Australian Government

Australian Trade and Investment Commission

Korean Hydrogen Market Update

SOUTH KOREA

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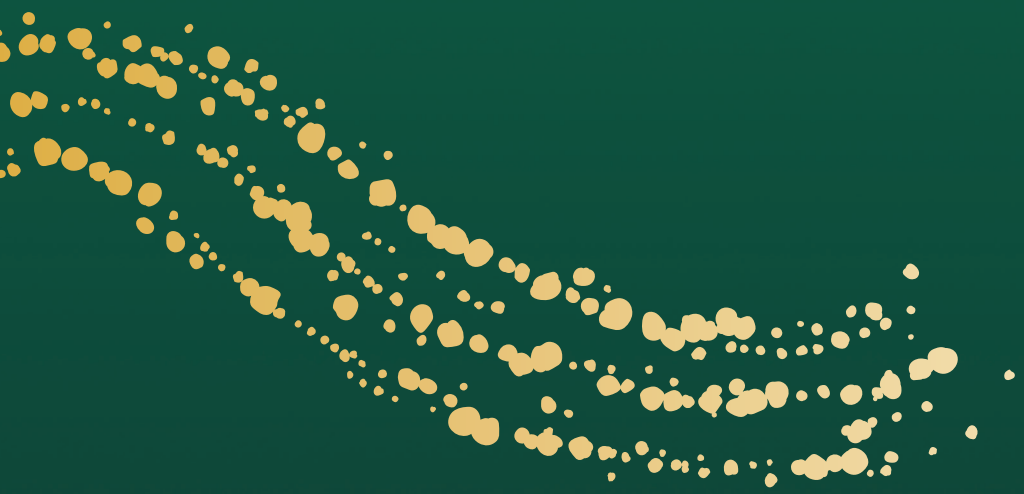


AUSTRALIA

Contents

Table of Content

Foreword

Both Korea and Australia have ambitious emissions reductions targets.

Korea's 2019 Hydrogen Economy Roadmap and its Hydrogen Economy Promotion and Hydrogen Safety Management Act have set the stage for Korea to quickly move towards establishing a new hydrogen economy.

Australia aims to become a clean energy superpower, taking advantage of its abundant renewable energy capabilities and its existing high quality energy export infrastructure.

It's therefore no surprise that Korean corporates are looking to Australia not only as a source of hydrogen but also for new green products such as clean ammonia and steel intermediates that will decarbonise hard to abate Korean industries and create new manufacturing jobs in Australia. It is also no surprise that Australia is looking to Korea as a source of world-leading technology like fuel cells and as a source of the capital needed to help get projects off the ground.

Businesses and governments in Korea and Australia have worked very successfully together to develop strong partnerships in coal, iron ore, refined petroleum and LNG – we have already started to do the same for the hydrogen industry, again taking advantage of the complementarity between our two economies.

We hope that this report helps set out in more detail where the opportunities lie.

Julie Quinn
Senior Trade and Investment Commissioner
Australian Trade and Investment Commission (Austrade) Seoul

1. Introduction

1.1. Korea's hydrogen economy

South Korea (Korea) has set itself ambitious goals for its hydrogen economy for 2030 and beyond but is already a global leader in the transition to hydrogen: the country boasts almost half of the world's installed capacity of utility-scale stationary fuel cells and its largest automotive company, Hyundai Motor Company, has supplied almost 60% of the world's Fuel Cell Electric Vehicles (FCEV) since launching its first commercial fuel cell vehicle in 2013. Korea is now looking to build on these strong foundations, a strategy that enjoys broad support across both the public and private sectors.

Korea's hydrogen industry is forecast to almost double in size from KRW 14.1 trillion (A$15.6bn) in 2020 to KRW 26.8 trillion (A$29.7bn) by 2030. This growth will be driven by investments from large local players such as Hyundai, POSCO, Doosan, SK, and Lotte who increasingly see hydrogen as a key growth engine. Hyundai Motor Company intends to spend KRW 7.6 trillion (A$8.4bn) under its 'Fuel Cell Vision 2030' and 'Hydrogen Wave 2040' programmes and looks well placed to capitalise on its early-mover advantage in fuel cells, both by selling its own fuel cell vehicles and by licensing its fuel cell systems to OEMs around the world. In addition, five of Korea's biggest conglomerates including Hyundai, SK, POSCO, Hanwha, and Hyosung have recently announced KRW 42 trillion (A$46.6bn) investment commitment in the hydrogen economy by 2030.

The Korean government announced its Hydrogen Economy Roadmap in 2019. The roadmap aims to deploy 15GW of utility-scale and 2.1GW of commercial and residential fuel cells by 2040. In terms of mobility, the goal is to have 2.9 million fuel cell cars including 40,000 fuel cell buses on the road in Korea by 2040 all supported by 1,200 hydrogen refuelling stations (HRS). The announcement of Korea's Green New Deal in July 2020 – a coronavirus stimulus plan outlining KRW 74 trillion (A$82.2bn) in 'green' public-private capital investment by 2025 – should help the country on its way to achieving these aggressive long-term goals.

Initial concerns that Korea's new president, Yoon Seok-yeol, would be less committed to hydrogen appear to unfounded: shortly after taking office in May 2022, Yoon urged the private sector to take the initiative in making overseas investments amid the growing importance of energy security and insisted that, "the government... will set up a stable hydrogen supply chain by securing production bases here and overseas."

Hydrogen ecosystem

Hydrogen is mainly sourced as a by-product gas from oil refineries located in the south of the country. There are three large petrochemical complexes in Ulsan, Yeosu, Seosan/Daesan where 85% of the local hydrogen production comes as a by-product from naphtha cracking which is then cleaned and distributed to customers. Around 14% of the hydrogen produced in Korea comes from large-scale steam methane reformers (SMR) built to order and constructed on or next to customer's sites. Less than 1% of hydrogen is currently sourced through water electrolysis.

Hydrogen is rapidly moving from being purely an industrial gas concern to a broader fuel used to generate power, heat, and energy for mobility. Industry experts believe that hydrogen demand in Korea could reach 1 million tonnes/year by 2025. The current hydrogen supply model which involves hydrogen being trucked via tube trailers to Korea's nascent Hydrogen Refuelling Stations (HRS) network, faces problems of sustainability and scalability. Out of almost 450,000 tonnes of hydrogen produced in 2021, only a small fraction was available for HRS or fuel cell power generation.

As most of the by-product hydrogen is produced and consumed by the petrochemical complexes, industry experts believe that even today there are only about 80,000 tonnes of hydrogen available to supply to the energy and mobility sectors. On average, the oil refineries in Korea consume about 3,000-5,000 Nm3/h of hydrogen while steel manufacturers use between 1,000 Nm3/h and 2,000 Nm3/h.

In the medium to longer term, one of Korea's hydrogen strategies involves moving towards green hydrogen with renewable energy-powered electrolysis but for now, the strategy is to use the extensive natural gas network as the main source of hydrogen for both power and mobility applications. Korea's strategy is to build out the most cost-effective hydrogen infrastructure in the short term and 'de-carbonise' the supply of the hydrogen at a later point rather than trying to start with a green hydrogen strategy from the start.

This approach received a lot of criticism and the Korean government announced 'First Basic Plan for Implementation of the Hydrogen Economy' in November 2021 to focus more on the production and import of green hydrogen. Moving forward, the government aims to accelerate the development of large-scale water electrolysis technologies and create infrastructure for imported hydrogen shifting the focus of supply to green hydrogen. The recent announcement of a Korean consortium's KRW 1.2 trillion (A$1.4bn) investment in a green hydrogen and ammonia plant in the UAE is a prime example of this strategy and one which Australia can look to emulate.

1.2. Key opportunities

Korea is the third largest market for Australian resource and energy exports after China and Japan, worth KRW 29 trillion (A$32.2bn) in 2021 and this can continue to grow with the export of liquefied hydrogen. According to the Ministry of Trade, Industry and Energy (MOTIE), Korea is planning to increase hydrogen production from about 450,000 tonnes/year in 2021 to 1.9 million tonnes/year by 2030 while importing 1.96 million tonnes/year of clean hydrogen from abroad. Although the Korean government is considering several import destinations for example, the Middle East and Europe, Australia is considered as one of the most viable suppliers of liquefied green hydrogen thanks in part to the existing LNG import infrastructure.

As mentioned in the Australia-Korea Low and Zero Emissions Technology Partnership agreement signed in December 2021, exporting hydrogen carrier solutions such as ammonia could be one of the short-term opportunities for Australia. Samsung Heavy Industries, one of the biggest shipbuilders in the world, in partnership with KOGAS, Korea's main natural gas importer, has committed to allocate KRW 18 trillion (A$25bn) to build special terminals in Busan and Yeosu ports by 2024 for the import of green ammonia for producing hydrogen. In addition, POSCO announced plans to import ammonia and to roll out large-scale ammonia-based hydrogen production hubs in four locations (Incheon, Daejeon, Yeosu and Ulsan) by 2025.

Korea's hard-to-abate sectors such as steelmaking, cement production and shipping have traditionally relied on coal, oil and natural gas. Decarbonisation of these sectors through domestically produced green hydrogen is challenging due to the high cost of renewable energy in Korea. Key players such as Korea Zinc, POSCO, Hyundai Steel, Samsung Heavy Industries, and Lotte Chemical expressed their intention to address this challenge through investment in overseas hydrogen hubs with the potential of producing hydrogen through methane reforming, ammonia synthesis in the short to medium term, and electrolysis with renewable energy such as wind and solar in the longer term. As a country with vast energy resources and its plans for hydrogen hubs, Australia is well placed to attract investment from Korea's hard-to-abate sector players who are seeking to export hydrogen to Korea.

Other areas for potential cooperation between Australia and Korea include carbon capture, use and storage technologies (CCUS), low-emission steel and iron ore production, synthetic fuels, advanced materials with properties related to thermal and pressure management, fibre composites, materials for cryogenic liquid storage, graphene solutions and fuel cell components such as ceramics, graphite, precious metals, and rare earth elements.

2. Hydrogen economy policies

2.1. Hydrogen Economy Roadmap

In January 2019, the Korean government announced the Hydrogen Economy Roadmap that set out its targets to 2040. The roadmap aims to increase the number of fuel cell cars to 67,000 by 2022 and to 2.9m units by 2040 and will support this growth with 310 HRS installed by 2022 and 1,200 HRS by 2040. It also aims to increase massively the installed capacity of utility-scale and residential fuel cells by 2040 to 15GW and 2.1GW respectively.

Although the Hydrogen Roadmap is a key guideline for the development of the hydrogen economy in Korea, some targets are regarded as 'too ambitious to achieve'. For example, the target to roll out 310 HRS by 2022 may be unfeasible as there are only about 200 HRS both operational and under construction as of May 2022. The Korean government understands that some of the targets are too ambitious, and in order to come up with more realistic goals the government is considering the introduction of a revised Hydrogen Economy Roadmap at some point in 2022.

2.2. Hydrogen Law

The National Assembly passed the Hydrogen Economy Promotion And Hydrogen Safety Management Act (Hydrogen Act) in February 2020 with a view to creating the legal framework for the realisation of the Hydrogen Economy Roadmap. The law came into effect in February 2021 and makes provisions for hydrogen equipment safety requirements, certification processes and clarifies the roles and responsibilities of various government agencies. The National Assembly approved several amendments to the hydrogen law in May 2022, which include the definition of clean hydrogen, optimisation of hydrogen generation equipment and hydrogen gas turbine certification processes. The law also creates a bidding market for purchase and supply of hydrogen power and sets the amount of hydrogen power that is generated in order to meet annual carbon emission goals.

Under the Hydrogen Act, the government can request the operators of 21 types of facilities such as industrial complexes, logistics centres and highway rest areas to build HRS with government subsidies. In addition, there are 12 types of facility operators such as IPPs and commercial building operators that can be asked by a local government to install fuel cells for power generation.

2.3. Green New Deal

In July 2020, the Korean government announced a Korean New Deal with the aim of creating 1.9m jobs by 2025. The New Deal consists of almost KRW 160 trillion (A$177.7bn) worth of total investment in the digital, green economy and 'safety net' spaces. Central government expenditure will account for KRW 115 trillion (A$127.7bn), while the remainder will be sourced from local governments and the private sector.

The Green New Deal is the term used to describe projects aimed at reducing the economy's carbon intensity and hydrogen is set to play a key role. The government has selected 5 key areas of investment: Green Smart Schools, Smart Green Industrial Complexes, Green Remodelling, Green Energy, and Green Mobility. Of the KRW 74 trillion (A$82.2bn) total capital investment under the Green New Deal, the largest portion – KRW 20 trillion (A$22.2bn) – will be used for green mobility, particularly hydrogen projects. Public organisations such as KOGAS, KEPCO and related ministries are tasked with developing plans to channel the funds.

Green New Deal funding will be applied to overcome the lack of short-term profitability with hydrogen infrastructure. For example, operating an HRS is not yet profitable due to low volumes and the high price of delivered hydrogen through tube trailers so attracting investment has proven difficult. To remedy this, the government adopted a Build-Transfer-Lease (BTL) model under the Green New Deal whereby the private sector builds the infrastructure, transfers the ownership to the government and then leases the infrastructure back from the government over a 30 or 50-year period.

2.4. Regulation and certification

The Hydrogen Act also regulates hydrogen equipment manufacturing and operation safety. Before the announcement of the Hydrogen Act, equipment such as electrolysers, portable fuel cells and hydrogen extractors (SMR), and fuel cell facilities that directly use hydrogen were not subject to regular government safety checks. With the introduction of the Act, safety assurance is carried out in three steps – technological safety at the design stage, an on-site examination upon completion of a facility, and annual safety checks. The Hydrogen Act designated Korea Standards Association (KSA) as the central organisation to certify fuel cell and other downstream hydrogen technologies and Korea Gas Safety Corporation (KGS) as the central government authority to test and certify high-pressure gas equipment such as SMR and compressors, storage tanks, etc.

According to the Hydrogen Act, all hydrogen-related equipment rated at over 10 bar design pressure is considered high-pressure gas equipment and will need to be certified by KGS. On the other hand, equipment below 10 bar design pressure is considered low-pressure gas equipment. Low-pressure gas equipment and fuel cell certification are regulated by Korea Occupational Safety and Health Agency (KOSHA).

More information on the KGS and KSA regulations can be found at:
http://www.kgs.or.kr/kgsmain_eng/kgs_services/manufactural_sys.jsp
https://eng.ksa.or.kr/ksa_kr/index.do

3. Key hydrogen initiatives

3.1. Hydrogen refuelling stations (HRS)

Currently, there are 162 HRS operating in Korea. The vast majority of these are 'truck-in' stations where the hydrogen is brought in by tube trailer from a supplier such as Deokyang or SPG. There are four operational HRS with on-site SMR commissioned during 2020-2022. In terms of capacity, HRS are divided into two broad categories: regular HRS with 650 kg/day and bus HRS with 1,000 kg/day refuelling capacity. Due to the low profitability of HRS operation, almost all HRS are being operated by the municipalities. HRS are often built close to CNG stations (most Korean buses run on CNG) or LPG stations (most Korean taxis run on LPG) as permits are easier to secure and some costs, such as safety protocols, can be shared across the stations.

HyNet

In 2019, 13 hydrogen companies with interests in the hydrogen space established a special purpose company (SPC) with the goal of building 100 HRS by 2022. Those companies were KOGAS, Hyundai Motors, Woodside, Nel, Valmax, Bumhan, SPG Hydrogen, JNK Heaters, Kolon Industries, Hyosung Heavy Industries, Air Liquide, Deokyang and Ecobio Holdings and together they invested a total of KRW 135bn (A$150m) into the SPC. However, Deokyang and Ecobio withdrew from the SPC in 2020, leaving 11 companies in the consortium.

HyNet built 60 HRS during 2020-2021 and is planning 40 more in 2022. Despite a degree of government involvement, HyNet acts as a private sector player investing 50% CAPEX on top of the government's 50% subsidy for HRS.

KOHYGEN

In March 2021, 9 companies, mainly the operators of petrol and LPG stations such as GS Caltex, S-Oil, Hyundai Oilbank and SK Gas formed an SPC called 'KOHYGEN' with the goal of building and operating HRS for passenger and heavy-duty hydrogen vehicles such as buses and trucks based on the HyNet model. KOHGYEN plans to build HRS across Korea with refuelling capacity of 1,000 kg/day and higher. Although there is no target for the number of HRS as there is with HyNet, KOHYGEN is in the process of building three HRS with capacity of 1,000 kg/day each and has applied for government approvals for an additional six HRS to be built in 2022.

3.2. Hub and spoke network

One of Korea's main strategies for rolling out hydrogen infrastructure is to build a hub and spoke network whereby hydrogen is produced at a centralised site and then transported to nearby HRS. Tube trailers are currently the only available option

but ultimately the plan is to build a hydrogen pipeline network linking the hub and the spokes where this is feasible. Korea already has a total of 200km of hydrogen pipelines mainly around the petrochemical complexes in Ulsan and Yeosu.

There are two essential procurement authorities in the hydrogen production market for HRS in Korea: MOTIE and KOGAS. Although their purpose is the same, MOTIE-sponsored projects are generally called 'base-type stations' and KOGAS-sponsored projects are called 'mother stations". Both MOTIE and KOGAS are planning to install SMR equipment in these stations with a view to transporting hydrogen to the nearby stations. By 2025, KOGAS and MOTIE are planning to roll out hydrogen hub and spoke networks in nine cities such as Incheon, Ansan, Daejeon, and Ulsan.

3.3. Hydrogen pilot cities

In December 2020, the Ministry of Land, Infrastructure and Transport (MOLIT) announced plans to build hydrogen pilot cities in Ulsan, Ansan and Wanju by 2022. According to the definition of a 'hydrogen city', the hydrogen gas must be used as a fuel for major urban functions such as cooling, heating, electricity, and transportation. The government had allocated KRW 105bn (A$116.6m) for the project and as of May 2022, the hydrogen pilot city projects have average completion rates of 65%, 34%, 16% in Ulsan, Ansan, and Wanju cities respectively. MOLIT pointed out public complaints, regulatory challenges, and lack of marketability as the main reasons for the slower than expected roll-out of the projects.

Table 1 **Status of hydrogen pilot cities (2022)**

Projects	Completion rate (%)		
	Ulsan	Ansan	Wanju
Hydrogen refuelling stations	95	65	25
Transportation	80	35	15
Residential cooling / heating	75	15	10
Fuel cell power generation	60	35	10
Hydrogen pipeline	95	10	10
PV-powered electrolysis	20	10	10
Hydrogen reformer	35	40	30
Average status	65	34	16

Source: MOLIT

4. Government partnerships

4.1. Low and Zero Emissions Technology Partnership

In December 2021, the Australian and Korean governments agreed to establish the Australia-Korea Low and Zero Emissions Technology Partnership with a view to collaborating on the supply of clean hydrogen and ammonia, low emissions steel, iron ore and carbon capture, use and storage (CCUS) technologies. Under the partnership, both governments committed to invest up to A$100 m towards the realisation of the above-mentioned initiatives.

The Australian government acknowledged that green technology and process advancements are critical to reducing the emissions intensity of the existing key Australian export commodities such as iron ore, coal, and natural gas which are used for Korea's hard-to-abate sectors such as steelmaking, cement, and chemicals. For their part, the Korean government stated its intention to decarbonise these sectors in the long-term by replacing fossil fuels with green hydrogen.

4.2. Hydrogen visions by key players

• POSCO

POSCO is the sixth largest steel producer in the world and has Korea's largest carbon footprint with annual emissions of approximately 80m tonnes. The company has committed to become carbon neutral by 2050 and hydrogen is a major component of that strategy. POSCO has developed its own hydrogen reduction steelmaking method, HyREX, which uses only hydrogen as a reducing agent. The company plans to open a demonstration plant in Pohang by 2028 where hydrogen demand will be 100,000 tonnes. General demand for hydrogen for steel production is then expected to increase to 1.6m tonnes by 2040 and 3.7m tonnes by 2050. Currently, POSCO has an annual production capacity of by-product hydrogen of 7,000 tonnes. It expects this figure to rise tenfold to 70,000 tonnes by 2026 but aims to cap its 'grey hydrogen' production there.

To meet the expected massive increase in demand for hydrogen beyond 2026 not only in steel but across the wider economy, POSCO plans to become a major supplier of clean hydrogen and is aiming to complete 7m tonnes of supply capacity by 2050 by investing in the overseas production of blue and green hydrogen. The company will invest an accumulated KRW 10 trillion (A$11bn) in projects by 2030 to develop 300,000 tonnes of green hydrogen and 130,000 tonnes of blue hydrogen. By 2050, it expects to have a supply capacity of 6.3m tonnes of green hydrogen and 700,000 tonnes of blue hydrogen. The steelmaker has identified 7 'strategic countries' for its hydrogen supply. Australia is one of those 7 countries and has been marked out as a particular focus for 'green hydrogen'. The company is already at various stages of cooperation with Fortesque Metal Group, Roy Hill and Hancock on hydrogen-related projects in the country.

• SK Group

SK Group, now Korea's second largest conglomerate, has committed to invest KRW 18 trillion (A$20bn) by 2025 to building out its hydrogen production, distribution and consumption ecosystem. In 2021, SK Group invested A$2.25bn in Plug Power and later that same year, SK E&S announced a joint venture with Plug Power which will see the domestic manufacture and roll-out of fuel cell and electrolysis technologies as well as liquid-hydrogen refuelling stations. Based on 2020 levels, SK Group has committed to cutting its emissions by 35% to 2030, by 85% to 2040 and aims to go carbon neutral before 2050.

SK E&S, Korea's leading retail gas company and, along with SK Innovation, SK Group's main vehicle for driving forward its hydrogen business, has set itself the ambitious goal of becoming the the world's leading hydrogen provider. By 2025, SK E&S aims to produce 280,000 tonnes of hydrogen, develop 7GW of renewable energy and use CCUS technology to import 10m tonnes of 'carbon neutral' LNG. SK E&S plans to complete the world's largest hydrogen liquefaction plant with an annual capacity of 30,000 tonnes at the SK Incheon Petrochemical Complex by 2023. By 2025 it plans to produce 250,000 tonnes of blue hydrogen a year at a site adjacent to Boryeong LNG Terminal.

SK E&S currently imports 1.15m tonnes of LNG a year from Australia, and announced it would invest another A$1.9bn in the Barossa and Caldita gas fields to turn them into greener gas fields by using CCS. The company plans to import 1.3m tonnes of LNG annually for 20 years from 2025 in order to use it to produce hydrogen for the domestic market.

• Hanwha Group

Hanwha's business interests intersect with the hydrogen economy in numerous ways; the company is a major manufacturer of solar panels, energy storage systems, hydrogen compression equipment, hydrogen storage tanks, membranes used for water electrolysis and is even moving into fuel cells for aviation. The company is also in the power generation business, develops solar and fuel cell power generation projects and recently acquired two international gas turbine companies with hydrogen combustion technologies.

Hanwha brought many of its disparate hydrogen-related businesses together under the name 'Hanwha Solutions' in 2020 and aims to dominate the global 'solar-to-hydrogen' business. The company has committed to going carbon neutral by 2050 and plans to invest KRW 1.2 trillion (A$1.3bn) in its 'green hydrogen' business by 2025. Of that investment, KRW 400bn (A$440m) will go to developing next-generation solar cells, KRW 200bn (A$220m) will be invested in the production, storage and distribution of hydrogen, KRW 300bn (A$330m) on the acquisition

and development of renewable power projects around the world and the remaining KRW 300bn (A$ 330m) will be invested in its global dispersed energy resource (DER) business.

• Hyundai Motor Group

Hyundai has committed to achieving carbon neutrality by 2045 and has been an early champion of the hydrogen transition. Hyundai Rotem is working on fuel cell trams and the roll-out of the domestic hydrogen production facilities (steam methane reformers) as well as refuelling infrastructure for fuel cell vehicles. Hyundai Steel manufactures the bipolar plates for the Hyundai's NEXO car and produces 3,500 tonnes of by-product hydrogen annually at its Dangjin Steel Mill, with plans to increase this to 40,000 tonnes by 2025. Hyundai Glovis, the company's logistics arm, is working with Samsung Engineering and the Global Green Growth Initiative to develop green hydrogen from a geothermal energy source in Indonesia.

It is Hyundai Motor Company, however, that is really driving Korea's transition to the hydrogen economy. In 2021, the company announced its Hydrogen Vision 2040 which aims to bring hydrogen into all aspects of our lives. Hyundai Motor Company is already the global leader in fuel cell passenger vehicles and has now rolled out fuel cell trucks – it plans to apply fuel cells systems to all its commercial vehicle models by 2028. Hyundai Motor Company aims to produce 50,000 fuel cell vehicles by 2030 and has committed to focusing on securing the supply of green hydrogen rather than blue hydrogen in the long run. To that end, the company has highlighted Australia as one of its key potential suppliers of green hydrogen.

In February 2022, Hyundai Motor Company has led a consortium of hydrogen equipment suppliers signed a MOU with Macquarie Capital to build and operate hydrogen buses in Australia.

• Samsung Group

Samsung is by some distance Korea's largest conglomerate. The jewel in the Samsung crown, Samsung Electronics, is Korea's largest consumer of electricity and yet has declined to commit to either carbon neutrality by 2050 or join the global RE100 group. While Samsung has had fuel cell businesses in the past, its current focus on hydrogen is driven mainly by Samsung C&T, the group's project developer and trading arm, and Samsung Engineering, the group's engineering plant division.

Samsung C&T has announced three MOUs in the last year to develop overseas hydrogen projects; one with the KEPCO subsidiary, KOSPO, which aims to develop green hydrogen and carbon-free ammonia projects overseas, a similar one with Doosan, KOSPO and Korean Institute of Energy Research (KIER) and finally one with POSCO and the Saudi Public Investment Fund which aims to develop a green

hydrogen project in Saudi Arabia. In June 2022, the company signed an agreement with KEPCO, KOWEPO and Petrolyn Chemie, to build a A$1.4bn plant in the UAE that can produce up to 200,000 tonnes of green ammonia a year. Meanwhile in 2022, Samsung Engineering signed an MOU with Lotte Chemical, POSCO and SEDC to develop a green hydrogen and ammonia plant in Sarawak, Malaysia and announced it will work with Hyundai Glovis to develop a green hydrogen project in Indonesia.

• Lotte Chemical

Lotte Chemical's hydrogen business plans stretch from hydrogen production to refuelling stations, hydrogen tank production, fuel cell power plant developments and related technologies such as carbon capture and utilisation (the company claims to be the first in Korea to develop a CCUS technology based on a gas separation membrane). Lotte Chemical plans to invest KRW 2 trillion (A$2.2bn) by 2025 and KRW 4.4 trillion (A$4.9bn) by 2030 in developing all aspects of its hydrogen business. Currently, the company produces 30,000 tonnes of by-product hydrogen but plans to develop 160,000 tonnes of blue hydrogen by 2025 and 600,000 tonnes of blue and green hydrogen by 2030. For its charging stations and fuel cell power plant development businesses, the company will work with JV partners such as AirLiquide and SK Gas.

• Hyosung Group

Hyosung Group has business interests ranging from advanced materials, carbon fibre and textiles to power systems and electrical equipment and as such its businesses touch many points on the hydrogen economy value chain. The group has committed to achieving net zero by 2050 and was a relatively early entrant into the hydrogen business. At the start of 2022, Hyosung announced KRW 1 trillion (A$1.1bn) investment in a project to build a green hydrogen production base in South Jeolla province. The project will start with a 10 MW electrolysis facility which will source its electricity from local wind power. This will ultimately be expanded to produce 200,000 tonnes of green hydrogen per year.

The hydrogen production base in South Jeolla province will build on the world's largest liquid hydrogen plant in Ulsan which is being constructed by Hyosung Heavy Industries along with Germany's Linde Group. The plant is expected to start operation in 2022 and will have an annual production capacity of 13,000 tonnes. Hyosung Heavy Industries is also a major player in HRS having built the country's first HRS at Hyundai Motor's R&D centre in 2008 and plans to have 30 completed HRS by the end of 2023.

• Korea Zinc

Korea Zinc is the world's largest smelter of zinc and lead and was the first Korean metals company to commit to the RE100 initiative. The company's global annual electricity bill averages around A$425m and in order to bring that cost down in the long run and decarbonise the company's processes, Korea Zinc has outlined aggressive plans to invest KRW 8.4 trillion (A$9.3bn) over the next six years in both renewable energy projects and hydrogen, with much of that investment seemingly destined for Australia.

The company's Australian arm, Ark Energy, recently announced that it would acquire 9GW of current and proposed wind and solar projects from Epuron Holdings with a view to producing and exporting green hydrogen from Australia to Korea. Although it will take a number of years for all these projects to be developed and linked to electrolysis facilities, Ark Energy expects to start producing hydrogen through 1 MW PEM electrolyser by the end of 2022 at Korea Zinc's Sun Metals refinery in Queensland using the electricity generated from Sun Metals' 124 MW solar power plant. Once complete, the plant should be able to produce approximately 140 tonnes of hydrogen annually which is expected to be used to power fuel cell trucks and even forklifts at the site.

• KOGAS

State-owned KOGAS, one of the largest buyers of LNG in the world with a near monopoly on the importation on natural gas into Korea, has stated that it sees its future as a hydrogen business. The company plans to build three hydrogen production plants in Gwangju, Changwon and Pyeongtaek, all based on steam methane reforming technology. KOGAS aims to produce over 1m tonnes of hydrogen by 2030, 668,000 of grey hydrogen, 167,000 of blue hydrogen and 200,000 tonnes of green hydrogen. The company expects to begin green hydrogen imports from 2027 and from 2030 onward, with plans to import 1.2m tonnes of green hydrogen per year. KOGAS is also aiming to introduce an increasing percentage of hydrogen into its natural gas supply. Currently it is aiming to reach a hydrogen blend of 20% by 2026.

• KEPCO

KEPCO and its subsidiaries account for more than one-third of Korea's total emissions. KEPCO is 51% owned by the Korean government, has a monopoly on the transmission, distribution and sale of electricity in Korea and its six subsidiaries are responsible for the majority of power generation. In its 'Zero for Green' strategy, the company has committed to become carbon neutral and to phase out all coal use by 2050.

KEPCO and its subsidiaries are active investors in utility-scale fuel cell power generation plants as obligators under the Renewable Portfolio Standard (RPS). Also, the government has set the goal of achieving up to a fifth of national power generation with hydrogen and ammonia-fed gas turbines by 2050 and KEPCO and its subsidiaries are working towards that goal. In partnership with private sector players, KEPCO and its subsidiaries are active in the development of green hydrogen and clean ammonia projects around the globe.

• GS Group

GS Group is set to invest KRW 21 trillion (A$23bn) on clean energy businesses ranging from small modular reactors to hydrogen over the next five years. Hydrogen forms one of the four pillars of the green energy strategy of GS Energy, the holding firm for the GS Group. GS Energy bought a 10% stake in an ammonia development project being run by Abu Dhabi National Oil Company (ADNOC) in late 2021. The deal will see GS Energy secure 200,00 tonnes of 'blue' ammonia annually from 2025, enough for 30,000 tonnes of hydrogen.

The group's refiner, GS Caltex – a joint venture between GS Energy and Chevron – plans to build a liquid hydrogen facility with KOGAS next to one of the country's LNG terminals with an annual capacity of 10,000 tonnes by 2024. In cooperation with Hyundai Motors, GS Caltex was the first company in Korea to open an all-in-one refuelling station in 2020 which can supply petrol, diesel, LPG, electricity for EVs and hydrogen for FCEVs.

• LG Group

LG Chem has committed to carbon neutral growth by 2030, net zero by 2050 and was the first Korean chemical company to commit to the RE100 initiative. LG Chem, along with LG Electronics and LG Corp acquired a controlling stake in Rolls Royce Fuel Cell Systems in 2012 but have been unable to commercialise the SOFC technology. Many now expect the chemical company – particularly famous for its developing world-class lithium-ion batteries – to enter the green hydrogen field in earnest, although no such strategic announcements have been made and the focus continues to be on its battery and related materials business. For now the company's hydrogen strategy appears to be focused on a partnership with the state-run research institute, KIST, to help speed up the commercialisation of hydrogen and carbon capture technologies.

4.3. Austrade allies

• H2KOREA

– Quasi-government organisation aiming to achieve a low-carbon hydrogen society and expand the use of hydrogen energy

– Government-designated agency responsible for international hydrogen cooperation

– Organised a hydrogen delegation to Australia in July 2019, led by Korean National Assembly member

– Jointly holds the H2 Mobility+Energy Show, Korea's flagship hydrogen exhibition and conference where Austrade Seoul has attended since its inaugural event in 2020

– Organised the inaugural 2022 Global Hydrogen Industrial Association Alliance (GHIAA) Forum on 25 May 2022 in Seoul, with 17 representative hydrogen industrial associations to strengthen international cooperation and establish a global cooperation network

– Responsible for the Hydrogen Economy Roadmap of Korea released in January 2019

– Currently Korean lead in the mobility partnership discussions with an Australian party led by Macquarie

• Korea Clean Ammonia Association

– Founded in December 2021, led by KIER

– Seeks to support domestic and international cooperation and provide technical support to secure overseas ammonia-based hydrogen supply and facilitate the use of zero carbon fuels

– Austrade Seoul plans to work closely with the association as a regular member to facilitate Australia-Korea business and R&D partnerships in the clean ammonia industry

4.4. Australia-Korea hydrogen events

Events	Agenda
Australia Clean Energy Hydrogen Roundtable (April 2021)	Joint H2 K, Australia Government introduction to Australia and Korea's Hydrogen programs
Australian Booth H2 Mobility+ Energy Show 2021 (September 8-11, 2021)	Introduction to main hydrogen hubs and project in Australia
President Moon's visit to Australia (December 12-13, 2021)	Agreement on strengthening cooperation in resources and energy. Low and zero emissions technology partnership with commitment to invest A$100m clean tech and resources
Australia-Korea Clean Energy Roundtable (February 23, 2022)	Discussion of commercial engagement and investment in low emissions technologies, hydrogen related projects and technology R&D between Australia and Korea
Australian Clean Energy Market Overview (June 14, 2022)	Joint Ashurst event to introduce the new hydrogen hubs and Australia's path to net zero by 2050
Team Australia Booth, H2 Mobility + Energy Show 2022 (August 31 – September 3, 2022)	Further promotion on Australia's main hydrogen projects with industry meetings to be scheduled.

Source: Austrade

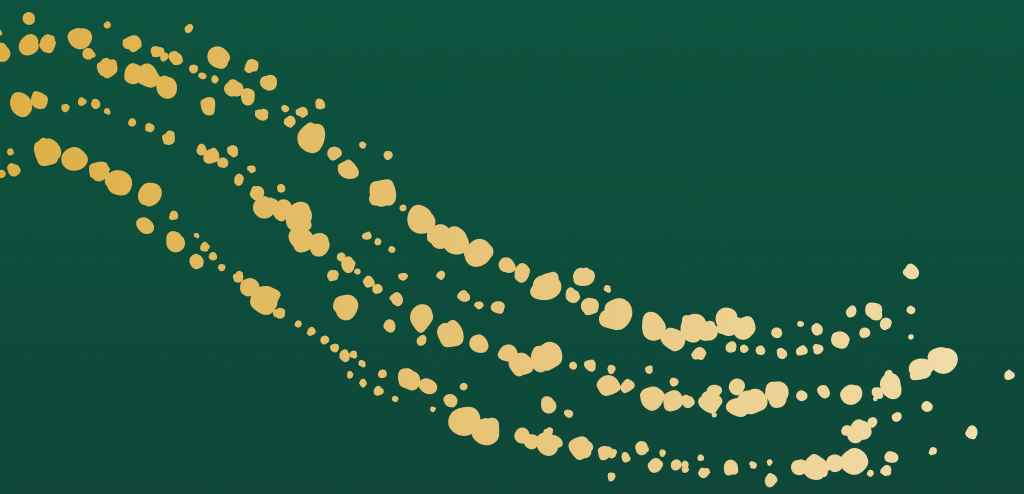
For further information please contact:

Bongsuk Cha
Senior Business Development Manager, Austrade Seoul
bongsuk.cha@austrade.gov.au

Ron Green
Trade & Investment Commissioner, Austrade Seoul
ron.green@austrade.gov.au

Australian Government

Australian Trade and Investment Commission



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