Ministry of Economic Affairs
and Climate Policy

Hydrogen Economy Development in Korea

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Hydrogen Economy Development in Korea
: Follow-up of the Roadmap [1](2019-2040) amid COVID-19

Embassy of the Kingdom of the Netherlands, Seoul

12 June, 2020

The Korean government has announced the Hydrogen Economy roadmap with ambitious numbers such as 81,000 hydrogen fuel cell vehicles (310 refueling stations) and 1.5GW stationary fuel cell power plants in Korea by 2022. According to the roadmap, 6.2 million hydrogen vehicles (1,200 refueling stations) and 15GW plants will be deployed in Korea by 2040 so that 4.9% of energy consumption will be supplied from hydrogen. Target for hydrogen production is 50% from by-product + electrolysis + import and 50% from reforming of natural gas by 2030. The focus of the roadmap is more of utilization of hydrogen because Korea has fuel cell automaker and stationary fuel cell manufacturers. On the other hand, technologies for hydrogen production, storage, transport and refueling station are mostly outsourced.

The Korean government put **more funding/policy supports for hydrogen economy amid COVID-19 crisis** under part of the Green New Deal scheme as it is considered as the next growth engine for struggling Korean heavy industries and way to reduce greenhouse gas emission. For instance, the national hydrogen economy committee led by the prime minister was originally planned for early 2021 but it was brought forward to this July in order to implement integrated support between ministries and agencies including MOTIE[2]/MOLIT[3]/MoE[4].

Seven thousand fuel cell vehicles are already accumulatively sold in Korea. Hydrogen taxi/bus is already operational in Korea and 10-ton truck will be deployed in late 2021-early 2022. MOTIE/MOLIT/MoE and Hyundai Motors made a deal with logistics companies (CJ, Coupang, etc.) to run the hydrogen logistics infrastructure by 2021.

Korean utility companies, which are mostly subsidiary of KEPCO, are mandated to have 10% renewable by 2023 and increase the potion to 28% by 2030 according to RPS targets. The companies need to invest in building 668MW stationary fuel cell power plants per a year to meet the roadmap target in 2040. Policies

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[1] Korea Hydrogen Economy Roadmap announced by Ministry of Trade, Industry and Energy on 17 January 2019 (https://www.motie.go.kr/common/download.do?fid=bbs&bbs_cd_n=81&bbs_seq_n=161262&file_seq_n=2)

[2] MOTIE: Ministry of Trade, Industry and Energy

[3] Ministry of Land, Infrastructure and Transport

[4] MoE: Ministry of Environment

to support the fuel cell power generation are following:

- Favorable LNG price for fuel cell: KRW 12.3(EUR 0.01)/MJ comparing to 13.6/MJ for regular use and 12.6/MJ for transport use. (Announced in May 2019)

- Favorable REC[5] factor for fuel cell (2.0) and long-term electricity supply contract (20 yrs.) was only allowed for PV but it will be available for FC as well.

- Fuel cell installation subsidy available for household/building use KRW 20B: up to 70% of cost depending on local contents.

Followings are notable recent developments in Korea:

1. Government

MOTIE announced that five cities (Busan, Daejeon, Chuncheon, Gwangju, and Changwon) are selected for these year's large/middle size hydrogen reforming stations (natural gas to hydrogen) to produce additional 7,400 tons of hydrogen per a day to feed 760 buses or 49,000 passenger cars with EUR 17M public funding matching with some private investment. (19 May 2020, MOTIE[6]) MOTIE is targeting the price of hydrogen around EUR 2.3/kg by 2023 so the ministry is subsidizing the market to reach the economy of scale.

MOLIT announced three cities (Ansan, Ulsan and Wanju-Jeonju) to be the **Hydrogen Pilot City** and Samcheok as national R&D center in December 2019[7].

- Ansan: Green Hydrogen production together with tidal power plant + LNG reformer and

[5] REC (Renewable Energy Certificate) is tradable renewable certificate that is a proof that energy has been generated from renewable sources such as solar or wind power. Each REC represents the environmental benefits of 1MWh of renewable energy generation. When you purchase RECs, renewable energy is generated on your behalf. The Korean government provides different weighting (multiplier) for facility type. (Such as 1.5 weighting for Solar PV floating on the water, 2.0 for offshore wind)

[6] MOTIE press release (http://www.motie.go.kr/motie/ne/motienewse/Motienews/bbs/bbsView.do?bbs_seq_n=155117302&bbs_cd_n=2)

[7] MOLIT press release (https://www.molit.go.kr/USR/NEWS/m_71/dtl.jsp?id=95083342)

hydrogen ship

- Ulsan: Hydrogen pipeline infrastructure and utilization pilots using by-product hydrogen
- Wanju-Jeonju: Hydrogen production/promotion/utilisation
- Samcheok: Liquified hydrogen storage/transport R&D/pilot

MoE has doubled its subsidy budget for hydrogen vehicles/refueling stations this year from 2019 to support 10,100 passenger vehicles, 180 buses and 40 refueling stations[8] (max. 50% of equipment cost for 27 general stations and 70% of 13 bus refueling stations) 7,000 hydrogen fuel cell cars are already accumulatively sold in Korea. Hydrogen taxi/bus is already operational in Korea and 10 ton trucks will be deployed in late 2021-early 2022. MOTIE/MOLIT/MoE and Hyundai Motors made a deal with logistics companies (CJ, Coupang, etc) to run the hydrogen logistics infrastructure by 2021.

Regional governments have plans and activities. **Ulsan city** is the most active as USD 1 billion investments for 11 years (2020-2030) to build a manufacturing complex for fuel cell and vehicles, R&D pilots and city run with hydrogen energy. It is also home of the Korea Hydrogen Industry Association (KHIA: http://www.h2.or.kr/) **Busan city**, the 2nd most populated city in Korea, is planning to build logistic hub for imported hydrogen using its liquified ammonia and bunkering infrastructure. The city is also looking into maritime usages of hydrogen. **Chungnam province**, where most of coal-fired plants are located, plans to invest USD 20 million to build residential fuel cell infrastructure and hydrogen drones for coastal surveillance/logistics from 2020 to 2022. **Pohang city** joined with Doosan Fuel Cell, Korea Hydro-Nuclear Power (in Gyeongju) and Postech to build national R&D/testing cluster from 2020 to 2025 by investing USD 200 million. **Saemanguem Green Hydrogen Production Cluster Program** (2022-2031, USD 500 million) is under feasibility study with 3GW renewable energy plant in Jeunbuk Province.

2. Private Sector

[Chaebol]

Hyundai Motors Group: The Company is looking for partners to invest or joint venture in order to stimulate the ecosystem.

[8] MoE policy announcement (http://www.me.go.kr/home/web/policy_data/read.do?menuId=10262&seq=7508)

- Hyundai Motors announced its strategy to build 500,000 hydrogen vehicles and 200,000 other fuel-cell systems (power plant, ship, train) by 2030 in the **FCEV[9] Vision 2030**[10] NEXO, her hydrogen fuel cell vehicle launched in 2018, became most sold FCEV in the world last year. Fuel-Cell bus with 480 km range is also commercialized at the Jeonju factory. Many suspects that Hyundai's air taxi venture with Uber[11] will be hydrogen powered.
- Hyundai Mobis: The Hyundai's captive tier 1 supplies fuel cell stack, which is 40% cost of FCEV, also build motors, inverter and hydrogen gas system. It expanded their production capacity from 3,000 in 2019 to 40,000 units by 2022. The company also built 450kW UPS using their PEMFC stack.
- Hyundai Rotem: The Hyundai's train and defense business entity has been struggling last few years. The company is building the hydrogen tram with 70 km/h speed and 200 km range by 2020. It announced plan to enter on-site reformer and EPC business for refueling stations[12] on June 10, 2020.
- Hyundai Steel provides fuel cell plates
- Hyundai Engineering works with the Korea Atomic Energy Research Institute to build eco-friendly hydrogen production technology using nuclear power (April, 2020) the same consortium won the Dutch experimental nuclear reactor project, OYSTER in 2014.
- Hyundai Construction Equipment (under Hyundai Heavy Industry Group, not Hyundai Motors Group) is working together with Hyundai Motor and Mobis to build the hydrogen-powered fork lift, excavator to launch commercial models in 2023.

Doosan Group

- Doosan started fuel cell business by acquiring Americal ClearEdgePower in 2014. Doosan Fuel Cell, spun-off from Doosan in 2019, produces **PAFC and has almost 80% of domestic market**

[9] FCEV (Fuel Cell Electric Vehicle)

[10] Hyundai Motors Group press release (December 2018) https://www.hyundai.news/eu/brand/hyundai-motor-group-reveals-fcev-vision-2030/

[11] Hyundai Motors press release: https://www.hyundai.com/worldwide/en/company/news/news-room/news/-0000016369

[12] Hyundai Rotem press release (https://www.hyundai-rotem.co.kr/PRCenter/News_View.asp?type=%EC%96%B8%EB%A1%A0%EB%B3%B4%EB%8F%84&idx=3991)

share from 2015 including the world's largest by-product hydrogen plant project (50MW) with Hanwha. Owing to the increasing orders, it targets USD 1billion revenue by 2023 It is working with Hyundai Motors Group (PEMFC) to build hybrid power plant with 440kW PAFC and 400kW PEMFC for residential and office buildings. Pilot projects, O&M are done in Ulsan Technopark.

- Doosan Mobility Innovation produces mobile hydrogen power pack and storage for mainly drones from 2019. It also currently sells two types of hydrogen drones.

Hyosung Group

- Hyosung signed deal with Linde Group to build the **world's largest liquefied hydrogen production/transport/refueling plant in Ulsan** by investing USD 300 million until 2022. Linde will provide technology/equipment to liquefy hydrogen and the JV will work on transporting and expanding refueling station to utilize the liquefied hydrogen.
- Hyosung Heavy Industry provided 700 bar hydrogen **refueling station** to Seoul in 2016 and the first urban hydrogen refueling station at the National Assembly in 2019. It has 40% of Market Share in Korean compressed natural gas station market from 2000.
- Hyosung Material provides carbon-fiber for hydrogen storage tanks.

SK Group

- SK E&C launched **joint venture with Bloom Energy to produce SOFC** in Korea in January, 2020. Large projects to build SOFC plants were already signed with the Korean cities Jincheon (80MW) and Boeun (100MW) in 2019.
- SK Gas supplies LPG to gas stations and SK Energy are working on a refueling station operator.

Hanwha Group

- Hanwha Energy/General Chemical invested USD 1B to American **Nikola Motor** in 2018 to obtain deals to supply solar power and hydrogen refueling station for Nikola.
- Hanwha Energy Joint Venture (JV) will produce electricity with 3 tons of byproduct hydrogen per hour from June 2020 using a 50Mw Doosan fuel cell (PAFC) in Seosan chemical complex in Chungnam Province.

- Hanwha Solution plans to provide hydrogen storage material.

POSCO

- POSCO Energy founded Korea Fuel Cell Co. Ltd. to continue MCFC (from American Fuel Cell Energy) business in November 2019. It suffered from quality issue from 2014 and recorded highest loss (USD 100 million) in 2018.

GS Group

- GS Caltex is working on refueling station and GS Retail is working on drone logistics using its stores and gas stations around the country.

[State-owned companies]

KOGAS (Korean Gasunie), KOGAS Technology Corp. and Korea Gas Safety Corporation are working on infrastructure, regulations and policy to nurture hydrogen economy. KOGAS led special purpose company (SPC) called **HyNET** to build H2 refueling stations in Korea together with Hyundai Motors and other local/international partners in 2019.

KEPCO: Korean TenneT. KEPCO and its utility subsidiaries including **KOEN, KOMP, KEWP** and **KHNP** are investing heavily on fuel cell power plants to meet RPS requirement

Jeju Energy Corp.: Jeju Island is planning for Carbon-Zero island with renewable power mix avg. 14.4% and max. 52% in 2019. Due to power oversupply from wind farm in Jeju, limiting power supply happened 64 times from 2015 to 2019. Jeju Energy Corp. signed deal with Hyundai Motors, Korea Midland Power Corp., and H2 Korea Alliance to find unused electricity to produce **green hydrogen** in January, 2020.

Busan Port Authority is working with Korean Register announced to build energy neutral port based on hydrogen.

Yeosu Gwangyang Port Authority signed MoU with Hyundai Motors to build infrastructure for hydrogen trucks logistics in February, 2020.

LH: Korean Social Housing Corporation under MOLIT has to comply with new regulation on building energy efficiency (**Zero-Energy Building Policy**) and its working with KEA (Korea Energy Agency) to

establish joint effort to optimize fuel-cell system for community housing environment from July, 2020.

[SME]

Elchemtech and **EM Solution** are local electrolysis companies in Korea. The companies receive

Bumhan Industry (http://bumhan.com/): develops fuel cell and reformer for submarine (ROK Navy) and high-pressure unit

JNK Heater develops steam reformer and supplied onsite refueling station for three cities in 2020.

Hylium: Korean startup developing Liquid Hydrogen storage spin. The company is currently supplying the storage to UAM (Urban Aerial Mobility) company in the U.S. and considering to move its base to America to interact with more customers. The company is currently in talk with JNK to find collaborative business model.

DeokYang, SPG, and SDG: Local gas refiner also specialized in producing hydrogen

Parker Hannifin Korea is an only supplier of valves for high pressure hydrogen (15,000-20,000 psi) certified by the Korea Gas Safety Corporation. The valves are available in Korea from June, 2020.

3. Knowledge Institute

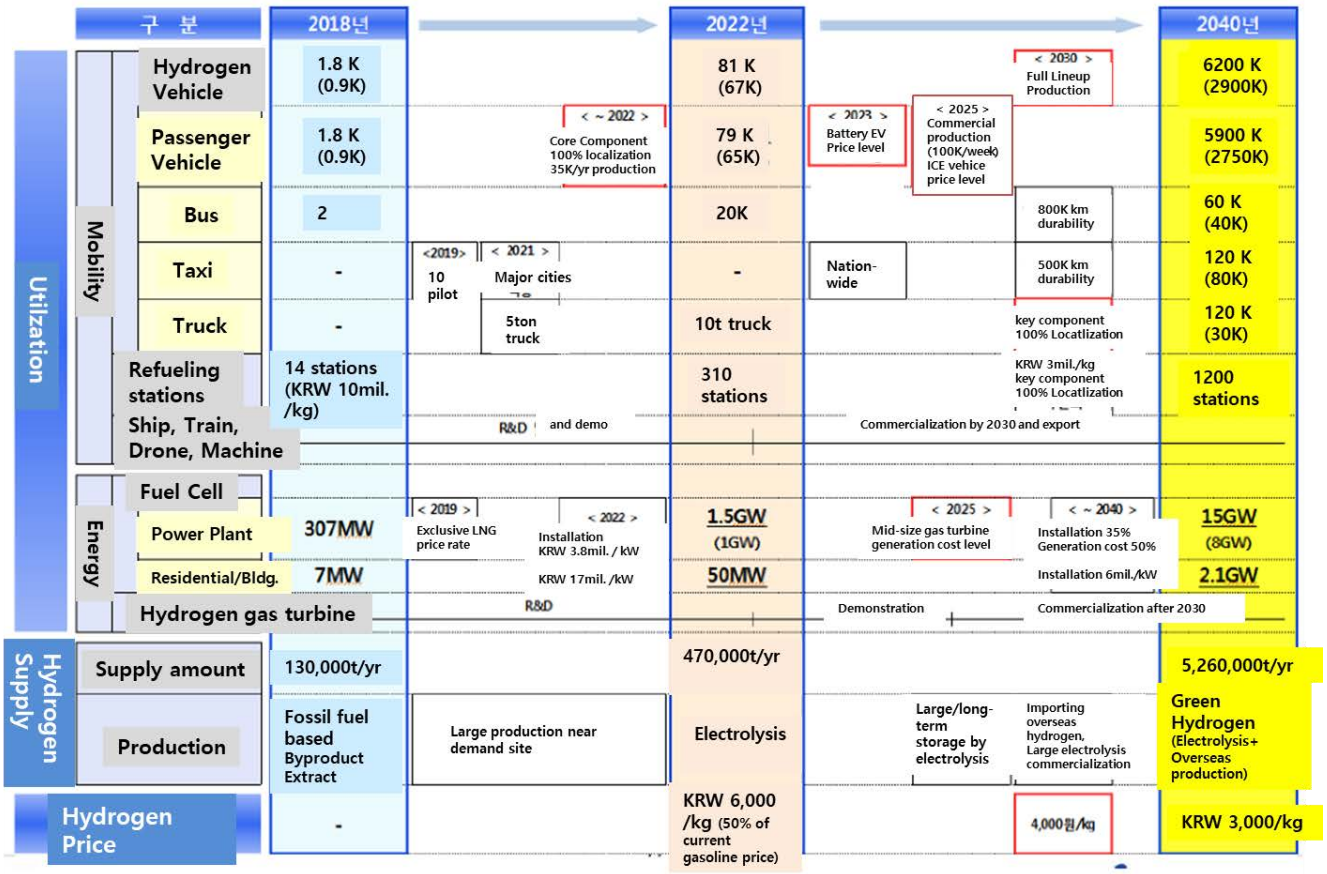
KIER (Korea Institute of Energy Research): National research center for energy under MOTIE and currently in charge of Hydrogen R&D Roadmap. It transferred gas reformer technology to Wonil T&I for USD 5 million in May 2020.

KETEP (Korea Institute of Energy Technology Evaluation and Planning): this government R&D institute under MOTIE is in charge of planning R&D/pilot projects in energy sector.

KIMM (Korea Institute of Machinery & Materials) leads a project on liquefied hydrogen plant for 0.5 ton/day production/storage/transport (2019-2023) with private-public consortium with **KIST** (hydrogen storage), KOGAS, and DSME.

PNU (Pusan National University) is leading hydrogen ship R&D platform program (USD 40 million, 2019-2024) with Samsung Heavy Industries, POSCO etc. to establish R&D and testing facility in Busan Port.

Appendix: Korean Government announced following Hydrogen Economy Roadmap (Jan, 2019)



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This publication was commissioned by the ministry of of Economic Affairs and Climate Policy

Publication number: RVO-119-2020/BR-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

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