

A photograph of the Tomakomai CCS Demonstration Project industrial facility. The image shows a complex network of silver metal pipes, green steel structures, and several tall, vertical distillation columns. The sky is clear and blue. The text is overlaid on the image.

Tomakomai CCS Demonstration Project – Key Results and Future Outlook

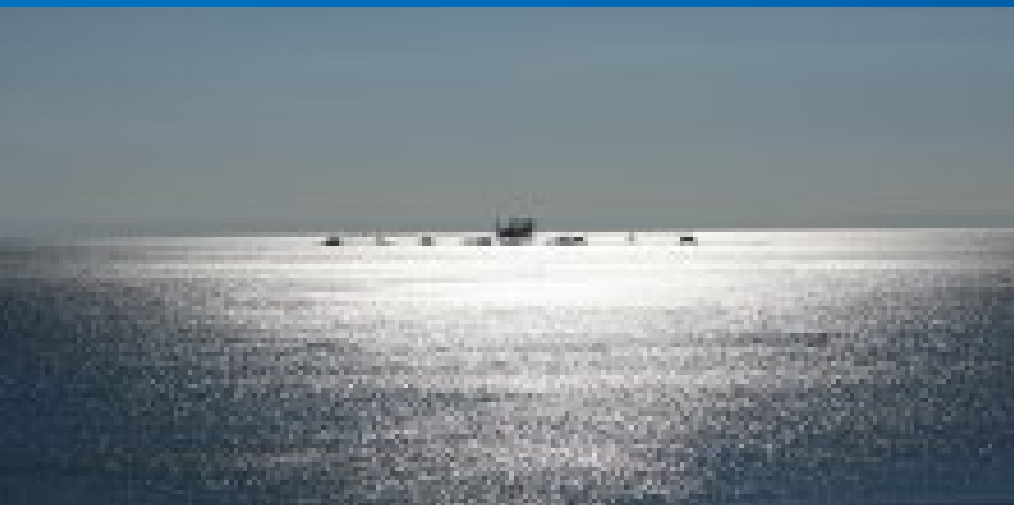
Jiro Tanaka
Japan CCS Co., Ltd.

Carbon Sequestration Leadership Forum
2022 Technical Group Mid-Year Meeting
June 27, 2022

Outline of Presentation

- Overview of Tomakomai CCS Demonstration Project
- Key Results of Tomakomai Project
- Public Engagement
- Future Outlook of Tomakomai Project
- Summary





Overview of Tomakomai CCS Demonstration Project

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Project Overview

Main objectives and tasks

- Demonstrate a full-chain CCS system from capture to storage
- Demonstrate that the CCS system is safe and reliable
- Remove concerns about earthquakes by the data collected;
 - No influence by natural earthquakes on CO₂ stored
 - No perceptible earth tremors induced by CO₂ injection
- Disclose project information and data and enhance understanding of CCS by local residents

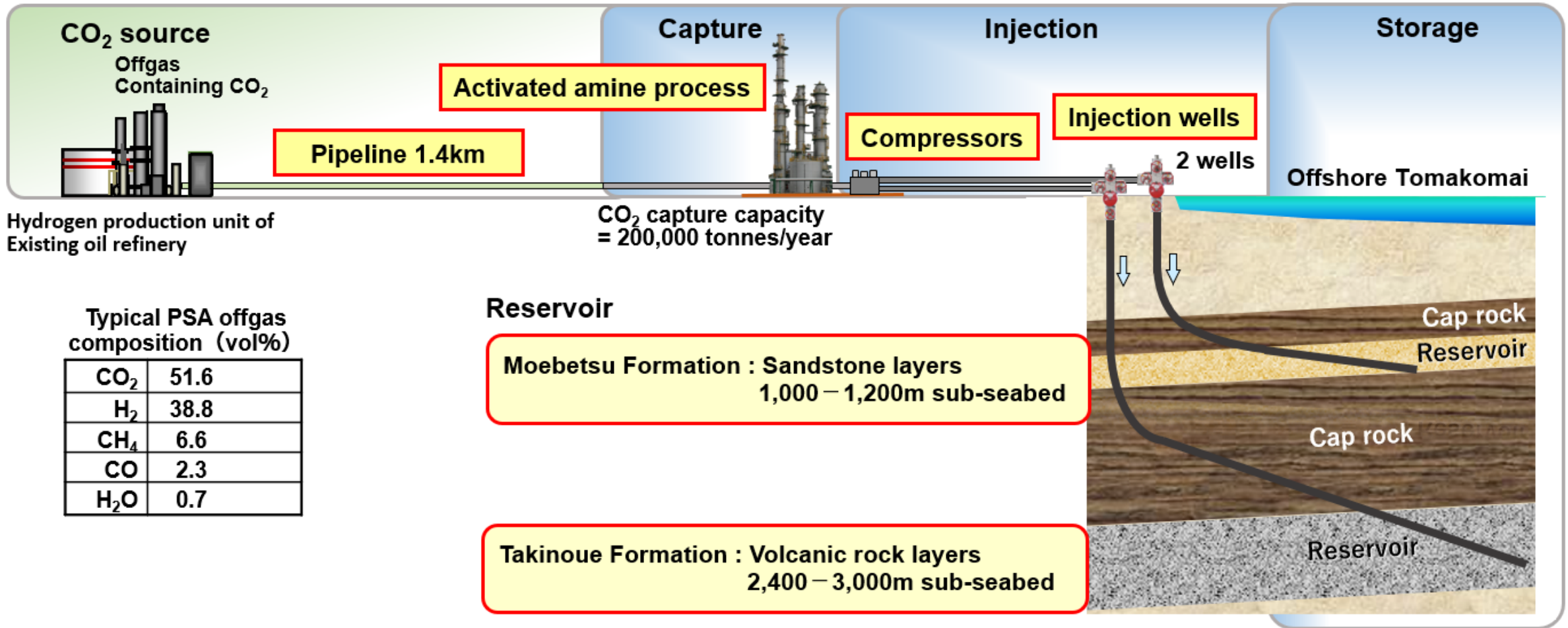


Tomakomai CCS Demonstration Center, Tomakomai City, Hokkaido



Project Scheme

- A portion of PSA (Pressure Swing Adsorption) offgas containing approximately 52% CO₂ generated by a hydrogen production unit in adjacent refinery is transported by 1.4km pipeline to Tomakomai Project capture facilities.

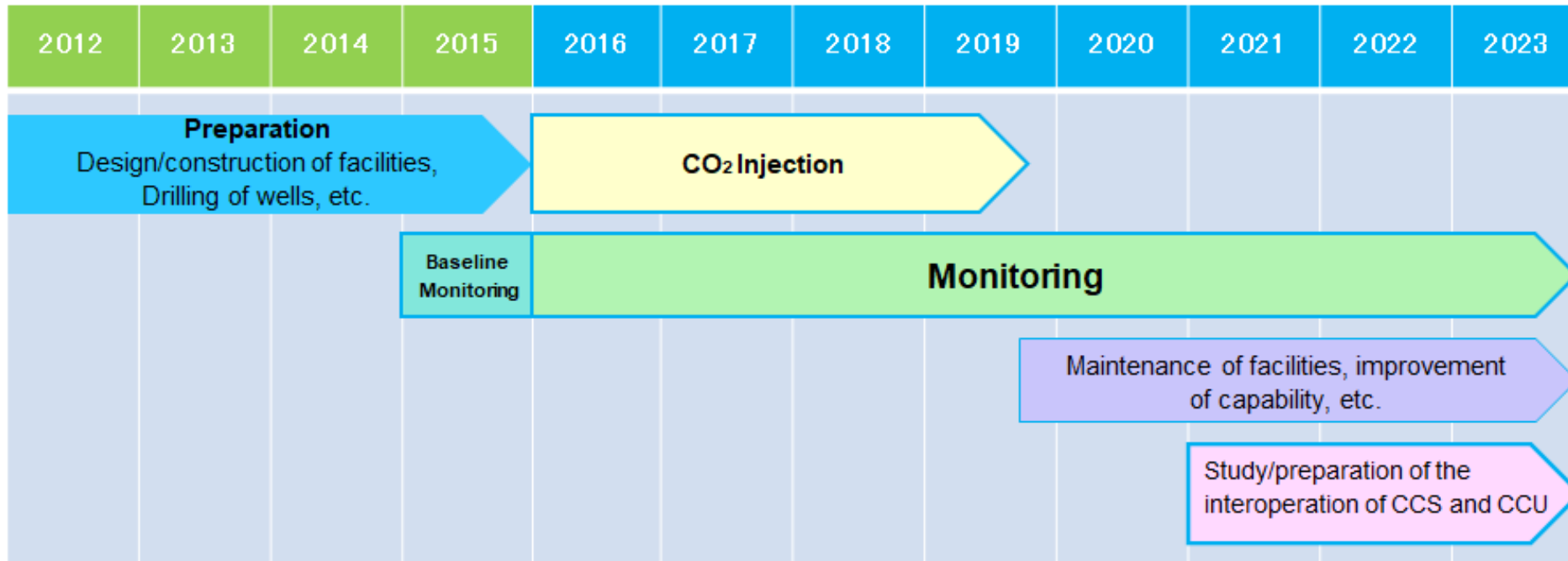


Typical PSA offgas composition (vol%)

CO ₂	51.6
H ₂	38.8
CH ₄	6.6
CO	2.3
H ₂ O	0.7

Project Schedule

- Constructed demonstration facilities **from FY2012 to 2015**
- Started injection **at scale of 100 thousand tonnes** per annum **from April 2016**
- Achieved initial target of **300 thousand tonnes cumulative injection on November 22, 2019**
- Monitoring is being continued, preparations for second stage of project are underway



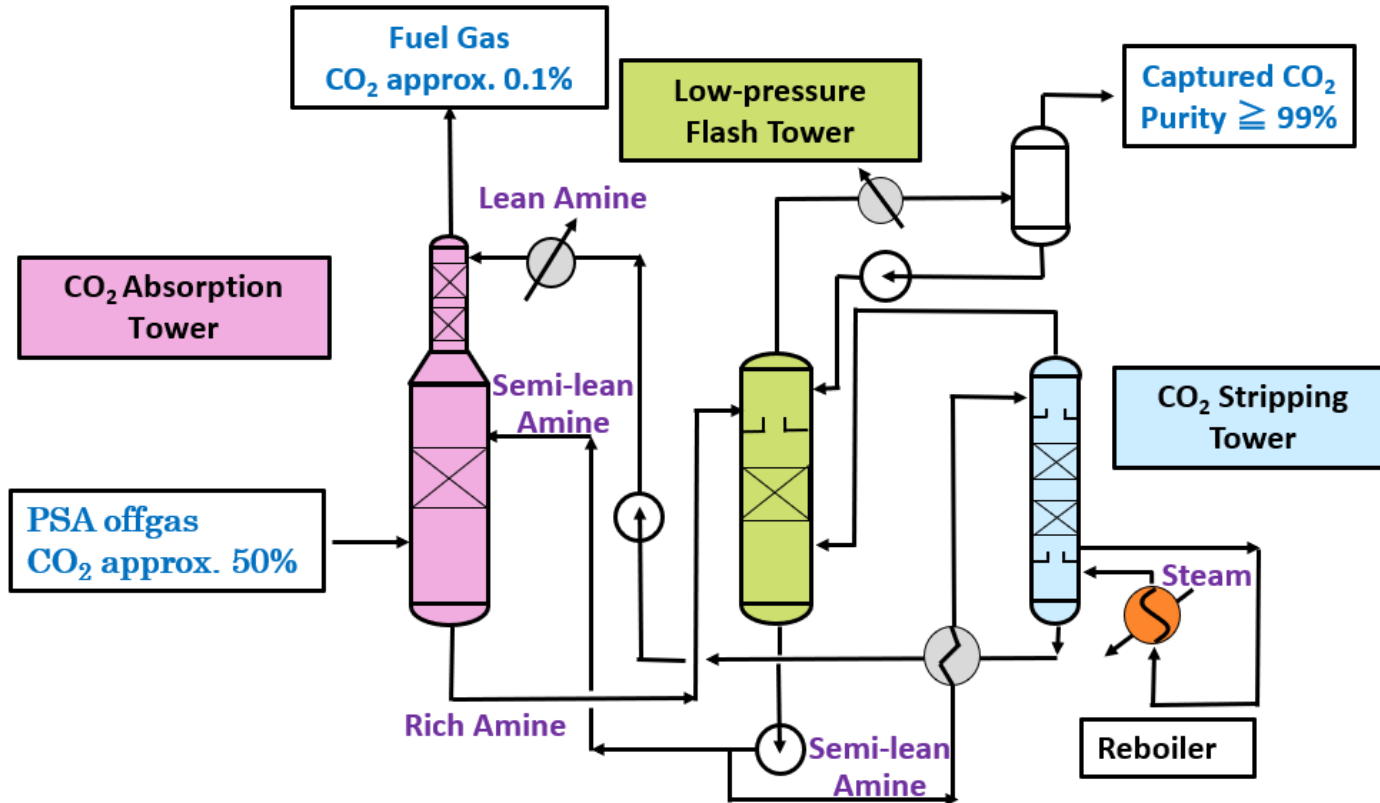
※ Years are in Japanese Fiscal Years (April of calendar year to March of following year)



Key Results of Tomakomai Project

CO₂ Capture Process

Two-stage absorption process



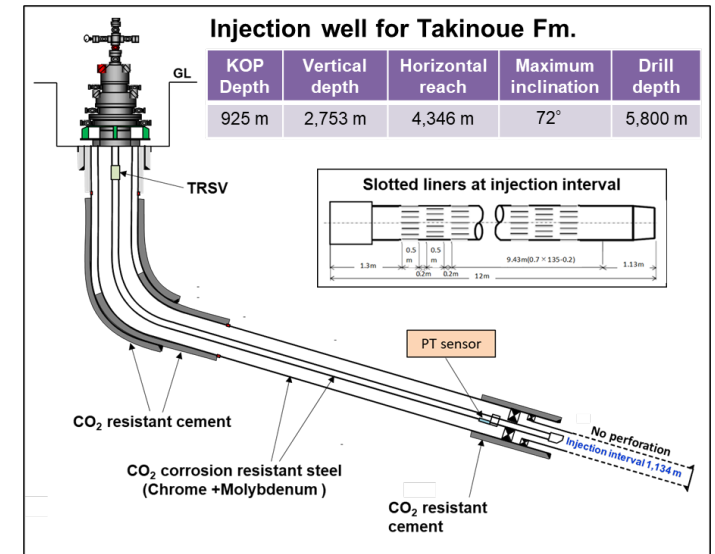
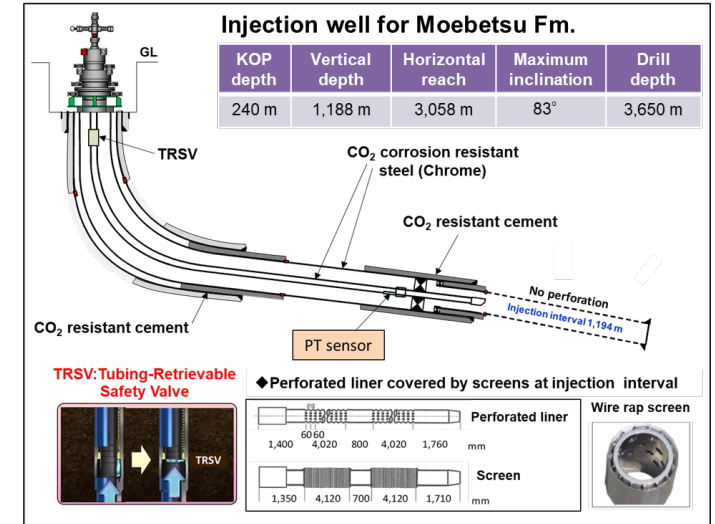
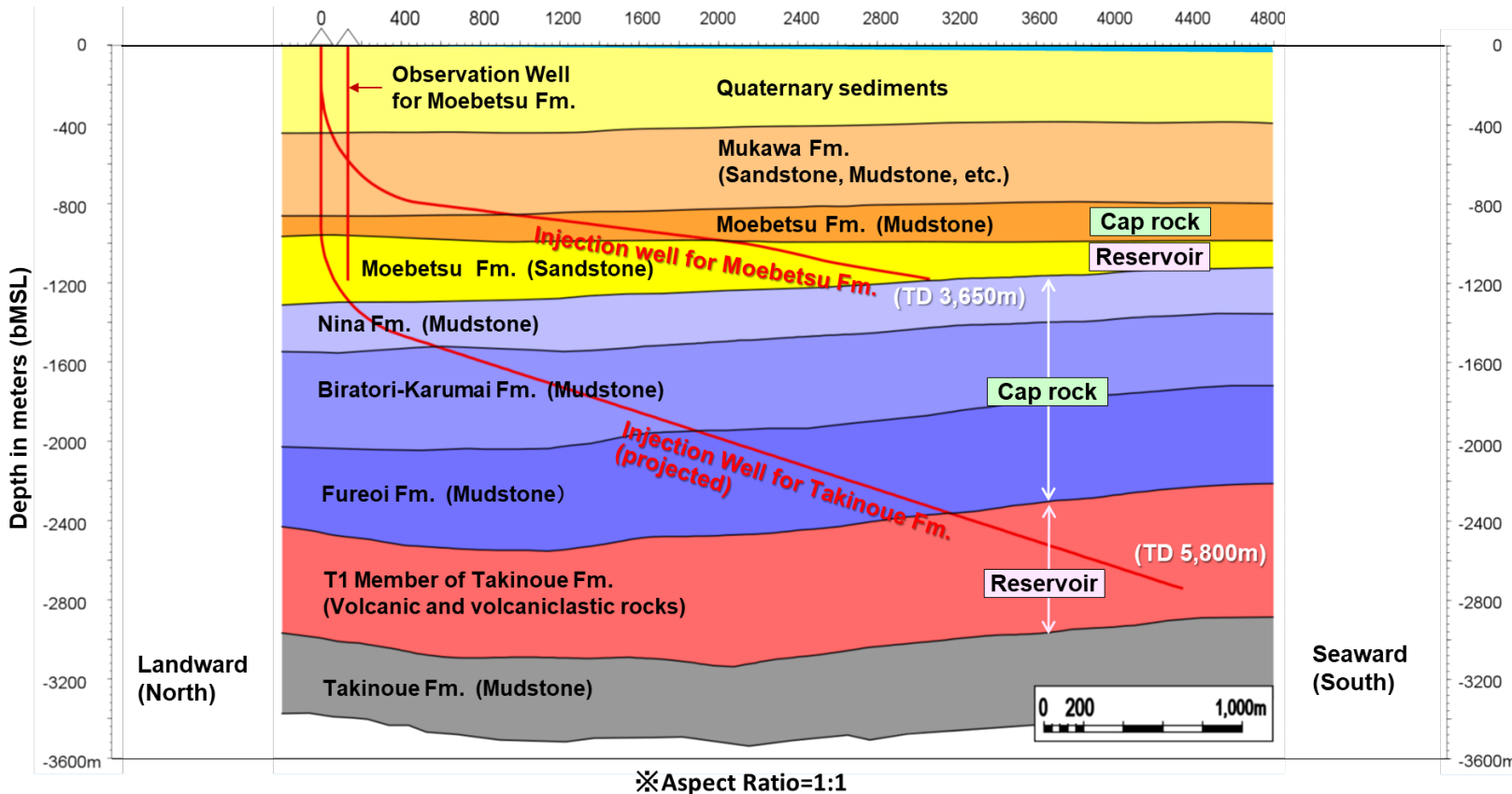
CO₂ Capture Results

	FY2016	FY2017	FY2019
CO ₂ recovery (t/h)	25.3	24.3	26.4
Reboiler duty (GJ/t-CO ₂)	0.923	0.882	0.915

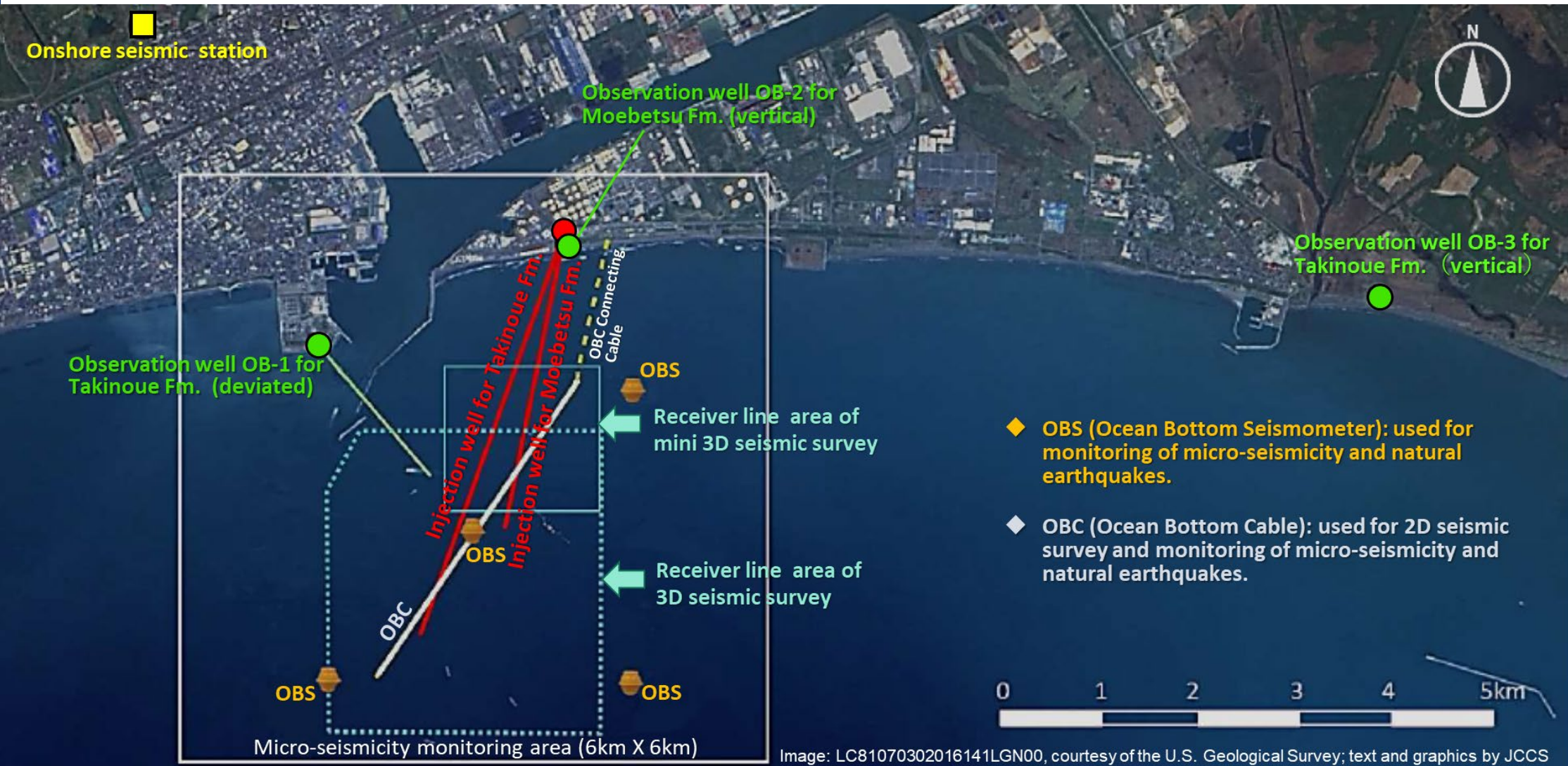
- Achieved reboiler duty of 0.882 - 0.923GJ/t-CO₂; (1/2 to 1/3 of conventional one stage absorption process)

Schematic Diagram of Geological Layers and Injection Wells

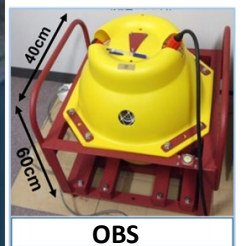
- ◆ The captured CO₂ is compressed and stored 3-4km offshore in two sub-seabed reservoirs at different depths – Moebetsu and Takinoue formations by two independent injection wells
- ◆ Deviated CO₂ injection wells drilled from onshore to offshore sub-seabed
 - Cost reduction of drilling, operation and maintenance
 - No disturbance on marine environment and harbor operation



Location of Monitoring Facilities

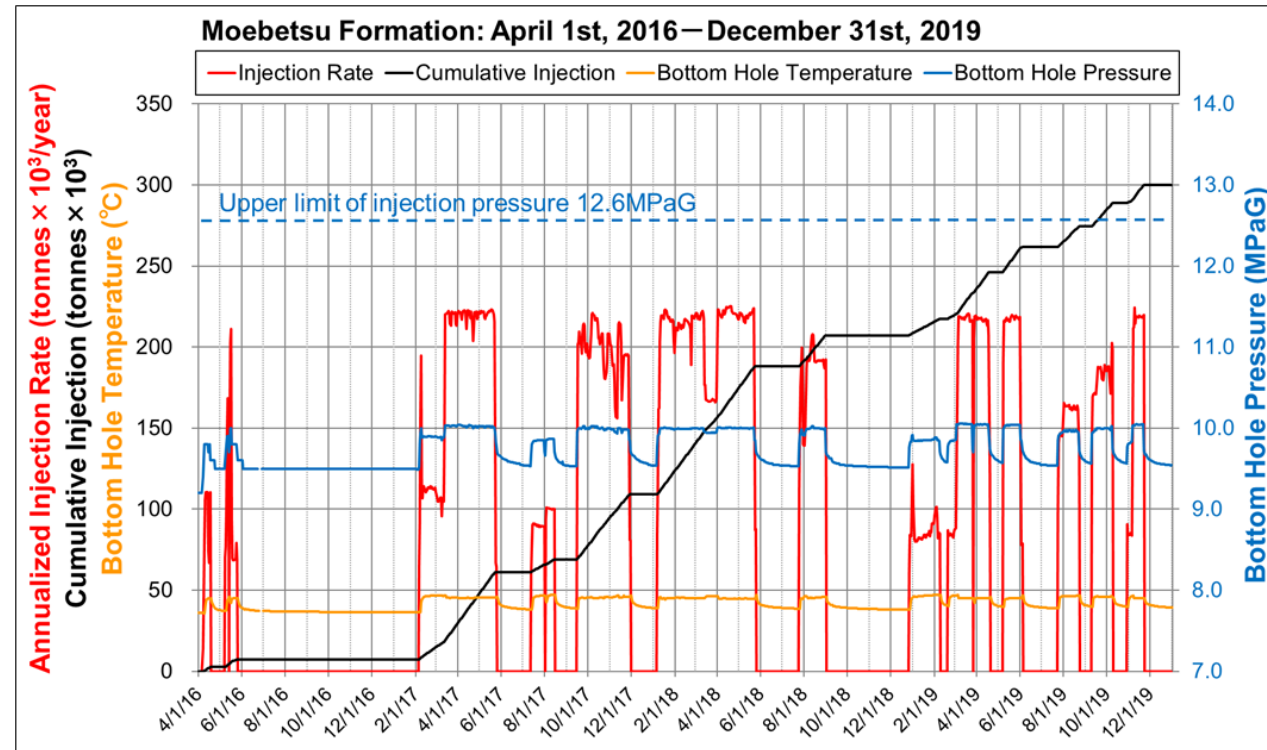


- ◆ **OBS (Ocean Bottom Seismometer):** used for monitoring of micro-seismicity and natural earthquakes.
- ◆ **OBC (Ocean Bottom Cable):** used for 2D seismic survey and monitoring of micro-seismicity and natural earthquakes.

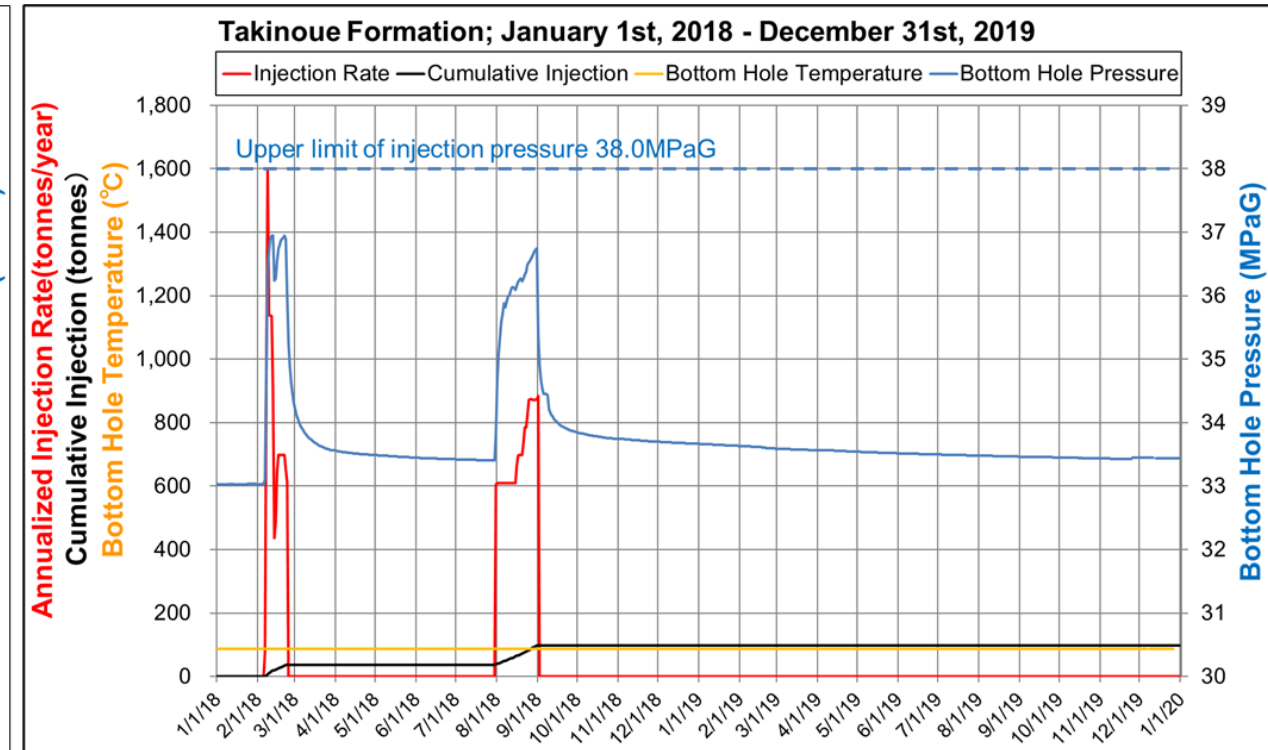


Results of CO₂ injection

- ◆ Achieved 300,110 tonnes cumulative CO₂ injection into 2 reservoirs at different depths (Moebetsu Formation – 300,012 tonnes, Takinoue Formation – 98 tonnes)
- ◆ At the injection well for the Moebetsu formation, the maximum bottomhole pressures recorded by PT sensor set close to reservoir during injection were much lower than the upper limit set to avoid destruction of the overlying cap rock.



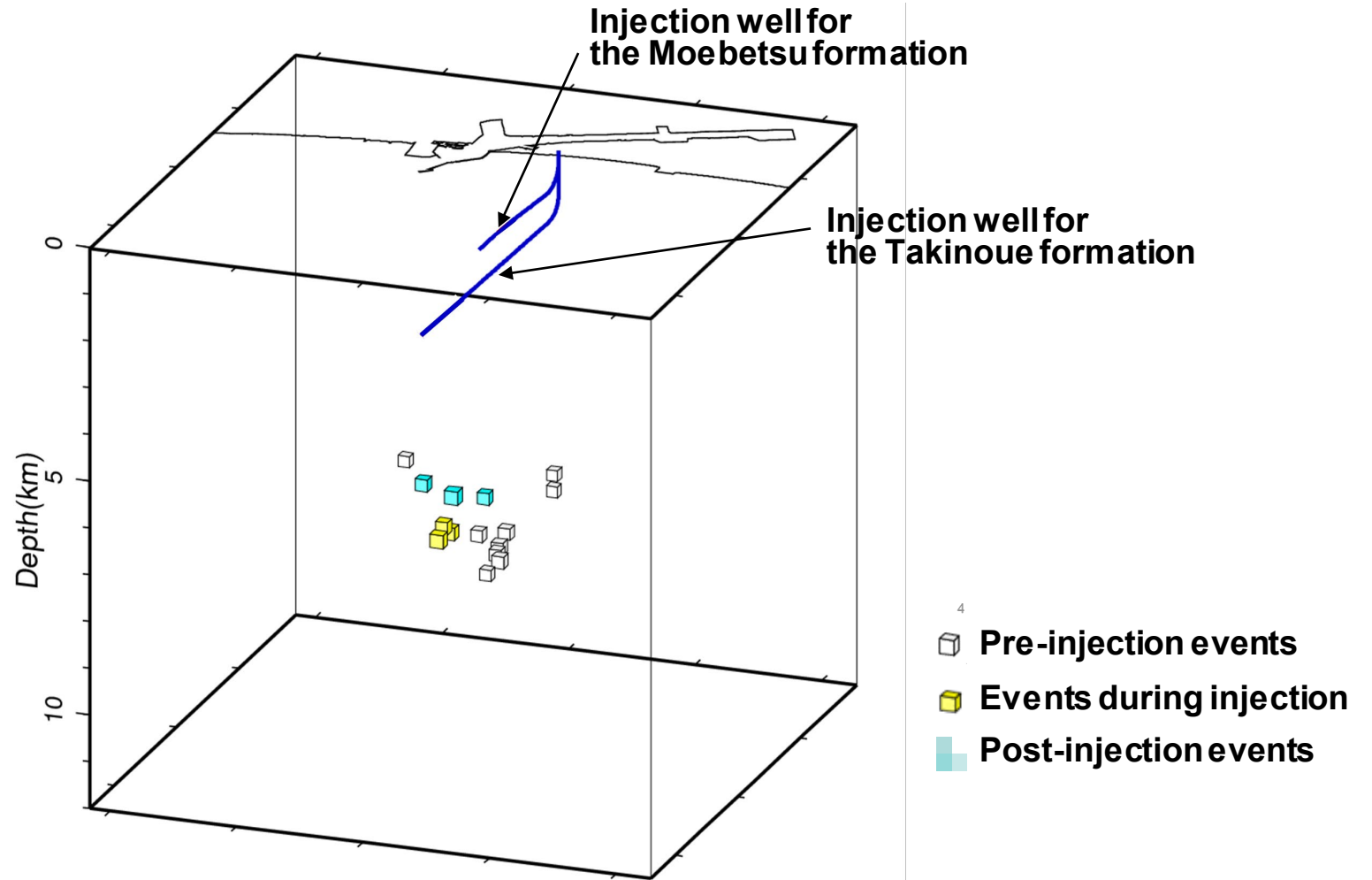
Injection record of Moebetsu Formation



Injection record of Takinoue Formation

Results of Micro-seismicity Monitoring

No micro-seismicity or natural earthquakes attributable to CO₂ injection were detected in vicinity of injection area



3D seismic survey results: comparison of 2nd to 5th time-lapse 3D seismic surveys

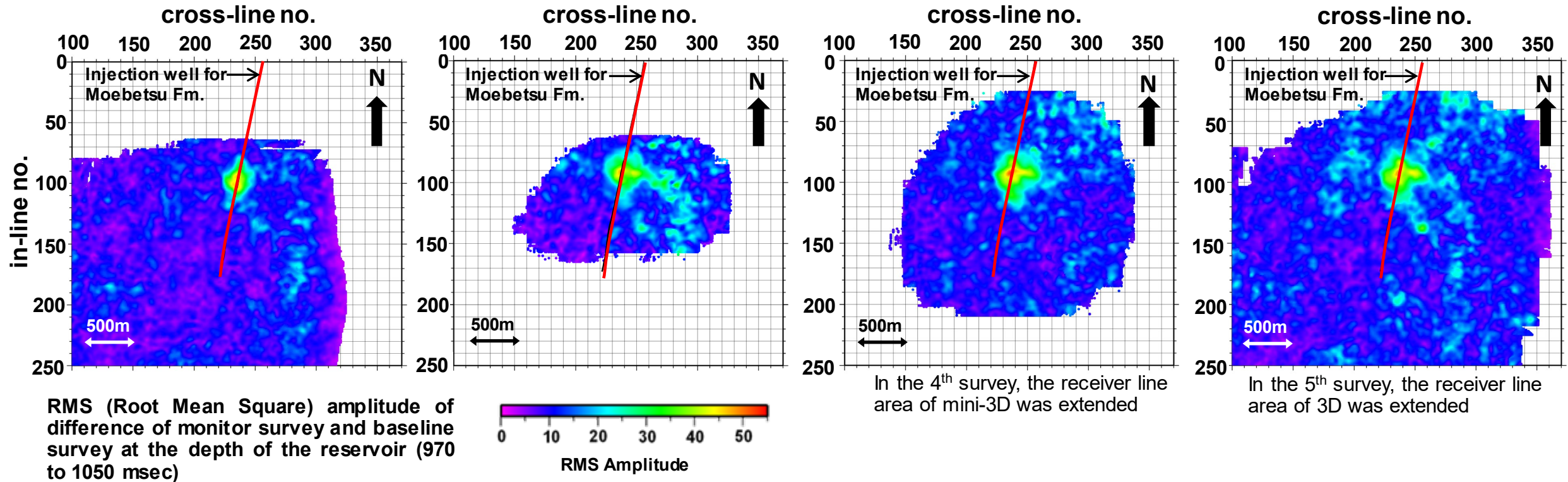
- ◆ The 2nd, 3rd, 4th and 5th monitor seismic surveys at cumulative CO₂ injection of approx. 65,000, 207,000 and 300,000 tonnes into the Moebetsu Formation detected anomalies, indicating evolution of the CO₂ plume

2nd monitor survey : 3D
JFY 2017 (61,239–69,070 tonnes)
During CO₂ injection

3rd monitor survey : mini-3D
JFY 2018 (207,209 tonnes)
During CO₂ injection

4th monitor survey : mini-3D
JFY 2019 (300,012 tonnes)
58–79 days after termination
of CO₂ injection

5th monitor survey : 3D
JFY 2019 (300,012 tonnes)
233–257 days after termination
of CO₂ injection



Marine environmental surveys

◆ Marine environmental surveys, seismic surveys and other monitoring were conducted under the five-year injection permit (FY2016–2020) from Ministry of the Environment (MOE) on the condition of implementation of the “monitoring plan” approved by MOE.

Monitoring Plan

Marine environmental survey

- Seasonal survey at 12 survey points
- Chemical measurements of seawater
- Chemical measurements of sea bottom sediments
- Plankton observation
- Benthos observation

Location and extent of CO₂

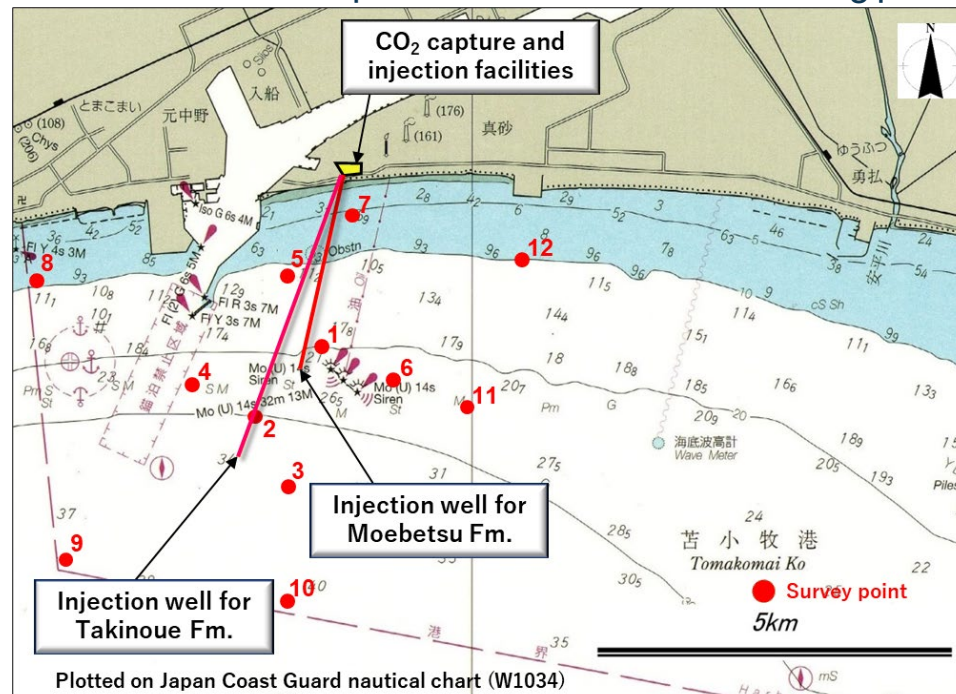
- Seismic survey (once a year)

Conditions of the formations

- Pressure and temperature at the injection wells and the observation wells (continuous observation)

Conditions of CO₂

- Measurement of CO₂ injection rate and injection temperature and pressure (continuous observation)
- CO₂ concentration analysis (gas chromatography analysis: once a year)



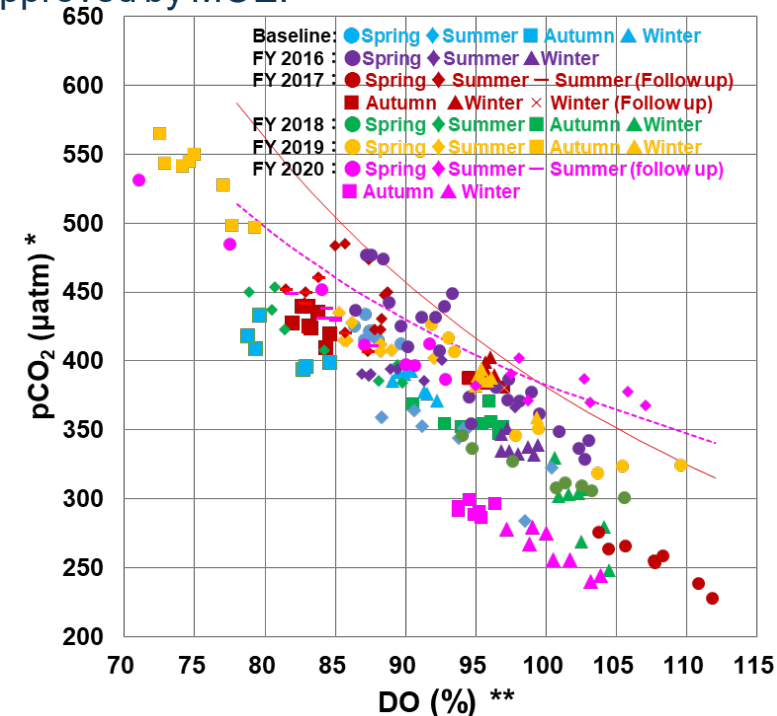
Water sampler



Bottom sampler



ROV



pCO₂/DO threshold in the monitoring plan (revised on Aug. 31st, 2018)

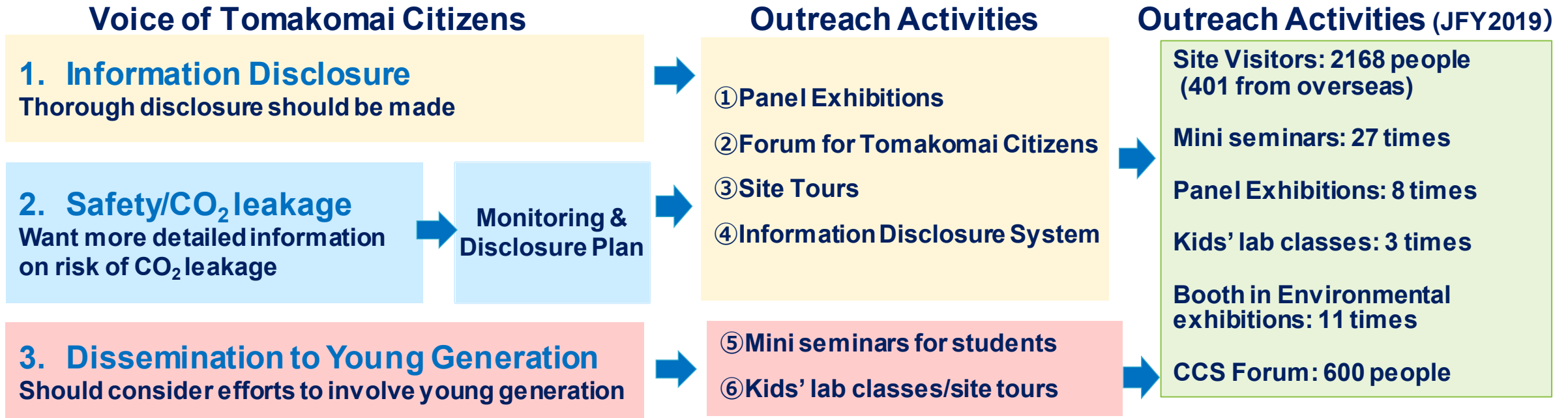


Public Engagement

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Public Outreach Activities



Outreach Activities:



Panel Exhibition in Tomakomai



Kids' lab class



Site Tours



Information disclosure system in Tomakomai City Hall

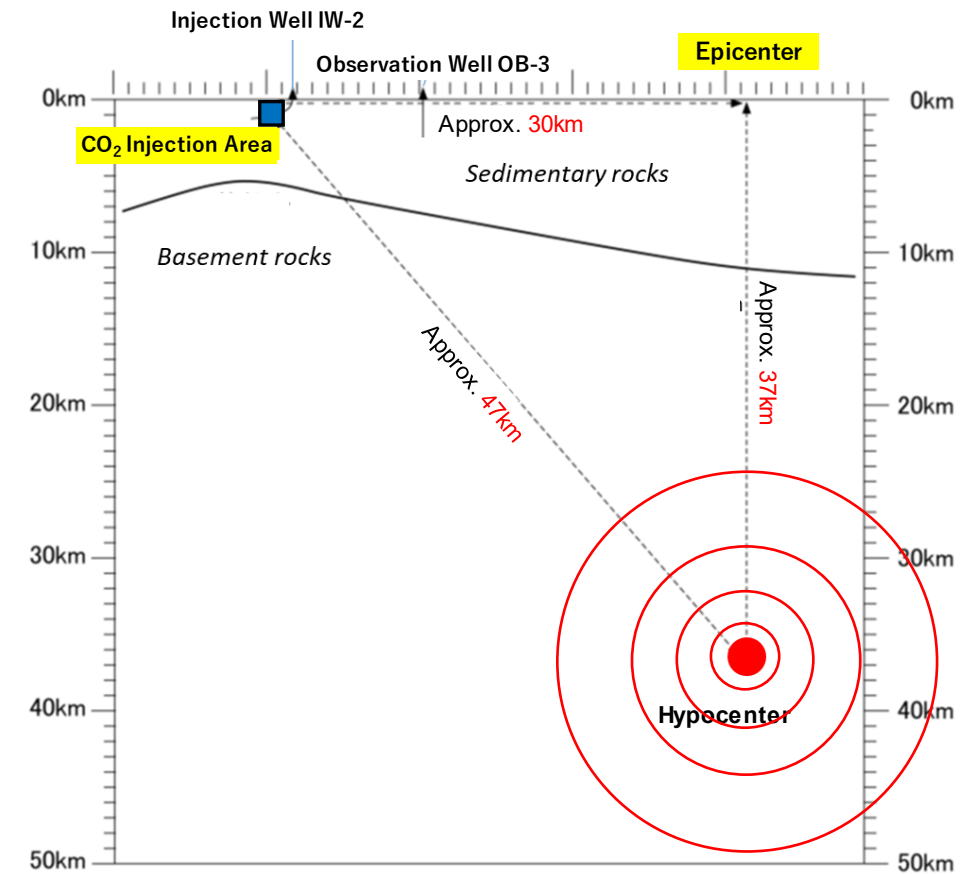
Project being conducted with understanding and support of local community

2018 Hokkaido Eastern Iburi Earthquake

- At 3:07am Sept. 6, 2018, a moment magnitude 6.6 earthquake at 37km depth occurred in central eastern part of Iburi region of Hokkaido. Tomakomai CCS demonstration site recorded seismic intensity of lower 5.



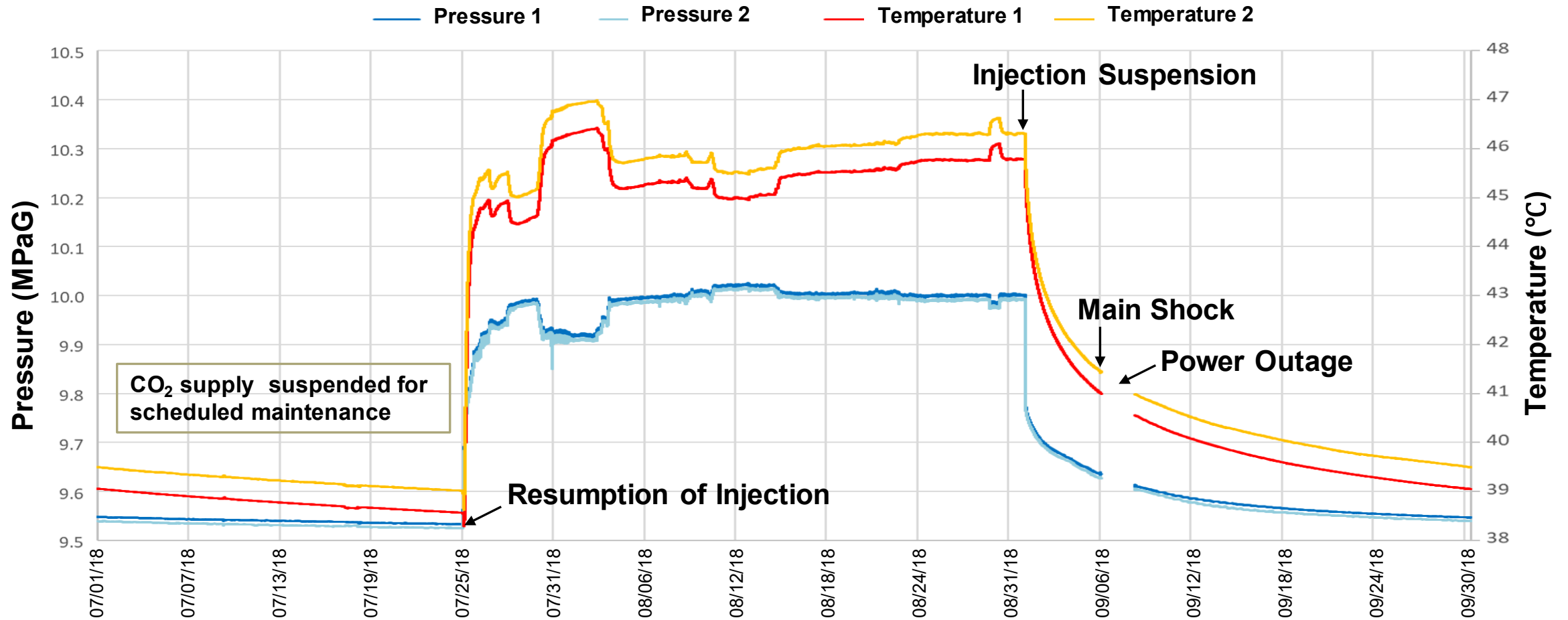
Plan view



Cross section view

2018 Hokkaido Eastern Iburi Earthquake

- Bottom hole pressures, temperatures of Moebetsu Formation injection well before/after earthquake



Measures taken by JCCS after the Hokkaido Eastern Iburi Earthquake

- 6th Sept. 2018: Moment Magnitude 6.6 earthquake occurred
- 12th Sept 2018: Posted JCCS's views on JCCS on HP
- 19th Oct. 2018: Convened an expert review meeting
- 21st Nov. 2018: Posted summary of review meeting on HP

Key points on JCCS HP:

1. No relationship between CO₂ injection and earthquake
2. No CO₂ leakage

※ Report on Expert Review Meeting:
(https://www.japanccs.com/wp/wp-content/uploads/2019/09/Research-Report-on-Impacts-of-Hokkaido-Eastern-Iburi-Earthquake-on-CO2-Reservoir_2nd-edition.pdf)

Key principles to minimize concerns of local community and general public:

- *Respond quickly*
- *Include technical explanation*

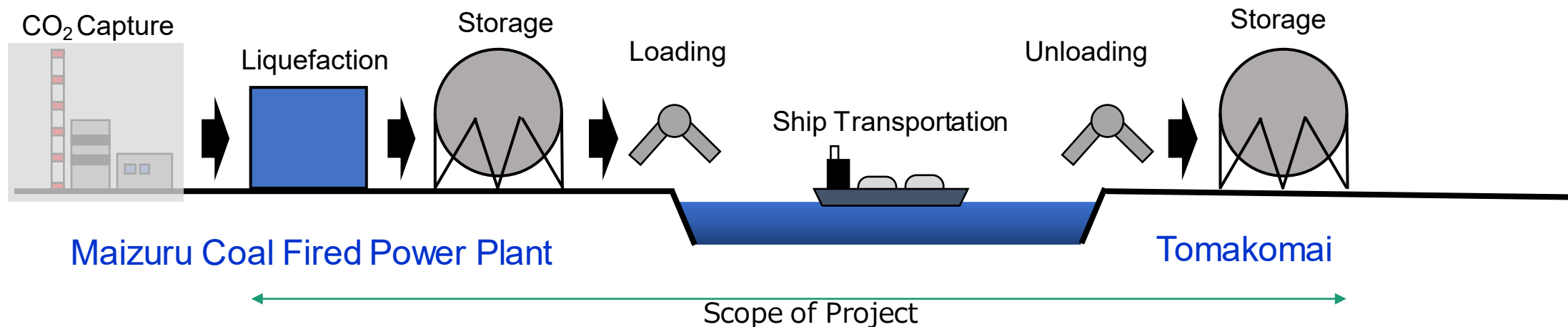


Future Outlook of Tomakomai Project

Overview of CO₂ Ship Transportation Project

Objectives and schedule of project

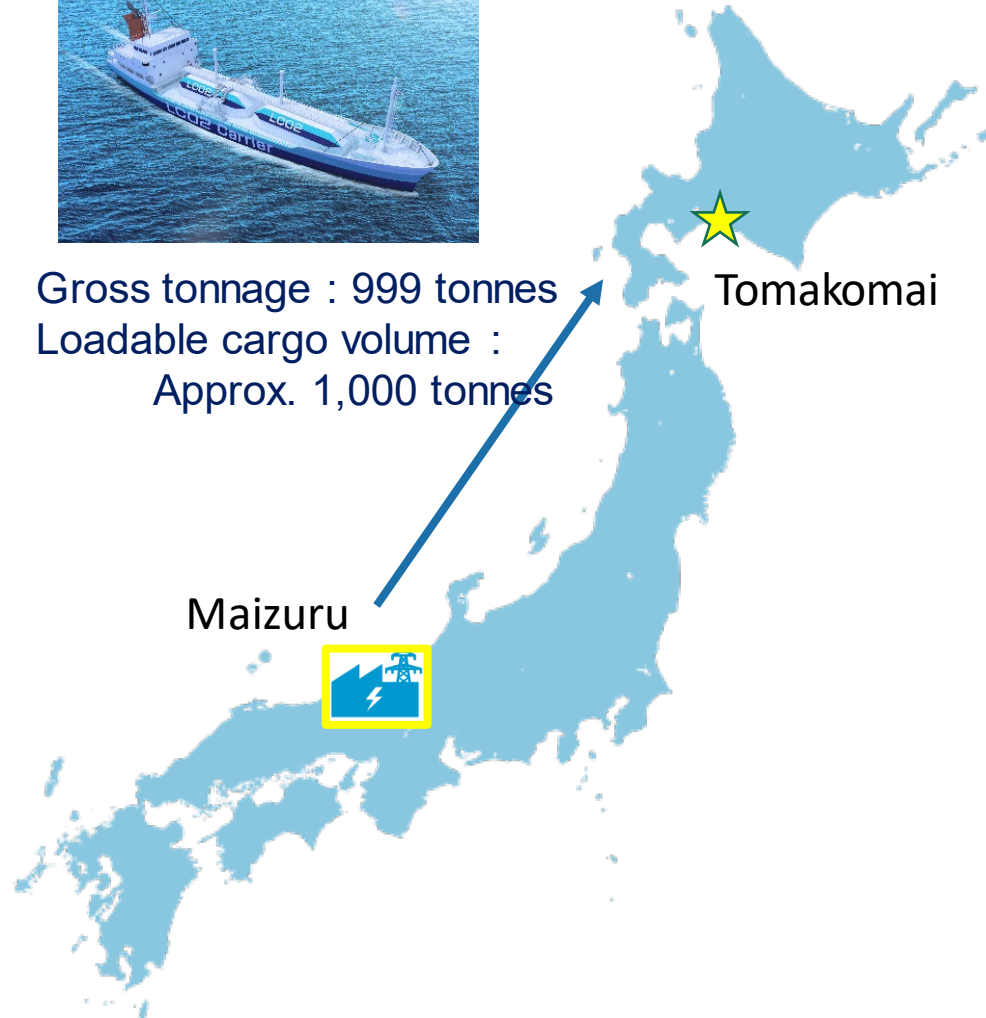
1. R&D of long-distance and large-scale transportation (~1M tonnes/year) and design of equipment
Schedule: FY2021 to FY2026 (FY : April to March)
2. Liquefied CO₂ ship transportation demonstration (~10,000 tonnes/year)
Schedule : Engineering, Procurement and Construction / FY2021 to FY2023
Ship transportation demonstration / FY2023 to FY2026
3. Study of ship transportation business models
Schedule : FY2021 to FY2026



Demonstration of CO₂ Ship Transportation



Gross tonnage : 999 tonnes
Loadable cargo volume :
Approx. 1,000 tonnes



Key Points

- World first CO₂ ship transportation for CCUS
- Identifying issues for social implementation in anticipation of future era of large-scale liquefied CO₂ shipping

Press Conference by Former Minister of Economy, Trade and Industry Hiroshige Seko



Utilize the Tomakomai CCS facility effectively and promote the development of “**Carbon Recycling**”.

Carbon recycling: Considering CO₂ as source for Carbon, capture CO₂ then utilize and recycle it as Carbon compounds.

August 21, 2019 at Tomakomai CCS Center



Summary

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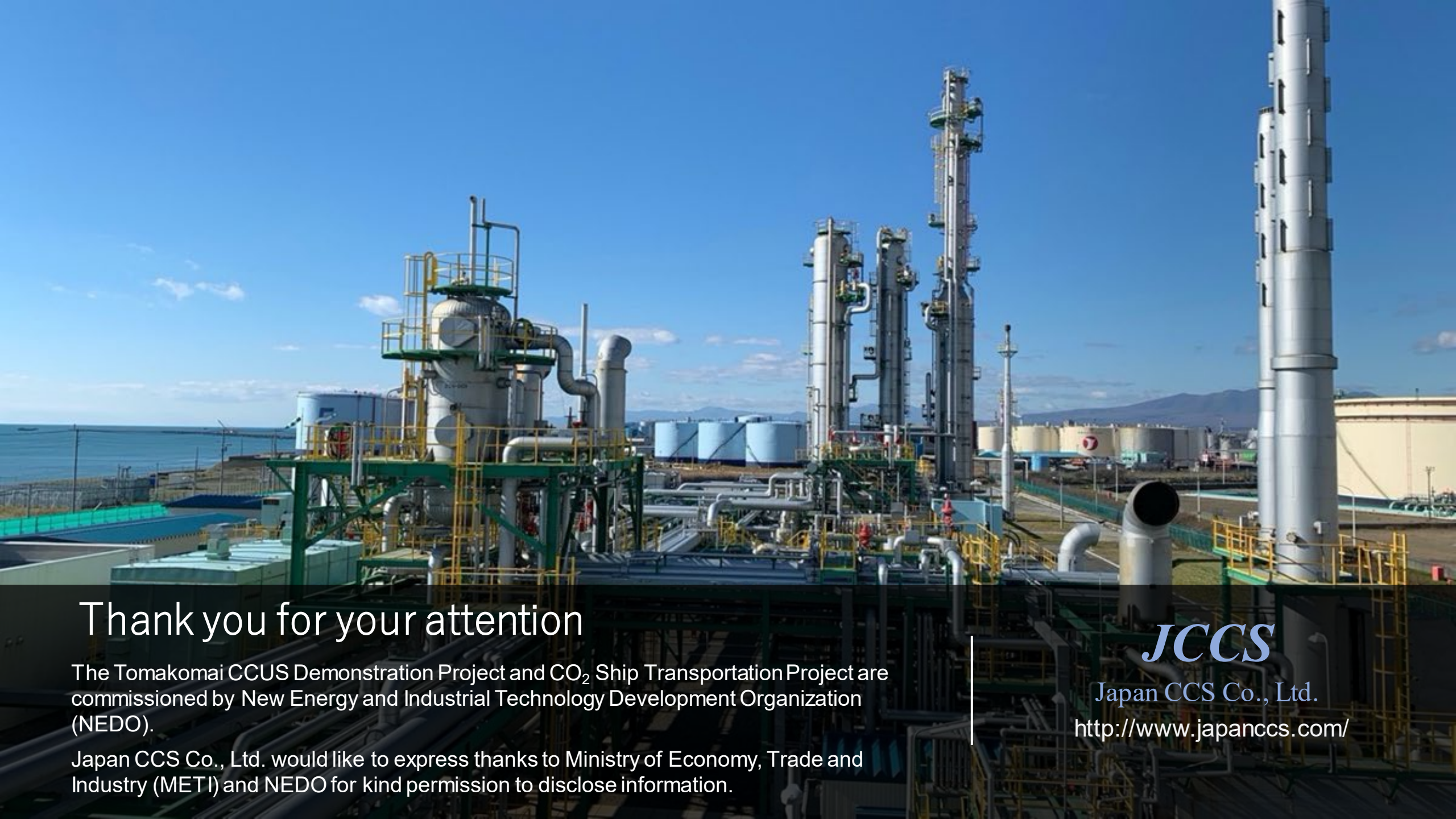
Summary

Key Results

- Operation of **full chain CCS system from capture to storage conducted successfully, target of 300,000 tonnes of CO₂ injection achieved**. Monitoring operations being continued.
- CO₂ capture process comprising two-stage absorption system with low pressure flash tower achieved **significantly lower capture energy than conventional system**
- Deviated injection wells from onshore site into offshore reservoirs saved drilling cost, avoided disturbance of marine environment and harbor operation
- Safety and reliability of CCS system demonstrated
- Concerns about **earthquakes and induced seismicity** addressed
 - Natural earthquakes have not caused damage to reservoirs; no data suggesting connection between CO₂ storage and earthquakes
 - Important to respond as quickly as possible, and to include technical data to minimize concerns.
- Project being conducted with **understanding and support of local community**
 - Importance of information disclosure and diligent efforts to secure understanding of local stakeholders

Looking Ahead

- Studies of **CO₂ ship transportation and carbon recycling** are in progress

A wide-angle photograph of an industrial facility, likely a CO2 capture plant, under a clear blue sky. The foreground and middle ground are filled with complex piping, metal walkways with yellow railings, and several tall, silver-colored distillation columns. In the background, there are several large, light blue cylindrical storage tanks. The facility is situated near a body of water, with a distant shoreline and mountains visible under a bright blue sky with a few wispy clouds.

Thank you for your attention

The Tomakomai CCUS Demonstration Project and CO₂ Ship Transportation Project are commissioned by New Energy and Industrial Technology Development Organization (NEDO).

Japan CCS Co., Ltd. would like to express thanks to Ministry of Economy, Trade and Industry (METI) and NEDO for kind permission to disclose information.

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