AUSTRALIAN HYDROGEN COUNCIL

Version 1

Hydrogen communications strategic framework

Developed for the NHS Communications and Engagement Sub-Working Group

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1	January 2022

AUSTRALIAN HYDROGEN COUNCIL

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Recommended workplan

Table 1 below summarises the actions recommended in this document. It is consistent with the actions and timeframe previously agreed with the NHS Communications and Engagement Sub-Working Group.

Strategic stage	#	Task	Page ref	Completed by
Lay the foundation: develop views on topics, stakeholders and timing, with risk management as the primary focus. This work forms the basis for the public communications approach as a whole.	1	Run workshops with jurisdictions and the communications community of practice on sample charts that plot topics for each of the six stakeholder groups, as per the example in Figure 5.	25	1 March 2022
	2	Engage with the currently known hubs and clusters to advise them of this programme of work and understand their communications approaches to date.	25	1 April 2022
	3	Develop the first draft of a communications risk register that can be shared by the members of the NHS Communications and Engagement Sub-Working Group.	25	1 May 2022
Fill knowledge gaps: progress specific research components to establish a base knowledge base on key matters as identified from stage 1.	4	Complete water project with Arup and socialise and test outputs with the NHS communications community of practice and water industry stakeholders, such as the Water Services Association of Australia.	28	1 March 2022
	5	Work with the jurisdictions to: • Identify and collate jurisdictional terminology views on hydrogen production types. • Test the need to engage focus groups to specifically understand views on terminology for different hydrogen production types.	28	1 March 2022
Develop messages: create above the line and below the line base messaging and associated suggested timeframes/triggers for publication.	6	Complete list of parties to be consulted on message content for NHS Communications and Engagement Sub-Working Group.	34	1 March 2022
	7	In consultation with the parties in the approved list, complete actions in Table 5, for review by the NHS Communications and Engagement Sub-Working Group.	34	1 June 2022
Start the delivery phase: find a home for general messages and test the need and scope for a communications toolkit.	8	Determine the best hosting site for information (with CSIRO's HyResource as a priority) and make general messages available.	37	1 July 2022
	9	Consult with the community of practice and jurisdictions on the design and intent of a communications delivery toolkit.	37	1 July 2022

Table 1: Tasks proposed in this document

1 Introduction

In 2019, the National Hydrogen Strategy (NHS) set out 57 joint actions agreed by the Australian Government and all states and territories. A key element of the NHS relates to building community knowledge and engagement, where the governments agreed to:

- Develop a community education program to provide clear and accessible information about risks, benefits and safe use. The program will communicate the particular benefits hydrogen development can bring to regions as well as more general benefits such as economic growth, lower carbon emissions and reduced air pollution (action 5.1).
- Support best practice for community engagement and its use to build community awareness and ensure community engagement for large or significant projects (action 5.2).[1]

The University of Queensland informed these agreements with a report written for the NHS called *Developing Community Trust in Hydrogen*.[2] This report concludes that there is no one-size-fits-all approach to community engagement for hydrogen, and it sets out some key considerations for future work in the area.

Since the release of the NHS there has been significant further work undertaken, including a two-year social licence programme through the Australian Hydrogen Council (AHC) and work on public communications developed for the NHS by the Tasmanian Government.

Building on this and other previous work, this project will develop the content for public communications about the emerging hydrogen industry and its impact on, and opportunities for, Australian consumers and communities. This content will be produced with a view to manage the risk of inconsistent, confusing or inaccurate information creating a loss of confidence in the sector. This is for international communications purposes as well – Australia relies on international trading relationships to achieve industry scale, and we are being watched closely.

It is intended that this work can be drawn on by governments and industry for their own communications.

1.1 Community education and engagement

The need for community education and engagement for communicating about hydrogen arises for several reasons.

First, making and using hydrogen as a substitute for fossil fuels is a major undertaking. The public will need to understand the reason for this undertaking, including the energy transition and export context. There is a need for clarity on what is to come and what it means for people's way of life (how they use energy/fuel, regional changes and environmental changes). It is reasonable for the public to expect dialogue, consultation and engagement on these matters.

Second, community education and engagement can help government and industry to anticipate and resolve any concerns, and to learn what is and is not a good idea. Through growing relationships and

[1] COAG Energy Council (2019), page12.
[2] Ashworth, Witt, Ferguson, Sehic (2019).

trust locally and more broadly, it can help create advocates and opportunities and prevent mistakes being made by the industry.

Third, it is responsible to teach people about specific uses for hydrogen. This is about the choices that are coming and empowering them to make those choices. It is also about safe handling of hydrogen.

1.2 Why we need a strategic approach

The emerging hydrogen industry will affect different regions and different markets in different timeframes, from now to beyond 2050. There are also diverse stakeholder groups, with different issues and concerns.

Ideally the industry will be supported by both communities and consumers, including businesses, with a welcome local presence and positive market perceptions. However, this is not a given, with social licence for hydrogen not guaranteed.

1.2.1 Supporting social licence in a complex and dynamic environment

The term 'social licence' is not well defined, but the usual understanding of it is as a social acceptance of an organisation or industry. This is generally a passive acceptance; social licence is not explicitly granted. In practice, discussions on social licence are about how to not lose it.

Organisations lose social licence where their activities have generated enough negative sentiment from their stakeholders that the organisation's continued operation (at least in the area of concern) is called into question. These effects are most damaging where actual (legal) licences are revoked based on community concern. In 2019 it was estimated that community opposition had "contributed to the delay, cancellation or mothballing of more than $20 billion of infrastructure projects in the last decade".[3]

There are many ways to lose social licence, but the common element is that there was a stakeholder view that harm was done, which may mean a *perception* of harm. At its heart, maintaining/not losing social licence is about being *seen to do no harm*. We tend to talk about the need for social licence in relation to activities that might cause harm, whether this is harm to the environment, animals or people. We don't talk about social licence for activities or entities considered to be harmless.

Social licence losses can be experienced in different ways across space and time. For example, a company with a poor safety record can lose reputation but regain it. It can lose its social licence and not affect the rest of the industry. Or an industry can lose social licence based on one or two cases (such as nuclear) and never regain it, or not regain it for decades. Or an industry can lose social licence over a much longer timeframe, such as the likely prospects for coal in the future.

Social licence for the hydrogen industry is a multifaceted topic, where we need to cover significant ground. For hydrogen production, this will be about localised perceptions of harm and benefit for communities hosting projects. For hydrogen use, there will be an array of touchpoints for consumers; hydrogen can be used in diverse ways and there are multiple potential markets. The

[3] Infrastructure Australia (2019), pages 15, 221.

good news is that the industry is starting from a position of neutral to positive community sentiment (see section 2.1.1).

It is worth noting that there is no one way to manage social licence. Given that it is a complicated concept related to external perceptions, even the notion of 'managing' social licence is fraught. Issues that may give rise to a loss of social licence are also too complex to manage in any holistic way; these matters are spread over many parties and subject to the luck (good and bad) and contingency of dynamic political environments.

For the sake of simplicity, the term 'managing social licence' will be used here to mean our collective efforts to support and protect the social licence of the emerging hydrogen industry. Industry players will themselves need to behave in ways that prevent and avoid harm (which is a matter for self- and state regulation), but collectively governments, industry and commentators can support *reputational risk management*, which is where communications play a role.

1.2.2 The role of public communications

The hydrogen sector is complex, and the communications associated with it will also be complex. However, in principle the public communications programme for hydrogen is simple; this is about meaningful stakeholder engagement, where stakeholders are listened to and understood, and communications are effective and transparent.

Much of the discussion on lost social licence to date relates to where public communications are seen to have failed on these matters, and examples of lost social licence are most prominent where local communities are affected. Such an example is Shell's 2010 experience in Barendrecht, a town in the Netherlands. Shell intended to store CO_2 from its Pernis oil refinery in a depleted gas field under the town, and the logistics for the project looked good. However, the project was cancelled after local opposition for the project.

Researchers have examined the case, finding that the:

1. **Content of communications were misaligned with audience need**

    - *Shell provided technical information that alienated/concerned the community.* In the initial sessions with stakeholders Shell was said to have provided information that was too technical, going so far as to highlight the exact locations of the gasfields under the town, which led to people checking where their house was on the map and becoming concerned if it was above the gasfields.[4] In these same sessions, Shell was also not able to answer other important questions raised by local politicians.[5]

    - *Communications did not discuss community benefits*, with the only benefits promoted being those for the project developers. Further, the project was not presented within the context of its benefit in responding to climate change, so broader benefits to society were also neglected in communications. Given the community members were concerned they would be exposed to risk from having the carbon dioxide stored under

[4] Feesntra, Mikunda, Brunsting (2010), page 17.
[5] Ibid., page 15.

their homes, "the idea of having no benefits but high risks influenced the rejection of the project".[6]

2. Communications timing lost trust

- *The community was informed too late.* Shell had provided its plans only when they were advanced, with key decisions already made. "The community was confronted with (maybe even overwhelmed by) the plans and felt little space for manoeuvre. They could not participate in the project or have their ideas or opinions incorporated. The community felt that the only possibility they had was to accept or reject the proposed plan. Due to the lack of participation and involvement in the process, they felt little need to accept a project with such a large (negative) local impact."[7]

- *Approvals timing meant that government was not trusted*. Environmental approvals were only sought after the national government had allocated a grant to the project. This led stakeholders to believe that the government preferred the project go ahead, and that the environmental assessment "would not be a neutral and fair process".[8]

3. Communications delivery created tension

- *Shell was seen as the main driver of the project for its own reasons*. The limited visibility of the national government at public meetings in the beginning of the process was considered to be key factor in subsequent debates. "Apart from a short presentation by a representative of the ministry … during the first public meeting, only limited attention was given to the standpoint of the national government, the role of this project in a national context and related national policy. This created the feeling that the project was Shell's idea. Reflecting on these meetings, an interviewee said that community irritation was raised and an atmosphere was created of Shell versus the public".[9]

- *Public debates left no room to move*. Stakeholders largely engaged with one another in public, with little informal and/or direct contact between the two sides of the argument. This was said to be a problem because it was difficult for stakeholders to reconsider or nuance their earlier expressed positions.[10] Further, both sides provided separate communications to the residents of Barendrecht, which amplified the standoff.

We can see from this example that Shell appears to have lost its social licence for the Barendrecht project because it did not communicate on the right topics to the right people at the right time, and that communications were not led by the right people or in the right fora. These are all matters that are addressed in this strategic framework.

[6] Ibid., page 27.
[7] Ibid., page 27.
[8] Ibid., page 27.
[9] Ibid., page 15.
[10] Ibid., page 29.

1.2.3 Hydrogen interactions with other social licence issues

Context is everything in communications. The development of the hydrogen industry is an exercise in understanding the complexity of context and how existing issues can impact stakeholder views.

From a risk perspective, negative sentiment about hydrogen may be generated if it is perceived to negatively impact people (e.g. health, safety, income, lifestyle) and/or nature (e.g. health and safety of animals and plants, land access, water access and quality, waste, cultural value, biodiversity). These concerns may be about how hydrogen is made, transported and used, which will then overlap with existing social licence concerns for similar or related industries.

Table 2 outlines some social licence issues from other industries that are relevant for the hydrogen industry.

Issue	Existing/past social licence issues	Relevance to hydrogen industry
Making hydrogen	*Electricity transmission infrastructure*: visual impacts, land access and use,[11] health, biodiversity, bushfire risk and community compensation.[12]	Highly relevant, and directly so where hydrogen producers focus on using grid electricity and so use transmission lines. Even if only minimally grid connected, the hydrogen industry could be caught up in negative sentiment if the coming renewables boom frustrates communities.
	Solar farms: land,[13] past developer behaviours, decommissioning and waste management.	Highly relevant, and directly so because solar will be a key input to renewable hydrogen production. The hydrogen industry could be caught up in negative sentiment if the coming renewables boom frustrates communities.
	Wind farms: onshore (land, noise, birdlife, visual impacts, past developer behaviours) and offshore (animals, birdlife, fishing, visual amenity);[14] also decommissioning[15] and waste management.	Highly relevant, and directly so because wind will be a key input to renewable hydrogen production. The hydrogen industry could be caught up in negative sentiment if the coming renewables boom frustrates communities.
	CSG production: land, 'fracking' and effects on water, including	Relevant but indirectly so, because water is an input for renewable hydrogen production and CSG set a precedent for

[11] For example, following community concerns about the path of the study corridor for the NSW Central-West Orana REZ, transmission operator Transgrid (2021, page 11) has "supported the NSW Government to consider alternative options for part of the study corridor", from the existing 500kV network to the Central-West Orana REZ.

[12] See Transgrid (2021), Davis (2021) and RE-Alliance (2021).

[13] See Cosby and Howard (2020), page 19.

[14] See Office of the Australian Energy Infrastructure Commissioner (2021), page 14.

[15] The Office of the Australian Energy Infrastructure Commissioner (2021, page 27) notes that we are about to enter a period where, decommissioning activities will commence for some of the initial wind farm projects around Australia. The cost of decommissioning tends to lie with the landowner, although some projects will be covered by trust funds paid into by proponents (but typically starting at year 20 of a 25-year lease period). With the risks involved, decommissioning could be very expensive, and possibly "more than the total income generated for the landowner over the 25-year lease period".

Issue	Existing/past social licence issues	Relevance to hydrogen industry
	waste management, procedural fairness.[16]	community opposition.[17] CSG was also an energy industry matter (we can expect the same players), and in the same regions of the country.
	Raw water use: stakeholder concern about water allocation and the effectiveness of water markets.[18]	Highly relevant, and directly so where projects use significant surface or groundwater for electrolysis.
	Seawater use: known issue of brine waste from desalination and effect on sea life, economic cost of desalination plants for communities.	Highly relevant, and directly so where projects treat significant amounts of seawater for electrolysis. Past opposition to existing or previous proposed desalination projects may resurface.
	CCS/CCUS: existing scepticism about fossil fuel interests and success rates, international concerns about land value (e.g. Barendrecht)[19] and safety.	Highly relevant, and directly so where hydrogen is made with CCS/CCUS. The hydrogen industry as a whole (that is, including renewable hydrogen) could also caught up in negative sentiment.
	Mining: coal and iron ore for jobs, and hydrogen production.	Relevant, but indirectly so, because water is used in large quantities for mining operations. Additionally, if coal is used as feedstock for some forms of hydrogen, diminishing social licence for coal may transfer to hydrogen. Hydrogen is also seen as a threat to mining jobs and economic viability for some communities.
Export	*LNG export*: local economy boom and bust, lack of coordination for proponents,[20] and domestic reserve policy.	Relevant, but indirectly so, as LNG was also an energy industry matter (we can expect the same players), and in the same regions of the country. Research has already found that people are concerned to ensure hydrogen is not exported at the cost of domestic use.[21] There will be a need to address water export as well.
	Ports: workforce concerns and consultation.	Past experience is relevant as it will affect community views of hydrogen as an export commodity.
Storage	*Hazardous goods*: e.g. 2020 Beirut port explosion from ammonium nitrate; CCS – see safety above.	Possibly relevant indirectly, but if ammonia continues to be considered the medium term vector for hydrogen this will be highly relevant.

[16] See Bond and Veitch (2020a), Luke (2017) also Moffat and Zhang (2014).

[17] Bond and Veitch (2020a) say "if communities or consumers do decide to resist future fuel developments or products, they will be able to draw on symbolic and tactical resources developed through opposition with CSG. Networks, both online and offline, that emerged to counter CSG could be reactivated. And if consumers wanted to resist contractors entering their properties to convert pipes and appliances, they would have to look no further for a rallying cry than the 'Lock the Gate' signs that remain fixed to some suburban front gates to this day", pages 95-96.

[18] See ACCC (2021).

[19] Parmiter and Bell (2010), page 7.

[20] Ibid. See also Reid, S. and Cann, G. (2016).

[21] This is from the work undertaken for the NHS, see Ashworth et al. (2019), page 37.

Issue	Existing/past social licence issues	Relevance to hydrogen industry
End user experience	*Natural gas*: access to supply/contracts.	See domestic policy above.
	Energy retail prices: concerns about affordability and energy company price gouging for smaller consumers.	Highly relevant, particularly where hydrogen is the fuel sold. Also hydrogen's role in the energy transition, with potential gas and electricity price rises for infrastructure.

Table 2: Social licence matters connected to the future hydrogen industry

Many of the matters in Table 2 have broad coverage in terms of societal concern, but it is important to note that most initial problems or concerns (all but the end user experience) will be felt locally, by parties who have interests in avoiding harm to their homes and businesses. We address this matter in section 2.

It will also be necessary to locate hydrogen communications within the larger communications piece on net zero.

1.2.4 Knowledge gaps need to be identified

There are many hydrogen announcements each week, and developments continue. We can expect that the broader community will have questions about the sector. However, we are also at the start of the development of the Australian hydrogen industry, so there is much we do not know about how it will proceed.

In many cases it will be perfectly acceptable that governments and the industry cannot answer a question in detail, but this is not always the case. Therefore, it is important that we develop a view on what questions need to be answered now, and at what level of detail. This is about understanding what people will want to know, assessing our ability to answer questions, and filling our own knowledge gaps on matters that require it.

The lack of global precedent for a major hydrogen industry makes this challenging. One the one hand, the hydrogen industry has no negative track record or longstanding reputational issues to manage. But this also means that we don't know what might derail the necessary work to get the industry up. And the industry has not banked years of incident-free operations to contextualise anything that might happen. The politics of climate change and of the changing fossil fuel markets mean that we don't know how some parties might strategically use a hydrogen incident, and we don't know how resilient the industry and politicians would be to such an attack.

On this matter, it is important to note that social licence risk is not directly aligned with what the technical experts might think. Engineers on a project may feel confident that risks are managed as well as possible, and that a business has even gone well above reasonable approaches to risk and harm management. However, this doesn't matter – social licence is about *stakeholders' perceptions of harm*, which can manifest and grow in unpredictable ways. Further, countering perceptions of harm with even more technical information can actually further erode a precarious social licence situation.

1.3 The approach

This project addresses a range of matters ensure we can meet the NHS objectives 5.1 and 5.2. The stages of work to the end of June 2022 are as follows:

1. **Lay the foundation**: draw on national expertise to develop a common view of communications topics, key stakeholders and timing, with risk management as the primary focus. This basis for the public communications approach as a whole.
2. **Fill remaining knowledge gaps**: progress specific research components to establish a base knowledge base on key matters as identified from stage 1.
3. **Develop messages**: create above the line and below the line base messaging and associated suggested timeframes/triggers for message delivery.
4. **Start the delivery phase**: find a home for general messages and test the need and scope for a communications toolkit.

The package of work is overseen by the Communications and Engagement Sub-Working Group (see separate terms of reference in Appendix A).

2 Laying the foundation

The emerging hydrogen industry has a strong set of messages on benefit, but we can see there is also risk to its social licence based on its direct and indirect connections with other social licence matters.

Meeting the NHS action to "to provide clear and accessible information about risks, benefits and safe use" requires us to understand how communications about these things could best be provided to support rather than risk the social licence of the industry. The risks and benefits of hydrogen are not uncontroversial or simple topics, so it is essential that we unpack them to consider who we are communicating with, on what topics, at what level of detail, and at what point in time.

It is important to understand the questions people have about the risks and benefits of the industry, so we can tailor messages that meet consumer need. We need to support shared language and communications, to achieve consistency across the Australian hydrogen industry, whether it is being spoken about by business, government, academia or others.

Further, we need consistency to present one voice of 'Team Australia' both locally and internationally, and to avoid unnecessary stakeholder confusion. The independence of states and territories going their own way, rather than presenting a united front, is a topic that has come up in community and stakeholder research[22] and is regularly experienced as a negative position for Australia in international trade discussions.

Consultation is a common thread through this document. This project must:

- Engage with all jurisdictions on communication needs regarding specific topics and timing, precedents, risks and opportunities for shared terminology.
- Consult early with other relevant stakeholders and researchers domestically and internationally to learn from experience (such as from projects that have gauged community sentiment) and build connections with related industries and governments.
- Consult with those building the hydrogen ecosystem (such as the hubs and clusters), and ideally build a network of hydrogen ambassadors from a wide range of trusted community leaders.

2.1 Topics for public communications

2.1.1 Research findings to date

In work undertaken with survey respondents and focus group participants on attitudes toward hydrogen, Australian research has found:

- People are generally positive about the development of a hydrogen industry in Australia but do "not have enough experience of hydrogen to form strongly enthusiastic attitudes towards

[22] Ashworth et al. (2019) page 5.

it".[23] The provision of factual information during a 2021 survey "did help to strengthen support for those who had previously expressed no opinion, however it did not influence those who were strongly opposed".[24]

- In 2019, people's questions and concerns focussed on "costs, benefits, opportunities, risks, and safety, as well as identifying the associated impacts for individuals, households, regions and the environment".[25] By 2021, safety was said to be "the number one priority for Australians to ensure the development of a successful hydrogen industry and will require adequate regulations are in place provide confidence".[26]
- People support using renewable energy to make hydrogen but recognise the challenge of achieving scale in renewables, including for siting projects. In 2021, it was found that while people accepted hydrogen for export use, "they were more likely to agree to a production facility near them for domestic use rather than for export".[27]
- In general, people are particularly interested in:
    - The longer-term strategy and the regional and national benefits from a hydrogen export industry, such as those related to jobs and skills.
    - The environmental impacts of the industry, with the use of water for electrolysis being a key concern, and particularly so for drought affected communities: in 2019 "the concept of exporting hydrogen and 'our water' was not viewed positively".[28]
    - Information that manages expectations on project timeframes and associated benefits.

These findings are consistent with public hydrogen discussions to date.

In time, we will also likely see questions from consumers about the effect of the energy transition – and the role of hydrogen – on energy/fuel affordability. It is important to note that people will likely not want to pay more for hydrogen. In a 2019 survey, close to a quarter of respondents said they would only pay for hydrogen if it was "cheaper than conventional technologies". Willingness to pay

[23] Martin, Ashworth, Petrova, Wade and Witt (2021), page 34.
[24] Ibid.
[25] Ashworth et al. (2019), page 6.
[26] Martin et al. (2021), page 10.
[27] Ibid. However, we need to consider what people thought domestic supply to be. The 2021 survey seemed to focus on domestic supply as only what people would use in the home – such as a replacement for natural gas for cooking and heating. Export was set against this rather than against a much larger domestic industry with manufacturing (and thus quality employment) capabilities. Similarly, it was noted in 2019 (Ashworth, 2019, page 22) that "Export had the highest support levels of all hydrogen applications provide [sic] safety, the environment and domestic supply are guaranteed". Again, given that 'domestic supply' hosts a suite of applications, and so seems to come both first and second priority depending on definitions, this is less of a clear direction about application priorities and more a sign that 'domestic' supply/use requires clarity for communications.
[28] Ashworth et al. (2019), page 7.

was found to correlate with global warming beliefs, but even those who believed that global warming presented a threat did not want to pay more for energy.[29]

Given the role of energy as an essential service for domestic and businesses, energy affordability (and system reliability) are fundamentally important community issues and will be of strong interest to political leaders, who will be seen by consumers (voters) as being ultimately responsible for the cost of living.

2.1.2 Proposed hydrogen communication topic categories

Given experience and research findings to date, the major topics that should be addressed by public communications on hydrogen are shown in Figure 1.

These are topic categories – there will be context, detail and further categories within many of these, depending on purpose and audience.

Topic categories that require message content

- Safety:
  - Community safety
  - Consumer safety
  - Employee safety
  - Emergency services requirements
- Environment:
  - Land access, coexistence with other uses and values (e.g. visual/auditory amenity, cultural/heritage, biodiversity)
  - Water access, quality, coexistence with other uses and values
  - Air quality and dust (e.g. from construction)
- Community:
  - Workforce opportunities and training; associated skills, contracts and services required
  - Project consultation and community engagement through project lifecycle (including decommissioning)
- New markets:
  - Choices available to purchase
  - Infrastructure to support choices, including refuelling
  - Hydrogen fuel/equipment comparison on key factors, including lifecycle costs
- General
  - Hydrogen basics
  - Economic benefits for regions and Australia as a whole
  - Renewables credentials
  - What future changes to expect
  - Where to find information
  - Energy security/independence (local and regional/national)
  - Implications for essential services costs

Figure 1: Hydrogen topics for public communications

[29] Ashworth et al. (2019), page 12.

Some of the topics in Figure 1 will be more significant to some individuals than others, and we can see from previous research that people's interest is most concentrated on safety for themselves and the environment. This makes sense given that the hydrogen industry is a new concept that could represent a change to existing lifestyles; people will in the first instance seek to protect themselves from loss and harm.

As noted above, social licence is not explicitly granted but it can certainly be taken away if a host community or broader society perceives harm will arise from outsider activities.

Figure 2 shows a basic version of Maslow's well-known hierarchy of needs, which identifies that people's most basic physiological needs (such as food and shelter) must be met before they tend to value psychological needs and the more esoteric value of self-actualisation. This is a useful way to think about the issues we can reasonably anticipate for the hydrogen industry and how strongly people will feel. We can see from this framing of issues that matters relating to basic needs must be prioritised in communications, where we must at the least be able to demonstrate and communicate no harm to people's way of life.[30]

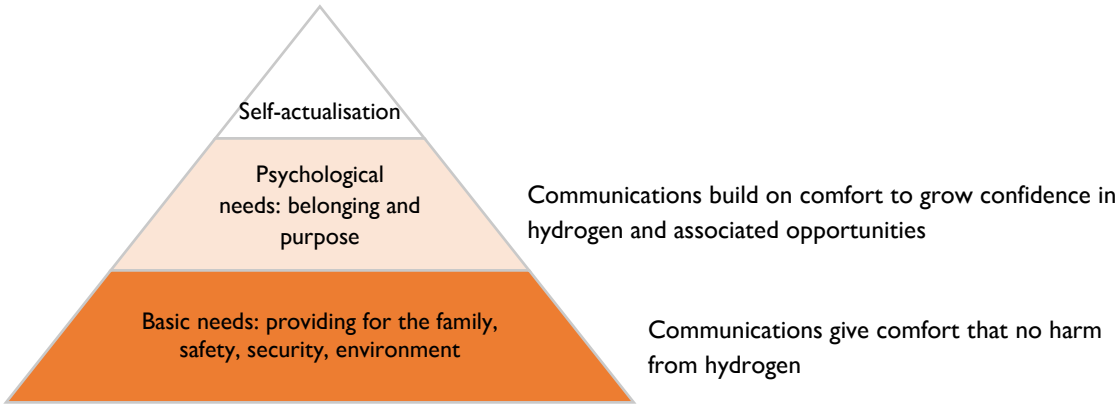

Figure 2: Maslow's hierarchy of needs repurposed for hydrogen communications

Figure 3 shows the hydrogen topics[31] allocated into four quadrants, which relate to the two dimensions of:

- whether a topic will be more likely oriented to localised or broader content and communications delivery; and
- the natural orientation of a topic toward harm or opportunity.

[30] Matters get more complicated if this framing is overlaid on concerns about the energy transition, because if hydrogen is introduced as a way of reducing loss in basic needs (that is, replacing jobs lost, and/or preventing further climate change) then the base level of the triangle would not be about harm but opportunity to reduce loss. However, it is unlikely that the bulk of the population would be starting from this position at this stage. Further, if people understood the issues well enough to see hydrogen as an inevitable step within the energy transition there would still be a need to start with communications about why it's not a *harmful* step.

[31] Except hydrogen basics, such as 'hydrogen is the lightest element' and 'hydrogen is made not found', because this information is not usefully weighted to any particular quadrant.

The allocation applies generally across stakeholders at this stage, and we can see that topics can shift quadrants. Some of the topics are more responsive to framing as a positive or negative, and so they can be – at different times, for different stakeholders – either a concern or an opportunity.

For example, 'water access and management' is framed here as more about a potential harm, because Australia is a relatively dry country and communities will be concerned about water use and water security. This could be a major issue if the industry's effect on local or regional water is seen as breaching basic needs of other stakeholders. However, this will depend on what kind of water is used, and where. Use of desalinated seawater is likely to be viewed more favourably than industry use of potable or high-quality raw water (although wastewater and waste products cannot be forgotten). Even with ground or surface water (not seawater), for irrigators and others who hold water rights, there may also be opportunities here for water trade with the industry.

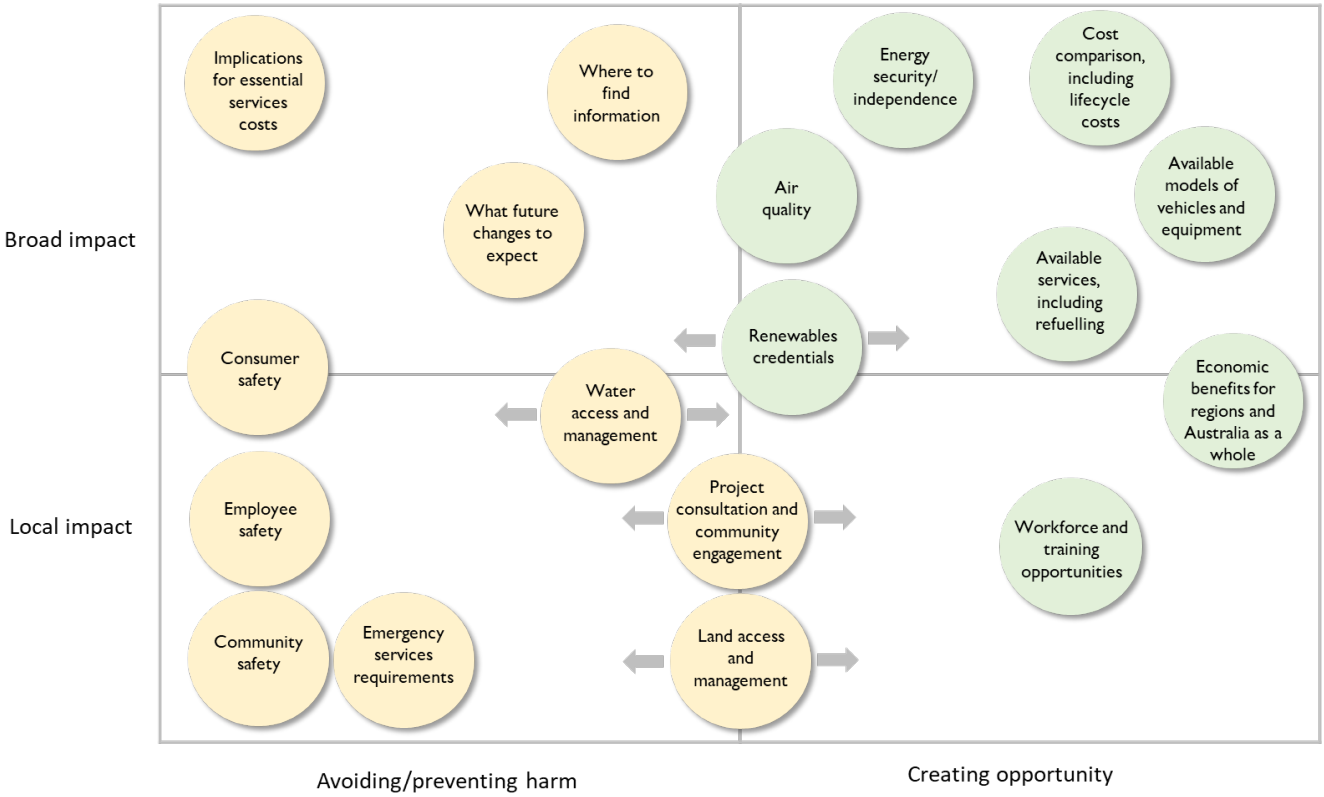

Figure 3: Hydrogen topics for public communications across key dimensions

Access to land is a similar matter. This is an issue related to the wind and solar generation required for the energy transition as a whole, and hydrogen needs are within that. The coming decades will see a massive increase in renewables, and we can anticipate community concerns about effects on the land and coexisting uses. Again, this could be a major issue for the industry if it is seen to jeopardise communities' use of their land. However, there are also opportunities for landowners to lease property or to otherwise benefit from projects on their land (although this needs to be understood from a social licence perspective as well, with the Office of the Australian Infrastructure

Commissioner (2021) noting the cases it has heard about landowners who have unmet expectations of hosting assets).[32]

It should be noted that the allocation in Figure 3 is based on the topic is likely to be initially experienced; for example, safety is initially a personal matter and feelings are stronger the closer to home safety issues occur. This is what makes this a local matter in the first instance. Of course, people in broader community and society can be concerned about harm that may affect others, but this is secondary, and may not become an issue if the matters can be addressed locally first.

2.2 Stakeholder groups

While there will be some degree of common interest across stakeholders on most of the topics proposed (and all are public interest matters) the intensity of that interest will vary across key stakeholder groups.

Table 3 shows the key stakeholder groups based on how their lives are – or will be – touched by hydrogen, and the kinds of things they are likely to want to know. The key groups shown are users of land and natural resources, workforce and required operational experts, consumers, societal influencers, and owners of outcomes. Strongly negative views from any one of these could cause a cascading effect that results in a loss of social licence for a business or the whole industry.

Stakeholder group	People
Group 1: Users of land and natural resources	People who highly value their use of the environment (land, water and air) for business or lifestyle, e.g., communities, neighbours,[33] councils, local businesses, landowners, residents, farmers, tourism operators, tourists.
Group 2: Hydrogen workforce and required holders of skills	a. Future direct and indirect employers and employees of the industry, e.g., engineers, technicians, mechanics, gas fitters. b. People supporting social services, e.g., emergency services.

[32] The time taken to approve a wind farm means that efficiency improvements can be made and turbine numbers can fall to achieve the same output. If a landowner expected to host a certain number of wind turbines (with an associated income stream) and the final number is smaller, the landowner can become aggrieved. Further:

> "The landowner may not only perceive that they have 'missed out' on a significant expected income stream, but may also raise concerns about the potential impacts of turbines located on neighbouring properties, including changes in amenity, audible noise, construction disruption, loss of property value and other effects of the wind or solar farm. The fact that the landowner's neighbours are hosting turbines or arrays and receiving payments can further aggravate the situation for the landowner that missed out" (Office of the Australian Infrastructure Commissioner, 2021, page 24).

[33] 'Neighbours' indicates people affected by projects but not as landowners. As noted by Office of the Australian Infrastructure Commissioner (2021, page 32): "Lack of effective consultation with neighbours can lead to a range of material issues for a project, including conspicuous opposition to the project (and any modifications to the proposed project), formal objections that may lead to planning/approval delays and appeals, legal actions against the project or planning authority, the project (or elements of the project) not being approved as well as widespread negative media coverage about the project and the industry more broadly".

Stakeholder group	People
Group 3: Active hydrogen consumers	People and businesses choosing to buy hydrogen or related products via: - fuel markets - vehicle and equipment markets, e.g., car, bus, truck, fleet, tractor, stationary fuel cell and appliances - service markets, e.g., FCEV maintenance via mechanic.
Group 4: Passive hydrogen consumers	a. People who don't choose to buy hydrogen but still use it, e.g., natural gas users receiving blended gas, users of FCEV public transport. b. People who may choose in the future (become Group 3) when the market evolves, e.g., future FCEV purchasers.
Group 5: Societal influencers	People engaging on hydrogen issues and/or industry reputation by: - observing and commenting, e.g., environmental activists, media - making connections, e.g., industry associations - advocating and sharing information, e.g., various comms people, local leaders.
Group 6: Owners of outcomes	People creating the markets/seen to own the outcomes, e.g., governments, councils, regulators.

Table 3: Draft stakeholder groups for communications purposes

This means of considering stakeholders was proposed by the Australian Hydrogen Council in 2021 and socialised with its social licence working group. Members of this working group include academics on social licence, industry and the federal and state governments.

The groups are not mutually exclusive or static. People will shift categories with life changes, and they will also fall into multiple categories because they value different things at the same time. For example, an owner of a large dairy farm might be in the following groups:

- Group 1 as a landowner and local business;
- Group 2 as an employer (in Group 3) that needs trained employees;
- Group 3 as an early adopter of hydrogen technology to treat milk;
- Group 4 as a possible future FCEV purchaser for its truck fleet; and
- Group 5 as a community leader and major employer in its region.

In developing public messaging, it is not being suggested here that separate messages are required for each group, but that work need to be undertaken to understand different perspectives and what must be accounted for. Early communications are less likely to be differentiated.

Another means of understanding stakeholders is to consider their demographics and likely psychological profiles. This is an approach commonly used in marketing as it helps identify key markets and the best channels for message delivery. However, this is where we need to see the difference between communications for our purposes – as having a strategic risk element that requires a foundation in understanding stakeholder concerns – and communications as marketing an existing or uncontroversial message.

As discussed in section 5, market segmentation analysis will be most useful as part of a delivery toolkit.

2.2.1 Topic priorities for stakeholder groups

The topics covered in the previous section will vary in their importance for the different groups. In fact, the formation of the groups in Table 3 is to some degree responsive to the topics that we know need to be addressed; it is a result of thinking about how the topics will be relevant to different stakeholders according to their core values.

However, we can be more precise by considering likely issue salience for the different groups; that is, understand their prioritisation of the topics communicated to them.

As an example of the differing topic priorities, Figure 5 shows how we might think of the interests of people in Group 1; that is, people who highly value their use of the environment (land, water and air) for business or lifestyle. The sizes of the bubbles in this figure broadly represent the different priorities that this group will give to these topics, with water access and management, land access and management, and project consultation and community engagement as the highest priorities (largest bubble size).

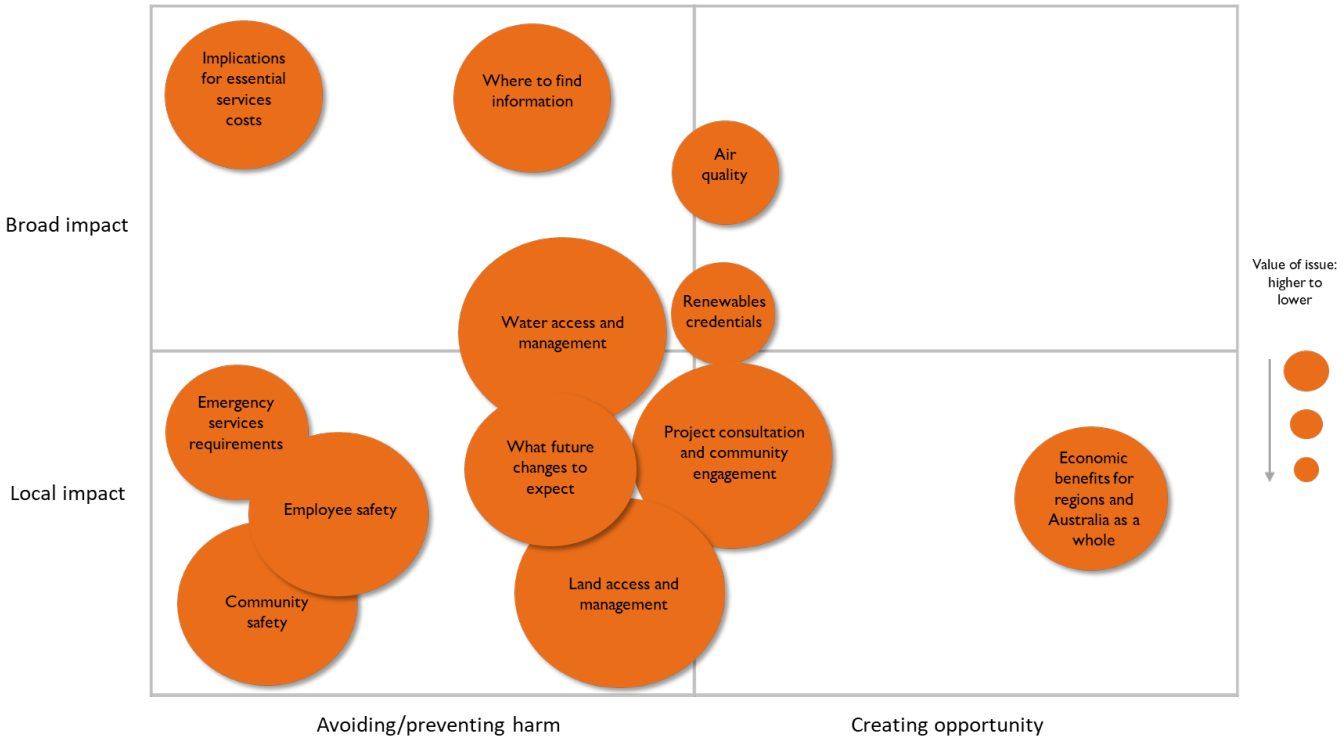

Figure 4: Example of Group 1 stakeholder needs for information with early topic priorities

Employee safety and community safety are shown as slightly lower priorities. While these are still important because Group 1 includes employers in regions (which may host hydrogen projects) and a need for an attractive (and thus safe) community, unless a Group 1 person is explicitly in the hydrogen industry, employees are unlikely to need significant safety training, and community safety

as a whole is unlikely to be as important to a Group 1 person as how their fundamental access to land and water (with no loss in amenity) may be affected.

Not all of the 18 topics are shown in Figure 5. This is because the categorisation is about topic priorities, and these will vary. This is not to say that the other topics are not important, but that they will not feature prominently for this group.

It is important to note that Figure 4 is a starting point, and we will have a version of each developed for Groups 1-6 to use as consultation documents with the social licence community of practice. These illustrations are a useful means of framing a complex set of issues to get people on the same page and to trigger further discussion.

2.2.2 Related industries

The need to provide communications about hydrogen will extend beyond hydrogen subject matter experts in industry and government. The prospect of hydrogen is relevant across much of the economy and there are several sectors adjacent to, or one step removed, from hydrogen. Parties in these sectors themselves might need to communicate with their own stakeholders about hydrogen; and ideally, they should do this with consistent language and a connection to reliable and sound information.

When in this capacity, people can be considered as being in Group 5, and this will include:

- water service providers;
- farming and irrigator groups;
- public transport fleet procurement divisions;
- NGOs in across a range of areas, but particularly in transport, water, energy and environment;
- relevant ombudsman and other complaints handling schemes;
- investment and financial advisors, both domestically and internationally; and
- chemicals and metals industry associations (although these are less dispersed, and knowledge will be higher).

We thus must ensure that messages developed through this project are shared with people in these and similar types of organisations.

2.3 Timing

Timing is as important for communications as understanding the audience and tailoring message content. Communicating too soon for a particular audience can create unmet needs and communicating too late may create a dangerous information vacuum. Communicating the right thing at the wrong time is still a failure in communication, and we can refer to cases like the Shell Barendrecht project to see why this is the case.

2.3.1 Communications needed now

General communications

The hydrogen industry does not yet exist at scale, and the various markets do not exist. Getting to scale will take years, so intensive, economy wide communications about changes to come are unlikely to be required for some time. Most of the groups in Table 3 are not currently highly engaged with hydrogen.

However, this is not to say that general communications are not required. Communications are already occurring about government investment announcements, such in hubs and infrastructure. Industry is also making investment announcements. Further, with the progress for emergency services training and for gas blending, people are hearing about hydrogen from their broader contacts. The media is also interested, with hydrogen featuring regularly in news articles and opinion pieces.

Research has also found that generating a degree of awareness for hydrogen has positive effects on consumer sentiment. Done properly, this can also create a prophylactic effect on industry reputation in the event of any negative publicity (such as an overseas or local safety incident).

General communications are thus vital and are a priority for this project. These communications will need to be carefully crafted to not set unrealistic expectations. Ideally, any detail should be provided as reference material that people can access when they like. Communications staff will also require access to core information, reference material and messaging that they can draw on for both proactive and reactive communications, with specialist information if there is a need for deeper enquiries (such as through a Minister's office).

Targeted communications

In the near term, communication will be needed most in communities that host projects and facilities. Production projects are happening right now, and communities – stakeholder Group 1 in particular – should be engaged from the start.

In principle, focusing on communities directly affected by the build phase of hydrogen projects simplifies the overall communications project, as geographical boundaries should make identifying issues and targeting training, monitoring and communications relatively easy. (However, the work to clarify context and views of a particular community should not be underestimated.)

The relative ease of targeting extends to end user markets for hydrogen. Public communications can target the limited number of people who currently use hydrogen, to ensure they are adequately informed. This is already occurring with the consumers receiving hydrogen blended into their natural gas in South Australia and New South Wales.

But hydrogen will also have relevance outside its means of production and use, and this is where things are harder to control. Hydrogen will be transported between sites, either by pipeline, tube trailer or within a vehicle that is using hydrogen in a fuel cell. So that means that anyone who might encounter the hydrogen on its path could have an experience that ultimately affects social licence. While hydrogen is no more or less hazardous than existing fuels and chemicals transported by road, it is new and not well understood in the community. An unfortunately timed serious road incident

could delay the industry for extended periods.[34] This then connects the need for information to general communications.

2.3.2 Longer term communications needs

In the longer term, public communications will need to account for all stakeholder groups, and for the different markets and their timeframes for action.

Communications about hydrogen will require stages per potential market, where it is important to develop a view of the ideal level of knowledge and engagement per stakeholder group. This is important to both 'take stakeholders on the journey' and not overwhelm them at any one time, and it is also important communications do not unnecessarily trigger concerns.

The risk focus of the work also means that we will be considering the questions that will be asked by stakeholders at a minimum of two or three layers of detail, so that communications do not have the unintended effect of losing public trust because we have started a conversation on a topical matter that we do not have the capacity to continue as required.

Further, there is a need for an understanding of project timing, to coordinate communications and messaging. This is because we will likely see multiple projects in some regions – such as the REZs – which can bring the potential for "residents to be 'surrounded' by wind turbines and/or solar arrays if such projects proceed".[35] This will compound any issues such as noise, visual amenity and economic loss, and construction schedules overlapping can place pressure on local resources (including workforce) and infrastructure.

2.3.3 Applying timing considerations to the proposed topics

Figure 5 is an amended version of Figure 4, where the difference is an additional colour coding for the order of messages and what is likely to be most valuable to Group 1 stakeholders.

The suggestion in Figure 5 is a staged approach, with the order of messages to be:

1. **Scene setting information** (darkest orange bubbles), where previous studies and experiences (such as in Barendrecht) have indicated it is important to start with communicating the reason for change and benefits to host communities and the nation, and what will happen next. While the content of these messages will not ultimately be as salient to Group 1 stakeholders as information relating to water, land and project consultation, there is a fundamental need to set the scene.
2. **Key messages** (medium orange bubbles), which for Group 1 will be messages about safety, land and water access and management, project consultation and relevant information about renewables credentials and air quality. This phase may have multiple stages, depending on the community.

[34] See Bond and Veitch (2020a, page 69), where they discuss the impact of a highly visible LPG vehicle accident in NSW. An LPG taxi exploded in 1979, causing new attention to similar incidents, and ultimately delaying the market for years.
[35] Office of the Australian Energy Infrastructure Commissioner (2021), pages 57-58.

3. **Follow up messages** (lighter orange bubbles) are addressed later, once people feel more comfortable about the previous communications. These are important issues but are likely to come up only once people have engaged on the other topics and have follow up questions. Alternatively, we could see these as messages that would not be proactively communicated but would form part of an information kit for interested parties to access.

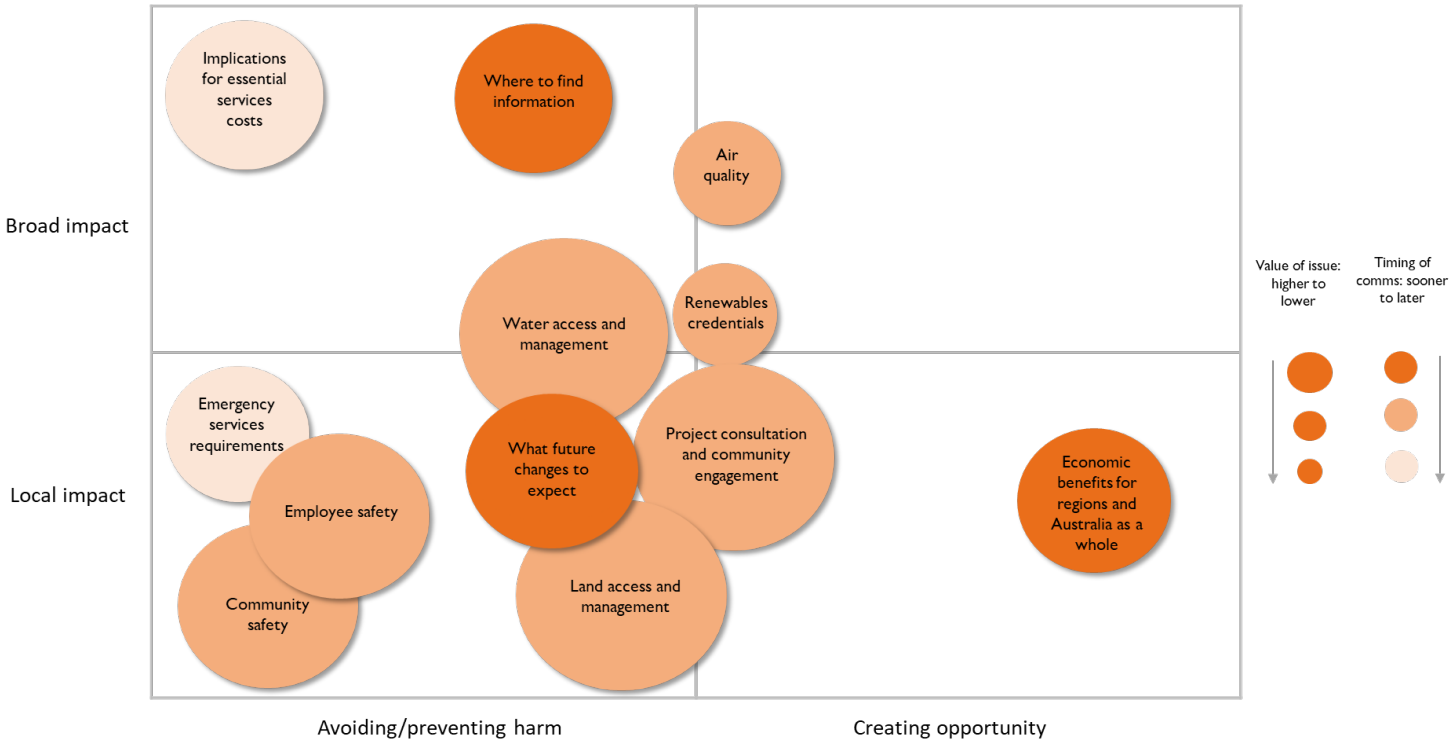

Figure 5: Example of Group 1 stakeholder needs for information, with early topic and timing priorities

As with Figure 4, Figure 5 is a starting point, and we will have a version of each developed for Groups 1-6 to use as consultation documents with the social licence community of practice. These will be the primary versions worked on.

2.3.4 Impact of hydrogen hubs

The past year has seen exciting developments in hydrogen industry collaboration, with:

- Announcements and a subsequent competitive process for seven hydrogen hubs, to be co-funded by the Australian Government. The final announcement about the successful parties will be made in the coming weeks. The hubs are expected to at key export locations and managed by consortia.
- Progress in bringing together 18 hydrogen clusters, with initial funding support from NERA. The clusters are regional communities of practice, with involvement from local businesses seeking to boost hydrogen industry development. The focus and approaches of the clusters vary significantly.
- Other hydrogen hub concepts that may or may not be related to clusters.

It is early days for all of these initiatives, but most have been the subject of public communications. Some are also explicitly seeking to develop and provide hydrogen messaging in their catchments.

The hubs and clusters collectively represent both an opportunity and a risk to the overall hydrogen communications project. On the one hand these provide an excellent opportunity for the developing industry to engage with communities from the start, and to ideally be in a better position to identify early issues that may arise so that they might be appropriately responded to. These projects can also provide an ongoing means of testing communications and receiving input from those on the ground.

On the other hand, preliminary messages to communities from the hubs and clusters might bring about some of the risks to social licence previously identified. At the least, as momentum grows the combined effect of the various project communications across the regions and the country as a whole might be confusing to domestic and international stakeholders, either in terminology or in claims about progress.

The hubs and clusters do not sit neatly in either of the local/broad or harm/opportunity dimensions in the previous figures. These initiatives are more local than national (by definition) but their catchments can be much broader than the usual understanding of community as 'that which hosts a project'. Their timing for communications will also not be neatly aligned with any particular hydrogen project, at least not in the traditional sense.

They are also more likely to be communicating about opportunity, and not engaging deeply on harm prevention, at least at the start. This is because the purpose of the hubs and clusters is about building local experience and innovation from the ground up, not about managing risk for an existing major project.

It is important that the NHS communications approach engages with all clusters and hubs, to:

- understand existing communications issues, approaches and perspectives;
- connect them with this communications project and seek consultation as appropriate; and
- share the outputs with them and maintain collaboration.

2.4 Next steps

Task 1: Run workshops with jurisdictions and the communications community of practice on sample charts that plot topics for each of the six stakeholder groups, as per the example in Figure 5. This should be complete by the end of February 2022.

Task 2: During February and March 2022, engage with the currently known hubs and clusters to advise them of this programme of work and understand their communications approaches to date.

Task 3: Develop a communications risk register that can be shared by the members of the NHS Communications and Engagement Sub-Working Group. First draft to be complete by end April 2022.

3 Filling knowledge gaps

The hydrogen industry does not yet exist at scale, it is not clear what applications it will best compete on, and prices and equipment are still in development. This means that there is a lot we do not know about the future industry.

However, we can still manage this level of uncertainty and produce communications that set the scene, give confidence and support future engagement. For example, we can craft messages about processes underway without needing to know the answers in detail for most topics.

A knowledge gap as conceptualised here is not just an absence of knowledge, but an absence of knowledge of important information that governments and the industry would be *expected* to know, and to know *now*. These will likely be topics that are more controversial and/or may represent potential harm, and also those that have answers (such as some technical questions). For these topics it is reasonable to have do more now, even if this is only to get project consensus on how to manage risk and communications in the future.

The initial assessment of likely knowledge gaps is shown in Table 5. This table provides an overview of the topics (as covered in section 2), the likely facts that are required now (where 'now' is any time within the next weeks and months), what is even knowable now, and the resulting knowledge gap. Currently, this assessment indicates that the current gaps are:

- our evidence base for water use by the future industry; and
- public views on green/clean terminology.

3.1 Water use by the future industry

Green hydrogen is generally made by splitting the hydrogen from the oxygen in water (electrolysis), using renewable electricity.

The water required to make 1 kilogram of hydrogen in this process is around 9 litres, which is the water for the chemical process (the stoichiometric value). This is the figure quoted in the NHS, with related comparisons. One such comparison is with the mining industry, where the NHS says:

> To produce enough hydrogen to satisfy Japan's projected annual imports in 2030 would require less than one per cent of the water now used by Australia's mining industry each year. To be a major supplier of a large-scale global hydrogen industry in 2050, however, would require more water. Under strong hydrogen growth settings, water consumption in 2050 in Australia may be the equivalent of about one-third of the water used now by the Australian mining industry.[36]

While the NHS also notes that water requirements will vary and that additional water will be required for cooling and input water purification, there are no figures associated with these statements.

The '9 litre' number and the mining industry comparisons have been widely referenced in the two years since the release of the NHS and stand as benchmark figures. However, as project proponents have progressed further with their planning, it has apparently become clearer that the

[36] COAG Energy Council (2019), page12.

stoichiometric value is not the most relevant when considering the required access to water. See Appendix B for further discussion.

Consulting firm Arup is working with the AHC to provide this project with water consumption figures that can inform considerations of risk and appropriate communications. Table 4 shows the kind of data we will be seeking. Arup will provide the figures and associated working for the first row, which we can then multiply out for key reference cases as per the rows below (which in turn can be used to understand industry use comparisons).

This work is underway, with results in February 2022.

Volume of…	Hydrogen gas		Liquid hydrogen		Ammonia	
1 kilogram	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*
Estimated export market in 2030	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*
Estimated export market in 2050	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*
Domestic transport 2050	*Good quality raw water in litres*	*Sea water in litres*	*Good quality raw water in litres*	*Sea water in litres*		

Table 4: Example water figures required

3.2 Terminology for the emerging industry's green credentials

The Australian Government has traditionally referred to 'clean' hydrogen, which covers both:

- renewable hydrogen, made by splitting hydrogen from oxygen in water, using renewable electricity, and producing no carbon; and
- non-renewable hydrogen, understood to mean hydrogen produced from fossil fuels (steam methane reforming or coal gasification) where the carbon associated with the process is captured and used or stored.

In practice, the carbon emissions associated with hydrogen production will be understood and certified via a certification scheme (in development), but this scheme is unlikely to be a foundation for public communications.

And while many in the industry use the colours 'green' and 'blue' to denote renewable and non-renewable hydrogen respectively, these are not helpful in the public forum and already are being used in negative ways.

'Clean' is a term that has previously been used to denote zero emissions, such as for the Clean Energy Council and the Clean Energy Finance Corporation, who each have a zero carbon remit. Stakeholders have advised that there is some scepticism about referring to non-renewable hydrogen as 'clean', and this scepticism might then reflect more broadly on the industry as a whole.

Ideally, we would not need to associate hydrogen with a means of production, but in practice this cannot be avoided. This is because there is an existing hydrogen industry, based on fossil fuels, and the future hydrogen industry has value *because* it is clean. To merge the two in communications – or be perceived as doing so – will create confusion.

It is also likely that terminology for the future hydrogen industry will need to be consistent with future communications on net zero commitments and related industry activity.

3.3 Next steps

Task 4: Complete water project with Arup and socialise and test outputs with the NHS communications community of practice and water industry stakeholders, such as the Water Services Association of Australia.

Task 5: Work with the jurisdictions to:

- Identify and collate jurisdictional terminology views on hydrogen production types.
- Test the need to engage focus groups to specifically understand views on terminology for different hydrogen production types, testing the following terms at least: green/blue/grey; clean/[alternative term]; renewable/non-renewable; zero emissions/low emissions; and engage focus groups as required.

Topic	Likely facts required now	What's knowable now	Current knowledge gap
Safety: • Community safety • Consumer safety • Employee safety • Emergency services requirements	• Existence of appropriate government regulations and industry training. • Emergency services are trained already.	• Work is occurring on developing regulations – see Standards Australia for examples. • Emergency services have been prioritised.	Just need message drafting – see section 4.

Environment:
• Land access, coexistence with other uses
• Water access, quality, coexistence with other uses
• Air quality and dust
	• Existence of reasonable processes to ensure fair access to all, and regulations to ensure no harm.
	• Answers to:
	  ○ How much land might be required?
	  ○ How much water might be required?
	  ○ Improvement on alternatives?
		• Work is occurring on land and water rights/access – at the least the jurisdictions are covering.
		• Given reasonably known physics/chemistry for hydrogen production we can provide scenarios for land and water use and provide points of comparison with key alternatives (diesel is a priority).
			Key knowledge gap is water use and comparisons. Need process engineering analysis for evidence base.
			Otherwise, just need scenarios and message drafting (see section 4).

Community: • Workforce opportunities and training; associated skills, contracts and services required • Project consultation and community engagement through project lifecycle (including decommissioning)	• Existence of appropriate government regulations and industry training. • Industry undertakings. • Quantification of benefits.	• Work is occurring on workforce planning – see NHS project and jurisdictional developments for examples. • AHC has an industry undertaking and developers also use established means of engagement. • Benefits to communities can't be quantified and scenarios/cases may set expectations that can't be met.	Workforce needs, but this is addressed via NHS work (in progress). Just need message drafting for now about what we do know (see section 4).

Topic	Likely facts required now	What's knowable now	Current knowledge gap
New markets: • Choices available to purchase • Infrastructure to support choices, including refuelling • Hydrogen fuel/equipment comparison on key factors, including lifecycle costs.	• What does using hydrogen feel/look like? • Timing for availability for models of vehicles and equipment, and for services, including refuelling. • Upfront and ongoing costs	• Demonstration FCEVs can be shown, also hydrogen BBQs. • Too soon on detail for models to come and total lifecycle costs. • Can share work on prioritising infrastructure. • Can also set broad scene for likely market rollout timeframes, noting that active and passive consumers of public and private hydrogen-powered transport need to be addressed sooner.	Need message drafting, and ideally this would be able to be tailored to different consumer types driving demand now and, in the future across Groups 3 and 4, considering separately: • major industrial consumers • large to small commercial consumers • residential consumers. (see section 4).
General: • Hydrogen basics • Where to find information • Economic benefits for regions and Australia as a whole • Renewables credentials • What future changes to expect • Where to find information • Energy security/independence (local and regional/national) • Implications for essential services costs	• Location of credible source of the truth. • Answers to: ○ Why hydrogen for Australia? ○ Why hydrogen for regions and cities? ○ What is green/blue/clean? ○ How much will it cost energy consumers?	• All but energy costs is knowable, at least at a general level. • Too soon to address energy costs in any detail but can provide comfort.	There can be a one stop shop for credible information but there isn't right now (see section 5). There is a perception issue with clean/green language, where we need a common way of addressing. Otherwise, just need message drafting (see section 4).

Table 5: Topics for communications and what we need to know

4 Developing the messages

It is important to make a start on public messages that can then be built upon and modified for later uses. The intent for this initial stage is to use the work from sections 1-3 to:

- Build public awareness and understanding of the hydrogen industry and what it means for Australia, with the intent to sow the seeds for consumer and community acceptance.
- Establish a common language for key matters, to avoid unnecessary complexity and confusion.
- Establish common responses to questions on key matters, to manage risk and prepare government and industry on the issues.
- Develop modules of information and questions and answers that can be put together in different ways for different purposes.

The messages (and ultimately the delivery toolkit discussed in section 5) are the key deliverables of this communications project, with the idea being that anyone who might need to provide information about the hydrogen industry has access to these and can use for their purposes.

4.1 AHC work to date

In consultation with stakeholders, the AHC has developed material that can be used as a basis for the work on messages. There are two elements to this:

- an industry undertaking for working with communities; and
- questions and answers for the general public.

4.1.1 The industry undertaking

The NHS[37] requires the AHC to develop an industry undertaking (such as a charter) to guide the development of Australia's hydrogen industry. The undertaking will specify appropriate principles to safeguard the community, communicate issues and engage with regulators.

Consistent with community expectations of social licence undertakings, the industry is also expected to provide accurate information and respond to community concerns in a way that meets both legislative requirements and community expectations. Industry is also expected to work with local communities to ensure benefits are distributed as fairly as possible.

In February 2020, the AHC created a working group of members and representatives from governments and academic institutions to address the matter of social licence and the industry undertaking. This group remains well subscribed.

To support the working group, AHC surveyed its members and key stakeholders in May 2020 to obtain views about how it might consider and develop the industry undertaking.

[37] COAG Energy Council (2019), pages 60 and 82.

Following further discussion with the working group about the survey outcomes and the best direction for the project, it was determined that in the first instance the undertaking would:

- reflect a set of principles for working with local communities;
- demonstrate an intent to avoid harm and share benefit;
- be based on relevant precedents and approaches; and
- be complemented in time with fact sheets and other communications.

The AHC assessed similar undertakings from the renewable energy, finance, and mining industries, and the UN's Sustainable Development Goals, and drafted principles that were then discussed and revised by the AHC working group. The final principles were released in September 2021.

4.1.2 Questions and answers for the public

Following the development of the undertaking, the AHC worked on draft questions and answers for the general public, and the content for fact sheets on relevant hydrogen matters.[38] This work was shared with the working group, with comments sought and a subsequent session held to address the issues. (The need for a workshop on water was discussed at that time, and the workshop was held in December 2021.)

The AHC completed the questions and answers for general purposes, leaving out questions that needed more evidence or consultation for now. This material is shown at Appendix C. Most of the questions and answers are high level, but these provide a starting point for the modules required for the NHS communications approach.

4.2 Process to complete a first draft

Table 6 repeats the first two columns from the table in the previous section, to show the topics for messaging and the likely facts required now. Assuming any knowledge gaps have been filled, the third column in the table now shows the actions required to craft the messages.

The priority in creating these messages will be to cover the topics effectively, but it can be expected that the means of delivering the messages may vary, whether this is proactive or reactive delivery, or whether the material is available for anyone to access. The channels for delivery will also need to be explored. The consultation in this process will help identify common views where they exist.

Topic	Likely facts required now	Actions required
Safety: • Community safety • Consumer safety • Employee safety • Emergency services requirements	• Existence of appropriate government regulations and industry training. • Emergency services are trained already.	• Start with general safety message in Appendix C and test need for further detail at this stage. • Speak with key safety agencies and complaints bodies and check context and test/socialise messaging.

[38] The AHC also drafted the basic stakeholder approach provided in this strategic document and socialised this with the social licence working group.

Topic	Likely facts required now	Actions required
		• Include any relevant/key policy announcements and project examples. • Consider jurisdictional detail and contact points for key safety agencies (even if only for toolkit users).

Environment:
• Land access, coexistence with other uses
• Water access, quality, coexistence with other uses
• Air quality
	• Existence of reasonable processes to ensure fair access to all, and regulations to ensure no harm.
	• Answers to:
	  ○ How much land might be required?
	  ○ How much water might be required?
	  ○ Improvement on alternatives?
		• Develop messaging on each matter from a national perspective.
		• Cover land and water questions even if only to use as briefing/back pocket needs
		• Include any relevant/key policy. Announcements and project examples.
		• Speak with key land/planning and water agencies and complaints bodies and check context and test/socialise messaging.
		• Consider jurisdictional detail and contact points for key agencies (even if only for toolkit users)

Community: • Workforce opportunities and training; associated skills, contracts and services required • Project consultation and community engagement through project lifecycle	• Existence of appropriate government regulations and industry training. • Industry undertakings. • Quantification of benefits.	• Develop messaging on workforce that identifies current NHS project and review as that project progresses. • Include any relevant/key policy announcements and project examples. • Speak with key workforce bodies and NHS skills advisory group and check context and test/socialise messaging. • AHC to complete industry undertaking and related material.

New markets:
• Choices available for purchase
• Infrastructure to support choices, including refuelling
• Hydrogen fuel/equipment comparison on key factors, including lifecycle costs.
	• What does using hydrogen feel/look like?
	• Timing for availability for models of vehicles and equipment, and for services, including refuelling.
	• Upfront and ongoing costs
		• Map key markets and likely timeframes
		• Consider different messages also for:
		  • major industrial consumers
		  • large to small commercial consumers
		  • residential consumers.
		• Include key policy announcements and project examples.
		• Speak with key industry associations and project partners to check context and test/socialise messaging.
		• Develop user experiences – see section 5.

General: • Hydrogen basics • Where to find information • Economic benefits for regions and Australia as a whole	• Location of credible source of the truth. • Answers to: ○ Why hydrogen for Australia?	• Create one stop shop for information (see section 5) that can be referred to. • Test hydrogen basics and other Qs and As in Appendix C. • Discuss smaller consumer questions with AER, ESC and ECA in the first instance.

Topic	Likely facts required now	Actions required
• Renewables credentials • What future changes to expect • Where to find information • Energy security/independence (local and regional/national) • Implications for essential services costs	○ Why hydrogen for regions and cities? ○ What is green/blue/ clean hydrogen? ○ How much will it cost energy consumers?	• Map out potential showcasing opportunities for schools and events.

Table 6: Facts to be communicated and actions required to develop messages

4.3 Engaging with experts

This strategic framework recommends stakeholder consultation with trusted experts at several points, and this can occur through the typical means used by the jurisdictions and key bodies involved.

The proposed actions in Table 6 indicate a more comprehensive consultation approach with subject matter experts such as regulatory bodies. It is likely that this can largely occur informally, via one-on-one meetings with specific subject matter experts, such as the Water Supply Association of Australia or the Office of the Australian Energy Infrastructure Commissioner. In other cases it will be better to coordinate views through workshops, such as for members of existing jurisdictional cross-regulatory groups. There needs to be a careful balance of inclusion and efficiency.

Importantly, an overarching principle to be used in this work is to maintain consistency with the language and the messaging in the NHS, and to achieve consistency across all Australian governments. This means that while industry and NGO views will be vital to the development of the messages, they will not determine the final outcome.

Prior to consultation commencing, the NHS sub-working group will be provided with a list of parties to be consulted. This will be an opportunity for adding or deleting parties as preferred.

4.4 Next steps

Task 6: Complete list of parties to be consulted on message content for NHS Communications and Engagement Sub-Working Group.

Task 7: In consultation with the parties in the approved list, complete actions in Table 5, with a draft for review by the NHS Communications and Engagement Sub-Working Group by end April 2022.

5 Starting the delivery phase

The previous sections of this strategic framework focussed on developing messages for different audiences and for different purposes, with an important overlay of timing for communications.

The next important element of the framework will how the messages are delivered: whether they are above or below the line, the channels to be used, and who delivers the key messages. This is about bringing the material to life. There will be a range of ways to do this, and this stage of the strategic framework will be to develop a view on how this might be achieved.

There are some key principles for how we can advise people who are planning hydrogen communications, as follows:

- **Do the homework** to understand the issues related to a particular audience and consider the best level of technical information to align with people's knowledge and need at a given time. There is significant research available that can assist in checking the necessary ground to cover, such as Ashworth et al. (2019, page 41), which shows the common elements of a literature review undertaken for the NHS. Section 2.3.3 of this document outlined a staged approach, that starts with (early) scene setting information, which lays the foundation for key messages and follow up messages. It is generally advisable to engage earlier than later, but this should be considered in light of any current knowledge gaps in the messaging (which could create concern rather than comfort) or external factors that may unnecessarily cause concern. There are also more subtle elements of context, such as a community's local history (which may be inherently for or against a controversial organisation or industry),[39] underlying cultural outlook and conflict legacy.[40]

  More localised engagement must also be founded on an understanding of local matters such as previous encounters with major projects (including current sources of uncertainty) and major stock and crop dates to avoid for farming communities.

- **Value integrity in delivery**, where the 'source of truth' will be an important consideration. Research for the NHS has already found that communication is seen as a major role for government, and that CSIRO was "was frequently named as an important, trustworthy and credible source of information".[41] The need for community trust in a message sender has been well documented,[42] and has also been found to influence ultimate trust in the technology discussed.[43] Trust will also have a cultural element and vary by community; for example, indigenous message senders are vital for indigenous communities. For CCS, it has been found that trust in the message sender can be more important that people's technical understanding: "A lack of awareness of CCS does not mean that people cannot quickly gain

[39] See Whitmarsh, Xenias and Jones (2019).
[40] See Colvin, Witt and Lacey (2016), page 492.
[41] Ashworth et al. (2019), pages 14, 40.
[42] Feesntra et al. (2010), page 15; Parmite and Bell (2010).
[43] Martin et al. (2021), page 13.

some understanding and ask complex questions", and scientists and the community are "often asking and trying to answer the same questions".[44]

- **Prioritise co-ordination**. This can be seen as an extension of the 'source of the truth' principle, where a common reference source is vital for the various hydrogen-related communications we can expect in the future.

  There is a need for active engagement as well. The many industry touchpoints for hydrogen should not be underestimated – at the least, government departments, complaints bodies and industry associations will be expected to understand the effect of hydrogen-related activity on their core business. A range of NGOs will also require assistance with communications. These parties can all be expected to fit within Groups 5 and 6 of the stakeholder analysis described in section 2 of this document.

  Further, the need for coordination extends to regions that may be the site of multiple projects, with REZs as key example. As noted by the Office of the Australian Energy Infrastructure Commissioner, coordination between project developers is required "from combined community engagement and communications initiatives by developers through to coordination of construction programs to minimise cumulative impacts on residents and townships".[45] Given the need to avoid the past LNG experiences in Queensland, it would seem desirable for governments to also exercise oversight.

  Finally, coordination is required to help support Team Australia messaging here and overseas. This has already emerged as an issue, and with the importance of bringing international investment to our country it must be prioritised.

Leading from this, we need to find a home for the public messages produced through this process. Ideally all information can be hosted on (and linked to) the CSIRO's HyResource site – there is already extensive information available on projects and policy, and the site is widely referenced. This needs to be resolved by the end of this project timeframe, with messages available (end June 2022).

5.1 The value of a toolkit

Ideally there would be a communications toolkit produced. While an actual toolkit is currently beyond the scope of this project, we can still test the likely needs for a toolkit and its content through the previous discussions, and perhaps hold a stakeholder workshop once the messages are complete.

The delivery toolkit could be a document for communications practitioners that provides key information about communications in the context of the developing hydrogen industry. It would ideally be a live document that can be shared across governments and relevant industry personnel. It would also provide key contacts and connections to other relevant material, such as the AHC's undertaking.[46]

[44] Parmiter and Bell (2010), page 8.
[45] Office of the Australian Energy Infrastructure Commissioner (2021), page 35.
[46] There is also a suite of related material for related industries that should be collated and made available, such as Clean Energy Council (2021), Victorian Government (2021) and Queensland Government (2021).

The toolkit would be a digestible reference document. It would summarise and contextualise the key matters for consideration and assistance for decision making (such as checklists) to help consider various means of message delivery. This might involve a suite of material, such as factsheets, brochures, images, infographics, and web content. The toolkit would not itself be a source of risk; this is not about spin or misleading behaviour, which will be clear in the language used.

The toolkit would provide basic communications advice on when to consider using traditional media versus social media for different communications to different audiences. Hydrogen researchers have already recommended the use of Facebook,[47] and the circumstances where this is best can be elucidated in the toolkit.[48] The toolkit would also provide information about other communications tools – such as apps and virtual meetings – and their best use.

The toolkit would also address local community engagement and ways of thinking about this. For example, it has been found that when engaging with local communities "place is important", such as meeting people at community centres and their homes.[49]

Further, many in industry and government believe that community acceptance of hydrogen will be heavily influenced by opportunities for the community to engage with hydrogen directly, such as by using hydrogen vehicles or cooking on hydrogen barbecues. There are also important benefits from engaging with schools to help drive interest in future hydrogen-related careers. The toolkit would provide suggestions and advice about how to consider and plan for opportunities to showcase hydrogen. This should also address safety and means of managing safe events.

5.2 Next steps

Task 8: Determine the best hosting site for information (with CSIRO's HyResource as a priority) and make general messages available.

Task 9: Consult with the community of practice and jurisdictions on the design and intent of a communications delivery toolkit.

[47] Ashworth et al. (2019).
[48] See also the stakeholder assessment undertaken by Bond and Veitch (2020b) for the Future Fuels CRC, based on media mentions.
[49] Parmiter and Bell (2010).

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Appendix A: NHS Sub-Working group Terms of Reference

Communications and Engagement sub-working group - National Hydrogen Work Plan

Terms of Reference

Proposal - overview:

Establish a Communications and Engagement sub-working group to develop and oversee a National Hydrogen Communication and Engagement work plan to build awareness and knowledge of the hydrogen sector and support the development of Australia's hydrogen industry.

The aim of the developed work plan is to ensure the Australian community has access to an impartial source of information about the benefits, risks, and safe use of hydrogen along with the economic growth and reduced emissions emanating from the use of hydrogen. The work plan will support best practice for community engagement with public trust vital for any new industry or technology.

Ongoing collaboration and a coordinated effort is required to take communications and engagement to the next level and give the industry the best chance of success. As projects move from planning to development, more community engagement will be needed, particularly in areas with regional hydrogen hubs and infrastructure.

Benefits of an inter-jurisdictional Communications and Engagement sub-working group are:

- efficiencies in sharing work where similarities exist
- consistent messaging is applied to the hydrogen sector
- streamlining, for example a dedicated group made up of people responsible for developing a communications and engagement work plan (noting that some jurisdictions may have differing levels of resources available)
- risk management, for example sharing early to ensure consistency of approach and messaging and identifying early where blockages might be.

Proposed scope:

As a directive of the National Hydrogen Strategy (Action items 5.1 and 5.2), the project objective is to seek the development of a (national) hydrogen community education program to build awareness and knowledge of the sector, supported by best practice for community engagement.

Building on the work undertaken by the University of Queensland, *Developing Community Trust in Hydrogen* 2019 report and their conclusion that there is no one-size-fits-all approach to community engagement for hydrogen, the sub-working group will collaborate on educational content and materials that are tailored to jurisdictional-specific engagement and communication needs to build community awareness and community engagement for hydrogen projects.

This will include:

- Understanding the different audiences and community segments that need to be engaged, what/how information is communicated, and the most effective/preferred channels, that results in community trust and engagement in hydrogen;

- Developing a shared understanding between jurisdictions around the levels of community engagement necessary for hydrogen developments including engagement with regional and remote communities and less populated jurisdictions like the Northern Territory;
- Developing agreed messages for communicating about hydrogen across jurisdictions to: raise awareness and understanding of the hydrogen opportunity in Australia, foster acceptance, communicate risks, benefits, safety and issues such as water use, environmental impact, and barriers to commercialisation like cost, transport and storage;
- Developing a suite of education and promotional materials that can be used by all jurisdictions for general and targeted (to specific audiences) communications and engagement activities;
- Collaborating and partnering with key trusted partners such as the CSIRO, Australian Hydrogen Council, Future Fuels CRC and academics who are planning, or in the process of delivering, community engagement and education content;
- Overseeing and contributing to the OMD Marketing Intelligence and The20 Building Community Knowledge and Engagement on Hydrogen Research Framework report, as led by the Department of State Growth, Tasmania; and
- Feeding into international messaging on Australia's approach to hydrogen. This can be linking into channels such as AusTrade offices, overseas councillors, and relevant trade shows.

Background:

At the last Hydrogen Project Team (HPT) meeting the benefit of creating a new sub-working group to progress a national hydrogen communications and engagement work plan was discussed and endorsed. In recent bilateral discussions with jurisdictional colleagues we have further canvassed the option of a sub-working group with nominated communication officers from each jurisdiction collaborating with policy personnel as we progress hydrogen messaging development and implementation.

It is proposed that a refresh of the communications and engagement work be undertaken with a newly developed Terms of Reference drafted and endorsed by all members. This refresh will allow for a re-calibration of the membership of the subgroup and the development of a membership list and Terms of Reference for the sub-working group reflecting membership from the HPT and jurisdictional communication officers.

It is further proposed that the Commonwealth lead the sub-working group however jurisdictions will be consulted on, and collaborated with, for the provision of input to the agreed scope of work.

Membership:

Membership of the Communications and Engagement sub-working group is open to a Hydrogen policy representative and a communications officer from each jurisdiction.

Whilst it is intended that members of the sub-working group will make themselves available for meetings, proxies may participate in meetings if decision making powers have been granted by their delegate.

Meetings:

It is proposed to hold meetings of the Communications and Engagement sub-working group every 4 to 6 weeks.

Appendix B: Water research

The need to update the narrative

In December, consulting firm GHD publicly released analysis[50] that suggested that total demand to make hydrogen will be far more than the basic stoichiometric value, and as much as 60-95 litres of raw water to make a kilogram of hydrogen for electrolysis. This is because the 9 litre amount is purified water, that comes from a larger volume of less pure water. There is also water use associated with process cooling.

While this release from GHD did not generate media or public commentary, it has raised concerns in the hydrogen policy community about the jump in volume and what this will mean to communities concerned about water security/scarcity.

Further, it would seem that the mining comparisons in the NHS might cause confusion, because we can expect that the mining figure included water for processing mined commodities, whereas the hydrogen figure did not.

Table 7 provides a comparison of the possible water figures if we multiply the GHD 60 litre volume to reach the NHS Energy of the Future scenario,[51] which is 34.1Mt of hydrogen produced by 2050. Based on this analysis, we can see that the water for electrolysis to meet the 2050 scenario is more like 2.5 times the total amount used in the mining industry. This number is only indicative: the comparison figures are an attempt to contextualise the 2050 hydrogen need for water if we just dropped it into the existing economy.

Sector/scenario[52]	Water (GL)	Proportion of industry total
Deloitte H2 in 2050	2,000	17%
Total agriculture, forestry and fishing	7,319	64%
Total mining	842	7%
Total manufacturing	550	5%
Other industries	744	7%
TOTAL	11,456	100%

Table 7: Comparison of water volumes based on Deloitte scenario

It should be noted that Australian household use is around 1.8-1.9 GL/year, and the hydrogen 2050 figure (to make 34 Mt hydrogen) is around the same.

While the Deloitte figure is a scenario only, the point is that if the 60 litre figure holds, volumes in the tens of mega tonnes – whenever they are produced – will have major water requirements that

[50] GHD (2021).
[51] COAG Energy Council (2019).
[52] All numbers except Deloitte figure from *ABS - 4610.0 Water Account, Australia, 2019-20*, released October 2021. Totals are use that is self-extracted or distributed, minus flows returned to the environment, and have taken out energy and water because too large (hydropower).

can easily be calculated using current public information. This in turn creates risk for the industry as a whole and requires a more nuanced understanding of the issues from the hydrogen communications and policy community.

Important trade offs to understand

The water for electrolysis can come from different sources, and each will have its issues for levels of treatment. The main water sources are groundwater, surface water, wastewater and seawater. The 'good quality raw water' in GHD's 60 litre assessment would likely be reasonably clean surface water, which brings greater social licence concerns and likely limitations for access to water rights in existing water markets.

If we look at other sources of water, the volume figures to make hydrogen increase because they require more treatment; for example, GHD suggests at least 150 litres of seawater would be required to produce 1 kg of hydrogen.

Although this is a larger number than the 60 litres, it can be expected to be less concerning from a social licence perspective given that seawater is not a limited resource like surface and groundwater. Some stakeholders have suggested[53] that this fact would indicate that desalination of seawater will be the best response to the industry's need. This may or may not be the case and it will depend on factors specific to locations and proponents. However, desalination (and all treatment of highly saline water, which might include some groundwater) will produce brine as waste, which will need to be dealt with. This water tends to be disposed back into the ocean, which creates further concern in some locations, such as effects on coral reefs.

Using wastewater is of course an option, and figures from the Water Supply Association of Australia (2020, page 3) indicate that treating wastewater to a potable water equivalent (such as deionised water for electrolysis) would also be cheaper than desalination. Water services businesses will be keen to engage with the hydrogen industry to find uses for wastewater, and this could be a logical fit with hydrogen needs. The challenge here will be producing enough wastewater at any given location, and the potential security of supply – there will be future sources of competition for this water, which may include community needs that are currently met with potable water. Wastewater is also used for environmental flows.

There are also other trade offs that need to be understood; for example, desalination is the obvious choice for security of supply, but the desalination process requires significantly more energy than treating wastewater.

These combined factors suggest that hydrogen production will need to rely on diversified sources of water, which further complicates – and likely regionalises – any general communications.

Finally, further processing of hydrogen to its liquid form, or to make ammonia, will also increase water use. Given the discussions about hydrogen are not limited to its gaseous form, this needs to be understood.

[53] The AHC ran a session for members, governments and academics on 10 December 2021 and has also had several subsequent conversations with industry and government stakeholders to test views.

Appendix C: Initial draft messages

What is hydrogen?

Hydrogen is the most abundant chemical substance in the world. It is everywhere – it is in the air we breathe and the water we drink. H is the chemical symbol for hydrogen.

When combined with oxygen, hydrogen creates a water molecule (H_2O). When combined with carbon, hydrogen creates methane (CH_4). Liberated from the molecules, it can be used to create energy.

Hydrogen is versatile. It can be produced from a range of sources and physically converted between its gaseous and liquid states. It can also be chemically converted into other forms, such as ammonia.

When hydrogen is produced from renewable or zero-carbon sources, it becomes a zero-emission energy source. Once produced, it can be stored for later use at any time and in any place. It can power public transportation such as buses, private transportation such as cars and trucks, in heating and cooling buildings, and in industrial uses such as forklifts, smelting steel, and manufacturing steel and aluminium.

All of these applications (and more) are being developed around the world.

Using hydrogen

What is hydrogen used for today?

Hydrogen is an industrial raw material, and it can be combined with other things to create hydrogen-based fuels and feedstocks. There is already a market in hydrogen for various applications, such as for making fertilizer for the agricultural sector. Most hydrogen used today is produced from fossil fuels.

How will we use hydrogen in the future?

We can expect hydrogen to continue to be used as an industrial raw material, but with new opportunities to decarbonise hydrogen production, future hydrogen can be clean and green.

When we are talking about the further potential for hydrogen to support decarbonisation, we are generally talking about hydrogen in its pure form, where it is an energy carrier. Hydrogen stores energy which can be used at later times and can be transported to different places. In this way, hydrogen acts like a battery. However, unlike conventional batteries, hydrogen technically allows indefinite energy storage periods.

Clean and renewable hydrogen can be used to help us to reduce emissions in the following ways.

Stationary energy

Hydrogen has two main uses in stationary electricity generation.

- It can produce heat though combustion or chemical processes (either in its pure form or as ammonia) to drive a turbine in much the same way that natural gas is currently used.

Hydrogen used in this way can reduce the carbon emissions of high temperature processes and existing fossil fuel powered electricity generators.

- It can be used in a fuel cell. When used in fuel cells, electrons are stripped from the molecule to create an electric current. The remainder of the molecule is combined with oxygen from the air to create water as a by-product. Fuel cells are generally used for smaller scale applications such as remote area power systems or backup generation.

In homes and businesses

Hydrogen can be used in homes and businesses just like natural gas, but when burned there are no carbon emissions, just water vapour and heat.

Businesses using natural gas for heating processes (manufacturing and food processing for example) already have the option to decarbonise energy use by converting to renewable electricity for many applications.

However, some processes – such as those requiring very high temperatures – are difficult to convert to electricity. Hydrogen can be a direct, low or zero emissions substitute for natural gas. Some of the industries where this could be used are steel and aluminium manufacturing, food processing, and brick and glass making.

One of the early applications for hydrogen in Australia is to blend into natural gas for homes and businesses. The addition of hydrogen to reticulated natural gas at low concentrations will not require any change to infrastructure or appliances and will lead to lower overall carbon emissions. It also provides a ready source of demand to encourage the market.

For transportation

Most land transport applications of hydrogen will involve the use of a fuel cell.

Fuel Cell Electric Vehicles, or FCEVs, have a tank where the hydrogen is stored, a battery (much smaller than for a battery electric vehicle) and a fuel cell.

Technology exists to run trains, aircraft and marine vessels on hydrogen in various forms and these are likely to play a large part in decarbonising freight and long-haul passenger transport.

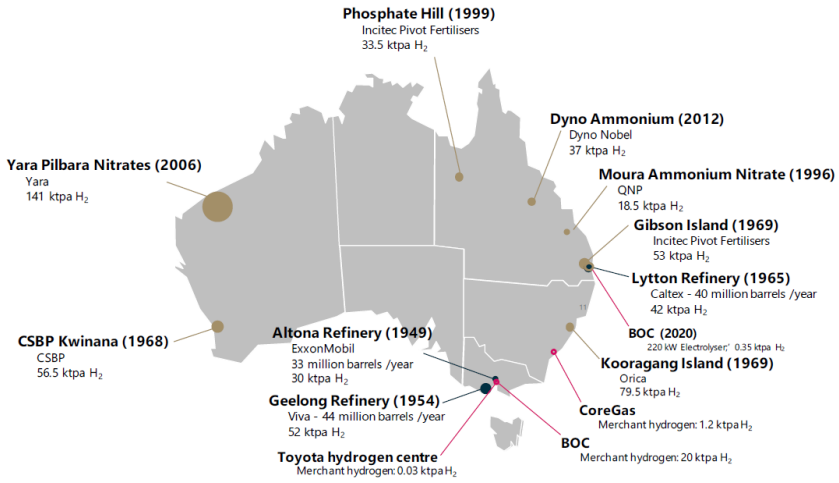
How much hydrogen is used today?

The International Energy Agency has identified around 70 million tonnes per year (MtH2/yr) of demand worldwide for ‘pure’ hydrogen (hydrogen with very low levels of additives or contaminants). Hydrogen of this type is commonly used for refining oil and producing ammonia for fertilizer.

There is a further 45 MtH2/yr of hydrogen used in a mixture of gases, such as synthesis gas, for fuel or feedstock. This hydrogen is mainly used for producing methanol and steel.

Almost all of the current market for hydrogen uses hydrogen made via fossil fuel processes, with carbon released into the atmosphere.

Figure 1-1 – Existing hydrogen production / use centres



SOURCE: Advisian (2021) *Australian hydrogen market study: Sector analysis summary*, 24 May, for the Clean Energy Finance Corporation, page 21, https://www.cefc.com.au/media/nhnhwlxu/australian-hydrogen-market-study.pdf

At this stage, what is the most likely use for clean and renewable hydrogen?

There are many potential markets for hydrogen, with a lot happening. This makes it difficult to predict which industry will be the first to use clean or renewable hydrogen commercially, and this may even vary by country.

For Australia, heavy transport is likely to be one of the first industries where hydrogen is an attractive alternative, because petrol and diesel are expensive and the cost for hydrogen is more competitive. The weight of batteries can also compromise effective payload for freight.

Replacing diesel use more generally will be possible for mining and remote communities.

Additionally, there are gas blending demonstrations already happening today where hydrogen is replacing a portion of natural gas and continue to be used for heating and cooking.

Making hydrogen

How do we make hydrogen?

Unlike traditional energy sources such as timber, coal, and petroleum products, hydrogen rarely occurs naturally in its pure form. Hydrogen bonds easily with other elements, such as oxygen to make water (H_2O) and carbon to make methane (CH_4).

We make hydrogen by splitting it out from these and other molecules via one of several processes.

Electrolysis

Electrolysis is the process of using electricity to split water molecules into hydrogen and oxygen atoms. This reaction takes place in a unit called an electrolyser. When renewable electricity is used in this process – such as direct from solar or wind farms – no carbon emissions are released during this process and we refer to the hydrogen as ‘green’ or renewable hydrogen.

Although electrolysis is a well-understood process, we do not yet produce large quantities of hydrogen this way. A global race is on to develop the technology at scale.

Steam Methane Reformation (SMR)

To produce hydrogen via SMR, water enters a furnace, producing steam at a very high temperature. This steam reacts with natural gas, producing hydrogen and carbon monoxide. A further process then reacts the carbon monoxide with more water to make additional hydrogen and carbon dioxide.

Although this method does produce carbon emissions, it can be considered 'clean' if the emissions are captured and permanently stored underground using a process known as carbon capture and storage.

Coal gasification

Contrary to popular belief, coal is not pure carbon. It also contains other elements, one of which is hydrogen. To get a lot of hydrogen from coal, the coal is put into a high-pressure 'gasifier' to release hydrogen and oxygen.

Brown coal generally contains more hydrogen than black coal (it has a higher water content) which is why the technology is being used in Victoria's Latrobe Valley.

Other hydrogen production pathways

Researchers are looking at other ways to extract hydrogen from its various molecular forms, such as:

- Reacting renewable liquid fuels, such as ethanol or methanol (alcohols), with high-temperature steam.
- Fermenting biomass (carbon-based matter) via micro-organisms, such as bacteria, which digest the carbon and release both sugars and hydrogen.
- Using micro-organisms, such as green microalgae or cyanobacteria, which use sunlight to split water into hydrogen and oxygen.
- Concentrating either solar or nuclear waste heat to drive a series of chemical reactions to produce hydrogen.
- Using semi-conductors that convert solar energy directly into chemical energy in the form of hydrogen.

Is hydrogen clean to make?

Production of hydrogen via electrolysis requires electricity which, depending on how it is generated, may or may not emit carbon.

Electrolysers can be connected directly to renewable energy sources such as solar and wind farms; that is, using electricity direct from the source and not via the electricity grid. This is referred to as 'off-grid' or 'behind the meter' generation, and it produces renewable (or 'green') hydrogen.

Hydrogen made with electricity from the grid can also be renewable if 100 per cent renewable electricity is used.

If electricity from the grid is not renewable, the hydrogen produced from this is not renewable. It may be that some projects have a mix of approaches (such as renewable hydrogen from solar during the day and non-renewable hydrogen from the grid overnight).

Where hydrogen is produced via steam methane reforming or coal gasification, carbon is a by-product. This hydrogen is considered clean (or 'blue') where carbon emissions are collected and stored through a process known as carbon capture and storage (CCS).

How do we know if hydrogen comes from renewable sources?

Hydrogen producers in Australia will have to demonstrate how their hydrogen was made. The Australian Government is working to develop a Guarantee of Origin scheme to ensure that consumers can verify the hydrogen production location, methodology, and the emissions profile associated with the hydrogen production.

Similar certification schemes are being developed across the world, such as the CertifHy project in Europe. Australia's scheme will need to be developed in line with the approaches taken by our trading partners so that they will recognise our certification.

More information

The Australian Government has been taking a lead role in the International Partnership for Hydrogen and Fuel Cells in the Economy's (IPHE) Production Analysis Taskforce, which is aiming to develop a methodology for determining the greenhouse gas emissions associated with the different hydrogen production pathways. This group is currently developing detailed accounting methodologies for five production pathways. IPHE is an international inter-governmental partnership whose objective is to facilitate and accelerate the transition to clean and efficient energy and mobility systems using fuel cells and hydrogen (FCH) technologies. It has 22 members including many European countries, the United Kingdom, the USA, Japan, Korea, Chile and others.

On 22 June 2021 the Department released its discussion paper on the design of a domestic hydrogen Guarantee of Origin scheme, that aligns with Australia's requirements and the international work being undertaken through IPHE.

Australian Government (2021) *A Hydrogen Guarantee of Origin scheme for Australia*, discussion paper, June.

Why now and what needs to happen

Why are we hearing so much about hydrogen these days?

Hydrogen is already an established fuel source, but it has not been able to compete with the established energy sector. Fossil fuels have provided a cheap and abundant source of energy and the price of hydrogen is not competitive.

But this is changing. Climate change is seeing a global need to decarbonise our economies, and the cost to produce renewable electricity has fallen significantly. While solar and wind power will electrify many parts of our economy, this will be difficult for some sectors where electricity will not

be an adequate replacement due to a need for very high temperatures, or for vehicles where batteries will not be efficient or practical. Renewable hydrogen offers a zero emissions alternative fuel source which could help cut emissions in sectors which face significant barriers to decarbonise, such as transport, manufacturing, and agriculture.

Hydrogen now has the potential to play a major part in the future energy mix. However, we still need to get the costs down and establish the industry at scale.

What's happening globally in hydrogen?

Countries around the world have taken legislative and policy steps to reduce carbon emissions, including developing hydrogen strategies. We are seeing the US, UK, Japan, Germany, South Korea taking an early lead, with each country stating hydrogen objectives for the next few years.

Have a look at the CSIRO's HyResource at https://research.csiro.au/hyresource/. This is a one stop shop for domestic and global hydrogen policies.

How do you create an industry that doesn't yet exist at scale?

The challenge faced by the hydrogen industry is akin to the age-old riddle – what came first, the chicken or the egg. Development of hydrogen production needs a stable, sizable consumer base, yet a stable, sizable consumer base needs stable, sizable supply.

Good policy is needed to encourage consumer demand and improve the economics of producing hydrogen, which would ultimately increase cost competitiveness of hydrogen supply and lead to greater uptake.

Are there any hydrogen projects at a commercial stage?

Clean and green hydrogen projects in Australia are currently in pilot and demonstration phases, but we expect them to reach commercial stages in the coming years.

Have a look at HyResource at https://research.csiro.au/hyresource/. This provides a great summary of the announced clean hydrogen projects in Australia to date.

Who is Australia's competition as a supplier?

Competing hydrogen producers such as Chile, Canada and Portugal as well as middle eastern countries, are scaling up hydrogen production capabilities. Anywhere that has land for solar and wind, or offshore wind, and has the capacity to do things at scale, is a potential competitor.

Australia has a long history as an energy exporter and the Australian hydrogen industry is committed to becoming a world leading hydrogen exporter.

Fuel cells and FCEVs

What is a fuel cell?

Fuel cells generate electricity through an electrochemical reaction, not combustion. Within the fuel cell, hydrogen and oxygen are combined to create electricity, heat, and water. Fuel cells never deplete or need recharging. Instead, they require a steady supply of hydrogen that the fuel cell combines with oxygen to provide the power.

Hydrogen fuel cells are being developed to power a wide range of vehicles: cars, trucks, heavy haulage vehicles, forklifts, trains and buses. Fuel cells can also provide power to homes and businesses, as well as provide power stability for hospitals, grocery stores, and data centres. Fuel cells are zero emission, and the only products are water, electricity, and heat.

Because there are no moving parts to a fuel cell, it operates silently and reliably. Fuel cells are also more efficient than internal combustion engines or steam turbines. Additionally, they can be combined into stacks, for large scale applications.

How does a fuel cell work?

A fuel cell works in the opposite way to an electrolyser.

Composed of two electrodes (a cathode and an anode) separated by an electrolyte membrane, a hydrogen fuel cells works in the following way:

- Hydrogen gas enters the fuel cell through the anode. In the anode, the atoms of hydrogen create a chemical reaction with a catalyst, splitting into protons and electrons. At the same time, oxygen from the atmosphere enters the fuel cell via the cathode. (The catalyst, typically made of platinum particles, facilitates the chemical reaction).
- There is a porous electrolyte membrane between anode and cathode. The positively charged protons pass through the membrane to the cathode and the negatively charged electrons are forced through a circuit generating electricity.
- In the cathode, the oxygen and protons then combine to produce water.

Is a fuel cell vehicle an electric vehicle?

Yes, the difference is that a fuel cell electric vehicle (FCEV) generates electricity as it moves, through the chemical reaction in the fuel cell. A battery electric vehicle (BEV) carries all of its electricity in a battery, but an FCEV carries hydrogen to make the electricity.

By carrying hydrogen instead of a large battery, FCEVs have more space for commercial payload and can carry enough fuel to achieve the same range as modern petrol or diesel vehicles.

Are fuel cell vehicles better than battery vehicles?

Fuel cell electric vehicles and battery electric vehicles each have various characteristics which make them more or less suitable for different applications.

The electricity produced by a fuel cell is no different to that produced by a battery, so most of the componentry in battery and fuel cell electric vehicles is identical.

Many cars (such as family cars) are likely to be run on batteries, but drivers who are likely to regularly travel long distances or do not have off street parking to enable night-time charging may find a fuel cell vehicle more appropriate.

Because there is a conversion involved, hydrogen to electricity is less efficient than electricity from a battery. However, hydrogen's light weight means that it is suitable in long distance and heavy haulage transport applications. Most heavy transport is suited to fuel cells rather than batteries, but there will almost certainly be exceptions.

Safety

When handled correctly, hydrogen is as safe as any of its alternatives. If not handled or stored correctly, hydrogen can combust; however, the same is true of natural gas, petrol or diesel.

One of the properties which makes hydrogen relatively safe when compared to other fuels is the fact that it is the lightest element. When hydrogen is released (because of a leak or spill) it disperses rapidly and is consequently unlikely to ignite.

Hydrogen has been safely produced, stored, and moved around the world since the 1950s, mostly in the petroleum processing and fertilizer sectors. Hydrogen does require controls to facilitate its safe use, but that is no different than needing to establish safety protocols for other fuels.

Safety guidance will need continued research and development while hydrogen continues to be developed for more applications across the economy.

There are international groups dedicated to establishing and maintaining an increasing number of hydrogen safety standards. For example, the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) is a government-to-government partnership working on safety standards, regulation development, certification of origin schemes, trading, intellectual property, and education. Australia and its key trading partners are all part of this collective and share leadership roles towards advancing an international set of standards for hydrogen.

The industry is working with Standards Australia and regulators to mirror international standards in Australia and establish the right regulatory framework to instil community confidence. Emergency services will need to be trained to respond to situations where hydrogen is present, and in Australia this work has begun.

As hydrogen infrastructure, and applications become more broadly available, demonstration projects and trials will proceed in a structured, logical way to ensure that hydrogen usage poses no greater risk that are than current fuels.

The work of Standards Australia

In July 2020, Standards Australia adopted eight international standards relating to hydrogen quality, storage, transportation and usage. The standards cover:

– safety aspects of hydrogen generators;

– the performance of stationary hydrogen generators for residential, commercial and industrial applications;

– the quality of hydrogen fuel for vehicular and stationary applications;

– the construction, safety and performance of systems to produce hydrogen by the electrolysis of water;

– design and safety features of systems to purify hydrogen to meet quality standards;

– design, construction and testing of portable hydrogen containers;

– design, manufacture and testing of tanks for hydrogen-powered vehicles;

– safety and testing of high pressure valves used in refuelling stations for hydrogen powered vehicles.