Dr Alan Finkel AO
Chairman, Hydrogen Strategy Group
COAG Energy Council
Australian Government

July 2019

Hydrogen Energy Supply Chain (HESC) Project submission to the COAG Hydrogen Working Group's Issues Papers series

Dear Dr Finkel,

The Hydrogen Energy Supply Chain (HESC) Project Partners are grateful for the opportunity to respond to the *National Hydrogen Strategy Issues Papers Series*, and to provide additional input on potential policies and actions to help realise the hydrogen opportunity that is presenting itself to Australia.

It is great to see the amount of progress that has been made since the Hydrogen Strategy Group's initial request for information, and the depth of thought that is being devoted to the development of a National Hydrogen Strategy. The issues papers comprehensively cover the key issues that will be vital for the uptake of the hydrogen economy in Australia, and appropriately draw together insights from a range of stakeholders in the hydrogen supply chain.

We particularly appreciate all of the references to the HESC Project and were encouraged to see that the timelines for our project align with your high-level timetable for the scale-up of the hydrogen industry. We also aspire to deliver on a key action that the issues papers state will be required to develop Australia's hydrogen export industry – the achievement of a Final Investment Decision on a large-scale hydrogen supply chain project.

In recognition of our aligned objectives and the valuable and diverse insights that we believe we can offer the Hydrogen Working Group, please find enclosed a second joint submission from the HESC Project Partners.

The submission includes a case study on the HESC Project and responds to the five issues most relevant to our project and the supply side of the hydrogen industry in which we operate:

- Issues Paper 1: Hydrogen at scale;
- Issues Paper 2: Attracting hydrogen investment;
- Issues Paper 3: Developing a hydrogen export industry;
- Issues Paper 4: Guarantees of Origin; and
- Issues Paper 5: Understanding community concerns for safety and the environment.

We are confident that the issues papers evince a strategic direction that will result in a world-class National Hydrogen Strategy, capable of shaping Australia into a global leader in hydrogen production, exportation and expertise. We are honoured to be providing input into this noble endeavour and eagerly await the final product.

Yours sincerely,

On behalf of the

HESC Project Partners

Eiichi Harada
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Enclosures

- *HESC Project case study;*
- *HESC Project Partners joint response to issues papers 1, 2, 3, 4 and 5.*

Submission to National Hydrogen Strategy Taskforce:

HESC Case Study

July 2019

CASE STUDY: THE HYDROGEN ENERGY SUPPLY CHAIN PROJECT

What we are trying to do with hydrogen

– The Hydrogen Energy Supply Chain (HESC) Project is a world-first pilot project to demonstrate that hydrogen produced from brown coal in Victoria's Latrobe Valley can be safely produced and transported to Japan, creating a supply chain that could put both Australia and Japan at the forefront of a hydrogen society.

– With the support of the Victorian, Australian and Japanese Governments, the HESC Project Partners aim to prove that the integration of various hydrogen supply chain elements can be successfully demonstrated before moving on to a larger commercial scale operation.

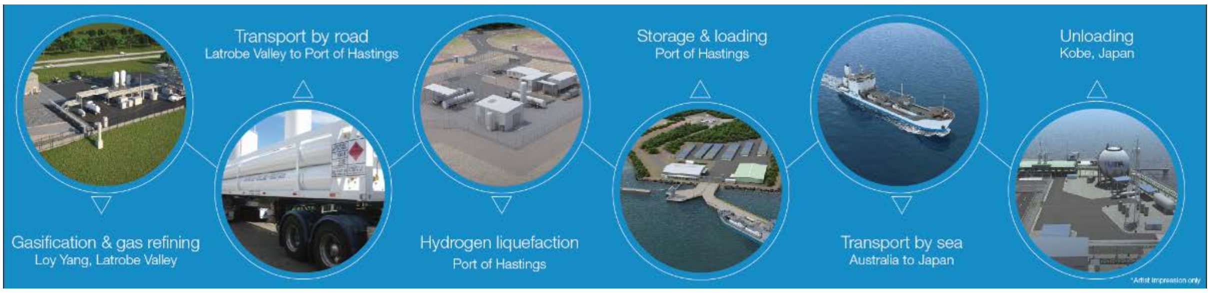
– The project therefore has two phases:

    - A pilot phase to demonstrate a fully integrated supply chain, including brown coal gasification and gas refining in the Latrobe Valley, hydrogen liquefaction and liquefied hydrogen storage at the Port of Hastings, and the safe transportation of liquefied hydrogen from Australia to Japan via a specialised marine carrier for unloading in Japan. Construction on the pilot facilities began in June 2019 and the pilot phase will operate for roughly one year from 2020 to 2021.

    - If the pilot is successful, the Project Partners will move towards commercial scale operations and a multi-billion dollar commercial phase. The decision to proceed to a commercial phase will be made in the 2020s with operations targeted in the 2030s, depending on the successful completion of the pilot phase, technical readiness, financial viability, regulatory approvals, social licence to operate and hydrogen demand.

– The establishment of the first integrated hydrogen supply chain through the HESC Project will spur the development of an innovative Australian hydrogen production and export industry. It is a unique opportunity for Australia to strategically position itself in a new and rapidly growing global market. The first-mover steps the HESC Project is taking now will provide Australia with significant competitive advantages that will persist in its marathon race to become the international hydrogen supplier of choice.

<u>HESC Pilot Project: Supply Chain Elements</u>



HESC

Steps we are taking to work with hydrogen during the pilot HESC Project

The HESC pilot project is focussed on demonstrating and integrating four key steps in the hydrogen supply chain:

Step 1: Hydrogen gas production from coal gasification – hydrogen gas will be produced from brown coal at a newly constructed facility located at AGL's Loy Yang Complex in the Latrobe Valley through a coal gasification process.

- During the one year pilot, roughly 160 tonnes of raw brown coal, from the Loy Yang mine, will be crushed, dried and fed into a gasifier. Brown coal from other mines in Victoria may also be tested.
- Using a combination of oxygen, high pressure and high temperature, the gasifier will then convert the coal to synthesis gas (syngas) comprising mainly of carbon monoxide and hydrogen.
- The syngas will be cleaned of impurities before steam is used to convert the carbon monoxide into additional hydrogen and carbon dioxide (CO_2). A separation system will then separate the syngas into hydrogen gas and CO_2.
- Up to three tonnes of gaseous hydrogen will be produced over the one year pilot with the capacity for 70 kg (0.07tonnes) per operating day. In preparation for the next steps in the supply chain, the hydrogen gas will be stored at the plant in a high pressure tube trailer that conforms to Australian safety standards.
- The gasification facility will also produce a small amount of CO_2 in the pilot phase – equivalent to the annual emissions from about 20 cars. Carbon offsets will be purchased to mitigate these CO_2 emissions.

Step 2: Ground transport of hydrogen gas – The gaseous hydrogen produced in Step 1 will be transported from the Latrobe Valley to the Port of Hastings by a pressurised tube trailer. The trucks will make the trip approximately once each month with a load of approximately 140 kg (0.14tonnes).

Step 3: Hydrogen liquefaction and storage – When the gaseous hydrogen arrives at the Port of Hastings it will be converted to liquefied hydrogen, stored, and then loaded onto a specialised marine carrier for transport to Japan.

- Construction has begun on the pilot scale hydrogen liquefaction plant and loading terminal located on BlueScope-owned land at the Port of Hastings.
- The facility will liquefy hydrogen gas by cooling it to − 253°C and reducing it to 1/800th its volume. Specially made refrigeration equipment will be used.
- The facility will be able produce up to 250 kg (0.25tonnes) of liquefied hydrogen per day.
- The liquefied hydrogen will be stored at the facility in a multi-layer vacuum insulated cryogenic container with a capacity of 2.9 tonnes.

Step 4: Marine transport of liquefied hydrogen – A specialised marine carrier will transport the liquefied hydrogen from the Port of Hastings to Japan.

- Approximately once every three months, the liquefied hydrogen stored at the Port of Hastings will be loaded onto the specialised marine carrier for transport to Japan.
- The marine carrier will use cryogenic storage tanks and vacuum insulation to contain the liquefied hydrogen and keep it at a very low temperature.
- Special insulation technology is being developed to prevent heat from turning the liquefied hydrogen back into a gas – a key challenge in transporting liquefied hydrogen.
- The transport of liquefied hydrogen over waters is supported by the International Maritime Organisation, which approved recommendations to safely transport bulk liquefied hydrogen in September 2016. Also, in January 2017, the Australian Maritime Safety Authority negotiated and agreed with the Japanese Government the "Minutes concerning the requirements applicable to ships carrying liquefied hydrogen in bulk".

Pathways to a commercial HESC Project

While delivering the pilot project, the HESC Project Partners are also exploring the issues that will need to be addressed in order to move forward with a commercial HESC. Beyond the demonstration of the supply chain elements in the pilot phase, some of the key activities being undertaken are as follows:

Building community trust– to proactively build awareness and understanding of the HESC pilot project, the technology involved, as well as the potential of hydrogen as an energy solution for Australia, and pave the way for commercialisation.

- Targeted engagement with key HESC stakeholders has been underway since January 2017, via community pop-up and drop-in information sessions. The Project Partners seek ongoing discussion and feedback from local communities.
- Bringing locally impacted communities on the commercialisation journey is a critical success factor for the project, and public sentiment will be an important consideration when identifying potential sites for commercial facilities.
- The Project Partners have also established working relationships with research organisations, including the CSIRO, to share insights, technology and innovation emerging from the pilot phase, and to ensure that benefits of an export industry are delivered to all Australians.

Finding a CCS solution – to ensure a long-term and sustainable solution for commercial production, the HESC Project will require a Carbon Capture and Storage (CCS) solution during commercial operations.

- Currently the Victorian and Federal Governments' CarbonNet Project is the most likely option for CO_2 mitigation in the commercial phase.
- The HESC Project Partners are working closely with CarbonNet to help drive the development of a commercial-scale CCS network between the Latrobe Valley and the Bass Strait.

Submission to National Hydrogen Strategy Taskforce:

Issues Paper Response

July 2019

ISSUES PAPER 1: HYDROGEN AT SCALE

Q1. What scale is needed to achieve scale efficiencies and overcome cost barriers?

- A commercial HESC would aspire to meet the 2030 hydrogen cost target set out by the Japanese Government – a cost, insurance and freight (CIF) price of approximately ¥30/Nm3 (roughly 3USD/Kg) when the hydrogen lands in Japan. As the issues paper makes clear, our ability to deliver on this goal will depend on increased scale in hydrogen production, transport and storage initiatives.
- As we scale up, different designs will be adopted to realise cost reductions, while still satisfying structural integrity and efficiency. Indeed, the HESC Project Partners are planning to complete a number of technical research and development (R&D) activities and cost reduction programs for the scaling up of key technologies and equipment by March 2023.
- The unit cost of delivered hydrogen will depend on the upfront capital expenses (CAPEX) associated with different supply chain elements and their ongoing operating expenses (OPEX). The HESC Project Partners are continuing to undertake financial analysis of the costs under different scenarios of a commercial HESC Project. The analysis will be refined to take account of the pilot project results, which will have implications for the design of the commercial HESC and its capacity, and the emerging international demand for hydrogen, which will underpin future pricing assumptions.

Q2. What approaches could most effectively leverage existing infrastructure, share risks and benefits and overcome scale-up development issues?

- Both the International Energy Agency (IEA) and the issues paper note the near term cost advantage of hydrogen produced from coal with CCS. This factor alone means that it is the best placed production approach to overcome scale-up development issues. Indeed, the pursuit of cost-effective initiatives such as the HESC Project in the near term will spur the development of infrastructure and expertise in hydrogen storage and transportation technologies that will benefit '*Team Hydrogen Australia'* for decades to come.
- While an initial focus on coal to hydrogen projects will benefit the HESC Project in the short-term, we will also bear the long-term risks of being overtaken by other production methods that can leverage the insights and technologies that are derived in our first-mover project. The HESC Project Partners are comfortable sharing the risks and benefits in this way to ensure the growth of the industry.
- Most illustratively, Australia is separated by more than 1,500km from potential hydrogen markets in Asia. As both the IEA and issues paper note, shipping liquid hydrogen will therefore be the most cost-effective transportation method to service future export markets. The HESC pilot project is already developing a specially designed marine carrier and associated loading/unloading facilities for this purpose. This represents critical infrastructure for the future of an Australian hydrogen export industry which could be used for all Australian-produced hydrogen, irrespective of production method. Our project will generate similar Australia-wide innovations and expertise in hydrogen liquefaction and storage technologies.

- More broadly, it makes sense for Australia to leverage its existing infrastructure and expertise in energy exports, and adopt an approach that focuses on developing the supply side of the hydrogen market. Letting more populated and energy import dependent countries, such as Japan and South Korea, drive the demand side of the equation will allow Australia to employ a focused low-cost strategy to become the international hydrogen supplier of choice.

- Australia is well-placed for the production of cost-competitive natural resources, including coal. Stable production and use of such resources is essential for scale-up developments of hydrogen supply chains, especially in the short to medium term. Political support and enabling regulations are also essential in ensuring a friendly business environment that encourages investment.

Q3. 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 up-skilling 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 HESC pilot project will be looking to employ local people for both the construction and the operation of the pilot plant. We are already providing employment for a number of local professionals as we undertake planning of the construction and operation phases. The HESC Project Partners will need extensive assistance from local sub-contractors and are supportive of efforts to up-skill and mobilise an Australian hydrogen workforce.
- Based near Victorian coal industries that are facing increasing external pressures, the HESC Project could represent a potential pathway to transition the local workforce to a more sustainable industry of the future. As a project that deals in brown coal, there is a potential overlap with existing skills that could be leveraged to springboard up-skilling efforts.
- The HESC Project Partners have also established working relationships with research organisations, including the CSIRO, to share insights, technology and innovation emerging from the pilot phase. We believe that such knowledge sharing initiatives are an important first step in building the next generation of hydrogen researchers and workers.

- We believe the Australian Government could provide the funding support for any training and education programs for building the next generation of hydrogen workforce skills.

Q4. What lessons can be learned from the experience of scaling up supply chains in other industries?

- As a consortium of businesses with significant experience across a wide range industries, we have been actively involved in the scaling up of a number of different supply chains, as set out below:
  - KHI can utilise its rich knowledge and experience on cryogenic storage applications gained through a long-term Liquefied Natural Gas (LNG) storage business, and then liquefied hydrogen storage for rocket fuels. The key for the

scaling up would be its cold insulation performance. KHI's double-hull tank structure for liquefied hydrogen storage with a vacuum filled with a thermal insulation material, that has been already successfully operated for over 30 years, could contribute to scaling up for the commercial HESC.

- KHI can also share learnings from the successful demonstration of its 100% hydrogen-fuelled gas turbine to supply heat and electricity for a residential area in Kobe in April 2018. KHI will continue to carry out tests to accumulate data and then build a new energy supply system for local communities.
- J-POWER can utilise its rich knowledge and experience on coal gasification and CO2 capture. Currently, large-scale demonstration tests are being conducted, and the insights from the demonstration tests will contribute to scaling up for the HESC Project.
- Iwatani can leverage its well-established and long-term experience in developing the existing liquid hydrogen supply chain in Japan and also its knowledge of importing and distributing LPG to Japan.
- Marubeni believes that trading of new commodities can develop once there is a big enough ecosystem of multiple consumers, suppliers, and ships. This often occurs subsequent to the establishment of an initial commercial stage which requires technical readiness as well as incentives to encourage and mitigate risks for customers to adopt a new product. This often includes government's incentives for early adopters.
- Whilst the industry is in its infancy, AGL believes there is medium-term potential for hydrogen use in Australia and is keen to acquire the knowledge that would lay the foundations for business opportunities in the following areas:
  - ➢ As a supplementary de-carbonising gas within the national gas grid;
  - ➢ Within the transport sector as a displacement to traditional combustion engine fuels; and
  - ➢ As an energy storage solution for time-lapsed distribution.

Q5. 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?

– The HESC Project Partners are encouraged to see that the timelines for the HESC Project align with the issues paper's high-level timetable for the scale-up of the hydrogen industry. The Final Investment Decision on a commercial HESC Project will be a key factor for the scale-up of Australia's hydrogen industry. The HESC Project Partners are working towards full alignment with the Japanese Government's plan to realise the commercial supply chains around 2030. As such, a number of preparatory activities will be completed before then, in the early-to-mid 2020s, which will set the basis for a Final Investment Decision on the commercial phase of the HESC Project.

– From a HESC perspective, we will be striving to complete the following actions while we begin commercialisation structuring activities:

- Successfully demonstrate and integrate the HESC pilot supply chain elements;

    - Obtain a social licence from local communities and the Australian public to progress to a commercial HESC;
    - Develop a realistic financial model of a commercial HESC that demonstrates positive return and profitability metrics;
    - Identify the regulatory approvals that will be required to support a commercial HESC in Australia, Japan and internationally; and
- Externally to the HESC Project, we will be hoping to see the following:
    - Growing demand for hydrogen in Japan and other international markets;
    - A Final Investment Decision on a CCS solution for the commercial HESC (currently the Australian Governments' CarbonNet Project);
- There are a number of measures and incentives which could support these milestones, which are outlined in response to Question 2 of Issues Paper 3.

ISSUES PAPER 2: ATTRACTING HYDROGEN INVESTMENT

Q1. What changes to existing government support and additional measures are needed to:

- **commercialise and scale up the hydrogen industry?**

– Commercialisation and scaling-up of hydrogen projects and supply chains such as the HESC Project are dependent on the development of a market, whether export and/or domestic, as well as production cost levels that meet expected targets, yet are sustainable in the long term. From a HESC perspective, scaling-up supply chain pilot projects requires:

- Support for further R&D in the form of both funding and cooperation to move from pilot to commercial phase. This could be achieved through:
  - ➢ Deepening of bilateral arrangements for cooperation on R&D and international hydrogen trade; and
  - ➢ Joint, pro-active monitoring of progress on bilateral cooperation on hydrogen, including technology promotion.

– Prioritisation of hydrogen projects in terms of site purchases/leases, port selection or other elements required for the supply chain, coupled with an integrated approval process for permits, licences and management plans, i.e. packaged approval processes to ensure certainty on compliance and timelines.

– Successful commercialisation of hydrogen projects will require:

- Support with specific, industry-led feasibility studies and independent verification of environmental value to be attributed to the price of landed hydrogen in export countries, to be considered on equal footing with LNG or other traditional fuels;
- Funding support for focused R&D to achieve reduced hydrogen production costs and higher efficiencies. This should include additional and continuous support to facilitate the development, at a commercial scale, of Carbon Capture and Storage (CCS)/Carbon Capture Utilisation and Storage (CCUS) infrastructure and technology to allow for the competitive production of clean hydrogen from fossil fuels;
- The Government should play a proactive role in creating awareness and educating communities on the importance of hydrogen in the future energy industry and its benefits to the economy. This will stimulate positive sentiment towards hydrogen and help achieve social licence for hydrogen projects.
- Cooperation between the Australian Government and export countries to create initial demand for hydrogen in both countries. Initiatives may include:
  - ➢ Government offtake agreements for first production of hydrogen at commercial scale, which could be part of a longer term plan to decarbonise public transport;
  - ➢ Tax incentives to create demand in small and large consumer markets (see response to Q4); and

- ➢ Prioritisation of hydrogen project applications for funding through ARENA, CEFC and other government agencies.

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

– The balance between domestic demand and exports will largely be a function of the market that exists at the time, both domestically and internationally, as well as the difference between export and domestic prices. Domestic market development is therefore of utmost importance, not only for commercialisation of hydrogen projects, but to ensure the full benefit of utilising Australia's abundant resources to build a hydrogen industry is shared with the Australian people.

– A domestic market will be supported through initiatives such as:

  - Reservation of production quantities for local use, based on long-term plans for the domestic market, e.g. refuelling infrastructure, regional refuelling depots for trains, heavy vehicle manufacturing plant establishment plans and long-term plans for injecting hydrogen into the local gas network;
  - Offtake of first production volumes from supported projects; and
  - Assessment of the appropriate environmental value that should be attached to the domestic price of clean hydrogen, to achieve parity with traditional fuels.

Q2. 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 investors are looking for healthy returns and long-term growth/stability. Apart from supporting the cost of production through subsidies or low interest loans, the Government may deploy additional strategies to attract private sector finance:

  - As hydrogen projects emerge over the short term, co-investment incentives could play an important role in attracting private sector finance for start-up hydrogen projects and supply chains. This could be done through one of the government's venture capital programmes;
  - For longer-term investment, the unique proposition of Australia's hydrogen market, i.e. abundance of resources to produce hydrogen over the long-term (such as solar, wind, fossil fuels with adequate CCS), should be a focus point in selling the opportunity;
  - Deepening bilateral cooperation with export partners, including incentive provisions in the Japan-Australia Economic Partnership Agreement (JAEPA) for hydrogen;
  - Creating policy stability over the long term, as well as development of technical and economic regulations for hydrogen; and
  - Adoption of stringent emissions standards for the transport sector over time to allow for a transition to clean hydrogen.

- It is anticipated that most of the potential private sector investment seeks for project financing opportunities to fund this type of energy projects. Since such finance could be only possible based on robust cash flow at each project, public support might be necessary in some areas that goes beyond private sector's efforts. This could include stable and unchanged legislation and/or government guarantees/undertakings for *force majeure* events or natural and/or social risks.

- Need incentives to make business cases more attractive to all parties by means of mitigation of potential risks such as Public-Private-Partnership (PPP).

Q3. 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?

– Building skill and attracting talent to the industry are vital for the Australia to become a major global player in hydrogen. This could be achieved through:

  - Funding support for STEM programmes focussed on hydrogen production technologies;
  - Collaboration with research organisations in developing training programmes at tertiary level;
  - Promoting careers in hydrogen to prospective student communities and providing financial assistance to students desiring to study towards a career in hydrogen; and
  - Hosting international conferences on hydrogen.

– Should international markets fail to emerge as expected, the most advanced domestic application is injection of hydrogen into the local gas network. This is already being tested at three locations in Australia:

  - Jemena's A$15 million H2GO project, which plans to connect with Jemena's existing gas network to deliver hydrogen to 1.3 million customers in NSW;
  - AGIG's demonstration production and distribution plant at Tonsley, South Australia, using a 1.25MW electrolyser to produce clean hydrogen for injection into the gas network, serving c. 720 households; and
  - ATCO's Clean Energy Innovation Hub (CEIH), which plans to inject hydrogen produced through solar powered electrolysis, into the micro-grid system at their Jandakot facility for testing as a direct fuel or blended with natural gas.

– Support for more such demonstration projects around the country should be considered and the COAG may play a coordination role in scaling up these demonstration projects in terms of a long-term plan to decarbonise the gas network. For example, COAG may discuss and push for government funding to scale-up demonstration projects in staggered time frames, in accordance with a preferred decarbonisation timeline. It may also consider co-funding options, between Federal and State Governments, and scaling-up of promising pilot projects.

Q4. 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?

– Tax incentives for hydrogen users will be important in the development of the domestic market. These may include:

  - Company income tax – accelerated depreciation of hydrogen facilities, to reduce the tax liability in the early operating years;
  - Fuel tax – exclusion of hydrogen from existing fuel taxes applicable to traditional fuels;
  - GST – exemption of hydrogen from general sales tax at the pump;
  - Any tax incentives will obviously be subject to analysis of impact on traditional fuels and on Government revenue in general; and
  - Tax incentives for domestic purchases of mixed LNG/hydrogen gas.

  NB: Any tax incentives will obviously be subject to analysis of impact on traditional fuels and on Government revenue in general.

– Development of safety standards and regulations to create comfort around the safety of hydrogen use, especially in the transport industry where safety around refuelling infrastructure may be a concern.

Q5. What market signals and settings are needed to capture hydrogen's sector coupling benefits? When should these market signals and settings be applied?

– With Australia being best positioned, both in terms of location and abundance of resources, to be a major hydrogen supplier to Asia, Government commitment and support of pilot projects, as well as support to commercialise proven projects around mid-2020s to 2030s will send a strong signal that Australia is able and willing to meet demand in the region.

– Commercialisation of hydrogen production from brown coal is dependent on the simultaneous commercialisation of CCS projects. Once CCS has been proven at commercial scale, CCS technology may be deployed more widely, to provide more opportunity for decarbonisation of existing industries and monetise Victoria's brown coal in a sustainable way. To achieve this, CCS needs to be enabled through removal of the barriers/prohibitions under the *Offshore Petroleum and Greenhouse Gas Storage Act*, and the *Clean Energy Finance Corporation Act*. It is important that these barriers are removed without further delay. Since commercial CCS project still need verification from the technical/economical viewpoint, governmental support might be necessary to successfully launch on commercial arrangement, especially at its early stage.

– A rapidly developing hydrogen export market will stimulate the development of road, rail and coastal shipping infrastructure to transport hydrogen to export ports and create thousands of jobs in the process. Government's role in assisting with establishment of relevant infrastructure such as export ports, hydrogen pipelines and related facilities will be vital in realising economic benefits from the hydrogen sector. These forms of assistance should be implemented by 2030s, by which time destination for supply, Japan, would expect hydrogen imports from Australia.

– As demand for hydrogen is expected to increase in the 2030s, so will the need for energy to power production plant. This opens up opportunities for further investment in solar and wind farms for electrolysis, as well as investment in integrated gasification combined cycle (IGCC) technology for hydrogen production facilities using brown coal and CCS.

ISSUES PAPER 3: DEVELOPING A HYDROGEN EXPORT INDUSTRY

Q1. How do we best position and sell the benefits to international partners of investing in Australia's emerging hydrogen industry?

- Widely communicate amongst government and private sector stakeholders the numerous competitive advantages enjoyed by Australia as a potential hydrogen producing and exporting nation, including:
  - abundance of natural resources for various hydrogen production pathways (diversification of production), including solar, wind, natural gas, brown coal and others;
  - cheap and large scale fossil-fuel resources, particularly brown coal, coupled with advanced CCS technology as well as safe and suitable geological sites which is touted, in the short term, as the most likely avenue to generate stable production at scale, in a cost-competitive and commercially feasible manner;
  - stable institutions and rule of law. Regulatory certainty is crucial to attract large capital investment;
  - an open and transparent foreign investment regime, coupled with overall macroeconomic stability;
  - high-ranking in ease of doing business indicators;
  - progress of multiple hydrogen production pilot projects at different scales and exploring various technological options. First and foremost the HESC Project, an initiative of national significance for both Australia and Japan, is expected to evolve into the world-first commercial scale supply chain for hydrogen production and export;
  - strong federal and state government backing for hydrogen industry development through policy and financial incentives; and
  - a wide network of free trade agreements and investment protection mechanisms for open exchange of goods and capital with partnering nations, including with key hydrogen export markets such as Japan, China, Korea, United States (US) and the European Union (EU) (prospective).

Q2. How could governments support the cost competitiveness of Australia's hydrogen exports?

- Continue to work with like-minded countries, i.e. Japan, in multilateral fora to strategically position Australia as a first mover in hydrogen export, including through regular engagement with the private sector, for example through the Hydrogen Council;
- Create a hydrogen-export taskforce within the Department of Foreign Affairs and Trade (DFAT)/Austrade tasked with promoting Australia's hydrogen exports and negotiate, in coordination with industry, special protocols to tackle tariff and non-tariff barriers to hydrogen exports in existing and prospective trade agreements;
- Provide financial and regulatory support for the speedy development of the necessary hydrogen export infrastructure, including at ports, pipelines, CCS, etc.

- Ensure that policy intervention on the supply side of hydrogen remains categorically technology neutral to maximise the chances of early commercialisation;
- Provide incentives, including tax benefits, for exporters to increase price competiveness of hydrogen against LNG;
- Establish relevant regulatory frameworks which grant legal, tax and any fiscal terms stabilities to exporters/investors covering the life span of hydrogen supply chain projects to make them bankable;
- Underwrite the first shipment of hydrogen exports and specific first-of-a kind project risk that a private company cannot take on, such as long-term carbon storage;
- Provide for a temporary royalty holiday period for first hydrogen exports; and
- Ensure a streamlined, integrated, approvals and regulations pathway for an H2 international supply chain, in collaboration with key trading partners. The work commenced by Australia and Japan in the context of the Hydrogen Ministerial Meeting of October 2018 is a positive first step in this direction, so is the combined work at the International Maritime Organization (IMO) for the international shipment of liquefied hydrogen at sea.

Q3. What could governments do to encourage commercial offtake agreements for export?

- As a first step, through the establishment of joint Japanese-Australian funding and financing support for hydrogen supply chains between the countries; and
- Demand-boosting policy incentives in destination markets will also be of the essence. These might include incentives for the uptake of fuel cell vehicles, carbon emission reduction mechanisms to make clean hydrogen more price competitive, R&D support to expedite the development of hydrogen turbines to produce electricity from hydrogen at scale.
- For further comments, see Section 2, Q1.

Q4. How do we balance our global competitiveness with ensuring all Australians benefit when considering the collection of government revenues from hydrogen exports?

- Whilst the hydrogen export industry is in its infancy, strong incentives such as tax and royalties breaks, as well as permitted export support mechanisms, might be necessary to position Australia as a prime competitor for hydrogen exports. Nonetheless, once the industry has reached a substantive scale, royalties, potentially excise, and other taxes will generate a whole new source of government revenue;
- For example, in the beginning era of LNG export industry, the Australian Government provided regulatory and financial incentives in its infancy stage to promote commercialisation, which ultimately occurred through strong and stable off-take agreements from buyers. Now the LNG industry is one of biggest source of government revenue and economic activity in Australia. Although there are some differences between the LNG industry in the 70s and the hydrogen industry today, we suggest that

the Australian Government could look at this case study to investigate the positive long-term effects of early investment in a nascent industry.

- Payroll, income and corporate taxes stemming from the establishment and affirmation of a new hydrogen industry will also generate a new source of revenue;
- It is important that the Australian Treasury consults openly and regularly with economic operators to ensure the development of an evidence-based hydrogen taxation framework which does not cripple growth potential and acts as a facilitator rather than an inhibitor of hydrogen industry development. The Australian Government should also be mindful of tax concessions in other countries, such as Singapore, to ensure Australia remains the country of choice in the region, for international investment in hydrogen production.

Q5. What can (or should) be done to ensure an appropriate balance between export and domestic demand?

- The Australian Government could provide policy and other incentives for the creation of a domestic hydrogen market, in addition to an export one. However, given the current features of the Australian energy market as well as the national energy and environment policy framework this might be achievable in the longer term;
- Countries like Japan have made hydrogen utilisation a key component of their domestic energy strategy, with well-established targets for various hydrogen applications. Australia could develop a similar set of targets to ensure local demand generation;
- Policies and incentives which would make hydrogen competitive, locally, with cheaper carbon-intensive alternatives could be explored. The transport sector might represent a low-hanging fruit for domestic hydrogen demand in the Australian context, together with hydrogen injection in existing gas grids. The Government could, for example, establish a percentage target of hydrogen injection with gradual increases against a well-defined timeline.

Q6. How ambitious is the target of fulfilling 50% of Japan and Korea's hydrogen imports by 2030?

- The HESC Project Partners believe in the feasibility to supply more than 50% of Japan's hydrogen importation targets from Australia, through the commercial HESC Project alone. Indeed, the Japanese Government's 5th Energy Plan[1] foresees the importation of roughly 300,000 tonnes of hydrogen annually. As referred to by NEDO in 2015, the commercial HESC Project, in its full scale, will supply roughly 225,000 tonnes of hydrogen per annum.

[1] Section 6-3 (3)) Building of international hydrogen supply chains and the introduction of hydrogen power generation to realize low-cost hydrogen use"(METI, July,2018).

ISSUES PAPER 4: GUARANTEES OF ORIGIN

Q1. When should Australia aim to have a guarantee of origin in place? Why is this timing important?

- Australia should have a guarantee of origin scheme in place by the early- to mid-2020s. This would align with the Working Group's high-level timetable for scale up and support the HESC Project in its prospective commercialisation activities.

- The requirements of a guarantee of origin scheme would inform the carbon capture rate that the market requires for the hydrogen produced from a commercial HESC. This would impact our negotiations with a CCS provider such as the CarbonNet Project.

- The ultimate cost of hydrogen in a commercial HESC would also be relative to the required carbon capture rate. While we are already aiming for a carbon capture rate of 90 per cent or more in the production phase of the supply chain, a guarantee of origin scheme could provide additional reliability to the financial analysis we are undertaking to support the assessment of a commercial HESC.

- Depending on the scope of a guarantee of origin scheme, it could also affect other commercialisation considerations (e.g. water usage, hydrogen purity, emissions associated with transportation and storage). The quicker a framework is developed, the quicker we can build its requirements into our commercialisation plans.

Q2. What would be the best initial scope for a guarantee of origin? Why?

- The initial scope for a guarantee of origin scheme should focus on the carbon emissions directly released through production, which are not sequestered via CCS, (Scope 1) and indirect emissions from the consumption of energy during the production process (Scope 2). These types of emissions are mostly closely linked to production activities and can be reliably reported by the producer using most of their own information.

- In due course, other indirect emissions (Scope 3) should also be added to the scheme, as ultimately consumers are most likely to care about the entirety of the hydrogen's lifecycle emissions. However, Scope 3 is a very broad category of emissions which could encompass resource extraction emissions all the way through to the emissions associated with the commute of a hydrogen retailer's employee. Hydrogen producers are unlikely to have all the information on these upstream and downstream emissions being generated in their value chain.

- As such, it will be important to develop a consistent framework whereby all producers are including the same Scope 3 emissions in their calculations, and a system where other players in the value chain are required to report their own emissions to the hydrogen producer. Indeed, when defining the scope of a guarantee of origin for hydrogen, considerations should be given to broader, non-hydrogen-industry-based, greenhouse gas accounting standards.

- It is also unclear who should be responsible for making the guarantee of origin. If the entire lifecycle of emissions are to be reported, and not just those for which the producer is responsible, perhaps it would make more sense for the final retailer to account for all the emissions before marketing the hydrogen to the consumer.

- Ultimately a guarantee of origin scheme should be technology neutral, be focused on reporting negative externalities, and should not discriminate between different production methods. The HESC Project Partners envisage a scheme where the same emissions thresholds apply to all forms of "clean hydrogen", without resorting to terminology around different colours of hydrogen.

Should there be two separate schemes for international and domestic requirements?

- Ideally there would only be one internationally administered guarantee of origin scheme for hydrogen. This would best facilitate trade and remove the need for complicated double accounting or conversions as hydrogen crosses international borders.

- As Australia positions itself to become a leader in exporting hydrogen to the world, it will be important to focus on a scheme that is accepted internationally. This is particularly the case given the size of the likely domestic market compared to the prospective demand for hydrogen from countries such as Japan, South Korea, China and the US.

- While consumers in different countries may have different tastes in their hydrogen (normally based on cost or emissions considerations), the HESC Project Partners strongly believe that Australia can play a key role in shaping an international guarantee of origin scheme built for the global hydrogen market.

Q3. 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?

- At this stage, it is not yet clear to which degree the Japanese consumer market would prefer clean hydrogen over cheaper alternatives. This is because the Japanese Government is yet to determine specific carbon-pricing mechanisms in the wake of the Paris Agreement.[2] There is, however, mention of preference for clean hydrogen in Japan's hydrogen society strategy. Consequently, we believe that any subsidised hydrogen demand would be geared towards clean hydrogen and, in particular, hydrogen from fossil fuels coupled with CCS/CCUS.

Q4. Should a guarantee of origin have an eligibility threshold? If yes, what should it be based on?

- There could be a maximum threshold for the carbon emissions associated with hydrogen before it is eligible to be called "clean hydrogen" under a guarantee of origin scheme. Importantly, any mandated threshold for "clean hydrogen" guarantee should take into account the specifications currently being negotiated between Project partners and the CarbonNet Project to ensure the commercial viability of the HESC Project.

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[2] See for instance the Cabinet Decision on 11 June 2019 regarding Japan's Long-Term Strategy under the Paris Agreement, available at https://www.env.go.jp/en/headline/2406.html.

– The threshold for a guarantee of origin scheme should be based on overarching global emissions reduction targets and intelligence on consumer preferences.

– The guarantee of origin threshold should be framed around the number of kilograms of carbon dioxide emissions associated with every kilogram of hydrogen that is produced.

– In the short term, the threshold may need to be established in a way that supports the scaling up of hydrogen production technologies and projects. Initial threshold could be established at a rate that are achievable now (e.g. 2 kilograms of carbon dioxide per kilogram of hydrogen[3]) and slowly increased over time as the industry matures.

Q5. Who is the most appropriate body to develop and maintain criteria for a guarantee of origin and administer certification? Why?

– Noting our response to question 3, that a cohesive international guarantee of origin scheme is preferable, it is likely that an international body would be best placed to promote a guarantee of origin scheme on a global scale.

– Potential international organisations include the International Standardisation Organization (ISO), first and foremost, and, secondarily, the World Customs Organization (WCO). Indeed, the ISO is already developing standards around hydrogen fuel quality.[4] Finally, the International Energy Agency (IEA) could also play a role, given the amount of ground-breaking thinking already done in this area through various hydrogen advisory panels, reports, etc.

– The hydrogen industry could provide their input into these forums through their national government representatives. The Hydrogen Council should also be afforded a seat at any table discussing an international guarantee of origin scheme.

[3] IEA, The Future of Hydrogen: Seizing today's opportunities, p.50.

[4] See, ISO/DIS 14687: Hydrogen fuel quality – product specification.

ISSUES PAPER 5: UNDERSTANDING COMMUNITY CONCERNS

Q1. Do existing regulations adequately manage the potential carbon emissions of a large-scale national hydrogen industry?

- More needs to be done to remove regulatory barriers preventing the development and adoption of CCS technologies.
- An amendment to the *Clean Energy Finance Corporation Act 2012* to remove the prohibition on the Clean Energy Finance Corporation (CEFC) investing in CCS projects/technologies is one of the potential barriers for CarbonNet commercialisation.
- Currently, the CEFC is prohibited from investing in CCS projects/technologies. In 2017, the *Clean Energy Finance Corporation Amendment (Carbon Capture and Storage) Bill 2017* was tabled by the Government in the Parliament. The bill lapsed when the House of Representatives was prorogued for the recent Federal election.
- A series of amendments to the *Offshore Petroleum and Greenhouse Gas Storage Act,* which were tabled in Parliament by Minister Canavan between May and December 2018, would also have provided regulatory benefits to the CarbonNet project and CCS more broadly. This bill has also now lapsed.

Q2. 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?

- While CCS projects are not directly under the remit of the HESC Project, a CCS solution will be required for the commercial HESC. Community concerns about the use of CCS will impact the HESC Project's ability to establish community acceptance for commercial scale operations, particularly in the areas where CCS would be implemented and also those who identify as CCS sceptics.
- It is important to acknowledge community concerns and where possible provide education and fact-based information materials to inform opinions. Trust can be gained without necessarily changing long-held opinions, so the goal should be to find ways to work within communities to establish and maintain a climate of trust and open dialogue, where it is possible to respectfully disagree.
- While acknowledging the sustained engagement that CarbonNet has undertaken within the communities the project is likely to impact, there appears to be a broader scepticism of the viability of CCS in Australia. This makes local conversations more difficult, even with academic references at hand. One way to address this could be a government-led (industry supported) participatory engagement exercise coupled with a broad awareness campaign to inform and educate communities on the facts of CCS. This has been done effectively by Infrastructure Victoria in its development of a 30-year Strategy, and by the South Australian Government via its 'Get to Know Nuclear' campaign.
- Such actions will not result in 'quick-wins', rather, they are longer term strategies to influence sentiment and opinion, so should be started earlier rather than later.
- Through our consultations with local communities, we understand that there is scepticism around the technical, economic and environmental viability of CCS projects such as the CarbonNet Project. The most pressing concern is around CO_2 containment and the potential that sequestered CO_2 leakage may occur, causing ocean acidification,

damage to marine life, and economic damage to local communities. When conducting offshore seismic surveys to assess sea floor viability, fishing communities have also expressed concerns about the effects that sound waves can have on marine life.

- When trying to manage these concerns, it will be important to engage with local communities on the proven safety of CCS. CCS is a confirmed technology with studies demonstrating that the risk of fault leakage risk is low,[5] and that there are viable techniques to monitor CO_2 injected for geological storage.[6] The Australian Governments should continue to play an important role and increase efforts to ensure the viability and public support for commercial scale CCS projects.
- Attention should also be devoted to the opportunity of CCU technologies to generate social and commercial value for regional areas. Utilising captured CO_2 in greenhouse agriculture and carbonation processes in the beverages industry are only two examples that could be explored with local communities.

Q3. What are the risks about using desalination plants or water recycling facilities to produce water for electrolysis?

- The use of desalination plants or water recycling facilities would create additional costs and community concerns, which could both pose risks to the scale-up of a hydrogen industry. Desalination plants and water recycling facilities are complex systems that would require significant amounts of energy, contribute to greenhouse emissions, and further increase the production costs of renewable hydrogen.
- Water resource management in Australia is also a sensitive topic, particularly in the light of recent media coverage of the Murray Darling Basin Plan and related projects. It would be inadvisable for the Australian hydrogen industry to express a need for these facilities, in the face of existing drinking water and agricultural needs.

Q4. How can we best balance the water and land use requirements for environmental, agricultural, community and hydrogen production uses?

- Australian drinking water resources are already stretched. In the face of population growth and the effects of climate change, which are likely to make them scarcer, hydrogen supply chains should rely on production methods with more sustainable amounts of water consumption.
- A short-term focus on hydrogen produced from coal with CCS could provide electrolysis technology with time to develop less water-intensive techniques or salt-water capabilities,[7] thereby foregoing the need to consider the need for risks of desalination plants or water recycling facilities.

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[5] See, Miocic, Johannes M., et al. "420,000 year assessment of fault leakage rates shows geological carbon storage is secure." *Scientific reports* 9.1 (2019): 769.

[6] See, Karolytė, Rūta, et al. "Tracing the migration of mantle CO2 in gas fields and mineral water springs in south-east Australia using noble gas and stable isotopes." *Geochimica et Cosmochimica Acta* 259 (2019): 109.

[7] See, e.g., the Scottish Seafuel Project: https://www.hydrogenfuelnews.com/seafuel-project-to-convert-seawater-into-sustainable-hydrogen-energy/8537836/

- As with other industries, balancing the land use requirements of the hydrogen industry will be an ongoing exercise in community engagement. This balance may be more challenging for large scale renewable products that require greater amounts of land.

Q5. 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?

- Highlighting the safeguards that will be employed to protect the environment will always be a critical factor in managing community expectations and facilitating industry development. Transparency from the hydrogen industry throughout project planning and development garners trust from the community and also results in greater levels of accountability.
- There are many major infrastructure projects in Australia that have progressed through such significant approval stages and hydrogen production plants would face similar scrutiny. However the methods for working through these approvals are already established, such as the Environment Effects Statement and planning scheme amendments, etc.
- There are sound engagement principles that apply consistently over vastly different projects, including early and frequent communication with impacted communities.
- As in the case of CCS, there would be some benefit in a government-led information campaign to raise awareness of the strategic value of a hydrogen industry for Australia which would underpin hydrogen production projects. In our experience consulting with communities and stakeholders, hydrogen was seen mostly in a positive light with some people expressing concern about safety.
- However, as already mentioned, regular and open consultation with the community is paramount to plan for commercialisation and the social licence to operate will be a key element in making a Final Investment Decision towards a commercial HESC Project.

Q6. What are the most important standards and regulations to have in place to ensure a safe hydrogen industry and address the community expectations?

- Standards and regulations that ensure the safety of hydrogen technologies, systems and components should be a priority for the industry. While the development of standards in emerging technologies can be difficult to develop and harmonise, the industry cannot afford safety incidents which might impact community perceptions and hydrogen demand.
- It should be noted that standards and regulations alone are not necessarily useful to address community concerns. They are often dense and contain industry jargon that can be inaccessible to a non-technical audience. There is a need to provide technical information in a publicly accessible way, e.g. through websites and digital tools designed for public consumption.
- While hydrogen technologies have a history of safe use, all conventional fuels have risks associated with them, and there have been some recent hydrogen incidents in Norway,

South Korea and California. These rare incidents can provide insights on the most important risks to mitigate with standards and regulations.

- Any such incident should be communicated in a way that maintains public trust. Transparency is critical in dealing with risk communications.
- Based on these incidents, the high pressure containment of gaseous hydrogen and its transference between different environments are an identifiable area of risk. Standards for compressed hydrogen, storage temperatures, transfer flow rates, and associated components may be an initial area to investigate.
- The HESC Project Partners also recognise the work being undertaken at Standards Australia, in support of efforts at the ISO, to identify and develop priority areas for standards in hydrogen production, storage, transport and end use.
- No doubt the new Technical Committee ME-093 on Hydrogen Technologies will be focusing on the priority standards identified in consultations with the hydrogen industry.[8]
- Regulation around liability and insurability will also be critical factors in the development of the hydrogen industry. Not only should regulation ensure accountability, but it should provide the framework for the hydrogen industry to obtain reasonable insurance for their projects.

Q7. 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?

- As a consortium of companies that are investing heavily in hydrogen, the HESC Project Partners would like to be kept informed of any government initiatives or policies which are likely to impact the Australian hydrogen industry. In this vein, we greatly appreciate the consultative approach that the COAG Energy Council has adopted to develop the National Hydrogen Strategy.
- Early consideration should also be given to the role of industry in the development of hydrogen regulations and standards. It is important that policymakers and standard-setting bodies consult closely with the hydrogen industry throughout this next stage of policy formulation.

Q9. 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?

- In the absence of specific standards and regulations pertaining to hydrogen, an industry code of conduct could provide a flexible mechanism to provide the Australian public with accessible information on acceptable practices. Although, compliance would be the most important factor in determining community acceptance. There is a wealth of community engagement principles that could be used as a basis for engagement governance in the

[8] Standards Australia, 'Hydrogen Standards Forum: Outcomes Report' (2018), available at: https://www.standards.org.au/getmedia/d51f264c-4744-45d7-a3eb-057c6fa19e0a/Hydrogen-Standards-Forum-Outcomes-Report.aspx

case of hydrogen. These include, for instance, IAP2, VAGO Best Practice for Public Participation, ISCA and AA1000 Stakeholder Engagement Standard 2015.

Q10. 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?

- It would constitute a heavy regulatory burden for private companies (especially foreign companies) to adopt and abide by multiple, disjoint approval and regulatory frameworks at the Federal, State and Local level. Harmonisation and red-tape avoidance will be important. For example, the State Government could play the role of primary facilitator to coordinate all processes with all levels of Government.

Q11. What further lessons can we learn from the mining, resources and renewable energy sectors about establishing and maintaining community support?

- All players in the energy sector have a responsibility to develop large scale projects in a way that is compatible with the environmental and social wellbeing of local communities.
- Experiences in the mining, resources and renewable energy sectors demonstrate that community support can be established and maintained when local stakeholders are given the opportunity to interact and provide feedback on proposed developments.
- Similar two-way conversations, where communities can be heard, and proponents can explain the benefits of their projects, will foster social licence for the hydrogen industry.
- The HESC Project Partners believe that our ongoing community engagements activities around the HESC Project have helped create a sense of involvement in decision-making for local communities, and provided them with an understanding of the economic growth and job opportunities that the project will bring to the region.

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