Enabling Renewable Hydrogen Export: Certifications and Beyond

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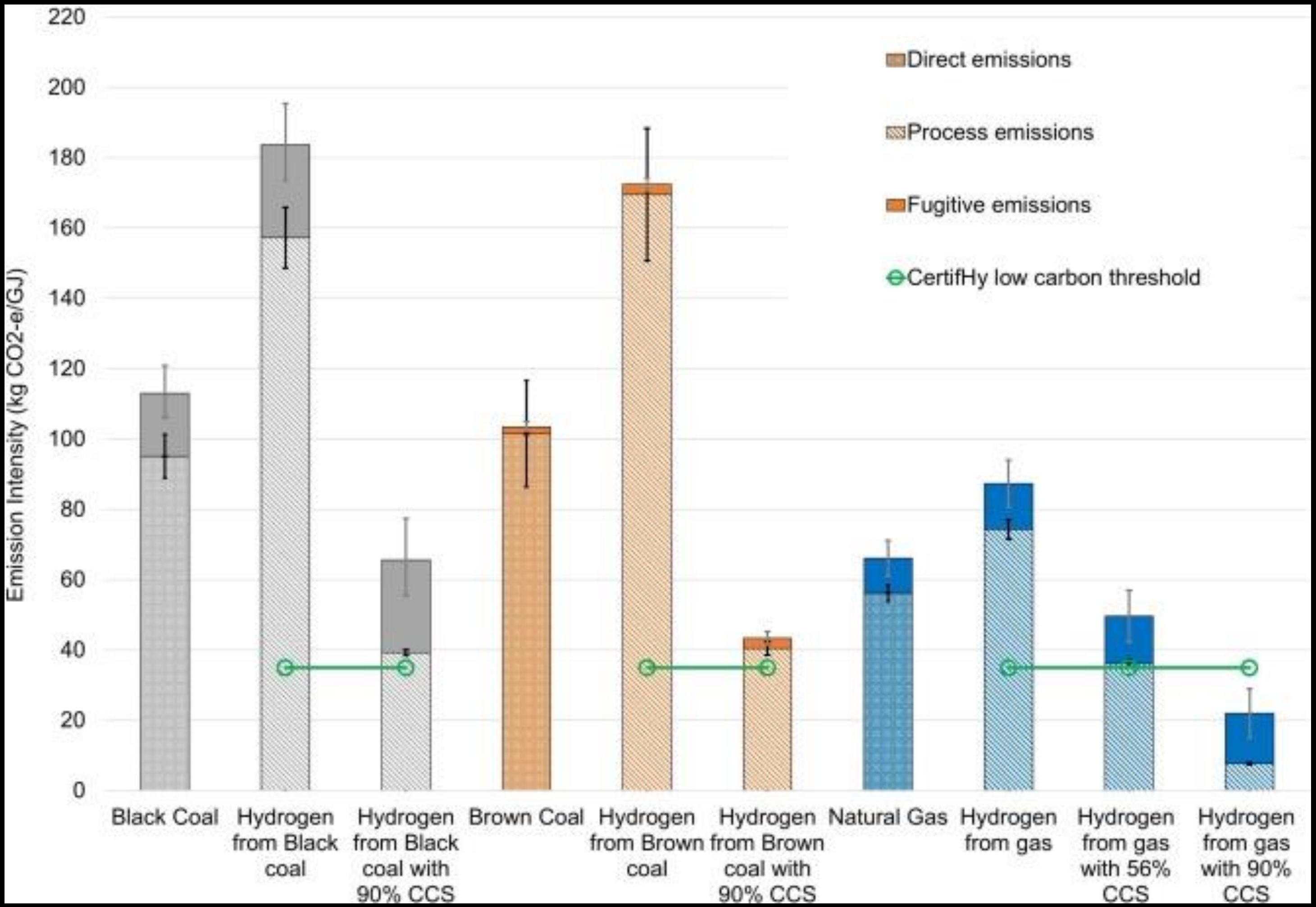
Renewable hydrogen as a game changer for the net zero transition

- With blue hydrogen where carbon capture rates are low, there is a risk of lock-in of scaled high-emissions fossil fuel production.
- if capture rates are high, there is a risk of stranded assets as hydrogen production with CCS may lose its competitive edge over green hydrogen



Source: Longden, Thomas, et al. "'Clean' hydrogen?–Comparing the emissions and costs of fossil fuel versus renewable electricity based hydrogen." *Applied Energy* 306 (2022): 118145.

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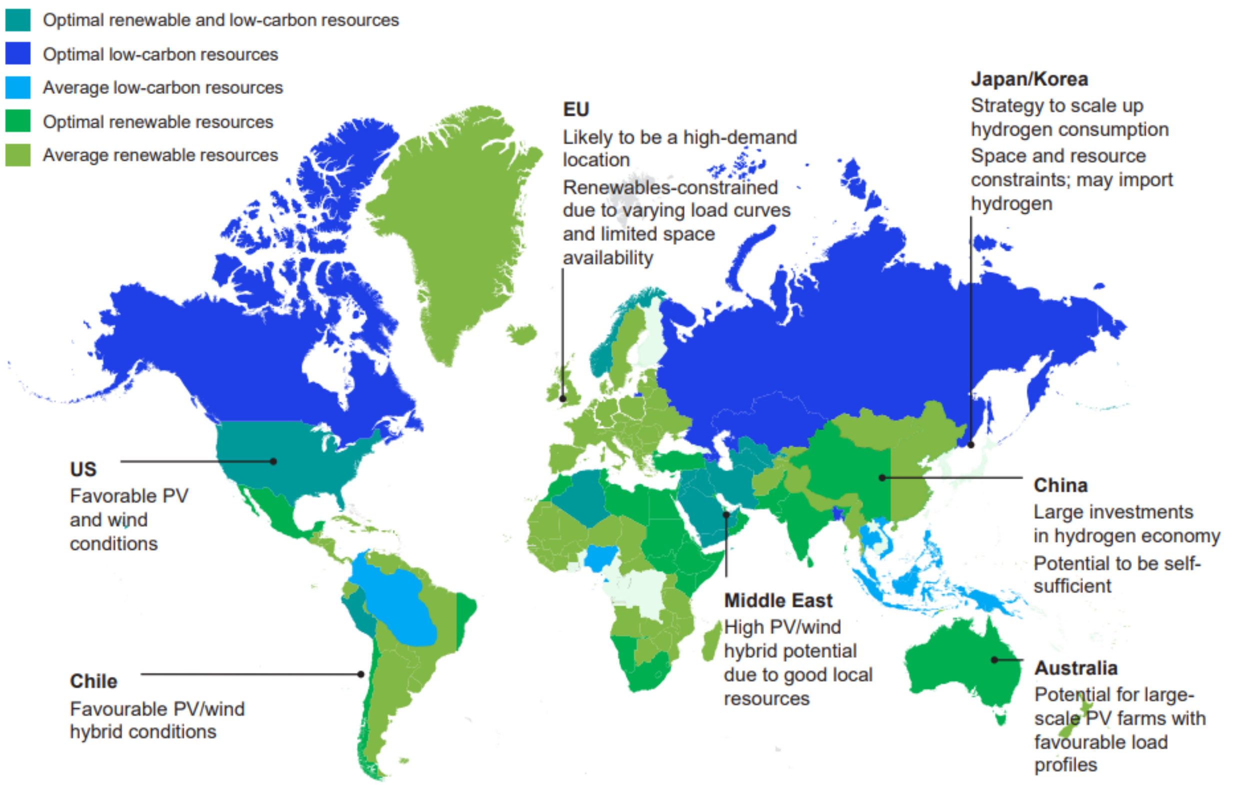
Australia as Renewable Hydrogen Powerhouse

Best source of low-carbon hydrogen in different regions



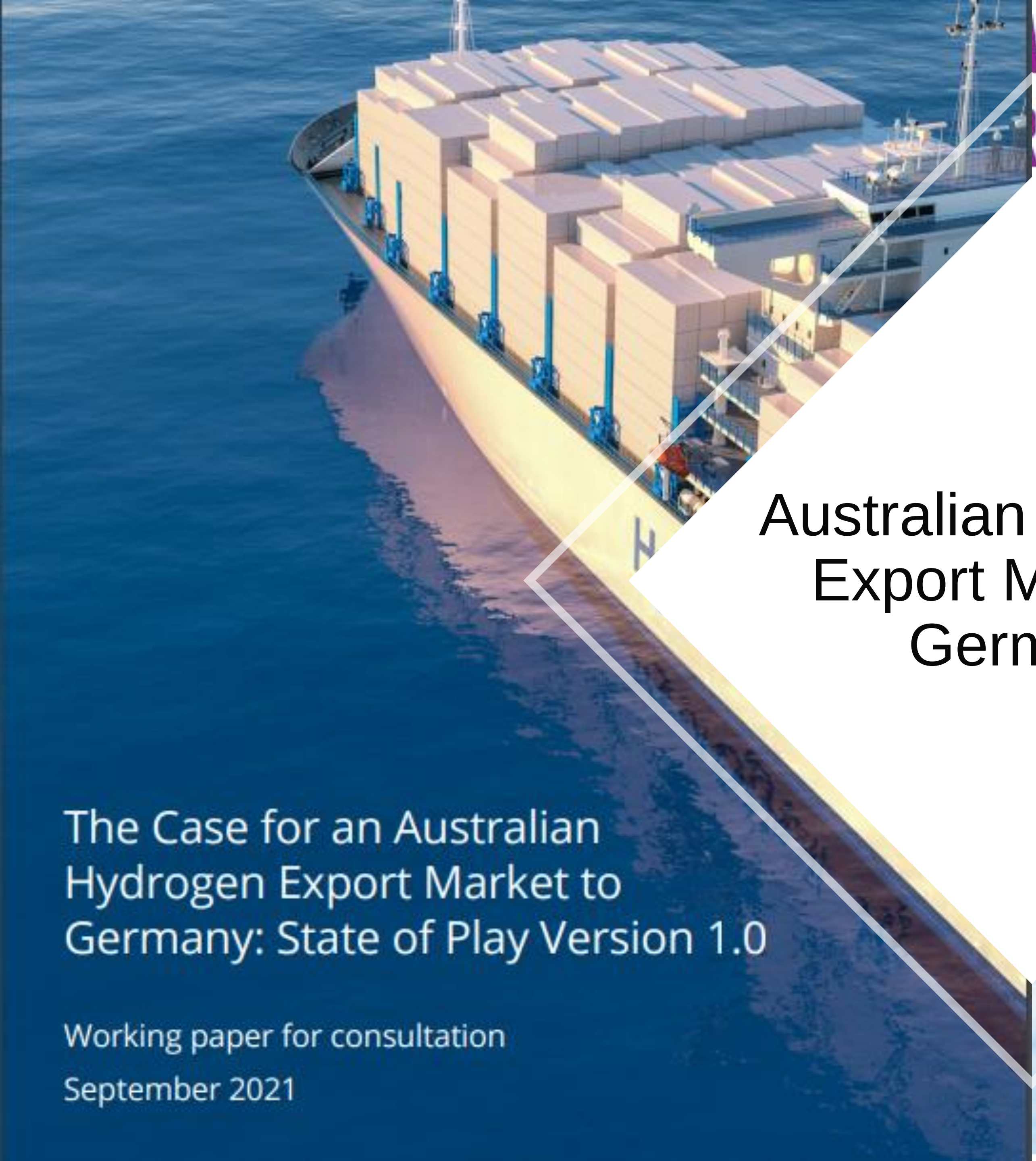
SOURCE: IEA; McKinsey

Demand centres, e.g. EU, North-east Asia, are often constrained for resources, and may not be able to self-supply hydrogen.

Countries with complementary load profiles of wind and PV can produce renewable hydrogen at very low prices.

Regions like China and the US are both demand centres and have favourable RES.

Source: Hydrogen Council, "Path to hydrogen competitiveness: a cost perspective." (2020).



Australian Hydrogen Export Market to Germany

Multi-criteria Analysis of Off-takers Preference Configuration

Table 15: Base Case, Energy Export Focused and Decarbonisation Focused Multi-criteria Analysis for the Hydrogen Export Value Chain.
(Here LH_2 is liquefied hydrogen, NH_3 is ammonia, CH_4 is methane, CH_3OH is methanol, LOHCs are liquid organic hydrogen carriers with di-methyl ether, DME, used as the example).

Criterion	Evaluation Band					Base Case MCA						Energy Export Focused MCA						Decarbonisation Focused MCA					
						Weighting	Score					Weighting	Score					Weighting	Score				
	LH_2	NH_3	CH_4	CH_3OH	LOHCs		LH_2	NH_3	CH_4	CH_3OH	LOHCs		LH_2	NH_3	CH_4	CH_3OH	LOHCs		LH_2	NH_3	CH_4	CH_3OH	LOHCs
Commercial Metrics																							
Technology Readiness	3	5	5	4	3	15.00	45	75	75	60	45	15.00	45	75	75	60	45	10.00	30	50	50	40	30
Capital Cost for Carrier Implementation in terms of energy exported p.a. (A$ kWh^{-1} yr^{-1})	2	2	5	2	1	15.00	30	30	75	30	15	5.00	10	10	25	10	5	5.00	10	10	25	10	5
Operating Cost for Carrier Production in terms of energy exported p.a. (A$ kWh^{-1} yr^{-1})	2	4	5	4	1	15.00	30	60	75	60	15	5.00	10	20	25	20	5	5.00	10	20	25	20	5
Hydrogen Export Metrics																							
Hydrogen Storage Density	5	3	4	2	1	5.00	25	15	20	10	5	15.00	75	45	60	30	15	5.00	25	15	20	10	5
Hydrogen Conversion Efficiency	5	3	4	5	4	5.00	25	15	20	25	20	5.00	25	15	20	25	20	5.00	25	15	20	25	20
Energy Export Metrics																							
Gravimetric Energy Density (MJ kg^{-1})	5	2	5	2	4	5.00	25	10	25	10	20	15.00	75	30	75	30	60	5.00	25	10	25	10	20
Volumetric Energy Density (MJ L^{-1})	1	2	5	4	5	5.00	5	10	25	20	25	15.00	15	30	75	60	75	5.00	5	10	25	20	25
Transportation Metrics																							
Transportation Cost (A$ kg^{-1})	5	4	3	5	5	10.00	50	40	30	50	50	5.00	5	20	15	25	25	5.00	5	20	15	25	25
Carrier Yield Loss During Transportation (%)	1	5	4	5	5	10.00	10	50	40	50	50	15.00	15	75	60	75	75	5.00	5	25	20	25	25
Decarbonisation Metrics																							
Decarbonisation Benefit	5	5	1	1	5	15.00	75	75	15	15	75	5.00	25	25	5	5	25	50.00	250	250	50	50	250
						Total	320	380	400	330	320	Total	300	345	435	340	350	Total	390	425	275	235	410

Note: The values in the tables are based on preliminary analysis of the values provided in the cited literature and is subject to change in the detailed analysis. The capital and operating costs represented include the cost of hydrogen generation from electrolysis, its conversion to the carrier, on loading to ship for export, and offloading at receiving port. The costs are then levelised based on the energy content of each hydrogen carrier (in kWh). The analysis is detailed in **Appendix C (Table C1-C2)**.

Choice of carriers is subject to off-takers' preference.

Internal infrastructure in the EU would substantially influence such preference.

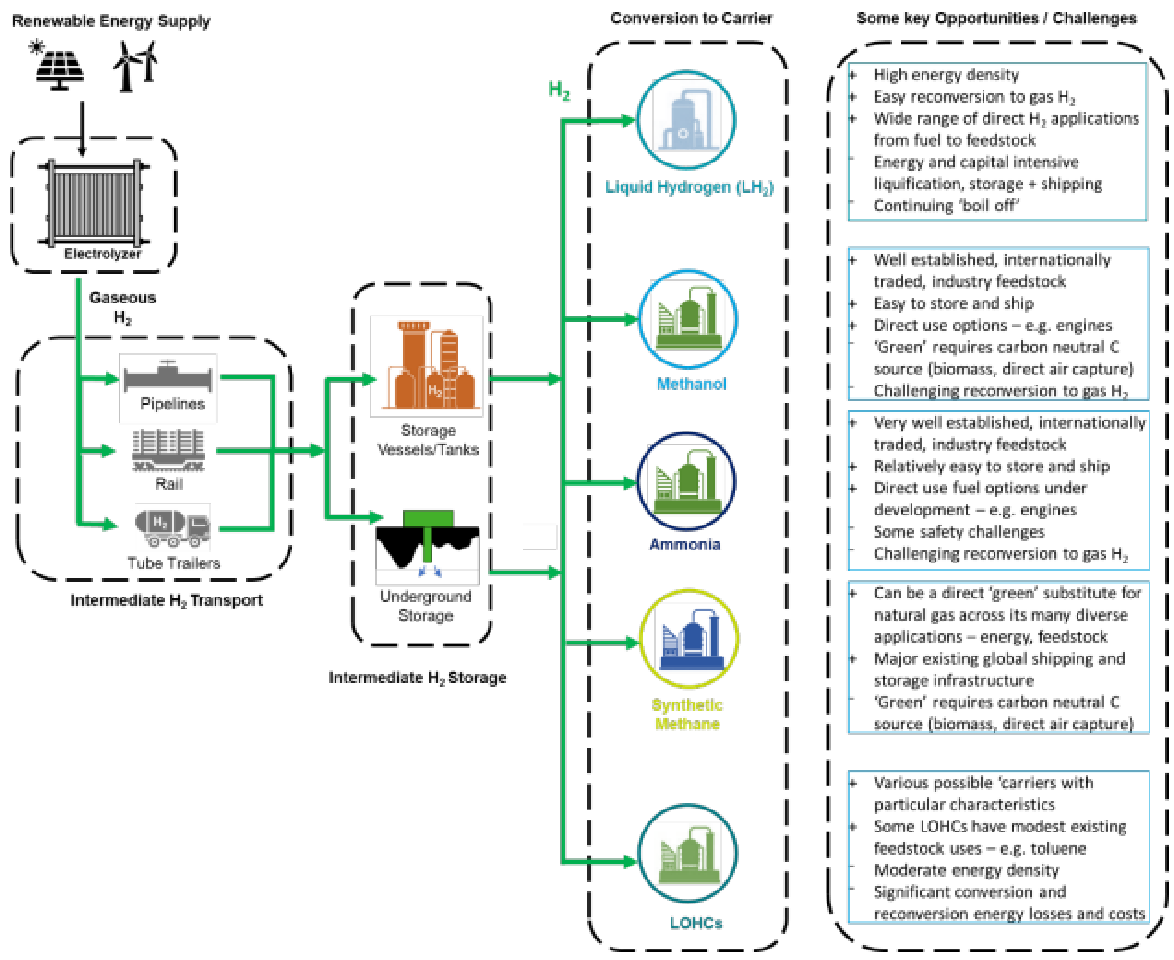
R. Daiyan, I. MacGill, R. Amal, S. Kara, K.F. Aguey-Zinsou, M.H. Khan, K. Polepalle, W. Rayward-Smith. (2021). *The Case for an Australian Hydrogen Export Market to Germany: State of Play Version 1.0.*

Potential barrier for exporters

- There are diversified infrastructure demands for different carriers, and it is not enough to consider pipelines only

- The reconversion cost can be high

Figure B: Opportunities and challenges for different hydrogen carriers considered.



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- Certifications to provide credible information
- Track embedded emissions when blending hydrogen in the natural gas pipeline
- Enhance compatibility to avoid regulatory competition
  - Carbon accounting boundaries
  - Certify actual emissions vs set thresholds

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Approaches to certifying Australia-Germany Green Hydrogen Supply Chains:

informing discussion

Produced for the German-Australian HySupply Project

In case you are interested:

- Aisbett, Emma, Wenting Cheng, Iain MacGill, and Lee White. (2022). *Approaches to certifying Australia-Germany Green Hydrogen Supply Chains: informing discussion*

- Cheng, Wenting, and Sora Lee. "How Green Are the National Hydrogen Strategies?". Sustainability 14, no. 3 (2022): 1930.

- Neill, Lily O', Fiona J. Beck, Karrina Nolan, and Wenting Cheng. "Renewable Hydrogen Will Be Produced on Land Traditionally Owned by First Nations People: Will Its Owners Benefit?". Australian Environment Review 36, no. 6 (2022): 149-58.

- White, Lee V, Reza Fazeli, Wenting Cheng, Emma Aisbett, Fiona J Beck, Kenneth GH Baldwin, Penelope Howarth, and Lily O'Neill. "Towards Emissions Certification Systems for International Trade in Hydrogen: The Policy Challenge of Defining Boundaries for Emissions Accounting." Energy 215 (2021): 119139.