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28 July 2019

Attn: Ms Alison Reeve
Taskforce Leader
National Hydrogen Strategy Taskforce
Department of Industry Innovation and Science
GPO Box 2013
Canberra ACT 2601

Dear Ms Reeve

REF: COAG ENERGY COUNCIL NATIONAL HYDROGEN STRATEGY WORKING GROUP ISSUES PAPERS

Woodside would like to thank the National Hydrogen Strategy Working Group for the opportunity to comment on the Issues Papers and for the opportunity to participate in the Working Group meetings.

Woodside agrees that it will take a concerted and coordinated effort to establish a significant hydrogen industry, and will require the support of all parties if Australia is to meet its goal of being a major player by 2030. The Working Group are to be congratulated on capturing a significant amount of information from a broad range of stakeholders and building a comprehensive picture, including opportunities and challenges, of a future hydrogen industry in Australia.

One critical area that Woodside strongly advocates needs for change is the requirement for hydrogen derived from fossil fuels to use Carbon Capture and Storage (CCS). We believe that arguing that "*'clean hydrogen' [is] defined as being produced… using fossil fuels with carbon capture and storage*"* is too narrow. The definition limits the development and application of other carbon conversion or offsetting technologies for managing the carbon produced from fossil fuel-based hydrogen. For example, considerable research and resources are being directed at developing carbon into new materials both here in Australia and overseas. As Issue Paper 1 notes the costs of CCS may fall overtime however other offsetting or carbon conversion technologies may also develop and prove more cost effective. We believe it would be beneficial for the development of a hydrogen export industry for the definition to be expanded accordingly.

Please find attached Woodside's comments to the Issues Papers.

Yours sincerely

pp.

Shannon O'Rourke
General Manager, Hydrogen
Woodside Energy

Attached: Woodside Energy Submission: National Hydrogen Strategy Issues Papers July 2019
Copy: Jason Crusan, Vice President, Technology, Woodside Energy

*National Hydrogen Strategy Issues Paper 1 Hydrogen and Scale

Woodside Energy Submission: National Hydrogen Strategy Issues Papers

July 2019

Issues Paper 1: Hydrogen at Scale

Questions

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

    - To lower the hurdles for investment we should design to minimise infrastructure needs and maximise gross profitability. Infrastructure endowments vary by location, and each technology has different infrastructure needs. If hydrogen production costs are the primary determinant of gross profitability, and these are relatively similar across locations, then it follows that minimum scale is driven by infrastructure needs for a given location together with the chosen technologies.
    - To illustrate, Liquid Organic Hydrogen Carriers (LOHC) technologies can utilise existing tank, loading and port infrastructure; whereas liquid hydrogen and ammonia technologies require dedicated storage and offtake infrastructure. However, both liquid hydrogen and ammonia technologies may utilise existing intermodal transport (e.g. isotainers) to overcome initial scale hurdles.
    - Introducing infrastructure needs by requiring geo-sequestration could be a significant barrier to becoming a global exporter of hydrogen, particularly if other jurisdictions opt for other CO2 mitigation methods, including offsets and carbon conversion technologies, that are more cost effective in their locality (e.g. Saudi Arabia utilising CCS for Enhanced Oil Recovery; an opportunity with limited potential in Australia).
    - We support the Working Group commissioning Geoscience Australia to develop a map and a short report locating and highlighting the size and potential resource availability of Australia's prospective hydrogen production regions. We would recommend Geoscience Australia consider sites suitable for sequestration in relation to prospective hydrogen production regions. The statement that "Australia has the advantage of proven offshore sites suitable for the sequestration that a large-scale CCS hydrogen industry will require*" is wide-ranging and does not appear to reflect the complexities and understanding different types of reservoirs and their location to potential hydrogen export facilities.

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

    - To maximise the advantage of scale, Australia should consider Government sponsored export regions and special economic zones. Special economic zones are utilised internationally to attract labour, investment and improve competitiveness in places like Hong Kong, Shenzhen, China; Batam, Indonesia; and Berlin, Germany.
    - Investment could be shaped through tax credits/incentives for investing in export hydrogen production and distribution, Government and private financed infrastructure, and favourable approval frameworks for chosen locations.
    - Private refuelling infrastructure owners could be encouraged to make their infrastructure shared with financial support, expedited regulatory and environmental approvals.

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

- The education and training sector, particularly for trades, needs to start modifying the training services in the near term (1-2 years) to start facilitating the transition. In many cases the core offerings require adaptation to accommodate a domestic and export hydrogen industry.
- Understanding upskilling needs by engaging with international jurisdictions who are more advanced (e.g. Germany) in their transition to a hydrogen industry to leverage learnings.
- We recommend an education and training taskforce to lead short and long-term planning for a transition. The taskforce would be populated by government, industry, industry associations and other key stakeholders.
- Supporting international visas for international experts to teach Australian employees.
- Tax incentives for investing in hydrogen training.

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

- **Economic activity around a particular location builds competitiveness.** China's experience with Shenzen commencing in the early 1980's is useful, as are industry case studies like the North East of England Process Industry Cluster; which now manufactures 50% of the UK's petrochemicals and 35% of the UK's pharmaceuticals. This can be achieved through fiscal incentives as well as industry coordination.
- **Government demand creation can assist in overcoming initial investment hurdles for industry.** Support for the Woodside operated North West Shelf Project (NWS Project) received from the Western Australian and Federal governments is an example of this. In August 1977 both governments and the project participants agreed on development conditions for an integrated domestic and LNG export project. The NWS Project was developed in two phases, Phase 1 domestic gas and Phase 2 LNG export. Phase 1 included the State Energy Commission of Western Australia (SECWA) having responsibility for the construction and funding of the 1500 km onshore pipeline from the gas plant on the Burrup Peninsular to Perth and the south west. In 1980 SECWA also signed contracts for the 20 year supply of 414 terajoules of gas and domestic gas sales commenced in August 1984. It was five years later in August 1989 the first LNG shipment arrived in Japan.
- **Acting at scale is critical to generate and sustain and internationally competitive cost advantage.** The experience of the UK motorcycle industry is instructive on the importance of industries with economies of scale. Please refer to "Strategy Alternatives for the British motorcycle industry – A report prepared for the Secretary of State for Industry by Boston Consulting Group". This report is available at: https://www.gov.uk/government/publications/strategy-alternatives-for-the-british-motorcycle-industry

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

- Harmonisation of legislation and regulations governing the industry by 2022 are required if the government's timeframe for a decision on at least one large-scale hydrogen supply project is to be met.
- Streamlined land access and project approvals requirements, including Health Safety Environment (HSE) related (State and Federal) to de-risk approvals timelines and provide certainty. Target 2022 to meet the government's timeframe for a decision on at least one large-scale hydrogen supply project.
- Direct adoption where practical of international standards by 2022 and accelerated development of standards to close gaps identified
- It is extremely important for State and Federal policies to be aligned.

Issues Paper 2: Attracting Hydrogen Investment

Questions

1. *What changes to existing government support and additional measures are needed to:*

    a. *commercialise and scale up the hydrogen industry?*

- To provide certainty and facilitate investment we advocate a clear, consistent and stable national policy together with regulations that are aligned at state level.
- Export: The state and federal governments should consider direct investment in shared infrastructure to promote the establishment of hydrogen producing regions; and consider grants and tax incentives to encourage production and/or sales.
- Domestic Transport: The state and federal governments should encourage a domestic hydrogen industry through procurement (supporting fleet purchases including bus fleets); and direct support of hydrogen fuelling demonstration sites as envisaged by COAG.
- Government setting firm and ambitious targets on hydrogen as a % of power/transport in Australia (e.g. by 2030 10% of Australia's power is produced from hydrogen and 15% of new car sales)
- Domestic Industry: Introduce measures that promote development and commercialisation of local content; by offering equalisation support for local export producers to select Australian made products. This support could be removed as the industries achieve scale.
- Power to Gas: The government could introduce a Zero Emissions Gas (ZEG) target, modelled off the Renewable Energy Target, to place an obligation on industrial consumers or wholesalers to source green hydrogen as part of their gas supply. A market-based system would maximise use of existing gas infrastructure and enable hydrogen to be generated where it's most cost effective. Allowing hydrogen to supplement domestic gas obligations will enable domestic hydrogen pipeline injection to be considered more favourably.
- Grid Stabilisation: The current renewable energy target system does not offer an incentive for dispatchable renewable energy. The government could consider compensation systems that create a market for dispatchable renewable energies. Hydrogen could then compete at grid level with other forms of dispatchable renewable power.
- Consideration should be given to the unit of measure for retail hydrogen. A defined "Litre of Gasoline Equivalent"; the energy equivalent of a litre of gasoline, adjusted to account for the higher efficiency of a fuel cell c.f. internal combustion energy vehicle would likely increase consumer transparency and acceptance. A consumer will have no reference for a "kilogram" of hydrogen and may be put off by a high per-kilogram price c.f. existing liquid fuels.

    o *ensure an appropriate balance between export and domestic demand?*

2. *How do we ensure an attractive investment environment for private sector finance? Which methods would be most effective in leveraging maximum private sector finance and which activities should governments prioritise with limited funds? How should these methods change over the short, medium and long term?*

- Private sector finance (capital) is prima facie attracted to investments with returns commensurate with risk.
- To provide certainty and facilitate investment we advocate a clear, consistent and stable national policy together with regulations that are aligned at state level.
- In the short / medium term the focus should be on supply and demand side incentives to develop the use of hydrogen as a low emission fuel.
- In addition to customer side incentives, also it is worth considering manufacturer incentives. Options may include for example:
    - The introduction of capped tax depreciation effective lives for manufacturers. Currently the ATO provides a 25-year tax depreciation for hydrogen manufacturing assets. A shorter depreciation period would improve economics of hydrogen manufacturing operations.
    - Expanded grants to support pilot projects and early stage demonstration.
    - Encouraging collaboration between industry and the research community, for example by introducing the R&D tax incentive collaboration premium (and/or similar to hydrogen projects).

3. *What level of domestic market support is needed to achieve COAG Energy Council's ambition of being a major global player in hydrogen? In particular, what types of support will best provide the necessary domestic skills and capabilities and ensure domestic markets are available in the event that international markets do not emerge as quickly or as extensively as expected?*

- Export industry will require significant capital and technology investment over a sustained period of time (~10 years).

  Types of support required:
    - CSIRO / R&D (eg universities) support to develop emerging hydrogen technologies
    - Australian capital (superannuation funds)
    - Streamlined approvals processes from all levels of government
    - Direct investment from foreign firms
- The Woodside operated North West Shelf Project (NWS Project) received support from both the West Australian and Federal governments when in August 1977 both governments and the project participants agreed on development conditions for an integrated domestic and LNG export project. The NWS Project was developed in two phases, Phase 1 domestic gas and Phase 2 LNG export. Of critical importance for the development of Western Australian's domestic gas in Phase 1 was the State Energy Commission of Western Australia (SECWA)

who had the responsibility for constructing and funding the 1500 km onshore pipeline from the gas plant on the Burrup Peninsular to Perth and the south west. Additionally, in 1980 SECWA signed contracts for the 20 year supply of 414 terajoules of gas and domestic gas sales commenced in August 1984. It was five years later in August 1989 the first LNG shipment arrived in Japan.

4. *What market and revenue designs and settings will best allow for sustainable growth of the hydrogen industry and an appropriate level of benefits flowing back to the Australian public?*

- The Government need to provide clarify on the long-term tax arrangements for hydrogen (e.g. fuel excise on an energy basis)
- Additional revenue arrangements should not be contemplated or made at this early stage that act to impede the growth of hydrogen industry. It is too early to start contemplating what future taxation arrangements may be appropriate once the industry is 'mature' – this should be assessed at a later stage.
- There is a comment in the paper that it is necessary to consider the tax, excise and royalty treatment of hydrogen while at the same time noting it is not specifically taxed, as it is not considered a fuel or mineral resource. The latter part of this sentence is correct - hydrogen should never be subject to royalty or resource rent based taxes given it is a downstream / value-add product and where derived from fossil fuels, these upstream arrangements are already subject to resource taxes.
- Clarity on excise arrangements is crucial. For example, Wesfarmers' investment into EVOL was substantially impacted by excise being added to LNG Fuels.

5. *What market signals and settings are needed to capture hydrogen's sector coupling benefits? When should these market signals and settings be applied?*

Issues Paper 3: Developing Australia's export industry

Questions

1. *How do we best position and sell the benefits to international partners of investing in Australia's emerging hydrogen industry?*

- Australia is a premier destination with excellent renewable resources, stable government, and is supportive of foreign investment.
- Australia should be seeking partnerships that are forged on shared value. This means buyers and sellers collaborating on solutions and exploring options at the outset of a development rather than negotiating solely on price.
- Australia should support demonstration/pilot projects of national significance in a way that both countries learn and benefit. Relationships will be built through these projects.
- Initial lighthouse projects must be carefully selected. Developments that are sensitive to local stakeholder needs will proceed smoothly and paint Australia in a positive light.
- We recommend looking to countries around the world who are well advanced in their hydrogen supply chain, like Germany, Korea, and Japan. These countries could have knowledgeable and willing partners to invest in Australia

2. *How could governments support the cost competitiveness of Australia's hydrogen exports?*

- Hydrogen has the potential for large economies of scale and scope. Capturing initial export projects will enable Australia to progress down the learning curve and become relatively advantaged.
- Measures to capture initial projects could include: Government to Government export agreements; direct project funding; support and fast-tracking of government approvals; fiscal incentives to develop hydrogen projects.
- Targeted research and development will be critical to create a cost and efficiency edge; however, Australia must take steps to accrue the benefits. The US Department of Energy's Hydrogen Program is a good example of a targeted program that has delivered results and positioned US domiciled companies advantageously in the global market. The US also directs aid and other benefits in a way that facilitates US trade and corporate development.

3. *What could governments do to encourage commercial offtake agreements for export?*

- Korean and Japanese companies are acting to support their government policy. These companies respond well to national objectives. Government to Government agreements, including trade agreements and memoranda of understanding are symbolic and important. These agreements send strong messages of support.
- Direct support may be necessary to reciprocate the government support of client nations.

- Competing nations are seeking commercial offtake by strengthening broad trade ties and offering foreign investments. Saudi Aramco recently announced $6bn in Korean refinery upgrades and Saudi companies simultaneously announced $8.6bn in adjacent Korean investments. https://www.bloomberg.com/news/articles/2019-06-26/aramco-plans-6-billion-korean-refinery-boost-to-place-saudi-oil ; https://www.saudiaramco.com/en/news-media/news/2019/aramco-12-agreements-korea-partners. Even the largest Australian companies would find it difficult to offer similar incentives to client nations. Australia must think carefully about the collective measures at its disposal to secure a favourable trade deal.
- We believe the Federal Government should lead trade negotiations. Multiple state-based approaches have the potential to make an Australian effort seem disconnected and haphazard; seen from the other side, it would be unusual for an individual Japanese prefecture, or Korean region to work independently from their national government. Business should be responsible for business to business negotiations.

4. *How do we balance our global competitiveness with ensuring all Australians benefit when considering the collection of government revenues from hydrogen exports?*

- In these early stages establishing global competitiveness is critical. Australia will not be able to tax an industry that doesn't exist. Every mechanism should be used to capture an early position that enables Australia to build advantage at scale.
- However, the benefits for Australians in the early stages could include; cheap renewable energy, implemented at scale; energy security; grid decarbonisation due to energy storage and grid support; equipment manufacturing and export; improved terms of trade; continued economic growth past the decline of fossil fuel industries; and local energy intensive resource processing.

5. *What can (or should) be done to ensure an appropriate balance between export and domestic demand?*

6. *How ambitious is the target of fulfilling 50% of Japan and Korea's hydrogen imports by 2030?*

- Depending on buyer's affordability, supplying 50% of Japan and Korea's hydrogen demand is ambitious, but achievable. Achieving a high market share will be important to secure the scale advantages which will continue to differentiate Australia.
- Market share is an important contributor to economic returns. Australia should pursue a strategy targeting high market share even if economic returns are lower in the medium term. https://hbr.org/1975/01/market-share-a-key-to-profitability
- Please note that Australia is not comparatively advantaged. The cost for renewable energy in Australia is higher than Saudi Arabia (2.13c/kWh). https://www.windpowermonthly.com/article/1488602/saudi-arabia-opens-wind-bids Australia will need to act decisively to secure the opportunity.

- Securing this target will require a focus on relatively mature midstream technologies, such as Ammonia. Further work is required on the other midstream technologies to broaden the export pathways.

Other comments:

- We support the government's potential actions below in Issues Paper 3 Table1 (below) highlighted in the 2020-23 timeframe however we believe the actions to a Final Investment Decision (assuming it is not a government decision) on a large-scale project by 2023-25 would require more than offtake agreements and considerable work will have to be done prior to this date.

Issues Paper 3: Table 1 – Potential actions required to develop Australia's hydrogen export industry

Secure high-level country-to-country strategic agreements and define frameworks **Secure Australia's role as a leader nation in international engagement, including multilateral, bilateral forums, and collaboration in conferences, trade fairs, international events** Collaborate and work with competitor nations, and global industry, to grow the market while maintaining a competitive advantage **Continue to support export supply chain pilot projects and associated RD&D to reduce the costs of production and transportation** Continue to pursue investment opportunities for their early commercialisation Develop guarantee of origin requirements to assist in substantiating clean hydrogen production and best position Australian clean hydrogen Carry out quantitative analysis to determine cost competitiveness of Australian hydrogen production for export Identify possible joint venture consortiums for future hydrogen supply chain development	Secure offtake agreements Achieve Final Investment Decision on at least one large-scale hydrogen supply chain project Finalise an infrastructure plan for hydrogen export supply chains Establish Australia as a global base for hydrogen trade (export trading platform) Continue to drive down the hydrogen supply chain cost curve – channel RD&D towards technologies and approaches to bring down the cost of production and at-scale supply Determine the best transport methods for Australia's export supply chains	Construct large-scale hydrogen supply chains to capture the benefits for Australia Achieve a target of fulfilling 50% of Japan and Korea's hydrogen imports by 2030

Issues Paper 4: Guarantees of Origin

Questions

1. *When should Australia aim to have a guarantee of origin in place? Why is this timing important?*

- As early as possible Australia must build a positive narrative around hydrogen production and consumption. A classification scheme will build trust and certainty in the minds of consumers and media. It will also avoid misclassification from industry participants.
- As much as possible, certification of origin schemes should draw from existing frameworks and use common language understood within the industry.
- We agree that certificates of origin should be managed through a Federal scheme with robust practices that govern classifications. Parallels can be drawn to the accreditation of Australian Carbon Credit Units (ACCUS) and governing processes that underpin the quality of the end product.
- One possible mechanism is to couple existing carbon credit schemes, NGERs reporting and hydrogen sales to generate a database of the emissions intensity of hydrogen produced in Australia. This way, the over-arching emissions intensity of the product can be tracked from the emissions of carbon to the acquittal of ACCUs.

2. *What would be the best initial scope for a guarantee of origin? Why? Should there be two separate schemes for international and domestic requirements?*

We advocate a scheme that is simple to understand, objectively true, incentivises decarbonisation and is low cost. These would be:

- Simple categorisation that contrasts renewable (green), non-renewable carbon-neutral (blue) and non-renewable with emissions (brown) sources; to make it easy to understand for an uninformed consumer.
- Considers both scope 1 and 2 emissions only; as these are (a) the only scopes of emissions within the control of the producer, (b) the only scopes within the definition of "origin", scope 3 includes destination and (c) ensures fair treatment between those producers who generate their own energy (scope 1) and those who purchase it (scope 2).
- Ensures that producers that use renewable electricity are objectively using a renewable source and have not relied on non-renewable sources to lower their cost. It would be false and misleading to assert that hydrogen produced using a grid connected electrolyser was wholly renewably sourced, if renewable energy certificates (REC) were used to back the assertion. REC only guarantee that a renewable energy was produced, not renewable energy produced at a given consumption time. Used in this way, REC are insufficient evidence of renewable energy consumption, especially from time of day dependent sources (solar) and intermittent sources like wind.
- Categorisation should be based proportionally on energy feedstock rather than lifecycle emissions or associated thresholds. This is intuitive, simple to understand and low cost to administer. It also has the added benefit of incentivising decarbonisation. In the above example, a grid connected producer could categorise a proportion of their production "blue"

and "green" based on the proportion of energy from each source, then command a market premium for green; and in doing so, incentivise further green production.

- Categorisation should also be based proportionally on a technology agnostic approach to carbon neutrality. Some companies will deploy fossil fuel cracking technologies that reduce carbon emissions by creating solid carbon. They will offset additional production costs with by-product revenue. Others will use CCS, carbon conversion technologies and offsets. By enabling blue or brown production to be categorised in proportion to the quantity of net carbon-neutral emissions, it will incentivise companies to invest in lowering emissions and enable them to do this based on market-based systems which are likely to be efficient and competitive on an international stage.
- A potential difficulty arises in the proportional approach to carbon neutrality, for instance when choosing between Steam Reforming and Autothermal Reforming technologies, each of which has a different emissions profile, and when thinking about how to differentiate between plant that is run efficiently and plant that is not.
- The final aspect of the system should allow companies to balance production across sites, even when those sites are not physically connected. A company may find it more efficient to concentrate different types of technology deployments in different areas. For instance, a large-scale green production system on the east coast, and blue production on the west. If the company is allowed to balance its production as a portfolio, it will enable the most efficient deployment of technologies across locations. We know that the distribution of renewable and non-renewable resources is highly location dependent across Australia, this aspect to the system will enable the most efficient deployment of hydrogen. In one sense, this approach is already implemented in the Renewable Energy Certificate program, and for procurement of electricity. Requiring the systems to be connected would substantially disadvantage Western Australia and the north west of Western Australia whose energy systems are disconnected and lower scale than their east coast counterparts.
- The choice of lable must not be misleading. For instance, Coal gasification with CCS is not net-zero emissions. Calling it "green" or "clean" is potentially detrimental to the integrity of the classification system. Clean infers aspects that may not be delivered in the whole of that system; and "Green" implies organic or environmentally sound or beneficial.
- Ideally international and domestic schemes should be built on the same foundations. There are examples in wider industry (e.g. Naturally Occurring Radioactive Materials – NORMS treatment) of consistent international understanding and implementation of governance. That not-withstanding, a domestic system that draws upon the lessons learnt from pilot phases of existing origin systems would be an option, with a view to being easily adaptable should a uniform international system take place.

3. *Beyond the University of Queensland report referenced above, and published hydrogen strategies from Japan and Korea, what intelligence on consumer and market preferences is available to inform an Australian guarantee of origin?*

- Woodside is investing heavily into business development of hydrogen export opportunities in our target export markets. Each market has a clear and distinct preference but ultimately are driven by commercial needs. So, while there is a desire for CCS for hydrogen from fossil fuels in the Japanese market, clients are not willing to pay for it. While there is a desire for carbon neutral hydrogen in Korea, that market is less concerned about emissions.

- A guarantee of origin system is an opportunity to frame product differentiation in a way that favours Australia's competitive advantages.
- Australia's competitive advantages include large scale land for renewable energy generation; we are one of five nations with "tree restoration potential" (https://amp.abc.net.au/article/11267556); and while we have fossil fuel resources, we are comparatively disadvantaged versus other nations in terms of creating value from CCS, whose economic applications are dominated by enhanced oil recovery.
- It would make sense that a guarantee system would differentiate based on renewable energy, and net carbon emissions enabling the use of offsets.

4. *Should a guarantee of origin have an eligibility threshold? If yes, what should it be based on?*

- If the eligibility threshold in question is whether to label a product "green" or "blue" based on a g/kg emissions threshold, then no. It should be a discrete categorisation, based on proportionality of the energy source, and proportionality on a net carbon neutrality – 20% of emissions offset from SMR based hydrogen, would produce 20% blue, 80% brown – a steam reforming system that takes 5% of its input energy from solar but its emissions were not offset or reduced in any way, would produce 5% green, 95% brown.

- Using g/kg methods, like promoted by CertifHy, could confuse the consumer and opens the classification to challenge. Who chooses the thresholds and what makes one amount objectively better than another.

- A simple "carbon neutral" or "not carbon neutral" classification – based on proportionality – enables producers to command a premium for their investment in achieving low emissions and encourages further emissions reductions over time. Threshold based systems do not provide an incentive for improvement beyond a threshold.

5. *Who is the most appropriate body to develop and maintain criteria for a guarantee of origin and administer certification? Why?*

- We believe the Government is the most appropriate body to develop and maintain criteria for a guarantee of origin system. A government administered system will maximise trust and appear impartial to domestic and export consumers.
- The eventual system could be incorporated into the respective Weights and Measures Act.

Issues Paper 5: Understanding community concerns for safety and the environment

Questions

1. *Do existing regulations adequately manage the potential carbon emissions of a large-scale national hydrogen industry?*

   - Yes. Existing legislation tracks and monitors emissions across the domestic economy for facilities that emit over 100kt CO2e. Given this is deemed appropriate for emissions intensive facilities such as power and fossil fuels, it is likely to be an appropriate framework for a hydrogen industry.

2. *What are the main community concerns about the use of CCS? How can we better manage these concerns and potential CCS projects in regional areas?*

   - We recommend evaluating the acceptance or understanding of CCS by the broader community through surveys.
   - Australian CCS potential is limited and highly location specific. Requiring the use of CCS could add substantial costs which could limit regional opportunities.
   - Although the Australian community desires low environmental impact, it also desires low cost energy and the associated employment opportunities. Source abatement through CCS is not the lowest cost form of abatement. Requiring it could defer Australian decarbonisation until renewable energies become competitive, or it could forgo the establishment of a large and robust carbon bio-sequestration market.

3. *What are the risks about using desalination plants or water recycling facilities to produce water for electrolysis?*

   - Addressing concerns around water resources will be key. Addressing the water lifecycle, such hyper-salinity, as part of environment approvals is a path to address the risks.

4. *How can we best balance the water and land use requirements for environmental, agricultural, community and hydrogen production uses?*

   - We need to learn the lessons of the onshore east coast gas industry and how to manage potential conflicting land uses. Early engagement is imperative.

5. *Hydrogen production projects will require significant project and environmental approvals at the local, state and federal level. What approaches could help to manage these approvals to facilitate industry development while providing suitable environmental and natural resource protections and managing community expectations? When do these approaches need to be in place by?*

- Governance systems for environmental approvals in mining and energy industries are well developed and accepted. Additional resources will be required will be to upskill State and Federal government departments on the impacts and benefits of hydrogen industry and to enable industry collaboration to expedite environmental approvals.

6. *What are the most important standards and regulations to have in place to ensure a safe hydrogen industry and address the community expectations?*

- Health, safety, environment and quality assurance need to be in place to address community expectations. A number of core concepts, principles, legislation, standards, and guidelines already exist within industry that can be applied to hydrogen production already (e.g. pressure vessel construction, relevant safety regulation) and much can be adapted from oil and gas and industrial process industries.
- For example; the petroleum industry's Safety Case Approach with the ALARP principle could be adopted for an export scale hydrogen facility.

Safety Case Approach – NOPSEMA (National Offshore Petroleum Safety and Environmental Management Authority)

There is a public expectation that risks from major industrial activities, such as offshore petroleum operations, will be regulated and controlled. The safety regulator provides 'independent' assurance to society, governments and industry that companies have identified the risks to health and safety and have put appropriate measures in place to control these risks. This 'control' can be exercised in a variety of ways, from a 'licence to operate' regime at one end of the spectrum to 'safety case regime' at the other.

The safety case regime

Objective based (or goal setting) regimes, including the safety case regime, are based on the principle that the legislation sets the broad safety goals to be attained and the operator of the facility develops the most appropriate methods of achieving those goals. A basic tenet is the premise that the ongoing management of safety is the responsibility of the operator and not the regulator.

The Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations 2009 (OPGGS) regulations set out the requirements for the contents of safety cases. A safety case for a facility must comply with OPGGS regulations.

ALARP is the regulation and management of safety-critical and safety-involved systems. One of the main objectives of the OPGGS(S) is to ensure that the risks to health and safety of people at offshore facilities are reduced to a level that is as low as reasonably practicable (ALARP).
A **safety case** has to show how an operator meets, or will meet, the requirements of the regulatory provisions relevant to the control of major accident event risks and the risks to health and safety of people at the operator's facility. Many of the requirements are qualified by the phrase "reduce the risks to a level that is ALARP". This means that the operator has to show, through reasoned and supported arguments, that there are no other practical measures that could reasonably be taken to reduce risks further.
The adopted control measures for any particular identified major accident event must be shown to collectively eliminate, or reduce to a level that is ALARP, the risk to health and safety.
https://www.nopsema.gov.au/assets/Guidance-notes/A138249.pdf

7. *As an individual, how would you like to be engaged on hydrogen projects? Which aspects would you like to be kept informed of? Which aspects would you like to be consulted on? Are there any types of issues or challenges that you, or affected communities, would want to be a part of formulating solutions and recommendations?*

8. *What are the best ways of engaging diverse communities in regional and remote areas?*

Please refer to answer below.

9. *What role could an industry code of conduct play in gaining community support for hydrogen projects? What community engagement principles would you like to see in an industry code of conduct?*

- Woodside advocates an integrated and consistent approach to stakeholder engagement to support the social and economic prosperity of the communities in which there are operation and to secure and maintain a licence to operate.

- Woodside's approach takes into account a range of relevant standards and frameworks including, amongst others, the International Finance Corporation (IFC)'s Performance Standards on Environmental and Social Sustainability, the International Petroleum Industry Environmental Conservation Association (IPIECA)'s Operational Level Grievance Mechanisms: Good Practice Survey and AccountAbility's AA1000 Stakeholder Engagement Standard (AA1000SES)

- We believe the following principles could be included in a code of conduct:
  - **Inclusivity:** All stakeholder engagement activities are undertaken in a manner that is inclusive of culture, gender and differing viewpoints. The views of vulnerable or marginalised groups that may be affected by the company's activities are sought out.
  - **Integrity and Respect:** All stakeholder engagement activities are undertaken in a manner that demonstrates openness, honesty and fairness.
  - **Transparency:** Transparency is maintained with stakeholders, particularly regarding providing timely information on any plans, developments and alterations that may affect them and notifying them of any decisions in relation to concerns they have raised.
  - **Accessibility:** Information is disclosed in a way that is easy to access and to understand for all stakeholders. In particular, technical information is communicated in an accessible format and in the languages spoken by the relevant stakeholders.
  - **Responsiveness:** Identified stakeholder issues and concerns are responded to in a timely manner.
  - **Informed Consultation and Participation:** 'Informed Consultation and Participation' (ICP) builds on the basic consultation process. It is a documented engagement and consultation process that results in the affected communities' informed participation. It involves an in-depth exchange of views and information through organized and iterative consultation where the project incorporates feedback and the views of affected communities on matters that affect them directly, into decision-making. The process captures both men's and women's views and reflects their different concerns and priorities about impacts, mitigation mechanisms, and benefits, where appropriate. The process also informs those affected about how their concerns have been considered (IFC

Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts - Stakeholder Engagement)

10. *What governance structures (such as legislation and regulation) would the federal, state and local governments need to put in place for a large-scale hydrogen facility?*

- State and Federal governments currently have appropriate governance for large scale projects.
- Amalgamating regulatory structures into a one stop shop for hydrogen developments may help speed up industry. The Western Australian government has a model framework for strategic projects.

11. *What further lessons can we learn from the mining, resources and renewable energy sectors about establishing and maintaining community support?*

Please refer to Answer 9.

Other comments:

- The Perth hydrogen bus trials provided excellent feedback on community engagement.
- Please see:

https://www.eltis.org/sites/default/files/case-studies/documents/dpl_perth_fuel_cell_trial_summary_of_achievments_2004-2007_200806_4.pdf and

http://www.accepth2.com/results/docs/AcceptH2_D9_Full-Analysis-Report_050804.pdf

https://www.eltis.org/discover/case-studies/perth-hydrogen-fuel-cell-bus-trial

Issues Paper 6: Hydrogen in the gas network

Questions

1. *Which existing gas distribution networks or stand-alone systems are 'hydrogen ready' and which are not? What safe upper limit applies? Does this readiness include meters, behind-the-meter infrastructure, and appliances?*
2. *What is the potential to have a test project of 100% hydrogen use in a small regional location and where?*

- We believe that there is potential for a "Hydrogen City" project in Australia.
- This could target a small regional town with limited chemical or industrial end use so that appliance replacement, consumer safety and education can be easily managed.
- Potential sites could include a suburb of Geraldton in the mid-West of Western Australia for pipeline distribution, or Karratha in Western Australia for bottled gas distribution.

3. *Which standards and regulations can be harmonised across jurisdictions considering the different structures and market settings (e.g. safety, codes of practice)?*

- State based Major Hazard Facility (MHF) legislation, Dangerous Goods Acts
- To facilitate transition, standards for end appliances need to be modified in a timeframe that aligns with industry capacity to supply new models. There needs to be awareness of the time to change the supply chain. New products should be capable of a reasonable range of blended H2:CH4 (e.g. 0 – 30%) feed stocks to cover the expected transition
- Land use zoning and approvals at State and council level – ensuring existing retail forecourts can host hydrogen as a product once safety requirements are demonstrated (safety zones met)
- Consideration should be given to the opportunity for sector coupling. A future hydrogen-based system will provide opportunities to produce gas and/or electricity. Mechanisms regulating connection and production (e.g. generating licences) should be streamlined.
- Emergency services requirements, for example the response to a hydrogen loss of containment should be the same across jurisdictions.

4. *What roles should government and industry play in addressing any consumer concerns and building social acceptance?*

- See comments in Issues Paper 5. Both have a key role to play – one in setting the framework and legislation to enable the industry, educating regulatory body workforce in hydrogen and communicating to customers how what they have in place ensures safety. Industry through engagements with all stakeholders (community; emergency services; local councils) as projects enter planning phase

5. *How could the actions included in Table 2 be improved? Are there other actions that should be added?*

- Inclusion of transmission systems as key infrastructure that needs to be able to carry hydrogen for the beyond 2030 timeframe. The networks will reach a limit if transmission systems cannot be used for delivering hydrogen from high capacity generating areas to end use locations

Other comments:

- The pressure of the gas in the pipeline is a key consideration. Medium and low-pressure pipelines can accept hydrogen injection
- Need to support industrial customers and keep them isolated from injection or test appliances being used. Heavy industrial equipment will need certification under different ranges of hydrogen blends to ensure that warranty is continued, and this will need careful management
- Communities will need to be informed so they understand changes without being concerned
- Trial areas need to understand that they cannot 'opt out' of hydrogen trials.
- A standard odorant and/or colourant will need to be considered for hydrogen. This will assist consumers and gas technicians in leak identification

Issues Paper 7: Hydrogen to support electricity systems

Questions

1. *How can hydrogen production best be integrated with current electricity systems (for instance, should large-scale hydrogen production be connected to current electricity systems)? Are there barriers or risks to integration that need be addressed in the Strategy?*

   - Hydrogen fuelling stations can act as an active distributed energy system. Stations may comprise an electrolyser to generate hydrogen for vehicles, energy storage, and demand response; and a fuel cell to support high rate electric vehicle charging and distributed generation. Stations may be supplemented by regional hydrogen production and distribution.
   - Hydrogen could be produced from excess renewables and then accessed from the energy hub. As an example, consumers' excess solar energy is fed back to the grid and used for district hydrogen storage. The hydrogen can be used for vehicle filling, electric vehicle fast charging, as domestic gas, or to satisfy electricity demand. The presence of a large, district electricity load and dispatch capability will help to maintain grid stability and maximise economic outcomes for all participants.
   - Electricity generation in a large-scale renewable hydrogen production system may far exceed local generation. We expect that large-scale systems will have some level of gas transmission and electricity grid connection to manage commercial risk and provide revenue diversity.
   - We do not expect that all generation from a large-scale system will be grid connected. Existing large scale renewably sourced production methods assume inverters, grid connection and rectifiers. This architecture has efficiency and cost penalties that might be avoided from an islanded direct current based production system.

2. *What, if any, future legislative, regulatory and market reforms are needed to ensure hydrogen supports, rather than hinders, electricity system operation and delivers benefits for consumers (for example by reducing demand during high price events)? What is the timeframe, and priority, for these changes?*

   - AEMO and Energy Networks Australia have recently consulted on distributed energy resources. https://www.aemo.com.au/Media-Centre/AEMO-and-ENA-paper-on-DER
   - Demand response mechanisms should be implemented as should supervisory control for distributed energy resources.

3. *Do current market frameworks incentivise the potential value of hydrogen to support electricity systems? What initiatives or changes required?*

   - Current renewable incentive systems (e.g. RET) do not differentiate the value of dispatchable and intermittent energy sources. A future market framework would account for emissions intensity and provide direct support to renewable generation capacity and energy storage systems that generate dispatchable renewable energy.

4. *Do current market frameworks allow for sector coupling and interactions between different markets that may result from hydrogen production (such as the interplay between gas, electricity, and transport sectors)? If not, what changes are required?*

5. *What factors should be considered when selecting pilot and demonstration projects? How can government best support pilots and demonstrations?*

Issues Paper 8: Hydrogen for transport

Questions

1. *What groups or companies could lead a consortium approach to building refuelling infrastructure?*

   - Recommended State governments undertake a tender process.

2. *What groups or companies could coordinate procurement of hydrogen cars, buses and ferries?*

   - The public sector is the largest buyer of vehicles in Australia accounting for roughly 4% of total new vehicle purchases. There are over 200,000 vehicles in Australia's public fleets. Government is best placed to be the vanguard of a zero-emissions-transport change.
   - Companies with return to base operations or high utilisation fleets are ideal candidates to target for procurement of hydrogen vehicles. These companies provide the closest line of sight for commercially viable refuelling infrastructure, and the refuelling infrastructure could be used to satisfy public fleet needs.
   - Consumer facing companies are also useful targets, as they are sensitive to environmental impact from their vehicles. As an example, Amazon, Walmart and Anheuser Busch moves into hydrogen are likely to be partially motivated by consumer image.
   - Finally, companies who have an international experience with Hydrogen may help deploy hydrogen infrastructure. Tower Transit (Transit Systems) already run hydrogen buses in the UK and have bus fleets in NSW and WA.

3. *Other than emissions limits and procurement policies, how could government actions (federal, state or local) support private investment in vehicles and infrastructure?*

   - Provide incentives for vehicle take up so early adopters, who accept greater risk and inconvenience in the initial stages, accrue a greater economic benefit (e.g. rebates for vehicle purchase, fuel subsidies / tax credits, exemption from luxury vehicle tax for HFCEVs, exemption from fuel excise).
   - Some global jurisdictions offer zero emissions vehicles traffic priority (Bus lane/priority lane driving). Western Australia has offered an exemption from the taxi levy for electric vehicles. London operates an Ultra Low Emission Zone that incentivises vehicles with low particulate, NOx and SOx emissions. While this system does not account for carbon emissions, it could be used as a model for a system that did incorporate carbon emissions.

4. *How can governments and industry reduce the financial, technology and operational risks of purchasing new technology vehicles?*

- Refer Answer 3.

- The government has a core role in lowering the perception of risk. The government could provide a strong signal of intent through hydrogen transport. Transport is the most visible sector to the public. Buses, trains and ferries are already proven and running overseas. A combined effort from both Government and Industry will be most effective.
- Using a zero-emission fleet of fuel cell vehicles, buses and/or trains that return to base will showcase hydrogen and allow it to be normalised for other transport vectors.

5. *What are some ways hydrogen vehicles could be showcased and demonstrated to the community at large?*

- Appoint hydrogen vehicle "ambassadors" e.g. Ministers, sports identities. As an example of this type of symbolism, the Korean government installed a refuelling system opposite its National Assembly building.
- A hydrogen endurance race, or sporting challenge (Formula-H).
- A mobile hydrogen education display that travels to community events.

6. *What are the key enablers and realistic timelines for a transition to:*
   - *Hydrogen-fuelled buses?*
   - *Hydrogen-fuelled passenger ferries?*
   - *Hydrogen-fuelled long-distance freight (including heavy trucks, trains and long-distance shipping)?*
   - *Hydrogen-fuelled forklifts and ancillary vehicles?*
   - *Hydrogen-fuelled light vehicles?*

- A transition to a meaningful market presence of hydrogen-based vehicles could take several decades in Australia, given the longevity of vehicles and the volume of existing stock. A McKinsey report "Hydrogen – Scaling Up – A Sustainable pathway for the global energy transition" produced for the Hydrogen Council in November 2017 provides valuable projections and 2030 milestones and 2050 targets in the transport sector. http://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf
- Re-fuelling infrastructure, vehicle availability and relative pricing will dictate the uptake rate. Competition will occur once there is greater optionality in the market. Greater global uptake of vehicles will help reduce prices in Australia.
- The first models of hydrogen buses, cars, trains, ferries and forklifts are available in global markets. Australia must prioritise the acceptance of these initial models, potentially providing accelerated or concessional approvals, together with considering direct subsidisation for these vehicles.
- Australia should consider the impacts that the taxation system has on vehicle uptake. Fringe benefits tax disincentivises vehicles for commercial fleets, when commercial fleets have great potential to lead a transition. Luxury car tax adds cost to new technology vehicles that are burdened by high initial cost and small scale. Hydrogen vehicles may be difficult to sell

as second-hand items and statutory depreciation rates do not adequately account for the potential salvage value in an emerging market.

- Trains should be considered as part of a public transport solution. Hydrogen trains are running in Germany and Canada has shown interest in hydrogen trains.

  Please see:

  https://www.cbc.ca/news/canada/british-columbia/transit-advocates-call-for-hydrogen-trains-on-century-old-fraser-valley-rail-corridor-1.5065117
  http://www.metrolinx.com/en/greaterregion/projects/hydrail.aspx

  The Hydrogen Council McKinsey report suggests that the lifetime economic cost of a hydrogen train solution could be half that of a conventional electric train, because it eliminates the capital cost of the electricity infrastructure.

Issues Paper 9: Hydrogen for Industrial Users

Questions

1. *Hydrogen as a chemical feedstock*

- *Other than using hydrogen or carbon capture and storage, are there other ways to reduce emissions from the manufacture of metals, particularly steel manufacturing?*

- **Hydrogen has potential to decarbonise the industrial sector. We suggest targeting niche markets that can sustain higher prices and ones that can play a foundation role in developing a green supply chain. The industrial sector could provide a good, mid-scale test environment for hydrogen pilot projects.**
- **There may be potential to utilize bio-feedstocks together with gasification.**

2. *Hydrogen for industrial heat*

- *What other energy sources are industrial users considering to reduce emissions from their industrial heat processes, and how cost-competitive are they compared to the fuel currently used?*

3. *Supplying clean hydrogen for industrial users*

- *What would industrial users of hydrogen need from a hydrogen supply network?*

- **The two levers to lower the cost of hydrogen production for industrial users are to: (1) utilise low cost feedstock (i.e. locating production in proximity to low cost energy sources); and (2) to re-use existing midstream infrastructure.**

- *Are there locations around Australia where there is an existing or potential demand for hydrogen from industry that are close to renewable energy or carbon capture and storage resources?*

- **Ideally, Hydrogen production should be co-located next to industrial hubs to reduce transmission or pipeline distribution costs. Locations such as Kwinana in Perth, North-West Australia and Mid-West Australia are prime regions to consider co-location hydrogen production with existing industrial hubs.**

4. *Technical considerations in transition to clean hydrogen*

- *What would a conversion to clean hydrogen look like in your industry, in terms of timing, effect on production, equipment changes?*

- For blue hydrogen (sourced from fossil fuel with carbon offset) likely to be in the very near to short term – 2030 time frame, whereas green hydrogen is unlikely until 2040 due to high electrolysis capital costs.
- Woodside envisages establishing domestic hydrogen production and an export pathway by 2030 focused initially on blue hydrogen with a green component. This mix will enable us to create a foothold in the market from which to grow. It will also enable us to learn about hydrogen production from renewables and optimise a system that could be scaled.
- As we move towards 2040 and 2050 we expect green hydrogen production to dominate, subject to the client's ability to pay and policy settings both here and overseas.
- We have line of sight to lower electrolysis costs and more efficient midstream technologies. We do not expect that the initial technology choices will be carried into the future.

- *What existing sites might be suitable to demonstrate industrial use of clean hydrogen?*

- *Does existing equipment in industrial heating applications have the technical capability to handle increased NOx emissions?*

- Yes. A large amount of industrial applications typically have adequate scrubbing systems to reduce NOx. General Electric have made progress in reducing NOx emissions through water injection into combustion systems to lower combustion temperatures.

5. *Hydrogen safety and regulation for industrial users*

- *Are there examples nationally and internationally that illustrate best practice for industrial hydrogen safety regulation and handling expertise?*

- The Australian petroleum industry through the Safety Case Approach with the ALARP principle (See Issues Paper 5 Question 6 for more information) are considered internationally best practice and could be adopted for at scale industrial hydrogen safety regulation and handling expertise.
- We contend safety cases are appropriate for large scale production where plant-scale risks exist, however this approach would be burdensome for small scale production, pilot projects and deployments.
- Japan prides itself on safety regulation and handling of hydrogen. However a key issue has emerged that that their high standards and conservative approach has resulted in higher hydrogen handling costs which are passed on to customers which has reduce affordability and impacted uptake.

6. *Role for governments in supporting a transition to clean hydrogen*

- *Are there any gaps in the existing mechanisms for government support for Australian industry to transition to hydrogen?*

- Debt facilities such as the Northern Australia Infrastructure Fund and Clean Energy Finance Corporation are not ideal for large scale hydrogen deployment. Large companies, most

suited for export scale deployment, may be able to secure debt on their balance sheets at rates that are competitive with these facilities.

- Equalisation grants (such as provided by Australian Renewable Energy Agency (ARENA)) and direct investments, would be better to help overcome barriers to market development.
- The Federal Government is encouraged to take a lead developing standards where they do not exist or adopting international hydrogen standards where available.