AUSTRALIAN HYDROGEN COUNCIL

21 June 2020

Re: Submission to Technology Investment Roadmap

The Australian Hydrogen Council (AHC) welcomes the opportunity to provide a submission to the Australian Government's *Technology Investment Roadmap discussion paper*.

AHC is the peak body for the hydrogen industry, with 43 members from across the hydrogen value chain. We connect the emerging hydrogen industry and its stakeholders in building a secure, clean and resilient energy future based on hydrogen.

AHC and its members are pleased to see the hydrogen stretch target of 'H_2 under 2' confirmed. We have developed an export timeline and milestones to reach this target, which we are currently discussing with stakeholders. We are also developing a domestic timeline and milestones.

Much of our submission summarises comprehensive analysis we have not provided here in order to manage the word limit. We would be happy to provide this analysis on request.

Should you have any questions please contact me (t: 0474 028 740 or e: fsimon@H2council.com.au).

Yours sincerely,

Dr Fiona Simon
Chief Executive Officer
Australian Hydrogen Council

AUSTRALIAN HYDROGEN COUNCIL

The Australian Hydrogen Council is…

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Getting to H_2 under $2: project and investment requirements to achieve scale in Australia's emerging hydrogen industry

1 Introduction

The hydrogen industry has enormous potential to benefit Australia, through new export markets, decarbonising the economy and supporting energy security. Work for the National Hydrogen Strategy has estimated potential benefits to Australia could be as high as $26 billion a year in additional GDP and 16,900 new jobs by 2050.[1]

The current industry mainly uses natural gas to produce hydrogen for industrial processes. However, the long-term objective is to make large volumes of green hydrogen through electrolysis, where hydrogen and oxygen in water are separated via an electrolyser. The opportunities for this form of hydrogen are vast, with demand for green hydrogen coming from international partners and domestic users as the push to decarbonise industries continues.

$26 bn/yr Possible GDP increase from hydrogen industry by 2050	**16,900** Possible new jobs by 2050	**>4** Strong rivals for the hydrogen export market
2030 When we need to get to H2<$2 to compete	**>10** Major projects to get to H2<$2 by 2030	**>5** Major projects to reach FID by 2022 for 2030 goal
>$2 bn Government co-investment required	**~3 times** Private money unlocked on government spend	**$3 bn-$28 bn/yr** Current Australian hydrocarbon subsidies
$539 m Announced as Australian governments' H2 investment	**$14.75 bn** Announced as German Government's H2 investment	**Mid-2022** ARENA closes, with no further H2 funding

Figure 1: Key hydrogen industry statistics at a glance

[1] Deloitte (2019) *Australian and global hydrogen demand growth scenario analysis*; COAG Energy Council – National Hydrogen Strategy Taskforce, November, p 1, http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-australian-and-global-hydrogen-demand-growth-scenario-analysis-report-2019_1.pdf

Electrolysis is an expensive process, primarily driven by the cost of the renewable electricity, which continues to decline. Electrolysers are also not yet mass produced and are not built at utility scale. While electrolyser costs are also expected to fall, the industry is still some way from being commercial. Hydrogen at scale also requires infrastructure to transport it and for a range of uses.

The Australian Hydrogen Council (AHC) has connected the National Hydrogen Strategy (NHS) scenarios with the 'H_2 under 2' stretch target, where 'H_2 under 2' means a production price of A$2/kg (excluding liquefaction, storage and shipping).

This submission focuses on the stretch target and how it can best be met, with a focus on cost/price matters and government co-investment. Figure 1 shows the key numbers from this submission at a glance.

Government policies are also vital to activate markets, whether these can support the supply side (to reduce the cost of production and delivery) or the demand side (to reduce the cost of purchase). Examples include tax credits/incentives, compliance standards, and new market mechanisms that value costs and benefits differently. AHC has developed policy positions on appropriate policy to stimulate the hydrogen market and can provide this separately.

Summary of AHC recommendations

The Australian Government should:

- Articulate the 'H_2 under 2' target as being 'H_2 under $2' by 2030, in order to have the best chance for Australia to compete effectively in the export market and meet the NHS goal of being within the top three hydrogen exporters.
- Support at least ten large hydrogen projects to get there.
- Facilitate reduced power costs for green hydrogen projects.
- Support a level playing field for hydrogen and its alternatives, both through policy and funding.
- Allocate further money to ARENA for funding hydrogen to its end date in July 2022, at $200 million a year.
- Extend ARENA's function for at least 10 years past its current end date, with at least $2 billion for hydrogen, to be allocated by 2025.

2 Getting hydrogen to scale: project milestones

2.1 Export

The International Energy Agency and World Energy Council have identified the potential for Australia to become one of the largest hydrogen producers in the world in meeting the clean energy needs of energy-intensive countries in the Asia-Pacific region.[2]

[2] Australian Government Department of Industry, Science, Energy and Resources (2019) 'The Australian resources sector - significance and opportunities', in *Australia's National Resources Statement*, February, https://www.industry.gov.au/data-and-publications/australias-national-resources-statement/the-australian-resources-sector-significance-and-opportunities

Deloitte's report for the NHS presents four scenarios for hydrogen development over a thirty-year time frame to 2050.[3] We believe that the *Targeted deployment* scenario is a suitable minimum success case for hydrogen in Australia. This scenario could see **A$2/kg by 2040**. Later than 2040 will likely mean that Australia will be outcompeted and will miss out on export opportunities.

However, even A$2/kg by 2040 **is less than ideal**. Japan has indicated that it is seeking hydrogen at a production price of A$2/kg post-2030, and Korea has proposed around A$1.7-2/kg by 2030.

A better version of the stretch target would be to aim for **A$2/kg by 2030**, so Australia does not risk being outcompeted by other countries in seizing the Asian export opportunity.[4] This is also more immediately consistent with the NHS goal to be in the top three exporting nations by 2030.

To achieve this more ambitious production cost of A$2/kg by 2030, Australia would need to accelerate the development of commercial scale projects – that is, around 10ktpa of hydrogen production per project, the equivalent of 100MW electrolyser scale for green hydrogen projects.

In our current estimation, achieving 'H_2 under 2' by 2030 equates to at least ten large scale projects (around 10ktpa/100MW) proceeding at current costs. At least five of these would need to reach the final investment decision stage by 2022. The remaining five would be larger again (perhaps closer to 50ktpa/500MW) and would need to reach the final investment decision stage by 2026. We are currently discussing these estimates with stakeholders.

This goal requires **significant** investment over the next decade to get multiple projects underway – this is the billions of dollars, rather than millions.

It also relies on significant reductions in the power costs for green hydrogen projects.

2.2 Domestic use

The main alternative that hydrogen will need to compete with in the Australian energy system is natural gas. A$2/kg hydrogen converts to approximately A$14/GJ in energy-equivalent terms using the higher heating value (HHV) of hydrogen.[5] At this price however, hydrogen is competitive with diesel used in heavy vehicle transport and remote power generation, assuming an average diesel price of A$1.5/L which is approximately A$40/GJ.[6]

In contrast, a hydrogen price of A$14/GJ is high when directly compared to historical Wallumbilla netback prices, which provide an indication of natural gas prices on the east coast of Australia. From 2018-2019, the Wallumbilla netback price averaged A$8/GJ and peaked at A$15/GJ in Jan-Feb 2019.[7]

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[3] Deloitte (2019) *Australian and global hydrogen demand growth scenario analysis*, COAG Energy Council – National Hydrogen Strategy Taskforce, November, pp. 48-56, http://www.coagenergycouncil.gov.au/sites/prod.energycouncil/files/publications/documents/nhs-australian-and-global-hydrogen-demand-growth-scenario-analysis-report-2019_1.pdf

[4] Deloitte has identified four 'strong competitors' to Australia: the US, Germany, Norway and Singapore (bid., pp 42--43.)

[5] Note that when fuels are converted to a $/GJ basis for comparison with natural gas, the higher heating value (HHV) is generally used. The HHV of hydrogen is 0.142 GJ/kg and implies A$14/GJ is equivalent to A$1.98/kg hydrogen. This approach differs from the National Hydrogen Strategy "Conversions and Units" page xiv, where the LHV (0.12 GJ/kg) is used, giving the metric A$10/GJ equals A$1.20/kg.

[6] Assumes an average diesel price of A$1.5/L and conversion rate of 1GJ = 27.7L. Source: https://www.globalpetrolprices.com/Australia/diesel_prices/

[7] Australian Competition and Consumer Commission (2020) LNG netback price series, https://www.accc.gov.au/regulated-infrastructure/energy/gas-inquiry-2017-2025/lng-netback-price-series

Hydrogen will struggle to compete with natural gas as a substitute fuel at A$14/GJ, unless a carbon signal is factored into the cost of supply of natural gas.

This echoes the supply cost analysis in the 2019 IEA *World Energy Outlook*[8] which identifies that hydrogen can substitute for gas by 2040, but only if the true cost of carbon is accounted for in the gas supply cost.

Recent Bloomberg New Energy Finance (BNEF) analysis suggests countries like Australia with best-in-class renewables and hydrogen storage could potentially deliver renewable hydrogen to local large-scale users at A$2.5/kg by 2030**.**[9] BNEF provides **a low case of A$2.11/kg** for delivered hydrogen costs to large-scale users in Australia.[10] Again, it is important to note that hydrogen does not reach these prices without significant government co-investment.

3 Co-investment required

The investment necessary to develop a hydrogen industry at the right scale could be tens of billions of dollars by 2050.

The good news is that the conditions necessary for such investment to occur in Australia are largely the same as for other large energy or resource investments, such as openness to foreign investment, stable policy/limited sovereign risk, and private sector appetite.

Further, the renewable technology revolution of the past decade is testament to the success of government policies in facilitating the cost reductions needed to make clean energy an economically viable alternative to fossil fuels in Australia.

We have also seen that the economic benefits associated with investment are considerable. In a recent bulletin, the Reserve Bank of Australia (RBA) stated:

> Renewable energy investment has supported activity and employment, particularly in regional areas where large-scale renewable generators tend to be located. Information from the Reserve Bank's liaison with energy industry stakeholders suggests that most components associated with renewable energy generation are imported (e.g. solar panels and wind turbines). Nonetheless, there are spill overs to domestic firms, with some contacts suggesting that local content accounts for 25–40 per cent of total costs. This local content is mainly engineering, construction and installation services. Some manufacturing firms have also reported stronger demand for locally produced electricity generation-related equipment.[11]

A real opportunity exists to build on the success of the renewables revolution in Australia and channel funding towards developing a hydrogen industry. Given the economic downturn associated with the 2019/20 bushfire season and COVID-19 crisis, investing in hydrogen infrastructure projects

[8] IEA (2019) *World Energy Outlook*, https://www.iea.org/reports/world-energy-outlook-2019, p. 76.
[9] BNEF (2020) *Hydrogen Economy Outlook: key messages*, March 30, pp. 4-5, https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar-2020.pdf
[10] Ibid., p. 5. The estimate is based on:
- Use of a large-scale alkaline electrolyser with capex of $135/kW in 2030.
- Storage costs assume 50% of total hydrogen demand passes through storage, and a salt cavern is used. Compression and conversion costs are included in storage.
- Transport costs are for a 50km transmission pipeline movement.

[11] De Atholia, T., Flannigan, G. and S. Lai (2020) 'Renewable energy investment in Australia', Reserve Bank of Australia, Bulletin – March, p. 37, https://www.rba.gov.au/publications/bulletin/2020/mar/pdf/renewable-energy-investment-in-australia.pdf

represents a tangible means of stimulating and rebuilding the economy, especially in regional communities.

It is also worth looking further afield for precedents to learn from: China has dominated the global solar market and benefitted from global subsidisation and growth of solar. The Chinese government focussed on solar as a strategic industry, committing US$47 billion to the development of the industry.[12] The strategy included hiring experts, buying companies, securing supply chains, and attracting investors with subsidised land, cheap loans and tax credits.

From this dominant position, China has been able to capture the major share of global solar subsidisation (with subsidies increasing producer surplus) and growth. China also benefits from the direct jobs (2.2 million jobs in solar PV in China),[13] but also the indirect jobs creation, investment and innovation of the upstream and downstream supply chain.

3.1 Minding the gap

The Hydrogen Council's 2020 *Path to hydrogen competitiveness* report (supported by McKinsey analysis) estimates that **US$70bn (A$100bn) of investment** in hydrogen is required across the globe by 2030 to meaningfully activate the global hydrogen economy:

> Reaching the scale required will call for funding an economic gap until a break-even point is reached – an investment to offset the initially higher costs of hydrogen as a fuel and of hydrogen equipment compared to alternatives. Instead of being perceived as costs, this should be seen as an investment to shift the energy system and industry to low-carbon technology. [14]

Although US$70bn (A$100bn) by 2030 seems sizable, the report notes that this accounts for less than 5% of annual global spending on energy. In comparison, support provided to renewables in Germany totalled roughly US$30 billion (A$43 billion) in 2019.[15]

BNEF analysis goes further, estimating that **US$150 billion (A$214 billion)** will be needed globally until 2030 to bridge the cost gap between hydrogen and the **cheapest fossil fuels**, not just the cheapest low-carbon alternative.[16] Post-2030, BNEF proposes that policy measures such as carbon signals, rather than a pure funding approach, will be necessary to drive the further adoption of hydrogen.

Public investments and policies to fill the gap can then unlock several times their value from the private sector. For example, the RBA notes that the:

> Clean Energy Finance Corporation (CEFC) and the Australian Renewable Energy Agency (ARENA) have played an important role in helping developers obtain finance by directly financing projects and encouraging private investment. These agencies have directly invested around $8.5 billion in clean

[12] Fialka, J. (2016) 'Why China is dominating the solar industry', *ClimateWire*, December 19, https://www.scientificamerican.com/article/why-china-is-dominating-the-solar-industry/
[13] IRENA (2018) *Renewable Energy and Jobs*, p. 15, https://irena.org/-/media/Files/IRENA/Agency/Publication/2018/May/IRENA_RE_Jobs_Annual_Review_2018.pdf
[14] Hydrogen Council (2020) *Path to hydrogen competitiveness: a cost perspective*, p.66, https://hydrogencouncil.com/en/path-to-hydrogen-competitiveness-a-cost-perspective/
[15] Ibid.
[16] BNEF (2020) *Hydrogen Economy Outlook: key messages*, March 30, pp. 4-5, https://data.bloomberglp.com/professional/sites/24/BNEF-Hydrogen-Economy-Outlook-Key-Messages-30-Mar-2020.pdf

> energy-related projects since inception. They estimate that this investment has encouraged a further $25 to $30 billion of additional private sector investment.[17] [18]

These data were from ARENA and CEFC's 2018-2019 Annual Reports. On its website, ARENA currently advises that since 2012, it has:

> supported 538 projects with $1.58 billion in grant funding, unlocking a total investment of almost $5.96 billion in Australia's renewable energy industry.[19]

Assuming all else is equal, these figures suggest that government funding in hydrogen might be expected to **unlock at least three times as much private investment**.

3.2 Governments' co-investment in hydrogen to date

The Australian Government has committed **approximately A$500 million** to accelerate the development of an Australian hydrogen industry.[20] The bulk of this is low-cost financing of A$300m provided by the CEFC via the Advancing Hydrogen Fund, which is limited to a small pool of eligible private sector investors and will only come into play when the industry can deliver returns.

A detailed breakdown of industry funding announcements to date is provided in Table 1. The current total is **$539 million.**

Announcement Date	Funding Provider	Funding (A$m)
18 September 2019	Western Australia Renewable Hydrogen Fund	10
22 November 2019	CEFC – low-cost financing for eligible parties	300
22 November 2019	ARENA – Renewable Hydrogen funding round	70
Late 2019 – early 2020	Early stage ARENA R&D and investments	44
25 November 2019	HESC Latrobe Valley brown coal project (Federal and VIC governments)	50
27 February 2020	QLD Hydrogen Industry Development Fund	15
02 March 2020	Tasmanian Government – mix of $20m grant, $20m loans and $10m for funds for support services	50
Total		**539**

Table 1– Australian hydrogen funding announced as at 14 June 2020

In contrast, in late 2019 Japan's Ministry of Economy, Trade and Industry (METI) was reported to be spending at least **¥108 billion (A$1.55 billion)** on hydrogen projects over a two-year period ending March 2020.[21]

Germany recently launched its National Hydrogen Strategy to ramp up the German hydrogen supply chain. This strategy includes an investment of **€9 billion (A$14.75 billion)**: €7 billion for the market

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[17] De Atholia, T., Flannigan, G. and S. Lai (2020) 'Renewable energy investment in Australia', Reserve Bank of Australia https://www.rba.gov.au/publications/bulletin/2020/mar/pdf/renewable-energy-investment-in-australia.pdf.

[18] If we take advice from the Hydrogen Council across two recent reports, a similar expectation of the ratio of public to private funds emerges: the 2020 report says around US$70 billion is required from government, and in a 2017 report the Council states that 'building the hydrogen economy would require annual investments of [US]$20 to 25 billion for a total of about [US]$280 billion until 2030' (p. 66). See Hydrogen Council (2017) *Hydrogen Scaling Up: A Sustainable Pathway for the Global Energy Transition*, November, https://hydrogencouncil.com/en/study-hydrogen-scaling-up/

[19] See https://arena.gov.au/about/

[20] Taylor, A. (2020) *Keynote Address at CEDA event Future Direction in Energy Technologies event*, 28 February, Hon. Angus Taylor, Minister for Energy and Emissions Reduction.

[21] Hornyak, T. (2019) 'How Toyota is helping Japan with its multibillion-dollar push to create a hydrogen-fueled society', *CNBC Business News*, February 26, https://www.cnbc.com/2019/02/26/how-toyota-is-helping-japan-create-a-hydrogen-fueled-society.html

ramp-up of hydrogen technologies in Germany and a further €2 billion euros for international partnerships.[22]

Although Japan and Germany have larger GDPs than Australia – which implies each country can provide greater investment in hydrogen – their government contributions indicate the magnitude of government support required to meaningfully activate the hydrogen industry.

3.3 Competing on a level playing field

It is also worth considering that hydrogen is competing with incumbent energy sources that already receive significant government support.

The International Renewable Energy Agency (IRENA) published a report in April 2020 analysing the value of global energy subsidies and their allocation by fuel using 2017 data.[23] The report found that globally "total, direct energy sector subsidies – including those to fossil fuels, renewables and nuclear power – are estimated to have been at least US$634 billion in 2017".

These were dominated by subsidies to fossil fuels, which accounted for around 70% (US$447 billion) of the total. On the other hand, "subsidies to renewable power generation technologies account for around 20% of total energy sector subsidies (US$128 billion)".

Turning to Australia, a 2014 report by the Overseas Development Institute estimated that **national level fossil fuel subsidies were worth between A$2.9-3.5 billion per year**.[24] This estimate does not include additional subsidies for fossil fuel exploration provided by state governments.

A 2019 International Monetary Fund paper calculated Australia's post-tax fossil fuel subsidies in 2015 as **US$19 billion (A$28 billion)**, or **US$1,198 per capita (A$1745)**.[25] Post-tax subsidies were defined as the differences between "actual consumer fuel prices and how much consumers would pay if prices fully reflected supply costs plus the taxes needed to reflect environmental costs and revenue requirements".[26]

In AHC's view, governments should support a level playing field, where the full environmental/lifecycle costs and benefits of hydrogen and its alternatives – including hydrocarbon incumbents – should be understood and valued.

Investments in hydrogen should also value the benefits hydrogen provides that other energy carriage sources cannot, such as delivering sector-coupling applications and conversion to different usable forms, as well as providing energy security through long term storage capabilities.

[22] Amelang, S. (2020) 'Germany's national hydrogen strategy', *Clean Energy Wire*, 10 June, https://www.cleanenergywire.org/factsheets/germanys-national-hydrogen-strategy

[23] Taylor, M. (2020) *Energy subsidies: Evolution in the global energy transformation to 2050*, International Renewable Energy Agency, Abu Dhabi, https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Apr/IRENA_Energy_subsidies_2020.pdf

[24] Makhijani, S. (2014) 'Fossil fuel exploration subsidies: Australia', a background paper to *The fossil fuel bailout: G20 subsidies for oil, gas and coal*, Oil Change International (OCI) and the Overseas Development Institute (ODI), November, https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9260.pdf

[25] Coady, D., Parry, I., Le, N-P., and B. Shang (2019) *Global Fossil Fuel Subsidies Remain Large: An Update Based on Country-Level Estimates*, IMF Working Paper, Fiscal Affairs Department, WP/19/89.

[26] Ibid., pp. 7-8.

4 The importance of ARENA

Until the industry has reached commercial scale, grant funding is essential; currently a funding gap exists even with the presence of concessional financing.

While we greatly appreciate investment from all governments, where there are multiple sources of funding, they should ideally be coordinated to incentivise development at scale.

ARENA remains the primary source of grant funding; however, its current hydrogen remit is limited to its current $70m hydrogen funding round, which will not sufficiently close the gap on its own. Only two or three hydrogen projects will be supported with this amount of funding.

Further, and most importantly, ARENA is scheduled to close its doors completely in mid-2022.

AHC believes that it is vital to extend ARENA's function for at least 10 years past its current end date, with significant funding for hydrogen that can get us to the project sizes detailed above.

We estimate that this requires:

- ARENA's existing funding for hydrogen to July 2022 to be increased by at least $200 million per year.
- Beyond 2022, the funding requirement could be around $2 bn, and it would need to be allocated by 2025.

It is critical that decisions on ARENA (or alternative funding bodies) are taken soon, in order to provide investment certainty to investors and allow legislation to be in place. It is also vital to confirm ARENA's future as soon as possible so ARENA staff – and their important expertise – can be retained.