ATSE
Australian Academy of Technological Sciences & Engineering

Hydrogen Production, Transport & Distribution

SUMMARY REPORT

Australia-Korea Innovation Virtual Workshop

30 March 2022
09.00-15.00 KST
11.00-17.00 AEDT

NAEK 한국공학한림원
The National Academy of Engineering of Korea

Australian Academy of Technological Sciences & Engineering

한국공학한림원 The National Academy of Engineering of Korea

Australia and South Korea aim to become major producers, exporters, and utilisers of hydrogen produced with renewable energy to help both nations realise carbon neutrality by 2050. Australia has abundant natural gas and renewable energy sources, a solid trade relationship with South Korea, and established export infrastructure, which provide an advantageous position for hydrogen production and exports.

Small and medium-sized and multi-national companies in Australia are participating in projects focused on energy production and use. In the fields of battery, fuel cell, and hydrogen vehicle technology, cooperation with overseas companies is essential to reach the full potential in application and adoption.

Korea has strengths in fuel cell, hydrogen car, and hydrogen charging station technologies, and is hoping to strengthen complementary cooperation with Australia from hydrogen production to utilisation. Australia is seeking to become a renewable hydrogen producer and exporter, and aims to establish relationships with Asian countries with advanced hydrogen technologies and infrastructure, as these are major potential importers of renewable hydrogen.

Australian and South Korean hydrogen value chain components are complimentary with clear production and consumption roles. The development of new energy trade relations to support the hydrogen economy would be built through cooperation between industry and government in both countries in each sector from production to implementation. This Innovation Workshop series aims to discuss industry development strategies, technology trends, and future opportunities for cooperation between the two countries. The focus of the March 2022 workshop was hydrogen production and transport technology, and the economic feasibility of a hydrogen industry.

The Australian Academy of Technological Sciences and Engineering (ATSE) and The National Academy of Engineering Korea (NAEK) present a summary of the workshop discussion and the current state of hydrogen below.

1. Hydrogen 'part of the plan' in 2030

Establishing a commercially viable hydrogen industry by 2030 that incorporates both domestic and export value chains is becoming a shared and credible scenario. Both Australia and South Korea have developed national roadmaps that bring together research and industry stakeholders. Through multi-sector investment, projects have demonstrated they can multiply returns across the hydrogen value chain. Initial operational projects are about to begin and are expected to produce small volumes of green hydrogen within the next calendar year. This demonstrates the start of the shift from discussions about technologies to the industrial output phase that will test infrastructure systems across the value chain. For example, South Korea plans to increase the number of fuel cell vehicles to 6.2 million and hydrogen stations to 1,200 by 2040. Hydrogen should contribute one third of South Korea's final energy consumption by 2050. Australia has established 2030 as the deadline for implementation of commercial green hydrogen, as this next period will facilitate a competitive decrease in hydrogen chain costs.

To achieve these decadal milestones, the hydrogen economy is accelerating the pursuit of vertical integration in the value chain across production, transportation, and utilisation. There is a consensus that hydrogen will play a major role in complementing the energy security and reliability of renewable power sources, including the limitation of EV batteries in heavy/ long-distance transport. The readiness for implementation is maturing as markets are identified for mid-short term (power plants and heavy transport) and long-term (drones, aircraft, ships), alongside research into best practice for social acceptance, legal agreements, and industrial management.

2. Scaling up is key

The workshop presented several examples of research and industry teams that are racing for mid-term solutions at scale. Scaling up means that orders of magnitude are radically modified:

- Electrolyser: existing 10 MW, target is 100 MW.
- Storage tanks 270 tons -> 3500 tons.
- Filling such gaps means efficiencies of all components are improved.

Workshop presentations demonstrated the broad spectrum of technologies currently under research and development. From membrane and advanced electrode technologies for electrolysis to material property compatibility of steel and plastic for hydrogen pipelines, and from new refrigerants in liquefiers to dual perovskite-silicon semiconductors for direct solar electrolysis – the research is diverse and comprehensive.

Key research priorities have been clearly identified for the industry to be able to scale up by 2030, and to successfully commercialise and export green hydrogen:

- Large-scale, high-efficiency, hybrid low-temperature water electrolysis (alkaline +PEM)
- Hydrogen liquefaction, storage and transportation.

CCUS is an important technology in relation to blue hydrogen.

Another sign the industry is scaling up is small capacity projects becoming operational in the next few years. This was exemplified by the Infinite Blue Energy's MEG project, which is expected to supply hydrogen to the WA market by Q4 2023. The production target for the plant is 3.3 tonne/day. Several MOUs have already been signed with partners ready to use the project's output.

3. Can existing infrastructure be adapted to net-zero emission fuels?

Australia has a vision for conversion of its entire gas networks to CO2 free biogas and hydrogen by 2050. Adding low emission hydrogen in Australian gas distribution networks has the added advantage of stimulating early hydrogen demand growth.

Challenges associated with blending biogas and hydrogen in gas networks, such as developing rotating equipment that can alternate between gas and hydrogen sources, are currently being examined by researchers. Priorities are improving material properties of steel and plastic for pipelines, and understanding residential and industrial appliance behaviour in different scenarios (low-level blending, high-level blending and 100% hydrogen).

4. Long-distance transportation challenges

Reliable and affordable liquified or pressurised hydrogen transport is a critical step for enabling Australia's long-distance exports of hydrogen. Parallels with the LNG industry's success story in Australia provide insights into the possible future of the hydrogen industry evolution. Next steps for a more cost-effective liquefaction process include optimising refrigerants and compressors to reduce boil-off, and increasing equipment efficiency.

Transporting liquefied or pressurised hydrogen leads to another set of challenges, due to issues including hydrogen's very low volumetric energy storage density. Scaling up to high-capacity and long-distance transportation requires liquid energy carriers with tank technology capable of resisting high pressure. Maintaining hydrogen purity and limiting leakage are other issues that need to be addressed.

Ammonia is an immediately available carrier to export clean hydrogen. There are currently no commercially available ships to transport liquefied hydrogen, however, ammonia can be used as a carrier of hydrogen and is already commonly safely transported in tankers.

5. Direct solar Hydrogen generation

Storing solar energy in a hydrogen carrier is the long-term vision of the industry as the 'Bottling Australian sunshine' tagline expresses. Academic and industry researchers are working hard to close the renewable electricity cost gap, as making green hydrogen viable will reduce the cost of renewable electricity, which in turn leads to future cost reduction of green hydrogen production.

Sunlight will be used to split water thanks to the development of photo-electrochemical cells that combine Perovskite solar cells with Silicon solar cells and lead to higher efficiency. These cells, when implemented with high performance, earth abundant catalysts, will produce hydrogen.

The objective is to meet a conversion efficiency target of solar to hydrogen (STH) of 20%, i.e., one fifth of the sun's energy stored directly as H_2.

6. Next steps

ATSE and NAEK are committed to assisting our economies and governments to forge a cooperative partnership towards building the international hydrogen economy, and ensuring domestic markets and infrastructure are ready for the transition to and uptake of green hydrogen power.

A second workshop will run in August 2022 with a focus on the costs of hydrogen and public-private partnerships.

For more information please contact
international@atse.org.au

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Australia and Korea aim to become major producers, exporters, and utilisers of hydrogen produced with renewable energy and realise carbon neutrality by 2050. The ATSE-NAEK meetings play an important role in encouraging bilateral collaboration with between academia and industry in both countries.

This new event is focused on technologies and topics that can make sustainable Hydrogen a successful solution in the short term. Discussions will cover maturing the most promising technologies, scaling up infrastructure and building up businesses. Hope you can join!

Virtual event via Zoom

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KST	AEDT		
09.00-09.10	11.00-11.10	**Opening remarks**	**Kylie Walker** – Chief Executive Officer Australian Academy of Technological Sciences & Engineering (ATSE) **Junghee Song** – Vice president, The National Academy of Engineering of Korea (NAEK)
SESSION 1 – Hydrogen production			
CHAIRS **Chinho Park** – Vice President for Research and Dean of Korea Institute of Energy Technology (KENTECH) **Dongke Zhang** FTSE – Director, Centre for Energy, The University of Western Australia; Chair, ATSE WA Division			
09.10-09.30	11.10-11.30	*Scaling Sustainable Hydrogen Infrastructure*	**Stephen GAULD –** Managing Director & CEO of Infinite Blue Energy
09.30-09.50	11.30-11.50	*Green Hydrogen Production Technologies in Korea*	**Changhee Kim** – Professor of KENTECH
09.50-10.10	11.50-12.10	*Adapt Infrastructure to Net Zero Emission Fuels*	**David Norman** – CEO of Future Fuels CRC
10.10-10.30	12.10-12.30	*Why We Building Up A Hydrogen Business*	**Hyungkyun Kwon** – Chiarman of SK E&S Hydrogen Biz Development Center
10.30-11.00	12.30-13.00	Discussion	
11.00-13.00	13.00-15.00	BREAK	
		SESSION 2 – Hydrogen transport and distribution	
CHAIRS **Dr Sarah Ryan FTSE** – Non-executive Director of Woodside, Viva Energy, Aurizon and OZ Minerals **Booki Kim** – President of Korea Research Institute of Ships and Ocean Engineering (KRISO)			
13.00-13.20	15.00-15.20	*Scaling up hydrogen liquefaction technology*	**Jihyun Hwang** – Head of Hydrogen Energy, KENTECH
13.20-13.40	15.20-15.40	*High efficiency, low cost – direct solar Hydrogen*	**Dr Fiona J. Beck** – Senior Fellow at the ANU School of Engineering
13.40-14.00	15.40-16.00	*Chemical Hydrogen Storage for Long Distance H_2 Transportation*	**Chang Won Yoon** – Professor of Pohang University of Science and Technology (POSTECH)
14.00-14.20	16.00-16.20	*Leveraging existing infrastructures – similarities and differences with LNG*	**Eric May** – CEO of Future Energy Exports CRC & Professor, UWA
14.20-15.00	16.20-17.00	Discussion and wrap up	

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