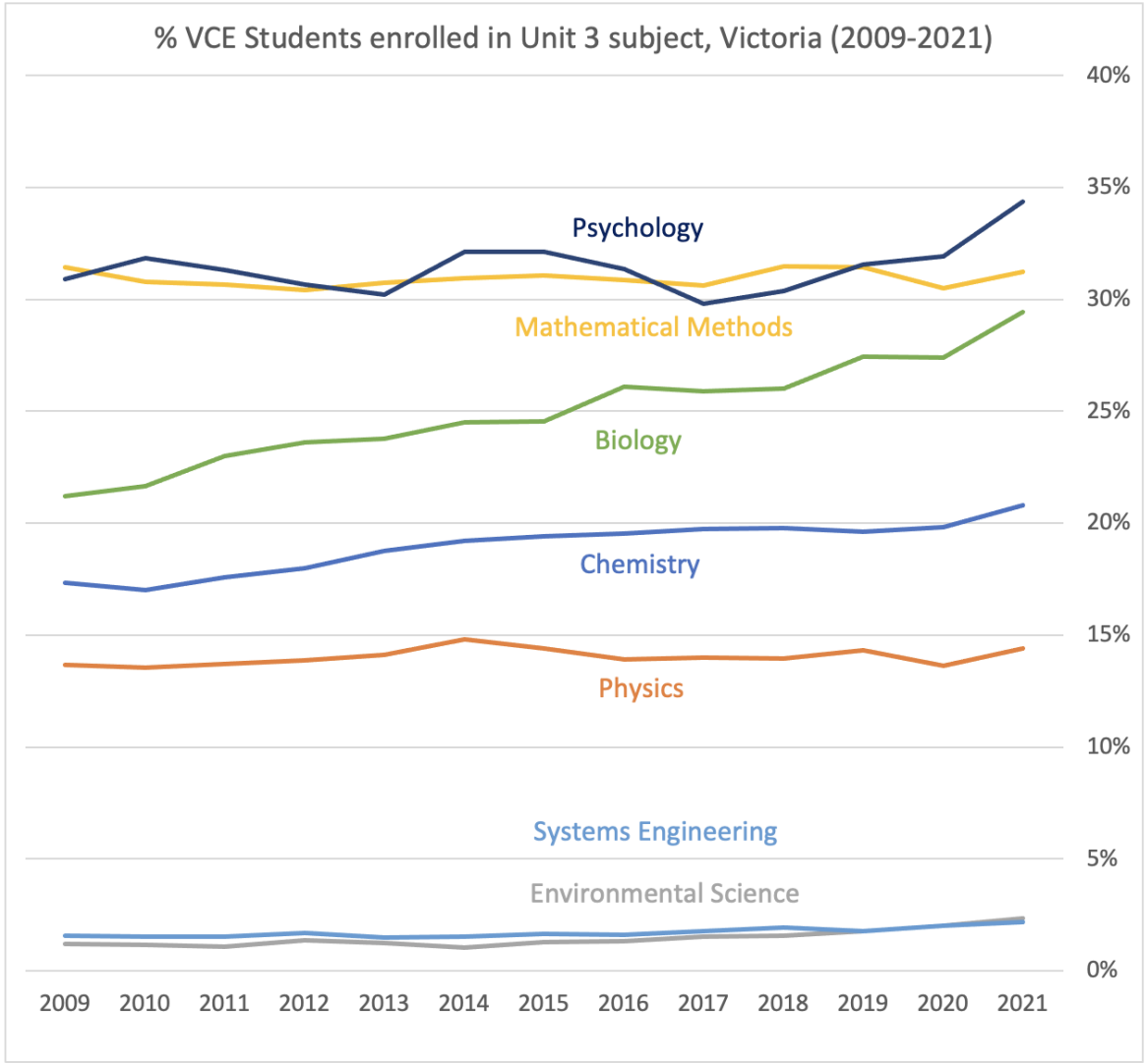
Only curriculum mentions of:

- Energy sources,
- Utilisation of energy
- Energy management
- Fuels



Where does the Jobs mindset begin? How far back should we go?

Further back? Lower secondary/primary (years 4-10)?

10-15 years from a 'H_2 job'

Australian CURRICULUM

Version 9 Australian curriculum (all learning areas)

- Economic decisions in urban infrastructure
- Design and Technology of renewable energy production
- Climate change
- Hydrogen?

Only ***one*** explicit mention

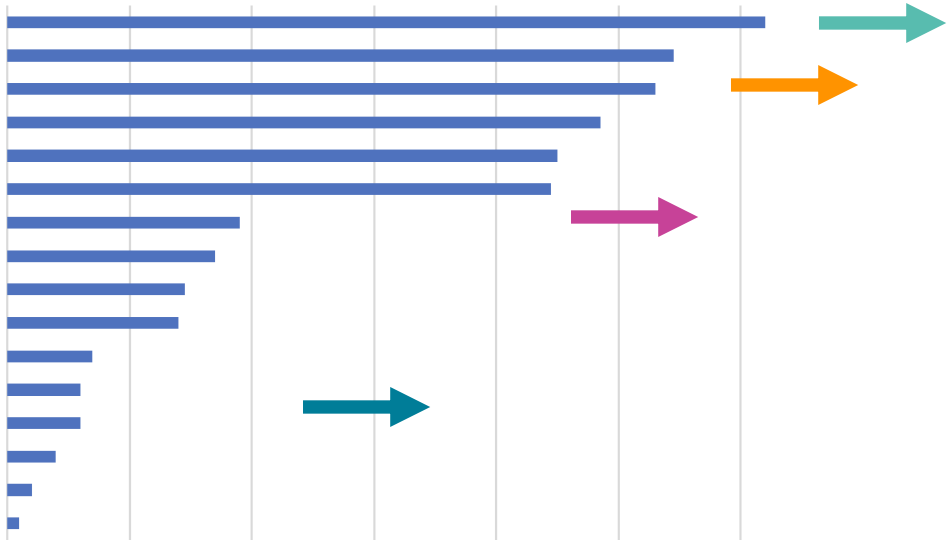
Year 8 Science…
↳ Science as a Human Endeavour…
↳ Use and Influence of Science…
↳Examine proposed scientific responses to contemp. issues…
↳ Elaboration 4 (of 5)…

*…development of hybrid and solar, electric and **hydrogen-powered** vehicles …*

So what *would* be useful hydrogen-relevant curricula in F-12?

Swinburne Victorian Hydrogen Hub (VH2) Hydrogen Skills Road Map

"Number of jobs requiring a hydrogen-specific capabilities…"



- Understanding properties of hydrogen
- Identify hazards, management
- Hydrogen embrittlement
- High-pressure systems, storage
- Ensuring social license

Vocational

- Understanding properties of hydrogen
- *Undertaking risk assessments?*
- *Properties of metals?*
- *Properties of gases, surface area, collision theory?*
- *Socio-scientific issue-relevant inquiry?*

Prim/Sec schools?

Available soon at https://www.swinburne.edu.au/research/platforms-initiatives/victorian-hydrogen-hub/

What is happening already?

Education and Outreach examples

Co-designed with universities / industry

Hydrogen in Schools: Curriculum for primary and secondary schools

Dr Peta White

Dr Seamus Delaney

Prof Russell Tytler

Dr Lam Pham

- Curriculum Benchmarking
- Design and implement new school resources

School of Education collaboration with Hycel Deakin

What is happening already?

Education and Outreach examples

Co-designed with universities / industry

Hydrogen as fuel / mobility

- Water, H_2 as fuel, electrification
- Mass/energy conversion
- What we need to make it ‘zero’/green
- Social/public perspective (ARENA survey)

Horizon Educational

https://www.horizoneducational.com/fuel-cell-car-science-kit/p1232

H-Tec Education

https://h-tec-education.com/fuel-cell-concept-car-gas-station-htec-d203

What is happening already?

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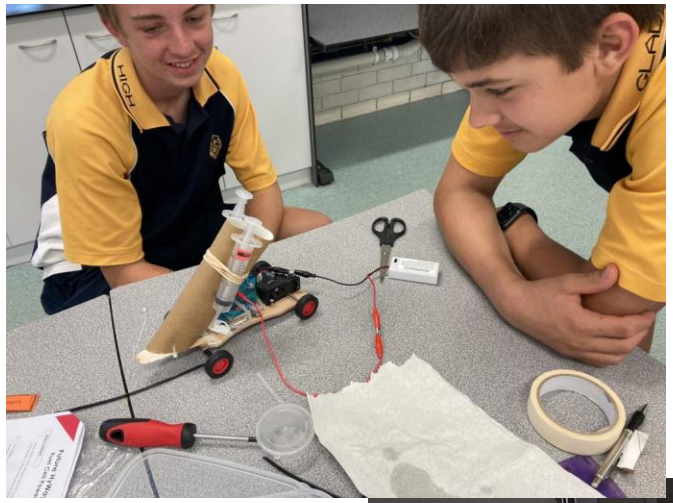
Hydrogen as fuel / mobility

- Water, H_2 as fuel, electrification
- Mass/energy conversion
- What we need to make it ‘zero’/green
- Social/public perspective (ARENA survey)
- Design thinking / Engineering principles



QMEA Future HyWay workshop

“Gladstone High School Students Test Power of Hydrogen” (2021) https://gladstonenews.com.au/gladstone-high-school-students-test-power-of-hydrogen/

What is happening already?

Education and Outreach examples

Co-designed with universities / industry

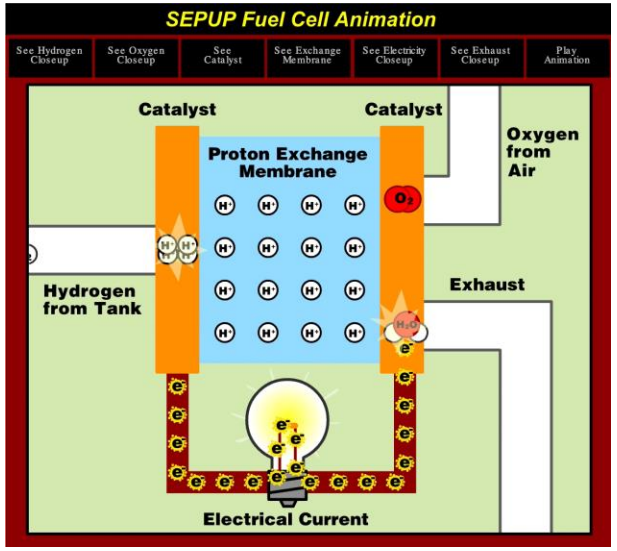
Fuel cell and electrolysis simulations

- Lower/Senior secondary representations of electrochemical science

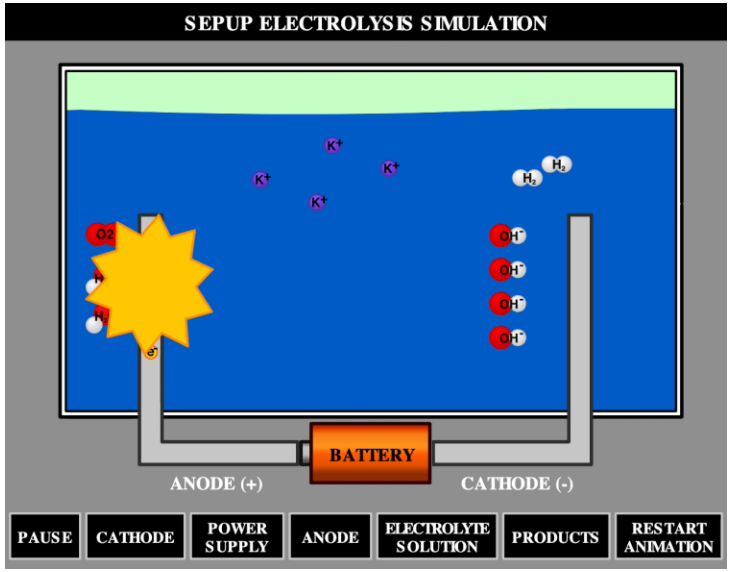
SEPUP
Issue-Oriented Science

Science Education for Public Understanding Program (SEPUP)

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



http://www.sepuplhs.org/high/hydrogen/fuelcell_sim5.html



http://www.sepuplhs.org/high/hydrogen/electrolysis_sim5.html

What is happening already?

Education and Outreach examples

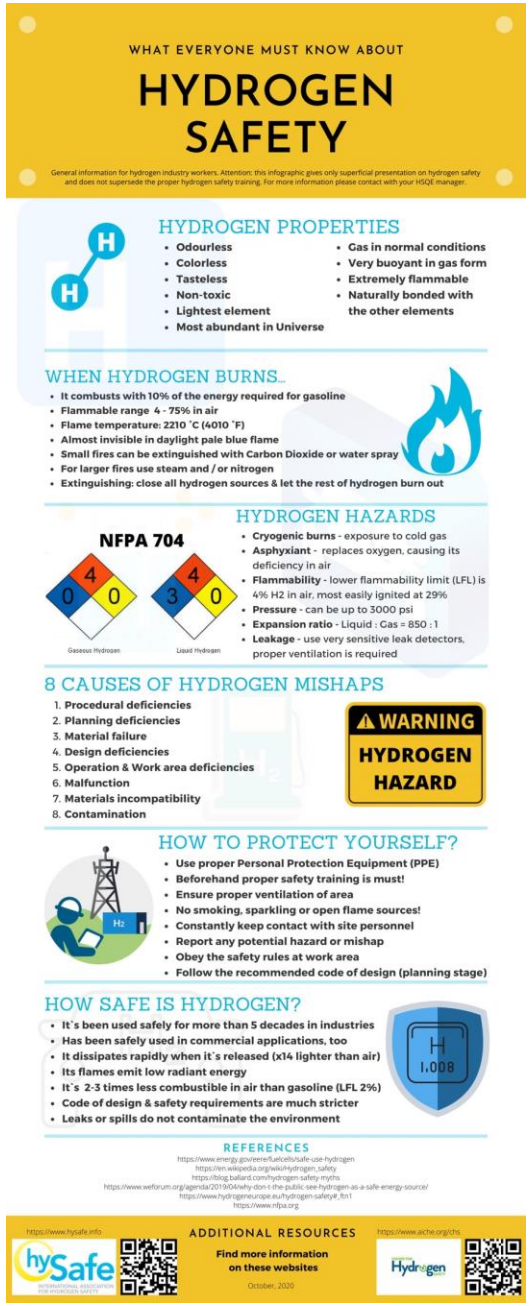
Co-designed with universities / industry

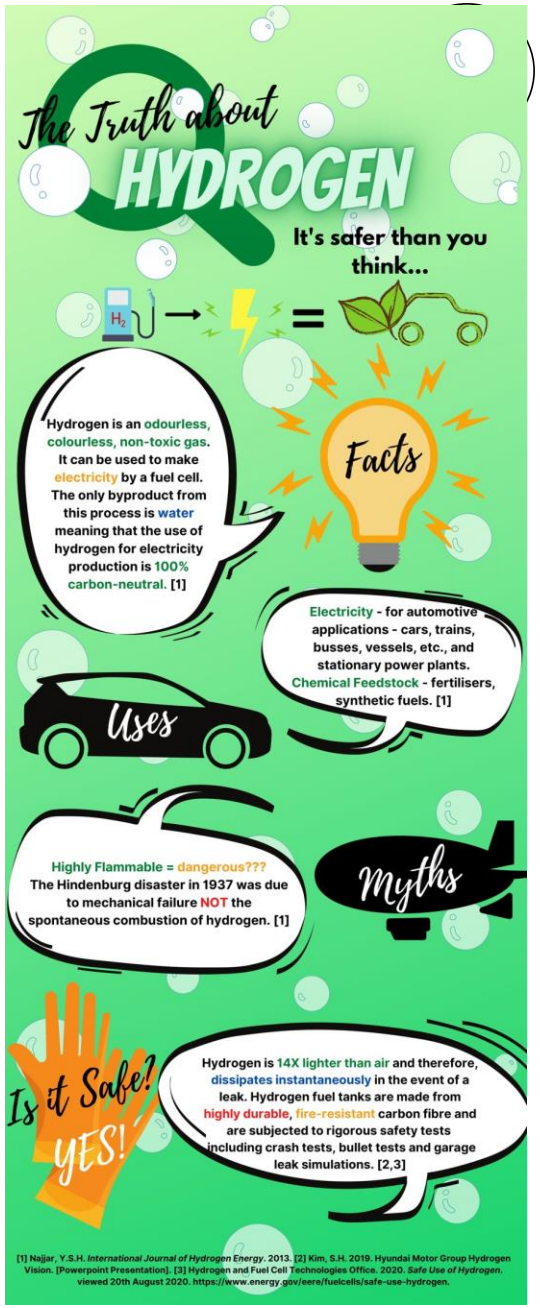
Hydrogen safety

- Science communication, public awareness

International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)

2020 University Winner and Runner-up – IPHE Education and Outreach group Student Infographic Challenge





https://www.iphe.net/challenge

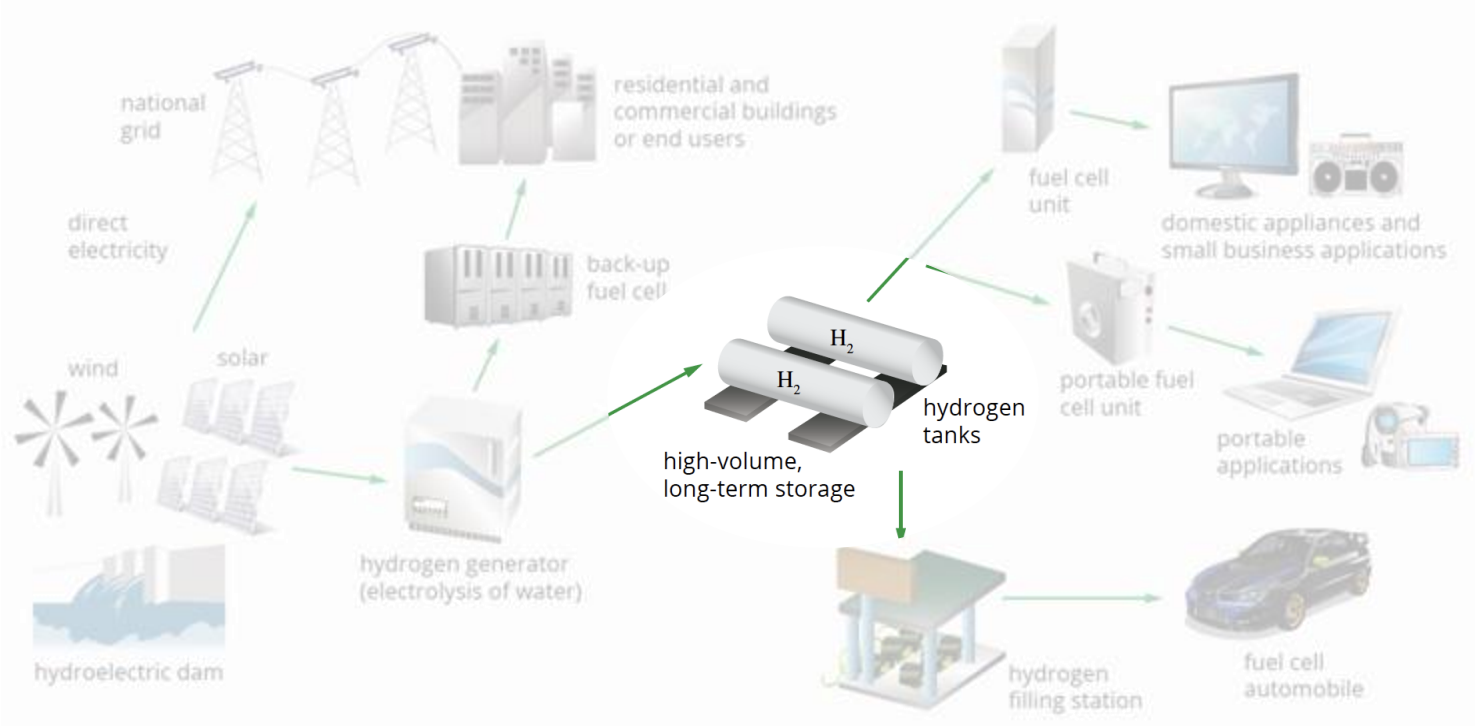
What is missing then? (Needed or Nice to Have?)

H2 storage

- Compressibility / Cryogenics
- Hydrogen embrittlement as context to study properties of metals?

Maybe these topics are seen more as Engineering than Science

The 'absent E' in school STEM subjects



Commons et al. (2017) *Heinemann Chemistry 2 Student Book*, 5th Ed, Pearson Australia, China, p. 156.

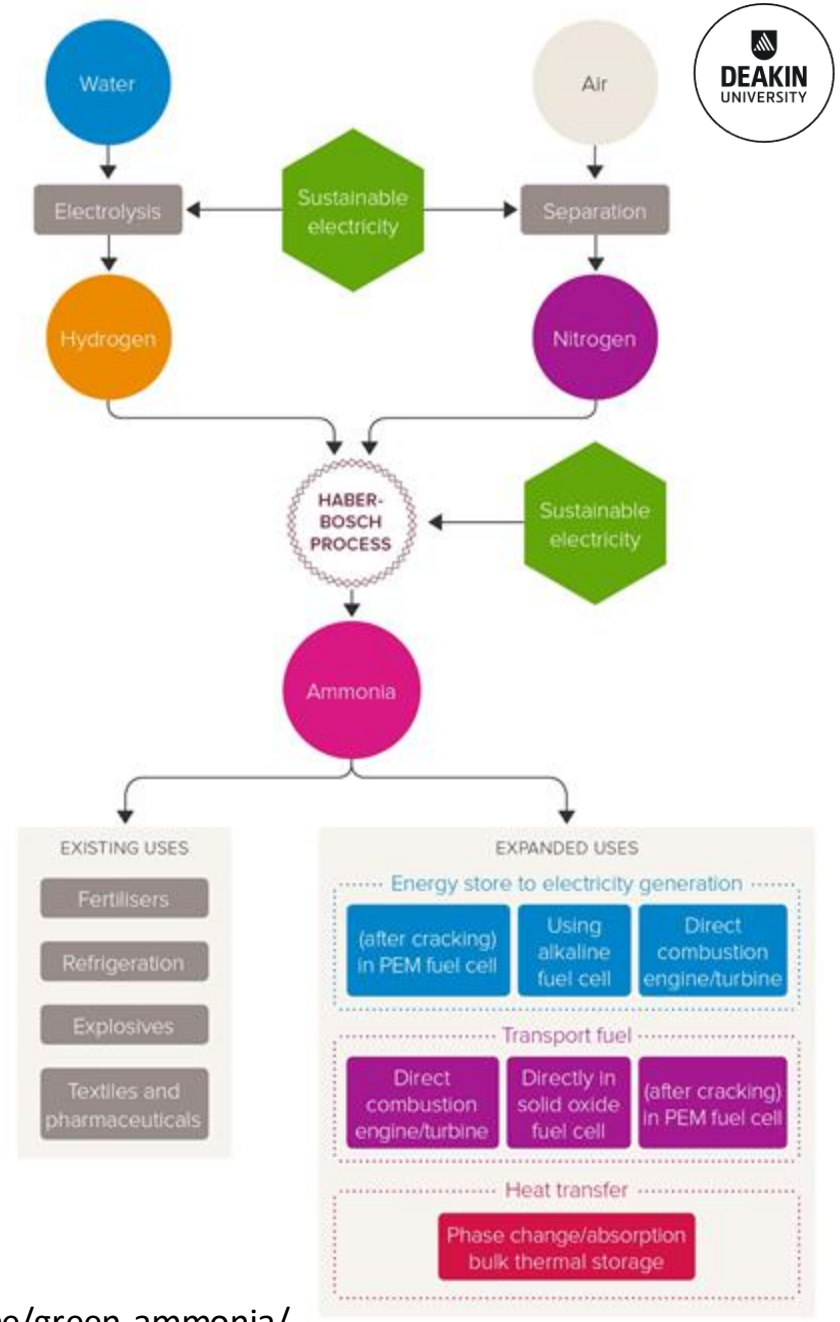
What is missing then? (Needed or Nice to Have?)

Other utilisations of hydrogen

- **Ammonia production**

$N_2 + 3H_2 \rightarrow 2\ NH_3$

- Ubiquitous chemical reaction in years 7-12 science teaching
- Many students (and teachers!) shocked to discover the SMR/fossil fuel connection to food production



https://royalsociety.org/topics-policy/projects/low-carbon-energy-programme/green-ammonia/

What is missing then? (Needed or Nice to Have?)

Other utilisations of hydrogen

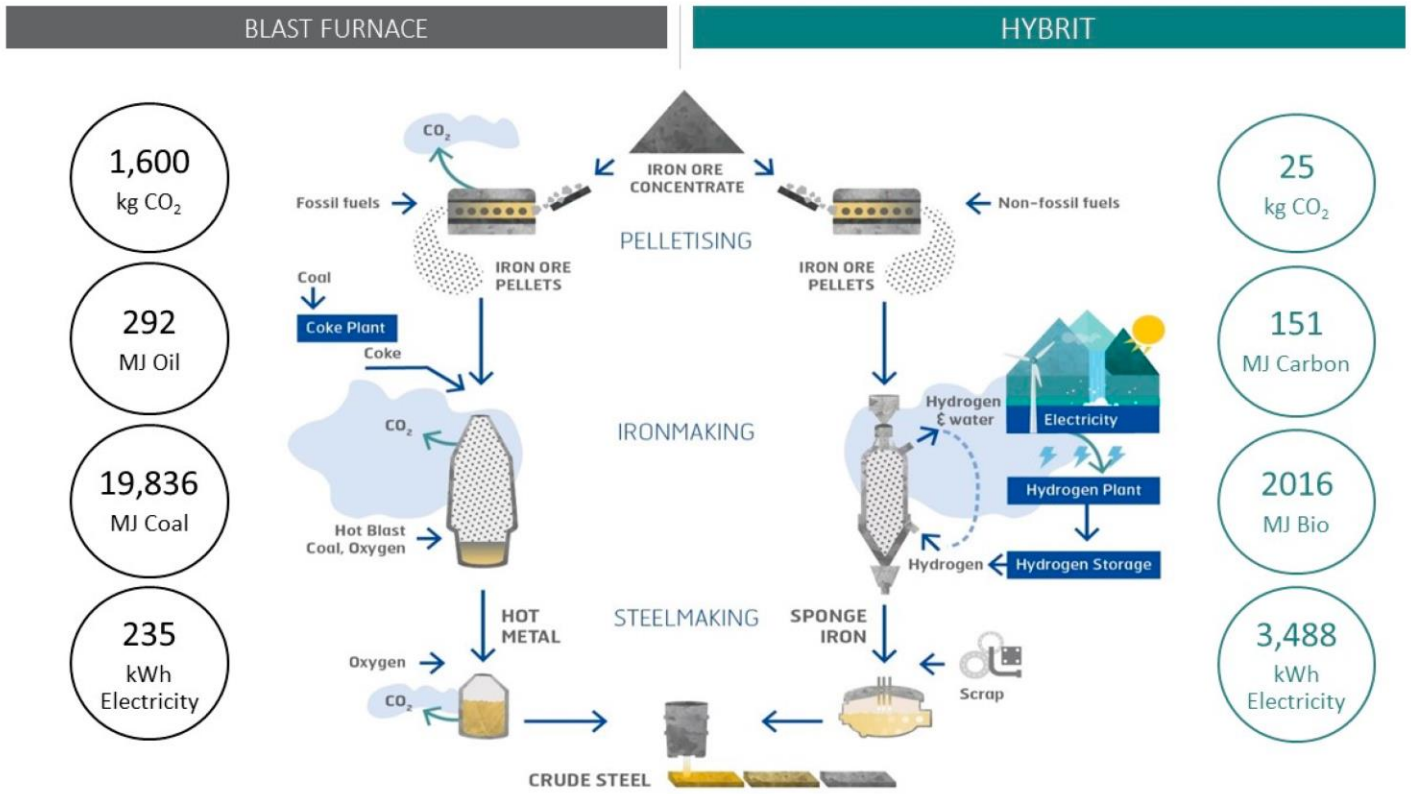
- **Steel production**

Iron ore + Coke → Iron + CO_2

- Blast furnace reaction another ubiquitous chemical equation in school science

Or too soon?

Will a child in primary school today find an Australian job in zero-emission steel production in ~15 years time?



Pei M, Petäjäniemi M, Regnell A, Wijk O. Toward a Fossil Free Future with HYBRIT: Development of Iron and Steelmaking Technology in Sweden and Finland. Metals. 2020; 10(7):972. https://doi.org/10.3390/met10070972

Final thoughts

Dr Seamus Delaney
Email: s.delaney@deakin.edu.au

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- Russell Tytler, Peta White, Seamus Delaney, Lam Pham, Jacob Mulyana

Hycel Deakin

- Loren Tuck, Ailiche Goddard-Clegg

Gender-equal STEM workforce – Gender stereotypes begin to cement in **8 to 12-year age** group, ideas form about which jobs are suitable for girls or boys

Hydrogen awareness of Generation Z (10 to 25-years) – From Siemen's Pace of Change survey (2019)

*"Nearly one-third (30%) of millennials and **22% of Generation Z** already know a lot about hydrogen energy, compared to **only 3% of baby boomers**…"*

https://news.siemens.co.uk/news/uk-public-demand-government-act-faster-to-develop-clean-energy