Australian Government

COAG Energy Council

NATIONAL HYDROGEN STRATEGY

Issues paper series

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This issues paper explores the challenges and issues related to producing hydrogen at scale. It explores how hydrogen is produced, and why we need to produce at scale in order to make the hydrogen vision a reality.

The COAG Energy Council Hydrogen Working Group seeks feedback on the potential role of national policies and actions in realising these opportunities.

A list of questions is presented at the end seeking further input from interested stakeholders.

Hydrogen at scale

This paper has been informed by submissions to the *Request for Information* released in March this year, as well as:

- targeted visits to countries that have already started to develop hydrogen technologies and markets
- the stakeholder roundtables that were held throughout May and June

The COAG Energy Council Hydrogen Working Group would like to thank industry and community members for their engagement in the strategy development process.

In this paper, unless otherwise indicated, 'hydrogen' refers to 'clean hydrogen,' defined as being produced using renewable energy or using fossil fuels with carbon capture and storage (CCS). This definition reflects the principle of technology neutrality set by COAG Energy and Resources Ministers when they commissioned a comprehensive and ambitious strategy for the development of an Australian hydrogen industry.

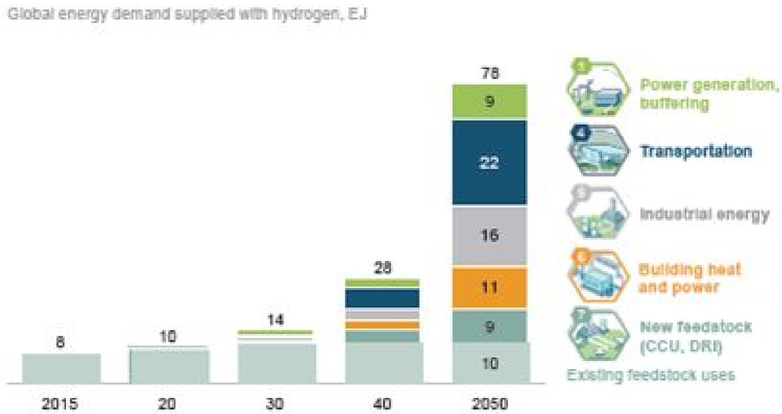
Background

Hydrogen is emerging as a major economic opportunity for Australia to lead in the global transition to low-emissions sources of energy. Falling renewable energy and hydrogen production and utilisation costs, coupled with continued development of CCS technologies are improving the commercial prospects for clean production of hydrogen, enabling new uses of hydrogen as a clean heating source and fuel and lowering of the carbon intensity of existing uses of hydrogen as feedstock in industrial processes.

The Hydrogen Council (a global consortium of hydrogen focused energy, transport and industrial companies) estimates there is potential for up to a 10-fold increase in hydrogen demand by 2050, as the falling cost of its production makes applications in transport, power and heating economic.

As shown in Figure 1, if realised, hydrogen could provide around 18% of the world's final energy demand – an increase from current global demand (for industrial feedstocks) of around 9 exajoules to 78 exajoules in 2050.[1] A more conservative assessment of economic potential from the International Renewable Energy Agency suggests that global demand for hydrogen for energy (separate to feedstocks) in 2050 would be lower than this, at about 8 exajoules globally, creating a total market of over 18 exajoules of hydrogen demand by 2050.[2] Nonetheless, even at this lower rate, this still represents a significant market – at least three times Australia's energy consumption in 2016-17.[3]

Figure 1: Future global hydrogen demand growth potential[4]



The International Energy Agency's World Energy Outlook projects Australia could easily produce 100 million tonnes of oil equivalent of hydrogen per year (which converts to 4.18 exajoules per year, or around two-thirds of Australia's current energy consumption). The Working Group has commissioned Geoscience Australia to develop a map and a short report locating and highlighting the size and potential resource availability of Australia's prospective hydrogen production regions, to better inform the Strategy about this potential. High-level economic modelling by ACIL Allen estimates that hydrogen exports could provide around $4 billion direct and indirect economic benefits to Australia by 2040 under medium demand growth settings.[5]

Hydrogen also has the potential to provide important domestic benefits such as contributing to decarbonising our energy systems and improving reliability and security. Australia's hydrogen opportunity will only become reality if we produce at scale – globally, countries will only transition their economies to hydrogen if the volumes of hydrogen needed to do so are achievable, available and, in the long term, at price parity with other forms of fuel. As discussed later in this paper, we need the cost efficiencies from production at scale to make hydrogen cost-effective.

Getting to scale will be a major endeavour. However, Australia has risen to similar challenges before. For example, after the first exports of Liquefied Natural Gas (LNG) in 1989, thirty years on Australia recently overtook Qatar as the world's largest LNG exporter.[6] This is buoyed by increasing export values, which grew from $31 billion in 2017-18 to $50 billion in 2018.[7]

Challenges, Barriers and Risks

Technology commercialisation

The established technology options for producing hydrogen are electrolysis of water using electricity, steam reformation of natural gas, or gasification of coal. Steam reformation of natural gas is currently the primary source of hydrogen production globally, accounting for around three-quarters of annual hydrogen production, which totals around 70 million tonnes annually.[8] The other quarter is largely supplied through coal gasification, which provides around 23% of this total, with oil and electricity-based production making up the remaining 2%. [9]

Current fossil-fuel-based hydrogen production is not clean, with emissions from the sector totalling about 830MtCO_2 per year. To transition to clean production, these emissions could be captured and stored. The International Energy Agency expects CCS could lead to reductions of up to 90% of carbon emissions from steam reformation, if applied to both process and energy emissions streams.[10]

There are other hydrogen production processes, involving catalytic cracking or thermal splitting of methane, biomass gasification and pyrolysis, thermochemical water splitting, photocatalysis, supercritical water gasification of biomass, and combined dark fermentation and anaerobic digestion.[11] As yet, however, these technologies are not commercial.

Once produced, hydrogen gas is typically compressed, liquefied (through cooling) or chemically converted into different substances (typically ammonia or methylcyclohexane) to facilitate shipping and handling.[12] On land, hydrogen gas can be transported via truck, rail and pipeline. As yet, there are currently no ships commercially available for the transport of liquefied hydrogen but at least one company has commenced construction of a liquefied hydrogen transport ship to be trialled between Japan and Australia.[13]

While there are relatively mature production, transport and storage technologies for hydrogen, these technologies are yet to be tested to work at scale, over long distances and as part of a viable global supply chain. Further technology commercialisation also needs to occur to bring production, transport and storage costs down.

As discussed in in detail in the *Attracting hydrogen investment* paper, to overcome commercialisation barriers, Australian governments could support technology research, demonstration and development to remove or lower barriers to market entry and reduce investment risk. Australian governments could also support collaborations that help us to effectively build on international efforts in this regard.

The *Attracting hydrogen investment* paper identifies a variety of national funding mechanisms that could be used to provide this support including the Australian Renewable Energy Agency (ARENA), the Clean Energy Finance Corporation (CEFC), the North Australia Infrastructure Fund (NAIF), Infrastructure Australia, and the Export Finance and Insurance Corporation (EFIC). There are also numerous jurisdictional funding initiatives.

Many stakeholders supported this idea. For example, in their submissions, the Australian Energy Council and Siemens called for governments to fund initial research and development to remove or lower barriers to market entry. Siemens noted:

> *'that government financial support … is a valuable investment to position Australia with the necessary skills, capabilities and capacity to address the demands of an export market while already delivering the domestic benefits espoused. In doing so, costs and risks for subsequent projects will be reduced and over time no further industry subsidies would be required for commercial hydrogen applications.'*

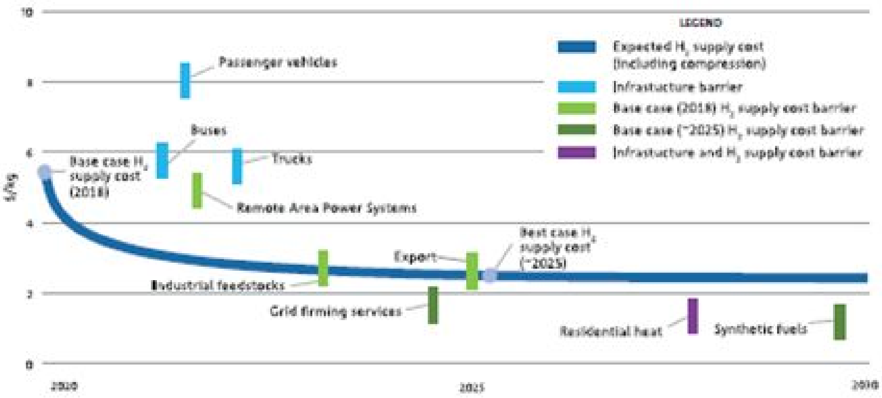
Stakeholders however advise caution in how and what type of support is provided. The Australian Energy Council noted that extended support from government may be interpreted as market intervention. Similarly, the WA Chamber of Commerce and Industry cautions against governments '*picking winners*' in terms of specific technologies and production methods.

Aside from providing funding, governments can also support commercialisation through the development and sharing of relevant information. For example, one way to improve the rate of scale-up would be to improve the sharing of knowledge and lessons learned from research and demonstration projects, such as is currently done with ARENA and CSIRO-supported projects. Industries can often be slow to move across the 'valley of death' because gaining learnings from pilot projects takes time and the information from pilots is often not widely shared.

Supply Chain Cost Reductions

Ultimately hydrogen must be cost-competitive with other fuels in specific application areas if it is to achieve widespread adoption. For example, Figure 2 shows hydrogen at $8/kg would be competitive against petrol on a kilometres-driven basis, whereas it would have to be nearer to $2/kg to compete with the landed costs of natural gas in importing countries.

Figure 2: Hydrogen competitiveness in targeted applications[14]



Currently, fossil-fuel-based processes produce hydrogen at a lower cost than renewable electricity electrolysis technologies. In 2018, hydrogen from natural gas without CCS cost in the range of $US1-1.80/kg hydrogen, depending on local gas prices.[15] These costs are expected to remain fairly constant, with costs forecast to remain within a $US1-2/kg hydrogen range in 2030.[16] The production cost of hydrogen from natural gas is influenced by various technical and economic factors, with the most important factors being gas prices and capital expenditure (CAPEX).[17] Costs for coal gasification are similar to those for natural gas steam reformation, where project viability is mostly dependent on the cost of CAPEX and coal availability and cost.[18] For Australia, if brown coal is the gasification fuel, the coal input cost would be significantly reduced due to its easy accessibility, abundance and very low price.

Fossil-fuel-based production processes will need to be coupled with CCS to produce clean hydrogen. Australia has the advantage of proven offshore sites suitable for the sequestration that a large-scale CCS hydrogen industry will require.[19] There is currently only one hydrogen project using CCS technology at commercial scale globally, which captures 40 per cent of the carbon dioxide produced by the facility. The International Energy Agency estimates the cost of achieving a 90% or more reduction in carbon dioxide using CCS to be around $80 US per tonne of carbon dioxide in hydrogen production facilities, and up to $90-115 per tonne of carbon dioxide in integrated ammonia/urea and methanol production facilities (as these facilities have more diluted carbon dioxide streams, increasing carbon capture costs).[20] Considering that production of 1 tonne of hydrogen creates around 10 tonnes of carbon dioxide using natural gas and around 19 tonnes of carbon dioxide using coal, this equates to cost of around $0.8-$1.15 US per kg for hydrogen using natural gas and $1.5-$2.1 US per kg of hydrogen from coal gasification.[21] These costs may fall over time as more CCS projects are implemented.

The cost of hydrogen produced from renewable-based electrolysis is currently expensive. However, there is potential for ongoing volume-driven innovation to bring electrolysis costs down in the near to mid-term.[22] The development of less costly materials, changes in design (for example from switching to larger multi-stack systems to increase overall electrolyser capacity) combined with economies of scale in manufacturing processes are all expected to drive down electrolyser costs over time.[23] The cost of renewable energy is also expected to continue to fall. This is reflected in Figure 3, which shows comparable global costs for fossil and renewable-based clean hydrogen production pathways in 2030.

Figure 3: Hydrogen production costs for different technology options, 2030[24]

Once produced, there are additional costs incurred from transport, storage and handling of hydrogen from producers to end users. Figures 4 and 5 show International Energy Agency estimates of these costs. Cost estimates vary considerably depending on the distance transported, methods of transport used and end-user requirements. It is expected that transporting large volumes of hydrogen as a gas by pipeline will be the cheapest method for distances up to 1,500km. Above 1,500km, shipping hydrogen as ammonia or as a liquid organic hydrogen carrier is likely to be more cost-effective.[25]

Figure 4: Cost of hydrogen storage and transmission by pipeline and ship, and costs of liquefaction and conversion[26]

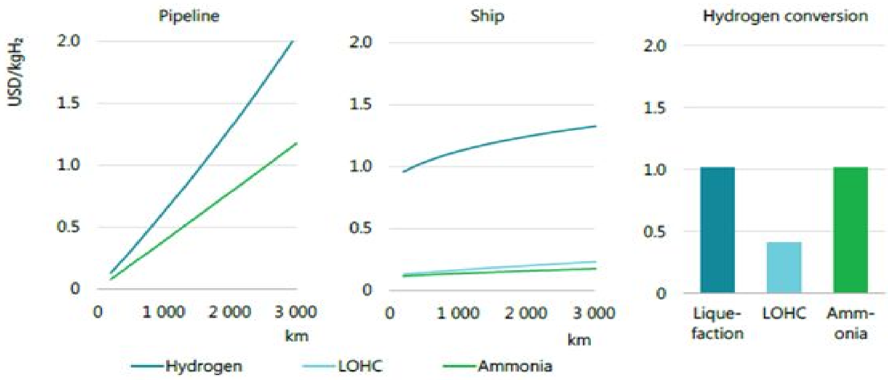
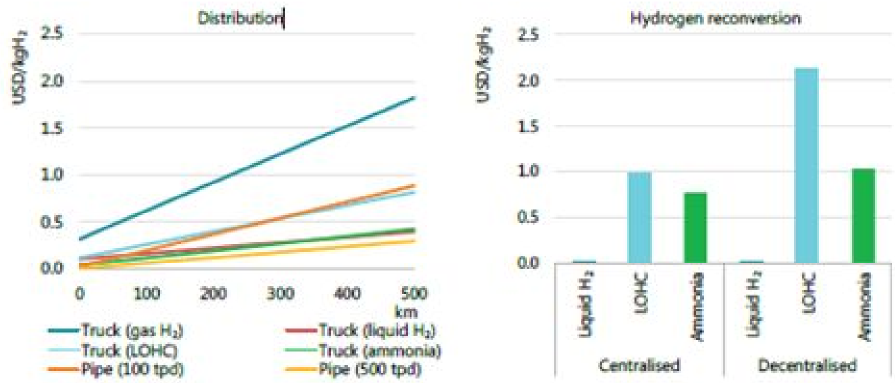


Figure 5: Cost of hydrogen distribution to a large centralised facility and reconversion [27]



Japan has provided clear targets through its Basic Hydrogen Strategy for a delivered cost of hydrogen to be US$3/kg by 2030 and that future reductions of hydrogen costs will need to be at the same level as conventional energy sources such as LNG. The Japanese Government has indicated earlier this year that hydrogen will need to be USD$1.3/kg (or ¥ 13/Nm^3) by 2050[28] – approximately equivalent to AUD$13.55/GJ. [29]

Based on current supply chain costs, more will need to be done to achieve these price targets. The International Energy Agency forecasts that exporting electrolytic hydrogen from Australia to Japan (as ammonia) will cost around USD $5.50/kg in 2030, with transport and handling (including the cost of conversion and reconversion to and from ammonia) costing just over USD$1.5/kg.[30] There will need to be concerted focus on innovation and efficient supply chain development to bring hydrogen costs closer to Japan's expectations.

Building at scale will be key to bringing hydrogen supply costs down. By achieving scale, fixed production, transport and storage costs can be spread over larger volumes of supply, lowering the unit cost of delivered hydrogen. In particular, minimising large-scale transport and storage costs will be critical to ensure that Australia's competitive advantage from its abundant natural resources is not offset by its distance from potential markets.

Australia will need to actively develop international markets to achieve scale cost efficiencies. Australia's hydrogen largest opportunity is as a supplier to other countries. This means the speed at which our industry scales up will be highly dependent on demand stimulus in other countries.

Preliminary estimates by the Working Group indicate that Australia would need to build around the equivalent of 3 GW of new solar power or around 2GW of new wind power in the next ten years to supply one-third of Japan's target of 300,000 tonnes of carbon-free hydrogen imports by 2030.[31] This target could be easily achieved – for example Australia currently has around 14.5GW of new wind and solar under construction.

To produce at a scale sufficient to achieve the prices demanded by Japan we will need to develop supply chains to supply several markets, and potentially a domestic market as well.

Building the required infrastructure

Producing, storing and transporting hydrogen at scale will require considerable new infrastructure. Australia already has substantial road, rail, storage and port infrastructure to support our extractives export industry. The value of this infrastructure is forecast to reach $278 billion in 2018/19.[32] Some of this infrastructure is public, some is privately operated for multiple uses, and some is built and operated solely by companies for their own specific use.

The emergence of a multi-billion dollar hydrogen industry would require new and upgraded public and private supply chain assets. These might include new: electricity generation capacity; electricity and gas networks; transport infrastructure like roads, rail and ports; as well as specific hydrogen production, storage and transport technologies. When designing these assets, planning needs to consider the impacts that climate change will have on extreme weather, sea levels, and changing rainfall patterns. New and existing infrastructure upgrades will need to be designed for a useful life of 50 years or more.

Development of this supply chain will require capital, a skilled construction and ongoing workforce (including in remote and regional areas), construction resources and access to land, potentially in environmentally and culturally significant regions. Issues regarding access to water, land and capital are raised in *Understanding community concerns for safety and the environment* and *Attracting hydrogen investment* papers and are not discussed further in this paper.

When determining how to scale up the hydrogen industry, infrastructure decisions need to consider how to best use or upgrade existing infrastructure (like existing ports or gas infrastructure) and efficiently size and locate new infrastructure requirements. When building large scale projects, effective planning coordination and risk sharing is needed to overcome 'chicken and egg' scale up challenges – where efficiencies are achieved by designing for scale, but building at large scale is hard to justify without demand already being in place.

These issues are not new. Various private-public partnership and other investment models have been successfully used before to overcome investment barriers efficiently and balance allocation of costs and risks at different stages. Internationally, the development of hydrogen 'valleys', involving geographical grouping and coordinated development of hydrogen production and use industries, have been proposed as a means of lowering project costs and risks.[33]

In its submission, the ANU Energy Change Institute calls for publicly funded hydrogen infrastructure investments to be located where they can serve multiple industries:

> *'Public investments related to the hydrogen industry should be planned in a way that allows flexibility in how the investment can be utilised in the future. For example, public infrastructure investments could be located where they are of benefit to other industries (such as minerals). Flexibility is particularly important given demand-side uncertainties in the hydrogen market.'*

Co-utilisation of infrastructure could provide advantages including minimising losses and allowing ramp-up of production when demand increases. Where use of existing infrastructure for hydrogen production and supply can be effectively integrated with existing uses, it can improve asset utilisation. It may also allow proponents to access existing easements and zoning approvals. This would require careful techno-economic analysis and consideration of potential locations of hydrogen production and access points, as well as storage and transport technologies.

Jemena and Mondo, in their submissions, noted Australia should aim to build on existing expertise and infrastructure in the gas industry to develop Australia's infrastructure plans, as well as look to emerging international hydrogen plans as models. The Global CCS Institute also advocates using existing port and rail infrastructure that currently serves oil and gas industries. This would allow hydrogen to be more readily used in more populated areas, which are sometimes located at great distances from potential areas of renewable energy generation. These comments are aligned with recommendations from the International Energy Agency, which in its report, *The Future of Hydrogen – Seizing Today's Opportunities*, identifies near term opportunities to help hydrogen achieve scale to include:

- Building on existing infrastructure, such as existing natural gas pipelines: and
- Creating and leveraging existing coastal industrial clusters, near ports as the nerve centres for scaling up the use of clean hydrogen.[34]

Scale-up support

The process of building hydrogen at scale will create new jobs and bring increased prosperity to Australia. However, the scale-up process may also be disruptive for the communities in which it is occurring.

If successful, rapid scale-up of the hydrogen industry has the potential to lead to a construction boom, which in turn may cause short to medium-term shortages of skilled workers, construction supplies and local resources, such as accommodation. Careful advance planning and training will be needed to build and enable mobilisation of a skilled and adaptive construction workforce and supply chain, to ensure resources are available in response to peaks in industry growth. At the same time, the safety of workers should be assured in the planning phase.

Companies will need to build and maintain good relationships with host communities. This is expanded on in the *Understanding community concerns for safety and the environment* paper. Much of the industry growth is expected to occur in remote and regional areas, which may not be fully prepared for changes that might occur. Establishment of hydrogen production, transport and storage facilities, particularly if coupled with extensive renewable energy generation development, may represent a significant change to the current landscape and economies of the regions in which they are established.

While communities could benefit significantly from the availability of co-located renewable energy and electrolysis facilities, particularly where they provide for new local industries, issues could arise if changes lead to a loss of amenity or cost of living increases. Ideally, efforts to provide support for and build community acceptance and understanding of hydrogen would occur ahead of and during large-scale construction, so that this can occur quickly and with the endorsement of the host community.

The emergence of a new industry in hydrogen will see the need for ongoing support for the local workforce and community. Re-training and skilling of the local workforce is likely to be needed to ensure capable and skilled staff are available to meet ongoing industry needs. Establishment of new community facilities or upgrade of existing facilities may be needed in response to changes to local communities, such as growth in the local town population. Support and potentially compensation will be needed where community members are adversely effected by the change.

In 2016 Deloitte Access Economics interviewed ten Australian LNG leaders to report on the lessons learned from growth of Australia's LNG Industry.[35] Excerpts from Deloitte's report about these interviews are set out in the case study below.

Case study: 'The good, the bad and the ugly…' - Lessons learned from growth of Australia's LNG Industry

The good:

- Need to stimulate innovation and embrace new thinking – *'Industry-leading innovations in infrastructure design, process improvement, and water stewardship, among others, have paved the way for further development of unconventional [gas] deposits around the world.'*
- Focus on employee conditions and engagement – *'To manage talent constraints, developers and contractors have paid considerable attention to creating rewarding work environments and attractive incentive schemes... The LNG projects in Australia have pioneered the use of technology to improve work conditions, such as establishing operation centres in cities.'*
- Amass an excellent health, safety and environmental record – *'Oil and gas explorers and producers in Australia have been working together to maintain the integrity of gas infrastructure and to preserve the environment and property. This collective focus on health, safety, and environment has paid off in improving public perception and in helping the sector to earn its social licence to operate.'*

The bad:

- Better manage the implications of concurrent projects – *'The industry did not think through or forecast very well, the consequences of several independent projects prosecuting a similar resource in parallel … For example, the three large LNG projects in Queensland don't even share a road…'*

- Take a long-term, collaborative approach to working with local communities – *'In some Australian states, proposed LNG projects faced significant opposition from local communities based on health, safety and environmental concerns… The industry could have reduced … regulatory burden, accelerated project delivery, and minimised non-recoverable costs by taking a longer-term, collaborative approach to working with local communities.'*

- Build a trading function from the outset – *'At the inception…most LNG was sold… through stable, predictable long-term contracts that were pegged to oil prices… there was little need to be proactive in developing spot markets or in building trading functions... Fast-forward ten years and long-term, oil-linked contracts are depressed, and operators increasingly need to find new buyers as well as to trade LNG cargoes to meet their commitments and optimise their assets'*

- Manage contractors more effectively – *'…participants called out the need for more effective governance of engineering, procurement and construction (EPC) contractors from the perspectives of contracts, risk, and finance… developers must have active managerial teams, sufficient administrative staff, and remediation processes in place…'*

The Ugly:

- Never use a legally driven framework as the primary method for assuring access to the resource – *'…Instead of approaching landowners as business partners, some companies relied on a purely technical, legal approach for securing the right-of-way for development. This impersonal approach aggravated communities and inflamed political sentiment… The industry would be better served by… instead approaching landowners and other stakeholders as partners in business and friendly neighbours in the community.'*

- Never get swept up in a groundswell of enthusiasm and a 'get it done at any cost' mentality – *'High oil prices at the inception… cultivated the view that hitting schedule was more important than managing expenses… This limited perspective led to major inefficiencies and a lack of focus on productivity outcomes.'*

- Never underestimate the industry's collective impact upon local markets – *'There is a high probability that undertaking several major capital projects within the same geographic area will create resource scarcities, which in turn will drive up costs to unsustainable levels… The industry must think very carefully about the long-term impact of its activities on local markets for labour, equipment, and services.'*

- Never go it alone – *'LNG developers in Australia mainly viewed their competitors as being the organisations down the road, and they raced each other to build infrastructure at almost any cost… industry must realise competition is global, not local… Had they taken this view from the outset, developers in Australia could have* *shared more infrastructure, thus minimising costs and better positioning themselves to compete more effectively with the rest of the world.'*

Actions to get to scale

It will take concerted and coordinated effort to establish Australia as a significant global player in the emerging hydrogen industry. The section below discusses the various actions and roles and responsibilities of government and industry in supporting hydrogen industry scale-up.

Actions to 2030

Hydrogen industry development and scale-up needs to start occurring now to achieve the COAG Energy Council's vision of Australia being a major global player in hydrogen by 2030. As identified across all of the papers, there are a variety of preparatory activities that need to occur before Australian hydrogen value chains can emerge. Figure 6 provides a high-level view on what the timetable to 2030 might include:

Figure 6: High-level timetable of actions to 2030

<table>
<tr><th>2019</th><th>2020 – 2025</th><th>2025 – 2030</th><th>2030 -2050</th></tr>
<tr><td rowspan="6">Agreement to national approach through COAG Energy Council</td><td>Demonstration projects</td><td>Commercialisation financing</td><td rowspan="7">Decarbonising the Australian economy and exporting to the world</td></tr>
<tr><td colspan="2">Country-to-country agreements – beginning with known markets</td></tr>
<tr><td colspan="2">← Regulatory reform →</td></tr>
<tr><td colspan="2">← Market building and innovation →</td></tr>
<tr><td colspan="2">← Skills development →</td></tr>
<tr><td colspan="2">← Other activities as identified through COAG process →</td></tr>
<tr><td colspan="3">← R&D, including international partnerships →</td></tr>
<tr><td colspan="4">← Build social licence and community acceptance through good governance, fair distribution of benefits and costs, and giving communities a say →</td></tr>
</table>

Role of governments

Commonwealth, State and Territory governments can play an important role establishing and promoting hydrogen as a new industry sector through measures such as:

- Facilitating and enabling international trade and engagement.
- Improving investor certainty though setting clear and long-term targets and policy settings.
- Ensuring stable and supportive governance and regulation.
- Providing measured and targeted supply and demand side stimulus.
- Developing and sharing relevant resource, industry and market information.
- Building community awareness and understanding of hydrogen

Submissions to the Working Group supported governments actively pursuing all these measures.

Consultations conducted by the Working Group and submissions from stakeholders have raised the question whether governance of energy markets in Australia is fit for purpose for hydrogen. New technologies and markets are increasingly coupling the gas, electricity and transport sectors. For example, as electric vehicles come into the Australian market, the transport and electricity sectors will be coupled together. Greater use of gas generation couples electricity and gas. This coupling means that there is a need to ensure regulation or incentives in one sector do not have unintended or perverse consequences in another.

If hydrogen production and use emerges at large scale, it could potentially accelerate this coupling effect. If governance structures do not follow, market regulation could emerge as a significant barrier to the hydrogen industry. This issue is discussed further in the *Hydrogen in the gas network* and *Hydrogen to support electricity systems* papers. However, the Working Group seeks stakeholder views on potential models for, and pathways to more integrated energy governance, and how these could help build Australia's hydrogen industry.

Case Study: South Australian Regulatory Working Group

In January 2018, the South Australian Government established a cross-government agency Hydrogen Regulation Working Group which includes the Metropolitan Fire Service and all other workplace safety, environmental, planning and technical regulation authorities that will be involved in the permitting of hydrogen facilities.

The Hydrogen Regulatory Working Group develops competency and awareness of hydrogen across the SA Government to ensure regulatory gaps are identified and addressed, whilst also adopting best practice from other jurisdictions across the world in regard to training and the safe management of hydrogen in South Australia. It also provides advice to proponents of hydrogen projects in the design phase to ensure these are compliant with existing legislative and regulatory requirements.

Role of industry

Industry will play a significant role in getting to scale, through activities including; developing pilot and demonstration projects to drive down costs through technology development and business model innovation; creating efficient networks and supply chains; driving market growth; acquiring necessary capital and resources; developing and enhancing workforce skills; and building the social licence to allow industry operation and scale-up to occur.

Specific activities industry will need to focus on in the short term will include:

- fostering community engagement and building social licence
- increasing collaboration and commercialisation
- improving international opportunities and market access
- enhancing management and workforce skills
- building robust supply chains and markets
- identifying opportunities for regulatory reform.

Questions

The National Hydrogen Taskforce is seeking responses to the questions below. You can submit your comments via the Department of Industry, Innovation and Science's consultation Hub:
https://consult.industry.gov.au/national-hydrogen-strategy-taskforce/national-hydrogen-strategy-issues-papers

1. *What scale is needed to achieve scale efficiencies and overcome cost barriers?*

2. *What approaches could most effectively leverage existing infrastructure, share risks and benefits and overcome scale-up development issues?*

3. *What arrangements should be put in place to prepare for and help manage expected transitional issues as they occur, including with respect to transitioning and upskilling the workforce? How do we ensure the availability of a skilled and mobile construction workforce and other resources to support scale-up as needed?*

4. *What lessons can be learned from the experience of scaling up supply chains in other industries?*

5. *When should the various activities needed to prepare for hydrogen industry scale-up be completed by? What measures and incentives are needed to achieve these timings?*

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