ECT RESPONSE TO
COAG ENERGY COUNCIL
NATIONAL HYDROGEN STRATEGY
ISSUES PAPERS

28 July 2019

1 | Hydrogen at scale

Link

Purpose

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

Questions

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

To be environmentally sustainable, a solution must first be economically sustainable.

Further analysis is required to determine the exact scale at which hydrogen production capacity and the supporting storage and distribution infrastructure will deliver cost-competitive hydrogen across specific target markets and applications.

The issue paper describes these uncertainties well, covering the need to meet price and volume targets in terms of off-take for specific end-users such as Japan and South Korea.

To meet the potential future demand from multiple applications and markets, which will likely be more closely coupled, an appropriate combination of CCS and green hydrogen production, storage and distribution infrastructure will be required to ensure a balance between affordability, reliability and emissions intensity.

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

The COAG Energy Council briefing paper ‘Hydrogen for Australia’s Future’ identifies the need for a transitional approach to bridge the gap between todays use of resources and a low or zero CO_2 emission future.

This acknowledges that fulfilling hydrogen production for export volumes via the dedicated renewable hydrogen route is currently more expensive than the CCS hydrogen route.

Compared to renewable hydrogen, CCS hydrogen, established in Victoria's Latrobe Valley could benefit from existing infrastructure, lower network overhead cost and ability to produce hydrogen at lower cost.

CCS hydrogen is scalable, capable of supporting export volume targets and domestic applications.

Innovations that can cost-effectively reduce the CO_2 intensity of current CCS hydrogen production processes should be supported, especially if the cost of their application is less than the alternative cost of CCS or purchasing CO_2 offsets.

In this regard, ECT has developed a unique low temperature, catalytic method for hydrogen production from lignite that may have a lower CO_2 footprint than current available methods. Cooperative development with CCS hydrogen project proponents via established R&D programs can accelerate commercialisation.

Successfully commercialised, COHgen could make CCS hydrogen cheaper than current estimates by reducing the cost of production, both in terms of direct production efficiencies and via lower CO_2 intensity.

Where lignite-based CCS hydrogen producers select a standard high-CO_2 gasification route, instead of COHgen's low CO_2 route, they will still need to pre-dry the lignite. In this case ECT offers an innovative drying process called Coldry.

Traditional lignite drying such as steam tube drying is high temperature and/or high pressure, requiring high paid energy input and generating CO_2.

The Coldry process is a low temperature, low pressure lignite drying process with a zero-CO_2 footprint, positioned to deliver a lower cost solution than alternative drying methods.

Zero direct CO_2 emissions from the Coldry drying stage results in lower total CO_2 emissions and therefore a lower carbon capture and storage (CCS) requirement and cost.

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?**

Successful approaches to support skill shortages may include coordination with the COAG Education Council to prepare a Hydrogen Energy Industry Training Needs Analysis and audit of appropriate courses and places required to support the industry. Consultation with engineering firms, academic institutions and unions can seek to achieve a balance between developing the domestic pool of skills and the need to import foreign workers.

As a specific example, upskilling or reskilling workers in the Latrobe Valley to support the shift from a coal-based electricity industry to a hydrogen production industry should overcome the otherwise negative employment prospects for the region.

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

The issues paper conveys the learning opportunity around the LNG industry well.

Further analysis is required of the unintended consequence of higher domestic gas prices and the flow on to higher electricity prices as gas is increasingly called upon to firm growing, intermittent wind and solar capacity.

Particular attention should be paid to how policies in adjacent areas, such as gas exploration bans and renewable energy mandates and subsidies impact energy reliability and affordability.

Analysis of the relative cost of supporting infrastructure required to link the source of production to markets is required, including transmission lines, gas pipes, storage and ports.

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?

The answer to this question appears driven by the pull of market initiatives in Japan and South Korea.

Government should seek to deliver policy certainty as a priority, which requires detailed techno-economic analysis of proposed scenarios across the various markets and applications to generate the data required for informed decision making.

2 | Attracting Hydrogen Investment

Link

This issues paper discusses the investment environment, long-term market structure and financial support needed to commercialise and build up a large-scale self-sustaining Australian hydrogen industry. Discussion includes possible sources of public and private financing, the broader investment environment and the ongoing support and market settings needed to enable industry growth while ensuring benefits to the Australian public.

Questions

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

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

    ii. **ensure an appropriate balance between export and domestic demand?**

Ongoing support for innovation in emissions reductions solutions for non-renewable hydrogen and renewable hydrogen is essential.

However, government need to support post-production CO_2 mitigation solutions such as CCS and pre or in-process innovations that avoid or minimise CO_2 emissions.

There is a danger that, in seeking economies of size and scale to support the feasibility of a CCS solution in a place like the Latrobe Valley, incentives will be directed away from 'brown hydrogen' innovation that aims to reduce emissions. Currently, the Victorian Government led CarbonNet project is planning a large scale, multi-billion dollar, CCS capture, distribution and storage network with the aim of handling the current CO_2 intensity of generation methods like gasification and steam reformation. This level of investment in CCS at the state level may create a structural bias towards hydrogen generation that has a high emissions profile as there will be an immediate need to maximise use of this new network to ensure rapid pay-back of the investment.

The Federal Government is well placed to balance this in-built bias by the Victorian State Government by offering a carbon credit system to incentivise brown hydrogen production that has a lower CO_2 emissions profile per tonne of Hydrogen produced.

CarbonNet Project has estimated that well-established CCS systems cost less than $30 per tonne of CO_2 stored, which could form the basis of a meaningful value signal to underpin investment in low-emissions solutions for brown hydrogen.

Federal Government should also consider providing dispensation to the proposed refund cap under the R&D incentive scheme for R&D directed towards supporting the hydrogen industry. As had been considered for the biotech sector, placing a cap on an industry sector where pre-commercial R&D is necessarily large, inhibits the development of technologies required to reach a scale adequate to overcome the risk of large capital investment items typical of this sector.

Whilst difficult for a country like Australia to not be led by the higher prices export markets pay for commodities, the risk of negative economic impact that prioritising export market growth over the domestic market is mitigated by the fact the hydrogen market is not currently an important part of Australia's energy mix and an export driven growth strategy is unlikely to have the same impact observed in LNG market with regard to the increased domestic price of natural gas.

However, there is still a risk that a higher margin energy commodity may displace other energy commodities through existing infrastructure and networks. Reduced access to established networks and infrastructure may place negative pressure on conventional energy sources as a result of supply shocks due to displacement.

The Government will need to consider preservation of the existing delivery and distribution infrastructure to avoid displacement and commit to the expenditure of new and bespoke infrastructure designed specifically for the hydrogen industry.

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?

Clear policy, with bipartisan support in areas like, R&D tax incentives, carbon credits or offsets, environmental laws governed by the EPA, climate change policy and mine rehabilitation, to name a few, is critical to reducing the sovereign and legislative risks of investing in Australia.

Private sector funds are inadequate in Australia to service such a large and transformative shift in energy supply systems and as such, foreign direct investment must be supported and stimulated.

Emphasis on supporting large scale hydrogen production, refinement and transportation using 'brown hydrogen' is likely to provide benefits for smaller scale, green hydrogen as the delivery systems to the market will be financed en masse by 'brown hydrogen'. The drive for renewable hydrogen attributes "pulled" through the networks and infrastructure by consumer demand are likely to be improved where that same infrastructure has been funded by 'brown hydrogen'. This is due to the lower costs of delivery, although capacity of these delivery systems to allow for retail and domestic access will be critical.

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?

Hydrogen will be a commodity. As such it will be price sensitive. Minimising production, storage and distribution cost is the key to competing globally.

Demonstration and evaluation of the technologies available and proposed for production, storage and transport will ensure the industry has access to the most appropriate data to deliver competitive outcomes.

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?

Hydrogen will be a commodity. As such, it's price will be highly sensitive to supply and demand. The Australian public, via government, will need to support early industry development to provide the social license for formative industry investment. The return on the successful outcome of this investment will be jobs and broader economic activity that will contribute to government revenues via corporate and income tax.

Any direct tax on hydrogen production should consider available margins and be proportionate to other countries.

Substantial lessons can be learnt from the USA's development of their unconventional gas industry in the formative days. This had the effect of balancing export and domestic demand to the extent that it reduced the impact of price inflation and supply access on domestic operations and consumption.

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

The issue papers identify learnings from the LNG industry and the impact of export parity pricing on domestic availability and pricing.

This is a complex economic area and structures need to consider the tension between export and domestic objectives.

Supply chain analysis is required to understand the delivered cost across markets and applications to facilitate focus. For example, it may be that renewable hydrogen produced locally in remote and regional communities is economic compared to energy alternatives such as diesel generation or the transported cost of petrol, whereas it may not be economic in the context of export to Japan or South Korea.

3 | Developing a hydrogen export industry

Link

This issues paper explores the opportunities for developing an export market for Australian hydrogen with partner countries.

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

Questions

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

The issues paper suggests positioning our brand as 'Hydrogen Australia'. This is appropriate considering Japan and South Korea are positioning themselves as 'customers of choice' on the demand side, attracting action from several nations, including Australia, eager to capture a slice of their market.

Leveraging our track record as a commodity exporter should present a capable, reliable proposition… a trusted partner and 'safe pair of hands'.

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

- Centralised planning and approvals, origin certification and regulatory support
- Natural monopolies should be identified, assessed and addressed by government to avoid duplication and provide equal access to project proponents
- Targeted financial mechanisms to help bridge the gap in the financial markets between nascent and mature technologies and industries
- Training programs to support demand for skilled labour to construct, operate and maintain hydrogen facilities
- Accreditation programs under regulatory requirements
- Energy policy, as it relates to the existing NEM and gas markets, has resulted in electricity and gas price increases in excess of the CPI, indicating fundamental issues with policy settings. Given the cost of primary energy feeds into the cost of hydrogen, energy policy needs to correct the legacy of decisions that have led to high energy costs if Australia is to compete globally.

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

- Bringing supply and demand players together via collaborative approaches such as the Hydrogen Energy Supply Chain (HESC) in Victoria which encourages risk sharing and goes a significant distance to dealing with the 'chicken and egg' problem
- Existing promotional mechanisms including Austrade should be tasked with promoting 'Hydrogen Australia'
- Australia could incorporate hydrogen industry support and supply under its foreign aid program.

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

Competitiveness begins by ensuring the cost of production is low enough to deliver a competitive product. Getting this right first provides the margin from which to calculate the scope for tax.

In setting revenue mechanisms, the government should benchmark against other hydrogen exporting countries to maintain international competitiveness.

Total excise or royalty revenue should be applied equitably regardless of the production method to ensure technology-neutrality. Consideration should be given to the fact that the cost of CCS hydrogen will already have included the embedded state lignite (or coal or gas) royalty costs.

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

We can learn from policy outcomes in the LNG market and National Electricity Market.

For example, when LNG export projects coincided with declines in Bass Strait production and bans on onshore exploration, the domestic gas market tightened, and price increases exceeded CPI.

Likewise, mandates and subsidies for wind and solar without corresponding value placed on grid reliability has contributed to wholesale electricity price increases above CPI in states with higher penetration of variable renewable electricity generation.

Export markets necessarily provide the volume of offtake to support scale up of production to commercial levels, with the resultant benefit of economies of scale flowing through to relatively smaller domestic applications. As such, export markets should be given priority, with producers required to meet domestic supply reliability measures as part of their social licence to export.

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

The report 'Hydrogen for Australia's Future', outlines Japanese and Korean hydrogen import targets for 2030 as 300,000 and 170,000 tonnes per annum respectively, with price guidance from Japan of A$33GJ (A$3.96kg). Total 235,000 tonnes.

The report, 'Hydrogen for Australia's Future' states:

> *To supply the potential 2030 export market of 500,000 tonnes would require more than 30,000 GWh of electricity. To put that in context, Australia's 2020 Large-scale Renewable Energy Target (LRET) is 33,000 GWh, while the total electrical energy generated in the National Electricity Market (NEM) in 2017 was 197,000 GWh.*

Using these figures, scaled to produce 235,000 tonnes, the electricity requirement would be 14,100GWh, which would need ~5.4GW of wind capacity (30% capacity factor) or ~6.4GW of solar capacity (25% capacity factor). This is dedicated capacity, in addition to any wind or solar committed or proposed for grid electricity.

The delivery of the renewable generation capacity and supporting infrastructure is technically possible, however further analysis is required to ascertain the likelihood of achieving the target landed cost, given the identified 10-fold decrease in renewable hydrogen costs required.

Germane to this question is the concept that past cost reductions for wind and solar can maintain a similar trajectory.

This is partly informed by scenarios in other areas of innovation, such as computing. Over the past 6 decades, Moore's Law has seen the efficiency of how computer chips use energy improve by over a billionfold.

Unfortunately, a similar transformation in how energy is produced or stored isn't just unlikely; it can't mirror anything close to Moore's Law with the physics we know today.

A report by CSIRO for AEMO, 'Electricity generation technology cost projections, 2017-2050' suggests wind may decrease in cost by 25% under aggressive climate policy. Large scale solar PV may decrease in cost by 45%. Well short of the 10-fold decrease required.

4 | Guarantees of origin

Link

This issues paper discusses the importance of traceability and certification to support regulatory systems and customer choices for hydrogen. The paper also explores international models, scheme requirements and governance arrangements.

Questions

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

The timing of a regime to guarantee the origin of Australian-made hydrogen as it relates to CO_2 is driven by end user requirements in the context of the promotion and marketing of 'Hydrogen Australia'.

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?**

The scheme should include scope 1 & 2 emissions so long as this is internationally consistent.

Australia should seek to harmonise domestic and international origin certification requirements where possible.

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?**

No comment.

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

No comment.

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

No preference.

5 | Community concerns

Link

This issues paper explores the current community perceptions of hydrogen technologies, environmental impacts, and particularly around growth in carbon emissions, water consumption and land use. It also outlines lessons from other sectors and explores models for community engagement, including with Indigenous Australians.

Questions

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

Requiring CCS for fossil fuel-based hydrogen production supports the principle of technology neutrality in the context of CO_2 constrained markets.

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?**

The issues paper adequately covers the key issues.

Many concerns arise through biased representations from narrow interest groups.

Education and unbiased information should be curated and provided by the government.

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

We note there are several research groups seeking to develop anodes for direct electrolysis of seawater. If successful, this may negate the need for desalination.

If this takes time or is unsuccessful, renewable hydrogen will need to incorporate the treatment cost, further hampering its economics.

If the desalination or water treatment plant is powered by fossil fuels, then this becomes a scope 2 CO_2 emission in the hydrogen supply chain, shifting the certification from zero to low-carbon.

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

CCS hydrogen is compact and could leverage the existing infrastructure in the Latrobe Valley, minimising land use and community disruption compared to renewable hydrogen alternatives.

The issues paper notes that water use is similar between CCS and renewable hydrogen. Planning for impacts on supply and price is essential regardless of the technology deployed.

Issues arise for renewable hydrogen facilities located in remote areas. Solar resources are located in areas with typically lower water resources. This requires the power be transmitted to locations with water availability, entailing transmission losses and additional infrastructure spending commitments.

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?**

A whole-of-government approach needs to be adopted via a central agency, with clear facilitation capability embedded within the approvals process, from project concept through to commissioning, certification and ongoing monitoring.

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

Existing hydrogen industry regulations provide an appropriate basis for regulation and education.

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?**

Any issues that impact on broader energy affordability or reliability are crucial to both export and domestic objectives.

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

The models identified in the issues paper are appropriate.

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?**

The models identified in the issues paper are appropriate.

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?**

Application of existing regulations delivered by existing structures, with the benefit of additional hydrogen-specific expertise, should deliver safe outcomes.

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

Safety is the number one consideration. Cost is the second. There is no long-term hydrogen opportunity domestically or internationally unless people know it is safe and until we can deliver hydrogen at the right price and on a reliable basis.

It is clear that CCS hydrogen and renewable hydrogen will receive support from sections of the community with different viewpoints. Objective, unbiased education is essential to ensure a technology-neutral approach.

6 | Hydrogen in gas network

Link

This issues paper explores the benefits, challenges and issues related to introducing hydrogen into Australia's gas distribution networks. It explores the actions needed to commence blending of hydrogen into these networks.

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?**

ECT defers to industry experts with regard to gas networks.

2. **What is the potential to have a test project of 100% hydrogen use in a small regional location and where?**

ECT defers to industry experts with regard to gas networks.

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

ECT defers to industry experts with regard to gas networks.

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

ECT defers to industry experts with regard to gas networks.

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

ECT defers to industry experts with regard to gas networks.

7 | Hydrogen to support electricity systems

Link

This issues paper explores the interplay between hydrogen production and electricity system operation and the opportunities for clean hydrogen to contribute to the resilience of 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?**

The issue paper provides a good overview of the challenges and options.

Three distinct opportunities for hydrogen have been highlighted through the consultation process:

1) Export
2) Domestic
3) Grid-firming

Two routes are proposed:

1) Renewable hydrogen (wind & solar plus electrolysis)
2) CCS hydrogen (fossil-fuels plus carbon capture and storage)

These routes present profoundly different primary energy scale challenges.

The Finkel Review recommended a Generator Reliability Obligation which provides that if a "new" variable renewable energy (VRE) generator wishes to connect in a region that is close to the limit of minimum dispatchable capacity, that it must provide an amount of new dispatchable generation capacity from within the same region.

That dispatchable generation capacity cannot come from existing sources.

There are times when the wind is blowing or the sun is shining, and no one needs the electricity. This electricity is generally curtailed and therefore lost. At present this may be as high as 10% of the time.

Directing this 'spare' renewable energy to storage, such as batteries, pumped hydro or hydrogen electrolysers would help firm the intermittency of wind and solar, creating dispatchable' renewable electricity. This is covered in detail in the CSIRO's National Hydrogen Roadmap.

Unfortunately, according to the National Hydrogen Roadmap, while renewable hydrogen has the lowest electricity input cost (~2c/kWh) when it uses otherwise curtailed wind or solar, the capacity factor of the electrolyser is close to 10%, resulting in an estimated hydrogen cost of ~$26kg due to inefficient plant utilisation.

Renewable hydrogen may have a place as a solution for grid-firming in the context of a broader approach utilising a combination of batteries, pumped hydro and hydrogen. This is outlined in ARENA's 2018 report; Comparison of Dispatchable Renewable Energy Options and should be considered a direct cost of wind and solar, per the Finkel Review recommendation.

Further analysis is required to confirm the techno-economic feasibility thresholds for renewable hydrogen firming as a result of increased wind and solar penetration.

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?

The scale challenge for the hydrogen industry is not hydrogen production itself but scaling the primary source of energy used to make the hydrogen.

Hydrogen production should not come at the expense of domestic energy affordability or reliability.

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

Hydrogen-based grid firming should be considered in the context of the broader application of firming options, including batteries and pumped hydro.

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?

Balancing supply and demand will be the challenge. The tension between servicing potentially more profitable export markets compared to domestic electricity markets may result in a similar outcome to the LNG market.

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

The HESC pilot in Victoria provides a good benchmark, involving a whole of supply chain approach.

8 | Hydrogen for transport

Link

This issues paper explores the benefits, risks and barriers to using hydrogen as a transport fuel in Australia by 2030. The COAG Energy Council Hydrogen Working Group seeks feedback on the potential role of national policies and actions in realising these opportunities.

Questions

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

ECT defers to industry experts on this question.

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

ECT defers to industry experts on this question.

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

ECT defers to industry experts on this question.

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

ECT defers to industry experts on this question.

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

ECT defers to industry experts on this question.

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?

ECT defers to industry experts on this question.

9 | Hydrogen for industrial users

Link

This issues paper explores the opportunities for hydrogen as a chemical feedstock and as a source of industrial heat.

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?**

The ability of hydrogen to act as a reductant in primary iron production is well-known. The barrier to adoption has been high cost, relative to the incumbent blast-furnace route.

It is envisaged that green hydrogen will one day deliver CO_2-free iron and steel via hydrogen-based methods.

Commercialisation of renewable hydrogen steel making is estimated to be a generation away given the scale and cost challenges.

ECT has developed the ideal transitional solution; HydroMOR. Short for Hydrogen-based Metal Oxide Reduction.

HydroMOR is the only lignite-based iron making process, replacing coking coal and thermal coal with lignite, combining it with iron ore fines or other metal oxide-bearing media via the Coldry process to produce a 'composite' pellet. The composite pellet is then fed into the unique HydroMOR furnace where several reactions take place:

- Pyrolysis and gasification of hydrocarbons within the lignite
- Catalytic thermal decomposition of the hydrocarbon gas to liberate hydrogen
- Reduction of iron oxide to iron at less than 900°C (relatively low temperature)
- Chemical looping of hydrogen within the process via a water-gas shift reaction (recycling the hydrogen for further reduction of iron oxides)

The result is the in-situ utilisation of hydrogen for iron making and the elimination of the cost needed to independently generate, transport, store and then apply it to iron ore, providing an advantage for regions with suitable lignite and iron ore resources.

Note that this approach is fundamentally more efficient than external production of hydrogen, followed by usage of that hydrogen within a process to reduce the oxide to metal.

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?**

Waste to energy or bio-mass to energy is the primary focus for industrial scale heat generation in the context of tackling emissions intensity and affordability.

Where waste or bio-mass is available and within desired specifications for moisture, energy and ash content, it is more cost-effective than the alternative of natural gas or LPG.

Waste and biomass are considered to be CO_2-neutral as it is expected to release greenhouses gases as part of their lifecycle, either via landfill methane emissions or natural decomposition.

To compete, hydrogen would need to deliver lower or equal energy cost than these alternatives in the context of any additional capital upgrades required to allow the boilers to use it in a safe manner.

3. Supplying clean hydrogen for industrial users

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

- **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?**

Given Victoria has the largest number of industrial boiler systems, the Latrobe Valley is a logical location for a CCS hydrogen facility and broader supporting gas network.

A detailed market study is required to answer this question on a national level.

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?**

- **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?**

In the context of small to medium scale utility process heating systems (e.g. 4-10MW boiler and hot water systems), conversion to hydrogen consumption would require, at minimum, complete change out of combustion systems to allow safe use of hydrogen as a combustion fuel, or entire replacement of the combustion and boiler systems in the case of existing solid fuel users.

The most sensible trial sites for conversion to hydrogen fuel would be existing natural gas boiler systems, where change out costs are constrained to fuel combustion systems.

Most existing systems encountered in the segment mentioned above do not have existing facilities or capabilities to handle increased NO_x emissions.

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?**

Existing hydrogen industry regulations should be applied.

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?**

The key to the transition is affordability and reliability.

CCS hydrogen is scalable and more affordable in the near term. Renewable hydrogen is more expensive and, according to current estimates, unlikely to achieve the 10-fold cost reduction required to meet market expectations by 2030 or even 2050.

Government support for CCS hydrogen is essential to bridge the gap between today’s use of resources and a zero-emission future.