World CCS Trend and Tomakomai CCS Project

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JCCS

Outline of Presentation

1. Japan's Strategy for CCS

2. Past, Present, and Future of CCS in Japan

3. World CCS Trend and Tomakomai CCS Project

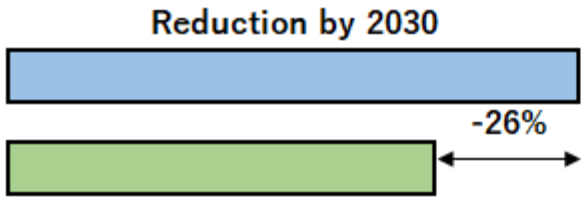
- World CCS Trend
- Overview of the Tomakomai Project
- Demonstration Facilities
- Injection Report
- Public Outreach Activities

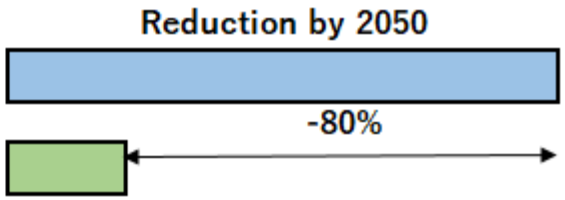
1. Japan's Strategy for CCS

Japan's Strategy for CCS (1/2)

Japan's Intended Nationally Determined Contribution (INDC) submitted to UNFCCC in 2015

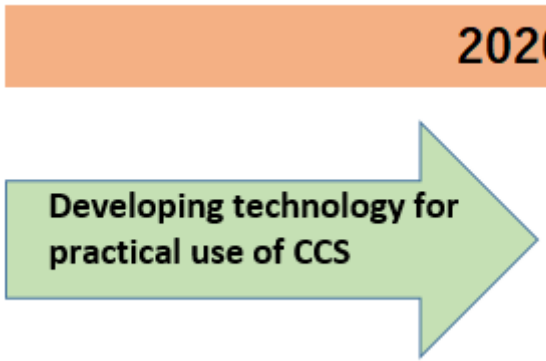
- Reduction of 26.0% of GHG emissions by fiscal year (FY) 2030 compared to FY 2013
- Japan will contribute proactively to long-term reductions of GHG emissions of developed countries in aggregate by 80% or more by 2050.





Japan's Strategic Energy Plan, 2014

- R&D will be conducted with a view to practical use of the CCS technology around 2020.
- A study will be conducted on introducing CCS-ready facilities as early as possible with due consideration given to the possible timing of the commercialization of CCS.



Japan's Strategy for CCS (2/2)

Japan's National Energy and Environmental Strategy for Technological Innovation towards 2050
Council for Science, Technology and Innovation, Cabinet Office, 2016

- Japan has identified 5 innovative technologies with potential to make huge impacts on emission reductions.
- 1 Energy Systems Integration, 2 Energy Saving, 3 Energy Storage, 4 Energy generation
  5 Capture and Effective Usage of Carbon Dioxide

Theme 1 Innovative CO_2 Capture Technology

- R&D target : To develop high efficiency chemical absorption, physical absorption, solid absorption, and membrane separation technologies
- Technical target : To reduce CO_2 capture energy by half (3.0GJ/t-CO_2 ⇒ 1.5GJ/t-CO_2) (See Fig.1)

Theme2 Effective CO_2 Utilization Technologies

- R&D target : Ex. To develop artificial photosynthesis technologies (See Fig.2)

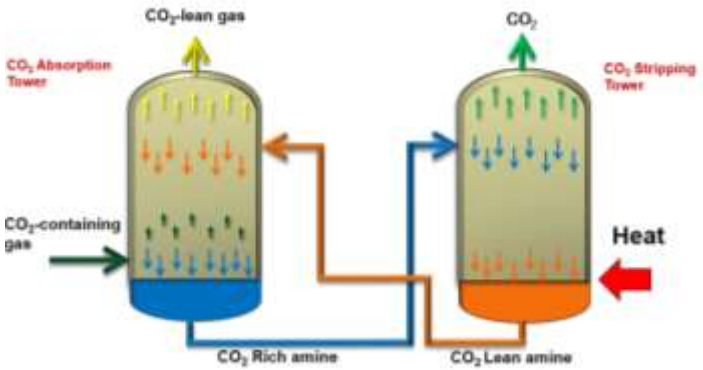
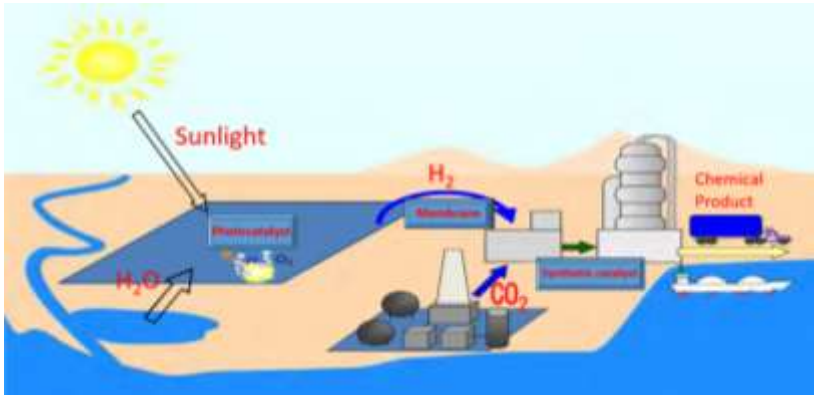


Fig.1 Conventional CO_2 Capture Technologies



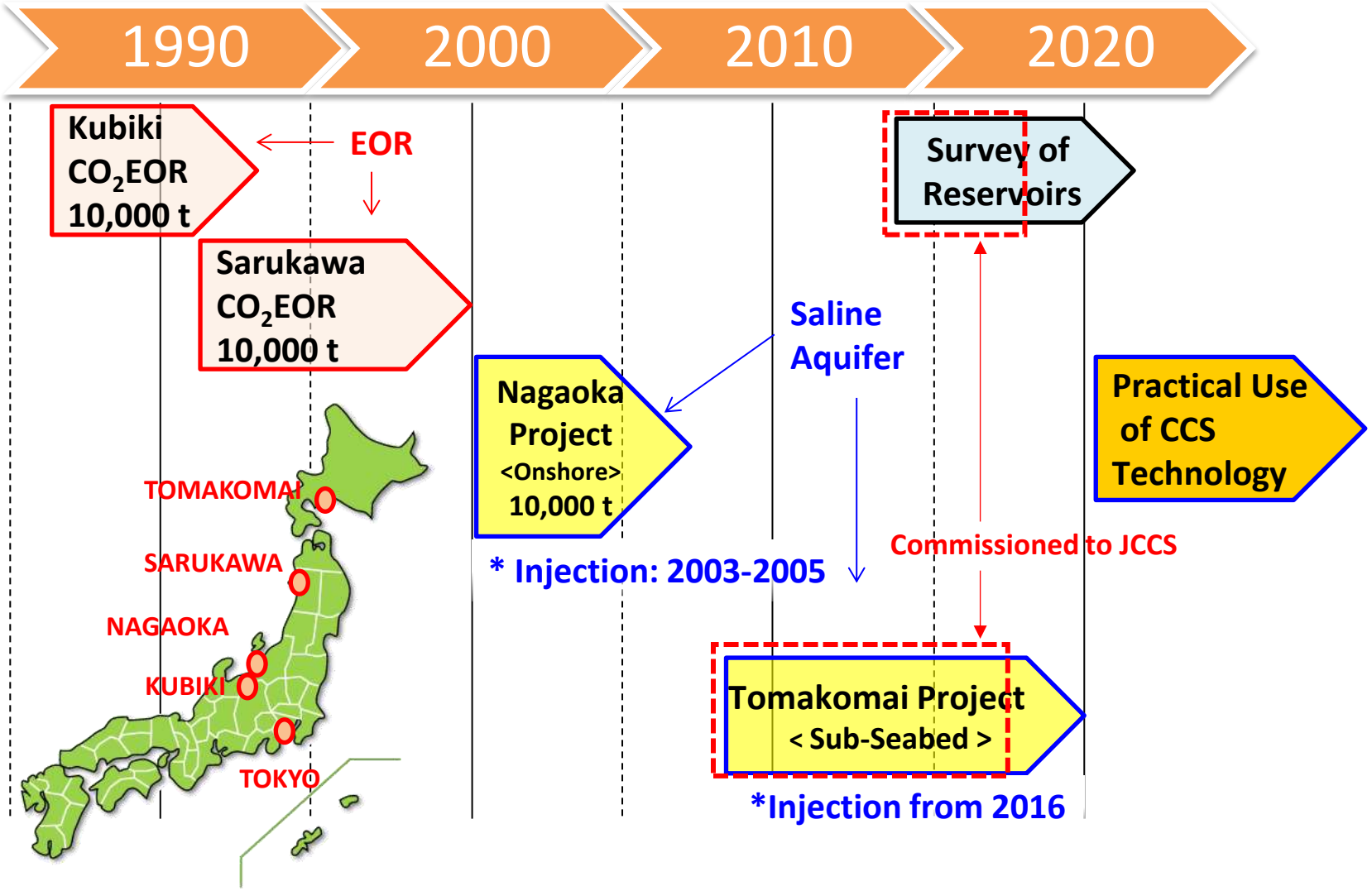
Source: Ministry of Economy, Trade and Industry (Japan)

Fig.2 Business Model Image

2. Past, Present, and Future of CCS in Japan

CO_2 Injection Projects in Japan

➢ Japan has promoted several CO_2 injection Projects.



CCS Site Survey Project

- It is necessary to identify CO2 storage sites for CCS deployment in Japan.
- Target : Specifying at least 3 sites by 2021 through seismic & drilling exploration.

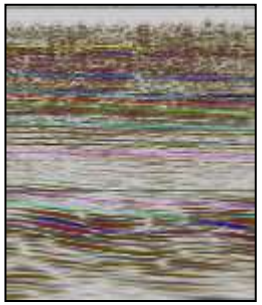
Commissioned to JCCS

Year	2014	2015	2016	2017	2018	2019	2020 ～

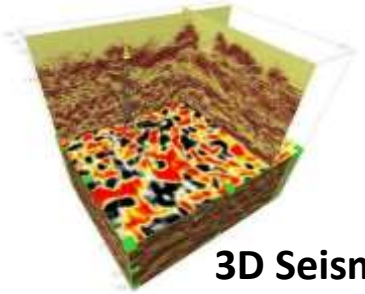
Investigation on Potential CO_2 Storage Site and Capabilities

2D Seismic Survey & Data Analysis

2D Seismic Data

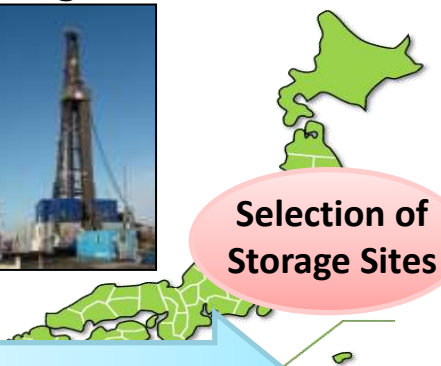


3D Seismic Survey & Data Analysis



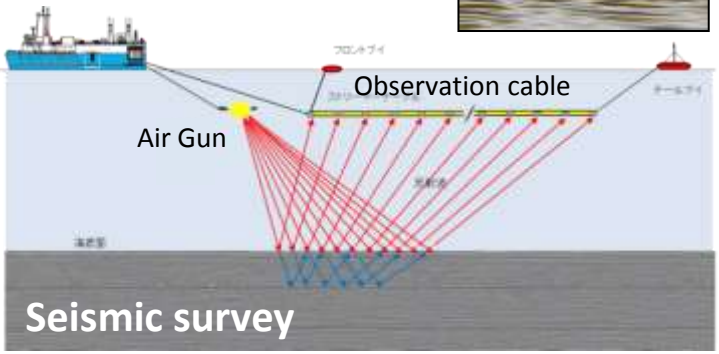
3D Seismic Data

Drilling wells



Selection of Storage Sites

Drilling Exploratory Wells, & Evaluation



Source: Ministry of Economy, Trade and Industry (Japan)

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3. World CCS Trend and Tomakomai CCS Project

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- Overview of the Tomakomai Project
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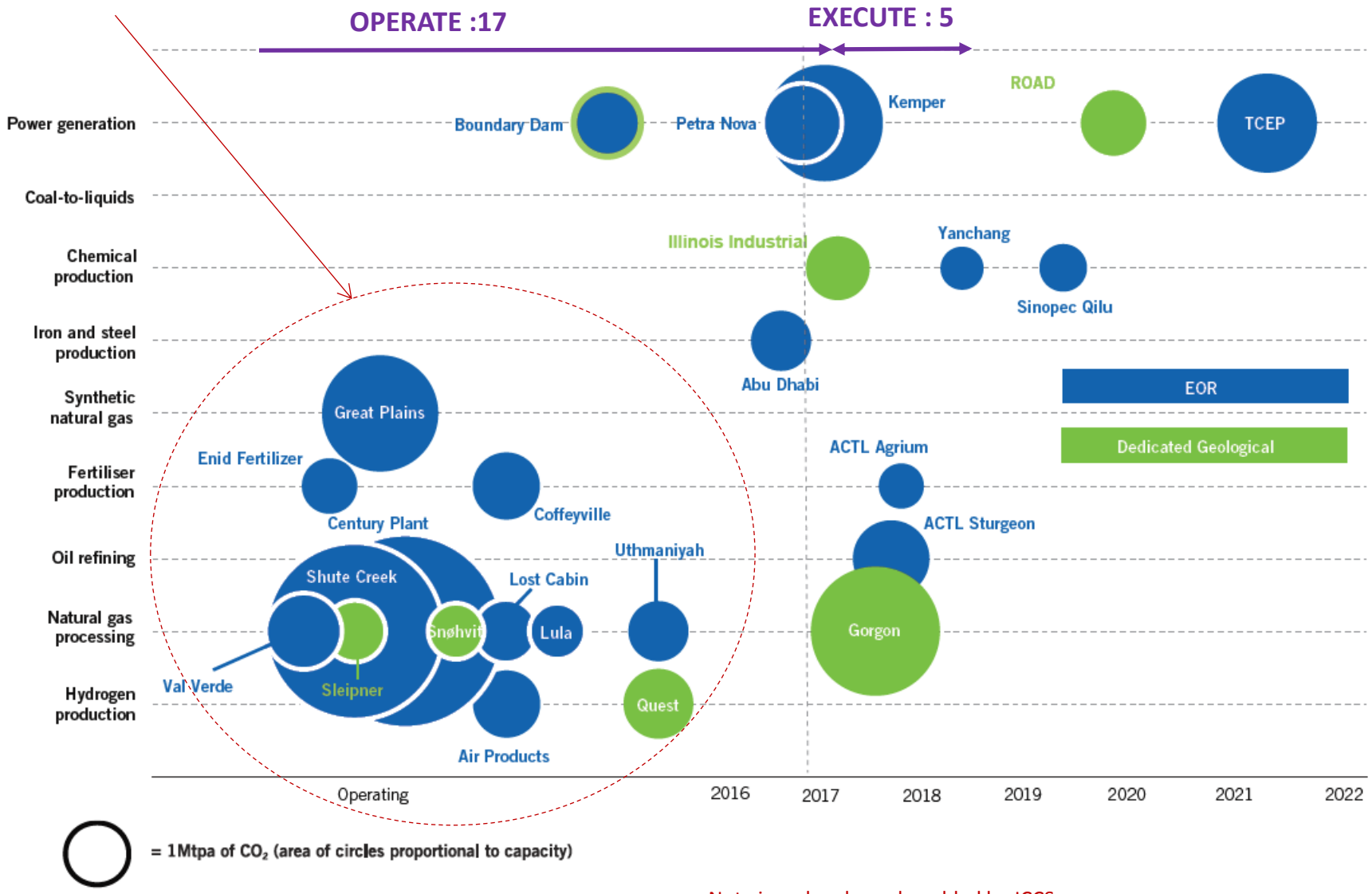
World CCS Trend

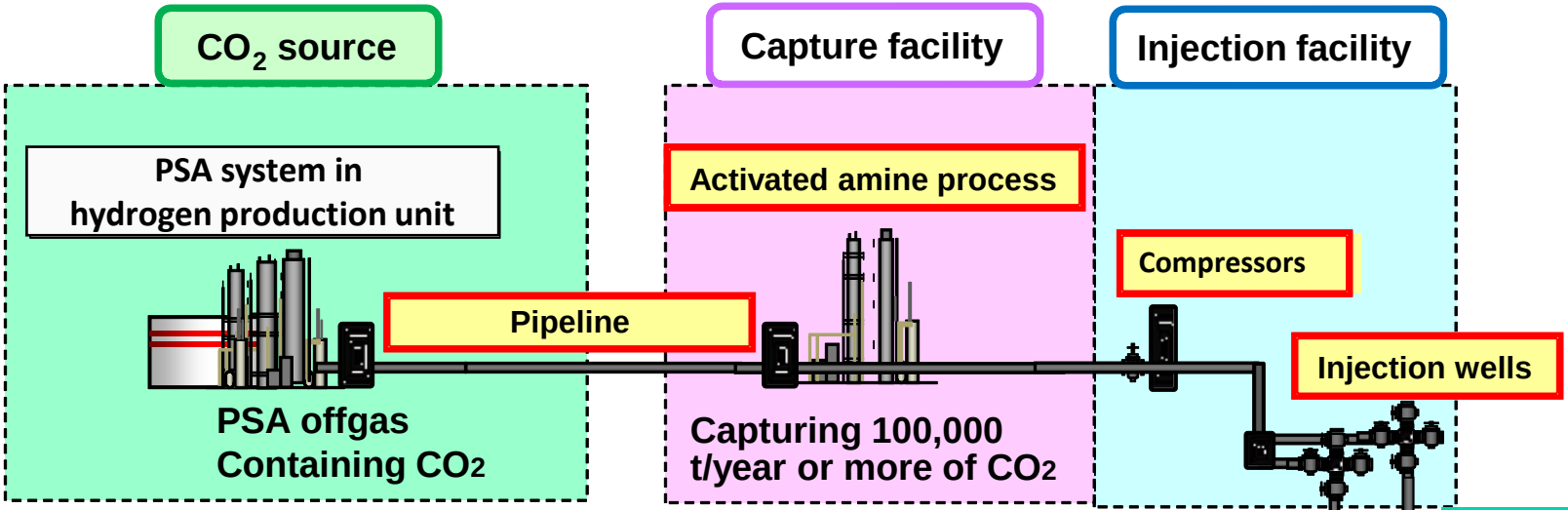
Tomakomai Demonstration Project falls into "high pressure CO_2-containing gas with high CO_2 partial pressure" category.



Source: GCCSI, Global Status of CCS 2016

Note in red and purple: added by JCCS

Flow Scheme of CCS Demonstration Project



Existing oil refinery

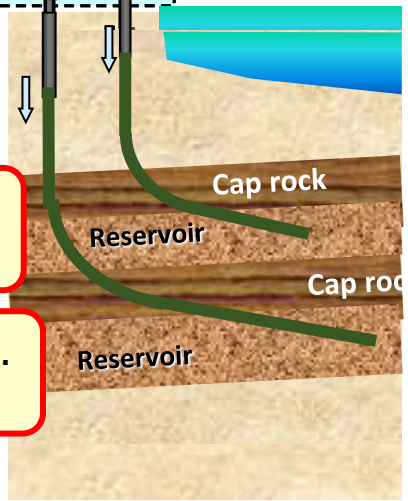
PSA (Pressure Swing Adsorption）

Typical composition of PSA Offgas

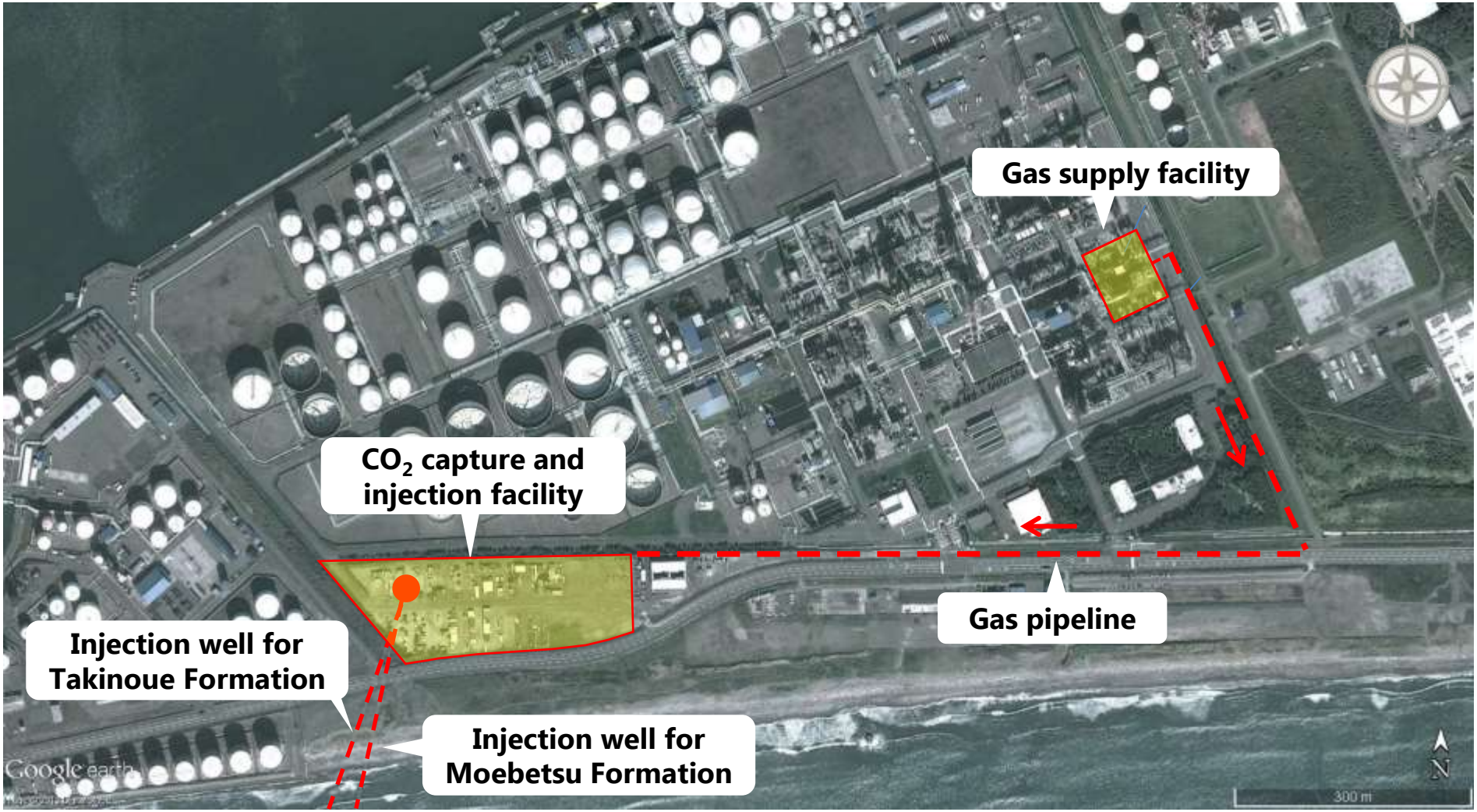
CO_2 =50%, H_2=40%,
CH_4 =6%, CO=3%, H_2O=1%

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

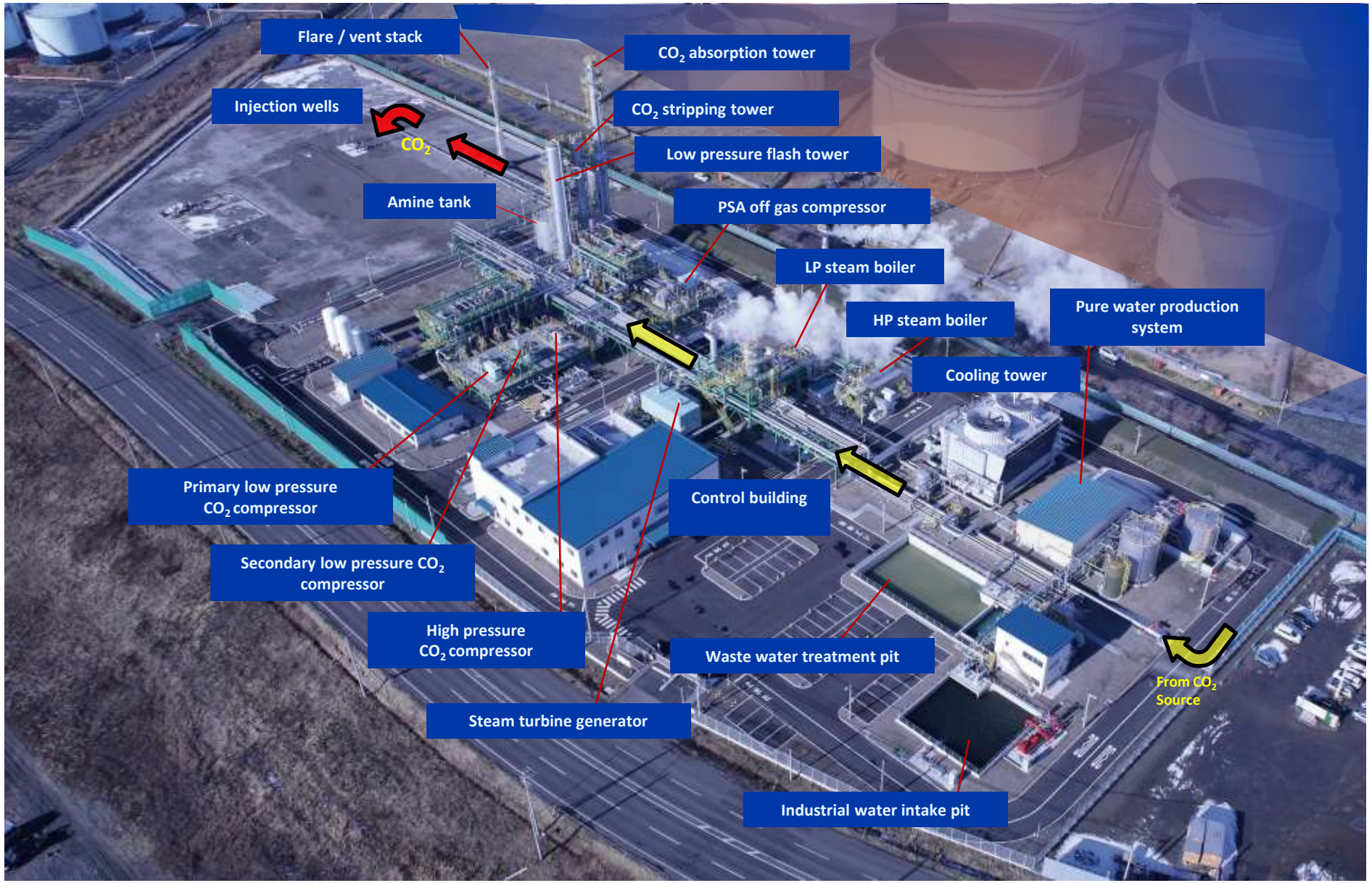
Reservoir :Volcanic Rocks layers of Takinoue Fm.
2,400～3,000m under the seabed



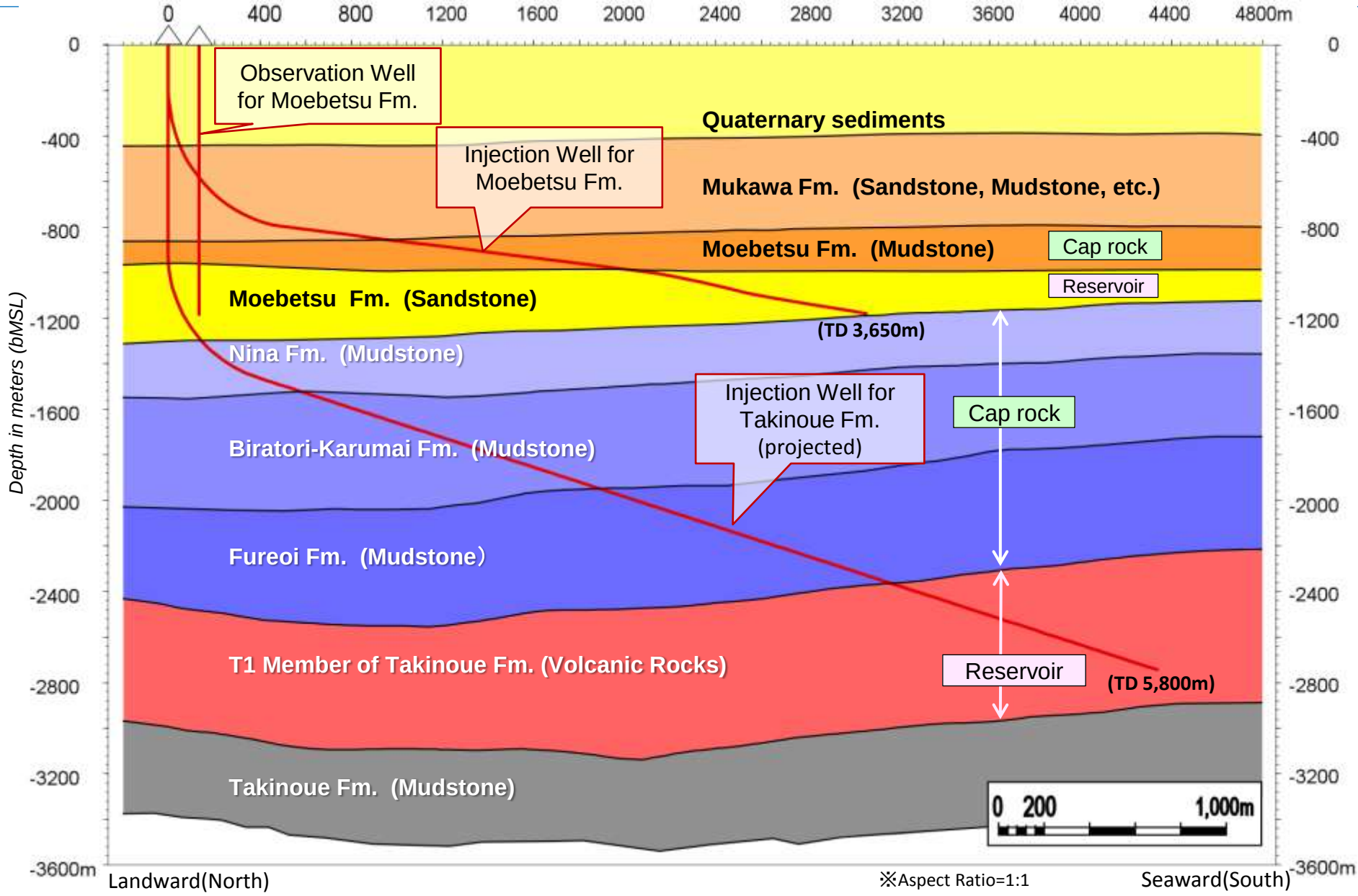
Positional Relation of Onshore Facilities



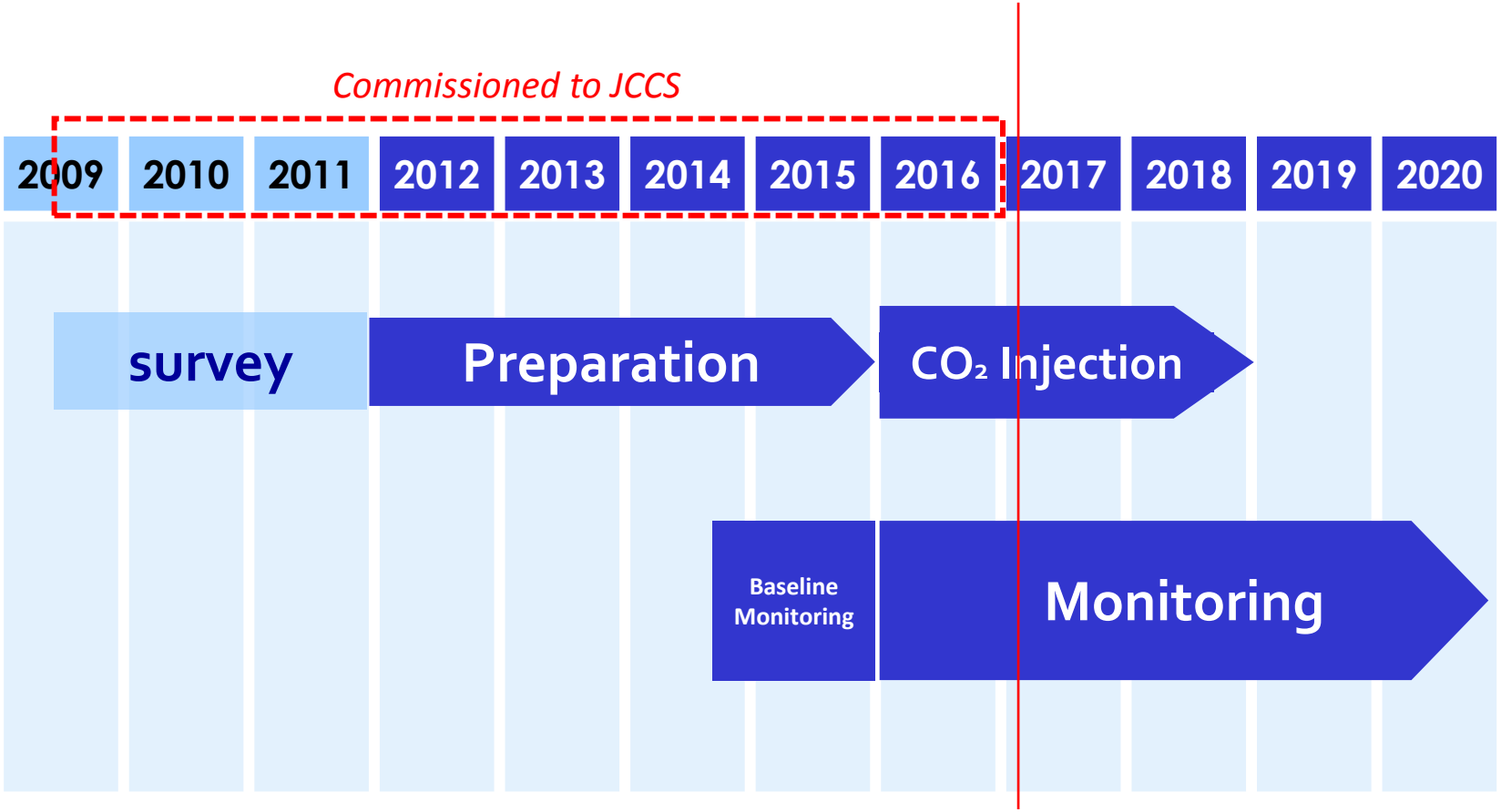
Aerial Photo of Capture and Injection Facilities



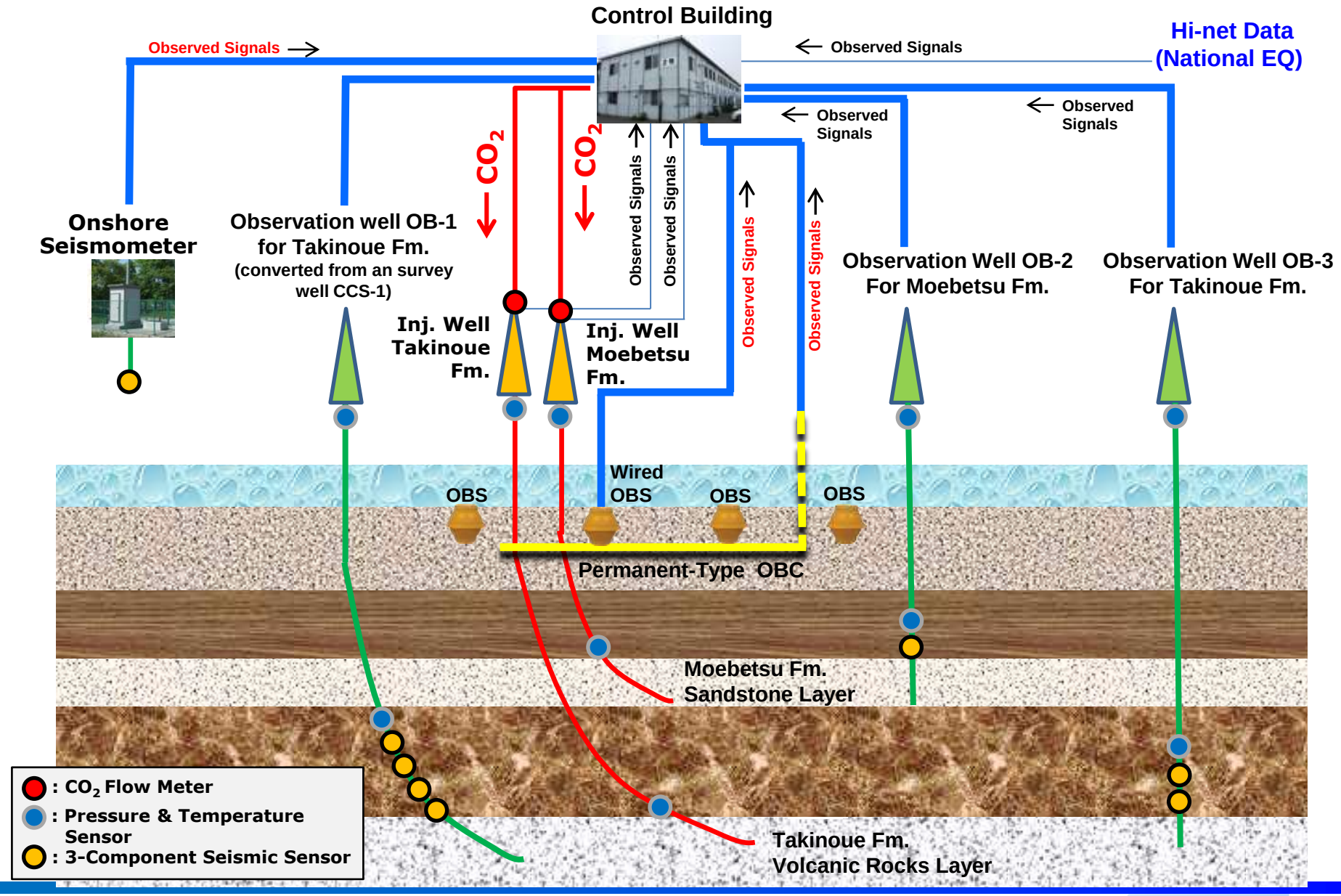
Schematic Geological Section



Project Schedule



Conceptual Diagram of Monitoring System



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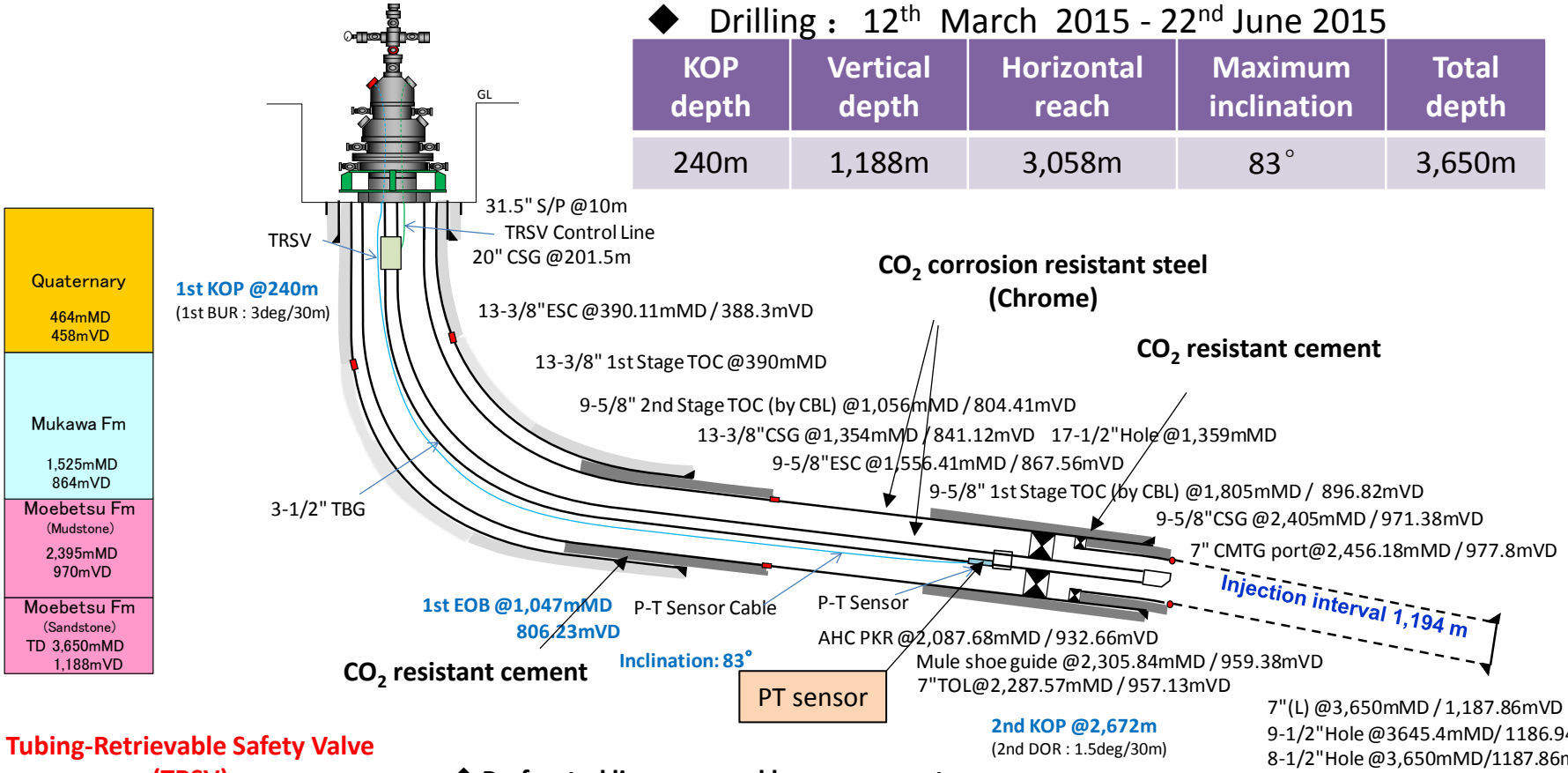
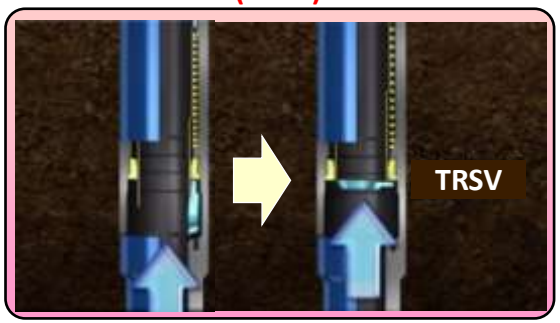
Injection well for Moebetsu Formation

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

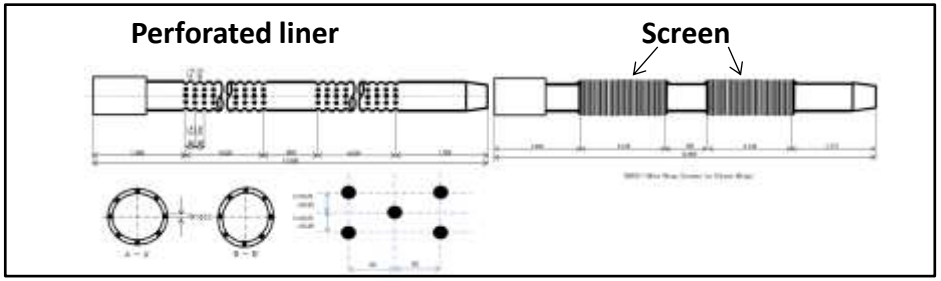
KOP depth	Vertical depth	Horizontal reach	Maximum inclination	Total depth
240m	1,188m	3,058m	83°	3,650m



Tubing-Retrievable Safety Valve (TRSV)



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



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

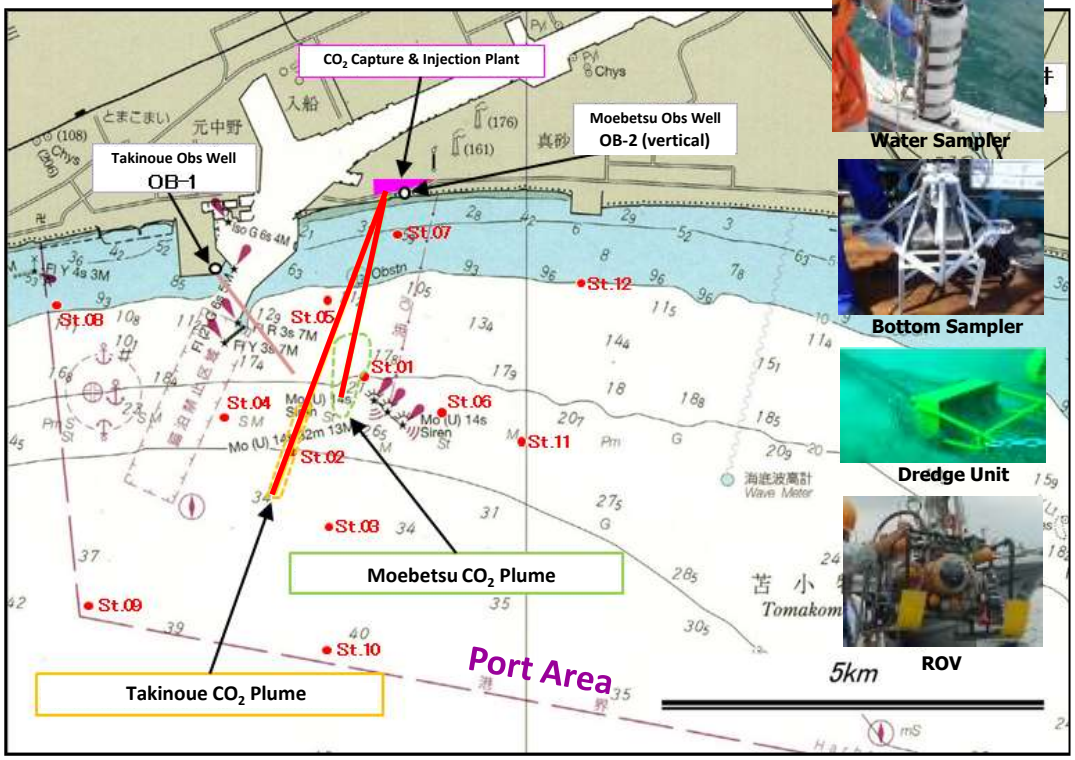
2. Methods of Survey

- 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

Environmental Survey Points




Side-Scan Sonar


Water Sampler

Bottom Sampler

Dredge Unit

ROV

St : Survey Point

Plotted on Japan Coast Guard nautical chart

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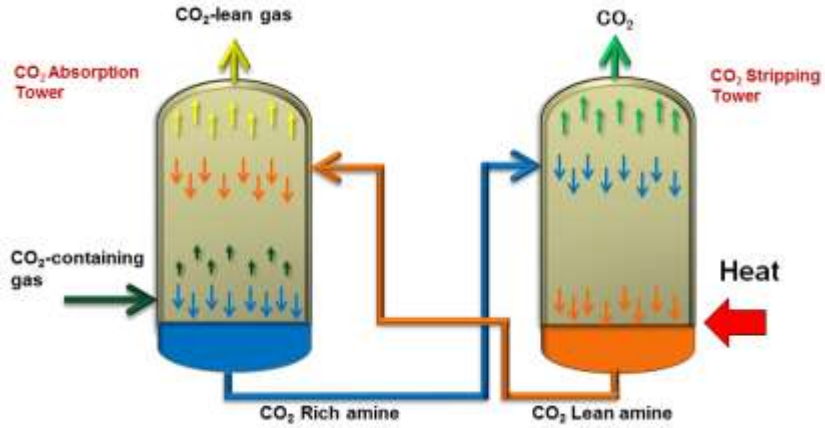
CO_2 Capture Process

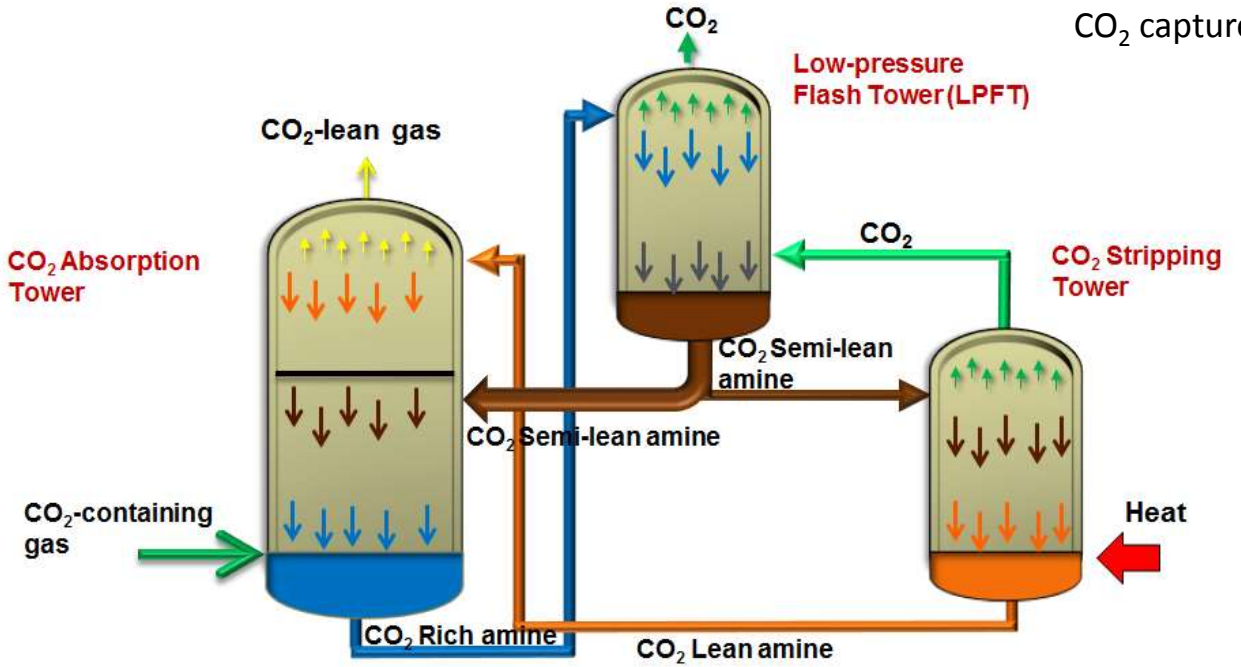


Conventional CO_2 Capture Process

CO_2 capture energy = 2.5~4.0 GJ/t-CO2

Tomakomai CO_2 Capture Process

CO_2 capture energy = 1.15~1.20 GJ/t-CO2



Note1 : CO_2 capture enery =[reboiler heat(steam) consumption / steam boiler efficiency + pump electricity consumption x electricity-heat conversion factor / power generation efficiency] / CO_2 flow rate

Note2 : Two-stage Absorption and Low-pressure Flash Tower ⇒ Applicable to high pressure CO_2-containing gas and high partial pressure of CO_2 case

CO_2 Capture Facilities and Compressors

Control Room

DCS (Distributed Control Systems)

Heads of Injection Wells

Takinoue Injection Well

Moebetsu Injection Wel

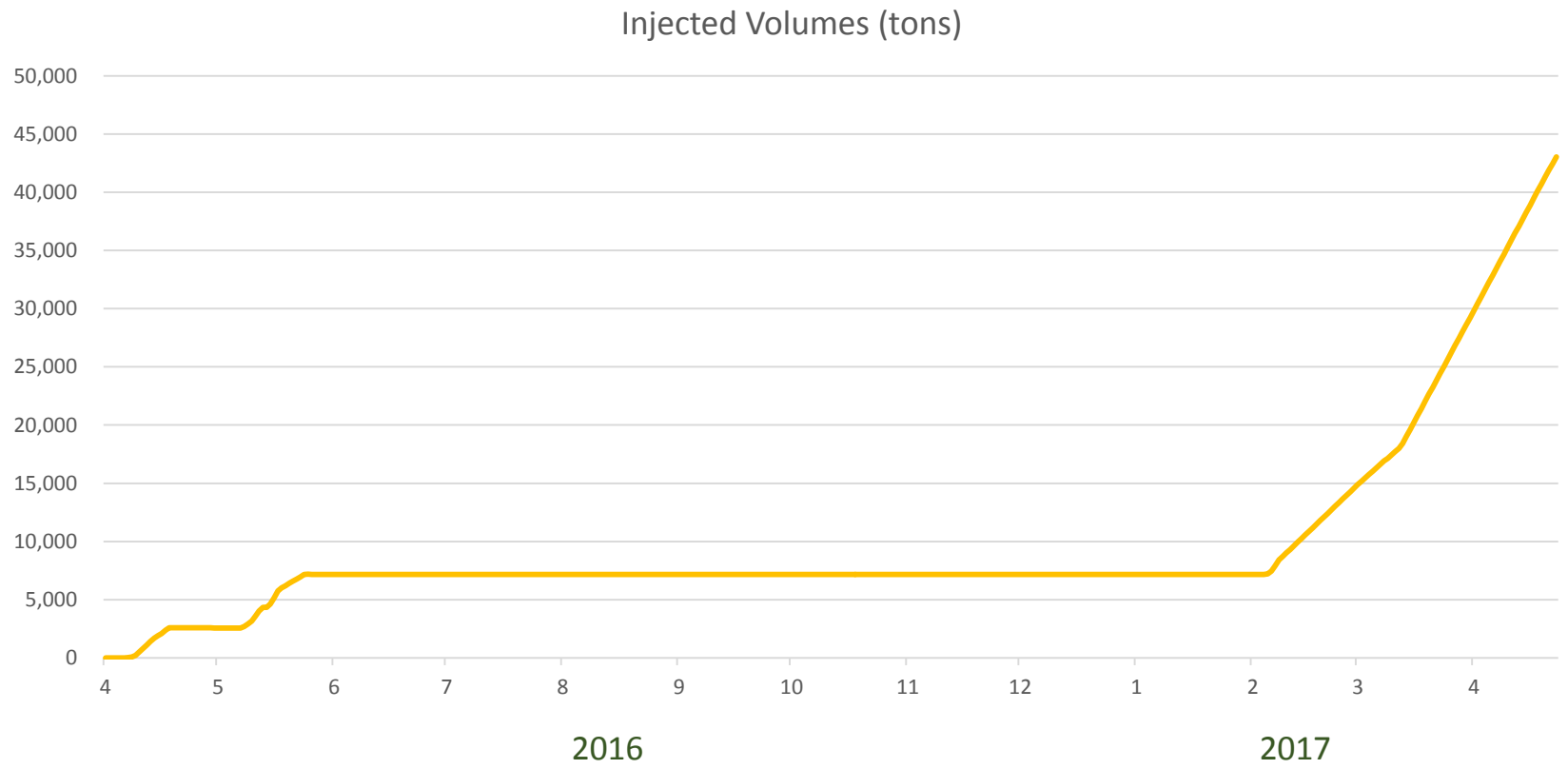
Prior to insulation

Sea Surface Locations above Two Injection Points

Injection Points：
3km and 4km from sea coast

Injection　Report

Injection Record



Note

1. Injection rate : 7.6~25.3 tons/hr (60,000~200,000 tons/year) , depends on the supply of CO_2 containing gas.
2. The bottom hole pressure was 9.2Mpa before injection and is 10Mpa during injection at the maximum injection rate.
3. The injection was stopped from June 2016 to July 2016 for the yearly maintenance of the oil refinery and CCS plant facilities.
4. The injection was stopped from August 2016 to February 2017 to conduct extra seawater survey and to revise the marine environmental survey plan. After permission, the injection restarted on February 2017.

Public Outreach Activities

Public Outreach Activities

Public outreach is essential for CCS

Main results of a survey of Tomakomai citizens on CCS :

1.Information Disclosure
Thorough disclosure should be made.
Want to know more about CCS.
Need diligent and careful attention for local stakeholders.

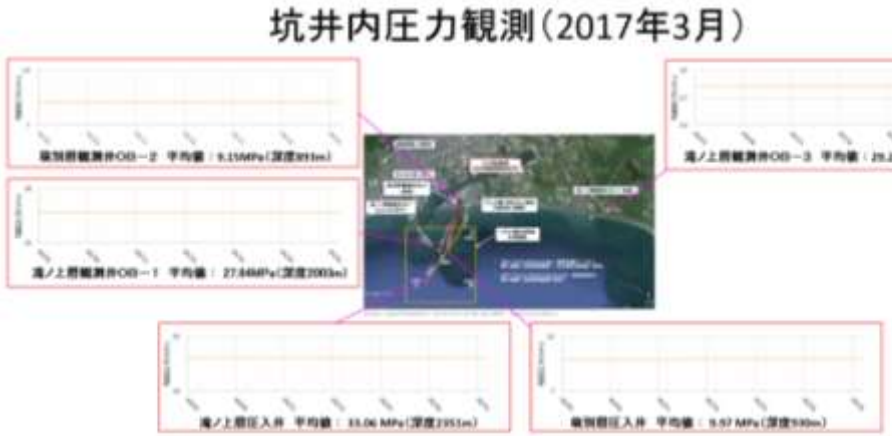
2.Safety
Need more information on the risk of CO_2 leakage.
Adequate attention should be paid to safety.

3.Disseminaiton to Young Generation
Participation of young generation in CCS forums is inadequate.
Information exchange events to encourage participation by young generation should be organized.

Our Public Outreach Activities

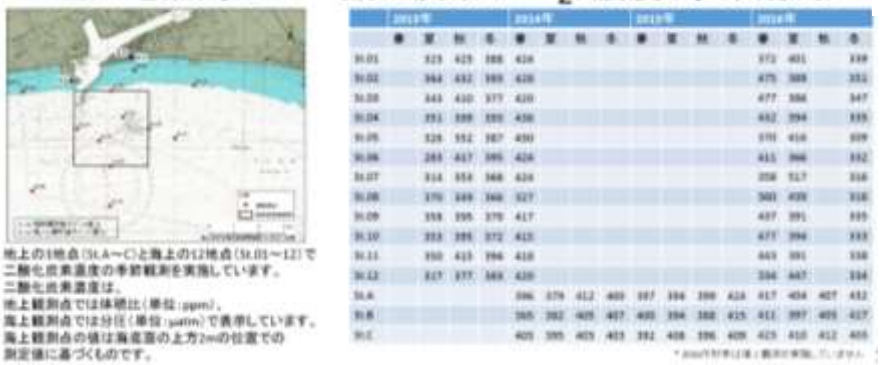
1.Released CCS DVD via website
2.Installed camera showing live construction site via website
3.Organizing panel exhibitions
4.Organizing annual CCS forums for citizens
5.Arranging site visits
6.Conducting lectures at universities
7.Arranging science classes for schoolchildren
8.Continuing information transmission through media
9.Disclosure of monitoring results of injection operations to citizens

Information Disclosure on Website



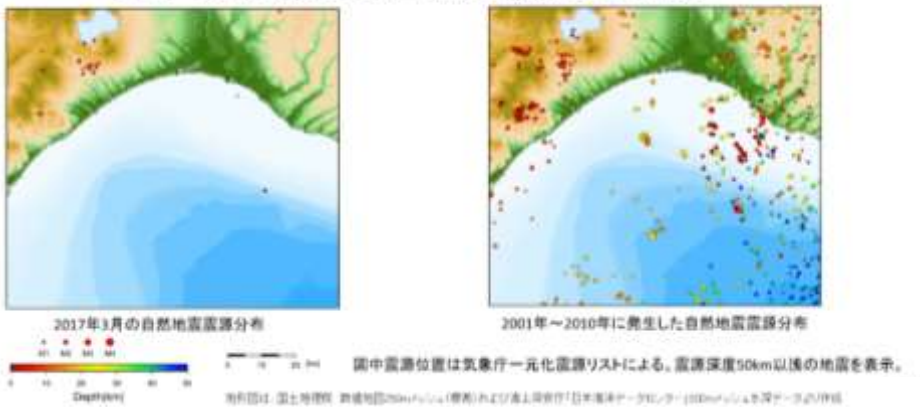
Borehole pressure on March, 2017

CO_2 concentration of seawater in each season

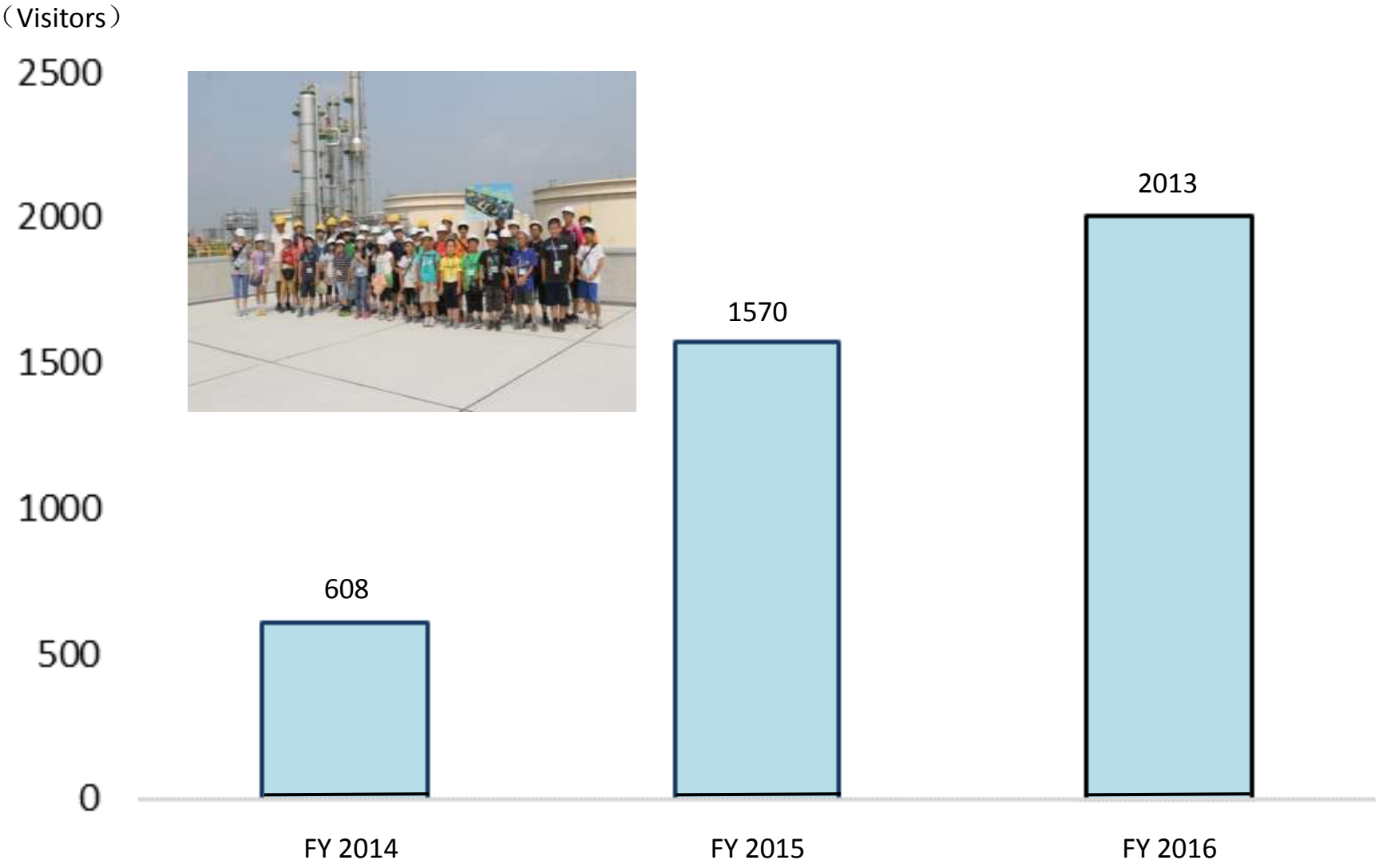


Location of the epicenter and magnitude of earthquakes near Tomakomai

March, 2017 **2001~2010**



Numbers of Visitors to Tomakomai CCS Demonstration Center



Public Outreach Activities in 2016

① **Panel Exhibitions:** 5 times in Sapporo, Tomakomai and neighboring towns

② **Site Visits:** total number of visitors: 2,013 (154 groups) from universities, research associations, local government, etc.

③ **Environmental Exhibitions:** “Eco-Pro* 2016”, “2016 Global Warming Prevention Exhibition” in Tokyo

④ **Kids Science Rooms:** games and experiments to learn about global warming, CO_2 and CCS (total of 2 times in Tomakomai)

⑤ **CCS Forum:** March 4, 2017 in Tomakomai (attendance: 312)

① Panel Exhibitions

② Site Visits

③ Env. Exhibitions

④ Kids Science Rooms

⑤ CCS Forum

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