Tomakomai CCS Demonstration Project

CSLF TECHNICAL GROUP MEETING

October 4, 2016
Japan CCS Co., Ltd. (JCCS)
Overview of Tomakomai Demonstration Project
Tomakomai CCS Demonstration Project Schedule

※Years are in Japanese Fiscal Years (April of calendar year thru March of following year)
## Demonstration Project Operation Schedule

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<th>FY2016</th>
<th>FY2017</th>
<th>FY2018</th>
<th>FY2019</th>
<th>FY2020</th>
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<td><strong>Surface Facilities</strong></td>
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<td>Injection Wells</td>
<td>Operation (CO₂ Separation/Injection)</td>
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<td><strong>Onshore Monitoring Facilities</strong></td>
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<td>Observation (Observation Well OB-1~3)</td>
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<td>(Temperature, Pressure, Natural Earthquakes, Micro-seismicity)</td>
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<td>Observation</td>
<td>Observation (Onshore Seismometer)</td>
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<td>Observation</td>
<td>Observation (OBC, OBS)</td>
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<td>Offshore Facilities</td>
<td>2D Seismic Survey (**)−1</td>
<td>3D Seismic Survey (**)−1</td>
<td>2D Seismic Survey</td>
<td>3D Seismic Survey</td>
<td>2D Seismic Survey</td>
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<td>Marine Environmental Survey (Seasonal)</td>
<td>(Current, Water Quality, Seabottom Conditions, Marine Life, etc.)</td>
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(*): 2D・3D Seismic Survey: survey method utilizing seismic reflection waves discharged from a seismic source of a seismic exploration vessel in order to delineate the subsea geological structure and/or formation characteristics. In this case, the data acquired is used to estimate the CO₂ storage distribution by 2D cross sections or arbitrary planal diagrams in 3D space.
Flow Scheme of CCS Demonstration Project

CO₂ source

Capture facility
Activated amine process
Compressors
Injection wells
Injection facility

PSA offgas containing CO₂ corresponding to more than 100,000 t/year

Activated amine process
Reservoir: T1 Member of Takinoue Fm.
2,400~3,000m under the seabed

Compressors
Injection wells
Pipeline

Existing oil refinery

PSA system in hydrogen production unit

PSA offgas containing CO₂

Pipeline

PSA (Pressure Swing Adsorption)

Reservoir: Sandstone layers of Moebetsu Fm.
1,000~1,200m under the seabed

Reservoir: T1 Member of Takinoue Fm.
2,400~3,000m under the seabed
【Project Goal】
- Demonstrate the technical viability of a full cycle CCS system from capture to injection and storage in saline aquifers on a practical scale, contributing to the establishment of CCS technology for practical use by 2020 and future deployment of CCS projects in Japan

【Objectives】
- In order to demonstrate technical viability, safety and reliability of CCS system;
  - Capture and inject 100,000 tonnes/year or more of CO₂ for 3 years
  - Monitor by the installed monitoring system and surveys for 5 years

【Tasks】
- Prepare capture and injection facilities, injection wells with a design capacity of 200,000 tonnes of CO₂ per year
- Prepare monitoring systems and gather data for geological storage and seismicity
- Estimate CO₂ behavior in the reservoirs by analysis of seismic and well data
- Confirm that existing technologies adopted in the system work properly and efficiently
- Confirm effectiveness of site selection guideline of METI by demonstrating no CO₂ leakage
- Establish guidelines for building and improving geological models
- Prepare technical standards of operation and safety for practicalization of CCS technology
- Share information and data obtained from the project with the public and relevant community groups in order to increase awareness and understanding of the benefits and viability of CCS
【Outcomes】
- Confirmation of the technical viability of a full CCS system in Japan
- Clarification of technical and social areas to be improved or solved for commercialization
- Mitigation of public concerns about earthquakes
  - Natural earthquakes do not influence or negatively impact stored CO₂
  - CO₂ injection does not cause any perceptible increase in earth tremors
- Enhancement of awareness and understanding of CCS technology and its benefits

【Other Considerations】
- Verification of onshore to offshore injection model
  - Lower drilling and maintenance costs
  - Securing public acceptance for offshore storage may be easier than onshore
  - Potentially smaller impact on environment in worst case leak scenario
  - Applicability to island nations
Main Features of Tomakomai CCS Project

- First full cycle CCS system deployed in Japan
- Two-stage CO\textsubscript{2} capture system providing for low energy consumption
- Deviated CO\textsubscript{2} injection wells drilled into offshore reservoirs from an onshore site.
- Injection interval length exceeding 1,100m to enhance injection efficiency
- Extensive monitoring system to address concerns about earthquakes
- CO\textsubscript{2} storage governed by Japanese law reflecting London 1996 Protocol
- First case of CCS near urban area requiring extensive stakeholder engagement
Positional Relation of Injection & Monitoring Systems

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**OBC (Ocean Bottom Cable):** used for 2D seismic survey and monitoring of micro-seismicity and natural earthquakes.

**OBS (Ocean Bottom Seismometer):** used for monitoring of micro-seismicity and natural earthquakes.
Positional Relation of Onshore Facilities

- **Injection well for Takinoue Formation**
- **Injection well for Moebetsu Formation**
- **CO₂ capture and injection facility**
- **Gas supply facility**
- **Gas pipeline**
Bird’s Eye View of Capture and Injection Facilities
Conventional CO2 Capture Process

CO2 Absorption Tower

CO2-lean gas

CO2-containing gas

CO2 Absorption Tower

CO2 Rich amine

CO2 Lean amine

CO2 Stripping Tower

Heat

CO2
Tomakomai CO2 Capture Process

- In LPFT, CO2 is stripped by depressurization; thermal energy of water vapor of CO2 Stripping Tower is also utilized to strip CO2.
- Greater part of semi-lean amine from LPFT is returned to CO2 Absorption Tower for CO2 absorption; as only the remaining smaller portion is sent to CO2 Stripping Tower, reboiler heat required can be reduced.

If pressure of gas containing CO2 and partial pressure of CO2 are relatively high, amine reboiler heat consumption is only 1/3~1/2 of conventional capture process.
**Schematic Geological Section**

- **Quaternary sediments**
- **Mukawa Fm. (Sandstone, Mudstone, etc.)**
- **Moebetsu Fm. (Mudstone)**
- **Reservoir**
- **Cap rock**

### Stratigraphic Units
- **Moebetsu Fm. (Sandstone)**
  - Depth: TD 5,800m
- **Nina Fm. (Mudstone)**
- **Biratori-Karumai Fm. (Mudstone)**
- **Fureoi Fm. (Mudstone)**
- **T1 Member of Takinoue Fm. (Volcanic Rocks)**
- **Takinoue Fm. (Mudstone)**

### Observations and Wells
- **Observation Well for Moebetsu Fm.**
- **Injection Well for Moebetsu Fm.**
- **Injection Well for Takinoue Fm. (projected)**

### Depth in meters (bMSL)
- TD 5,800m
- TD 3,650m

**Aspect Ratio=1:1**
Injection well for Moebetsu Formation

**Drilling:** 12th March 2015 - 22nd June 2015

<table>
<thead>
<tr>
<th>KOP depth</th>
<th>Vertical depth</th>
<th>Horizontal reach</th>
<th>Maximum inclination</th>
<th>Total depth</th>
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<tbody>
<tr>
<td>240m</td>
<td>1,188m</td>
<td>3,058m</td>
<td>83°</td>
<td>3,650m</td>
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- **Tubing-Retrievable Safety Valve (TRSV)**
  - 1st KOP @240m (1st BUR : 3deg/30m)
  - GL 31.5" S/P @10m
  - TRSV Control Line
  - 20" CSG @201.5m
  - 13-3/8"ESC @390.11mMD / 388.3mVD
  - 1st Stage TOC @390mMD
  - 13-3/8" 1st Stage TOC @390mMD
  - 9-5/8" 2nd Stage TOC (by CBL) @1,056mMD / 804.11mVD
  - 13-3/8"CSG @1,354mMD / 841.12mVD
  - 17-1/2" Hole @1,359mMD
  - 9-5/8"ESC @1,556.41mMD / 867.56mVD
  - 9-5/8" 1st Stage TOC (by CBL) @1,805mMD / 986.82mVD
  - 9-5/8"CSG @2,405mMD / 971.38mVD
  - 7" CMTG port @2,456.18mMD / 977.8mVD
  - Inclination: 83°

- **CO₂ corrosion resistant cement**
  - Moebetsu (mudstone)
  - Moebetsu (sandstone)
  - TD 3,650mMD / 1,188mVD

- **CO₂ resistant cement**
  - Injection interval: 1,194 m
  - 1st EOB @1,047mMD
  - 806.23mVD
  - Inclination: 83°
  - Mule shoe guide @2,305.84mMD / 959.38mVD
  - AHC PKR @2,087.68mMD / 932.66mVD
  - P-T Sensor Cable
  - P-T Sensor
  - PT sensor

- **TRSV Control Line**
  - 31.5" S/P @10m
  - 20" CSG @201.5m

- **2nd KOP @2,672m**
  - (2nd DOR : 1.5deg/30m)
  - 3-1/2" TBG
  - 2nd EOD @2,780mMD
  - 1,022.91mVD
  - Inclination: 79°
  - 7"(L) @3,650mMD / 1,187.86mVD

- **Perforated liner covered by screens**
  - at injection interval

- **Inclination: 79°**
  - 2nd EOD @2,780mMD
  - 1,022.91mVD

- **Injection interval: 1,194 m**

- **Injection well for Moebetsu Formation**

- **Injection well for Moebetsu Formation**

- **Injection well for Moebetsu Formation**

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Seismic Monitoring Program

Onshore Seismometer

Observation well OB-1 for Takinoue Fm. (converted from an survey well CCS-1)

Inj. Well Takinoue Fm.

Inj. Well Moebetsu Fm.

Permanent-Type OBC

Moebetsu Fm. Sandstone Layer

Seismic Monitoring Program

Observed Signals

Hi-net Data (Natural EQ)

CO$_2$

Observed Signals

CO$_2$

Observed Signals

OBS

Wired OBS

OBS

OBS

Takinoue Fm. T1 Member

: CO$_2$ Flow Meter

: Pressure & Temperature Sensor

: 3-Component Seismic Sensor

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Marine Environmental Survey

Marine environment shall be surveyed based on “Act on Prevention of Marine Pollution and Maritime Disaster” by which geological storage of CO$_2$ under the seabed is regulated.

1. Survey Area
   - 12 survey points in Tomakomai Port Area

2. Methods of Survey
   - Seabed survey by Side-Scan Sonar and Sub-bottom Profiler
   - Current direction and speed survey by Current Meter
   - Sampling of seawater by Water Sampler for concentration of salt etc. and plankton observation
   - Seabed mud survey by Bottom Sampler
   - Collection of benthos by Net or Dredge Unit
   - Observation of benthos by divers or ROV

3. Surveys in Three Stages
   - During EPC period
   - During demonstration operation
     - During CO$_2$ injection
     - After CO$_2$ injection
   - After demonstration operation

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2008 Establishment of Japan CCS  
2009 3D seismic survey offshore Tomakomai  
2010 Establishment of Tomakomai CCS Promotion Association  
2012 Commencement of Tomakomai CCS Demonstration Project

**Tomakomai CCS Promotion Association**

Activities:  
1) Attraction of CCS Demonstration Project to Tomakomai  
2) Information communication to Tomakomai citizens on CCS, etc.

Chairman: Tomakomai City Mayor

Members: All major corporations in Tomakomai and industrial associations, Tomakomai Fishery Cooperative

Secretariat: Tomakomai City
Conclusion

- Full cycle CCS system from capture to storage is in operation; objective is to develop practical CCS technology by around 2020
  - Demonstrate safety and reliability of CCS system
  - Remove concerns about earthquakes

- Unique features of project
  - Efficient two-stage capture system
  - Deviated injection wells from onshore site into offshore reservoirs
  - Extensive monitoring system

- Test results indicate superior injectivity of shallow reservoir
- Extensive stakeholder engagement being undertaken
  - Maintaining close communications with Tomakomai fishery cooperative, local government
Thank you for your attention.

http://www.japanccs.com/