

# Hydrogen and Climate: Trojan Horse or Golden Goose?

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*Hydrogen technology could play a part in global emissions reduction if based on renewable energy. Without proper policy guidance, however, a new hydrogen industry could extend the use of coal and gas industries, locking in fossil fuel infrastructure and greenhouse gas emissions for decades to come.*

Request for input – National Hydrogen Strategy

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# Summary

The development of hydrogen energy has been promoted as a lower-emissions alternative to Australian coal and gas exports. However, there is a significant risk that the promise of hydrogen as a low-carbon alternative, for domestic use and export, could backfire. The development of Australia's hydrogen industry could be used as a proverbial Trojan horse, to provide a new lease of life for fossil fuels through the production of hydrogen.

“Brown hydrogen” (produced from coal gasification) and “blue hydrogen” (produced from natural gas) are currently far lower cost than “green hydrogen” (produced from electrolysis powered by renewables). As such, unless there are clear policies to exclude brown and blue hydrogen, they will be the default hydrogen export. For the purpose of this paper – we will simplify the lexicon and use “fossil hydrogen” to denote hydrogen from fossil fuels.

The Government is in a position to regulate and guide the industry over the next fifty years. Green hydrogen presents Australia with a potential zero-carbon energy source for domestic and international use. The Government should avoid past mistakes and prevent hydrogen being used as a vehicle for the extension or even expansion of fossil fuels. This will require limiting the industry to green hydrogen.

## Fossil Fuel - Hydrogen Fool

Currently Australia is the largest exporter of coal and natural gas<sup>1</sup> in the world. Of Australia's top 5 exports in 2017-18, coal and natural gas came in second and fourth position, accounting for \$91.3 billion or almost a quarter of Australia's total export revenue (\$403.2 billion).<sup>2</sup> In terms of risk management, this represents an undiversified export portfolio at extreme risk of decline as the world moves to reach the Paris Agreement target.

Energy production and use is the largest source of global greenhouse gas emissions, and the energy sector is shifting to help achieve the objectives of the Paris Agreement. Under the International Energy Agency's Sustainable Development Scenario (SDS), energy-related emissions peak around 2020 and then decline rapidly. By 2040, they are

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1 Jaganathan (10 Dec 2018) *Australia grabs world's biggest LNG exporter crown from Qatar in Nov*, Reuters, Available at: <https://www.reuters.com/article/us-australia-qatar-lng/australia-grabs-worlds-biggest-lng-exporter-crown-from-qatar-in-nov-idUSKBN1O907N>

2 Australian Government Department of Foreign Affairs and Trade (2018) *Composition of trade: Australia 2017-2018*, p 5. Available at: <https://dfat.gov.au/about-us/publications/pages/composition-of-trade.aspx>

at around half of today's level and on course toward net-zero emissions by 2070.<sup>3</sup> This is considered by many to be in line with the Paris Agreement, with others arguing for a faster transition by mid-2050. Either way it leaves little room for a hydrogen industry reliant on coal and gas.

Just as the promise of “clean coal” with carbon capture and storage and the myth of gas as “clean energy” have ultimately delayed action on climate change, the promise of hydrogen could be used as a pretext to delay the necessary transition away from fossil fuels and potentially lock in further fossil fuel infrastructure and emissions for decades to come.

To maintain low-carbon hydrogen using fossil fuels, carbon capture and storage (CCS) technology would need to be employed. Yet CCS has failed both at home (note Chevron's Gorgon CCS the best example of that failure) and overseas. In fact every international CCS target, embellishing the potential of technology, has failed. There is no need to hitch Australia's fortunes to fossil hydrogen with CCS. It would also be problematic to assume carbon credits could be used to offset emissions from fossil hydrogen. Global emissions need to decrease and offsetting new emissions (from production) simply maintains the status quo.

Given the need to phase out coal and gas exports over the coming decades, if Australia is to take the opportunity to develop a hydrogen export industry to replace these industries, it will be essential to commit to producing *green* hydrogen and rule out fossil hydrogen. Australia must push the global effort to differentiate between fossil fuel and zero-emissions hydrogen and become the market leaders in renewable hydrogen.

Done correctly, Australia is in a unique position to capitalise on its renewable resources, geographic location and established trading ties to the Asia-Pacific to lead the world in green hydrogen exports. The economic benefits of this could be sizable, contributing \$4.3 billion to the Australian economy and creating employment opportunities for over 7,000 (FTE) individuals by 2040.<sup>4</sup>

A commitment to renewable hydrogen would help to diversify Australia's exports, reduce our reliance on fossil fuels, create a future-proofed and resilient national hydrogen industry, contribute to long-term economic prosperity and yield genuine greenhouse gas reductions.

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<sup>3</sup> International Energy Agency (2019) *Sustainable Development Scenario*, Available at: <https://www.iea.org/weo/weomodel/sds/>

<sup>4</sup> ACIL Allen (consulting for ARENA) (August 2018) *Opportunities for Australia from hydrogen exports*, p vi.

## Getting to Paris

Recent research suggests that large-scale renewable hydrogen might be cost-competitive with fossil-fuel based hydrogen within the next five years if relatively modest government incentives are implemented.<sup>5</sup> The timing could be well-aligned if seafaring hydrogen carriers are developed and deployed, and a critical mass of hydrogen infrastructure from export to end use is established.<sup>6</sup>

If this eventuates and trading partners such as Japan and Korea succeed in transforming their current energy infrastructure to “hydrogen economy” infrastructure, Australia could potentially export clean, renewable hydrogen to the world. At a domestic level, our electricity market could use renewable hydrogen as stored energy to provide firming power to the grid, noting there are already a range of existing, proven, commercially available zero carbon energy storage technologies

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<sup>5</sup> Glenk and Reichelstein (25 February 2019) *Economics of converting renewable power to hydrogen*, Nature Energy, Vol 4, p 216–222.

<sup>6</sup> Chang (26 March 2019) *Speech at Inaugural Australian Hydrogen Energy Summit*, Korea Advanced Institute of Science and Technology, AHEC member.

# Introduction

The National Hydrogen Strategy consultation provides an early opportunity to step back and consider the potential positives and pitfalls of this new industry. The Australia Institute Climate & Energy Program welcomes the opportunity to have input into the Strategy.

As countries reorient their economies to limit the release of greenhouse gases, new economic and technological opportunities arise. The prospect of a global hydrogen economy is one such powerful case. But it must be built on zero-carbon hydrogen.

The Australia Institute's submission to the National Hydrogen Strategy raises the question – will Australia take this opportunity to establish ourselves as a leader in a clean, renewable hydrogen industry that firmly aligns with the objectives of the Paris Agreement, or will we be held prisoner to a fossil fuel-based hydrogen industry?

# Hydrogen Technology

Hydrogen production using coal and natural gas, through steam methane reforming (SMR) and coal gasification, are mature technologies and currently dominate global hydrogen production. However, advanced technology also exists for renewable hydrogen produced via electrolysis with renewable electricity through proton exchange membranes or polymer-electrolyte membranes (PEM).

Traditionally PEM has been more expensive than SMR due to high costs for electrolyzers and traditionally higher costs of renewable energy. However, these costs are reducing rapidly with solar and wind energy now cheaper than power from existing thermal generation.<sup>7</sup> Costs for electrolyzers are also decreasing quickly. Recent research found that "renewable hydrogen might become cost competitive with large-scale fossil hydrogen supply within the next decade".<sup>8</sup> This could be expedited with the right mix of government incentives. A 30 percent investment tax credit for electrolyzers could see renewable hydrogen reaching a competitive price four and a half years earlier.<sup>9</sup>

This research, from Stanford and a number of German universities, is based on a financial model for a theoretical system of a wind farm connected to a hydrogen electrolyser situated in Germany and Texas. Their analysis shows that to build a system with both wind and a hydrogen electrolyser, the break-even price for hydrogen needs to be €3.23 (AUD\$5.13) per kilogram in Germany and US\$3.53 (AUD\$4.98) per kilogram in Texas, which is already cost-competitive for current small and medium-scale hydrogen production.<sup>10</sup> This is particularly relevant in the potential use of hydrogen in remote communities in Australia for remote area power systems (RAPS) and on-site renewable hydrogen production.

However, it is not yet competitive with large-scale fossil hydrogen, which retails in the range of €1.5 to 2.5 (\$AUD 2.38-3.97) per kilogram. Note this is without including additional costs involved in reducing emissions (carbon capture and storage or a carbon price).

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<sup>7</sup> Lazard (November 2018) *Lazard's Levelized cost of energy analysis: Version 12.0*, Available at: <https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf> (Also see CSIRO and AEMO's *GenCost 2018* <https://www.csiro.au/~media/News-releases/2018/Annual-update-finds-renewables-are-cheapest-new-build-power/GenCost2018.pdf>)

<sup>8</sup> Glenk and Reichelstein (25 February 2019) *Economics of converting renewable power to hydrogen*, Nature Energy, Vol 4, p 216–222

<sup>9</sup> Ibid.

<sup>10</sup> Ibid.

## Timing is everything

Recent research suggests renewable hydrogen could reach parity with fossil hydrogen within a 4.5 to 10 year time-frame. Even if this eventuates, it would need to coincide with the successful deployment of seafaring hydrogen transportation and a hydrogen economy in customer countries for renewable hydrogen exports to be feasible.

The Republic of Korea (South Korea), a leader alongside Japan in hydrogen research and development, stated in their Hydrogen Economy Roadmap that:

Shipping liquefied hydrogen is not yet a viable option economically, but costs will decrease with liquefaction and storage technology development. Liquefaction and storage (USD 0.40 per kilogram of hydrogen in 2050) will still be the biggest cost factor of total liquefied shipping transportation (USD 0.56 per kilogram of hydrogen).<sup>11</sup>

The Australian Hydrogen Export Consortium (AHEC), a South Korean and Australian partnership founded in January 2019, is expecting their hydrogen liquefaction carrier to be commercially active at scale by 2025.<sup>12</sup>

Whilst the race is on to supply Asia-Pacific hydrogen export markets, there is still substantial research and development work to be done on the storage and transport of hydrogen. Japan is acutely aware of this missing link in the international supply chain and has actively developed partnerships with Saudi Arabia, Brunei, Norway and Australia to trial different forms of technology. The Hydrogen Energy Supply Chain (HESC) project will trial a hydrogen liquefaction carrier designed by Kawasaki Heavy Industries, with pilot testing expected in 2020.<sup>13</sup>

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<sup>11</sup> Republic of South Korea (17 January 2019) *Hydrogen Economy Roadmap*, p 37.

<sup>12</sup> Chang (26 March 2019) *Speech at Inaugural Australian Hydrogen Energy Summit*, Korea Advanced Institute of Science and Technology, AHEC member.

<sup>13</sup> For more on Kawasaki's Hydrogen Road please see [https://www.youtube.com/watch?v=oCjhYe6Y\\_Go](https://www.youtube.com/watch?v=oCjhYe6Y_Go)

# All roads should lead to Paris

At the 2015 UN Climate Change Conference, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) came together to set the global direction and ambition to address climate change. The Paris Agreement aim:

Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change...<sup>14</sup>

The effect is that all countries and all industries should look to reduce their greenhouse gas emissions going forward. The development of a new industry like hydrogen should occur through the prism of a carbon-constrained future and Australia's ongoing commitment to reduce its emissions until it reaches net-zero.

## Australia's carbon footprint

Australia is currently underperforming and not on track to meet its 2030 Paris target, to reduce emissions 26% by 2030 from a 2005 baseline.<sup>15</sup> Emissions in Australia continue to rise. In the year to September 2018 emissions went up 0.9 percent, primarily due to a 19.7 percent increase in liquefied natural gas (LNG) exports, predominantly from a significant increase in LNG production in Western Australia.<sup>16</sup> The increase in LNG production has driven a 7.3% increase in fugitive emissions over the year to September 2018. Total emissions growth was also due to increases in stationary energy, transport, fugitives, industrial processes and waste sectors.

It should be remembered that Australia's Paris pledge (26%) is inconsistent with our global responsibilities and with climate science.<sup>17</sup> The Climate Change Authority showed that a 2030 target of 40-60 percent below 2000 levels would be more scientifically responsible in order to limit global warming to under 2 degrees Celsius.<sup>18</sup>

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14 UNFCCC (2015) *Paris Agreement*, Article 2, p 2. Available at: [https://unfccc.int/files/meetings/paris\\_nov\\_2015/application/pdf/paris\\_agreement\\_english\\_.pdf](https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf)

15 Pears (31 January 2019) *Australia is counting on cooking the books to meet its climate targets*, The Conversation, Available at: <https://theconversation.com/australia-is-counting-on-cooking-the-books-to-meet-its-climate-targets-110768>

16 Australian Department of Environment and Energy (September 2018) *Quarterly Update of Australia's National Greenhouse Gas Inventory*

17 Pears (31 January 2019) *Australia is counting on cooking the books to meet its climate targets*, The Conversation, Available at: <https://theconversation.com/australia-is-counting-on-cooking-the-books-to-meet-its-climate-targets-110768>

18 Australian Government Climate Change Authority (2 July 2015) *Final Report on Australia's Future Emissions Reduction Targets*, Available at: <http://climatechangeauthority.gov.au/sites/prod.climatechangeauthority.gov.au/files/Final-report-Australias-future-emissions-reduction-targets.pdf>

Additionally, our fossil-fuel exports means Australia’s annual exported CO<sub>2</sub> emissions are 44 tonnes per person, greater than Saudi Arabia’s 35.5 tonnes per person, and significantly larger than the United States.<sup>19</sup> Our exports of fossil fuels put us in the top tier of countries responsible for exporting emissions.

## Australia’s green advantage

Australia has some of the best solar and wind assets in the world, coupled with a large and relatively unpopulated land area, and a skilled workforce. This potentially gives Australia a comparative advantage in rapidly deploying large-scale green hydrogen generation by electrolysis, powered with low-cost renewable energy.

Australia’s renewable energy resources have been recognised in South Korea’s Hydrogen Economy Roadmap as a potential comparative advantage in hydrogen production if the industry manages to achieve (much) lower production and transport costs:

“Importing hydrogen from a country like Australia could become economically viable if the industry can achieve lower production costs there, along with lower transportation costs. The LCOH from centralised electrolysis in Australia should decrease at a steeper rate than in Korea, due to its comparatively cheaper and more abundant solar power.”<sup>20</sup>

Australia’s electricity grid is undergoing a rapid transformation with unprecedented levels of renewable energy entering the system. In 2018, Australia experienced another record-breaking year for large-scale renewables and also for small-scale rooftop solar PV.<sup>21</sup> In 2018:

- More than 3,300 MW of large scale renewables was added, bringing the total accredited capacity to 18,700 MW
- More than 1,500 MW of small-scale solar PV capacity was installed (a 30 percent increase since 2017), bringing the cumulative national total to over 8,000 MW
- More than 2 million small-scale solar PV systems are now installed in total across Australia

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<sup>19</sup> Bertelsmann Stiftung and Sustainable Development Solutions Network (2018) *2018 SGD Index and dashboards report: Global responsibilities- implementing the goals*, Available at: <http://www.sdindex.org/assets/files/2018/02%20SDGS%20Country%20profiles%20edition%20WEB%20V3%20180718.pdf>

<sup>20</sup> Republic of South Korea (17 January 2019) *Hydrogen Economy Roadmap*, p 37

<sup>21</sup> Clean Energy Regulator (2019) *Large-scale Renewable Energy Target supply data and Small-scale Renewable Energy Scheme data*, Available at: <http://www.cleanenergyregulator.gov.au/>

This adoption of renewable energy is happening at a fast rate with Australia now leading the world in per capita renewables installation rates.<sup>22</sup> Although there are many factors involved, for theoretical purposes if Australia's uptake in renewables continues at current rates, Australia will be on track to reach 50 percent renewable energy in 2024.<sup>23</sup>

Critically we have now passed the tipping point where the levelised cost of electricity (LCOE) for new build renewables is cheaper than the marginal cost of operating existing thermal coal generation.<sup>24</sup> Renewable energy technology is cost-competitive and ready to be utilised for renewable hydrogen production.

Meeting the projected demand for Australian renewable hydrogen exports<sup>25</sup> with electrolysis would require Australia to nearly double the electricity supply by 2040. However, estimates suggest that due to the rapid growth of the renewable energy industry in Australia it is feasible to provide this additional electricity with renewable energy by 2040,<sup>26</sup> if the growth of the renewable energy capacity continues at its current rate of 5.6 GWpa.

However, given fossil hydrogen is currently lower cost than green hydrogen, and the incumbency of the coal and gas industries as an energy exporter absent climate policy, it is likely that fossil hydrogen infrastructure would be built prior to renewable hydrogen. In this case, with capital sunk into fossil fuel infrastructure, renewable hydrogen would have to compete against incumbent infrastructure such as coal gasification plants and is likely to be crowded out over coming decades.

Government policy direction, prior to major technology and infrastructure investments, would ensure the hydrogen industry is not trapped by fossil hydrogen.

## Can CCS deliver low-carbon brown and blue hydrogen?

Australia's emissions reductions are already lagging; the country cannot afford to increase our emissions by producing hydrogen with fossil fuels. Any fossil hydrogen would need its emissions captured.

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22 Blakers, et al. (8 Feb 2019) *Analysis and Policy Observatory, Australia: the renewable energy superstar*, Available at: <https://apo.org.au/node/218826>

23 Baldwin, et al. (10 September 2018) *Australia's renewable energy industry is delivering rapid and deep emissions cuts*, The Energy Change Institute, Australian National University, Available at:

<http://energy.anu.edu.au/files/Australia%27s%20renewable%20Energy%20Industry%20is%20delivering%20rapid%20and%20deep%20emissions%20cuts.pdf>.

24 Lazard (November 2018) *Lazard's Levelized cost of energy analysis: Version 12.0*, Available at: <https://www.lazard.com/media/450784/lazards-levelized-cost-of-energy-version-120-vfinal.pdf>

25 ACIL Allen, consulting to ARENA (August 2018) *Opportunities for Australia from hydrogen exports*, p 47, Table 4.9

26 Beck et al. (2019) *Australia's Future as a Zero-Carbon Energy Exporter*.

If fossil hydrogen is generated with coal and natural gas using thermochemical methods like coal gasification or SMR, CO<sub>2</sub> is emitted during the process. Emissions can be theoretically mitigated with CCS, however not all of the emitted CO<sub>2</sub> can be captured: some CO<sub>2</sub> will escape into the atmosphere, and additional CO<sub>2</sub> may be emitted due to the extra electricity needed to compress, transport and store CO<sub>2</sub>.<sup>27</sup> The efficiency of CCS depends on the technology being used and the type of carbon emitting process, however it is usually between 80-90 percent.<sup>28</sup>

Analysis shows that Australia would need to implement CCS at an almost impossible rate over the next 15-20 years to sequester the emissions from fossil hydrogen generation, if it was to meet the projected Australian export opportunity.<sup>29</sup>

Since 2003, the Australian Government has put \$1.3 billion of taxpayers' money towards CCS initiatives.<sup>30</sup> Australia institute research has found that, despite this generous funding no large-scale CCS projects are currently operating successfully in Australia.<sup>31</sup> CCS has also failed to meet the targets set for it by the G8, the International Energy Agency, Australian Coal Association and the Council of the European Union.<sup>32</sup>

One example of CCS' failure to deliver reliable and cost-effective emissions reduction technology is the Gorgon gas project in Western Australia. Approval of the Gorgon project was predicated on the establishment of a CCS facility to sequester between 5.5 and 7.8Mt of CO<sub>2</sub> over the first two years of operation.<sup>33</sup> The CCS failed to operate and has suffered delays<sup>34</sup> including in the last month.<sup>35</sup> This makes Gorgon not only a failed CCS project, but a major driver of Australia's increased greenhouse gas emissions.

CCS encourages the use of fossil-fuel derived energy, drawing the focus away from existing technologies which are more affordable and more effective at reducing emissions. CCS initiatives have been shown to be neither credible nor dependable. The

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27 Ibid.

28 Muradov (May 2017) *Low to near-zero CO<sub>2</sub> production of hydrogen from fossil fuels: Status and perspectives*, International Journal of Hydrogen Energy, vol 42, no 20, p 14058–14088

29 Beck et al. (2019) *Australia's Future as a Zero-Carbon Energy Exporter*

30 Australia Institute (2017) *Money for nothing*, Available at: <http://www.tai.org.au/content/money-nothing>

31 Ibid.

32 Australia Institute (2018) *Sunk Costs: Carbon capture and storage will miss every target set for it*, Available at:

<http://www.tai.org.au/sites/default/files/P546%20Sunk%20costs%20%5BWEB%5D.pdf>

33 Milne (2017) *Carbon hiccup for Chevron with 5 million-tonne greenhouse gas problem at Gorgon LNG plant*, The West Australian. Available at:

<https://thewest.com.au/business/oil-gas/carbon-hiccup-for-chevron-with-5-million-tonnegreenhouse-gas-problem-at-gorgon-lng-plant-ng-b88694565z>

34 Australia Institute (2018) *Gorgon-tuan Problem*, Available at: <http://www.tai.org.au/sites/default/files/P635%20Gorgon-tuan%20Problem%20%5BWeb%5D.pdf>

35 Milne (2019) *Chevron delays underground storage of carbon dioxide for Gorgon*, The West Australian, Available at: <https://thewest.com.au/business/oil-gas/chevron-delays-underground-storage-of-carbon-dioxide-for-gorgon-ng-b881125789z>

energy market should be decarbonised through uptake of renewable energy, closure of fossil fuel power plants and increased energy efficiency.

Any hydrogen industry must be low-carbon and reliable. The only form of hydrogen technology capable of meeting these requirements and transitioning Australia towards a net-zero emissions energy future is green hydrogen.

## Technology pathways: piggyback vs leapfrog

One argument in Australia's hydrogen debate is that by supporting brown and blue hydrogen production Australia can later piggyback off those technologies when green hydrogen technology improves.

For example, Woodside Petroleum claim:

Blue hydrogen is the key to building scale and lowering costs, enabling an earlier transition to green.<sup>36</sup>

While an appealing argument at face value, this line of thinking raises questions that are rarely addressed by fossil hydrogen proponents, including:

- Do fossil and green hydrogen share the same production characteristics?
- Do they have central or distributed production pathways?
- What is the level of shared infrastructure, technology, cost components, spillover effects or likely knowledge transfer?
- Instead of piggybacking on brown and blue hydrogen production green hydrogen could leapfrog it?

These questions should be thoroughly examined by the Hydrogen Working Group in developing the National Hydrogen Strategy and ensuring a future hydrogen industry actually reduces emissions rather than undermines our commitments to the Paris Agreement.

## Social Licence

Preliminary research undertaken for the Hydrogen Strategy Group shows that the public has concerns about producing fossil hydrogen instead of green hydrogen:

Participants expressed mixed feelings about producing hydrogen from fossil fuels with CCS rather than renewables, with cost and environmental impacts being critical to acceptance of either.<sup>37</sup>

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<sup>36</sup> Woodside (2018) *Hydrogen*, Available at: <https://www.woodside.com.au/innovation/hydrogen>

This public sentiment is crucial to consider, and highlights the public’s concern over climate change and the environment. It also foreshadows that there may be large-scale public opposition to hydrogen production methods that rely on fossil fuels and unproven CCS technologies.<sup>38</sup> The CSIRO report confirms that:

When compared with other hydrogen production pathways, thermochemical production coupled with CCS is likely to carry additional social license challenges.<sup>39</sup>

This is due to the capital intensity of these projects, concerns over continued use of fossil fuels, and questions over long-term CCS viability.<sup>40</sup> Furthermore, there is research that reveals a perceptions that investments into CCS come at the expense of investing in renewables.<sup>41</sup>

The Government has an opportunity to bolster the social licence of hydrogen by ensuring it is green and aligned to the Paris Agreement. Failure to do so will see hydrogen used by the fossil fuel industry to extend the life of polluting coal and gas developments. This would see the hydrogen industry become as controversial and politicised as technologies such as ‘clean coal’ CCS, ‘high efficiency low emissions (HELE)’ coal fired power and fracked gas. If “brown and blue” hydrogen are allowed to become another marketing exercise, it will cause major challenges and delays for the development of a hydrogen industry.

## Fair Dinkum Hydrogen?

The market for renewable hydrogen is already growing, led by Europe and the development of the green and “low carbon” hydrogen market. In 2018, the CertifHy project was launched, to design the “first European Union wide Green and Low Carbon Certification System” based on a Guarantee of Origin certification process.<sup>42</sup> The CertifHy project has led to the issuance of more than 76,000 Guarantees of Origin, of which over 3,600 have already been used so far.

Certification such as CertifHy already has wide support in Australia, including from the federal Labor party in their national hydrogen plan,<sup>43</sup> as well as various state

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37 Hydrogen Strategy Group (2018) *A briefing paper for the COAG Energy Council: Hydrogen for Australia’s future*

38 Beck et al. (2019) *Australia’s Future as a Zero-Carbon Energy Exporter*

39 CSIRO (2018) *National Hydrogen Roadmap*, p 25

40 Ibid.

41 Ashworth et al. (2013) *Public preferences to CCS: How does it change across countries?*, *Energy Procedia*, volume 37, pages 7410–7418

42 CertifHy, (2019) Available at: [www.certifhy.eu/](http://www.certifhy.eu/)

43 Australian Labor Party (2019) *National Hydrogen Plan*, Available at: <https://alp.org.au/media/1520/190121-factsheet-hydrogen-plan.pdf>

governments such as Western Australia, South Australia and Queensland all calling for hydrogen carbon status certification.

The CertifHY scheme is still at the pilot phase and consideration should be given to the final system. However there is a real risk that green hydrogen is lost in the ambiguity given the inclusion of “low carbon” hydrogen in the certification system. Unless there is a clear and robust differentiation of CertifHy green hydrogen from “low-carbon” hydrogen then other certification systems should be considered.

# Conclusion

Will Australia create a bold vision for the future by developing a new, carbon-free hydrogen industry, or be held prisoner to fossil fuels?

For the past 10 years Australia has lacked political leadership and a long-term vision on climate and energy.<sup>44</sup> What Australia needs is a strong direction that people, community and business will rally around and promote; to look at the future positively, to see the opportunities, create them and reap them.

The development of a green hydrogen economy is one such vision and opportunity to deliver critical greenhouse gas emission reductions and economic growth; to help Australia and the global community reach our commitments under the Paris Agreement and to grow national prosperity.

However, it is critical that Australia develops the right type of hydrogen industry that actually delivers on both of these components. This cannot be overstated. To create a hydrogen industry that is based on coal and natural gas will fail environmentally and economically, robs it of a social license and will hold the industry prisoner to fossil fuel interests.

In 2018, a record \$26 billion was invested in large-scale renewable energy projects, either underway or completed during the year.<sup>45</sup> This investment led to substantial new employment opportunities with the creation of 13,000 jobs, a large proportion in regional areas.

Opportunities do exist in the green economy; they are real and need to be seized.

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<sup>44</sup> Centre for Economic Development of Australia (2013) *Setting Public Policy*, Available at:

<https://www.ceda.com.au/CEDA/media/Attachments/pdf/15372~spp2013.pdf>

<sup>45</sup> Clean Energy Council (2018) *Clean energy project investment doubles in 2018 to top record \$20 billion*, Available at:

<https://www.cleanenergycouncil.org.au/news/clean-energy-project-investment-doubles-in-2018-to-top-record-20-billion>.

# Annex: Key policy questions and responses

## 1. What do you think are the two or three most significant recent developments in hydrogen?

- Rise of renewable hydrogen with technological breakthroughs reducing the cost of green hydrogen and forecasting it to be cost-competitive with large-scale fossil hydrogen within the next decade, or half that if modest government incentives are put in place.<sup>46</sup>
- Developments in transportation e.g. CSIRO work on metal membrane that converts hydrogen back from ammonia to a very high grade.

## 2. What are the most important safety issues to consider in producing, handling and using hydrogen in Australia?

- Development of Australian Standards in alignment with international safety standards to ensure the public's safety, to build trust and increase the public perceptions that hydrogen is safe to use.

## 3. What environmental and community impacts should we examine?

- Environmental and climate change impacts of the greenhouse gas emissions released during the production of fossil (brown and blue) hydrogen - this is of critical importance.
- Environmental risks of carbon capture and storage, e.g. potential contamination of artesian water and emissions leakage.
- Community views on hydrogen should be investigated. Research from University of Queensland<sup>47</sup> indicates that the public has a negative attitude towards producing hydrogen from fossil fuels with CCS rather than renewables. There may be large-scale public opposition to fossil hydrogen generation and unproven CCS technologies.
- Ensure the hydrogen industry is granted a social licence to operate and that benefits are shared fairly. A hydrogen industry should support:
  - Regional jobs and regional economic development
  - Indigenous employment opportunities
  - Secure and independent power supply for remote locations and indigenous communities.

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<sup>46</sup> Glenk and Reichelstein (25 February 2019) *Economics of converting renewable power to hydrogen*, Nature Energy, Vol 4, p 216–222

<sup>47</sup> Lambert and Ashworth (2018) *The Australian public's perception of hydrogen for energy*, Available at: <https://arena.gov.au/assets/2018/12/the-australian-publics-perception-of-hydrogen-for-energy.pdf>

- Opportunity for just transition, to assist workers/communities reliant on coal economically to transition to new, growing industries that have a strong future. Create a national discourse for positive industrial transition.
- Ensure there is a domestic hydrogen reservation policy (learning from the pitfalls of the LNG market development) to maintain domestic support for the hydrogen industry.
- Environmental considerations with the transportation of hydrogen, either pressurised or liquefied hydrogen, or in chemical carriers such as ammonia.
  - Noting ammonia is highly soluble in water and has moderate long term toxicity to aquatic life under normal conditions (temperature and pH). At high levels of ammonia, toxic effects can be observed, including the death of animals, birds, fish and death or low growth rate in plants.<sup>48</sup>

#### **4. How can Australia influence and accelerate the development of a global market for hydrogen?**

- Overcome technological barriers that are preventing an interconnected global hydrogen market. Deliver critical scientific breakthroughs, such as CSIRO's metal membrane that filters pure hydrogen gas from ammonia. Focus our intellectual efforts and investment on solving those problems and export the intellectual property to open up more markets internationally.
- Consideration in international climate change negotiations of how scope 3 emissions, in regards to hydrogen's embedded emissions, are treated in national greenhouse gas accounting.
- Product differentiation: commit to green hydrogen and promote the demand for internationally. This is Australia's unique selling point versus competing with countries (e.g. Norway, Saudi Arabia and Brunei) in the generic market.

#### **5. What are the top two or three factors required for a successful hydrogen export industry?**

- Guarantee of Origin: Brand Australia for green hydrogen. Clear certification will be critical for the carbon status of the hydrogen product we export.
- Making renewable hydrogen cost-competitive as soon as possible:
  - Low-cost renewable energy:
    - Ensure enough renewable energy is built and that the NEM can accommodate it (unless hydrogen production is economical off grid).
  - Reduce the cost of electrolyzers.

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<sup>48</sup> Australian Government Department of Environment and Energy (2019) *National Pollutant Inventory: Ammonia*, Available at:

<http://www.npi.gov.au/resource/ammonia-total>

- Bilateral trade negotiations and confirming future trade partnerships, securing export markets.

## **6. What are the top two or three opportunities for the use of clean hydrogen in Australia?**

- Green metal industry: form a world leading green metallurgy sector.
  - Green steel: continue to decarbonise steel following Sanjeev Gupta's 'Green Metal' strategy to use renewable energy to improve manufacturing efficiencies and provide greater control over the entire process. Investigate use of hydrogen as reductant in steel making (see HYBRIT project by Vattenfall).<sup>49</sup>
  - Fortescue's energy strategy: reducing carbon, lowering cost, securing supply. Automation of operations with robotics is already world leading.
- Transport: Long haul trucking, train freight, car fleets, bus fleets.

## **7. What are the main barriers to the use of hydrogen in Australia?**

- Australia is a high-emissions society and the hydrogen industry could further exacerbate the problem if it is reliant on fossil hydrogen (including with the false hope of CCS).
- The lack of a price on carbon is skewing the cost and reducing the uptake of green hydrogen.
- Social licence: for the hydrogen industry to successfully develop in Australia, for domestic consumption and export, the support of the Australian public must be secured.
- Lack of infrastructure for hydrogen transportation.

## **8. What are some examples where a strategic national approach could lower costs and shorten timelines for developing a clean hydrogen industry?**

- Ensure that there is no duplication of projects / research areas across states and territories.
- Provide federal tax incentives for electrolyzers.
- Ensure knowledge sharing, strategic partnerships and collaboration as seen by ARENA and its role in reducing utility-scale renewable energy costs in Australia.

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<sup>49</sup> HYBRIT, *HYBRIT project*, Available at: <http://www.hybriddevelopment.com/>