

Trade Mission: Norwegian CCS delegation visit to South Korea

1. Background

Innovation Norway in Seoul has noticed a growing demand from South Korean stakeholders for adopting new CCUS technologies to achieve their GHG reduction.

South Korea's 2030 National Determined Contribution (NDC) is to reduce its GHG emissions by 40% compared to 2018 level, and 11.2 million tons of CO₂ through CCUS technologies by 2030. According to the NDC plan, CCS takes up to 4.8Mtpa by 2030.

In South Korea, the CCUS Act proposal passed at a plenary session of the National Assembly on January 9, 2024. The Act came into effect in February 2025. The Act stipulates the process for CCUS developments, such as designating a location candidate for ocean carbon storage and operating such facilities, as well as support measures for businesses in the industry.

Also, South Korea is pursuing transboundary CCS projects in Asia Pacific region due to insufficient domestic storage compared to the emissions. South Korea is building a consortium comprising emitters, EPC, shipbuilding and E&P companies to achieve better economics and synergies.

One of reasons for paying attention to CCUS lies in South Korea's industrial structure, of which the manufacturing sector accounts for 28% of the total emissions. In South Korea, where most industries emit a lot of greenhouse gases, it is difficult to rely solely on renewable energy to reduce carbon emissions to "zero" by 2050.

Reflecting the trends in South Korea, the first Korean CCUS delegation, consisting of 16 Korean experts from 7 companies, visited Bergen in October 2024 to explore new collaboration opportunities with relevant Norwegian CCS value chain stakeholders.

2. Market opportunities in South Korea

This initiative is a follow-up of the above-mentioned Korean CCUS business delegation visit to Bergen in October 2024. Our aim is to develop the dialogue with key Korean stakeholders.

Norwegian CCS lessons learned from early-stage feasibility studies, value chain development and projects/initiatives will be of great help to South Korean stakeholders' CCS initiatives at home and Asia Pacific.

According to our assessments, the most relevant business opportunities for Norwegian companies exist within the following aspects:

- Proven CO₂ capture technologies with modular systems for commercial use.
- Scalable LCO₂ storage solutions for infrastructure development.
- New building of large CO₂ carriers for transboundary CCS projects.
- CO₂ transportation between South Korea and Asia Pacific
- Maritime suppliers for loading and offloading systems onboard
- Verification of re-purposing subsea pipelines
- New concepts of CO₂ offshore direct injection
- Floating/subsea engineering and installation
- Geophysical assessment of potential offshore CO₂ storage sites
- Safety and monitoring systems

3. Rough program on the Norwegian CCS delegation visits to South Korea

3.1 Objective: Exploring business opportunities related to Korea's CCS activities

As participant in our program, you will get a unique opportunity to

- acquire useful information and insights about the Korean CCS market, i.e., Korean industrial efforts and developments domestically and in the Asia Pacific region, needs, stakeholders, governmental regulations & strategies etc.
- promote/present your technology solution/services
- network and speed date with relevant Korean stakeholders

3.2 Dates: Tentatively June 11 (Wed) – 12 (Thu), 2025

The program is planned in conjunction with K-CCS International Conference in Seoul.

3.3 Program (draft)

(1) June 11 (Wed), 2025

A tailor-made promotional program consisting of Korea-Norway CCS Business Forum, speed dating and networking reception with invited Korean stakeholders.

- Venue: TBD
- Time: 09:30-20:00
- We are targeting to mobilize the following Korean stakeholders (however, they may be adjusted depending on the Norwegian participant companies):
 - CCS developers: KNOC, SK Innovation E&S, GS Caltex and POSCO International
 - EPCs on CCS infrastructure: Carbonco, Samsung E&A, Hyundai E&C and GS E&C
 - CO2 emitters: 5 GENCOs
 - CO2 carriers & shipping: HMM, SK Shipping, HD KSOE, Samsung Heavy Industries and Hanwha Ocean
 - Geophysical services: KIGAM and SK Earthon
- The bilateral CCS Business Forum will be co-hosted by The Norwegian Embassy, Innovation Norway, and Korea CCUS Association.
- Participation in the forum will give Norwegian companies the opportunity to present their technologies and solutions.
- Speed dating with relevant Korean stakeholders
- Networking dinner reception hosted by the Norwegian Ambassador (TBC later)

(2) June 12 (Thu), 2025

On the second day, the Norwegian CCS delegation is entitled to participate at the K-CCS International Conference and VIP dinner hosted by 'Korean Ministry of Trade, Industry and Energy' and Korea CCUS Association.

- Venue: Hotel Fairmont Ambassador Seoul
- Time: 09:30-19:30
- Kindly refer to the enclosed the draft of K-CCS International Conference program.
- As of today, ExxonMobil, Chevron, Shell and Singaporean Ministry confirmed their participation at the K-CCS International Conference. The program will be updated.
- A representative of the Norwegian Embassy in Seoul will join the policy session.

3.4 Participation Fee

The participation fee will range from NOK 10,000 – 15,000 per company depending on the total number of participating companies. The fee covers the costs associated with organizing the program, admission to the K-CCS International Conference, networking events with catering and relevant activities. The participation fee does not include flights, accommodation, local transports and meals outside the program.

3.5 Remarks

The interest from a certain minimum number of Norwegian companies is required to proceed with the delegation program. ***Kindly respond to us if you are interested in the program in South Korea within March 31, 2025.***

Mobilization of participant companies is based on a “first come – first serve” basis.

3.6 Contact Persons

Dooseok Kim, Senior Market Advisor, Innovation Norway:

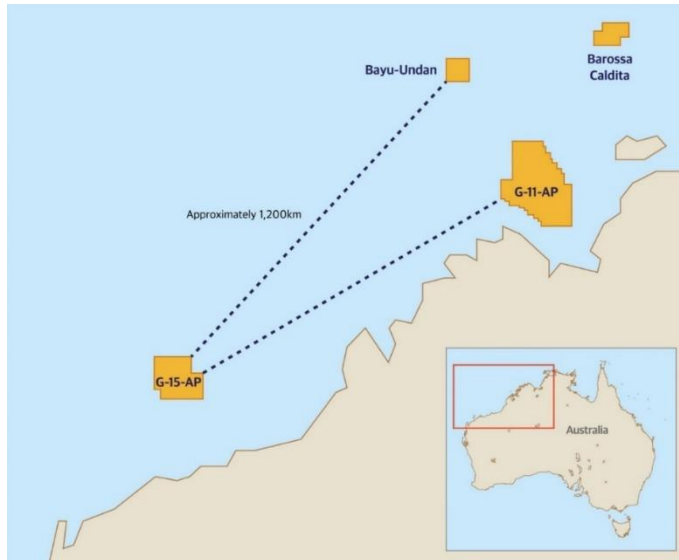
dooseok.kim@innovationnorway.no

Per Christer Lund, Energy & Technology Counsellor:

perlu@innovationnorway.no

Appendix) Overview on major CCS activities by Korean stakeholders

[Site location: Bayu-Undan, Barrosa, G-11-AP, and G-15-AP]



SK Innovation E&S is participating **Bayu-Undan** Joint Venture. Together with Santos (36.5%), INPEX (9.6%), ENI (9.2%), Tokyo Timor Sea Resources (7.6%) and Timor GAP E.P. (16%), SK Innovation E&S holds 21% share of the joint venture. The Bayu-Undan field is located approximately 500 kilometers northwest of Darwin in Timor-Leste offshore waters and the CCS project could potentially safely and permanently store up to 10 million tons of CO₂ per year.

In South Korea, both SK Innovation E&S and Korea Midland Power Company (KOMIPO) are building a Boryeong Blue Hydrogen plant using imported LNG from **Barossa Gas Field**, Australia to produce 250,000 tons of blue hydrogen annually. The Co₂ captured during blue hydrogen production will be liquefied to ship back to Australian Darwin port for permanent storage at the Bayu-Undan Gas field in Timor-Leste offshore waters.

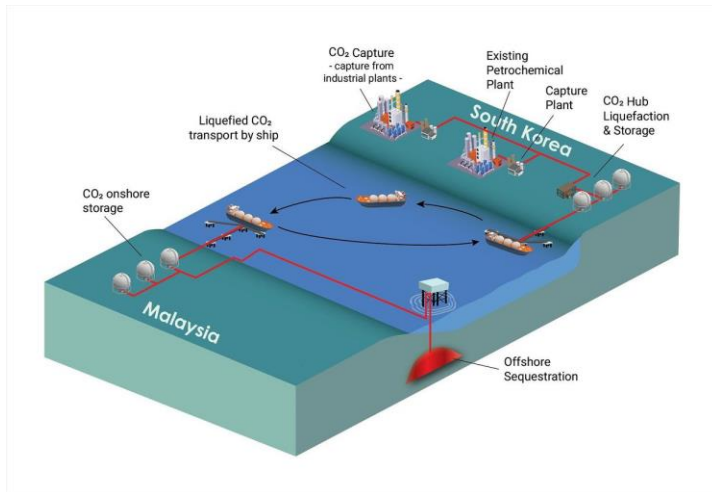
The South Korean government completed the ratification process of the London Protocol back in April 2022. In addition, Australia recently passed the National Assembly a bill related to amendments to the London Protocol, which allows the transfer of carbon dioxide between countries. Starting with the 32nd Korea-Australia Energy Resources Cooperation Committee held in October 2023, bilateral consultations began on Korea's first Co₂ border transfer agreement with Australian government.

Furthermore, SK Innovation E&S (30%) together with Santos (40%) and Chevron (30%) acquired the right to explore the potential offshore Co₂ storage at the **G-11-AP Block** located in the Bonaparte Basin off the coast of northern Australia for carbon dioxide.

In August 2024, SK Earthon secured joint exploration rights for an offshore carbon dioxide storage site in the **G-15-AP Block** of the Carnarvon Basin, Northern Australia. With a 20% stake in this project, SK Earthon partners with InCapture (75%) and CarbonCQ (5%). This

acquisition significantly strengthens SK EARTHON's resource development efforts and accelerates its advancements in Carbon Capture and Storage (CCS) technologies.

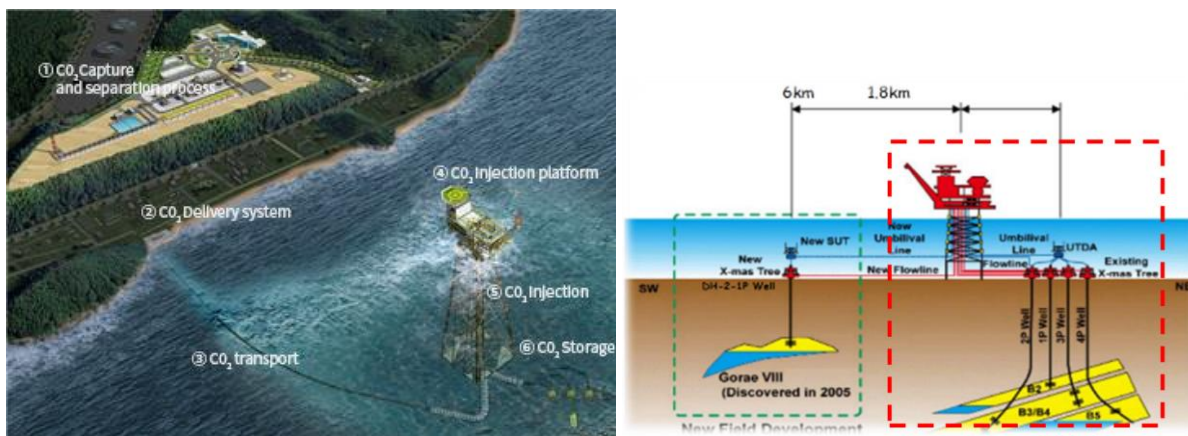
[Shepherd CCS Project mimetic diagram]



Since 2022, South Korea and Malaysia have joined hands to win the Shepherd CCS project. This project aims to achieve carbon reduction and establish hub terminals in the strategically located areas of Ulsan and Yeosu in South Korea, and Sarawak in Malaysia. All three areas are major industrial complexes.

Samsung E&A is an EPC company developing Korea-Malaysia Shepherd CCS project. Petronas, Shell Gas & Power Developments B.V., and 8 Korean companies (SK Energy, SK EARTHON, Samsung E&A, Samsung Heavy Industries, Lotte Chemical, Korea National Oil Corporation, Hanwha Corporation, and Air Liquide Korea) are participating the Shepherd project. After completion of feasibility study in August 2023, pre-FEED is being conducted since June 2024. FEED will start June 2025 and Korea-Malaysia bilateral agreement is planned at Q1 2026.

[Donghae CCS project outline]



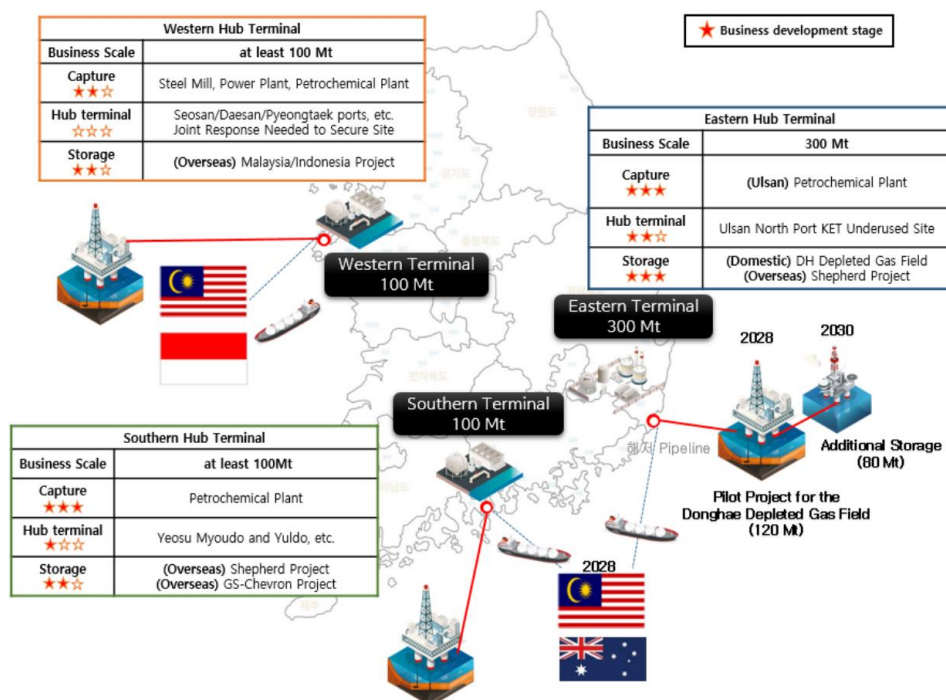
KNOC discovered Donghae gas field in 1998 and produced total of 45.4MMboe of gas and condensate oil from 2004 to 2021. The Donghae Gas Field is located 58 km southeast of Ulsan. The depleted reservoir holds a wealth of data from the exploration, development,

and production process and has sufficient storage capacity, making it ideal for CO₂ storage.

Utilizing a depleted gas reservoir in the East Sea of offshore Korea, Korea National Oil Corporation (KNOC) initiated the nation's first large-scale CCS demonstration project. An eastern CO₂ hub terminal will be constructed at Ulsan North Port to store 300Mt of CO₂ captured by petrochemical plants in the Ulsan region. The plan is to repurpose existing subsea pipelines for the first demonstration of a 120Mt of CO₂ injection to depleted Donghae Gas Field by 2030 and further additional 80 Mt storage.

KNOC initiates the installation of CO₂ hub terminals for export. The Western hub terminal (100Mt) will collect CO₂ from regional steel mills, power and petrochemical plants. Export aims for Korean CCS projects in Malaysia and Indonesia. The Southern hub terminal will have a 100Mt of storage capacity (100Mt) aiming for the export to Overseas Shepherd CCS and GS-Chevron CCS projects. The Eastern hub terminal (300Mt) will collect CO₂ from Petrochemical plants in Ulsan for permanent storage at domestic Donghae CCS project as well as for exporting to Shepherd CCS project.

[The plan of CO₂ hub terminals in South Korea]



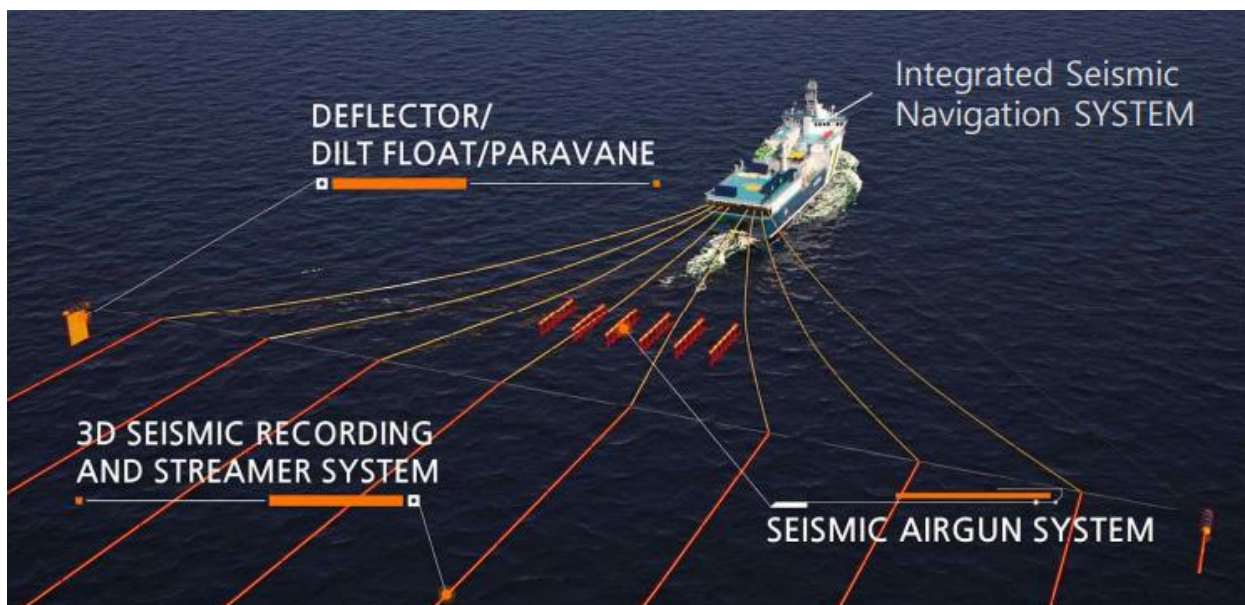
Currently, Hyundai E&C performs a pre-FEED for existing facilities such as an offshore platform and subsea injection systems that were operated during natural gas production,

as well as new facilities such as hub terminals and pipelines, and infrastructure in the onshore and offshore areas required for CO₂ transportation and storage. By doing so, design specifications and conceptual designs will be derived, and standards necessary to proceed with the CCS project at the Donghae Gas Field will be established, including technical specifications for each construction type, a list of required equipment, licensing items, and project costs.

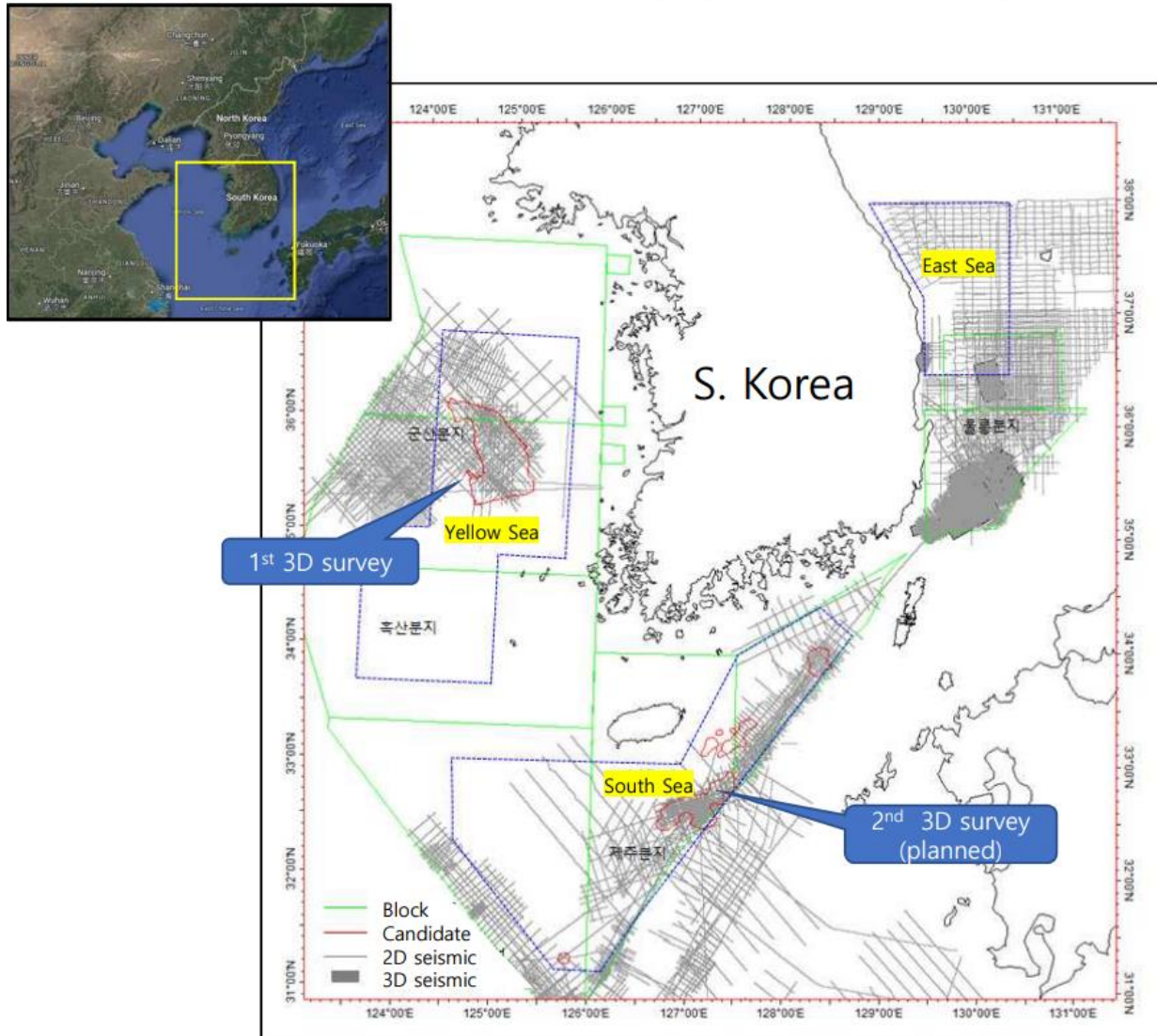
KNOC operates Gwanggaeto Project, which is a master plan to expand the resource territory of South Korea and find oil and gas fields of 1 trillion ft³, four times the size of the Donghae gas field, through extensive exploration in Korean water. The project is also looking for candidate storage sites for 4 million tons of CO₂ p.a. by 2030 on the Korean continental shelf.

KIGAM (Korea Institute of Geoscience and Mineral Resources) is participating in the national project of 'securing large-scale commercial-grade CO₂ storage through comprehensive 2D/3D physical exploration and computerized material processing for each region of the Korean Peninsula' hosted by the Ministry of Trade, Industry and Energy and KETEP (Korea Institute of Energy Technology Evaluation and Planning). Seven institutions and companies including KNOC and SK Eathon are participating in the project. Dividing the sea area into 3 zones and evaluating how much CO₂ can be stored in which place and by conducting extensive and precise exploration of each region.

[R/V Tamhae3, owned by KIGAM]



Offshore CCS Site Survey ('23.11 ~ '26.12)



Regarding carbon capture technologies in South Korea, there are two local brands as a wet-type – ‘KoSol’ developed by Korea Electric Power Research Institute (KEPRI) and ‘KIERSOL’ by the Korea Institute of Energy Research (KIER). The technologies have been demonstrated in Korea and transferred to businesses to develop further commercially.

Another Korean absorbent ‘KEP-CO2P’ is a spherical solid powder based on potassium carbonate that selectively absorbs carbon dioxide contained in the exhaust gas of coal-fired power generation. It was developed by KEPRI and transferred to businesses.

Using membrane technology, CO₂ separation and processing were co-developed by KEPRI and Astroma in South Korea.

[Demonstration project completed]

- KoSol, a 10MWe Boryeong power plant, Korea Midland Power Co. (Coal)
- KIERSOL, a 0.5MWe Taean power plant, Korea Western Power Co. (Coal)
- KIERSOL, a 10ton/day capture, Sungshin Cemnet (cement)
- KEP-CO₂P, a 10MWe Hadong power plant, Korea Southern Power Co. (Coal)
- CO₂ membrane (KEPRI & Astroma), a 10MWe power plant, Korea Esat-West Power Co. (Coal)

As an information, there are 59 coal power plants with a 37.9 GW installation capacity owned by 5 GENCOs in South Korea. After several CO₂ capture demonstrations at coal power plants, KEPRI and 5 GENCOs are now conducting a new CO₂ capture demonstration project using the same wet-type absorbents on a liquefied natural gas (LNG) combined cycle power plants. The key is to increase the capture rate to more than 90% and minimize the amount of energy required for capture, even under conditions of CO₂ concentration that are relatively lower than exhaust gases such as coal-fired power plants and steel mills.

[List of public 5 GENCOs]

- Korea South-East Power Co., Ltd. (KOEN)
- Korea Midland Power Co., Ltd. (KOMIPO)
- Korea Western Power Co., Ltd. (KOWEPO)
- Korea Southern Power Co., Ltd. (KOSPO)
- Korea East-West Power Co., Ltd. (EWP)

According to Dr. Ho Seop Lee, head of the K-CCUS, "Currently, CCUS technology in South Korea is 70-80% compared to technology leaders." Those local wet-type solutions are generally evaluated the TRL 7, and they are transferred to businesses for the further commercial development in South Korea. However, the actual need of CO₂ capture technology from South Korean EPC players are a bit different. The EPC players are looking for more reliable, proven, and modular-based absorbents from overseas suppliers.

Regarding CO₂ carrier development in South Korea, Korean shipyards are receiving inquiries from international customers. Basically, the main dimension of CO₂ carrier concept is almost the same as the design of semi-pressured LPG carriers using C-type bi-lobe cargo tanks. Depending on the customers' business model, sometimes multi-cargo loading is required. The cooling method of re-liquefaction on CO₂ carriers is based on

refrigerant indirect cooling instead of seawater direct cooling at LPG carriers. Regarding CO2 transfer from a LOC2 shuttle tanker to an offshore unit/platform, Korean shipyards think that overseas technologies such as Norwegian BLS (bow loading systems) or STL (submerged terret loading) could be adoptable.