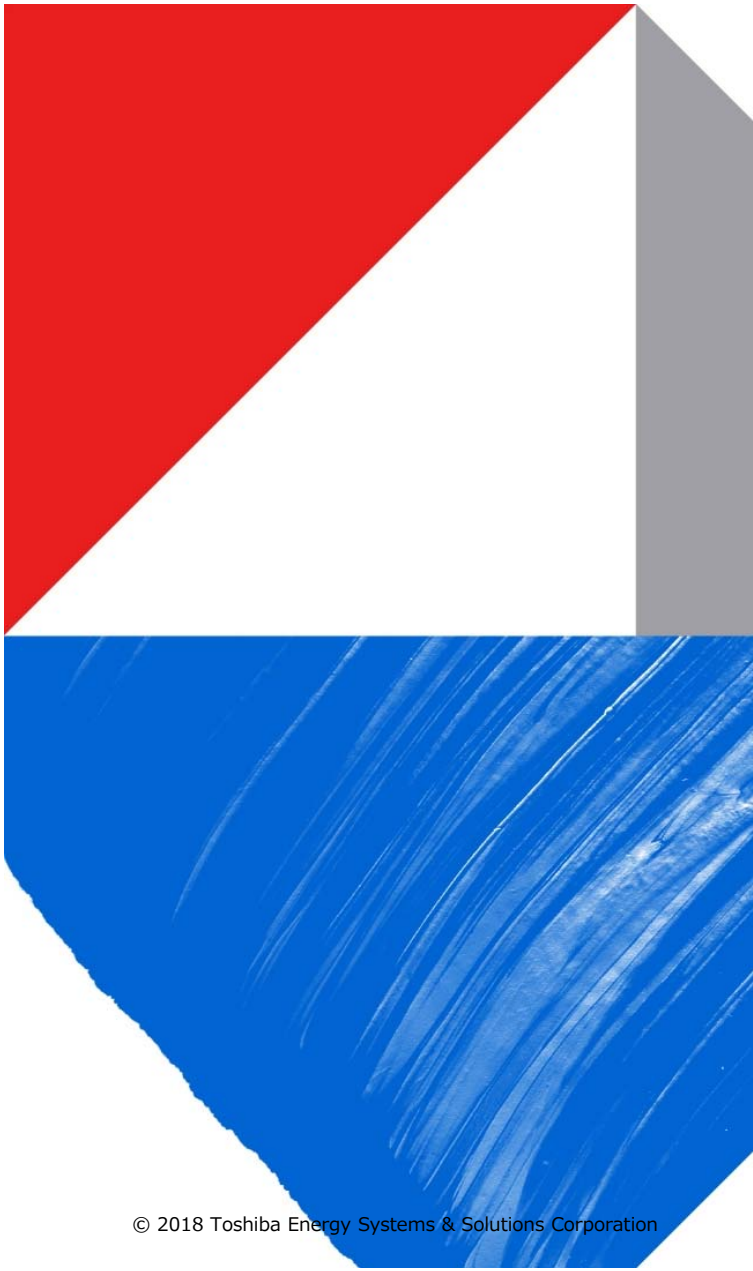
TOSHIBA

COP24 Japan Pavilion – International Workshop on CCS

CCUS Policies and Related Activities in Japan

December 12th, 2018

Kensuke Suzuki
Toshiba Energy Systems & Solutions Corporation



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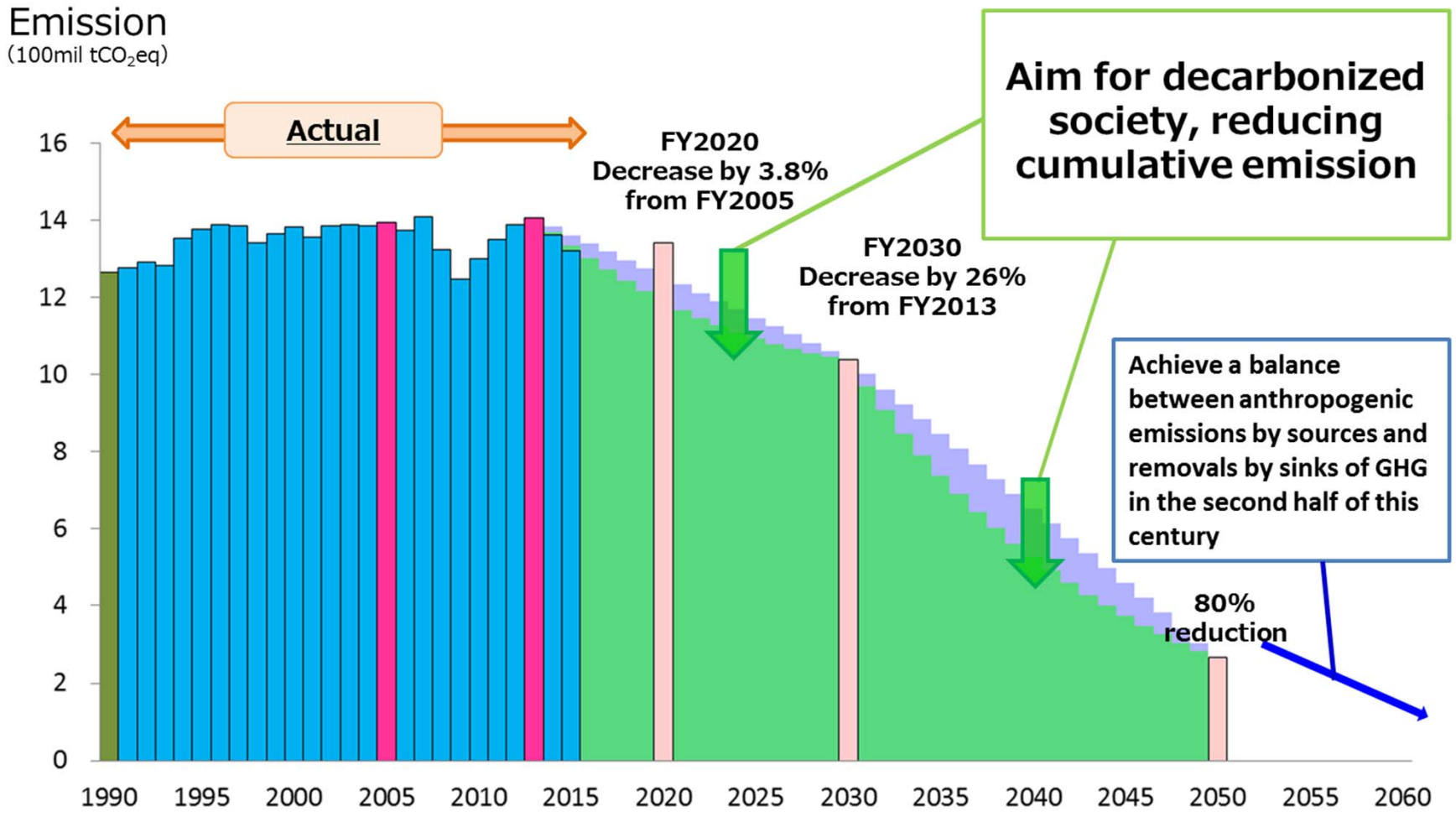
CO_2 Emission and Reduction Target for Japan



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Japanese Government Policy Settings on CCUS (1)

Strategic Energy Plan

Cabinet Decision on July 2018

Research and development will be conducted with a view to practical use of the carbon capture, utilization and storage (CCUS) technology around 2020 and, with due consideration given to the possible timing of the commercialization of carbon capture and storage (CCS) technology, a study will be conducted on introducing CCS-ready facilities as early as possible. Through these measures, **including steady efforts toward the demonstration of a series of CCS processes of capture, transportation, injection and storage in Japan and a study on suitable sites for storage**, the introduction of coal thermal power generation that gives consideration to further reduction of the environmental impact will be promoted.

Ministry of the Environment (MOEJ)'s Long-Term Low Carbon Vision

Central Environment Council, March 2016

2050 scenario for significant reduction in various sectors in 2050:

- Share of low carbon electricity supply (i.e., renewable energy, **CCS** and nuclear) increases to more than 90%
- **CCS and CCU is deployed to most of the fossil fuel fired power plants and to parts of other industrial emission sources**

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Japanese Government Policy Settings on CCUS (2)

Ministry of Economy, Trade & Industry (METI) & MOEJ Agreement on Fossil Fuel Fired Power Plants

METI&MOEJ, April 2013

◆ **To urge the power sector to develop an effective sector-wide framework for CO2 emissions reduction**

◆ **In relation to the 2050 goal of GHG emission reduction:**

- **To accelerate technology development of CCS and conduct a survey on potential CO2 storage sites for commercialization of CCS by around 2020**
- **To consider introduction of CCS at coal-fired power plants by 2030 and identify requirements for CCS Ready**
- **For power plants expected to operate up to 2050, we urge operators to consider technology development for practical use of CO2 capture facilities**

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Business Domain of Toshiba Energy Systems & Services Corporation

Power Generation Systems

Thermal Power

Nuclear Power

Transmission and Distribution / Energy Storage

Transformer

Supervisory Control And Data Acquisition Systems (SCADA)

Hydrogen-based Autonomous Energy Supply System

Stationary Battery Energy Storage Systems

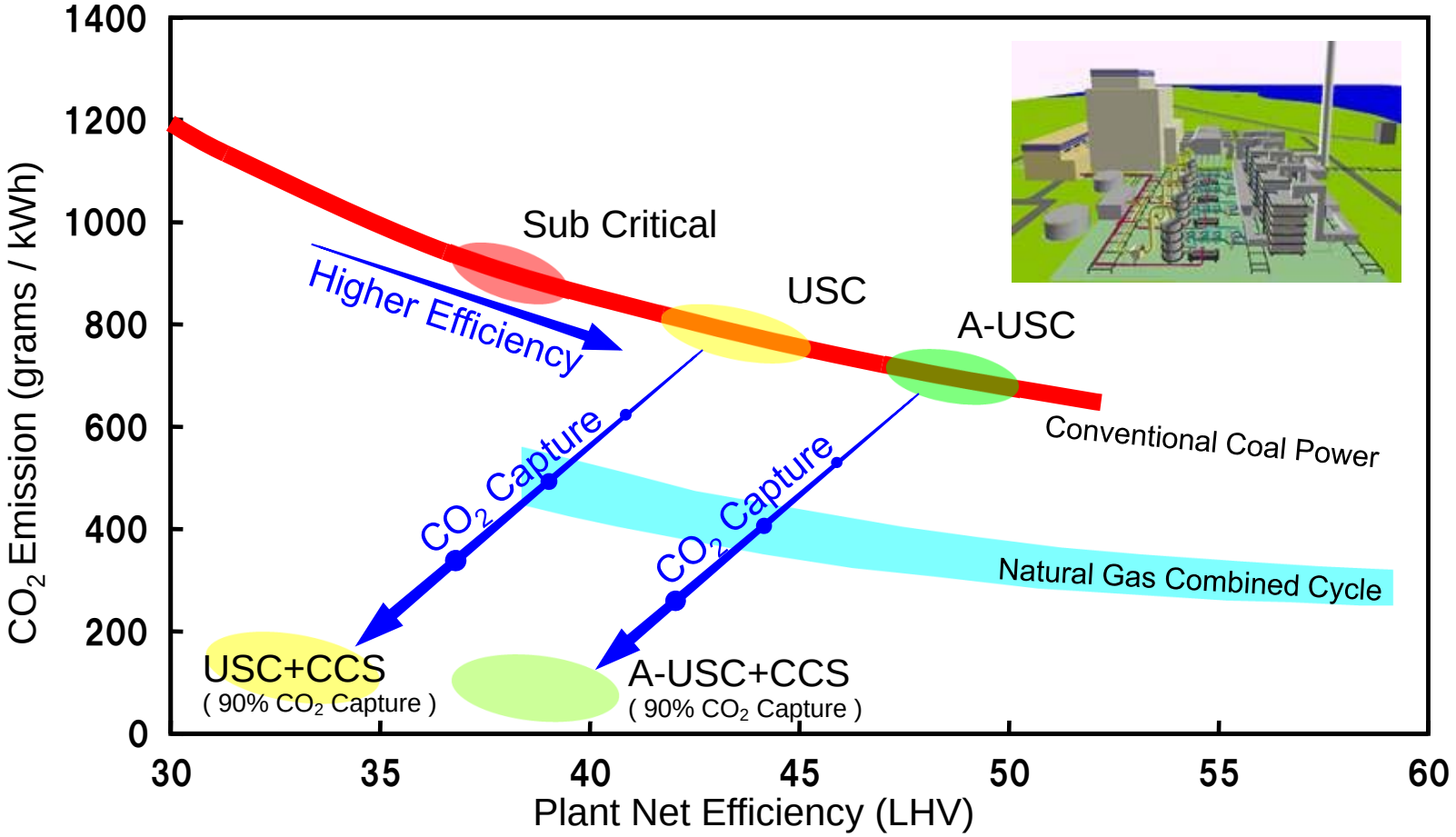
Renewable Energy

Hydro Power

Geothermal Power

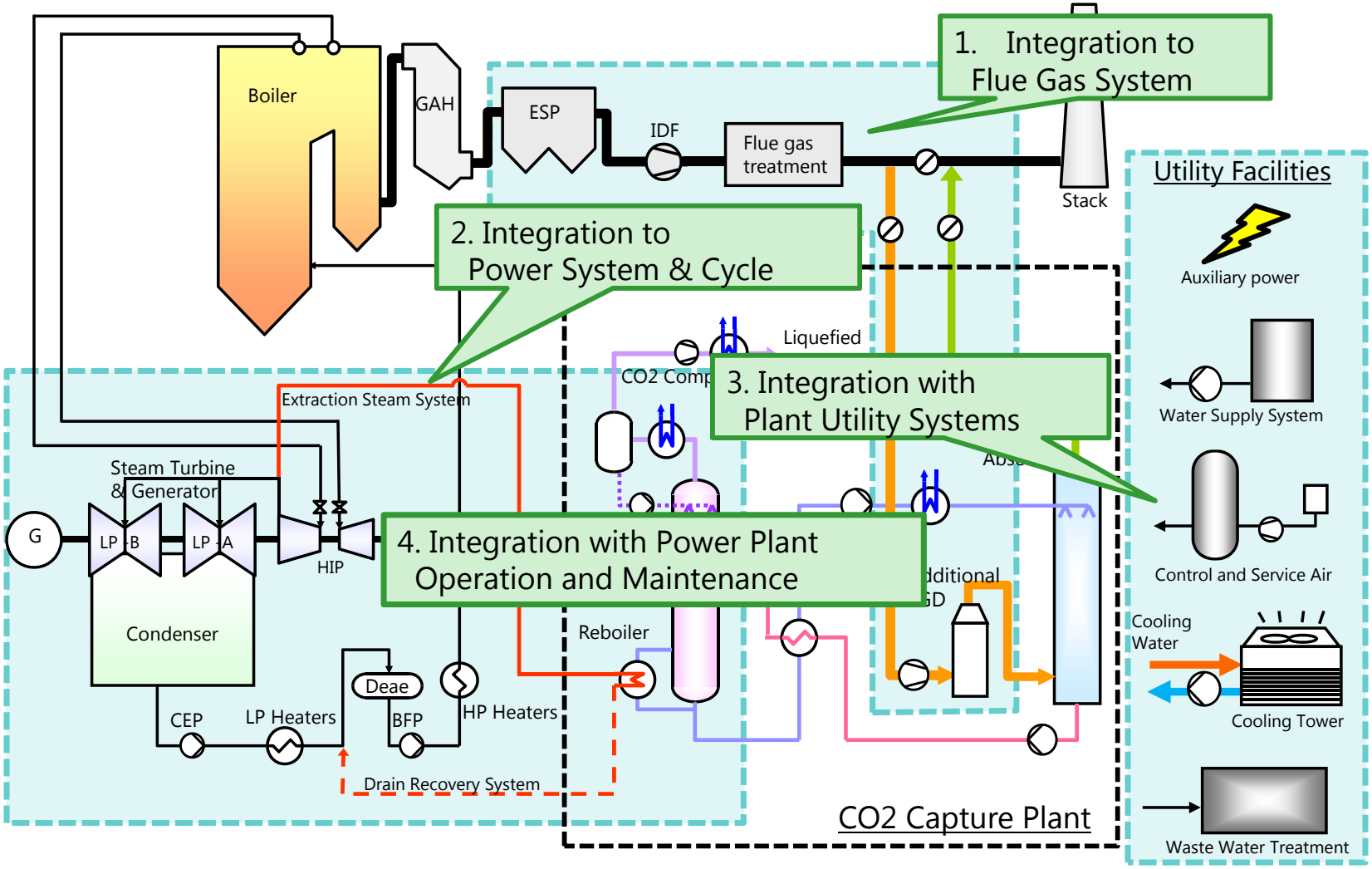
Solar Power

Reducing CO_2 Emission from Thermal Power Plants

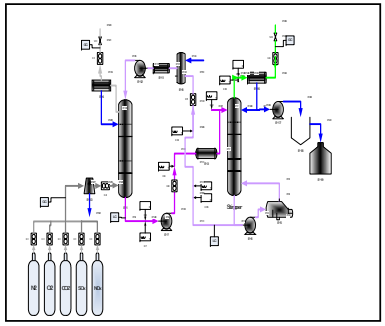


Substantial CO_2 reduction is realized by Integration and Optimization of both High efficiency Turbine Cycles and CCS technology

Integrating CO_2 Capture to Thermal Power Plants



CO_2 Capture Technology Implementation Flow



Screening of Absorbents and Evaluation of System Performance Improvement by Simulation

Evaluation of Basic Properties and Absorption Performance

Performance / Degradation Evaluation by Small Loop

Overall Demonstration at Mikawa - PCC Pilot Plant

Large Scale Demonstration/ Commercial Plant

CO_2 Capture Plant Deployment

Mikawa* Post Combustion Capture Pilot Plant

Commenced : Sep. 2009
Technology : PCC (Post Combustion Capture)
Amine-based Chemical Absorption
(Toshiba's Solvent System)
Capacity : 10 ton-CO_2 / day
Flue Gas Source: Mikawa Biomass Thermal Power Plant
(operable also with coal)
Operation : Cumulative 11794 hours on live flue gas

Ministry of the Environment
Sustainable CCS Project
CO_2 Capture Demonstration Plant

Saga City CCU Plant

Commenced : Sep. 2016
Technology : Toshiba's PCC System
Capacity : 10 ton-CO_2 / day
Flue Gas Source: Saga City municipal waste incineration plant
Operation : More than two years on live flue gas of plant
CO_2 Usage : Captured CO_2 used for agriculture and algae cultivation

* Mikawa Thermal Power Plant – Property of SIGMA POWER Ariake Co.Ltd.

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Ministry of the Environment (MOEJ) On-going CCS Projects

1. Sustainable CCS Project

To demonstrate application of capture facilities and to conduct comprehensive studies to introduce CCS

Project Term: Fiscal Year 2014 to 2020

2. Investigation of Potential CO_2 Storage Sites

Joint project with Ministry of Economy, Trade and Industry (METI)
Project Term: Fiscal Year 2014 to 2021

Material from “Long-term perspective on CO2 reduction by utilizing CCS technologies” presentation by MOEJ @ GHGT-14

1. Sustainable CCS Project - Outline

Demonstration of CO_2 capture technology integrated with coal-fired power plant

Investigation of strategies to introduce CCS in Japan

Task 1: Capture
Demonstration of large-scale CO_2 capture technology

1. Design, installation and preparation of large-scale CO_2 capture facility demonstration
2. Review of environmental impact reduction measures for CO_2 Capture Facilities

Task 2: Transportation
Study for captured CO_2 transport by ship

1. CO_2 transport Scenarios
2. CO_2 transport from large CO_2 capture facility to subsea reservoir
3. Operation of CO_2 capture, transport and reservoir

Task 3: Storage and Monitoring
Study for constraining and remediating CO_2 leakage stored under seabed

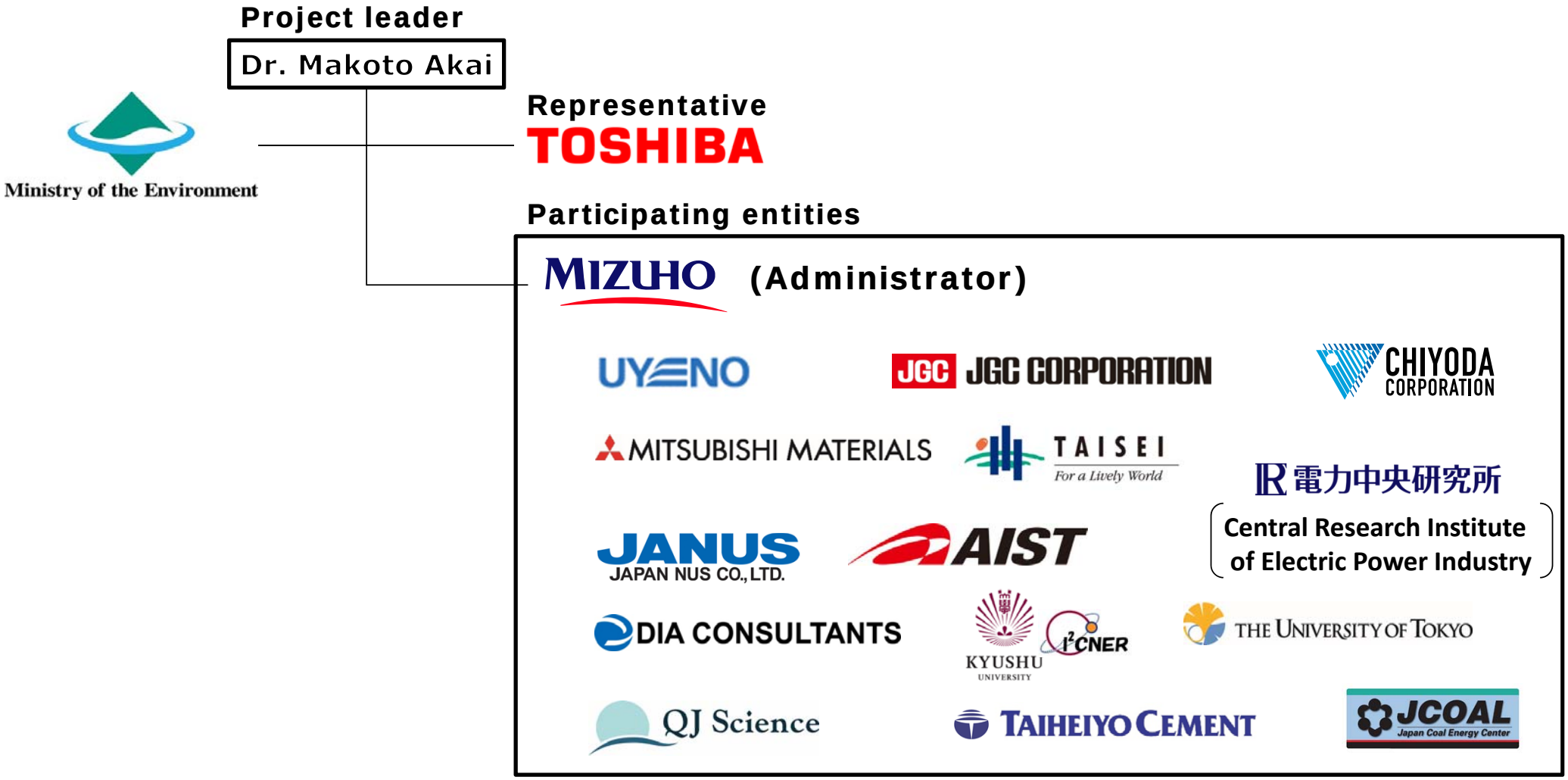
1. CO_2 containment, remediation and design of seafloor equipment
2. CO_2 hydrate formation verification
3. Development of CO_2 monitoring system in offshore environment

Task 4: Policies and Measures
Investigation of CCS deployment in Japan

1. Study on policies and socio-economic issues
2. Scenarios and communication strategy for consensus building between stakeholders
3. Draft of Roadmap for CCS Deployment toward 2050

Material from “Long-term perspective on CO2 reduction by utilizing CCS technologies” presentation by MOEJ @ GHGT-14

1. Sustainable CCS Project – Project Entities



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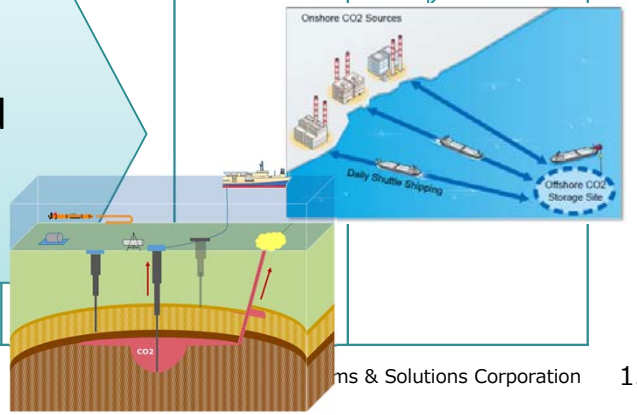
1. Sustainable CCS Project – Project Schedule

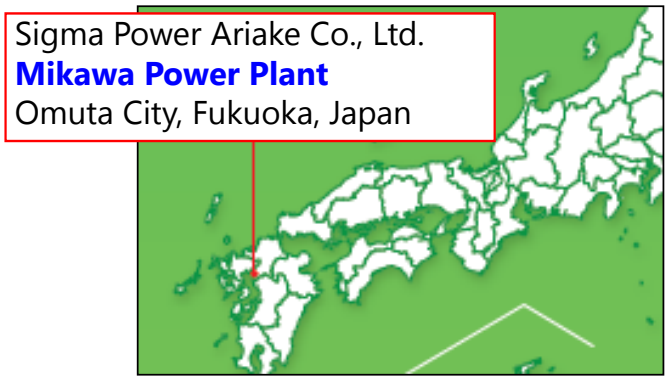
Sustainable CCS Project	'14	'15	'16	'17	'18	'19	'20	'21	'22-
Demonstration of CO2 capture technology			Facility/modification basic design, details design, etc.				Demonstration		
					Construction work				
	Feasibility study							Step-by-step Deployment	
Investigation of strategies to introduce CCS			• Study of CO2 transportation • Study for constraining and remediating CO2 leakage stored • Development of strategies to introduce CCS (e.g. Social acceptance)						



Material from "Long-term perspective on CO2 reduction by utilizing CCS technologies" presentation by MOEJ @ GHGT-14

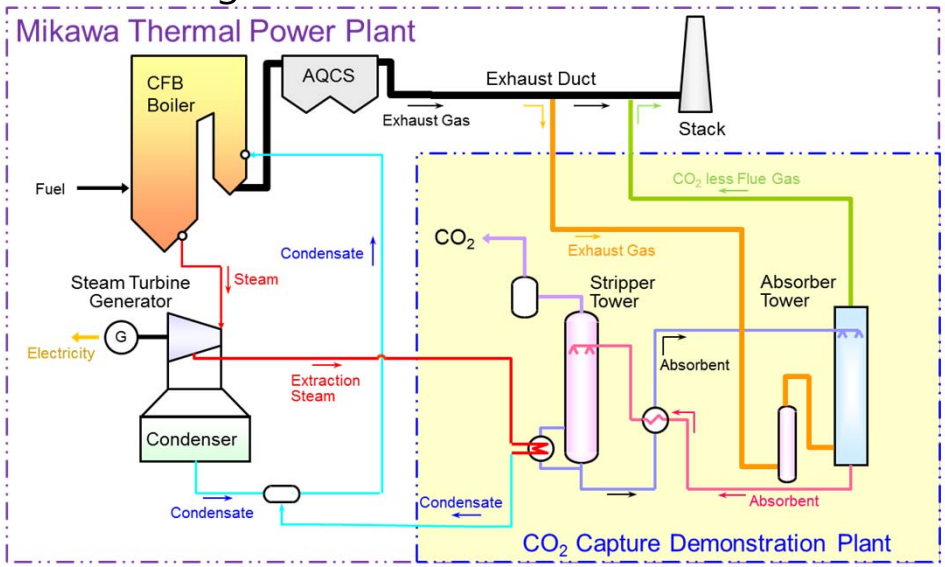
1. Sustainable CCS Project - Demonstration of large-scale CO_2 capture technology (1)

Power Plant for Demonstration



49MW Biomass- and/or Coal-fired Power Plant

Plant Configuration

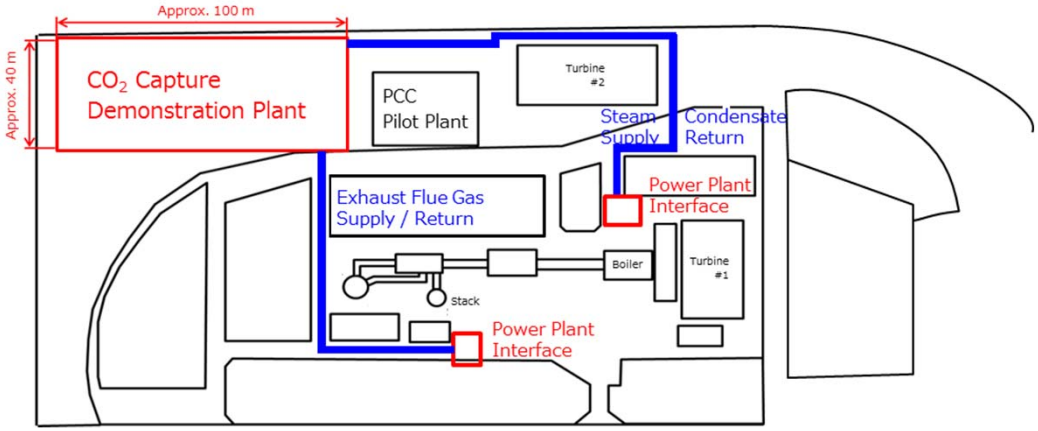


- The CO_2 Capture Demonstration Plant will be designed and built to capture more than **500 tons-CO_2/day** from Mikawa Power Plant (**more than 50%** of its total emissions)
- The Capture Plant will be built and **fully integrated with the Power Plant**, with turbine extraction steam feeding the energy for regeneration of CO_2 at the stripper tower.
- The old coal boiler was replaced with a boiler capable of **also burning 100% biomass**. The new boiler is now fully operational and normally operating on biomass fuel. Consequently, the project will become one of the first **BECCS project** in the world.

Power Plant for Demonstration

1. Sustainable CCS Project - Demonstration of large-scale CO_2 capture technology (2)

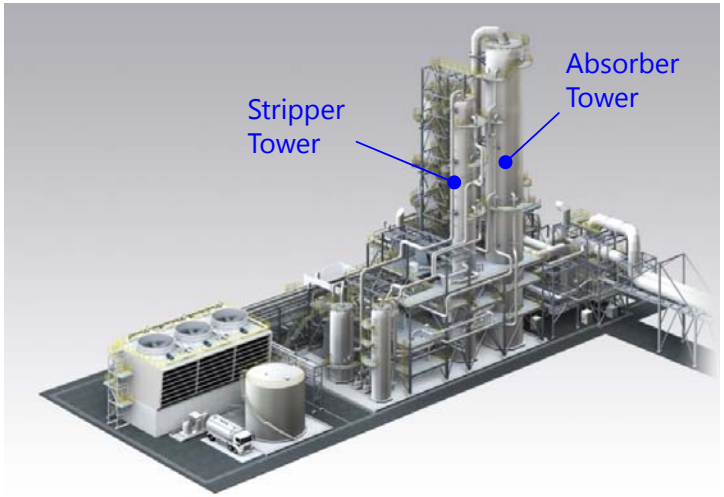
Mikawa Power Plant Site Plot Plan



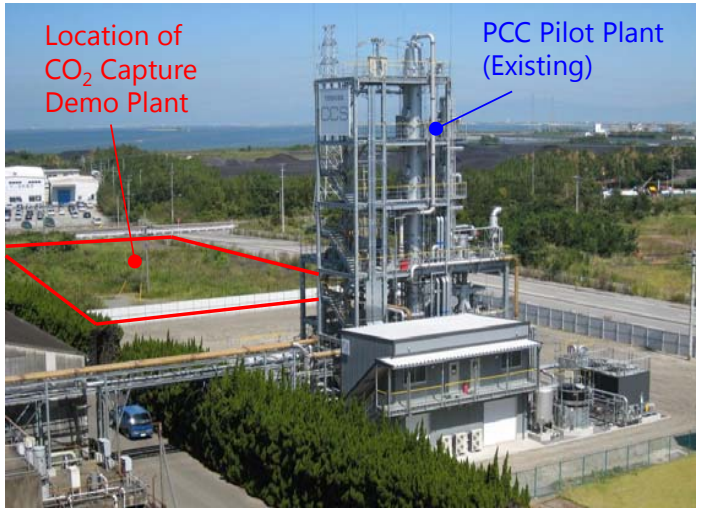
Site Groundbreaking: Dec. 2017
Construction Start: Feb. 2018
Commissioning Start: Spring 2020

* Photo of Groundbreaking Ceremony
Courtesy of Ariake Shimpo Newspaper

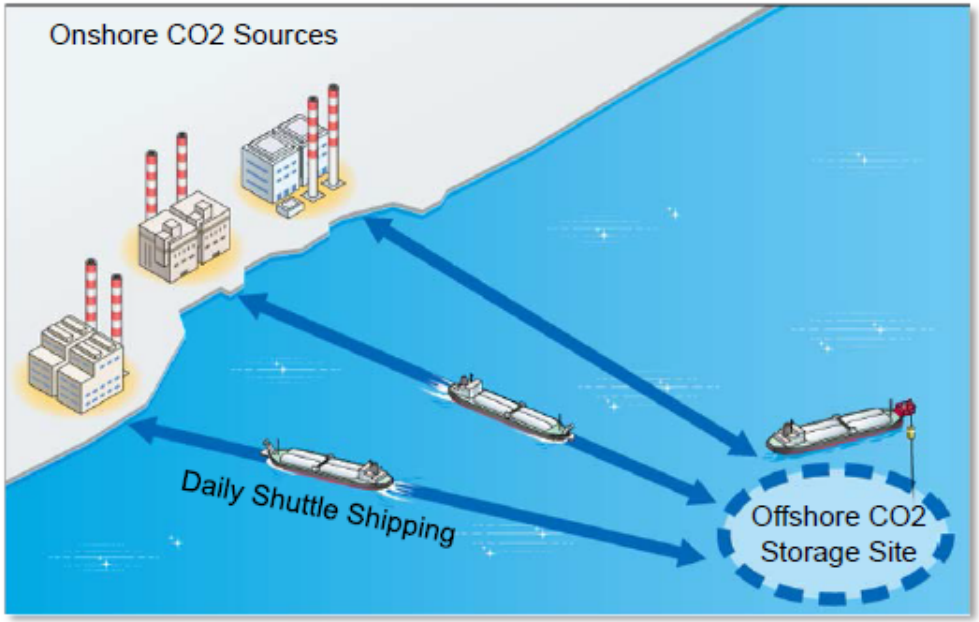
Planned Layout of CO_2 Capture Demo Plant



CO_2 Capture Demo Plant Construction Site



1. Sustainable CCS Project - Study for captured CO_2 transportation by ship



◆Why offshore CO_2 storage ?

1. Most of CO_2 emission sources exist along coasts.
2. Offshore areas are less used compared to coastal waters.

◆Key benefits of CO_2 transportation by Ship

1. Easy to match source and sink
2. Flexible to change transportation/storage plans

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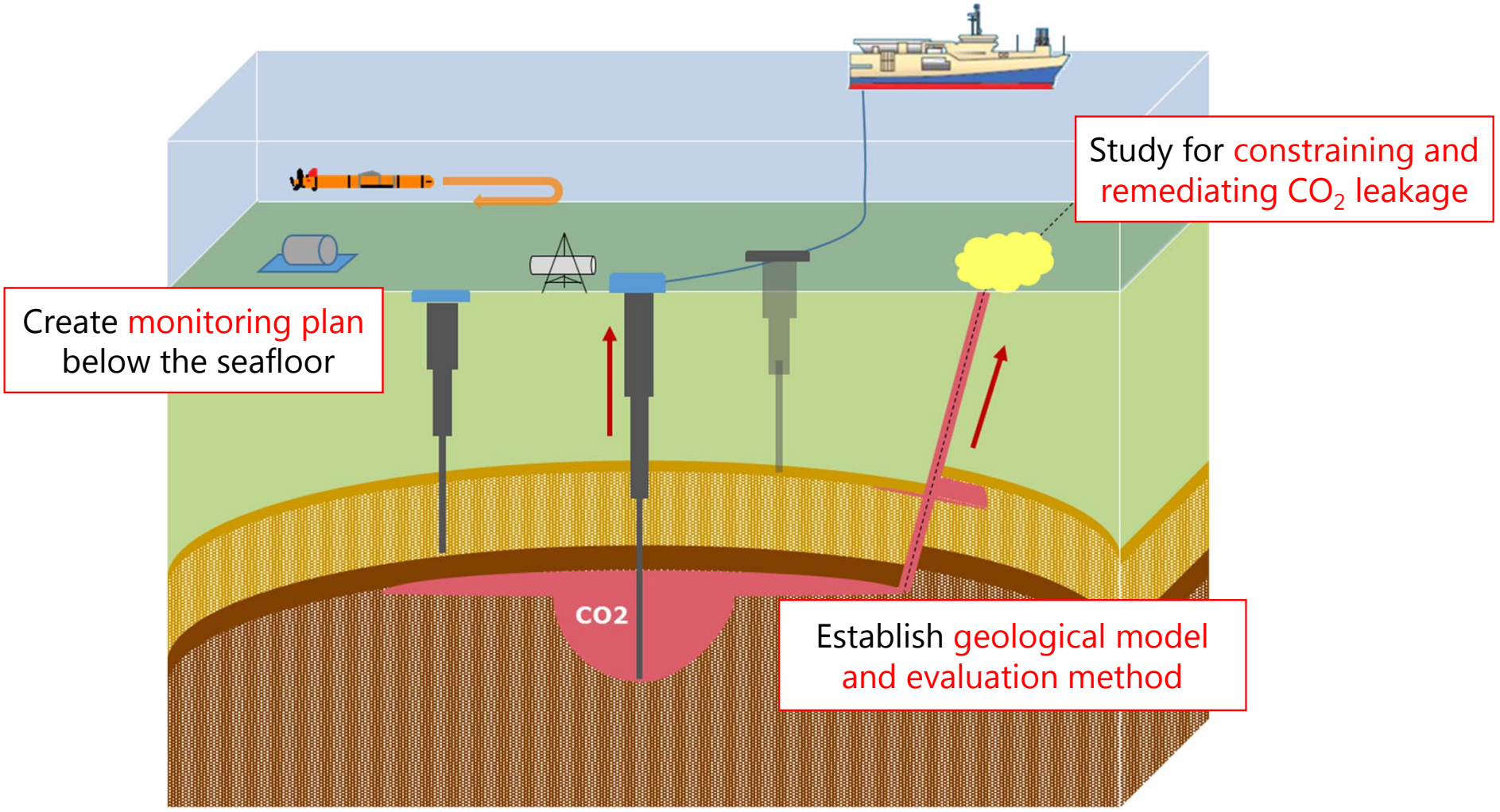
1. Sustainable CCS Project - Study for constraining and remediating CO_2 leakage stored under seabed



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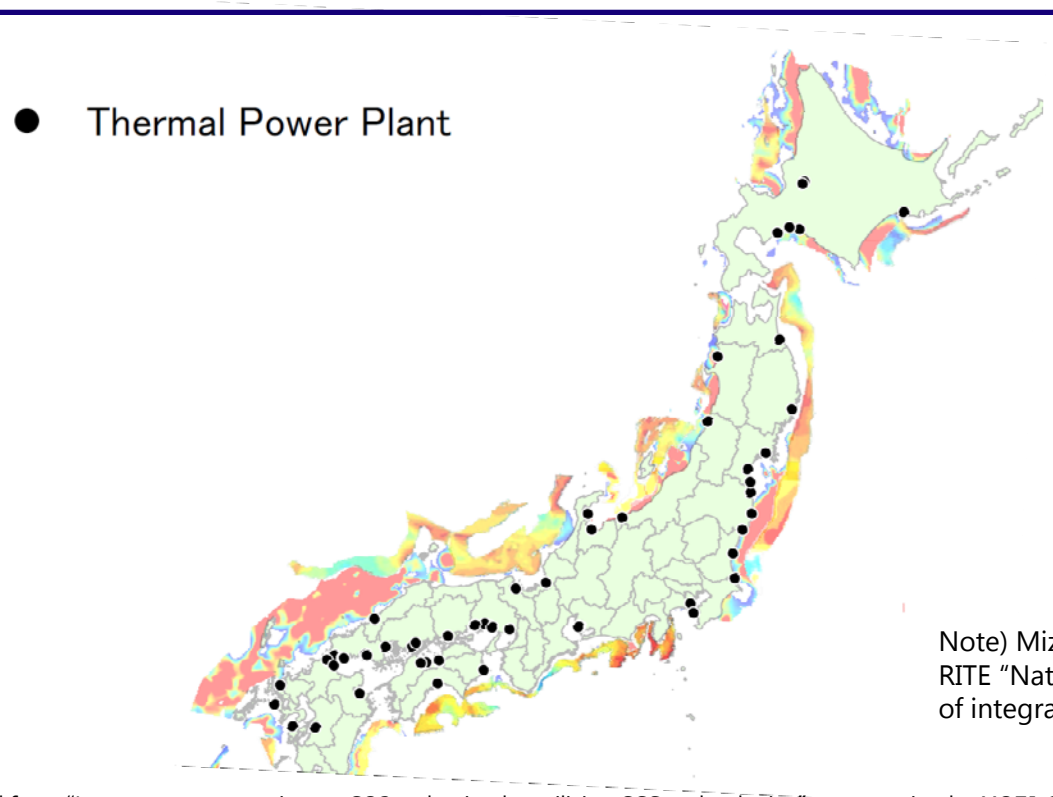
2. Investigation of Potential CO_2 Storage Sites

- Identify potential CO_2 storage sites in waters surrounding Japan by 2021.
- A previous study conducted by RITE in 2005 estimated that there is about 146 billion tons of CO_2 storage potential in the offshore waters of Japan.



Note) Mizuho Information & Research Institute creates these figures by using data of RITE "Nationwide storage potential quantity survey", and NEDO/AIST (2012) "Evaluation of integrated system covering from power generation to carbon dioxide storage" etc.

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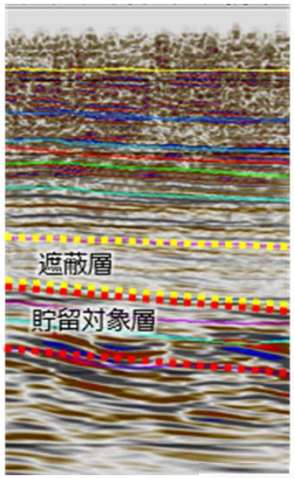
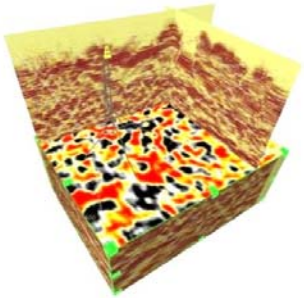
2. Investigation of Potential CO_2 Storage Sites - Schedule

FY	2014	2015	2016	2017	2018	2019	2020	2021

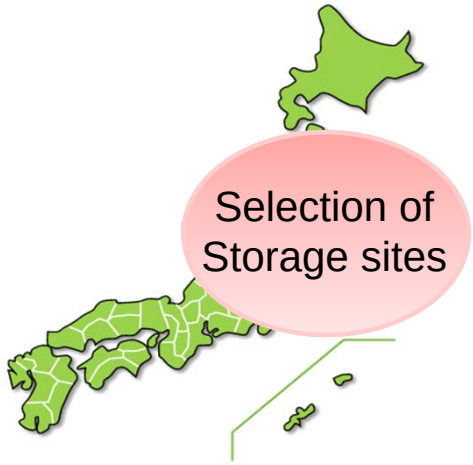


2D Seismic Acquisition & Geological Analysis



3D Seismic Acquisition & Geological Analysis

Drilling Exploratory Wells & Evaluation



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Thank you for your attention !