CERTIFYING AMMONIA FOR TRADE AND ENVIRONMENTAL BENEFIT

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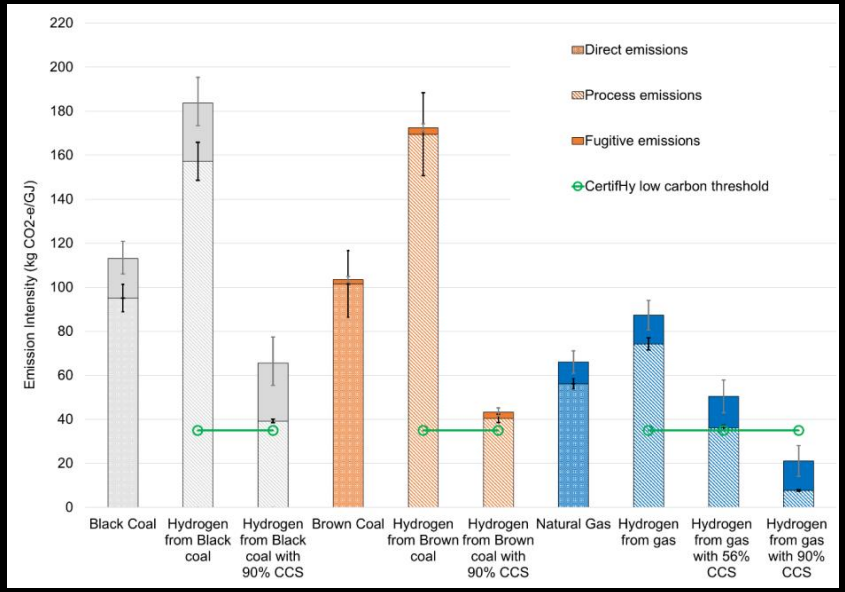
Why ammonia energy?

- The raison d'etre for ammonia as an energy carrier is greenhouse gas emissions reductions.
- Ammonia can be used as a fuel itself, or as a carrier for hydrogen.

But not all H2/NH3 is clean

Source: Longden et al 2021



Average and marginal consequential emissions from grid-connected electrolyser-H2
Source: Stocks & White, forthcoming

Region	Average intensity t_{CO2}/MWh	Average intensity t_{CO2}/MWh	Average H_2 kg_{CO2}/kg	Marginal H_2 kg_{CO2}/kg
NSW	0.81	0.66	44.6	36.3
VIC	1.02	0.55	56.1	30.3
QLD	0.81	0.66	44.6	36.3
SA	0.44	0.53	24.2	29.2
TAS	0.15	0.31	***8.3***	17.1

Certification is the only way buyers can be confident they are buying clean and/or green

Green Certification

- H2 & NH3 from 100% renewable energy
- Should be net zero emission
- Challenges for grid-connected even with RE certificates (Stocks & White)
- EU may require geographic and temporal alignment of RE production and electricity consumption

Clean Certification

- Flexible and technology neutral
- Gas, coal, grid-connected electrolysis
- Certify how much embedded emissions – not necessarily zero
- National Greenhouse Accounting methodologies could be adapted (Reeve & Aisbett)

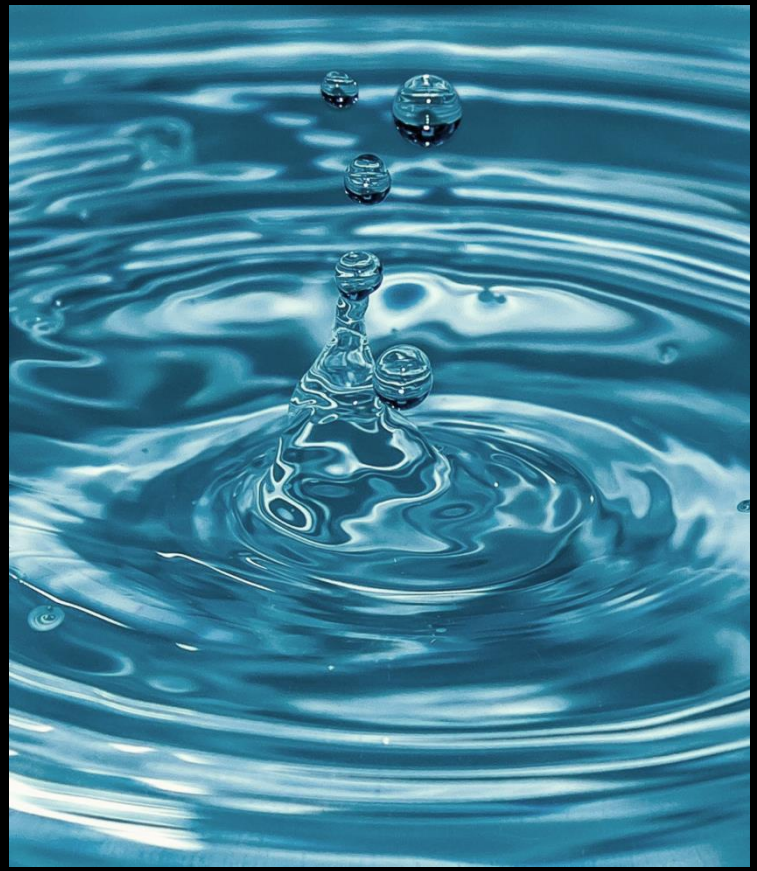


Image from www.canva.com

Types of certification

Schemes tend to divide into two types

Guarantee of Origin (GO)

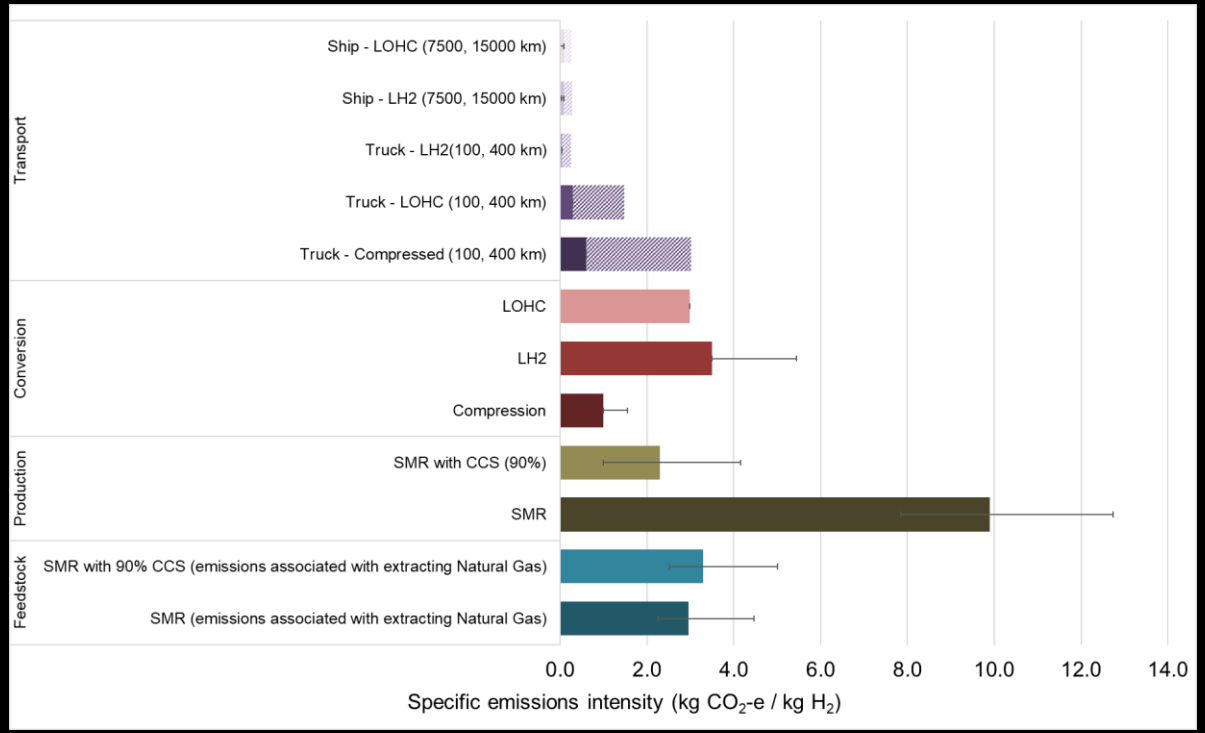
- Primarily concerned with how the hydrogen was produced
- Do not generally account for embedded carbon in the plant, storage, transport and conversion at the customer gate (but do typically cover Feedstock and Production)

Life Cycle Accounting (LCA)

- Typically account for carbon emissions over whole life cycle, including transport, storage, conversion/reconversion, and use
- Some variation in which parts of the life cycle are covered
- Can be administratively more burdensome

A modular approach?

- Emissions occur all along value chains
- Comprehensive boundaries guide better decisions
- Single, comprehensive boundaries may disadvantage exporters like Australia
- A modular approach to boundaries can ensure environmental and trade distortions are minimised (White et al, *Energy*)



White, L. V., Fazeli, R., Cheng, W., Aisbett, E., Beck, F.J., Baldwin, K.G.H., Howarth, P., O'Neill, L., 2021. Towards emissions certification systems for international trade in hydrogen: The policy challenge of defining boundaries for emissions accounting. Energy 215, 119139. https://doi.org/10.1016/j.energy.2020.119139

CONCLUSION

Boundary Questions

- Guarantee of Origin Schemes (GoS) are a good starting point
- Need to go all the way to resource extraction (feedstock is not just H2)
- GoSs can be expanded over time using a modular approach to increase value chain coverage

Green versus Clean

- We are already seeing the emergence of both “green” and “clean” certification schemes
- “Regulatory competition” will be a feature of the certification landscape at least initially
- Experience in forestry suggests consumers will ultimate determine which dominates

Additionality and consequential emissions

- A rigorous approach to additionality for grid-connected electrolysers will be important to avoid substantial carbon emissions during the energy transition