CO_2 Storage Technology

Background and Objective

It is necessary to use coal which is evaluated to have huge potential in the world for supplying stable electricity in the future. However, it is also necessary to reduce CO_2 emissions from thermal power plants into the atmosphere for preventing global warming. Therefore, CCS technology which captures CO_2 from thermal power plants and stores it underground is studied with a view to development.

In this project, we collected information of the latest CCS activities in Japan and the world, understood basic phenomena and developed fundamental technologies for storing CO_2 into underground considering characteristics of geological structures around the thermal plants in Japan.

Main results

1. Collection of information on CCS in the world

The Japanese government released the basic energy plan which included the intention to start discussions on adoption of the CCS Ready policy for new or expanded coal-fired power plants. To make preparation for that discussion, technical and procedural requirement for CCSR* plants and political implication of CCSR were indicated mainly citing from the Global CCS Institute reports (Table 1) [V10012]. Furthermore, technical, economic, political, financial and social uncertainties were pointed out as reasons for the cancellation of the Barendrecht CCS project planned in the Netherlands [V10011].

2. Site evaluation technology

Geological condition and physical characteristics of the CO_2 storage reservoirs and seal layers in 19 proposed sites in Japan were compared with those of 26 overseas sites. As for the results, porosity and thickness of the reservoir were not so much different, but permeability of the reservoir in Japan looks smaller in one order magnitude. This may mean that CO_2 injection pressure will be higher in Japan.

3. Understanding CO_2 performance

A geological and hydrological model was constructed for the CO_2 storage proposed site of ZeroGen which has promoted a CCS project in Australia with the information of the seismic survey results and in-house tests for rock samples from the site conducted by CRIEPI through the collaboration between ZeroGen and CRIEPI. Underground CO_2 distribution during injection was predicted by the numerical simulation with the model. A numerical simulation showed that gravity and resistivity anomaly on the ground surface caused by the CO_2 injection was estimated to be measurable. Therefore, the gravity and resistivity surveys can be applied as monitoring methods for CO_2 distribution.

4. Evaluation of CO_2 transportation by ship

CO_2 transportation by shuttle tankers with CO_2 injection pumps was studied for technical and economical practicability by the collaboration work with the University of Tokyo. This CO_2 transportation system may be useful for selecting CO_2 storage sites (Fig. 1).

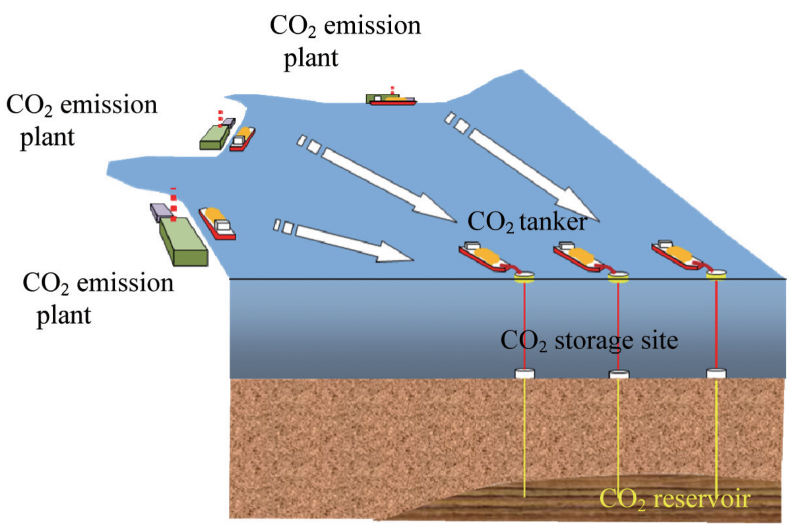
5. CO_2 mineral trapping technology development

CO_2 dissolved water was injected into a 1,000 m deep well in which the bottom-hole temperature was measured as 200 degree C at the Ogachi site. According to the CO_2 dissolved water injection tests, carbonate minerals were produced in relatively short time and permeability of rock decreased. These results mean that CO_2 may be stored stable as carbonate minerals [N10051].

Table 1 Main requirements and criteria for CCS Ready plant

The Global CCS Institute proposes definitions of CCSR plant as follows. Based on these proposals, discussions on an introduction of CCSR policy into Japan will be progressed.

A CCS Ready plant is one that is Capture Ready, Transport Ready, and Storage Ready.
Capture Ready Plant ■ Sited such that transport and storage of captured volumes are technically feasible ■ Technically capable of being retrofitted for CO_2 capture using one or more reasonable choices of technology at an acceptable economic cost ■ Adequate space allowance has been made for the future addition of CO_2 capture-related equipment, retrofit construction, and delivery to a CO_2 pipeline or other transportation system ■ All required environmental, safety, and other approvals have been identified ■ Public awareness and engagement activities related to potential future capture facilities have been performed
Transport Ready Plant ■ Potential transport methods are technically capable of transporting captured CO_2 from the source(s) to geologic storage ready site(s) at an acceptable economic cost ■ Transport routes are feasible, rights of way can be obtained, and any conflicting surface and subsurface land uses have been identified and/or resolved ■ All required environmental, safety, and other approvals for transport have been identified ■ Public awareness and engagement activities related to potential future transportation have been performed
Storage Ready Plant ■ One or more storage sites have been identified that are technically capable of, and commercially accessible for, geological storage of full volumes of captured CO_2, at an acceptable economic cost ■ Adequate capability, injectivity, and storage integrity have been shown to exist at the storage site(s) ■ Any conflicting surface and subsurface land uses at the storage site(s) have been identified and/or resolved ■ All required environmental, safety, and other approvals have been identified ■ Public awareness and engagement activities related to potential future storage have been performed



CO_2 captured at the CO_2 emission plants are transported by tankers to storage sites and injected into underground below the sea floor. Four tankers with 3,000 tons capacity are evaluated to be enough for transporting CO_2 of around one million tons per year, which is the volume transported in large-scale CO_2 injection projects in the world at the moment.

Fig. 1 Concept of CO_2 transportation by ship

There will be many difficulties in keeping land to transport CO_2 by pipeline in Japan. CO_2 transportation by ship is evaluated to be effective for selecting CO_2 storage sites.

(*) CCSR: Plants which can retrofit CCS functions (see Table 1), when legal and economical promotion policy is introduced.