Tomakomai CCS Demonstration Project

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Project At a Glance

Project Description

A large-scale CCS demonstration project is being undertaken by the Ministry of Economy, Trade and Industry of Japan (METI) in Tomakomai, Hokkaido Prefecture, Japan. The objective is to demonstrate the viability of a full CCS system, from CO_2 capture to injection and storage. Approximately one hundred thousand tonnes/year or more of CO_2 will be injected and stored in offshore reservoirs in the Tomakomai port area. The implementation of the project has been commissioned to Japan CCS Co., Ltd. Construction of facilities was completed in October 2015, and after a test-run in February, CO_2 injection commenced in April 2016.

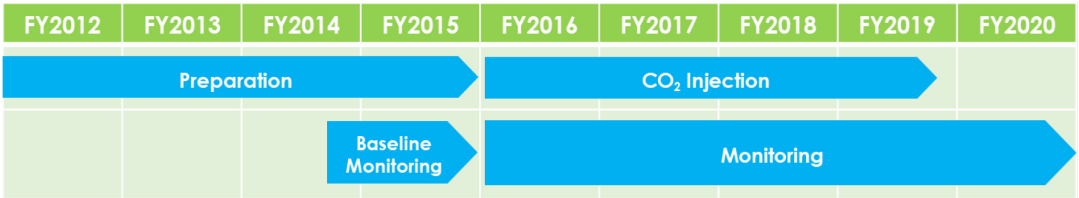
Project Site Tomakomai City, Hokkaido

Main CCS Parameters

CO_2 Source	Capture Type	Storage Formation	CO_2 Stored	Storage Type
Hydrogen production unit in oil refinery	Industrial separation/ Chemical absorption	Sandstone at 1,000-1,200m depth & volcanic rocks at 2,400-3,000m depth	100,000 tonnes/ year or more	Deep saline aquifers

Schedule 9 years from FY2012-2020

FY: from April of calendar year to following March



Objectives & Tasks

- Demonstrate an integrated CCS system from capture to storage
- Confirm existing technologies adopted in the system work properly and efficiently
- Demonstrate that the CCS system is safe and reliable
- Confirm effectiveness of METI site selection guideline by demonstrating no leakage
- Remove concerns about earthquakes by the data collected
  - Natural earthquakes will have no effect on stored CO_2
  - Noticeable tremors will not be caused by CO_2 injection
- Confirm that guidelines for building and improving geological models are appropriate
- Prepare technical standards of operation and safety for practicalization of CCS technology
- Disclose project information & data and enhance understanding of CCS by the general public
- Clearly define areas to be improved or solved for commercialization

Progress to Date & Demonstration Schedule

Selection of Tomakomai Area

Tomakomai was selected from among 115 candidate sites as a result of comprehensive investigations and site surveys, and was authorized by the Evaluation Committee organized by the Ministry of Economy, Trade and Industry of Japan (METI). The data collected by detailed site surveys were used to establish a geological model and to perform simulation of long-term CO_2 behavior prediction. The results obtained revealed that the geological structures and formations in the Tomakomai area were highly suitable for geological CO_2 storage.

Preparation

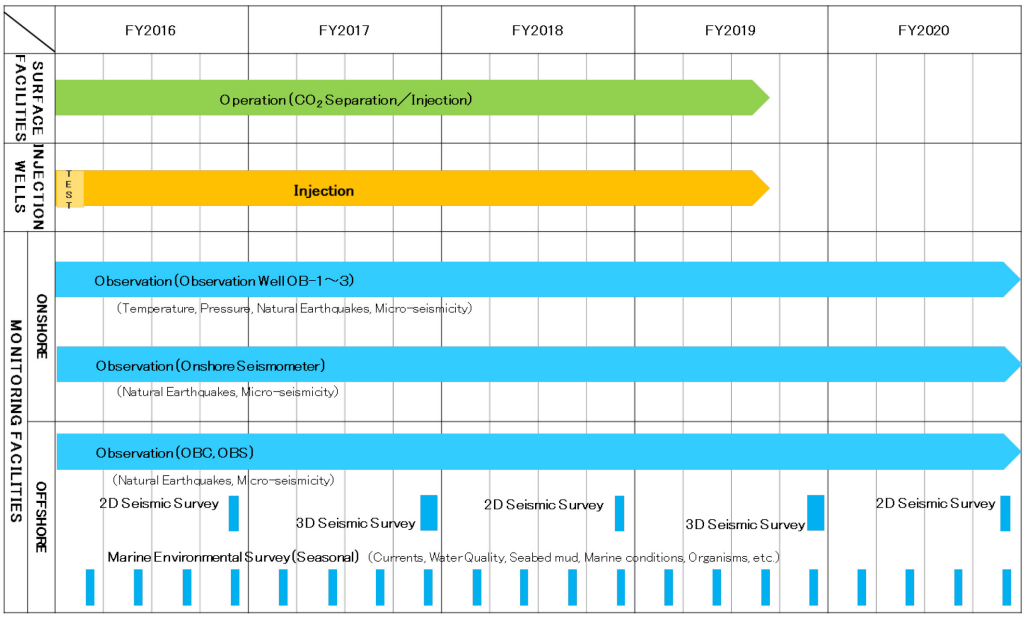
During the Preparation phase (FY2012 – FY2015), the following work was conducted

- **Construction of onshore facilities**
  - Design, construction and commissioning of facilities necessary for capture and injection of CO_2
- **Drilling of injection wells**
  - Drilling of wells for injecting CO_2 into deep subsea reservoirs
- **Baseline monitoring**
  - Development of monitoring network for obtaining baseline data
- **Studies of regulations and standards for safety**
  - Review of laws and regulations, technical standards and guidelines related to CCS

Demonstration Operation Schedule

The Demonstration Operation (FY2016 – FY2020) constitutes the following:

- **CO_2 Separation/Injection**
  - Test injection has been completed, and full injection will be conducted until mid FY2019.
- **Monitoring**
  - Monitoring of CO_2 behavior, natural earthquakes, micro-seismicity by observation wells, seismometers, and 2D/3D seismic surveys will be carried out during CO_2 injection, and for 2 years after termination of injection.
  - Marine environmental surveys will be carried out seasonally (4 times per year), each year between FY2016 and FY2020.



Main Features of Tomakomai Project

- First full cycle CCS system deployed in Japan
- Low energy CO_2 capture process
  → Page 4
- First case of deviated CO_2 injection wells drilled offshore from onshore site
  → Page 5, 6
  - Lower drilling & maintenance costs
  - 1 km injection interval enhances injection efficiency
- Extensive monitoring system
  → Page 7
  - Confirm safety and stability of CCS system
  - Remove concerns about earthquakes
- CO_2 storage governed by Act on Prevention of Marine Pollution & Maritime Disaster (Japanese law reflecting London Protocol)
  → Page 8
- First case of CCS near urban area; extensive public outreach activities engaging local government, residents and industry
  → Page 9

Bird's eye view of Onshore Facilities

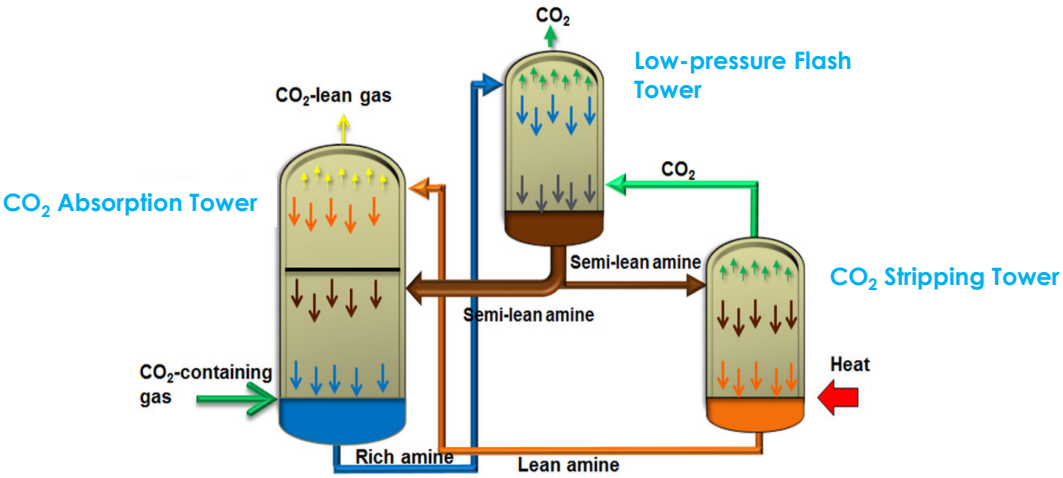
CO_2 Capture Process

Two-stage Absorption System with Low-pressure Flash Tower

- **Depressurization in Low Pressure Flash Tower strips substantial portion of CO_2**
- **Energy consumption is 1/2 to 1/3 of conventional CO_2 capture process**

The CO_2 source is a hydrogen production unit (HPU) of an adjacent oil refinery, which supplies off gas containing approximately 50% CO_2 from a Pressure Swing Adsorption (PSA) hydrogen purification unit. In the capture facility, gaseous CO_2 of 99% purity or more is recovered by a commercially proven amine scrubbing process. A two-stage absorption system including a low pressure flash tower reduces the amine reboiler duty in the capture system, and the energy consumption for CO_2 capture is approximately 1/2 to 1/3 of a conventional CO_2 capture process.

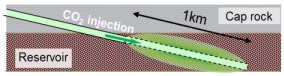
Tomakomai CO_2 Capture Process



CO_2 Injection

Injecting from Onshore to Offshore

- **Deviated wells from onshore to offshore**
  - Lower drilling and maintenance costs
- **Injection into two different reservoirs**
  - 1Km injection interval enhances injection efficiency

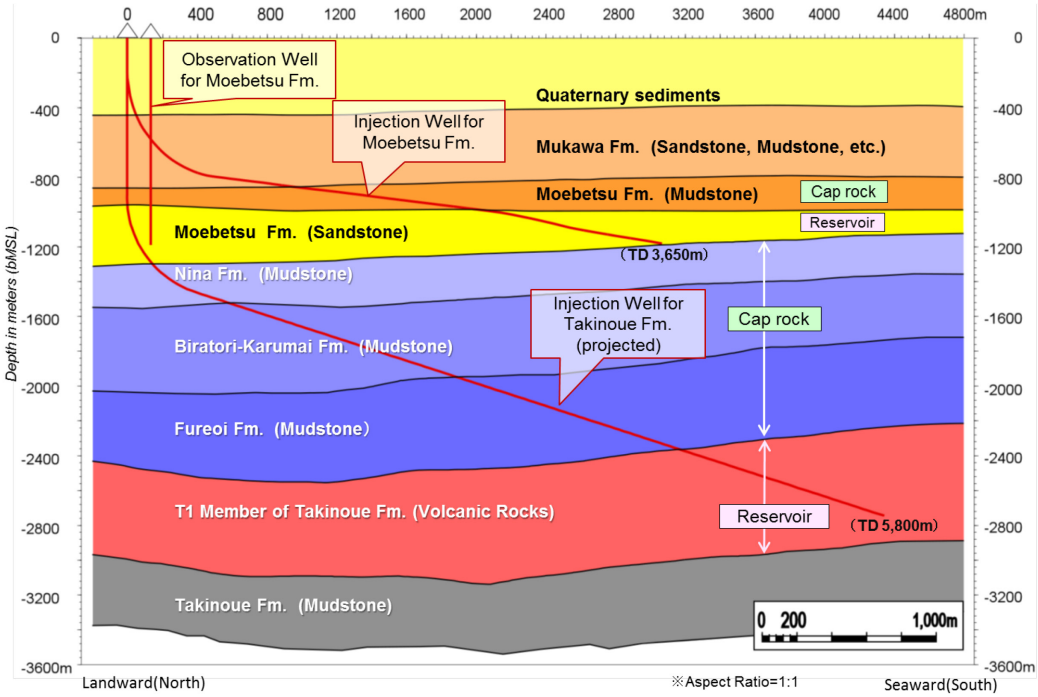


At the onshore injection facility, the CO_2 is compressed and injected into two different offshore reservoirs by two separate deviated wells. The storage points are located 3 to 4km offshore. The shallow reservoir (**Moebetsu Formation**), a saline aquifer mainly composed of sandstone located approximately 1,000m below the seabed, was reached by an extended reach drilling (ERD) well with a maximum inclination of 83 degrees, vertical depth of 1,188m and horizontal reach of 3,058m. A perforated liner covered by sand control screens was set over the injection interval of almost 1,200m in length in order to minimize sand flow back into the well. The deep reservoir (**Takinoue Formation**) is a saline aquifer composed of volcanic/volcaniclastic rocks located approximately 2,500m below the seabed. The deep injection well has a maximum inclination of 72 degrees, vertical depth of 2,753m and horizontal reach of 4,346m.

Compressor

Heads of injection wells

Schematic Geological Section

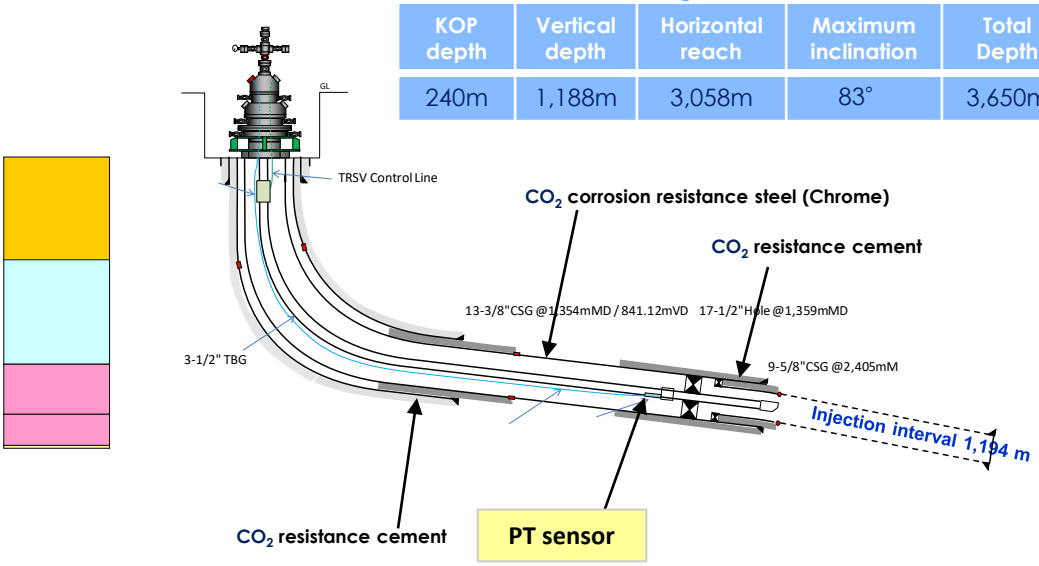


Wellbore Schematic Diagrams

Injection Well for Moebetsu Formation

Drilling: 12th Mar. 2015 - 22nd Jun. 2015

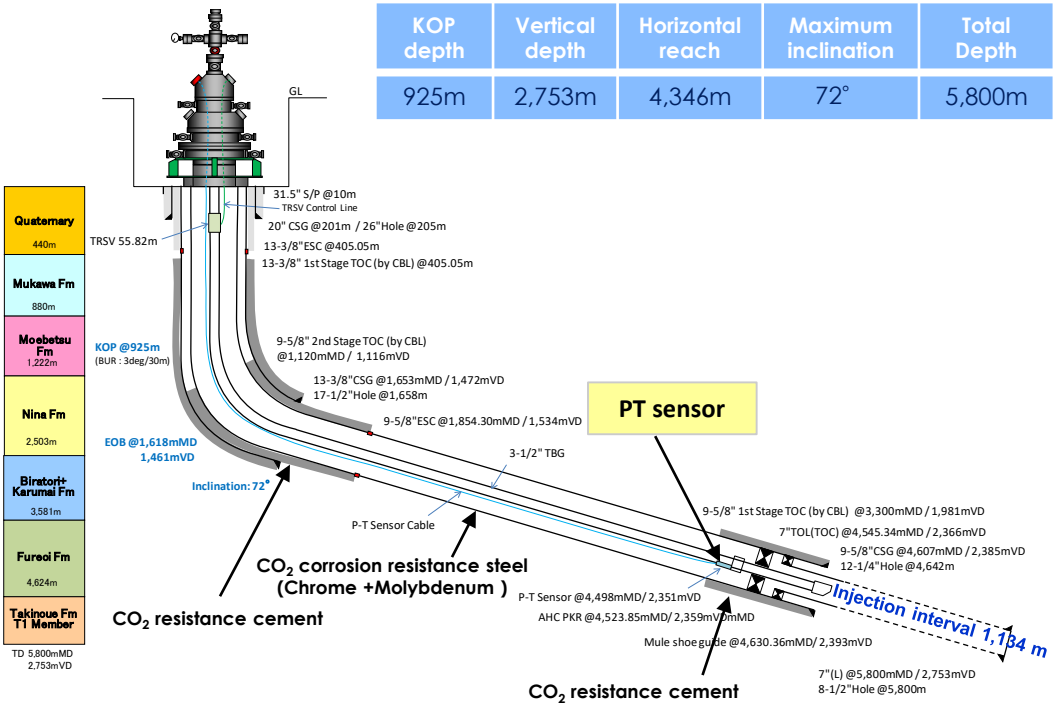
KOP depth	Vertical depth	Horizontal reach	Maximum inclination	Total Depth
240m	1,188m	3,058m	83°	3,650m



Injection Well for Takinoue Formation

Drilling: 19th Oct. 2014 – 25th Feb. 2015

KOP depth	Vertical depth	Horizontal reach	Maximum inclination	Total Depth
925m	2,753m	4,346m	72°	5,800m



Monitoring & Verification

Objectives of Monitoring and Verification

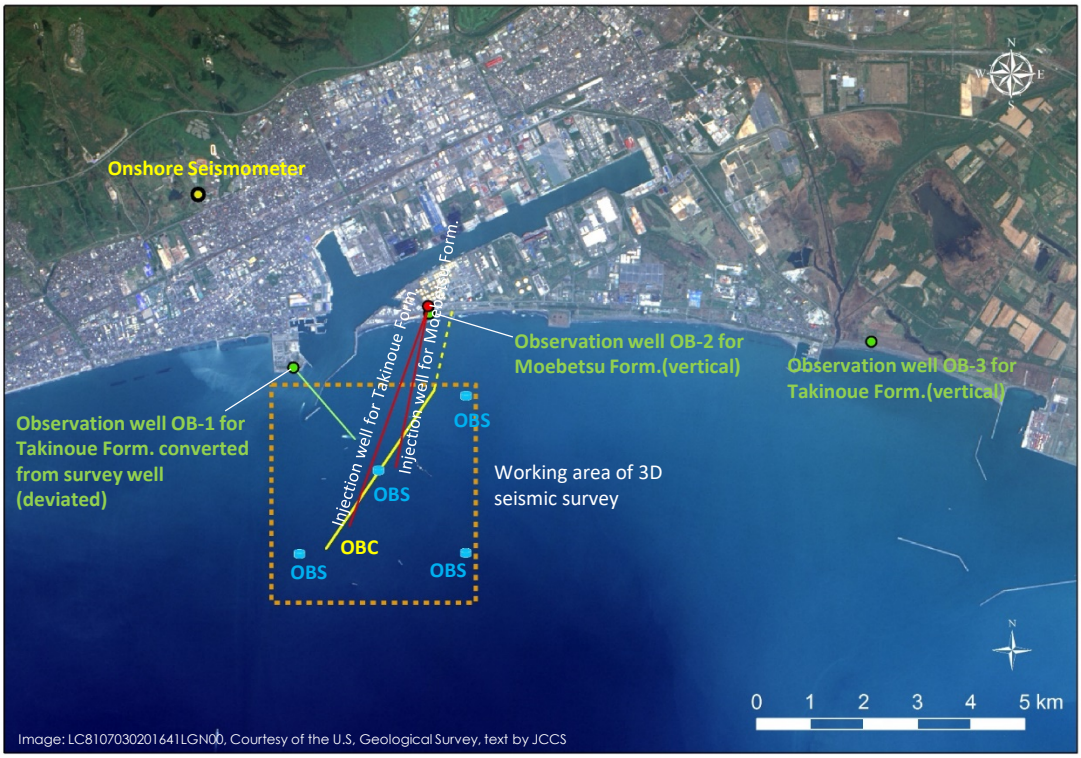
- **Confirm the safety and stability of CO_2 injection**
  - The CO_2 behavior in the reservoirs will be monitored continuously to detect any CO_2 leakage.
  - Seismic surveys to delineate the subsurface CO_2 distribution, and monitoring of the injected CO_2 volume, formation pressure and temperature will be conducted.
  - Baseline seismic surveys were conducted during the site survey and preparation phases, and 2D and 3D seismic surveys will be repeated yearly until the end of the project.
  - The monitoring data will be used to update a simulation model to predict CO_2 behavior.

- **Verify that natural earthquakes do not affect the stored CO_2, and that CO_2 injection does not cause any increase in noticeable tremors**
  - Monitoring of natural earthquakes and micro-seismicity will be conducted

- **Monitor the marine environment**
  - Surveys and monitoring will be conducted on ocean currents, water quality, seabed mud, marine organisms, etc., in accordance with the "Act on Prevention of Marine Pollution and Maritime Disaster".

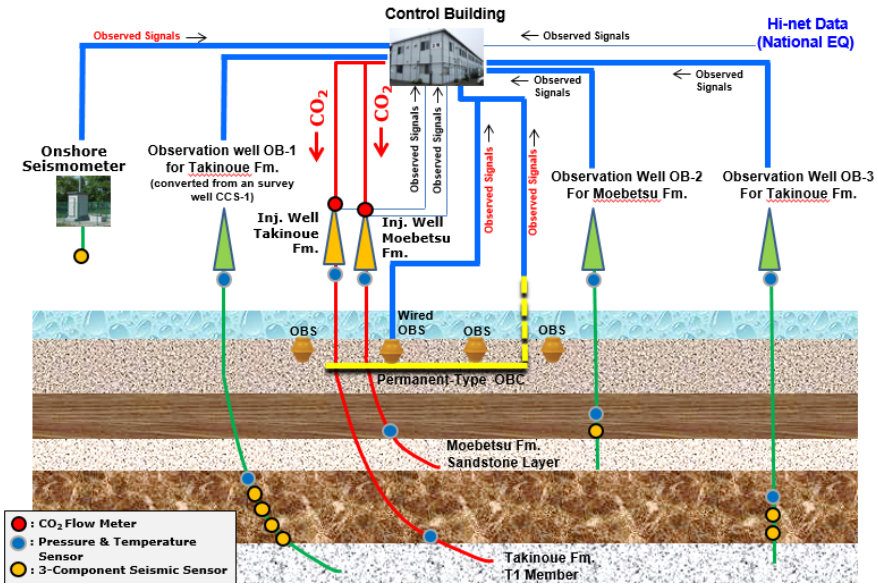
Monitoring System

An extensive monitoring system comprising 3 observation wells, 4 ocean bottom seismometers, 1 ocean bottom cable, wellbore temperature/pressure, and flow meters has been established to continuously measure the temperature and pressure of the reservoirs, and to monitor natural earthquakes and micro-seismicity.



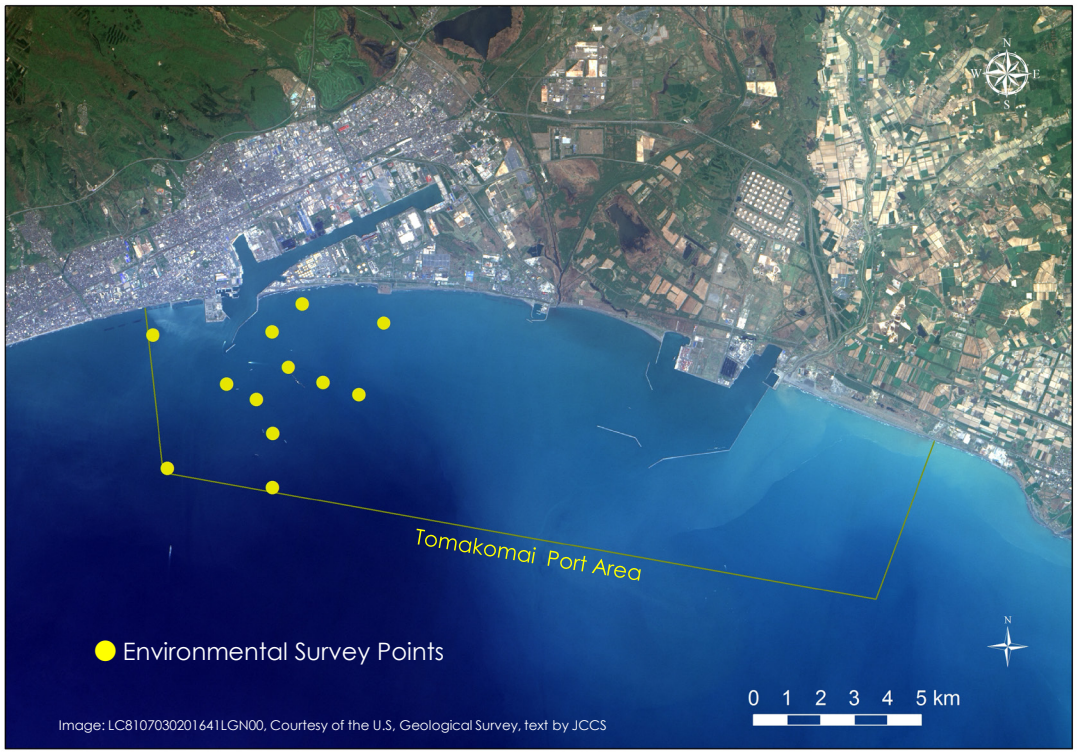
Monitoring & Verification

Schematic Diagram of Monitoring System



Marine Environmental Monitoring

Subsea CO_2 geological storage is regulated by the "Act on Prevention of Marine Pollution and Maritime Disaster", enforced to reflect the London 1996 Protocol. Marine environmental surveys were conducted in FY2013 and FY2014; from FY2016, seasonal surveys will be conducted quarterly.



Public Engagement

In Tomakomai City

Tomakomai City has a population of 173,000, and as the operation is taking place in the port area, intensive stakeholder engagement has been implemented since FY2011. Securing the strong support of the Tomakomai government, a wide range of activities; providing information on JCCS's website, exhibitions and forums for residents, receiving site visits, engaging in consultation and collaboration with government officials and fishery cooperatives, conducting interviews with local and national media, etc., is being carried out.

Tomakomai CCS Promotion Association

- Activities
  - Attraction of CCS Demonstration Project to Tomakomai
  - Information communication to Tomakomai citizens on CCS, etc.
- Chairman : Tomakomai City Mayor
- Secretariat : Tomakomai City
- Members : All major corporations in Tomakomai and industrial associations including Tomakomai Fishery Cooperative

Association Meeting

News Letters Published by CCS Promotion Association

Various Activities for local communities

Panel Exhibitions

CCS Forums

Site tours & Lectures

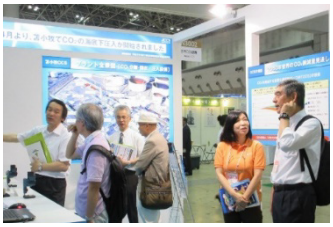
CCS courses for senior citizens

Science classes & site tours for school children

Public Engagement & International Activities

Other areas in Japan & overseas


University lectures

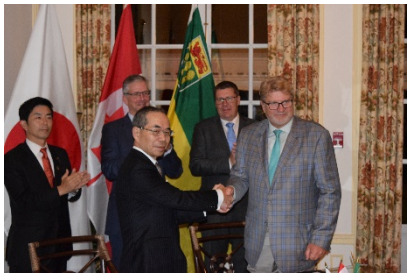

Environmental exhibitions in Japan


Site visits from overseas

CCS Seminar at Japan Pavilion at COP24 in Poland

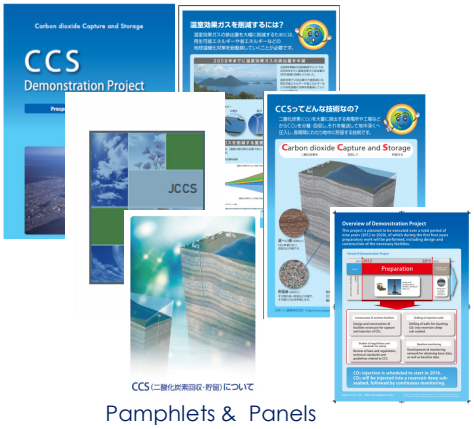
JCCS Booth at GHGT-14


Presentations at International Meetings


MOU with Canada's International CCS Knowledge Centre on October 8, 2019


Information Exchange Meeting

Outreach Materials



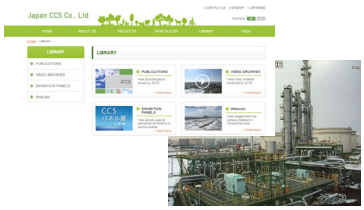
Pamphlets & Panels

School Supply

English/Chinese Cartoons

Promotion Movies

Animation Movie



JCCS Website