# $CO_2$ 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 instead of releasing it into the atmosphere. There are various methods for 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 $CO_2$ storage in highly porous sandstone aquifers containing formation water.

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

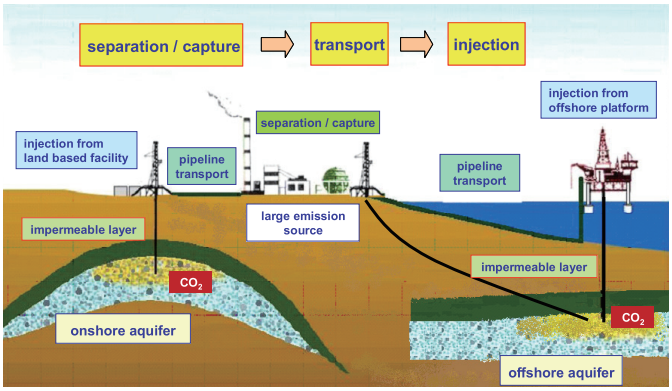



**Fig.1 Concept of $CO_2$ geological storage**

"R&D project of $CO_2$ Geological Storage Technology" supported by METI was launched in 2000 to scientifically verify the feasibility of $CO_2$ storage in subsurface aquifers in Japan, focusing on its effectiveness as global warming countermeasures. In particular, for the $CO_2$ injection demonstration test conducted at the test 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. In 2007, we measured the behavior of stored $CO_2$ in the reservoir using several monitoring techniques, and it was clear that the $CO_2$ had been kept safely stored in the aquifer.

The passable possibility of the implementation of geological storage in Japan was indicated by the $CO_2$ injection demonstration test in Nagaoka for eight years.

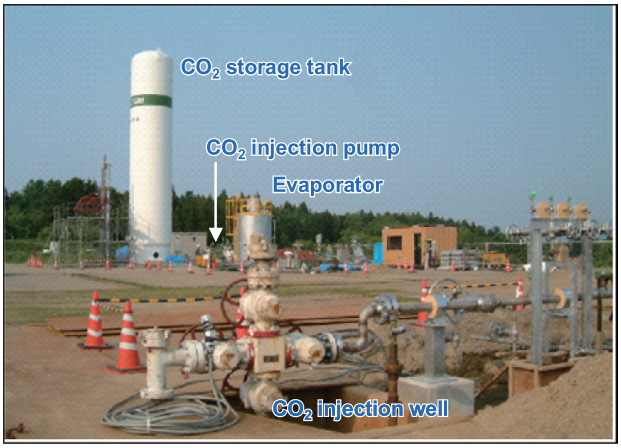




**Fig.2 Nagaoka demonstration test site**

RITE has supported large-scale demonstrations of $CO_2$ geological storage since 2008. Since there is a strong possibility that reservoirs under sea bottom are the place for $CO_2$ geological storage in the future in Japan, we need to develop new fundamental technologies such as monitoring methodology etc.

RITE has been working on evaluation of $CO_2$ storage performance, $CO_2$ behavior evaluation in reservoirs and monitoring technologies of long-term $CO_2$ behavior in reservoirs. In the evaluation of $CO_2$ storage performance, we have researched the development of geological structure analysis methodology and the evaluation technology of $CO_2$ storage amount to prove a stable $CO_2$ geological storage. In the $CO_2$ behavior evaluation in reservoirs, we have studied the monitoring technology of $CO_2$ behavior such as a seismic survey, its alternative monitoring technologies and the $CO_2$ behavior prediction technology including model simulation. In the monitoring technologies of long-term $CO_2$ behavior in reservoirs, we have advanced the analysis of $CO_2$ storage mechanism in res-

ervoirs and the development of low-cost long-term monitoring technologies. Moreover, we have conducted the elastic wave measurement using rock core samples and the threshold pressure measurement for safety of the cap rock as a fundamental study supporting some technical issues of the $CO_2$ geological storage.

We intend to research and develop the technical issues found out in the large-scale demonstrations in progress and to work aiming at commercialization of $CO_2$ geological storage in the future.

## IZEC (International Zero Emission Coal) 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, the combination of high-efficiency coal power generation technology and CCS technology that separates, captures, and stores the $CO_2$ emitted from high-efficiency coal power plants receives attention and has been developed in the world.

As such combined technologies, Post-Combustion, Oxy-Fuel and Pre-Combustion are specified (See Fig.3). At present, many zero emission coal power generation projects such as FutureGen in U.S. are planned all over the world.

In Japan, some plans such as "Innovative Zero Emission Coal Gasification Generation Project" supervised by NEDO have also started.

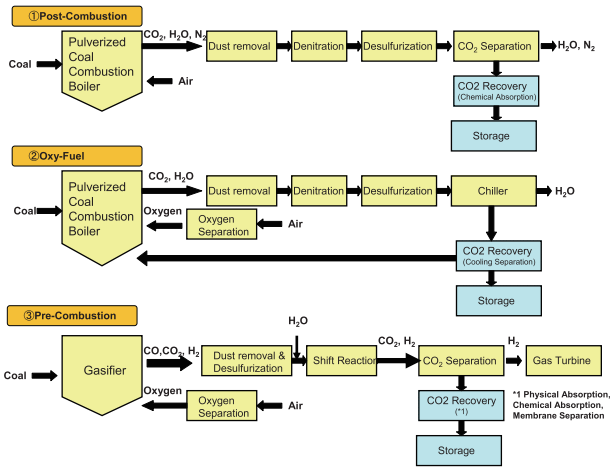



**Fig.3 Process of Zero Emission Coal Power Generation**

To demonstrate zero emission, consolidation of a broad range of technologies and strong financial resources are required. Thus, investigating the current status of zero emission coal power generation projects all over the world from viewpoints of both technology and development, and promoting and enlightening public awareness of the zero emission coal power generation are of great significance in considering our comprehensive implementation strategy for its practical use in Japan.

Reflecting the above, RITE has conducted IZEC (International Zero Emission Coal) project since FY 2007. The major subjects are (1) Collecting and sorting information regarding zero emission coal power generation projects all over the world; (2) Collecting and sorting information regarding zero emission/CCS initiatives of the nations concerned and international organizations; (3) Promoting and enlightening public awareness of zero emission coal power generation through operating "IZEC Symposium", "IZEC Forum" and so on.

We are conducting the current status surveys of more than 48 demonstration and pilot projects mostly in EU, U.S. and Australia. Furthermore, we have investigated the initiatives, policies and strategies of EU, Britain, Norway, Holland, Germany, U.S., Canada, Australia and so on. In FY 2009, we conducted a survey on the current status and criteria of capture ready especially in Britain and Germany.

For propagation and enlightenment, we have prepared a web site for IZEC and update the databases of the International Zero Emission Coal projects, the initiatives in the world, the current status of clean coal in each nation and so on. In addition, we will hold "IZEC Forum" which informs the related industry of the collected information and "IZEC Symposium" which invites representatives of projects overseas.

Through these activities, our objective is to contribute to determine comprehensive strategy for the practical use of zero emission coal power generation in Japan.

## China CCS-EOR Project

CCS, the technology to capture and store $CO_2$ from fossil fuel, is essential as the countermeasures against global warming until 2100. In particular, CCS-EOR (Enhanced Oil Recovery) which can bring commercial advantage of increased oil production is expected to be realized at early stage.

In the United States, CCS-EOR which utilizes natural $CO_2$ has already been developed in a 60 million-ton scale a year. Moreover, its application to the coal-fired power stations which emit a large amount of $CO_2$ is expected.

In the recent years, the amount of $CO_2$ emission in China has been increasing and becomes the largest in the world. Japan also emits a large amount of $CO_2$ which corresponds to the 4th largest. Therefore, the cooperation between China and Japan in CCS-EOR study has a very significant meaning from the viewpoint of global warming prevention internationally.

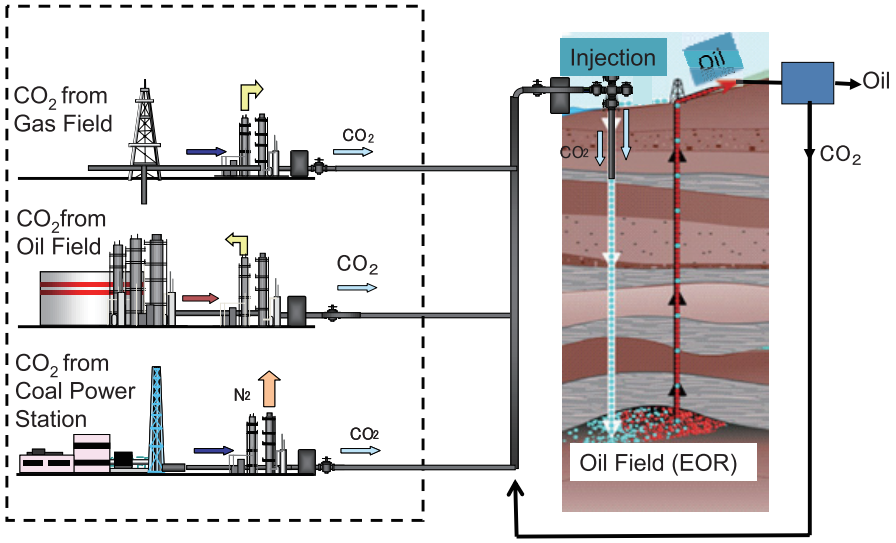
RITE has started technical exchanges including CCS-EOR, energy conservation, environmental preservation and GHG reduction with China National Petroleum Corporation (CNPC). This year, we held CCS-EOR Workshop at Beijing in September and exchanged the technical knowledge shown below:

- $CO_2$ Capture Technology (Chemical Absorption, Physical Absorption and Membrane

Separation)
- ➢$CO_2$ Storage Basic Research
- ➢$CO_2$ Monitoring
- ➢$CO_2$ Simulation
- ➢EOR
- ➢Total System

We also sent researchers to China and exchanged technical knowledge of CT scan application in the $CO_2$ storage basic research.

From now on, we will carry forward technical exchanges and implement the practicability study of CCS-EOR based on the technical exchange results, so as to contribute realization of low-carbon society and ensure energy security.




**CCS-EOR: Achievement of both Huge $CO_2$ Storage and Increasing Oil Production**

**Fig4. Outline of CCS-EOR**