

# Education – F-12 Schools and the Hydrogen Future

Australian Hydrogen Council Webinar –  
Jobs & Skills in Hydrogen

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## ► 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>

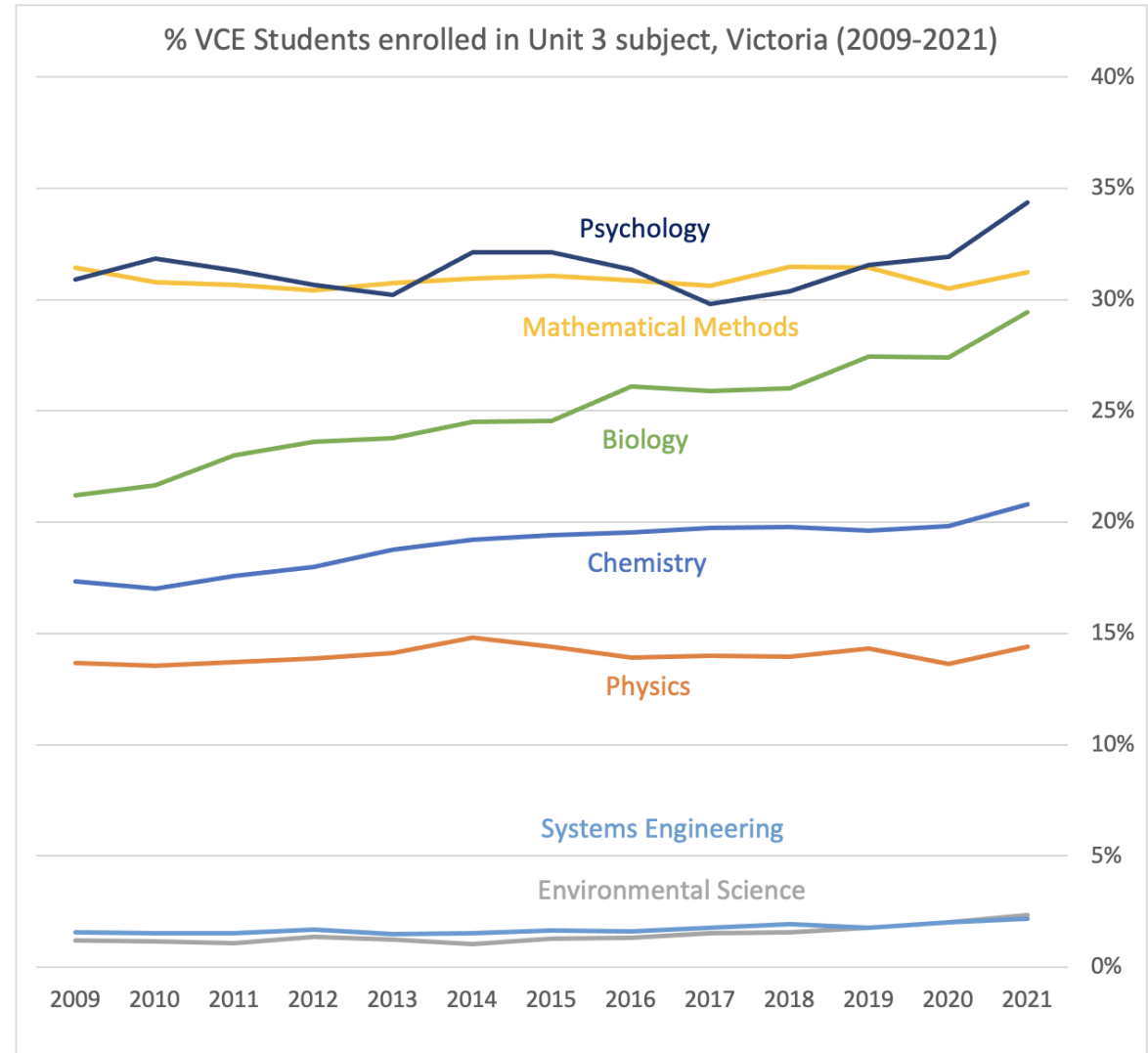
# ▶ Where does the Jobs mindset begin? How far back should we go?

**Senior secondary (years 10-12)?**

3-10 years from a 'H<sub>2</sub> 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*, 5<sup>th</sup> Ed, Pearson Australia, China, p. 146.

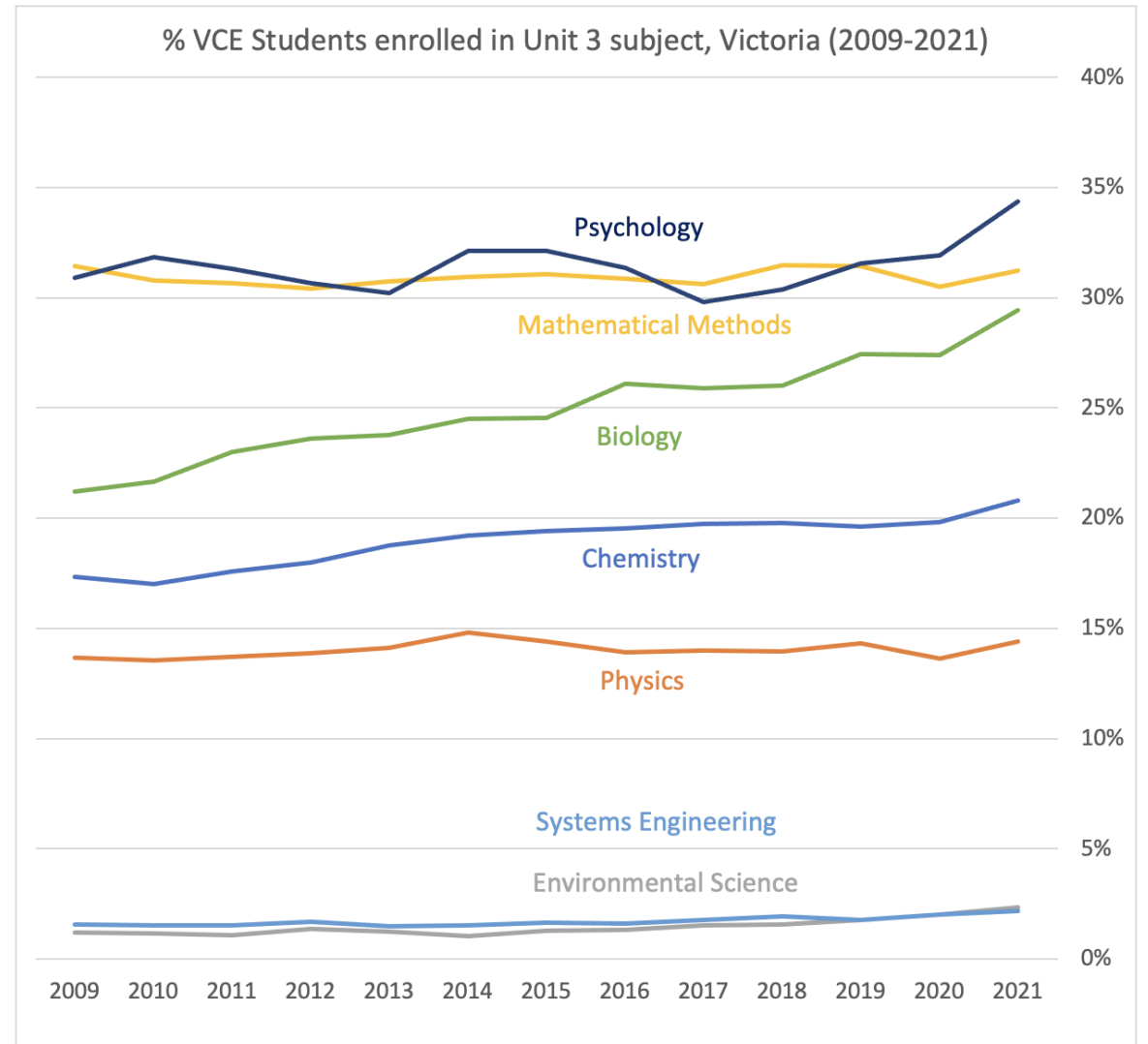
### CHEMFILE

#### 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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## Senior secondary (years 10-12)?

3-10 years from a 'H<sub>2</sub> job'

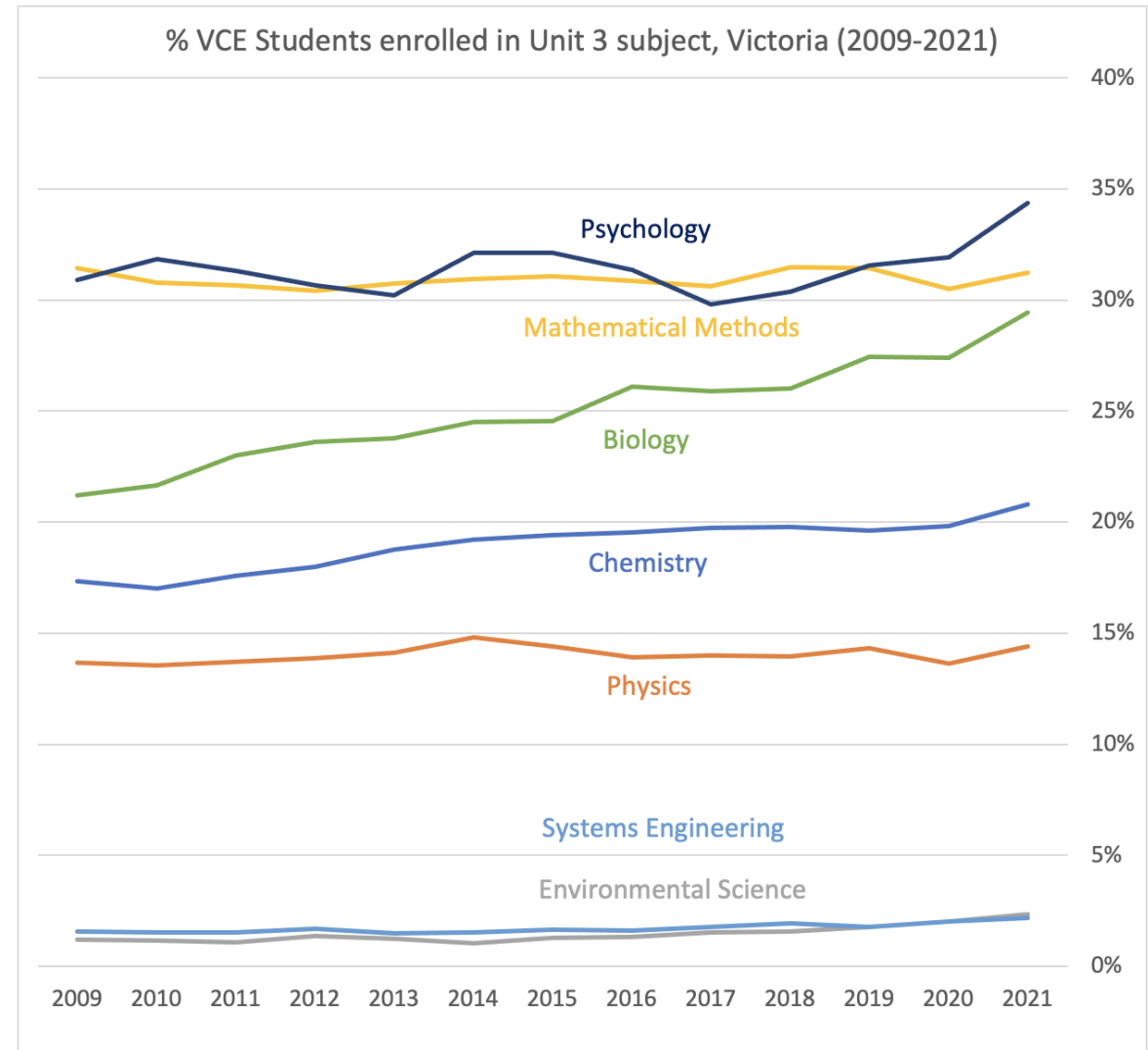
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Only curriculum mentions of:

- 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<sub>2</sub> job'



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)...

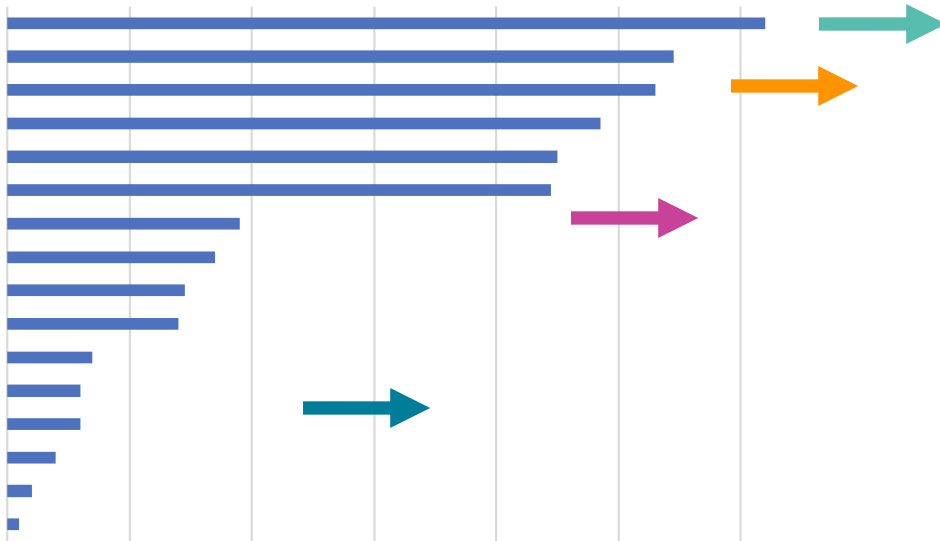
*...development of hybrid and solar, electric and **hydrogen-powered** vehicles ...*



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

Vocational

Prim/Sec schools?

## ► 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

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### Hydrogen as fuel / mobility

- Water, H<sub>2</sub> 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>

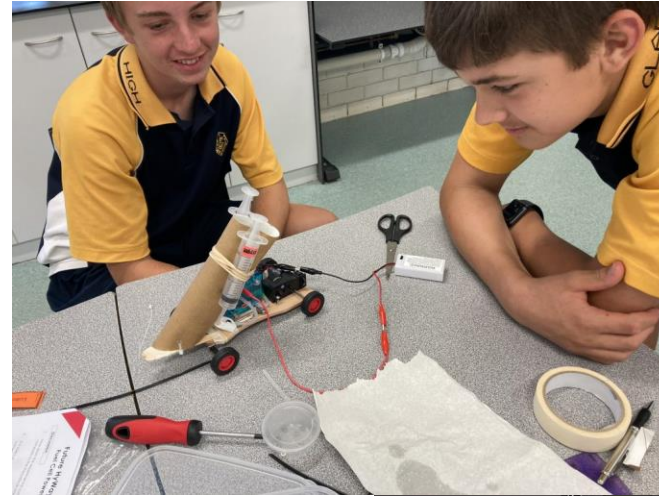
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Hydrogen as fuel / mobility

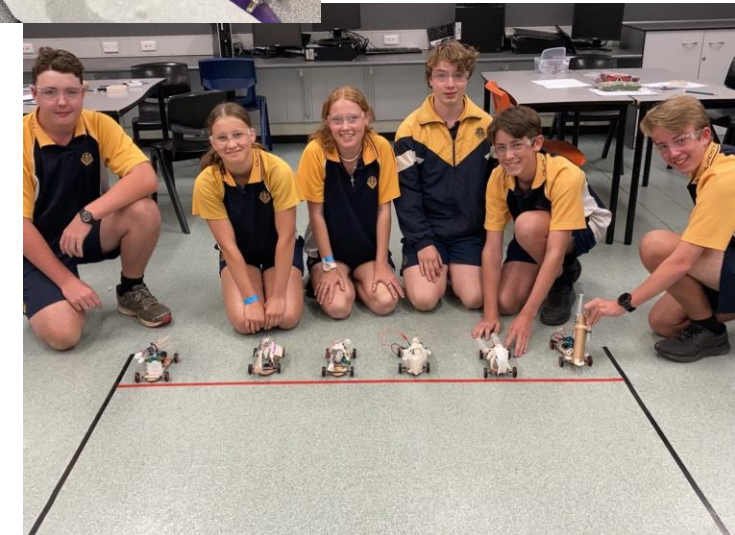
- Water, H<sub>2</sub> as fuel, electrification
- Mass/energy conversion
- What we need to make it 'zero' / green
- Social/public perspective (ARENA survey)
- Design thinking / Engineering principles



QUEENSLAND  
resources  
COUNCIL

QMEA  
RESOURCES SKILLS ACADEMY

QMEA Future  
HyWay  
workshop



# ► What is happening already?

## Education and Outreach examples

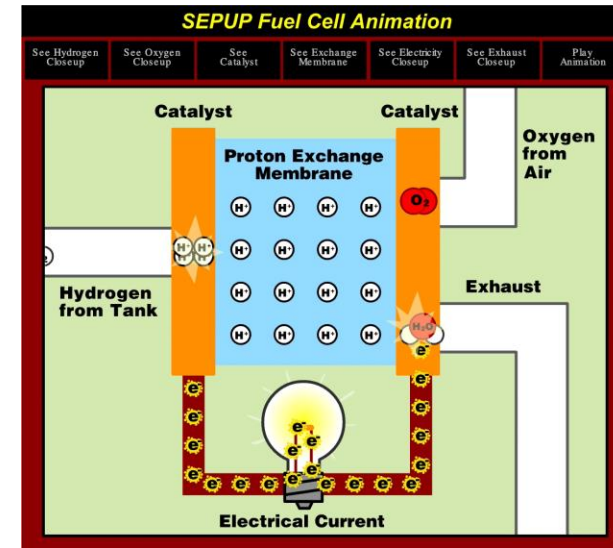
Co-designed with universities / industry

Fuel cell and electrolysis simulations

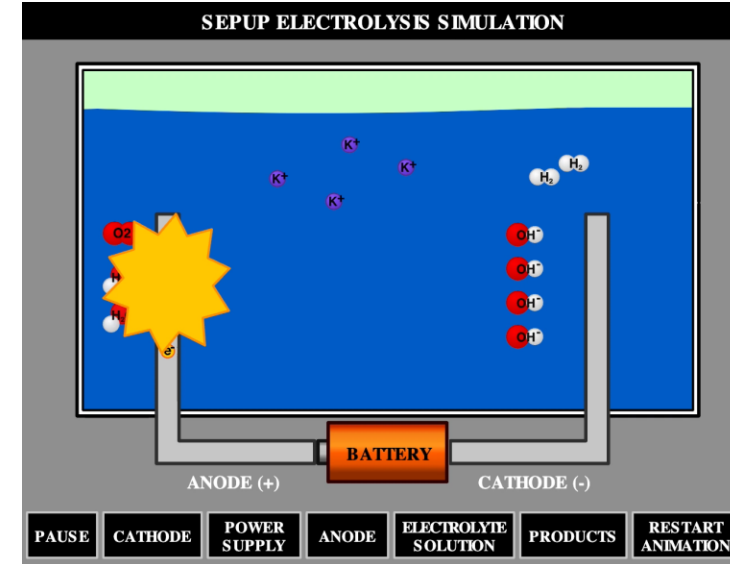
- Lower/Senior secondary representations of electrochemical science



Science Education for Public Understanding Program (SEPUP)



[http://www.sepuplhs.org/high/hydrogen/fuelcell\\_sim5.html](http://www.sepuplhs.org/high/hydrogen/fuelcell_sim5.html)



[http://www.sepuplhs.org/high/hydrogen/electrolysis\\_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

### WHAT EVERYONE MUST KNOW ABOUT HYDROGEN SAFETY

General information for hydrogen industry workers. Attention: this infographic gives only superficial presentation on hydrogen safety and does not supersede the proper hydrogen safety training. For more information please contact with your HSEQ manager.

#### HYDROGEN PROPERTIES

- Odourless
- Colorless
- Tasteless
- Non-toxic
- Lightest element
- Most abundant in Universe
- Gas in normal conditions
- Very buoyant in gas form
- Extremely flammable
- Naturally bonded with the other elements

#### WHEN HYDROGEN BURNS...

- It combusts with 10% of the energy required for gasoline
- Flammable range 4 - 75% in air
- Flame temperature: 2210 °C (4010 °F)
- Almost invisible in daylight pale blue flame
- Small fires can be extinguished with Carbon Dioxide or water spray
- For larger fires use steam and / or nitrogen
- Extinguishing: close all hydrogen sources & let the rest of hydrogen burn out

#### HYDROGEN HAZARDS

**NFPA 704**

0	4	0
0	3	0

- Cryogenic burns - exposure to cold gas
- Asphyxiant - replaces oxygen, causing its deficiency in air
- Flammability - lower flammability limit (LFL) is 4% H2 in air, most easily ignited at 29%
- Pressure - can be up to 3000 psi
- Expansion ratio - Liquid : Gas = 850 : 1
- Leakage - use very sensitive leak detectors, proper ventilation is required

#### 8 CAUSES OF HYDROGEN MISHAPS

1. Procedural deficiencies
2. Planning deficiencies
3. Material failure
4. Design deficiencies
5. Operation & Work area deficiencies
6. Malfunction
7. Materials incompatibility
8. Contamination

#### HOW TO PROTECT YOURSELF?

- Use proper Personal Protection Equipment (PPE)
- Beforehand proper safety training is must!
- Ensure proper ventilation of area
- No smoking, sparking or open flame sources!
- Constantly keep contact with site personnel
- Report any potential hazard or mishap
- Obey the safety rules at work area
- Follow the recommended code of design (planning stage)

#### HOW SAFE IS HYDROGEN?

- It's been used safely for more than 5 decades in industries
- Has been safely used in commercial applications, too
- It dissipates rapidly when it's released (x14 lighter than air)
- Its flames emit low radiant energy
- It's 2-3 times less combustible in air than gasoline (LFL 2%)
- Code of design & safety requirements are much stricter
- Leaks or spills do not contaminate the environment

#### REFERENCES

<https://www.energy.gov/eere/fuelcells/safe-use-hydrogen>  
<https://www.northeastern.edu/hydrogen-safety>  
<https://blog.balford.com/hydrogen-safety-myths>  
<https://www.norforum.org/agenda/2019/04/04/why-does-the-public-see-hydrogen-as-a-safe-energy-source/>  
[https://www.hydrogen-europe.eu/hydrogen-safety\\_01/](https://www.hydrogen-europe.eu/hydrogen-safety_01/)  
<https://www.nfpa.org>

#### ADDITIONAL RESOURCES

<https://www.hySafe.info> Find more information on these websites <https://www.ache.org/che>

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### The Truth about HYDROGEN

It's safer than you think...

#### Facts

- Hydrogen is an odourless, colourless, non-toxic gas. It can be used to make electricity by a fuel cell. The only byproduct from this process is water meaning that the use of hydrogen for electricity production is 100% carbon-neutral. [1]
- Electricity - for automotive applications - cars, trains, busses, vessels, etc., and stationary power plants. Chemical Feedstock - fertilisers, synthetic fuels. [1]

#### Myths

- Highly Flammable = dangerous??? The Hindenburg disaster in 1937 was due to mechanical failure NOT the spontaneous combustion of hydrogen. [1]
- Hydrogen is 14X lighter than air and therefore, dissipates instantaneously in the event of a leak. Hydrogen fuel tanks are made from highly durable, fire-resistant carbon fibre and are subjected to rigorous safety tests including crash tests, bullet tests and garage leak simulations. [2, 3]

#### Uses

Is it Safe? YES!

[1] Najjar, Y.S.H. International Journal of Hydrogen Energy. 2013. [2] Kim, S.H. 2019. Hyundai Motor Group Hydrogen Vision. [Powerpoint Presentation]. [3] Hydrogen and Fuel Cell Technologies Office. 2020. Safe Use of Hydrogen. viewed 20th August 2020. <https://www.energy.gov/eere/fuelcells/safe-use-hydrogen>.

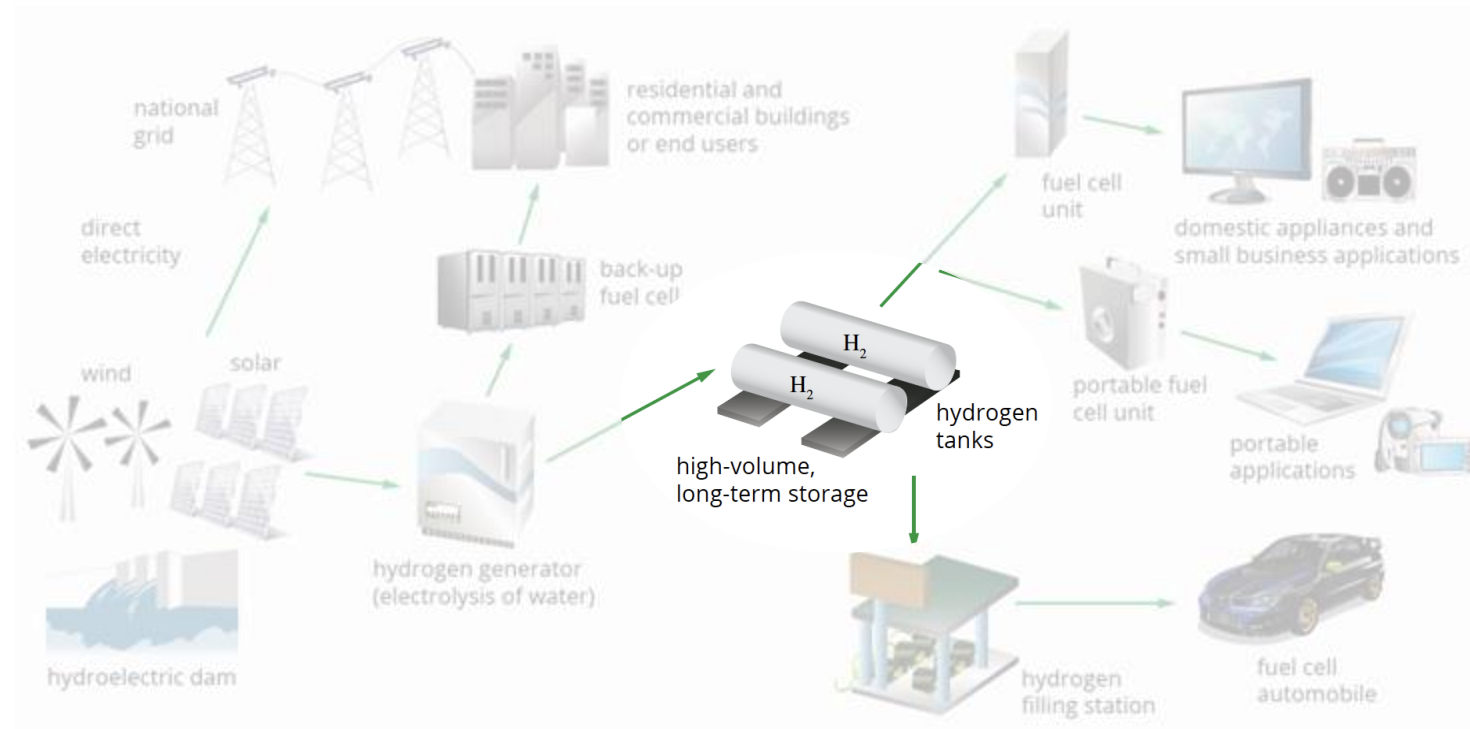
# ► What is missing then? (Needed or Nice to Have?)

## 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*, 5<sup>th</sup> Ed, Pearson Australia, China, p. 156.

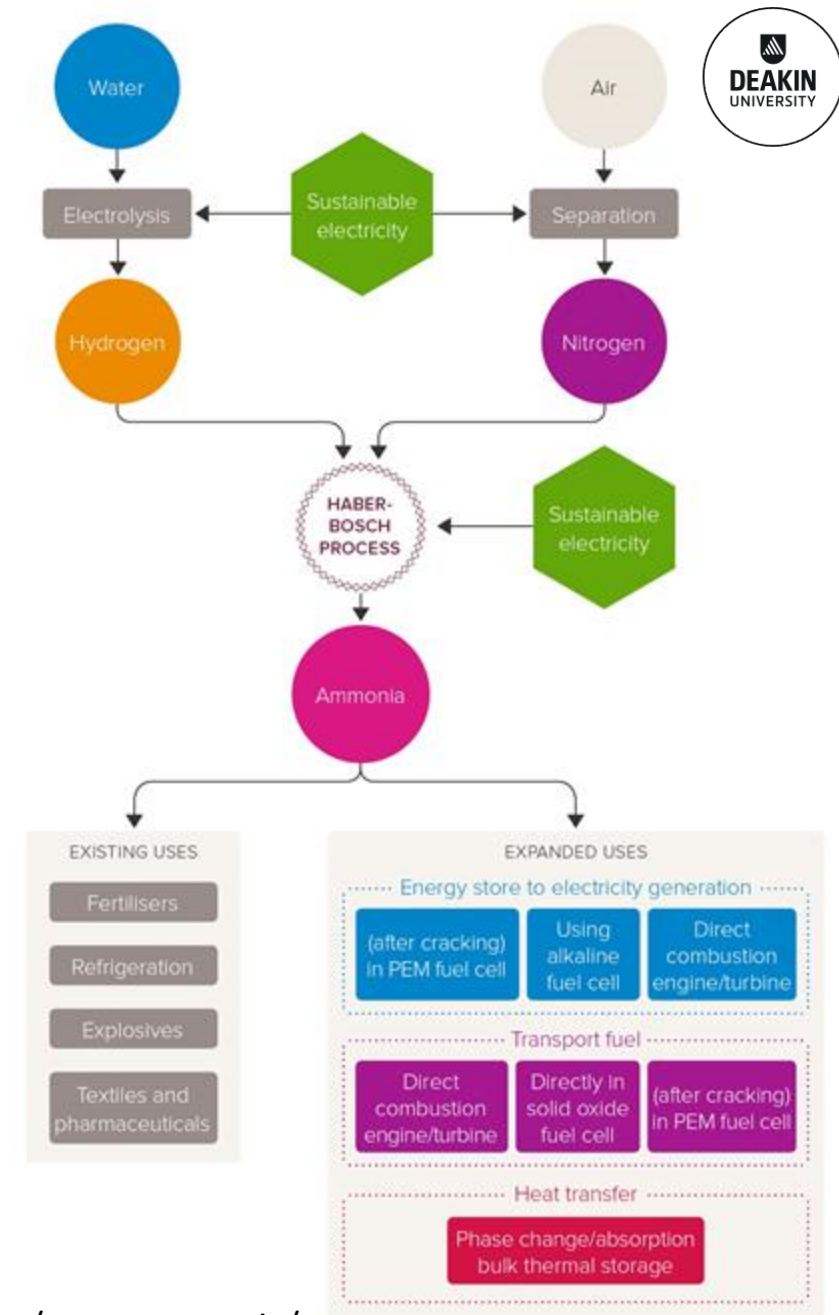
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## Other utilisations of hydrogen

- **Ammonia production**



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





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

## Other utilisations of hydrogen

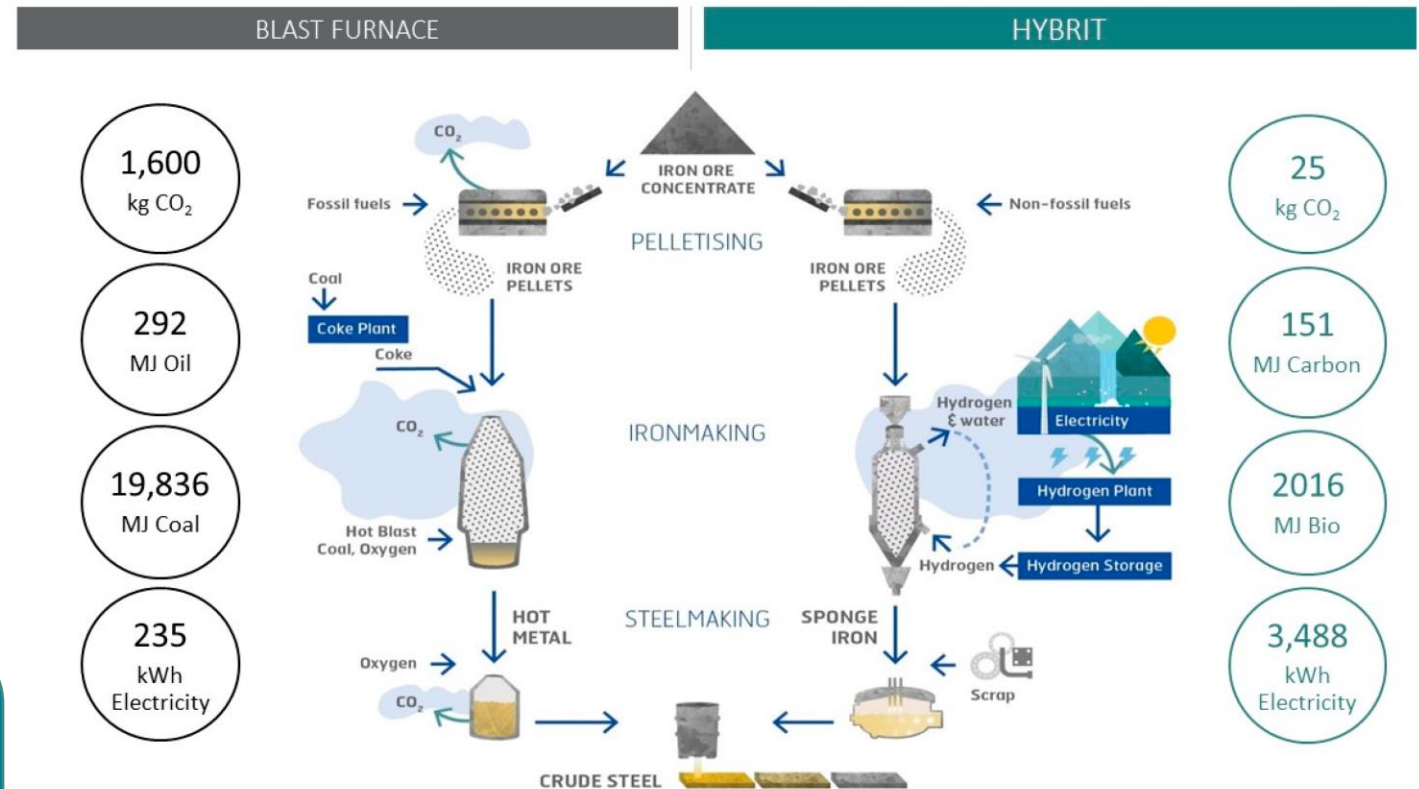
- **Steel production**

Iron ore + Coke → Iron + CO<sub>2</sub>

- 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, Petäjaniemi 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

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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...**”*