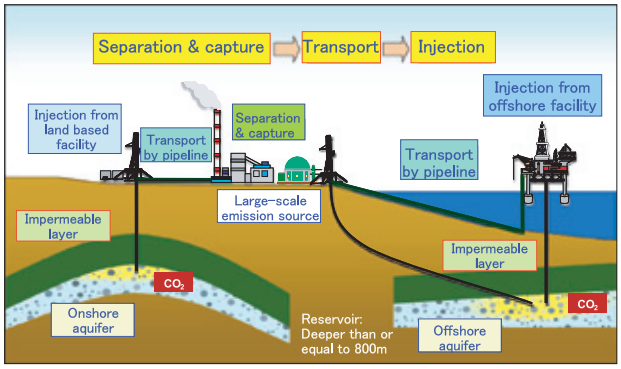
CO_2 Storage Research Group

CO_2 Storage Technology Development for Practical Application

CO_2 Geological Storage Project

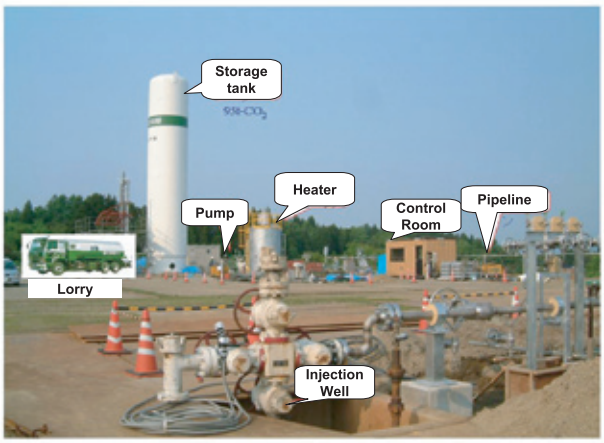
The CO_2 geological storage technology is a technology for safely and securely trapping CO_2, a greenhouse gas, into subsurfaces without releasing it into the atmosphere. There are various methods for the storage, including EOR, which injects CO_2 into depleted oil fields and recovers the enhanced oil; isolation of CO_2 in depleted gas fields; ECBM, which injects CO_2 in coal seams and recovers methane; and storage of CO_2 in highly porous sandstone aquifers, containing formation water.

RITE has been working on aquifer storage, which enables stable storage of CO_2 over long periods because there is a gas- and water-impermeable sealing layer on top of the aquifer where CO_2 is stored. Since technology of underground natural gas storage can be applied, this method is thought to be the most immediately effective and closest to practical use.



Concept of CO_2 geological storage

"R&D project of CO_2 Geological Storage Technology" was launched in 2000 to scientifically verify the feasibility of CO_2 storage in subsurface aquifers in Japan, focusing on its effectiveness as a global warming countermeasure. In particular, for the CO_2 injection demonstration test conducted at the Iwanohara site in Nagaoka City, Niigata Prefecture, 10,400 tons of CO_2 were injected in the aquifer of 1,100m depth below the ground during the period from July 2003 to January 2005. The underground behavior of CO_2 was observed by cross-well seismic tomography and well loggings, and a behavior prediction simulator was developed, based on the observation data. Besides, during testing, the Chuetsu Earthquake took place in Niigata Prefecture, approx. 20km away from the Iwanohara site, but no abnormalities were found in the injected CO_2, the aquifer, and the well, confirming the safety of the storage. In 2007, the CO_2 stored underground were monitored to improve the accuracy of the prediction technique.



Iwanohara demonstration test site

Our activities have clarified the scientific feasibility of geological storage in Japan. On the other hand, CO_2 geological storage technology development and demonstration is steadily progressing and is closer to practical use as a CO_2 emission reduction measure around the world. Therefore, it is necessary to clarify the effectiveness of CO_2 geological storage and issues for its practical application, and develop a social system.

RITE has performed a comprehensive research & development and assessment of CO_2 geological storage through effectiveness assessment studies; drawing up a road map of technological demonstration / practical use; investigation of the suppositional points; survey on the potential capacity of CO_2 aquifer storage nationwide; related and peripheral studies, including domestic and international policies and technological trends; preparation of information dissemination functions; and safety studies. In addition, to establish safety and security assessment techniques, we have conducted monitoring of injected CO_2 at the Iwanohara site, basic studies of geological storage mechanisms, and studies to promote the accuracy of CO_2 behavior prediction techniques.

In future research and development, in addition to clarifying issues in promoting CCS (Carbon dioxide Capture & Storage), we will develop technology required to turn it into a reality, survey of CO_2 storage potential and conduct basic studies for a larger scale demonstration test of the governmental target of 100,000 tons of CO_2 storage per year.

We held the "CCS Workshop 2007 ~ The forefront

of CO_2 Separation, Recovery and Storage Technology～ " in the Keihanna Plaza, Kansai Science City in February 2007 and the "CCS Workshop Tokyo 2007～ As a Core Technology of CO_2 Emission Control Measures～ " in November 2007. In these international workshops, we introduced the research achievements of the Nagaoka project as well as future research plans. For details, see page 19 of this document.

CO_2 Ocean Sequestration Project

The ocean dissolves a large quantity of CO_2. Since there is sufficient potentiality to dissolve CO_2 in the middle and deep layers of the ocean, which is rapidly increasing in the atmosphere, CO_2 ocean sequestration technology has been considered. This technology captures CO_2 from large emission sources and directly injects it into deep-sea areas without passing through the ocean surface. RITE has been developing technology for CO_2 dilution and injection to middle ocean layer using a Moving Ship method, as shown in the following figure. According to chapter 6 of the IPCC special report "Carbon dioxide Capture and Storage" in 2005, ocean sequestration is evaluated as an effective technology to mitigate climate change. The challenge in preparing this technology for practical use lies in controlling the impact of CO_2, which is injected directly into the ocean, on marine species. Development of environmental impact prediction technology is our immediate challenge.

In phase 1 of this project, which was implemented from FY1997 to FY2001, we conducted a CO_2 macroscopic behavioral study, an analysis of CO_2 behavior behind the release nozzles, and predictions and investigations of biological impacts. In the following phase 2 (from FY2002 to FY2011), we are developing and assessing technology aimed at "Study of environmental impact assessment for CO_2 ocean sequestration for mitigation of climate change"

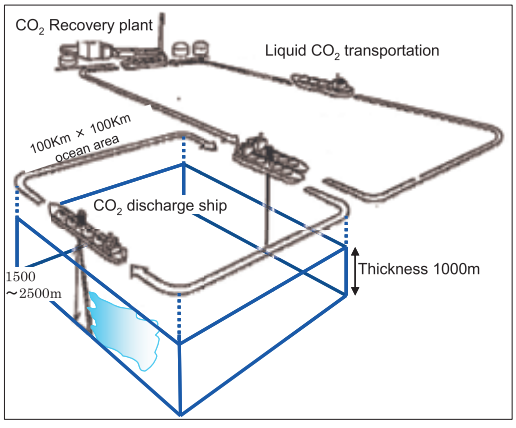


Fig. 1 Image of ocean sequestration using a Moving Ship

As a result, for CO_2 discharge using a Moving Ship method, the simulation predicted that within a few hours, the CO_2 concentration is lower than the natural fluctuation range and the acute impact on marine living species is negligible. To clarify the image of ocean sequestration in practical use, the engineering study of its implementation was carried out under the case which is the ocean sequestration of about 50 million tons of CO_2 annually into the ocean near Japan, and got the result that the CO_2 concentration can be reduced to below the level of the predicted no-effect concentration. These results were reported in the special symposium of Japan Ocean Society "CO_2 ocean sequestration: what is the appropriate assessment for the environmental impact"and promoted scientists' understanding.

We reviewed R & D themes to be developed in 2007 and conducted the following activities: (1) Study on trends in CO_2 ocean sequestration technology (1. Preparing the base to promote understanding and 2. Establishing a global network), (2)Study on biological impact assessment for CO_2 ocean sequestration (1. Developing biological impact assessment techniques, 2. Collecting biological impact data in the actual ocean, and 3. Studying the CO_2 impact on deep-sea living species) and (3) Development of CO_2 behavior technology (1. Developing CO_2 behavior observation and prediction technology, and 2. Potential ocean sequestration assessment).

In future development, we will proceed with development of ocean sequestration technology for practical application by developing a more accurate CO_2 behavior prediction technology, as well as biological models of the middle and deep layers of the ocean and long-term impact prediction technology, by taking advantage of achievements such as environmental impact assessment technology and CO_2 dilution technology. However, to put the ocean sequestration technology into practical use in the future, it is necessary to demonstrate developed technology by conducting experiments in the actual ocean, and ultimately, to trace the CO_2 behavior in several 100 km scale, and to investigate the biological impact. In addition, since the ocean is a human common property, international consensus to implement the ocean sequestration test is essential. Therefore, we will make efforts to establish a global network not only to promote scientists' understanding of ocean sequestration but also to acquire agreement to experiment via international treaty.

FutureGen Project

Fossil fuels account for approximately 80% of global energy sources and the long-term use of coal is expected in the future. Clean coal power generation in particular attracts a lot of attention. From the perspective of global warming, it is necessary to combine coal gasification power generation technology and CCS technology that separates, recovers, and stores the emitted CO_2 in the earth in order to achieve this goal. It is through the FutureGen program that the United States aims at practical use of zero emission clean energy power generation to meet these expectations.

FutureGen is a system to gasify coal using pure oxygen, generate power using the hydrogen gas obtained, capture the CO_2 generated, and store it in geological formation (see Figure 2).

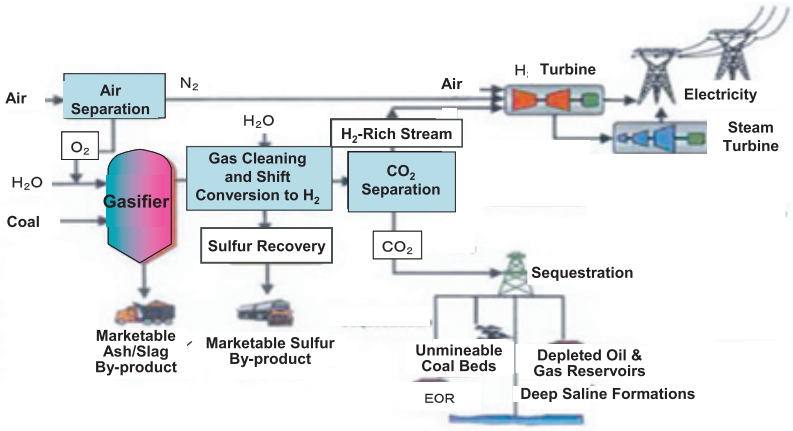


Fig. 2 FutureGen system outline

On the other hand, Japan has reached the global level in the coal gasification technology, and achieved world-class results in CCS technology, especially in CO_2 separation and recovery technologies and CO_2 geological storage technology development. We are now in the stage of developing a technology by integrating these technologies, focusing on zero emission clean energy power generation similar to that of the FutureGen program.

To demonstrate zero emission, consolidation of a broad range of technologies and strong financial resources are required. Thus, participating in an international cooperation framework lead by the United States is of great significance in obtaining technological information of this innovative zero emission coal gasification power generation technology, considering our comprehensive strategy for its practical use and promoting and enlightening public awareness for the technology..

Reflecting the above, RITE proposed the "Coal Gasification Technology Demonstration and Deployment Project" in 2007 and has just launched the FutureGen project. The major work will be

(1) Collecting and sorting information related to the FutureGen project;
(2) Assessing the development of FutureGen;
(3) Comprehensive strategy planning and investigation;
(4) Operating the FutureGen Domestic Industrial Cooperation Promotion Association (tentative name);
(5) Providing CCS technology information, popularizing and enlightening public awareness for CCS technology.

We are conducting several surveys with regards to information collection and development status assessment related to the FutureGen project, including investigating the site selection method implemented by the FutureGen Alliance (FG industrial alliance) and studying the up to date information of candidate technologies for the FutureGen Process, such as the coal gasification power generation and CO_2 separation & recovery technology. For popularization and enlightenment, we are now preparing a Web site for the FutureGen progress & enlightenment and will introduce the project schedule, plant image schematics, and alliance members in Japanese. In addition, we will hold the "FutureGen Workshop 2008" in February 2008.

For our future projects, we will conduct coal gasification and CCS related field surveys in the US, Europe, and Australia, and a domestic study based on information obtained from the field survey. Through these activities, our goals are for FutureGen project achievements to contribute to the development of global warming countermeasure technologies in Japan, and the incubation of new business in Japanese industries to serve our national benefits. We also plan to deliver and publicize the project achievements through our website, brochures, and reporting sessions.