Essay compendium for the 2024 APAC Hydrogen Summit and Exhibition

Australian Hydrogen Council
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Australian Hydrogen Council
e: info@h2council.com.au
w: H2council.com.au

AUSTRALIAN HYDROGEN COUNCIL

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Foreword

This is the second Asia Pacific Hydrogen Summit and Exhibition that the Australian Hydrogen Council has delivered in partnership with the Sustainable Energy Council. We are delighted to bring together key people from across the region to share insights at a pivotal time for our industry.

To build on the key insights gathered from this year's conference, we have collected essays from key thinkers in the energy transition from across our region.

As the peak representative body for the Australian hydrogen industry, we are accelerating the development of the hydrogen industry through policy advocacy, network building, and information sharing.

We do this by collaborating with industry, governments, business associations, local and international partners, and research institutions. This allows us to aggregate evidence and perspectives to inform the right policy settings.

Through this work, we have become a trusted advisor and advocate for our members across the hydrogen value chain and key stakeholders in the region.

A lot has happened over the past 12 months, with the Australian Government announcing new policies that have put Australia back in the race. That is why I felt it was important to share our own paper that outlines key national policies relevant to the hydrogen industry and the current state of play for each. This refers to, and builds on, many of our submissions produced this year.

There is plenty of work to do, and I can't emphasise enough how important it is for continued collaboration. I would like to thank those who have contributed to this collection of insights, and encourage readers to continue engaging with the Australian Hydrogen Council as we continue driving the industry forward.

Fiona Simon
Chief Executive Officer
Australian Hydrogen Council

AUSTRALIA: Opening address for the conference

Fiona Simon,[1] CEO, Australian Hydrogen Council, Melbourne

Introduction

In this opening address I would like to talk about the following themes:

- the energy transition through time,
- the interconnectedness of sectors and options, and
- our resulting expectations.

None of this is inherently new, but I am keen to reframe our hydrogen conversations, particularly given what we have been seeing since we last met.

A transition not a leap

Our shared intent is for the global economy to *transition* from one state (very high carbon emissions) to another (low to zero carbon emissions) to better manage and prevent catastrophic climate change. 'Energy transition' is a term most of us use, and it is the reason for what we are trying to achieve with developing new means of producing and using hydrogen.

However, I think that the meaning of 'transition' – and particularly when we speak about the energy transition – is not well aligned with our human propensity to avoid uncertainty and change, and to undervalue common goods. Usually, people tend to accept change and personal risk only when the cost of doing so is clearly outweighed by the cost of sticking with the status quo. This is evident in our institutions and made worse by the short-termism of today's news, financial reporting, and election cycles. Living with long-term change, and its associated short-term uncertainty, is generally quite discomforting.

The energy transition's misalignment with our basic way of being is not as obvious when the main trade is in announcements, the common currency of talk about future action. However, everything becomes more challenging when it becomes time to act and to make choices.

IRENA has recently referred to the 'green hydrogen deadlock' where potential off-takers (consumers) and suppliers are unable to move forward without further information – such as about prices and commitments.[2] And potential suppliers are hesitant to build and deploy without firm offtake

[1] This is an extended version of the opening address for the APAC Hydrogen Summit, delivered 12 September 2024.

[2] IRENA (2004) *Green hydrogen strategy: A guide to design*, International Renewable Energy Agency, Abu Dhabi,

agreements. This seems an apt characterisation of much of the hydrogen conversation these days. First-of-a-kind projects are uncertain and risky, with a strong need for information for both supply and demand sides.

I note also that the conversation is shifting from early ambitious production targets and a 'build it and they will come' mentality, to increased arguments for demand incentives and a better understanding of consumers' willingness to pay for a pre-commodity.

It is unhelpful that many places, including Australia, lack meaningful (economy-wide) carbon pricing. This is the key solution for a society that needs to transition and runs a market economy – price is the signal of value for all things.

However, no one tends to *want* to pay more. Cost of living pressures make regulatory 'sticks' like broad carbon pricing unattractive politically. The transition requires reallocation of costs to move from one state to another, but 'reallocation' is not good news politically; the transition must make everyone a winner. And governments want to stay in power.

Now, I believe we will find our way through all of this. There is hope: while carbon pricing 'sticks' have further to go, governments across the world have at least prioritised 'carrot'-based, subsidy approaches to effect the transition. These may not activate market development terribly quickly, or across whole markets, but they will have an effect.

There are also other means of providing market mechanisms to value carbon beyond an economy-wide carbon price, and in Australia the hydrogen-relevant initiatives include the Safeguard Mechanism and the Capacity Investment Scheme. These are discussed further in the final essay in this compendium and can be bolstered to better approximate the carbon pricing to drive the right investment to reach net zero.

And I note there are other possibilities for cost reallocation. For example, the Climate Change Authority has recently suggested "a review of the Australian tax and transfer system could potentially reveal opportunities to reallocate public funding to better align with the government's Net Zero Plan". [3] The authority goes on to suggest the Fuel Tax Credit[4] could be phased out, with the AU$10 billion of government expenditure on this programme instead redeployed towards the deployment of low and zero emissions vehicles and machinery.[5]

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see https://www.irena.org/Publications/2024/Jul/Green-hydrogen-strategy-A-guide-to-design.

[3] Climate Change Authority (2024) *Sector Pathways Review*, page 184, see https://www.climatechangeauthority.gov.au/sites/default/files/documents/2024-09/2024SectorPathwaysReview.pdf.

[4] The Fuel Tax Credit is an offset to the fuel tax that applies to users of diesel who do not use public roads, even though the tax goes to the broader federal budget rather than being specifically used for road upkeep.

[5] We note that a version of the credit could even be retained without affecting entities in agriculture or freight; Climate Energy Finance has called for the introduction of a cap of AU$50 million per annum, per consolidated group. This would essentially take major mining companies out of the Fuel Tax Credit scheme, with "not a single firm or entity operating in Australia's agricultural sector or road transport/freight" affected. See Climate Energy Finance (2024) *Reforming the Fuel Tax Credit Scheme is not 'economy-wrecking', but will align economic incentives with Australia's climate ambition and accelerate our pathway to a Future Made in Australia*, Matt Pollard, 29 August, https://climateenergyfinance.org/wp-content/uploads/2024/08/Fuel-Tax-Credit-Scheme-Report-Response.pdf.

Other non-price tools of government are also important to support progress, including:

- Demand side policy, such as carbon or fuel mandates, which kickstart the market. Examples here include the EU's Renewable Energy Directive (RED) and ReFuelEU Aviation for sustainable aviation fuels, and California's Low Carbon Fuel Standard (LCFS).

- Financing and constructing common user infrastructure, such as ports and pipelines. This need is significant; for example, the US has stated that even after its production tax credit has been accounted for, US$85-$215 billion in cumulative investment is required to scale the domestic hydrogen economy through to 2030 (10 MMT pa), with *as much as half* of this funding required to develop the midstream or end-use infrastructure.[6]

- Planning and regulation to better support community engagement. This is a particular issue for potential hydrogen-producing countries like Australia: in 2019 it was estimated that community opposition had "contributed to the delay, cancellation or mothballing of more than AU$20 billion of infrastructure projects in the last decade".[7] There has been significant development to support engagement with a range of stakeholders in the past year, including rules for community engagement on major transmission projects,[8] a major community engagement review from the Australian Infrastructure Commissioner[9] that may result in a national developer rating scheme,[10] and the development of a First Nations Clean Energy Strategy.[11]

- A 'one stop shop' or 'front door for investors' approach to simplify investor decision-making and to develop investment propositions to attract private and institutional capital. We have advocated for this for some time and are pleased to see it is being taken up by the Australian

[6] US Department of Energy (2023) *Pathways to Commercial Liftoff: Clean Hydrogen*, March, page 42, see https://liftoff.energy.gov/wp-content/uploads/2023/05/20230523-Pathways-to-Commercial-Liftoff-Clean-Hydrogen.pdf.

[7] Infrastructure Australia (2019), Infrastructure Australia (2019) *An Assessment of Australia's Future Infrastructure Needs: The Australian Infrastructure Audit 2019*, June, pages 15 and 221, see https://www.infrastructureaustralia.gov.au/sites/default/files/2020-10/Audit%202019_Full%20pdf_Updates%20September%202020.pdf.

[8] Australian Energy Market Commission (2023) *Final community engagement rules for major transmission projects*, see https://www.aemc.gov.au/news-centre/media-releases/final-community-engagement-rules-major-transmission-projects#:~:text=The%20AEMC%20has%20published%20its%20final%20requirements%20for,engagement%20throughout%20the%20regulatory%20investment%20test%20%28the%20RIT-T%29.

[9] Australian Energy Infrastructure Commissioner (2023) *Community Engagement Review: Report to the Minister for Climate Change and Energy*, December, released 2 February 2024, see https://www.aeic.gov.au/news-media/news/community-engagement-review-report.

[10] Vorrath, S. (2024) 'A national renewables developer ratings scheme needed to help build better community engagement in grid projects', *Switched On*, June 24, https://switchedon.reneweconomy.com.au/content/a-national-renewables-developer-ratings-scheme-needed-to-help-build-better-community-engagement-in-grid-projects.

[11] DCCEEW (n.d.) First Nations Clean Energy Strategy, accessed 5 September 2024, see https://www.energy.gov.au/energy-and-climate-change-ministerial-council/working-groups/first-nations-engagement-working-group/first-nations-clean-energy-strategy.

Government in its Future Made in Australia package to support international investment in Australian projects.

- Improved permitting and approvals processes; I am pleased to see strong stakeholder and Australian Government support in principle, and there was also money allocated in the 2024 Budget to strengthen and streamline environmental approval decisions on priority projects.

For us in hydrogen these would all help drive change, and the right mix of settings could even approximate the effect of stronger carbon price signals.

Our industry development will happen in phases, and we must hold the line to get the hard work done now so we are ready for scale later. It is also about hybrid solutions, with pathways to 'better', so we do not let perfect get in the way of progress.

I also want to congratulate the Australian Climate Change Authority on its Sector Pathways Review report, released recently.[12] This is the outcome of a comprehensive modelling and consultative exercise that is to inform the Australian Government's Net Zero Plan. This report will be an important reference for all of us in the Australian energy transition space.

The interconnectedness of all things

The second theme of my address is interconnectedness; of sectors, regions and countries. Beyond the obvious trade possibilities, hydrogen is a connector of sectors and issues, which is both a good and no-so-good thing.

This is a good thing when hydrogen is seen as relevant to multiple parties and so it has currency: everyone is talking about it, seeing the possibilities, and starting the work to manage risk and realise opportunity. IRENA advises that as of May 2024, 46 national (and supra-national) strategies and 8 roadmaps on hydrogen had been drafted and published, and at least 20 more countries were in the process of producing such documents.[13]

In these last years across the many studies, strategies and roadmaps, we have talked about hydrogen connecting a range of industries, such as steel, ammonia, methanol, aluminium, bricks, cement, food, glass, and even crematoria. In transport, we talked about passenger vehicles, buses, trucks – small through to very large mining trucks and road trains – rail, shipping and aviation. In energy we have talked about hydrogen as a means of providing long term storage for electricity grids, as replacing natural gas in pipelines, and as the energy to be burned for several of the aforementioned industries. There have been many announcements, and I want to note that those announcements over the past few years mattered, even the ones that did not proceed as planned. We evaluated and we learned.

[12] Climate Change Authority (2024) *Sector Pathways Review*, released 5 September 2024, see https://www.climatechangeauthority.gov.au/sites/default/files/documents/2024-09/2024SectorPathwaysReview.pdf.

[13] IRENA (2004) *Green hydrogen strategy: A guide to design*, International Renewable Energy Agency, Abu Dhabi, see https://www.irena.org/Publications/2024/Jul/Green-hydrogen-strategy-A-guide-to-design.

But being a connector is less good when it means that our resulting view is all too big and amorphous to be reckoned with. Where no *one* entity or government department is truly responsible for implementation, because to plan for hydrogen means to have understood and planned for decarbonisation across all key industry types (with the attendant matters of long-lived equipment and replacement cycles) and transport modes, and across energy and trade portfolios. It also means having understood and planned for infrastructure, land and water use, including interaction with the renewables to be built, and the biogenic feedstock availability that hydrogen must supplement for future e-fuels. And to plan for the workforce needs across a range of sectors.

The energy transition debates are a mirror to our complex society. Society deals with complexity through differentiation and specialisation, such as various sectors of the economy, and geographical divisions such as states and territories. But this means that detailed cross-sector and cross boundary activity can then become everyone's – so really, no one's – explicit business.

For this reason, I'm pleased that we are moving away from talking about hydrogen in the abstract – the thing we could make and should make – to the *reason* why we make it; its purpose. We are better now at naming the priority end uses. And because of this, governments' industry, transport and energy portfolios are better positioned to individually (but not entirely independently) examine and plan for hydrogen solving their sector decarbonisation needs. We are seeing this in Australia with current policy developments to create a Net Zero Plan based on separate – but connected – sectoral plans. We are improving in our understanding of alternatives and complementary approaches.

We are also seeing more hybridisation to manage change, to try new ways of doing things, and to find the right efficiencies. Hybrid approaches may also provide long-term solutions to a range of decarbonisation problems: I am hearing more and more about how biogenic feedstock for fuels and hydrogen might complement one another and, similarly, how batteries plus hydrogen can effect transport decarbonisation.

The conversation on interconnectedness is also now starting to go where it must into the much larger questions about societal values and trade-offs, and how we value the use of land for a range of purposes. The need to co-optimise land use for energy, food and biodiversity. These are vital matters and will inevitably cause political frictions with clashes of public interests. For governments needing to find a way through, renewables, and by extension hydrogen, will be both a problem and a solution.

This leads to the last theme, which is people's perception of the emerging industry, including the contest over definitions, timing, and what is and is not a myth.

Perceptions and expectations

The energy transition is a contested space: values collide on every possible point, and even science is seen to be subjective. This is frustrating but understandable. The energy transition seeks to shift systems of systems away from incumbent positions that have, until recently, been seen as the driving force of progress. These incumbent positions are still largely supported by current market forces and social institutions.

We are also very early in the transition, so perceptions of risk abound. No one wants to be the one who misses out or pays more. Even the spectrum of *optimism* is vast: with the range of different assumptions people employ in forecasting energy use, and their favourite technologies, there is a diverse range of futures that might unfold and a diverse set of associated enthusiasms to choose from.

As if this was not already challenging enough, in building the hydrogen industry we need to confront additional uncertainties. Unlike the global LNG market, or the early solar industry – two often used examples of how new industries can develop over time – we need to create an entirely new market for clean and green hydrogen, with new forms of production, new ways to use hydrogen and a new end-to-end supply chain that is supported with an appropriately resourced ecosystem. To compare, it took LNG and solar PV years to get to scale *even though* each produced energy that society could immediately use and value.

And while we build hydrogen capabilities, we must also enable the transition within the electricity system: we need to build out renewables capacity at an unprecedented rate for the sake of the electricity system, as well as for hydrogen, and in doing this costly exercise also bring prices *down* for renewable or green hydrogen to be competitive. Australia is not on track so far, with ARENA stating the need for the cost of renewable electricity to be below $20/MWh (compared to the levelised cost of electrons from solar PV which was at $60/MWh in March 2024) to facilitate viable green hydrogen production.[14] However, we are improving, with investment in large-scale generation moving in the right direction, according to a recent report by the Clean Energy Council.[15]

In short, this was always going to take time. It was not going to be easy, or cheap, and there are still many uncertainties. All it takes is a dip into the debates about hydrogen on LinkedIn to see that there are a great many strongly held, but opposite, views on hydrogen, based on often very different interests and assumptions.

Despite this, we can take some comfort that common views about the future hydrogen industry are emerging. These are as follows:

1. We will need hydrogen in the energy transition for its chemical uses:
    - Clean and green hydrogen is required because we already need it to make ammonia and the nitrogen fertilisers that keep half the world alive. This use needs to be decarbonised.
    - Hydrogen will have a role to decarbonise steel – producing Direct Reduced Iron (DRI) with hydrogen will be a necessary means to decarbonise at least the first part of the steelmaking process.
2. Hydrogen as a direct fuel is more contested, but it is still valid. Hydrogen is being used to replace diesel for remote power needs. It is still in the mix as a means to decarbonise heavy

[14] Australian Renewable Energy Agency (2024) 'The role of green hydrogen and ultra-low cost solar in Australia's superpower vision', *ARENAWIRE*, 13 March, https://arena.gov.au/blog/the-role-of-green-hydrogen-and-ultra-low-cost-solar-in-australias-superpower-vision/.

[15] Clean Energy Council (2024) 'Energy storage thrives as new investment in large-scale generation eclipses 2023 total', 3 September, https://cleanenergycouncil.org.au/news-resources/renewable-projects-quarterly-report-q2-2024.

road transport and smaller aircraft. Collectively, matters of efficiency, infrastructure needs, and viable alternatives are being worked through, as well as hybrids between batteries and hydrogen.

3. Hydrogen as a chemical feedstock for future fuels also hold promise:
    - feedstock for ammonia or methanol for future shipping fuels – hydrogen is needed for both pathways;
    - feedstock for the aviation fuels of the future – the e-SAF when we need to scale beyond biogenic feedstocks, and right now as a supporting act to process biogenic feedstocks.

These use cases may not meet early hopes for a 'hydrogen society' or 'hydrogen economy'. However, even if these are the niche uses, they are enormous. Producing the volumes of hydrogen required for these uses will need terawatts of new power and further hundreds of billions of dollars of investment in production capabilities, industrial facilities and associated infrastructure. These uses alone will require close attention to priorities, efficiencies, and sequencing to be feasible, and scaling up will take years.

The nature of what might be a 'hydrogen economy' will also vary by nation. For example, Australia will most likely not be a hydrogen economy but an electrified economy; a weather-dependent, renewables-plus-storage economy, with hydrogen playing an important supporting role to get the electrons to where and when they are needed (including as hydrogen derivatives). We can do this because of our vast renewable electricity potential.

Other countries, and particularly those that are more dependent on imports, are working through their options. And the questions are still live about the right mix of alternatives, at what price, with what carbon emissions acceptance and in what timeframe.

So given all this, what are the myths to bust?

1. First, it is a myth that hydrogen is a choice, and that we can choose to not develop this industry. We cannot get to net zero without hydrogen.

    The good news is that we are seeing a convergence of views that we *must* move ahead and now we have more sophisticated thinking about how we do it.

2. Second, it is wrong to conclude that the hydrogen industry has failed because some projects have been delayed, or proponents have pulled out of projects.

    The good news is that this is a normal process (but a lack of carbon pricing and demand incentives does not help). We are learning from experience and unpacking the devilish detail on project-specific risks and challenges. We are finding the pathways to progress rather than perfection, for phasing over expecting one grand leap in progress.

3. Third, it is not true that all hydrogen end uses are locked down and we all know what we need and by when. There is still room for end uses to expand or contract, based on a complex host of factors. The required volumes are also very much a matter of whose model you use.

> The good news is that we have started to converge on general pros and cons for hydrogen in different use cases. We are paying better attention to demand side needs and timeframes, customer willingness and capacity to pay, and the right policy settings to support these.

Because of current Australian politics, I would add the emerging myth that hydrogen and nuclear are somehow comparable. Or that hydrogen should be in any way caught up in nuclear debates. No. Hydrogen is expensive and hard for different reasons, and ones that are far more surmountable in a country that has no meaningful history with nuclear. (And of course hydrogen is a carrier of energy not a means of producing it.)

Conclusion

In conclusion, we are still collectively – and here I mean globally, regionally, nationally, locally – finding the right ways to plan for and implement, the transition away from fossil fuels.

In all things, including hydrogen, framing is everything: how we frame the problem, the solution and the pathways. This is about working out the boundary conditions for a problem (across time and space) to then understand the possible solutions and the means of valuing hybrid responses in the interim.

As evidence of failures and successes build up over time, I believe we have cause to feel positive, because to know that *this is hard, but this is what it takes*, is surely better than not having started.

We know we need to build this industry, and we are doing what it takes to get there.

JAPAN: The challenge to create demand for hydrogen

Tatsuya Terazawa, Chairman and CEO, Institute of Energy Economics, Tokyo

In contrast to the significant number of project announcements to supply clean hydrogen, the official number of offtake agreements has remained very limited. There are at least three factors preventing the materialization of demand for hydrogen. The high cost, lack of infrastructure and the underdevelopment of specific use sectors are the three factors.

Japan's Hydrogen Promotion Act (HPA), authorized by Japan's Diet on May 17, is designed to offset the cost differential of hydrogen and to help develop the necessary infrastructure for hydrogen. HPA could be the trigger to create a global demand for clean hydrogen, contributing to the development of a global hydrogen market.

While HPA is expected to have a significant impact on the creation of demand for hydrogen, specific use sectors much be developed as well.

1. HPA: the trigger to create a market for clean hydrogen

With the global excitement about low carbon (clean) hydrogen and the many announcements of supply projects, the demand side for hydrogen is lagging behind with very few offtakes officially decided. In fact, the announced volume of offtakes is just about 10% of the expected supply.

What are the impediments for offtakes? The single most important obstacle is that clean hydrogen is just too expensive today. Market mechanism alone will not justify procurement of clean hydrogen. Policies need to be introduced to create the initial market for clean hydrogen.

Carbon pricing through EU ETS can narrow the cost differential between clean hydrogen and grey hydrogen. The current level of carbon price is far too low to replace conventional energy, such as natural gas or coal. Many policy measures such as the European Hydrogen Bank and H2 Global have been introduced in Europe. While these measures should help create the initial market, it is unclear if a sufficient budget has been set aside to create the market, especially for imported hydrogen.

The US IRA is very powerful. It could help replace grey hydrogen by clean hydrogen. But the draft for 45V[16] which determines the criteria for eligible green hydrogen is viewed as too stringent to support broad introduction of clean hydrogen while its objective is considered to be legitimate. For the time being, blue hydrogen utilizing 45Q will probably be the leading means to introduce clean hydrogen in the US. This will help the replacement of grey hydrogen by clean hydrogen but not powerful enough to replace conventional energies, such as natural gas or coal.

The second impediment is the lack of infrastructure to receive clean hydrogen. To keep hydrogen liquified, it must be cooled down to minus 253℃, much lower than the minus 161℃ required for

[16] 45V and 45Q refer to their part in the US IRA which provides tax credits.

LNG. Existing tanks cannot be used “as is”. Even if ammonia is used as a carrier to avoid the need to cool down so much, safety measures need to be introduced to deal with its toxic nature. Cracking facilities to turn ammonia back to hydrogen must also be developed.

Japan’s Hydrogen Promotion Act (HPA) which was recently authorized by Japan’s Diet (May 17) is designed to overcome these two major impediments to create the market for clean hydrogen.

2. HPA introduces a framework to offset cost differentials

HPA introduces the framework to offset cost differentials. The strike price will be determined to cover the cost of supplying clean hydrogen for the next 15 years. The reference prices for hydrogen and ammonia will be the cost of LNG and the cost of coal, respectively. As Japan will introduce carbon pricing, first with the formal introduction of ETS in 2026, followed by the introduction of carbon surcharge in 2028, the effect of carbon pricing will be reflected in the reference prices.

The Government of Japan will provide subsidies to offset (in full or in part) the difference between the strike price and the reference prices. As you can see from the design, this framework should help replace LNG with clean hydrogen and replace coal with clean ammonia.

3. HPA has a broad scope: color agnostic, domestic/import, hydrogen derivatives

HPA is “color agnostic”. A threshold for carbon intensity will be introduced to define low carbon or clean hydrogen. But as long as the threshold is satisfied, the energy source to produce hydrogen is not limited to only renewable energies. The difference in carbon intensity will be considered in the evaluation process of the projects.

HPA can be applied to both domestically produced hydrogen and imported hydrogen. As the HPA highlights the importance of energy security, it is recognized that domestically produced hydrogen would receive preference. But due to an expected limited scale of domestically produced hydrogen, I believe that imported hydrogen will play a greater role, in volume, under HPA.

HPA coverage extends beyond hydrogen. In addition to ammonia, which is generally considered as the cheapest means to transport hydrogen, e-fuels, i.e. synthetic fuels produced from hydrogen, and e-NG (or e-Natural Gas), i.e. synthetic methane produced from hydrogen, are both understood to be covered. e-fuels can be part of SAF to fly airplanes and they can also run vehicles in a decarbonized manner to complement EVs. e-NG has the advantage of utilizing the existing infrastructure to supply natural gas or LNG and is considered as a pragmatic pathway to decarbonize city gas which is widely used in Japan for industrial and residential use.

4. Qualification for support: timely supply, long term commitment, secured users

To be qualified for the support to offset cost differentials, the projects need to satisfy several qualifications.

First, the projects will have to supply clean hydrogen by 2030 which is the target year for the current energy strategy of Japan.

Second, the project operators will have to commit to continue supplying clean hydrogen for 10 years after the initial 15-year support by the government.

Third, the projects will have to secure users of the clean hydrogen. Industrial users must be part of the committed users. Power companies can also be part of the user group. I have to stress this point as some potential project operators appear to be just forming a team from the supply side only without securing the user side. The absence of committed Japanese users will disqualify such projects for support.

5. Support to develop the necessary infrastructure

Hydrogen and ammonia require new infrastructures. Tanks, pipelines and cracking facilities are all needed. To help the introduction and distribution of hydrogen and ammonia, HPA provides a financial framework to support the development of the necessary infrastructures. The current vision is to develop hydrogen hubs, typically building upon the existing industrial complexes with steel mills, chemical plants and power plants. In many cases, the committed users for the cost differential support will most likely overlap with the industrial and power sector users located in such industrial complexes. In this manner, there will be a synergy between the two pillars of support, i.e. cost differential support and infrastructure support, under HPA.

6. Three trillion yen (20 billion US dollars) support for hydrogen

Prime Minister Kishida has pledged 20 trillion yen of government budget to support the 150 trillion yen in new investments required for the energy transition over the next ten years. Investments are expected from both the public and private sectors. The policy package named “GX Promotion Strategy”, adopted one year ago, aims to accelerate the Green Transformation. Out of this whole package, PM Kishida has pledged 3 trillion yen (about 20 billion US dollars) of government money to support the introduction of clean hydrogen under the HPA.

The scale of government subsidy is substantial and most probably larger than any other country/region’s dedicated support to hydrogen. The allocated budget to cover the cost differentials will be committed for 15 years and may not be sufficient to provide support for all the projects currently under planning. This long-term framework for the initial 15 years is longer than the 10-year support program under the US IRA. This long-term framework will greatly help the projects receiving support, but at the same time, will limit the number of projects that can be financially supported.

I understand there are many projects, both domestic and international, aiming to receive the support under HPA. The process to select those projects will have to be very competitive, especially for international projects.

7. Highly competitive process and the need to enhance appeal of the projects

HPA is legally bound to be enacted within 6 months after the authorization by the Diet. The Japanese Government will try hard to enact HPA earlier than the legal requirement. The actual enactment will take place by this fall, when the formal process of selecting the projects will start.

Assuming the domestically produced hydrogen will receive preference due to energy security considerations, the selection process will be highly competitive especially for international projects. The expected lack of scale of domestically produced hydrogen should provide significant room for imported hydrogen. The large number of international projects under planning will lead to an intensive competition among all projects.

To win within the selection process, the projects will have to enhance their appeal in the eyes of the Japanese Government. What will be the key factors?

While HPA does not go into details, we can reasonably identify several major and relevant factors.

First, cost is essential. The cost assessment may incorporate the amount of carbon to be abated. The support provided in the exporting country will certainly have an impact on the cost. Our institute, IEEJ, conducted a study in 2021 which showed that blue ammonia from Saudi Arabia would be the lowest cost supplier to Japan. IEEJ revised its study in December 2023 to reflect the impact of the US IRA and the new results show that blue ammonia from the US, would now be the lowest cost supplier.

As it is strategically important for the international projects to be in the first group to be selected by Japan, it is now the appropriate time to strengthen support in the exporting countries. Canada has introduced policy measures which are comparable to the US IRA. Australia has also strengthened its policy to support hydrogen which is highly welcome. At the same time, the absence of support for blue hydrogen/ammonia and the relatively modest level of support compared with the US IRA may affect the attractiveness of Australian hydrogen/ammonia. Any additional support provided by the exporting countries would enhance the appeal of their projects, but such support must be in place before the official Japanese selection process proceeds.

HPA specifically states that the projects will have to contribute to the competitiveness of Japanese industries, both in the supply side and in the user side. While the exact meaning is not fully articulated in HPA, I believe that the committed users of clean hydrogen must be part of the industries important for Japan. I also believe that the technologies/players used in the production and transportation of clean hydrogen will enhance the appeal of the projects if they are associated with Japanese industries. The equity participation of Japanese players in the upstream will also enhance the appeal.

8. The opportunity

With its total budget of three trillion yen (roughly 20 billion USD), the HPA could be the trigger of substantial offtakes and a major contributor to the development of a global market for clean hydrogen. The framework for clean hydrogen, under HPA, is probably the most powerful one in the

world. It provides support for cost differentials for 15 years. While being color agnostic, it is designed broadly enough to cover imported hydrogen as well as ammonia, e-fuels and e-NG. HPA helps the development of the necessary infrastructure as well. HPA provides a great opportunity for the creation of a global clean hydrogen market.

HPA also stipulates that, in addition to budget measures, regulatory reform will be pursued to expand the hydrogen market. Carbon pricing will be introduced to incorporate externalities of fossil fuels which will incentivize the use of clean hydrogen. Other regulatory reform specific to sectors, such as the power sector, will be considered to expand the use of clean hydrogen in such sectors. Based on HPA, the Japanese Government is committed to introduce multiple measures to expand the market for clean hydrogen.

To be a global player in the supply of clean hydrogen, I believe that it is strategically important to be selected in the first group of projects to be supported. As the selection process will be highly competitive, the appeal of the projects will need to be “as enhanced as possible” before the formal process proceeds. While the enhancement may require substantial policy support from the exporting countries, consideration of technologies/players used in the production and transportation will also play significant roles. Joining the first group of clean hydrogen suppliers with commercial scale will give those projects the strategic advantage to be leaders in an emerging clean hydrogen market. This opportunity cannot be missed.

9. Development of specific use sectors

While HPA will help offset the cost differential and develop the necessary infrastructure, specific use sectors must be developed as well. The bold expectation for the future is the realization of a hydrogen society. But the development of specific use sectors will have to take place in stages.

The first stage will be using ammonia for cofiring in coal fired power plants. Starting with 20% cofiring, the ratio will be gradually raised to 50%. With the urgent need to reduce CO2 emissions by coal fired power plants, this use of ammonia for cofiring should provide the first significant demand sector for clean hydrogen and its derivatives. In Japan, many coal fired power plants are located nearby large industrial complexes. Part of the ammonia delivered to coal fired power plants will be delivered to nearby industrial complexes to be used as fuel to generate heat for industrial uses. Ammonia will partially replace natural gas and coal used today for heat generation.

I understand that there are some people who are critical of using ammonia for cofiring. But without cofiring, the first significant use sector with volume will be hard to be developed leading to the delay in introducing clean hydrogen. As the old saying goes, “The perfect may be the enemy of the good.” The use of hydrogen/ammonia in the power sector is strategically very important.

The second stage will be a combination of several use sectors. Ammonia will be used more broadly for generating heat in the industrial sector. Clean methanol and ammonia produced from hydrogen will start being used as fuel for ocean shipping. Hydrogen will be used for cofiring in gas fired power plants.

In the third stage, 100% burning of hydrogen for power generation will be realized. Hydrogen will be used more broadly in the steel production process including for direct reduction. New types of clean

energy produced from hydrogen will be introduced, starting with SAF. Subsequently, e-NG and e-fuel for vehicles will be deployed. At this stage, hydrogen will be used broadly in the economy, getting closer to the hydrogen society dreamed by many.

10. Necessary policies and actions

Offsetting cost differential with government budget will eventually face its limits. End use does not necessarily grow without a policy push. We should not be complacent with the passage of HPA. Further policies and actions must be discussed.

First, carbon pricing must be introduced to add the cost of externalities to competing conventional energies such as coal and gas. Carbon pricing should help narrow the cost gap.

Second, there must be a clear policy, including regulation, to require decarbonization of the power sector within a clear timeframe. Such a policy should incentivize power companies to adopt hydrogen/ammonia.

Third, to address the cost increase of power companies and city gas companies, a mechanism to ensure the additional cost through the use of clean hydrogen/ammonia/e-NG can be passed on to the users of power and city gas must be considered.

Fourth, regulation to require the use of SAF in the aviation industry must be introduced. In Japan, already a regulation is in place which requires 10% mix of SAF by 2030. SAF will probably start with the use of bio feedstocks, but due to volume constraints, will have to eventually shift to SAF produced from hydrogen.

Fifth, innovation must be accelerated. Large scale gas turbines which can burn 100% hydrogen must be commercialized. Engines for ships which can use ammonia must be developed. Steel production process using hydrogen must be developed.

Finally, cost reduction is absolutely necessary. In addition to innovation, scale should help drive the cost down. Looking back at the history of LNG, the expansion of scale through the participation of more countries was very helpful. LNG was pioneered by Japan, followed by Korea and by Taiwan, subsequently by China and South East Asian countries. It took more than 50 years after the first shipment of LNG to Japan in 1969 to realize the LNG market as we see today. For hydrogen, we must shorten the time frame by ensuring that more countries participate from the early stage to realize scale and to ensure cost reduction. And the use of hydrogen should not be limited by the importing countries. Hydrogen producing countries can help expand the scale and reduce the cost by generating demand for hydrogen domestically at the source country. International collaboration is essential for the expansion of the use of hydrogen.

Hydrogen is a very important pillar of the energy transition. It has a great potential. But the potential can only be achieved through policies and actions by many players. Japan is taking the lead on this aspect. Australia can also play a greater role.

APAC: The geopolitics of hydrogen in the Indo-Pacific region[17]

Jane Nakano, Senior Fellow, Energy Security and Climate Change Program, Center for Strategic and International Studies, Washington

Hydrogen is an energy carrier that is gaining attention globally as a low-carbon or non-carbon-emitting energy source, whether burned in an engine to produce heat or used in a fuel cell to produce electricity. Hydrogen is also uniquely flexible. It can take various forms for transport, such as ammonia. In addition, various types of energy sources can be used in producing hydrogen, including hydrocarbons such as natural gas and coal, renewables such as wind and solar power, and nuclear energy.

A growing number of countries are starting to either examine the potential role of clean hydrogen in their energy systems or consider their own role in growing hydrogen supply chains. According to the International Energy Agency (IEA), 17 governments have released hydrogen strategies and over 20 additional governments have announced that they are developing strategies.[18]

Hydrogen has emerged as a major focus among the Indo-Pacific economies, some as potential producers and exporters and others as growing consumers and importers. Specifically, Asian economies in the region increasingly view hydrogen as a useful energy source to help meet energy demand while decarbonizing their energy systems. Several Asian governments have released hydrogen strategies and roadmaps to support the use of clean hydrogen, while others have expressed official interest in examining the economic viability of hydrogen use.

Several global energy supplier countries have expressed interest in producing and supplying hydrogen to Asian markets. Many of these countries are traditional hydrocarbon suppliers to Asia. These supplier governments have shown strong interest in the economic opportunities associated with exporting hydrogen.

The motivations and objectives of these countries have important implications beyond their respective national borders. The hydrogen strategies of key Asian consumer governments and their supplier governments could affect not only inter-fuel competition but also international energy relations—for example, through changes in trading and investment patterns. These changes can affect the region's energy security and decarbonization efforts and raise some important geopolitical implications.

[17] This is a summary of a previously published CSIS report. Full version originally published: Nakano, J. (2022) *The Geopolitics of Hydrogen in the Indo-Pacific Region*, Centre for Strategic & International Studies, June, https://www.csis.org/analysis/geopolitics-hydrogen-indo-pacific-region.

[18] International Energy Agency (IEA), *Global Hydrogen Review 2021: Executive Summary* (Paris: IEA, November 2021), https://www.iea.org/reports/global-hydrogen-review-2021/executive-summary.

Interests, visions, and motivations

Interests are rising and visions are starting to solidify for the production and consumption of hydrogen across several major Asian markets and their top, traditional energy supplier countries. The visions underline priorities and offer insights into what motivates these countries' exploration or pursuit of hydrogen initiatives. Motivations are largely shaped by a country's resources, geographical characteristics, energy trade ties, economic and industrial structures, and technological competence.

Key Asian countries

Asia is home to several major global energy importers. Yet, the energy consumption mixes and import profiles of regional economies are diverse, shaped or constrained by geographic characteristics, natural resource endowments, and economic strength. Similarly diverse are hydrogen visions among Asian countries, owing to a high degree of heterogeneity across these characteristics and conditions.

To Japan and South Korea, clean hydrogen is about decarbonizing their economies while creating a new, competitive industry as a means for continued economic development. The synergy between consuming hydrogen for decarbonization and advancing hydrogen uses is advanced under Japan's Green Growth Strategy Through Achieving Carbon Neutrality in 2050, which identifies hydrogen as one of the 14 key sectors that will aid the country in achieving the dual objectives of decarbonization and economic development. Through significant public financial support to these sectors, the Green Growth Strategy is expected to yield economic benefits in the order of JPY 90 trillion ($880 billion) in 2030 and JPY 190 trillion ($1.8 trillion) in 2050.[19] Likewise, hydrogen is one of the key sectors that underpins South Korea's Green New Deal under the Moon Jae-in administration. The South Korean government sees hydrogen as a potential driver of economic growth worth KRW 43 trillion ($34 billion).[20]

The transportation sector, specifically fuel cell vehicles (FCVs), has been the dominant focus of clean hydrogen in Japan and South Korea. In particular, Japan and South Korea both have a globally competitive automaker which has invested heavily in the development and deployment of FCVs and undertaken technology research and innovation since early on in hydrogen's development. Government promotion of FCVs in these countries may be as much about extending national industrial competitiveness as it is about decarbonizing the transportation sector.

Experiences and expertise in managing significant reliance on maritime transport for energy imports may be an asset that can unlock economic opportunities for Japan and South Korea. Engineering and energy companies from Japan and South Korea have experiences and expertise with processing and shipping liquefied natural gas (LNG) that can be leveraged to position them as competitive

[19] Note that all the currency conversion in this report is based on the exchange rates as of early June 2022. Ministry of Economy, Trade and Industry of Japan (METI), "'Green Growth Strategy Through Achieving Carbon Neutrality in 2050' Formulated," press release, December 25, 2020, https://www.meti.go.jp/english/press/2020/1225_001.html.

[20] "Hydrogen Economy: Roadmap of Korea," Ministry of Trade, Industry and Energy of the Republic of Korea (MOTIE), January 2019, 2, https://docs.wixstatic.com/ugd/45185a_fc2f37727595437590891a3c7ca0d025.pdf.

stakeholders in emerging hydrogen supply chains, including in liquefying, storing, and shipping hydrogen (in various forms of carriers, such as ammonia).

Meanwhile, the case for hydrogen use in Japan and South Korea is more nuanced when it comes to energy security. Both countries have limited natural resources for domestic natural gas production to support blue hydrogen production, as well as limited available flatland for massive renewable capacity to support green hydrogen production. As such, a hydrogen economy alone will likely not solve their energy import reliance. Cooperation with resource-rich countries is therefore at the core of the hydrogen visions of Japan and South Korea. Nuclear energy may also have a unique role to play. The two countries have experience and expertise in nuclear power generation, which could aid in the pursuit of hydrogen. In fact, the Japanese government has already identified nuclear energy as a potential source of clean hydrogen production. Nuclear energy may become an option in South Korea under the leadership of President Yoon Suk Yeol (in office since May 2022), who has called for nuclear energy to account for 30 percent of South Korea's total energy generation.[21]

In contrast to Japan and South Korea, China and India have hydrocarbon resources as well as large landmasses that are relatively conducive to energy infrastructure siting. Clean hydrogen deployment, particularly renewable-based hydrogen production, appeals to their desire to grow renewable energy capacity, which in turn can help strengthen energy security.

Expanding renewable energy capacity is as much about mitigating a steeper rise in fossil fuel import dependence as it is about decarbonization for China and India. For example, despite the availability of domestic hydrocarbon resources, China's import dependence is already high, at 73 percent for oil and 41 percent for natural gas as of 2020.[22] India's combined expenditure for fossil fuel imports is forecast to triple over the next two decades, as the country's net dependence on imported oil rises from 75 percent today to over 90 percent by 2040.[23] In both countries, a key question is whether renewable capacity expansion can keep pace with growing demand from electricity generation and hydrogen production. China's and India's hydrogen pursuits are also driven by economic and industrial interests. China is increasingly interested in advancing technology innovation and expanding manufacturing capacity, not only to meet domestic demand but also to serve overseas markets.[24] For India, green hydrogen could become an export commodity to countries such as Japan and South Korea while also serving the domestic market.[25]

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[21] Heesu Lee and Youkyung Lee, "South Korea's Pro-Nuclear President-Elect Boosts Atomic Stocks," Bloomberg, March 9, 2022, https://www.bloomberg.com/news/articles/2022-03-10/south-korea-s-pro-nuclear-president-elect-boosts-atomic-stocks?sref=B2BBHw9t.

[22] BP, BP Statistical Review of World Energy 2021: China's Energy Market in 2020 (London: BP, 2021), https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-china-insights.pdf.

[23] IEA, India Energy Outlook 2021 (Paris: IEA, February 2021), https://www.iea.org/reports/india-energy-outlook-2021.

[24] Huaxia, "China maps 2021-2035 plan on hydrogen energy development," Xinhua, March 23, 2022, http://www.xinhuanet.com/english/20220323/428eaeae2c0a41b98ffb8d5ef4e91190/c.html.

[25] Lakshmi Priya, "India's National Hydrogen Mission and Prospects for Cooperation with GCC," Manohar Parrikar Institute for Defence Studies and Analyses, August 27, 2021, 1, https://idsa.in/issuebrief/india-national-hydrogen-mission-n-gcc-lpriya-270821.

Neither China nor India has articulated detailed pathways, action plans, or timelines for developing a clean hydrogen sector. Existing policies and official statements have a greater focus on the supply side of the equation, providing limited insights into how the domestic market may grow. In addition, China's and India's visions are much less focused on creating international supply chains or regional markets than Japan and South Korea are. Likewise, China's government does not seem to view hydrogen as a vehicle for an economy-wide transformation. As major energy consumers in the world, the pace and scope of hydrogen development and use in China and India will have important implications for both global hydrogen development and global decarbonization.

There is a tremendous diversity among the **Southeast Asian economies** in terms of energy production and consumption profiles. While countries such as Brunei, Indonesia, and Malaysia are traditional natural gas exporters to regional markets, Singapore and Thailand are long-time importers. Such diversity is also evident in Southeast Asian governments' varying levels of interest in and approaches to a hydrogen economy.

Generally, interest and progress toward hydrogen development in Southeast Asia is more limited than in the countries discussed above, as energy access (both quantitatively, such as population and geographic coverage, and qualitatively, such as stability and duration of power provision) remains to be an overarching priority for regional policymakers. The production, transportation, and consumption of clean hydrogen commands large initial capital expenditure.[26] As such, political support for launching a major hydrogen industrial strategy or providing significant public funding toward clean hydrogen production and applications remains limited in the region. The fragmented state of electricity networks in the region as well as the lack of affordability and access to technologies make raising the share of renewable energy in the region difficult, which in turn frustrates the development of clean hydrogen.[27]

Singapore stands out as a leading country in the development of clean hydrogen economy, not only in Southeast Asia but in the wider Indo-Pacific region. Singapore's desire to remain key to the regional energy trade is a strong driver for its emerging international engagements, including government-to-government and commercial engagements in hydrogen projects. Elsewhere, several regional economies with natural resources, such as Malaysia, are exploring ways to gain economic opportunities from the hydrogen value chains that are emerging within the Indo-Pacific region.

Traditional energy supplier countries

Interest in hydrogen is rising among countries rich in hydrocarbon resources that are major energy exporters to Asia. Economic diversification tops the list of motivations for clean hydrogen development, as the supplier governments increasingly recognize that hydrocarbon resource production and consumption are under growing scrutiny from investors, political leaders, and civil society in advanced industrialized countries for their greenhouse gas–emitting attributes. Additionally, the hydrogen strategies of leading supplier countries are largely about adapting their

[26] KBR, Study of Hydrogen Imports and Downstream Applications for Singapore (Houston, TX: KBR, 2020), 89, https/www.nccs.gov.sg/docs/default-source/default-document-library/hydrogen-study-report.
[27] Han Phoumin, "The Role of Hydrogen in ASEAN's Clean Energy Future," National Bureau of Asian Research, August 20, 2021, 4–5, https://www.nbr.org/wp-content/uploads/pdfs/publications/asia_edge_phoumin_aug21.pdf.

economies to the low-carbon preferences of their trading partners in the increasingly carbon-constrained world.

As a country in the Indo-Pacific region rich with energy resources, **Australia** has shown a significant level of interest in developing a clean hydrogen economy and becoming a major supplier of clean hydrogen. Already among the largest exporters of LNG, coal, and uranium today, Australia seeks to become one of the top three hydrogen exporters to Asian markets.[28] Essentially, the path for hydrogen in Australia is about adapting the country's energy export profile to a new reality that is defined by the energy transition and Asian markets' growing interest in low-carbon energy imports.

The country also sees additional economic benefits arising from developing a hydrogen economy. Hydrogen production is seen as an opportunity to diversify the economy, attract investment, provide jobs, and reinvigorate trading relationships, potentially even reaching new markets. In fact, Australia's vision has a highly pragmatic undertone, seeking to proactively capture economic value from the global energy transition and generate national-level synergy from state-level economic development needs and interests.

The Australian government also values the decarbonization benefits of clean hydrogen development. In fact, Australia's climate action is primarily focused on advancing low-emissions technologies such as hydrogen rather than directly on emissions reductions. Moreover, the ongoing effort to develop a "guarantee of origin" system for the hydrogen sector reflects Australia's desire to assume a leadership role in creating an international clean hydrogen market.[29]

Saudi Arabia's interest in hydrogen is primarily driven by its desire to ensure economic security. Developing a clean hydrogen sector can help the world's top crude oil exporter meet several key mandates of the Saudi Vision 2030, such as diversifying exports, leveraging existing sectors' supply chains to increase local contents, and developing new industrial sectors.[30]

Clean hydrogen could generate a new stream of export revenue that allows Saudi Arabia to become less reliant on oil as the key source of export revenue. This is particularly relevant in the carbon-constrained modern world characterized by a wave of net-zero targets from governments and industries, including Saudi Arabia's own (by 2060). In 2020, oil exports accounted for about 70 percent of the country's total exports in terms of value and about 53 percent of Saudi government revenues.[31] In October 2021, Saudi energy minister Prince Abdulaziz bin Salman al-Saud stated that the country wants to become the top supplier of hydrogen in the world. It has clean hydrogen production targets of 2.9 Mt/year by 2030 and 4 Mt/year by 2035.[32]

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[28] COAG Energy Council Hydrogen Working Group, Australia's National Hydrogen Strategy (Canberra: Commonwealth of Australia, 2019), https://www.industry.gov.au/sites/default/files/2019-11/australias-national-hydrogen-strategy.pdf.
[29] Ibid.
[30] "The Progress & Achievements of Saudi Arabia – Vision 2030," Kingdom of Saudi Arabia, https://www.vision2030.gov.sa.
[31] U.S. Energy Information Administration (EIA), Country Analysis Executive Summary: Saudi Arabia (Washington, DC: EIA, 2021), https://www.eia.gov/international/overview/country/SAU.
[32] Saeed Azhar, Yousef Saba, and Shakeel Ahmad, "Saudi Arabia Wants to be Top Supplier of Hydrogen – Energy Minister," Reuters, October 24, 2021, https://www.reuters.com/business/energy/saudi-arabia-wants-be-top-supplier-hydrogen-energy-minister-2021-10-24/.

The current focus is to gain a large market share in blue hydrogen, particularly in the form of blue ammonia—ammonia produced from the combination of ammonia synthesis using hydrocarbon carbon capture, utilization, and storage—in the coming decade.[33] Blue hydrogen and its derivatives can help the country leverage its hydrocarbon resources and existing expertise and infrastructure, such as in carbon capture and storage. In the future, green hydrogen could help the country develop a new industrial sector. Saudi Arabia's green hydrogen–related technological and economic experiments are being incubated in the futuristic city of Neom.

As the first Middle Eastern country to announce a mid-century carbon neutrality commitment, the **United Arab Emirates** (UAE) sees hydrogen as both a potential economic driver and a key tool for climate action. But even before launching the Hydrogen Leadership Roadmap at the United Nations Climate Change Conference in Glasgow (COP26) in November 2021, the UAE identified hydrogen as "a fuel of the future" in its Nationally Determined Contribution under the Paris Agreement, updated in December 2020.[34] The country currently uses hydrogen from unabated natural gas or methane, but the roadmap announcement signals a growing effort to decarbonize its hydrogen supply and consumption profile.[35]

Key implications

Energy security

The domestic production of clean hydrogen could help China and India alleviate, although not solve, energy security challenges amid their rising energy demand. Insofar as these countries already have a heavy and growing import dependence for hydrocarbons such as natural gas, they appear more partial to pursuing the capability to produce renewable-based hydrogen, so as not to further their hydrocarbon needs. Whether renewable capacity expansion can keep pace with the demand growth from both electricity generation and hydrogen production is an important question. China's and India's large and growing energy requirements could mean that much of the clean hydrogen produced in both countries will go to satisfy domestic needs.

Hydrogen is unlikely to materially enhance energy security for countries that currently are highly dependent on energy imports and have a limited renewable resource potential domestically. Specifically, import dependence may not see a material improvement for Japan and South Korea, both of which are heavily resource constrained domestically in satisfying their hydrocarbon needs, including in terms of natural gas supplies. These constraints mean blue hydrogen development is unlikely to become an energy security solution. Also, geographic characteristics make a larger

[33] Matthew Martin et al., "Saudi Aramco Bets on Blue Hydrogen Exports Ramping Up from 2030," Bloomberg, June 27, 2021, https://www.bloomberg.com/news/articles/2021-06-27/aramco-says-timing-of-next-blue-ammonia-cargo-depends-on-buyers.

[34] Lina Ibrahim and Hazem Hussein, "UAE Announces Hydrogen Leadership Roadmap, Reinforcing Nation's Commitment to Driving Economic Opportunity Through Decisive Climate Action," Emirates News Agency – WAM, November 4, 2021, https://www.wam.ae/en/details/1395302988986; and Julio Friedmann and Robin Mills, The UAE's Role in the Global Hydrogen Economy (Dubai: Qamar Energy, September 2021), 9, https://qamarenergy.com/sites/default/files/The%20UAE's%20Role%20in%20the%20Global%20Hydrogen%20Economy.pdf.

[35] Friedmann and Mills, The UAE's Role in the Global Hydrogen Economy, 6.

deployment of renewable capacity to support green hydrogen production unlikely, particularly at a level that can materially reduce energy import reliance. Meanwhile, nuclear energy has import substitution potential for Japan and South Korea, both of which have decades of nuclear energy research and innovation expertise as well as operational capacity.

However, hydrogen could unlock new energy ties with countries that are outside of the current menu of suppliers, leading to enhance energy security through supplier diversification. For example, Chile seeks to become a leading global exporter of green hydrogen and ammonia by 2040 and sees Asia as a top-level destination.[36] In particular, a clean hydrogen trade that does not rely on prevailing maritime transit routes would improve energy security for importer countries. Insofar as U.S. oil and gas supplies have diversified the pool of energy suppliers to Asian markets, U.S. hydrogen shipments could also provide an energy security benefit to the Indo-Pacific region.

Decarbonization

The hydrogen strategies and actions of Indo-Pacific countries do not suggest a particular preference for renewable-based hydrogen over hydrocarbon-based hydrogen, at least in the near term. Japan's and South Korea's official strategic documents acknowledge the optimal decarbonization benefits from using green hydrogen but also indicate how they view investment in blue hydrogen supply chains as a pragmatic path toward creating clean hydrogen demand and markets, which in turn can help develop green hydrogen production and markets. This approach has been mirrored by the steps being taken by major energy suppliers to Asian markets that are prospective hydrogen exporters. Going forward, however, the declining cost of green hydrogen production is a key factor that could alter the economic and business assumptions that underpin these countries' approaches and investment priorities.

Meanwhile, some Southeast Asian countries appear to see supplying unabated hydrogen (or "gray hydrogen") as an entryway to the budding hydrogen supply chain and an attractive stream of revenue. Aside from the question of whether Southeast Asian countries can mobilize sufficient investment to establish capacities to turn their hydrocarbon resources into hydrogen supplies for exports, the commercial efficacy of exporting gray hydrogen is also uncertain. As a major prospective hydrogen exporter to Asia, Australia is developing a "guarantee of origin" certification mechanism to encourage Australian businesses to sell low-emissions hydrogen domestically and globally. A similar system is well underway within the European Union. Acceptance by trading partners is essential for such a system, and the Australian government appears eager to promote it both bilaterally and multilaterally. Other major prospective hydrogen exporters to Asia may see a commercial rationale to join in promoting such a certification system in the Indo-Pacific region, helping to ensure a return on investment in clean hydrogen production and supply processes that would be expected by European customers.

Meanwhile, hydrogen use in the power sector stirs a decarbonization debate. Technological research and innovation on ammonia co-combustion is an issue that has elicited varying reactions. Proponents view ammonia co-combustion as a means to reduce carbon emissions from the process of electricity generation from fossil fuels, including coal. According to the IEA's The Future of Hydrogen report,

[36] Ministry of Energy, National Green Hydrogen Strategy (Santiago, Chile: Government of Chile, November 2020), 18, https://energia.gob.cl/sites/default/files/national_green_hydrogen_strategy_-_chile.pdf.

ammonia co-combustion at a 20 percent share could reduce the annual carbon emissions of coal-fired power plants by one-fifth. Yet, ammonia co-combustion technology has come under scrutiny from those who view it as a means to prolong the life of coal-fired power generation assets, or hydrocarbons as electricity sources more generally.

Geopolitics

Hydrogen technology innovation and manufacturing capacities may not be immune from the ongoing geoeconomic competition. Hydrogen can be produced from various sources, and the availability of hydrocarbon resources is not the primary determinant of participation in clean hydrogen supply chains. Instead, access to technology to convert resources into various forms of hydrogen is an important license to participate in clean hydrogen value chains. Chinese enterprises are expanding the country's domestic capacity to manufacture electrolyzers, and their cheap alkaline electrolyzers have turned China into a major supplier of electrolyzers. However, alkaline electrolyzers are much less compatible with intermittent renewable energy sources than polymer electrolyte membrane (PEM) electrolyzers, which are more technologically advanced. A critical element of the overall equation is whether China can successfully replicate its commanding position seen in other clean energy supply chains, such as for solar photovoltaic (PV) cells and electric vehicle batteries.

Several major economies, such as the United States, Europe and Japan, are investing in hydrogen technology development and equipment manufacturing to ensure stable access to clean hydrogen and safeguard energy transitions against foreign dependence that could become politically or economically untenable. This is a new industrial area with opportunities to shape supply chains and mitigate the supply chain concentration in China seen in other clean energy technologies.

Also, the clean hydrogen trade could alter some bilateral energy ties. There is a strong alignment of interests between clean hydrogen importers and suppliers. A few of the Asian countries look to their existing energy ties as an important vehicle to ensure access to clean hydrogen supplies, while the energy supplier countries surveyed look to clean hydrogen as a key to maintaining market shares in Asia. In particular, clean hydrogen supply chain initiatives that Japan and South Korea have with their traditional energy suppliers in the Middle East are likely to reinforce their respective bilateral energy ties.

Clean hydrogen may also alter existing energy relations in several ways. One such bilateral relationship is between Australia and China. Against the backdrop of rising geopolitical tension with China, the Australian government has explored a number of low-emissions energy partnerships that incorporate hydrogen commitments with traditional partners, such as Japan, South Korea, and Singapore, as part of an effort to minimize Australia's economic exposure to China.[37] Clean hydrogen is emerging as a key vehicle to help Australia rebalance its relations with Asian markets that have become dominated by China.

[37] Author's interview with James Bowen, March 10, 2022 (email).

SINGAPORE: GCMD's safety study on piloting ammonia bunkering[38]

Global Centre for Maritime Decarbonisation, Singapore

Overview

The Global Centre for Maritime Decarbonisation (GCMD) is supporting international shipping to meet or exceed the International Maritime Organization's (IMO) 2030 and 2050 goals of reducing its greenhouse gas emissions. As part of this effort, one of GCMD's focuses is to identify and help close technical and operational gaps in adopting alternative fuels, such as green ammonia.

In January 2022, GCMD commissioned a study to define the safety and operational envelopes under which ammonia bunkering pilots can be carried out in the port waters of Singapore, the world's largest bunkering hub and second largest container port.

DNV Maritime Advisory (DNV) was appointed to undertake this study. Supported by Surbana Jurong (SJ) and the Singapore Maritime Academy (SMA), this study aims to establish the basis for executing a pilot that would eventually enable the bunkering of ammonia with industry-wide applicability. The DNV-led consortium consulted extensively with a GCMD-curated group of 22 study partners and obtained feedback from more than 130 Industry and Consultation Alignment Panel (iCAP) members. The consortium also had discussions with relevant regulators to help refine their analyses. The scope of the study includes:

1. Forecasting ammonia marine fuel demand to establish capacity needs in Singapore
2. Analysing and recommending feasible operating concepts for an ammonia bunkering pilot
3. Screening, evaluating, and selecting suitable sites for an ammonia bunkering pilot
4. Identifying hazards and key risks and establishing mitigation protocols for the pilot
5. Undertaking the Quantitative Risk Assessment for an ammonia bunkering pilot
6. Estimating total capital expenditure (CAPEX) for an ammonia bunkering pilot
7. Compiling a guidebook on ammonia bunkering pilots for seaports exploring ammonia as a marine fuel

[38] Executive Summary from GCMD's report on "Safety and Operational Guidelines for Piloting Ammonia Bunkering in Singapore", September 2023. The full public report is available online at https://www.gcformd.org/ammoniabunkeringreportdownload.

Ammonia bunker demand forecast in Singapore

The demand for ammonia as a fuel impacts ammonia storage capacity calculations (throughput assessment), regulatory considerations, and infrastructural needs. To forecast the ammonia bunker demand in Singapore, a DNV-led consortium applied a comprehensive bottom-up and top-down approach accounting for the probability of vessels adopting ammonia as fuel, its potential share in a ship's total energy consumption, carbon taxes, fleet growth, and energy prices.

Three scenarios (optimistic, pessimistic, and realistic) were developed based on past global bunker consumption data and anticipated market conditions.[39] The realistic scenario predicts that ammonia will comprise 10% of all marine fuels bunkered in Singapore in 2040, before rising to 37% by 2050. Given that Singapore's demand for conventional marine fuels was consistently 20% of global marine fuel demand from 2012–2021, this study assumes Singapore's demand for ammonia as a marine fuel will reach a corresponding 20% of the global demand for ammonia by 2045.

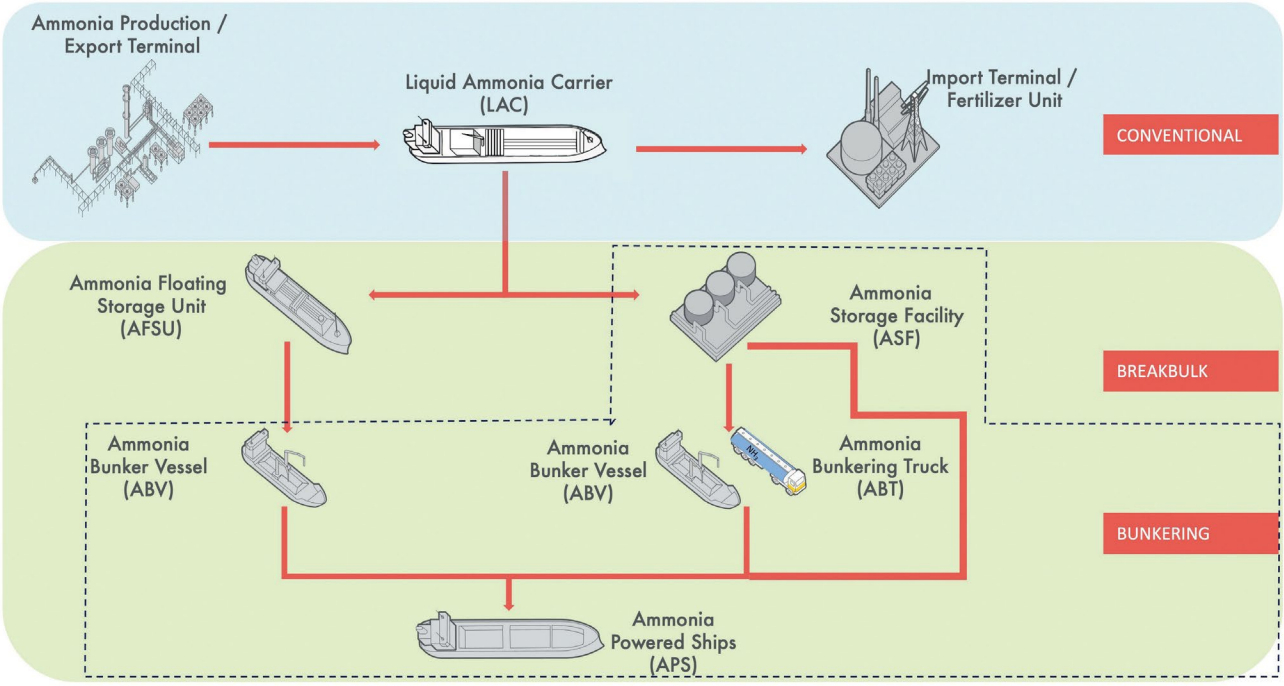
This projection corresponds to a total ammonia marine fuel demand of approximately 50 million tonnes (MT) by 2050 in Singapore and a significant corresponding increase in that same period for ammonia bunkering related assets, i.e. bunker vessels, port infrastructure and storage capacity. Therefore, regulators should consider developing a regulatory framework enabling the growth of an ammonia bunkering ecosystem and encouraging private sector investment from fuel suppliers, bunker operators, storage facility operators, and shipowners. This regulatory framework should be developed without delay, considering the time required for infrastructure buildout, competency development and operational readiness of the bunkering ecosystem given the safety concerns around handling ammonia as a bunker fuel.

Concept selection

Ammonia must be safely transferred from producers to marine fuel suppliers and eventually to vessels powered by ammonia bunker fuel. Based on DNV's ammonia bunker demand forecast, the consortium performed detailed technical analyses on the following modes of ammonia transfer:

+ Ship-to-ship (STS) breakbulk at an anchorage or a jetty-based location
+ Shore-to-ship (SHTS) breakbulk at a jetty-based location
+ STS bunkering at an anchorage or a jetty-based location
+ SHTS bunkering at a jetty-based location
+ Truck-to-ship bunkering at a jetty-based location

[39] As this report was completed in April 2023, the Revised IMO GHG Ambitions adopted at MEPC80 in July 2023 was not incorporated in this ammonia demand forecast.



Concept for ammonia bunkering operations

Two feasible operational concepts were shortlisted for breakbulk or fuel transfer between sources of supply or storage. Additionally, four technically feasible concepts were shortlisted for bunkering operations that involved transferring ammonia to vessels. Of the above six shortlisted operational concepts, there are five operating models the industry could pursue. The following four concepts are recommended as part of GCMD's pilot to demonstrate the transfer of ammonia as a marine fuel.

+ Concept 1: Liquid Ammonia Carrier (LAC) to Ammonia Bunker Vessel (ABV)/LAC, i.e. STS, at a breakbulk terminal in Singapore (Terminal A)
+ Concept 2: LAC to ABV, i.e. STS, breakbulk activity at anchorage
+ Concept 3: ABV to Ammonia Powered Ship (APS), i.e. STS, bunkering at anchorage
+ Concept 4: Ammonia Shore Facility (ASF) to APS, i.e. SHTS, bunkering at a tank terminal in Singapore (Terminal D)

These operating models include transfers from ships supplying liquid ammonia to ammonia bunkering vessels at jetty-based locations and anchorages, transfers from smaller ammonia bunkering vessels to ships powered by ammonia, and transfers from shore-based ammonia storage facilities to ships powered by ammonia.

Site selection study

Raffles Reserved Anchorage was identified to pilot concepts 2 and 3. To determine suitable land-based sites for piloting concepts 1 and 4, a detailed three-step analysis was carried out:

(a) **Site screening:** Shortlist potential sites based on a set of conditions required or beneficial for the development of ammonia transfer pilots

(b) **Site evaluation:** Quantitative evaluation based on a penalty system to rank potential sites and shortlist the two most suitable ones for pilot concept development

(c) **Validation:** Alignment with relevant stakeholders to verify the suitability of the sites for the intended pilot, subject to regulatory approvals

Seven potential land-based sites, Terminals A to E and Port A and Port B, were initially identified with the help of industry stakeholders. Thereafter, these sites were quantitatively evaluated using 43 criteria across five categories (Marine, Land, Health Safety & Environment (HSE), and Accessibility & Constructability). Ultimately, a jetty-based facility and a tank terminal (both based in Jurong Island in Singapore) were deemed more appropriate than the other sites for this pilot, contingent on further upfront investment requirements. The identified sites are designated in this report as Terminal A and Terminal D. Both facilities are sheltered, close to major navigation channels, and equipped with adequate jetty and sea space for ship manoeuvrability. No potential disruptions to current operations were identified.

Further analysis was performed to determine the optimal combination of site and pilot concept based on which the following combinations were selected, in addition to STS breakbulk and bunkering at Raffles Reserved Anchorage:

+ LAC to ABV/LAC, i.e. STS, breakbulk at Terminal A
+ ASF to APS, i.e. SHTS, bunkering at Terminal D

Due to a lack of road access to the berth and restricted vehicle access near the storage tank area, neither site would be suitable for a truck-to-ship ammonia bunkering pilot. The tank-to-ship concept is thus assessed for pilot demonstration at Terminal D, given an existing ammonia tank and supporting infrastructure, which would minimise the impact on current operations and development costs. Terminal A is suitable for piloting the cross-dock breakbulk concept as it minimises the impact on current terminal operations and marine traffic.

Hazard identification

During the Hazard Identification (HAZID) exercise, about 400 potential hazards were identified based on the four operating concepts and three selected sites (two land sites and one at anchorage). Most of the potential risks were medium-risk and mitigable based on risk-ranking results. None of the risks identified were classified as high-risk.

Recommendations on operational and safety measures to further mitigate these risks were provided.

Quantitative risk assessment

A Coarse QRA was conducted to estimate the risk of injury or fatality according to the "QRA Technical Guidance" (Rev. No. 3, November 9, 2016) issued by the National Environment Agency (NEA) under the Ministry of Sustainability and the Environment of Singapore. All four pilot concepts at the three selected sites meet the "QRA Criteria Guidelines" (Rev. No. 1, August 31, 2016) issued by the Major Hazards Department (MHD) under the Ministry of Manpower of Singapore.

For a breakbulk pilot at anchorage, the safety zone ranges from 200 m to 320 m, subject to an "As Low as Reasonably Practicable" (ALARP) evaluation. For a bunkering pilot at anchorage, the safety zone ranges from 150 m to 320 m, subject to an ALARP evaluation. These values are to be taken as indicative and not absolute, as regulatory requirements for ammonia bunkering do not currently exist. Therefore, before the size of the safety zone is finalised, an ALARP evaluation by the owner/operator of vessels should be carried out to determine "reasonableness".

The HAZID and Coarse QRA were conducted based on pilot project requirements and did not reflect the hazards of full-scale commercial operations. Further studies will be required to address the safety of full-scale ammonia bunkering operations for the four concepts at three locations. The study is also based on the selected pilot models and available data, and risks must be reassessed for future changes to the concept design or operations.

Due to potential commercial sensitivities, the hazard identification and Coarse QRA for pilot concepts at Terminal A and Terminal D will not be made available at this stage. Nonetheless, assessments carried out for STS breakbulk and bunkering concepts at Raffles Reserved Anchorage have been included in this report to highlight the factors that have been considered for pilot concepts at Terminal A and Terminal D, with which the learnings can accelerate the operationalisation of pilots and trials.

Capital expenditure (CAPEX) estimates

Having shortlisted operating concepts and sites and identified key mitigations required to manage risks, a Basis of Estimate (BoE) was developed. The land-side project cost was broken down into direct and indirect costs. Direct material costs include equipment, instrument, electrical, piping, and associated components. Indirect costs include construction, project management, third-party, and other preliminary costs. The cost estimate factored in costings of the relevant disciplines (e.g. piping, civil, electrical, and instrumentation) and combined budgetary quotes from construction contractors and equipment suppliers (e.g. loading arms) based on Surbana Jurong's in-house cost data from similar projects.

Considering the early stage of this pilot project, a cost accuracy of approximately 40% is expected. Estimated costs are not disclosed as they are sensitive to the location of deployment, brownfield modifications, materials cost, procurement strategy, local taxes and other related parameters. However, based on the two pilot concepts at the identified land sites where the model was applied, the range of results illustrates the high dependency on the already invested infrastructure. The cost estimates for the two land-side developments are in the order of SGD1 million to SGD10 million; the differentiating primary cost drivers are the installation of mechanical equipment at Terminal A and

the higher cost of project management and procurement services at Terminal D.

Guidebook for ammonia bunkering

Chapter 7 of the full report is a guidebook applicable to vessels conducting ammonia transfers and bunkering pilots. The guidebook outlines the properties of ammonia, the requirements for custody transfer, the measuring of ammonia quantity and ammonia quality, etc. It also contains recommendations for pilot bunkering procedures and safety and competency requirements for personnel operating in the ammonia marine fuel ecosystem.

Leveraging its experience with LNG bunkering and liquefied gas tanker courses, the Singapore Maritime Academy has included since March 2023 ammonia handling in its training courses related to alternative fuels under the International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels (IGF Code) and other industry guidelines. This new course will be further enhanced with the development of ammonia-powered engines and vessels.

The full report has been submitted as a draft technical reference to the Singapore Standards Council's Chemical Standards Committee (CSC) Technical Committee for Bunkering (Cryogenic and Gaseous Fuel) to ensure that the learnings from this GCMD study will benefit the drafting of guidelines, standards and policies to bunker ammonia locally. This report was also submitted to international standards development organisations to support the development of guidelines surrounding ammonia bunkering internationally.

Disclaimer:

This report is for informational purposes only and was developed based on the best available knowledge, bearing in mind the commercial sensitivities of our 22 Study Partners who had graciously shared the necessary data needed for the study, and the more than 130 Industry Consultation and Alignment Panel (iCAP) members who had provided valuable feedback. The Global Centre for Maritime Decarbonisation (GCMD) makes no representation or warranty, express or implied. The report should be taken as a basis for considerations by interested parties intending to carry out ammonia bunkering, and not as a definitive recommendation.

AUSTRALIA: Beyond the National Hydrogen Strategy – a stocktake of related Australian policy initiatives

Fiona Simon, CEO, Australian Hydrogen Council, Melbourne

Introduction

With the imminent release of Australia's revised National Hydrogen Strategy, it is a good time to contextualise this strategy within the overall federal policy framework.

There is currently a need for greater policy integration both within and across departments. However, the picture is changing, with increased government attention on how to connect the various sectors and apply top-down prioritisation and expectation setting. The Australian Government is undertaking a programme of systemic reform, including creating a Net Zero Plan, enabling regional development through a new Net Zero Economic Agency, funding infrastructure and technology through enhanced industry policy, and attracting private investment through large scale tax credits and other subsidies through the new Future Made in Australia policy package.

Figure 1 on page 35 shows the current array of Australian Government policy measures that are relevant to hydrogen. This is not an exhaustive list and is provided for illustrative purposes. This essay discusses the most important measures from this list for the development of the clean and green hydrogen industry, as shown in Table 1.

Measure	Policy intent
The Safeguard Mechanism	Pricing carbon emissions from heavy industry
The Guarantee of Origin Scheme	Certifying carbon emissions
Sector decarbonisation plans, leading to a Net Zero Plan	National planning to get to net zero
Future Made in Australia Bill	Ensuring major funding support is in the national interest
Hydrogen Production Tax Credit and Hydrogen Headstart expansion	Providing hydrogen-specific financial support
Carbon Leakage Review	Exploring the need for a Carbon Border Adjustment Mechanism
AEMO's Integrated System Plan (ISP)	Planning for renewable electricity infrastructure needs
Capacity Investment Scheme	To promote certainty in renewables and storage capacity investments through revenue underwriting
Sustainable Finance Roadmap, taxonomy and green bonds	Sustainable finance reform to mobilise private capital and provide transparency
The National Energy Workforce Strategy	Planning a workforce to meet the energy transition challenge
National Electric Vehicle Strategy	To support uptake of electric passenger vehicles

Table 1: Key policy measures for the emerging hydrogen industry

We address the current state of play as well as the AHC's policy positions, which are in turn discussed in greater detail across a range of submissions made to recent government consultations. We note also that in August 2023 the AHC provided a comprehensive submission to the Australian Government's National Hydrogen Strategy review consultation, with 53 recommendations. The content of this essay builds on arguments made in that paper, which are generally still relevant a year later, and we note are consistent with the direction taken by government in the various reforms.

Box 1: Why hydrogen?

Electrification is an integral element of Australia's decarbonisation, and we support the logic of electrifying wherever this is possible and economic. However, this is already not an easy task, with almost 80 per cent of Australia's domestic energy consumption in FY2021-2022 in the form of molecules rather than electrons.[40]

While many applications for molecules will shift to electrons as electrification emerges as the most efficient option for continued operations, there is still a significant portion of industrial activity that will not be covered. And hydrogen is the only large-scale option for decarbonising energy that requires molecules.

Further, Australia is a trusted energy partner across Asia and the export of molecules is critical to Australia's prosperity. It is integral that export of energy vectors remains an option that is actively supported by government policy and incentives. Our trade partners are confronting their own decarbonisation challenges within their national context, and Australia has an important role in remaining a source of clean energy, in whatever form is required.

This is all before we consider the promise for hydrogen to decarbonise industry through its use as a chemical to reduce iron ore to iron. Hydrogen is also the chemical building block for ammonia and methanol. Each of these industries could be grown as Australian export markets, with the potential for new high-value jobs. (It will be necessary to decarbonise these sectors to protect Australia's exports at the very least given future exports can be expected to face a carbon price at the importing country's border.)

The growth of Australia's hydrogen industry therefore not only supports domestic decarbonisation but also provides Australia with an opportunity to add value to existing raw exports and create new export opportunities. This will improve Australia's slide down Harvard's globally recognised Atlas of Economic Complexity, where Australia is at 93rd place (from 60th in 2000) with Uganda, Armenia and Honduras ranked directly ahead of us.

It will also require a level of Australian local industry participation all along the value chain to support the production, storage, movement and use of hydrogen. The ambition of the AHC is to see the Australian industry become a global leader in aspects of the hydrogen supply chain through our universities, start-ups and SMEs developing and commercialising innovative technologies.

[40] Calculated based on data found in Table H and Table R of Department of Climate Change, Energy, the Environment and Water (2023) *Australian Energy Statistics,* Australian Government, September, https://www.energy.gov.au/publications/australian-energy-update-2023.

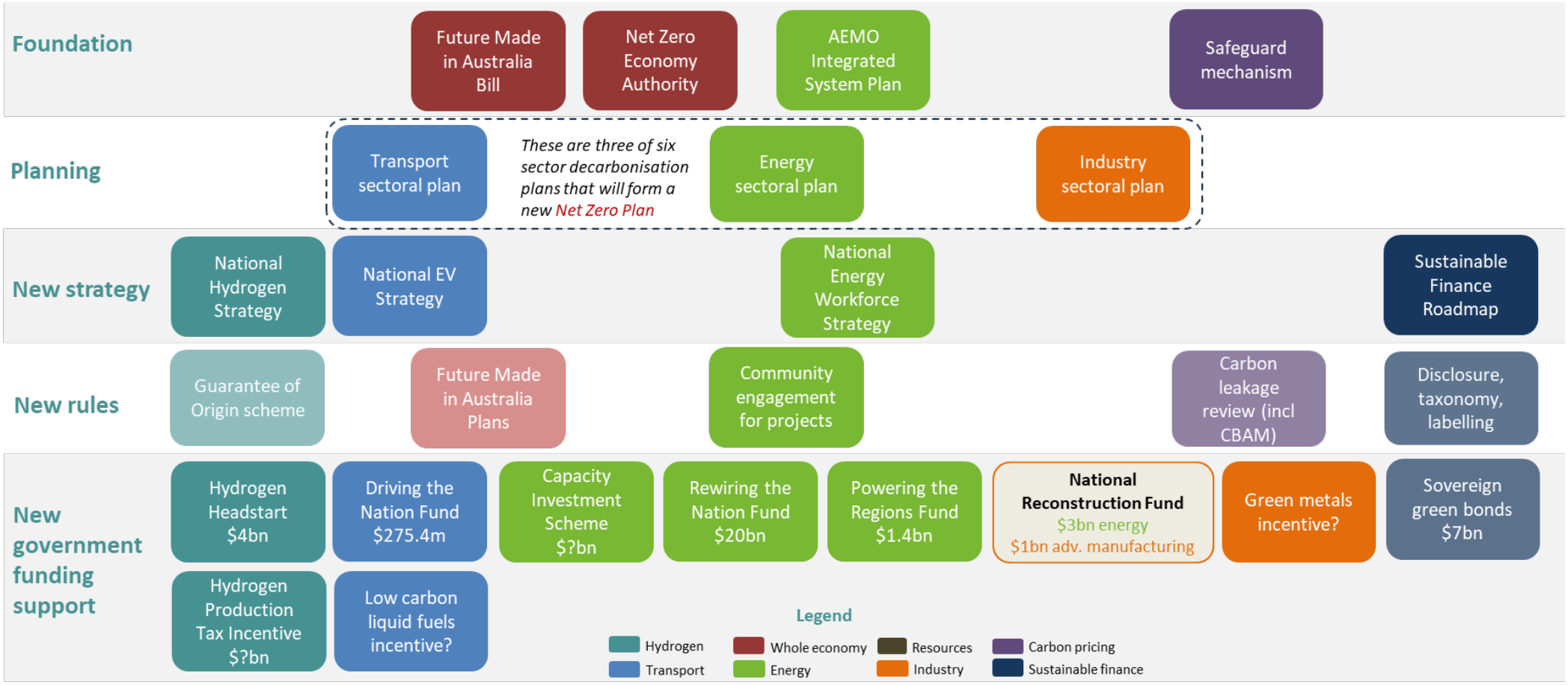


Figure 1: Australian federal policy environment – key elements for hydrogen

1. The Safeguard Mechanism

FOUNDATION POLICY – CARBON PRICING

Description and status

The Safeguard Mechanism[41] is the Australian Government's policy for reducing emissions at Australia's largest industrial facilities. The policy sets legislated limits on the greenhouse gas emissions per facility. These limits ('baselines') decline over time, requiring the facility owners to plan for, and invest in, decarbonisation initiatives. While the original Safeguard Mechanism commenced in 2016, it was reformed in 2023 to tighten the baselines and better ensure emissions reductions.

The Safeguard Mechanism applies to industrial facilities emitting more than 100,000 tonnes of carbon dioxide equivalent (CO_2-e) per year. There were 219 safeguard facilities in the 2022-23 reporting year.[42]

As part of the Safeguard Mechanism reforms in 2023, the Department of Climate Change, Energy, the Environment and Water (DCCEEW) reviewed production variables[43] to ensure they remained appropriate and effective in meeting the emissions reduction objective. A new hydrogen emissions intensity target was introduced (for new facilities), at 7.13 t CO_2-e/t of gaseous or liquefied hydrogen. This target is to inform a facility's baseline under the Safeguard Mechanism.

The government intends to review the Safeguard Mechanism policy settings in 2026-27.

AHC position

The amended Safeguard Mechanism is the key government policy to ensure industry decarbonisation aligns with legislated net zero targets and is Australia's core replacement for a carbon price.

It is positive that the Safeguard Mechanism exists, but it does not go far enough.

The legislation only covers the emissions of the nation's highest emitters. It also does not go far enough to incentivise covered organisations to commit stronger or faster action. While there have been promising trials announced, the Safeguard Mechanism – in its role as a pseudo carbon price – will need to be bolstered to accelerate uptake of decarbonisation solutions and increase investment in production facilities for clean and green hydrogen and derivatives.[44]

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[41] DCCEEW (n.d.) 'Safeguard Mechanism', updated 7 June, accessed 5 September 2024, https://www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism

[42] Clean Energy Regulator (n.d.) 'Safeguard Mechanism', updated 8 July, accessed 5 September 2024, https://cer.gov.au/schemes/safeguard-mechanism.

[43] DCCEEW (2024) *Safeguard Mechanism: Prescribed production variables and default emissions intensities*, see https://www.dcceew.gov.au/sites/default/files/documents/safeguard-mechanism-document-production-variable-definitions-2024.pdf.

[44] AHC (2023) *A fit-for-purpose refreshed National Hydrogen Strategy: next steps for building Australia's hydrogen*

Overall, whilst significant export of hydrogen and its derivatives is not anticipated until the 2030s, planning and environmental approvals for the development and construction of supply chains and supporting infrastructure need to begin now. Private sector actors will not make the required investment decisions until there is policy certainty and stability, alongside dedicated and long-term financial incentive or subsidy announced by the Australian Government.

Regarding the production variable emissions intensity target of 7.13 t CO_2-e/t of gaseous or liquefied hydrogen, it is unclear how this number was calculated.

Furthermore, under the production variable, hydrogen is considered trade exposed. This refers to the risk of incurring a green premium and how this domestic decarbonisation can be potentially undercut and undermined by imported, emissions-intensive alternatives. Under the Safeguard Mechanism, this vulnerability is recognised and combatted with access to additional support and a potentially lower annual reduction in baseline for trade-exposed industries rather than the standard 4.9%. Provided that Australia is trying to establish hydrogen and its derivatives at scale to address our hard to abate sectors and support our green advanced manufacturing ambitions, we need to protect our domestic production.

AHC is supportive of this acknowledgement. However, it needs further alignment to the Carbon Leakage Review.[45] In our submission to that consultation, AHC requested that hydrogen, ammonia and urea be included on the carbon leakage list.[46] DCCEEW should align these two milestone policies, ensuring that hydrogen and its derivatives are considered and protected as trade exposed products.

industry, August, https://h2council.com.au/ahc-publications/.

[45] DCCEEW (2023) *Public consultation on the proposed approach to assess and address carbon leakage risk, as part of the Carbon Leakage Review*, https://consult.dcceew.gov.au/consultation-proposed-approach-carbon-leakage-risk-as-part-of-the-carbon-leakage-review.

[46] AHC (2023) *Re: Public consultation on the proposed approach to assess and address carbon leakage risk, as part of the Carbon Leakage Review*, 15 December, https://h2council.com.au/wp-content/uploads/2023/12/231215-Carbon-Leakage-Review-AHC-SUB_for-submission.pdf.

2. The Guarantee of Origin

NEW RULES - HYDROGEN

Description and status

The Guarantee of Origin scheme (GO scheme) is an emissions accounting framework that allows buyers of hydrogen to have confidence in the low emissions claims of producers.

Intended to align with international methodologies, this is Australia's primary means of certifying the emissions intensity not only of hydrogen, but an increasing portfolio of products.

The GO scheme will be run by the Clean Energy Regulator (CER) and will allow for a range of variables to be measured, tracked and reported on, and discussions are in progress to extend the coverage of the scheme to a range of other products, such as biogas and green metals.

The GO scheme does not set a policy view on what is an acceptable level of emissions intensity; rather, it provides the means by which covered products can demonstrate compliance with any external emissions requirement.

The GO scheme is voluntary, but compliance is/will be mandated through key Australian Government funding mechanisms, such as Hydrogen Headstart and the Hydrogen Production Tax Incentive.

As of September 2024, the scheme is yet to be legislated through the federal Parliament.

AHC position

There is a clear need for a robust and trusted means of certifying emissions claims for hydrogen, and this has been raised as the industry's primary issue for some years. The AHC has been driving progress on this issue since 2018 and has engaged closely with DCCEEW and the CER. We support their development of a robust and versatile scheme that will meet the needs of a broad range of stakeholders.

The concept of a certification scheme for hydrogen has evolved considerably since the release of the initial discussion paper on the development of a Hydrogen Guarantee of Origin in mid-2021. The mechanism now being referred to as the GO scheme provides an architecture for tracking emissions well beyond the 'rubber stamping' concept envisaged by some when the need for a certification scheme was initially raised. By remaining agnostic to production pathway and emissions intensity DCCEEW is establishing a scheme which can adapt to the needs of industry and consumers beyond merely the production and use of hydrogen.

We are aware of Australian Government efforts, both bilaterally with trading partners and through the International Partnership on Hydrogen and Fuel Cells in the Economy (IPHE) to push for a globally recognised methodology for accounting for emissions and we consider that the GO approach can serve to underpin efforts to ensure that global reporting of emissions related to traded commodities is robust.

There is a range of other national and jurisdictional schemes that relate to emissions reporting, such as a GreenPower Renewable Gas Certification Pilot and the NSW Renewable Fuel Scheme (RFS). These often apply to the same producer of hydrogen and are governed and administered by different bodies; we seek information about how these may overlap with the GO scheme, as well as how the GO scheme will operate alongside initiatives such as the proposed Australian Carbon Border Adjustment Mechanism (CBAM) and the sector decarbonisation plans currently in development.

There is also a need for interoperability – many of the large-scale hydrogen and derivatives projects proposed for Australia have export ambitions and are keen to ensure consistency across international jurisdictions. In addition, AHC members are calling for multilateral interoperability rather than point to point (e.g. Australia-EU, Australia-Japan) interoperability.

3. Sector decarbonisation plans

PLANNING – TRANSPORT, ENERGY AND INDUSTRY (FOR NET ZERO PLAN)

Description and status

The Australian Government is working on a Net Zero Plan to reach the legislated target of net zero greenhouse gas emissions by 2050.

Led by DCCEEW, and in coordination with other departments, six sectoral emissions reduction plans are being developed to support the Net Zero Plan. These are electricity and energy; transport; industry;[47] agriculture and land; resources; and the built environment.

The six sectoral plans are supported by modelling and advice from the Climate Change Authority on targets and pathways, which was released recently in a major report.[48]

Of the six plans, energy, transport and industry directly relate to hydrogen, and resources is adjacent.[49] Consultation is ongoing, with discussion papers on electricity and energy,[50] transport,[51] and agriculture, and green metals[52] released in recent months.

Current timeframes for completion are unclear and it is also unclear how the National Hydrogen Strategy will align, but we anticipate it will sit alongside the Net Zero Plan.

AHC position

We support the development of the Net Zero Plan (and the six sectoral decarbonisation plans) and have engaged with the relevant departments.

Overall, a common theme for AHC across hydrogen use cases is that planning and environmental approvals for the development and construction of supply chains and supporting infrastructure need to begin now. Significant investment decisions will not be taken by private sector actors until there is

[47] DISR (2024) 'Net zero sector plans for industry, resources and the built environment', 17 June, News, https://www.industry.gov.au/news/net-zero-sector-plans-industry-resources-and-built-environment#:~:text=The%20Australian%20Government%20is%20developing%20a

[48] Climate Change Authority (2024) *Sector Pathways Review*, released 5 September 2024, see https://www.climatechangeauthority.gov.au/sites/default/files/documents/2024-09/2024SectorPathwaysReview.pdf.

[49] Note that ammonia to make fertiliser is not under the agriculture sector plan but the industry sector plan.

[50] DCCEEW (n.d.) 'Electricity and Energy Sector Plan, updated 14 May 2024, accessed 5 September 2024, https://www.dcceew.gov.au/climate-change/emissions-reduction/net-zero/electricity-and-energy-sector-plan#:~:text=The%20Electricity%20and%20Energy%20Sector%20Plan

[51] DITRCA (2024) *Transport and Infrastructure Net Zero Consultation Roadmap,* https://consult.dcceew.gov.au/transport-and-infrastructure-net-zero-consultation-roadmap.

[52] See Department of Industry, Science and Resources (2024) *Green Metals, A Future Made in Australia: Unlocking Australia's Green Iron, Steel, Alumina and Aluminium Opportunity*, Consultation paper, May, see https://consult.industry.gov.au/unlocking-green-metals.

policy certainty and stability, alongside dedicated and long-term financial incentives or subsidies announced by the Australian Government.

Australian policy and decision makers are creating the economic conditions for the emergence of entire new industries in Australia. The products that could be manufactured, produced, and traded are central to the energy and economic security of our trading and security partners across the region. If we are to be successful in the efforts to decarbonise not only Australia but the region, Australian governments must be willing to increase their risk appetite – to expand the suite of investment options to include equity stakes, large debt financing and expanded contracts for difference to incentivise the uptake of clean molecules in place of those derived from fossil fuels. We commend the Australian Government for its investment in the National Reconstruction Fund (Australia's manufacturing bank) to supplement the important work of the CEFC (Australia's green bank). But funding provided to these two agencies should be an order of magnitude higher if Australia's industrial and decarbonisation aims are to be met.

Our regional partners – in Japan, Korea, Taiwan, and Singapore as well as across ASEAN – are ready to co-invest and co-design the early mover Australia projects, but not at any price and not without Australia demonstrating willingness to carry some of the cost burden and investment risk. The AHC contends that in the absence of very significant and rapid reallocation of Australian private capital, the scale of the investments required for hydrogen production (power, transmission, storage of electrons, electrolysers, storage of hydrogen as well as downstream uses of the hydrogen such as production of ammonia or reduction of iron ore) necessitate international investment. We are hopeful that the regional and national investment priorities arising from the sector decarbonisation strategies will consider the role of hydrogen investment.

Electricity and energy

The AHC submission to the Electricity and Energy Sector Plan addressed planning, grid capabilities and the role of molecules,[53] and key arguments have been repeated elsewhere in this essay.

The AHC supports electrifying where this makes sense, and following the research and data when it comes to the hard to abate areas. Comprehensive and published planning information – defined here as projections and assessments of future energy supply and demand pathways – would assist governments, the private sector and the public to make informed decisions about their options and actions for broader net zero planning.

No planning and reporting information of this type is currently being produced. AEMO's ISP is the nearest example of a comparable product, but it does not cover oil, energy exports, the consumption of electricity and gas off main grids, or the achievement of policy and programmatic goals. So, while the ISP is an important input to a national energy planning document, it serves a different, more specific, and limited purpose. We are pleased with the recent review and plans to increase the scope of the ISP,[54] however, this needs to be expanded if we are to capture comprehensive net zero modelling. We discuss this further in section 8 of this essay.

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[53] AHC (2024) *Electricity & Energy Sector Plan – Discussion Paper*, 26 April, see https://h2council.com.au/wp-content/uploads/2024/04/240426-AHC-submission_Electricity-and-Energy-Sector-Plan.pdf.

[54] Energy and Climate Change Ministerial Council (2024) *Response to the Review of the Integrated System Plan*, Australian Government, see https://www.energy.gov.au/sites/default/files/2024-04/ecmc-response-to-isp-

The challenge for Australia is that we still need to build the renewables capacity that we are relying on to power our future renewable superpower ambition. This is on top of what is required to decarbonise the grid and provide system reliability. The need to build renewables to produce hydrogen is one of the most significant matters for consideration, where governments will be confronted with – and will need to explicitly manage, if not accommodate – competing priorities.

This also relates to electricity prices, where electricity pricing is a key driver of hydrogen costs. Australia is not on track so far, with electricity prices much higher than they need to be for the hydrogen industry to develop as required. Given that Australia's potential renewable superpower status is founded on anticipated future cheap electricity prices, this is also a matter of importance for the Net Zero by 2050 Plan. Policy initiatives that support hydrogen projects include concessions or exemptions on Transmission Use of System (TUoS) charges, as previously suggested by AHC in various fora. We are also supportive of the Capacity Investment Scheme, as covered under section 9 of this essay.

When considering next steps, as we have previously advocated,[55] the REZ and industry hubs model of funding and coordination should be extended to cover so-called Hydrogen Economic Zones (or Low Carbon Precincts) to facilitate planning across industries and with some degree of central (that is, government led) funding and coordination. We believe that the focused parameters of industrial decarbonisation within key regions will assist in identifying and addressing the challenges that arise within the net zero transition. Crucially, this concentrated precinct would supply the data required to inform and sequence wider Australian decarbonisation decisions, as well as provide central locations to develop R&D, explore international partnerships (such as through green shipping corridors) and address barriers (such as common user infrastructure investment).

We must also build Australia's clean energy workforce, as discussed in section 11 of this essay.

Transport

Our submission to the Transport and Infrastructure Net Zero Consultation Roadmap reiterated our recommendation to the Australian Government on its revised National Hydrogen Strategy,[56] where we ask for Australian Government support for hydrogen in heavy road transport with a national ZLEV strategy, fleet trials, transition funds, and either a heavy vehicle fuel efficiency standard or sales target.

Our current view is that these positions are still reasonable,[57] and that a desirable policy instrument for road transport could be a supply chain emissions target that addresses scope 3 emissions for major retailers that use heavy road transport. We expect this would mean minor cost pass through when spread across all consumers (assuming retailers sought to pass costs on).

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review.pdf.

[55] AHC (2023) *A fit-for-purpose refreshed National Hydrogen Strategy: next steps for building Australia's hydrogen industry*, August, https://h2council.com.au/ahc-publications/.

[56] Ibid.

[57] AHC (2024) *Submission to the low carbon liquid fuels and transport sector plan*, 18 July, https://h2council.com.au/wp-content/uploads/2024/07/240718-AHC-submission-to-LCLF-and-transport-sector-plan.pdf.

We suggest that the Australian Government should assess how quickly road vehicle fleets might need to turn over to reasonably meet emissions objectives and consider the demand side mechanisms to encourage this. Incentives need to encourage consumer technology shifts to the longer term low and zero emissions technologies. This seems most promising for battery and fuel cell electric road and rail transport. Government-funded renewable diesel incentives would then be suitable for a specific transition period while it may be needed.

For maritime, we will need to prepare for the planning and infrastructure requirements across Australian ports. Considering the lack of availability of space at existing Australian ports, and that Australia will generally be the taker of shipping company appetites for fuels, the Australian Government may need to nominate the best locations for specific segments of the maritime transition. Timely analysis and decision making must be undertaken to determine the target ports if we are to meet the ambitious whole of economy decarbonisation targets under the Paris agreements, International Maritime Organisation, and national legislation.

Hydrogen as a direct road transport fuel

Australia has nine hydrogen refuelling stations opened and another four under construction.[58] This is not sufficient to support transport uses of hydrogen, and the significant Australian Government trial that the industry has been calling for to derisk investment, the Hydrogen Highways initiative, continues to be pushed back and delayed. (We note that the 2024-25 federal budget allocated $75 million over four years to the Hydrogen Highways initiative;[59] however, the original application results were expected in early 2023, and the industry has no greater clarity on the proposed process.)

We have argued for some time that there needs to be pilots and trials of vehicles on Australian roads to be able to inform freight and logistics firms' assessments of total cost of ownership, or TCO. The Hydrogen Highways project was supposed to provide this information. The ongoing delay just furthers the problem that offtake cannot be agreed when the total cost of a fleet replacement to hydrogen fuel cell heavy vehicles remains so uncertain.

There is urgency to test the technology in use in Australia so that there is total cost of ownership assurance, the OEMs have the time and confidence to manufacture or retrofit fuel cell heavy vehicles at scale, and Australia can progress beyond trials. This is a multi-year endeavour, and the Australian Government has a necessary role here to prioritise establishing the hydrogen refuelling infrastructure, helping to accelerate the timeline and derisk fleet transition.

We note that the Hydrogen Production Tax Incentive is currently proposed to only apply to production facilities that have a minimum capacity on 10MW, which would not cover most hydrogen refuelling stations currently in development, therefore making them ineligible.[60] Furthermore, this credit is only expected to apply from 2027-28, which does not incentivise more the immediate scale

[58] HyResource (2024) *Hydrogen Refuelling Stations spreadsheet*, CSIRO, accessed 5 September 2024, updated April 2024, see https://research.csiro.au/hyresource/projects/hydrogen-refuelling-stations/
[59] Treasury (2024) *Budget 2024-25, Federal financial relations: budget paper no. 3*, Australian Government, 14 May, see https://budget.gov.au/content/bp3/download/bp3_2024-25.pdf.
[60] Treasury (2024) *Hydrogen production tax incentive*, Australian Government, https://treasury.gov.au/consultation/c2024-541265.

up of hydrogen refuelling stations that will be required to derisk range anxiety and encourage vehicle supply in Australia.

Low carbon liquid fuels (hydrogen as potential feedstock)

We agree that there is an opportunity for Australia to establish a low carbon fuels (LCLF) industry. This supports fuel security, recognises the lower energy density of green fuels, and incentivises decarbonisation through supply. Separate modes of transport and industries are working to unpack the research, trajectory, and timelines of different low carbon fuel options, but there is significant overlap, especially regarding biofuels and hydrogen.

The Australian Government consultation papers on low carbon liquid fuels[61] and the transport roadmap[62] (for the sectoral plan) have clearly shown a preference for using biogenic feedstock to make future fuels for road and air transport. As we have noted in our responses,[63] prioritising biofuels for near term use is a reasonable perspective. However, we caution the Australian Government to not put off harder work to develop at-scale solutions. Biofuels are the transitionary step for most liquid fuel uses while electrification and hydrogen capabilities are scaled up, and they will continue to play a vital long-term role for smaller scale use. In our view biofuels must be enabled but cannot *deprioritise* Australian Government efforts to develop policy to electrify, use batteries, and have the hydrogen infrastructure and supply for when the demand requires it. This obviously varies by transport mode – where hydrogen is used it could be for hydrogen as a fuel (such as for heavy road freight) or hydrogen as feedstock (for future maritime or aviation fuels). In any event, building out hydrogen capability and infrastructure will take time and needs to start now to be ready for when it is required.

Renewable diesel and SAF (whether biofuel or hydrogen-based) have been merged in recent government consultations, but it is important to note that these are not equivalent in terms of their long-term value to Australia's transport decarbonisation efforts. Renewable diesel is expected to have a shorter-term role, such as in heavy road transport and will be used more in regional and rural areas, for vehicles that are not yet ready for retirement, and while the technology and refuelling/recharging networks are being rolled out. Furthermore, incentivising renewable diesel could lead to the perverse outcome of delaying or undermining the transition to electrification, which is already a commercially available and governmentally subsidised technology in some transport modes. In contrast, SAF is a genuinely long-term play.

On the matter of biogenic feedstock, biofuels are of course not all the same; this is a diverse family of feedstocks with their own different emissions characteristics. One thing all biofuels have in common, besides drop-in capabilities, is natural constraints on production. Waste streams are certainly

[61] DITRCA and DCCEEW (2024) *Low Carbon Liquid Fuels A Future Made in Australia: Unlocking Australia's low carbon liquid fuel opportunity*, Consultation Paper, see https://www.infrastructure.gov.au/sites/default/files/documents/low-carbon-liquid-fuels-consultation-paper.pdf.

[62] DITRCA (2024) *Transport and Infrastructure Net Zero Consultation Roadmap,* https://consult.dcceew.gov.au/transport-and-infrastructure-net-zero-consultation-roadmap.

[63] AHC (2024) *Submission to the low carbon liquid fuels and transport sector plan*, 18 July, https://h2council.com.au/wp-content/uploads/2024/07/240718-AHC-submission-to-LCLF-and-transport-sector-plan.pdf.

constrained, and crop requirements for land and water can reach the point where biofuel production starts to compete with food.[64] Additionally, there are implications for biodiversity and fertility of land where rising impacts of climate change are expected to already be impacting crop yield. These are finite and vital resources that need to be managed carefully and responsibly.

To add complexity, there will be competition for biofuels for the hard to abate transport modes, particularly in aviation and maritime, where the demand will outweigh the possible supply of biofuels. These modes of transport must strategically sequence their decarbonisation and the feedstocks each can potentially use. We need greater clarity on the natural constraints of biofuels; this is a matter not only of fuel security but also food security.

We are supportive of an LCLF industry in Australia and welcome demand side incentives and policy mandates. These then need to sit alongside investment and infrastructure in the long-term net zero fuel solutions, such as hydrogen. The best approach for aviation would be mandates for future long-term use of SAF, and incentives to help producers and users close the commercial gap.

We also support the Australian Government's commitment to funding to develop a certification scheme for LCLF through an expansion of the Guarantee of Origin scheme, and its plan to build on ARENA's SAF Funding Initiative.

Industry

The Australian Government has advised that the industrial sectoral plan will cover:[65]

- alumina and aluminium;
- waste and resource recovery;
- chemicals and plastics;
- iron and steel;
- cement and concrete;
- food and beverages;
- pulp and paper;
- manufacturing;
- metals refining and smelting; and
- synthetic greenhouse gases.

The consultation for the industry sectoral plan has generally not been public, with targeted discussions held to date. A paper on potential incentives for building the green metals sector was

[64] CSIRO (2023) *Sustainable Aviation Fuel Roadmap*, see https://www.csiro.au/en/research/technology-space/energy/sustainable-aviation-fuel.
[65] DISR (2024) 'Net zero sector plans for industry, resources and the built environment', News, 17 June, https://www.industry.gov.au/news/net-zero-sector-plans-industry-resources-and-built-environment#:~:text=Industrial%20sector%20plan%20The%20industrial%20sector%20plan%20is,impacted%20by%20the%20economy%E2%80%99s%20transition%20to%20net%20zero.

released in May 2024.[66] The discussion below reflects the AHC's submission to that process. We write more comprehensively about industrial hydrogen uses in our August 2023 position paper, and we also completed a report with Australian Alliance for Energy Productivity (A2EP) on decarbonisation options for different high temperature heating applications.[67]

Iron

The AHC strongly supports work to develop the role for hydrogen in steel making.

Hydrogen can support the production of green iron in steelmaking by removing oxygen from the iron ore. Direct reduced iron (DRI) is currently produced at scale with natural gas; however, steelmakers are considering the use of hydrogen for DRI manufacturing to make the steelmaking process CO_2-free, and several projects are in train. This could be a significant export opportunity for Australia, as countries seek to reduce their energy consumption and shift to importing iron from countries like Australia rather than importing iron ore and using energy domestically for processing. (The iron-to-steel stage is likely to remain in countries using the steel because steel is a relatively complex and bespoke product.)

While Australia is not a first mover on DRI with hydrogen, we are the largest exporter of iron ore, and so there is a market opportunity. This is particularly as decarbonisation policies start to bite and we can produce hydrogen cleanly. Given that the technologies currently being piloted and trialled (direct reduction furnace technology, electric arc furnace) are not expected to be deployed at scale until the late 2030s/early 2040s, Australian governments and corporates have significant motivation and lead time to ensure investment in the secure supply of hydrogen feedstock for DRI.

However, Australia could still be left behind in the global move to green steel. The bulk of the iron ore currently mined for export in Australia is incompatible for use in the production of DRI as the ore contains too many impurities. Australian iron ore is predominantly hematite-goethite, which, while a higher-grade ore, is not ideal for the DRI process because processing it to the required standard is currently difficult. Magnetite is a lower grade ore but can be processed (a process called beneficiation) for use in DRI processes. As noted by the Australian Industry Energy Transitions Initiative:

> Developing new methods of processing hematite-goethite for its use in green steelmaking (especially DRI-EAF) could allow continued use of existing mines and infrastructure and preserve Australia's current iron ore markets. The processing of hematite-goethite for use in DRI-EAF technologies is poorly understood and will require R&D to enable commercially viable methods. Furthermore, yield losses during beneficiation will need to be addressed so as to not decrease the economic viability of this route.[68]

[66] See Department of Industry, Science and Resources (2024) *Green Metals, A Future Made in Australia: Unlocking Australia's Green Iron, Steel, Alumina and Aluminium Opportunity*, Consultation paper, May, see https://consult.industry.gov.au/unlocking-green-metals.

[67] Australian Alliance for Energy Productivity (2023) *Bringing the heat: Hydrogen's role in decarbonising Australian industrial process heat*, August, see https://h2council.com.au/wp-content/uploads/2023/08/Bringing-the-heat-report-for-AHC-25-August-2023.pdf.

[68] Climateworks Centre and Climate-KIC Australia (2023) *Pathways to industrial decarbonisation: Positioning Australian industry to prosper in a net zero global economy*, Australian Industry Energy Transitions Initiative,

There is therefore a fundamental need to develop and demonstrate means of producing DRI from both magnetite *and* hematite-goethite if Australia is to reach its potential in iron exports.

Alumina

Hydrogen can also support green alumina production. Australia is the second largest producer of alumina in the world, and the largest exporter. Primary aluminium is made from bauxite, which is refined to make alumina before being smelted to make aluminium. Refining bauxite to produce alumina has four stages: digestion, clarification, precipitation, and calcination. Digestion takes place at 150-270°C and calcination at temperatures above 1000°C. Hydrogen can substitute for natural gas in calcination and is considered a strong alternative to electrification.

The pathway for green metals is still nascent as the technologies are being developed. We know that there will be requirements for low-cost renewable electricity and hydrogen (as metals processing is energy intensive), and in some cases, the ongoing technology will not be determined until the results of trials and demonstrations have been finalised. Therefore, multiple streams of investment will continue to be required to investigate each technology until there is a clear, proven pathway. For example, ARENA has backed both the electrification and hydrogen studies in the alumina calcination process with the outcomes expected in 2030. The outcomes of studies such as these, alongside industry-led pilot studies and the sustainable finance taxonomies, will assist investors in their long-term investment strategies.

We are pleased to see the dedication to developing the technology pipeline for the processing of green metals under the FMIA agenda, including through the ARENA-administered Innovation Fund (to facilitate commercial scale up) and the Green Metals Innovation Network (to plan for and train the future workforce). It is Australia's opportunity to focus this support and investment on the information gaps and prove up prospective technologies through long term, robust studies and analysis.

Supply side support for green metals end users

The Australian Government's rollout or development of the demand side support models for green metals should where possible be matched with the Hydrogen Production Tax Incentive (HPTI) to simultaneously support demand and supply for priority industries.

The focus on green metals is a comparative advantage for Australia to reconsider the flow of trade of our most valuable resources. This investment into decarbonising and maintaining existing Australian metals processing facilities can contribute to the expansion and diversification of Australian exports and increase Australia's sovereign manufacturing capability, for example in the development of the offshore wind industry. One of the key concerns surrounding this policy is timeliness - Australia's metal processing facilities are aging and need to strategically plan and reinvest in technology that will allow them to trade in an increasingly decarbonised world.

Significant consideration will also need to be given to the downstream costs on construction. Construction already has long lead times and inflated costs due to supply chain challenges, and the

Phase 3, February, see https://www.energy-transitions.org/publications/pathways-to-industrial-decarbonisation/.

green metals industry will inherently have a green premium, which will result in a flow down impact onto the consumer. The challenge requires strategic planning and could benefit from mechanisms that directly support consumer uptake.

One of the greatest opportunities to boost demand is the utilisation of government procurement levers, especially in the use of decarbonised materials in government supported or funded projects, similar to the United States' *Buy Clean Initiative:*[69]

> Through Buy Clean, the Federal Government is for the first time prioritizing the use of American-made, lower-carbon construction materials in Federal procurement and Federally-funded projects. This is advancing America's industrial capacity to supply the goods and materials of the future while growing good jobs for American workers.

A similar Australian demand side initiative could mandate, where possible, that projects supported under FMIA and other investment vehicles source green cement and metals (as well as the technologies developed and manufactured in Australia) in the construction of any buildings or projects backed by public investment. By committing to being the first customer for green metals and other decarbonised products, the Australian Government creates demand, supports the order book of nascent Australian companies, and reduces risk and uncertainty for subsequent buyers and investors.

This type of initiative would ideally be supported by a strong and rigorous Australian carbon border adjustment mechanism (CBAM) to avoid the perverse outcome of parallel imports of cheaper, more emissions intensive materials undercutting Australia's decarbonisation investment and efforts. The Australian Government should also consider an ASEAN level CBAM, both to strengthen regional investment partnerships and initiatives aimed at increasing friendshoring in critical sectors and to increase the likelihood of successful industrial decarbonisation.

We also support the Australian Government's commitment to funding the development of a certification scheme for green metals through an expansion of the Guarantee of Origin scheme. Given that the nascent green metals industry will require significant investment and attract a green premium, it is vital that there is robust certification of the emissions intensity across the product lifecycle. There is not yet a globally agreed definition of 'green' or 'clean' for metals, and there is significant work to be done in designing adequate emissions recording; however, this work will safeguard against greenwashing and facilitate investor confidence.

We recommend that the expansion of the Guarantee of Origin Scheme covers green metals to align with international best practice for the measurement and certification of scope 1, 2, and 3 emissions for the production of DRI and green steel.

[69] Office of the Federal Chief Sustainability Officer (2023) *Federal Buy Clean Initiative,* Council on Environmental Quality, USA Government, see https://www.sustainability.gov/buyclean/.

4. The Future Made in Australia Bill

FOUNDATION – WHOLE ECONOMY

Description and status

The Future Made in Australia (FMIA) package was first raised in the 2024–25 Budget, and a Future Made in Australia Bill[70] has since been introduced to Parliament.

The FMIA is essentially Australia's answer to the US Inflation Reduction Act. It sets out a process to identify sectors of national interest which might then receive government financial support through key agencies, such as ARENA.

It also sets out that an applicant for, or recipient of, FMIA support must have a Future Made in Australia Plan, which demonstrates community benefits, defined by compliance with principles set out in the Bill and in subsequent rules.

Five sectors have been stated in the Bill to already be aligned with a new National Interest Framework[71] under the Future Made in Australia policy package: renewable hydrogen, critical minerals processing, green metals, low carbon liquid fuels, and clean energy manufacturing, including battery and solar panel supply chains.[72]

The final coverage of funding/financial support bodies is not yet clear, but the FMIA provisions may ultimately reset how the Australian Government provides a range of funding to key industries, including all business-as-usual activities of ARENA and Export Finance Australia. There is also necessary overlap between topics covered through the FMIA and the sectoral plans, with the key examples being green metals and low carbon liquid fuels (each recently a topic of consultation as discussed above).

On 4 July 2024, the Senate referred the FMIA legislative draft to the Senate Economics Legislation Committee for inquiry and report by early September 2024.[73]

[70] Parliament of the Commonwealth of Australia (2024) *Future Made in Australia Bill 2024*, 'A Bill for an Act to unlock investment in a Future Made in Australia, and for related purposes', see https://parlinfo.aph.gov.au/parlInfo/download/legislation/bills/r7219_first-reps/toc_pdf/24084b01.PDF;fileType=application%2Fpdf#search=%22legislation/bills/r7219_first-reps/0000%22.

[71] Treasury (2024) *Future Made in Australia National Interest Framework: Supporting paper*, 14 May, see https://treasury.gov.au/sites/default/files/2024-05/p2024-526942-fmia-nif.pdf

[72] Australian Government (2024) *Budget 2024-25 A Future Made in Australia*, see https://budget.gov.au/content/factsheets/download/factsheet-fmia.pdf.

[73] Parliament of the Commonwealth of Australia (n.d,) 'Future Made in Australia Bill 2024 [Provisions] and the Future Made in Australia (Omnibus Amendments No. 1) Bill 2024 [Provisions]', Parliamentary business, accessed 5 September 2004, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/FutureMadeinAustralia#:~:text=On%204%20July%202024,%20the%20Senate.

AHC position

The FMIA is a vital Australian Government response to changes in global supply chains and energy security, as well as a necessary step to reinvigorate Australian capabilities and grow economic complexity.[74] The energy transition is hugely challenging, but it also presents an important opportunity for Australia to develop competitive advantage in renewable energy production, technology and use within the global marketplace, as well as ensuring ongoing prosperity in our region.

Notably, of the five industries aligned with the National Interest Framework, hydrogen plays a vital role in most, including green metals, low carbon liquid fuels, clean energy manufacturing (such as electrolysers), and renewable hydrogen itself. There has already been progress in the demand side mechanisms of green metals and low carbon liquid fuels, and, coupled with the FMIA Innovation Fund and Hydrogen Headstart, the overall policy framework should help derisk investment into the hydrogen value chain.

A front door for investors

The FMIA Bill seeks to create a front door for investors, to "provide a single point of contact for investors and companies with major, transformational investment proposals, delivering a coordinated approach to investment attraction and facilitation for these projects".

We welcome the announcement of this intent, and note it is aligned with our own advocacy. For some time now, the AHC has observed that the complexity and uncertainty of the investment environment and the overall ecosystem (multiple states, regulatory differences, permitting within states) is making hydrogen project proponents' decisions unnecessarily difficult. There is a need for investors and other decision makers to recognise meaningful investments in new infrastructure and technology, and the current environment is not conducive to this. Government thus has a role to direct investors' attention to the opportunities; to help create value propositions that investors recognise.

Community benefits

The FMIA Bill seeks to hold recipients of significant funding accountable to the community by aligning corporate activity with government expectations on community benefits. The community benefit principles set out in the FMIA Bill are:

> *(a) that Future Made in Australia support should provide community benefits, in particular by:*
>
> *(i) promoting safe and secure jobs that are well paid and have good conditions; and*
>
> *(ii) developing more skilled and inclusive workforces, including by investing in training and skills development and broadening opportunities for workforce participation; and*
>
> *(iii) engaging collaboratively with and achieving positive outcomes for local communities, such as First Nations communities and communities directly affected by the transition to net zero; and*
>
> *(iv) strengthening domestic industrial capabilities, including through stronger local supply chains; and*

[74] AHC (2024) *The Future Made in Australia Bill*, 26 July, https://h2council.com.au/wp-content/uploads/2024/07/240726-AHC-FMIA-submission.pdf.

(v) demonstrating transparency and compliance in relation to the management of tax affairs, including benefits received under Future Made in Australia supports; and

(b) any other principles specified in the rules for the purposes of this paragraph.

We are supportive of the principles and their role to guide decision makers on how FMIA outcomes would benefit the community.

We note that delivery on the intent is likely to differ across Australia given the diversity of communities that will benefit, differences in opinion about how communities would like to benefit, and the maturity of different sectors covered by the FMIA. There will be a balance required so that processes for demonstrating benefit do not stifle the innovation the funding was intended to support.

Project proponents are often already reporting to government on how they meet objectives outlined in the community benefit principles, and these existing approaches can readily be reviewed and used. We urge an assessment and consolidation of existing obligations to ensure they align with the FMIA, rather than the imposition of a requirement for a new set of plans to be developed which may just add administrative burden without necessarily providing additional benefits. Key examples include the Australian Industry Participation (AIP) Plans required when participants receive Australian Government funding,[75] alongside Environmental Management Plans, Stakeholder Management Plans and Cultural Heritage Management Plans.

[75] See Department of Industry, Science and Resource (n.d.) *Australian Government funded projects*, Australian Government, https://www.industry.gov.au/major-projects-and-procurement/australian-industry-participation/australian-government-funded-projects.

5. The Hydrogen Production Tax Incentive

NEW GOVERNMENT FUNDING SUPPORT – HYDROGEN

Description and status

The Hydrogen Production Tax Incentive (HPTI) is a tax credit aimed at addressing the cost of hydrogen production to support the Australian industry getting to scale.

The HPTI has been proposed as AU$2 per kg of hydrogen, for facilities larger than 10MW per facility, and for production at under or equal to a 0.6kg CO2e/kgH2 threshold.

The HPTI is available for hydrogen produced from eligible facilities for up to 10 years between 1 July 2027 and 30 June 2040.

While the HPTI is committed in the 2024-25 federal budget as AU$6.7 billion over 10 years, in practice this is an uncapped incentive.

The HPTI connects with (and likely sits under) the FMIA, and any money provided will probably be subject to the community benefits principles being met, through the recipient submitting a compliant Future Made in Australia Plan.

AHC position

Within the overall FMIA approach, the HPTI is a most welcome hydrogen initiative that signals to Australian investors and the rest of the world that Australia is back in the game for attracting project investment, and the technology, capability and workforce opportunities that come with it.[76]
The announcement and funding of the HPTI signals the confidence of the Australian Government in the hydrogen and derivatives industries and provides a recognition that clean molecules and fuels will be needed if Australia is to achieve whole-of-economy decarbonisation.

We are pleased to note that the Australian Government is considering support models for particular end uses, such as for green metals and low carbon liquid fuels. We support these demand side initiatives and see them as being matched with the HPTI to simultaneously support demand and supply for priority industries. It is vital that the different initiatives are able to work together for those projects that are eligible.

There is a diversity of views within the AHC membership on some of the details of the HPTI as currently set out in the consultation paper, but overall we think that the design strikes the right balance to drive sustainable industry growth.

We note that at $2/kg the HPTI is less than other schemes; particularly the IRA, against which it will be most compared. Ideally the HPTI would be twice as much at least to close the commercial gap. However, we note that this was an unlikely outcome for this policy at this time. We also note that the

[76] AHC (2024) *The Hydrogen Production Tax Incentive*, 12 July, https://h2council.com.au/wp-content/uploads/2024/07/240712-AHC-HPTI-submission_final.pdf.

Australian Government has recognised that more is required, and that Hydrogen Headstart is intended to support a small number of first movers in the years prior to the HPTI taking effect. The announcement of the second round of Hydrogen Headstart in the May budget is very welcome.

We also note that the IRA is becoming encumbered with additional criteria for eligibility that are commonly considered to stifle the growth of the hydrogen industry. With the HPTI the Australian Government can reclaim some of the attention and investment dollars that shifted from here to the US.

The HPTI is an uncapped incentive, meaning that any and all projects that meet the eligibility criteria will receive the $2/kg of hydrogen over the specified timeframes, and any one project can receive as much or as little as the hydrogen it produces. This design feature has been welcomed by both industry and the AHC.

Regarding the eligibility criteria, we understand the Australian Government's desire to focus on large scale projects, and to tighten project delivery as much as possible. We suggest that lessons already learned in hydrogen have shown that greater flexibility is required at this stage, such as for:

- **Timing**: We note that the proposed subsidy is proposed for only ten years, rather than for fifteen, which would be in line with the support provided by other nations as well as the expectations of industry and lenders.

  The AHC strongly urges an extension of the end date for the HPTI to 30 June 2045, in order to enable the long lead times required by projects and in recognition of the difficulties in securing workforce for project delivery.

- **Size**: We believe that the HPTI should in principle be available to all projects – that is, not limited to use or size. There will be a need to demonstrate capacity and seriousness of intent of course, so as to maintain legitimacy of the initiative and not reflect an unnecessary administrative burden for the government. This may mean a minimum size is required; we have suggested 1 MW rather than the 10MW proposed.

  A 1 MW size limit may, in fact, be necessary to incentivise investment in domestic decarbonisation opportunities. If these smaller projects are excluded, it is likely they will be considered less attractive as investment propositions and will find it increasingly difficult to attract private capital, with the flow on impact on regional and domestic decarbonisation efforts.

- **Commercial structures**: The eligibility criteria related to eligible entities requires clarification. The commercial structures for project delivery are quite varied, with a range of domestic and international investors often included in joint venture or SPV arrangements. In some instances, government-owned or backed entities are also equity holders (domestic Australian government as well as international). We would suggest that this definition be entity-agnostic, thereby extending eligibility to companies, trusts, and partnerships. Such an inclusive approach will significantly enhance the effectiveness of the incentive by ensuring that the type of holding vehicle does not impede the achievement of the HPTI's objectives.

The complexity of structuring should be reflected in the eligibility criteria, with members also seeking clarification around the transferability of the tax incentive benefits within and between the commercial partners. This is important to clarify as it will have implications for investors into Australian backed projects.

- **Carbon emissions maximum**: The AU$2/kg of hydrogen under the HPTI equates (approximately) to the US$1/kg subsidy proposed under the IRA for emissions between 0.45 and 1.45kg of CO2e. Given currency exchange, the Australian figure is slightly more generous than the US for projects above 0.45kg CO2e (to the 0.6kg CO2e threshold). The Australian figure is then less competitive for very low emissions hydrogen and obviously there is no support at all where emissions are higher than 0.6kg CO2e.

  We recognise that this is a renewable hydrogen initiative and a higher emissions intensity to account for non-renewable hydrogen is not contemplated in the policy. We note that this may limit Australia's competitive value in importing markets which are currently open to higher emissions hydrogen.

  Even for hydrogen projects using electrolysis, there may be benefit in starting with a slightly higher carbon emissions level so that grid-connected projects can get up in the medium term and progress the industry to scale.

Finally, the proposed incentive may not be indexed for inflation, and we strongly recommend that the Australian Government reconsiders this decision. It is the industry standard for electricity power purchase agreements (PPAs) to be indexed to inflation or CPI; not indexing the HPTI would be inconsistent with industry standards and expectations. A lack of inflation adjustment for the HPTI means the real value of the tax offset will have declined more than 10 per cent by the time the HPTI comes into effect, and by around a third by the time it expires (based on Commonwealth Budget 2024-25 CPI inflation forecasts).

6. Hydrogen Headstart

NEW GOVERNMENT FUNDING SUPPORT – HYDROGEN

Description and status

Hydrogen Headstart is a grant programme, first announced in the May 2023 federal Budget. The initial value was AU$2 billion, to be shared between two or three Australian projects.

A process was undertaken by the Australian Government to consult on design principles. First round submissions were received, with a shortlist of six projects publicly announced in December last year. Shortlisted parties submitted their more detailed submissions in July 2024, and final announcements for the AU$2 billion are likely for later this year.

In the May 2024 federal Budget a second round of Hydrogen Headstart was announced, with a further AU$2 billion announced. The process of delivering this second round is not yet public.

AHC position

The Hydrogen Headstart is a welcome initiative for the hydrogen industry, and we have been pleased to see the Australian Government fast track the process to date.

Hydrogen Headstart is intended for the first-of-a-kind projects to reduce the commercial gap ahead of the HPTI coming into effect. We remain hopeful that the funding will *sufficiently* close what we know is a widening commercial gap, as a result of inflationary pressures and higher than expected electricity prices. Many of our members have advised us that Hydrogen Headstart still needs to be stacked with other price and non-price benefits to make a difference, including support mechanisms from overseas.

There are now questions as to whether money received through Hydrogen Headstart can be stacked with the HPTI – on the one hand, receiving Headstart funding should not mean access to the HPTI is impeded, but on the other hand we can understand a desire for the government to not allow what may essentially be double-dipping from public funds.

We know the government is aware of these matters, and we await further announcements.

7. The Carbon Leakage Review

NEW RULES – CARBON PRICING

Description and status

In March 2023 the Australian Government announced a review of carbon leakage[77] as part of its reform of the Safeguard Mechanism.

Lead by Professor Jotzo from the Australian National University, the overarching intention of the review is to assess the impact of carbon mitigation policies on the viability of existing industries, as well as on investment attraction.

The Review has been asked to focus on an assessment of carbon leakage risks, the development of policy options to address carbon leakage, and an assessment of the feasibility of an Australian Carbon Border Adjustment Mechanism (CBAM), particularly in relation to steel and cement.[78]

We understand that Professor Jotzo has submitted the final review report to government.

AHC position

We support the Carbon Leakage Review. In an increasingly carbon constrained world, many nations are exploring carbon border leakage mechanisms, so as to prevent unfair dumping of products produced in countries without significant decarbonisation policies and intentions. The most prominent mechanism is the CBAM in the European Union.[79]

An Australian CBAM would increase the volumes of green energy/products domestically produced, as it would aim to avoid parallel imports of grey products, such as cement and steel (but ideally also hydrogen, ammonia and urea), which otherwise would undermine Australia's decarbonisation efforts and investment.

We have argued that it makes sense that we need to protect emerging, domestic production, and so hydrogen, ammonia and urea should be included on the carbon leakage list.[80] Hydrogen is feedstock for ammonia, which is feedstock for urea.

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[77] Carbon leakage occurs where companies move their facilities to jurisdictions with weaker emission constraints. This is bad for the original host industry because it loses a source of GDP and it is bad for the planet because it results in higher global emissions.

[78] DCCEEW (2023) *Public consultation on the proposed approach to assess and address carbon leakage risk, as part of the Carbon Leakage Review*, see https://consult.dcceew.gov.au/consultation-proposed-approach-carbon-leakagerisk-as-part-of-the-carbon-leakage-review.

[79] European Commission (2024) *Carbon Border Adjustment Mechanism*, see https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en.

[80] AHC (2023) *Re: Public consultation on the proposed approach to assess and address carbon leakage risk, as part of the Carbon Leakage Review*, 15 December, see https://h2council.com.au/wp-content/uploads/2023/12/231215- Carbon-Leakage-Review-AHC-SUB_for-submission.pdf.

Including hydrogen, ammonia and urea (or the best one or combination) on the Australian carbon leakage list would:

- **Align with other jurisdictions:** Global policy and legislative trends indicate that the remit of carbon border adjustment schemes will increase to cover a range of products beyond fossil fuels or their replacements such as hydrogen, ammonia and methanol.
- **Align with the Safeguard Mechanism:** The Safeguard Mechanism (a major consideration of the Carbon Leakage Review) now has a hydrogen production variable. Additionally, ammonia production is already covered under the Safeguard Mechanism, with the ammonia industry one of Australia's most emissions intensive.
- **Make room for future new industries by defraying the green premium:** Australia will need to develop a hydrogen supply chain to realise our energy transition. This includes decarbonising our existing industries, such as ammonia. Across seven sites, Australia currently supplies over 2Mtpa of ammonia and imports the remaining demand. As we look to transition and expand our green ammonia production, this will naturally be delivered at a green premium, leaving Australia's ammonia producers at risk to traditional fossil fuel ammonia being imported at a lower cost. A CBAM can help defray the green premium. We also note that Australia currently imports over 80% of its urea, mostly from the Middle East. A CBAM on urea (or hydrogen or ammonia, its precursors) will provide a means to reduce Australia's reliance on imports by incentivising domestic supply.

In the context of hydrogen, the considerations of the Guarantee of Origin scheme should be incorporated into the operations of the CBAM.

In our view it is vital that policy seeks to not only find the balance between the direct costs to reach industrial decarbonisation objectives and the costs of keeping strategically viable industries in Australia, but also includes the major indirect costs. This then requires an assessment of the industries in question to not only consider economic criteria, but also address:

- each industry's role in the economy, including contribution to GDP, regional prosperity and quality jobs;
- relative timeframes for likely pathways to decarbonisation both in Australia and potentially competing countries, and effects on the above; and
- the relative mobility of each industry (that is, the necessary investment and threshold for moving investment away from Australia).

Assessment and analysis of the impacts of high energy prices in the EU (for example, the impact on the petrochemical industries), alongside the carbon pricing and CBAM measures, would be illustrative as a counterfactual for proposed Australian reforms. These experiences may illustrate the types of policies that would need to be in place in Australia to prevent capital flight as well as (hopefully) incentivise investment.

8. AEMO's Integrated System Plan

FOUNDATION - ENERGY

Description and status

The Australian Energy Market Operator's (AEMO) Integrated System Plan (ISP) is a scenarios-based roadmap for the National Electricity Market to transition to net zero by 2050. It sets out the required generation, storage and network investments. In the absence of an alternative, the ISP is used by many in the energy industry as the primary modelling for the future energy system.

AEMO also develops an Inputs, Assumptions and Scenarios Report (IASR) relates to the inputs, assumptions and scenarios it proposes to use in its next year's forecasting and planning activities, including the ISP.

The 2024 ISP and associated material was released in June 2024.[81] AEMO is currently developing the 2026 ISP. Work is now underway to develop the Draft 2025 IASR, which is set for release in December 2024.

AHC position

AEMO's modelling is key to how Australian stakeholders, especially governments, view and make decisions regarding the future energy portfolio, including the infrastructure, planning and policy required. AEMO recognises the necessary role of hydrogen in Australia for tackling the hard to electrify sectors and achieving net zero, and we are pleased to see that this is touched on in each of the current IASR scenarios set out by AEMO.

However, AEMO has recently proposed that the 2025 IASR scenarios will be largely similar to the previous 2023 versions.[82] We do not agree with this approach. There has been significant policy progressed since 2023 which impacts hydrogen, and this ambition and strategic direction should be reflected in the development of AEMO scenarios and forecasting. Even in its 'niche' uses (such as green iron and ammonia/methanol production), hydrogen will require a significant and long-term boost to Australia's electricity system – both on and off grid – as well as in other infrastructure such as pipelines.

In our view, the material that should be accounted for includes:

- all modelling and work undertaken for the revised National Hydrogen Strategy;
- the modelling undertaken by the Climate Change Authority for the Net Zero Plan (the Sector Pathways Review);

[81] See AEMO (n.d) *2024 Integrated System Plan*, accessed 4 September 2024, see https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp.
[82] AEMO (2024) *2025 IASR Scenarios*, Consultation Paper, 17 July, see https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2024/2025-iasr-scenarios/consultation-paper.pdf?la=en.

- other government work on the sectoral decarbonisation plans;
- the findings relating to business cases from Hydrogen Headstart; and
- Treasury modelling and consultation on the HPTI.

Further, we would expect the policy intent of the above and the broader FMIA to also inform AEMO's understanding of scenarios, given that industrial policy and funding initiatives will likely affect energy use by type and location. While much of the analysis and data will not be public, it should be shareable within the Australian Government to support planning.

The above data would support the current ISP, but we note that the natural parameters of the ISP means that some important analysis is still currently out of scope. For Australia to appropriately sequence the complex energy transition, we need advanced planning and regular reassessment across the wider net zero undertaking. Modelling could identify efficiencies and opportunities such as for developing common user infrastructure. It could also clarify understanding and assist policy development on the role for hydrogen in supporting the electricity grid, whether as a means of storage to be then fed back into the grid when needed, or where electrolysers act as a flexible load.

We need additional, interconnected data that interrogates the intricacies of the complete system. This level of planning is a significant task but would provide the required confidence to invest, navigate risk and identify opportunities.

We encourage the Australian Government to consider the scale of modelling and forecasting required to decarbonise effectively and sequence efficiently, and fund publicly available and granular modelling across the entire net zero system.

9. The Capacity Investment Scheme

NEW GOVERNMENT FUNDING SUPPORT - ENERGY

Description and status

In late 2023, the Australian Government announced the expansion of the Capacity Investment Scheme (CIS, previously a pilot only) to target a total of 32 GW of new capacity nationally, made up of 23 GW of renewable capacity and 9 GW of clean dispatchable capacity (primarily for batteries but potentially including hydrogen for long duration storage).

The Australian Government will provide revenue underwriting for successful CIS tender projects, with an agreed revenue 'floor' and 'ceiling'. This in intended to decrease financial risks for investors.

The Australian Government is negotiating Renewable Energy Transformation Agreements with states and territories, which includes delivering around half of the capacity (18 of 32 GW) of the expanded CIS.

The expanded CIS will be rolled out from 2024 to 2027. There will be regular competitive tenders held approximately every 6 months, with the first tender having launched in May this year. Auction results for this tender were announced on 4 September, supporting six large scale battery projects.[83]

There are two more CIS tenders currently in progress, with the next tender expected to open late this year.

The expected costs of CIS contracts are confidential.

AHC position

The AHC has not formally provided a public position on the CIS. However, we support all efforts from the government to encourage investment in renewable energy and storage developments. This is for the sake of the energy transition as a whole, as well as greater availability of renewable electricity for hydrogen developments.

We note with interest the recent findings of the Climate Change Authority[84] that the design of the CIS is unlikely to attract tenders from necessary long duration storage options such as pumped hydro storage, which has lead times of over eight years and relatively high upfront costs. It is also considered unlikely to support more nascent technology or provide the longer-term signals needed for investment in the electricity sector beyond 2030.

[83] DCCEEW (2024) 'Capacity Investment Scheme supports 6 new projects in Vic and SA', website, accessed 4 September 2024, see https://www.dcceew.gov.au/about/news/capacity-investment-scheme-supports-6-new-projects-vic-sa.

[84] Climate Change Authority (2024) *Sector Pathways Review*, 5 September, page 32, see https://www.climatechangeauthority.gov.au/sites/default/files/documents/2024-09/2024SectorPathwaysReview.pdf.

10. The Sustainable Finance Roadmap, taxonomy and green bonds

NEW STRATEGY, NEW GOVERNMENT FUNDING SUPPORT – SUSTAINABLE FINANCE

Description and status

Following consultation in 2023, the Australian Government released a Sustainable Finance Roadmap[85] in June 2024.

The Roadmap sets out a range of actions to reduce barriers to investment into sustainable activities, explicitly addressing improved transparency on climate and sustainability, financial system capabilities, and Australian Government leadership and engagement.

Important elements include:

- Mandatory climate-related financial disclosure requirements for large businesses and financial institutions, to take effect from 1 January 2025. The bill on this matter passed the Senate in late August 2024.
- The government's partnership with the Australian Sustainable Finance Institute (ASFI) to develop an Australian sustainable finance taxonomy. ASFI will finalise development of the initial Australian Sustainable Finance Taxonomy by the end of 2024. This will cover 'green' and 'transition' activities that contribute to climate change mitigation, in six priority sectors, as well as 'do no significant harm' and 'minimum social safeguard' criteria.
- The release of green bonds with the first green bond was issued on 4 June 2024. The bond line is AU$7 billion in size and will mature in June 2034. The Government will provide green bond investors with regular and transparent allocation and impact reporting. Annual reporting will commence in 2025 will be published on the AOFM website.

AHC position

There is an apparent consensus on the need for increased policy and regulatory action to increase the rate of capital reallocation away from fossil fuels and activities incompatible with net zero. However, despite this consensus, the rate of capital flows to new energy projects (relative to capital flows in traditional extractive industries or technology investments) remains too low and too slow.

Feedback from AHC members indicates that it is not a shortage of capital that has prevented projects from progressing to FID and construction. Rather, lenders have proven to be risk averse, unwilling to finance projects developing clean molecule supply chains.

The AHC welcomes the roadmap and the range of actions it puts into place.[86]

[85] The Australian Government the Treasury (2024) Sustainable Finance Roadmap, June, see https://treasury.gov.au/sites/default/files/2024-06/p2024-536290.pdf

[86] AHC (2023) *Re: Sustainable Finance Strategy*, 1 December, see https://h2council.com.au/wp-content/uploads/2023/12/231201-Sustainable-Finance-Strategy_AHC-submission.pdf.

We also seek for the various initiatives within the roadmap to explicitly account for clean and green hydrogen. Australia has existing and emerging capabilities in producing, moving, storing, and using hydrogen and its derivatives. For these capacities to increase, the requirements for the supply chains need to be explicitly considered and modelled, rather than emerge as implied within the taxonomies.[87]

We also note that the initial taxonomy will be available for use on a voluntary basis by both the private and public sectors. In our view, the sustainable finance taxonomy is a significant policy to assist investor due diligence, and we prefer this is mandated rather than voluntary.

[87] AHC (2024) *Australian Sustainable Finance Taxonomy V0.1 consultation*, 7 July, see https://h2council.com.au/wp-content/uploads/2024/07/240707-AHC-submission-to-ASFI.pdf.

11. The National Energy Workforce Strategy

NEW STRATEGY - ENERGY

Description and status

The National Energy Workforce Strategy[88] will seek to ensure Australia has the workforce it needs to meet its net zero ambitions.

The stated aims of the strategy are to:

- Build on existing workforce resources to identify current and future skills gaps in the energy sector and help plan for energy workforce needs.
- Provide a national framework for coordinating existing and planned workforce-initiatives from the Australian, state and territory governments.
- Foster an environment that enables the clean energy workforce to grow, adapt and build the skills and capability we need to reach net zero emissions by 2050.
- Build on the work of Jobs and Skills Australia through the Clean Energy Capacity Study while not undertaking additional workforce projections.

A consultation paper was released in August 2024, where this describes the need to address shortages in the clean energy workforce.

AHC position

Clean energy projects are experiencing current skill shortages in critical occupations. For example, the 2023 Skills Priority List (SPL) found that 73% of Electrotechnology and Telecommunications Trades and 100% of Construction and Trades Worker occupations are in shortage nationally.[89]

Skill shortages will be exacerbated in the coming years as renewable energy projects of growing scale are deployed at a more rapid rate. Jobs and Skills Australia (JSA) found that Australia needs an additional 32,000 electricians and 450,000 construction jobs to 2030 to meet legislated 2030 decarbonisation targets.[90] It concluded that current policy settings will not deliver the workforce needed to meet existing targets. It also found that while clean energy will provide a pathway for some transitioning workers, this workforce is too small to supply the rapidly growing needs of industry.

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[88] DCCEEW (2024) *National Energy Workforce Strategy*, accessed 4 September 2024, last updated 1 August 2024, see https://www.dcceew.gov.au/energy/workforce#:~:text=The%20Australian%20Government%20is%20developing%20a.

[89] Jobs and Skills Australia (2023) *2023 Skills Priority List: Key Findings Report,* Canberra, Australia, see https://www.jobsandskills.gov.au/sites/default/files/2023-10/2023%20SPL%20Key%20Findings%20Report.pdf.

[90] Jobs and Skills Australia (2023) *The Clean Energy Generation*, Canberra, Australia, see https://www.jobsandskills.gov.au/sites/default/files/2023-10/The%20Clean%20Energy%20Generation_0.pdf.

The need for a workforce skilled in handling hydrogen will add to these current requirements. While there is an existing workforce in hydrogen, the roles are largely in-house for major chemical producers and refiners, and the workforce is relatively small scale.

As shown in , the future clean and green hydrogen industry will be much more complex, with a diverse range of newer roles in addition to a need for more traditional electrical trades, construction workers and process engineers. These newer roles to make hydrogen include handling feedstocks of various types, electrolyser manufacturing and maintenance, and handling liquid hydrogen. Further jobs are then created to use hydrogen and hydrogen products in a range of ways, such as in maintaining vehicles, exporting ammonia, producing green metals, and producing low carbon liquid fuels such as sustainable aviation fuel.

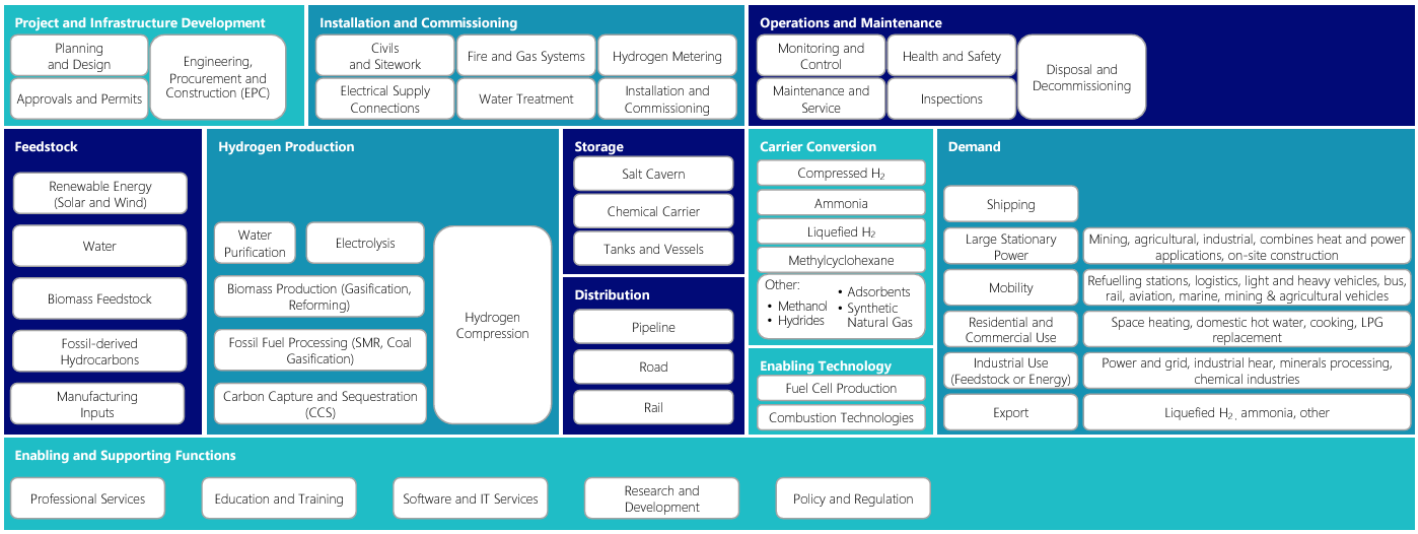

Figure 2: Hydrogen supply chain framework. Source: ARUP 2023.[91]

The diverse array of what is considered a hydrogen job in the emerging industry has, unfortunately, led to the workforce being insufficiently understood and modelled, and has left data gaps. There is still very little clarity and publicly available modelling on the scale, composition, location and pace of the emerging clean and green hydrogen workforce, let alone how this will be affected by the new ambition and investment of the FMIA.

There needs to be better assessment of the current and forecast hydrogen workforce. This modelling needs to comprehensively cover the full hydrogen value chain within Australia, either in a single or series of work packages. This would need consistent methodologies and inputs, as well as a degree of flexibility for key policy changes. The Australian Government is the natural owner of this undertaking; it already holds the strategic direction and action plan for Australia's policy framework, as well as the most extensive knowledge bank of Australian hydrogen projects through the Hydrogen Hubs, Hydrogen Headstart, and ARENA and CEFC processes.

[91] Arup (2023) *Powering Up: Seizing Australia's Hydrogen Opportunity by 2040*, National Energy Resources Australia, see https://h2council.com.au/wp-content/uploads/2023/04/230331-NERA-Powering-Up-HETS-Study.pdf.

The HPTI is proposed to start providing $2/kg for hydrogen produced from 1 July 2027, which means that projects will be racing and competing to ensure that they are producing from the start date, maximising their incentive. It is therefore vital that we collectively understand, model, communicate and begin addressing any issues in preparation for this date.

12. The National Electric Vehicle Strategy

NEW STRATEGY - TRANSPORT

Description and status

Released by the Australian Government in 2023, the National Electric Vehicle Strategy[92] sets out to get more EVs on the road and support EV charging infrastructure. FCEVs was covered in the basic definition of EVs.

A light vehicle Fuel Efficiency Standard was announced in the strategy, and this measure came into effect on 1 July 24.

Primarily battery-focussed, the strategy only addresses hydrogen in a brief discussion about the establishment of hydrogen highways; that is, refuelling networks for key freight routes. Other than this there is no substantive discussion about hydrogen.

A comprehensive and in-depth review of the strategy will be undertaken in 2026.

AHC position

We raise only for completeness: the AHC does not have a position on the National EV Strategy other than to note it is disappointingly silent on what is needed for hydrogen in transport, and also does not meaningfully address heavy vehicles. As discussed above in section 3 of this essay, we have advocated for some time for heavy vehicle policy, and for hydrogen infrastructure and demand support within this. The transport sectoral plan will hopefully add some substance to the policy environment.

[92] DCCEEW (2023) *National Electric Vehicle Strategy*, see https://www.dcceew.gov.au/sites/default/files/documents/national-electric-vehicle-strategy.pdf.