

International CCUS and Hydrogen Symposium 2021

Ministry of the Environment Sustainable CCS Project

TOSHIBA

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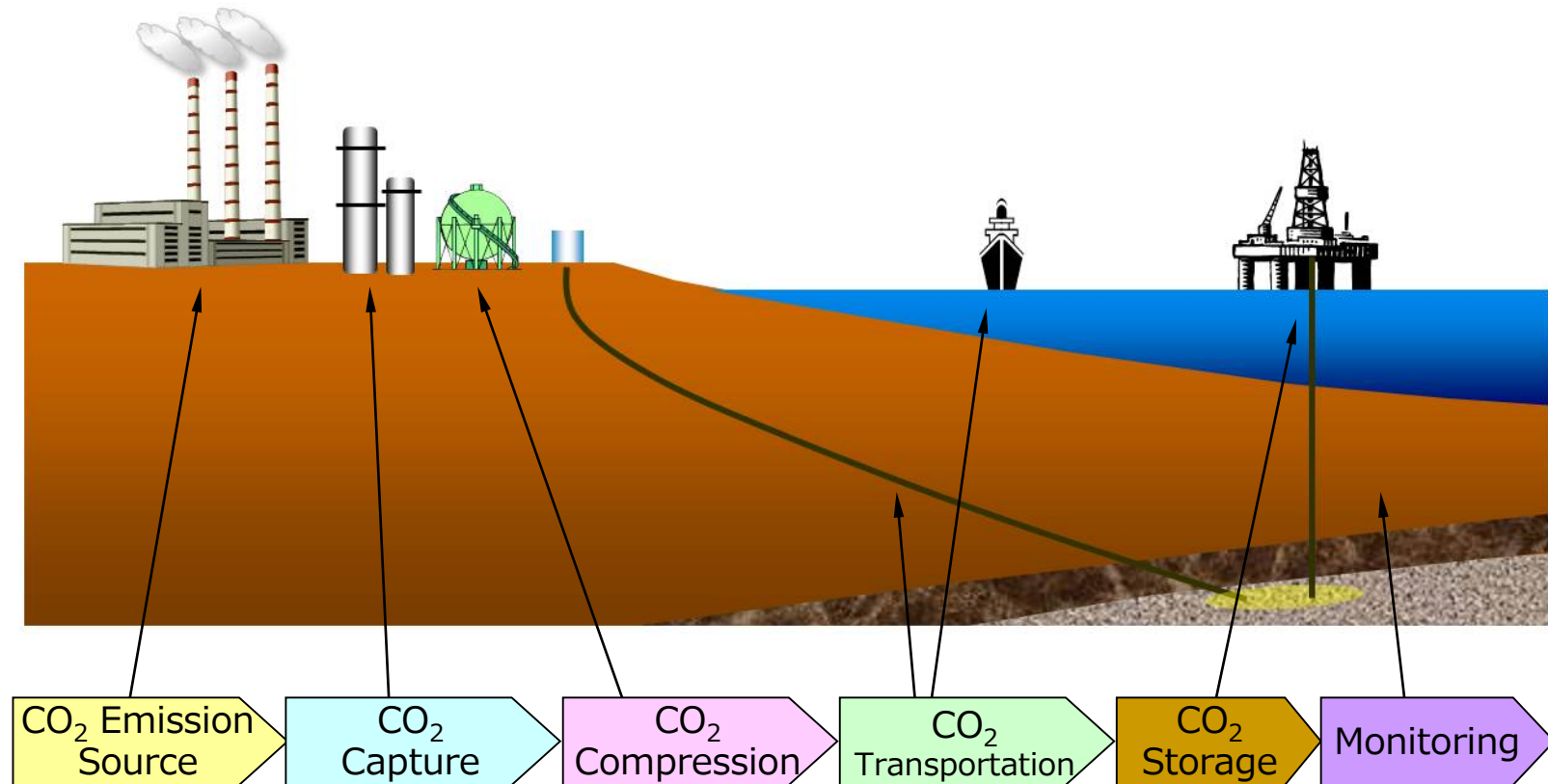
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03 Transport, Storage,
Policies and measures

01

About this project

Full-chain CCS



Project details

Sustainable CCS Project (funded by Ministry of the Environment)

① Capture

Toshiba Energy Systems & Solutions
Mizuho Information & Research Institute



CO2
capture:
500tCO2/
day

Demonstration Plant

Evaluating the operation of the
thermal power plant with large-
scale CO2 capturing plant etc.

② Transport

Uyeno Transtech
JGC JAPAN Corp.
Chiyoda Corp.
University of Tokyo
Taisei Corp.

Consideration of CO2
transport method
suitable for Japanese
condition

③ Storage

Mitsubishi Materials
Taisei Corp.
CRIEPI
INPEX
Mitsubishi Corporation
Exploration

JANUS
AIST
University of Tokyo
DIA Consultant
Kyushu University

Storage planning
for the candidate
sites, following the
suitable site
identification

Monitoring planning
for the candidate
sites, following the
suitable site
identification

④ Policies and measures

QJ Science
JANUS
Mizuho Information &
Research Institute
Kyushu University

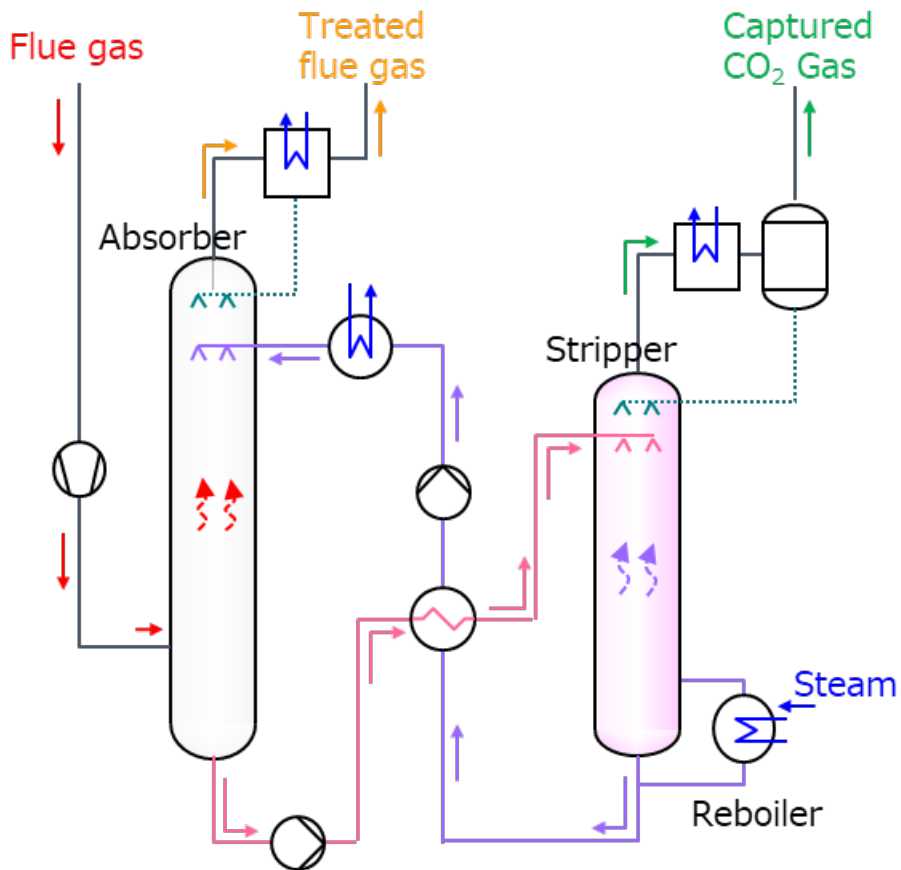
Taiheiyo Cement
JCOAL

- Examination and assessment of CCS deployment path
- Assessment of the relevant technologies via working groups and expert interviews
- Organizing an international symposium etc.

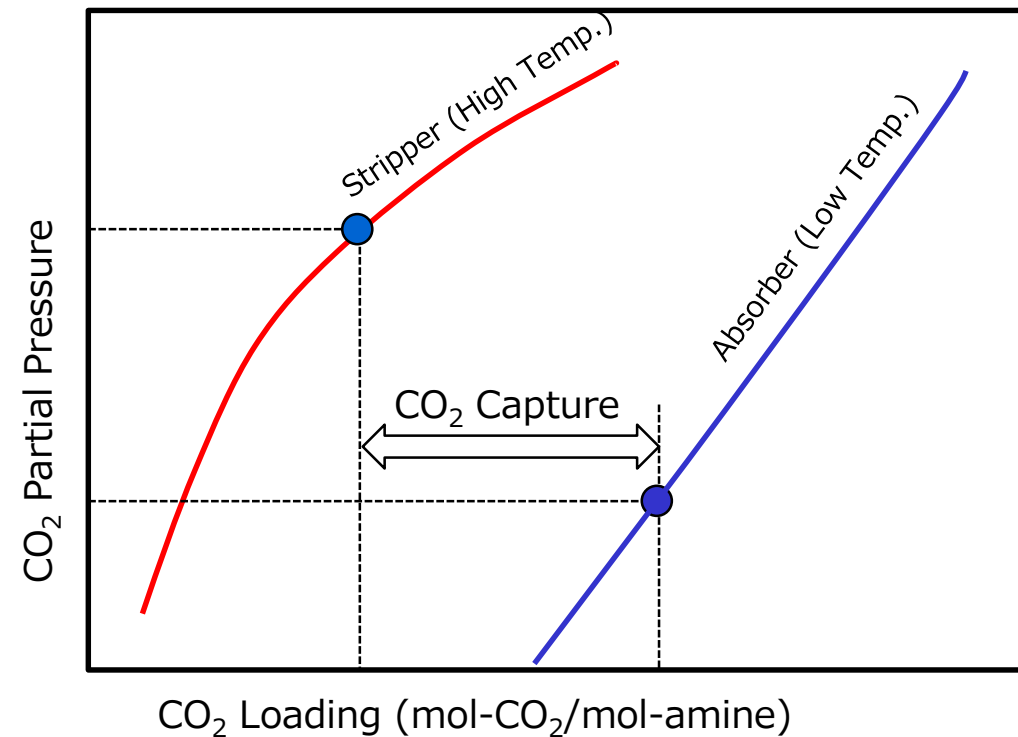
02

Capture

CO₂ Capture System and Characteristic of Amine Solvent

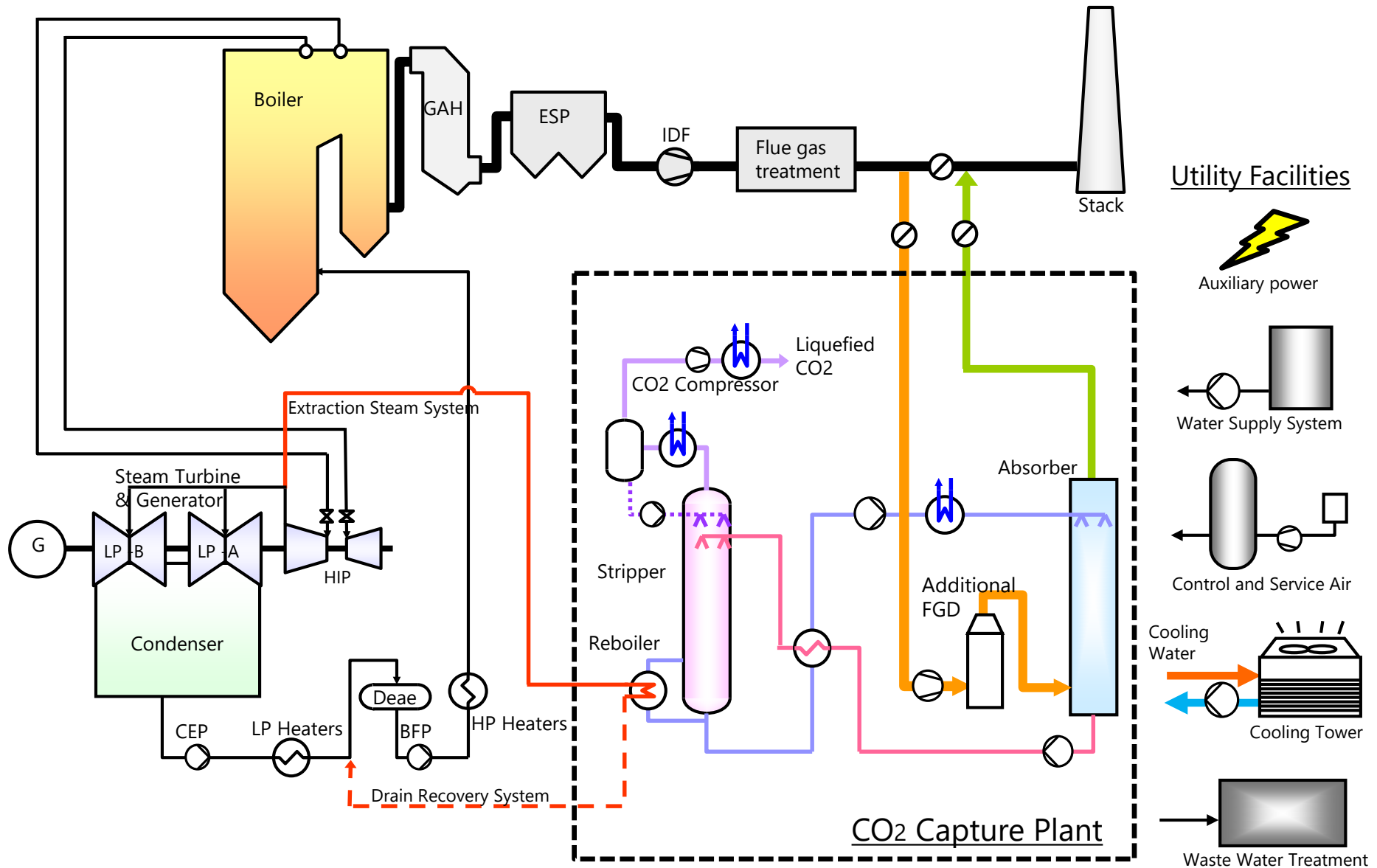


Flow diagram of Chemical Absorption System

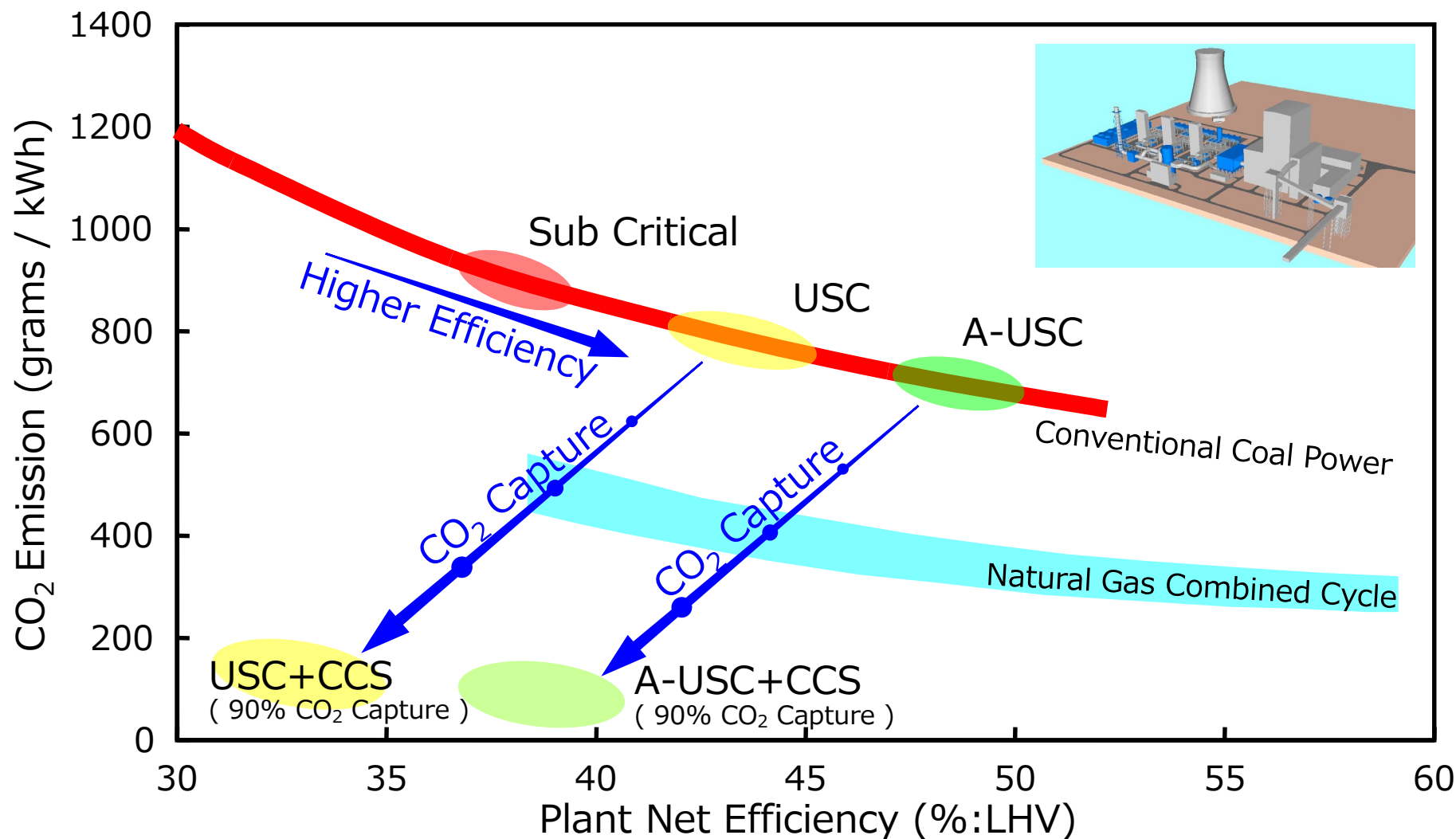


Characteristic of amine solvent

Thermal Power Plant with CO₂ Capture



Reducing CO₂ Emission from Thermal Power Plants



Mikawa Thermal Power Plant in Omuta City

Omuta City : City developed with coal



Sigma Power Ariake Co., Ltd.
Mikawa Power Plant
Omuta City, Fukuoka, Japan

- A.D.1469 "Burning stone" was found by a farmer in Omuta.
- A.D.1721 Mining in Miike coal mine (in Omuta/Arao) started.
- A.D.1997 Miike coal mine was closed.
- A.D.2015 Miike coal mine was registered as world heritage.



Miyahara Pit
at Miike coal mine



Port of Miike

Mikawa Thermal Power Plant & Testing Facilities

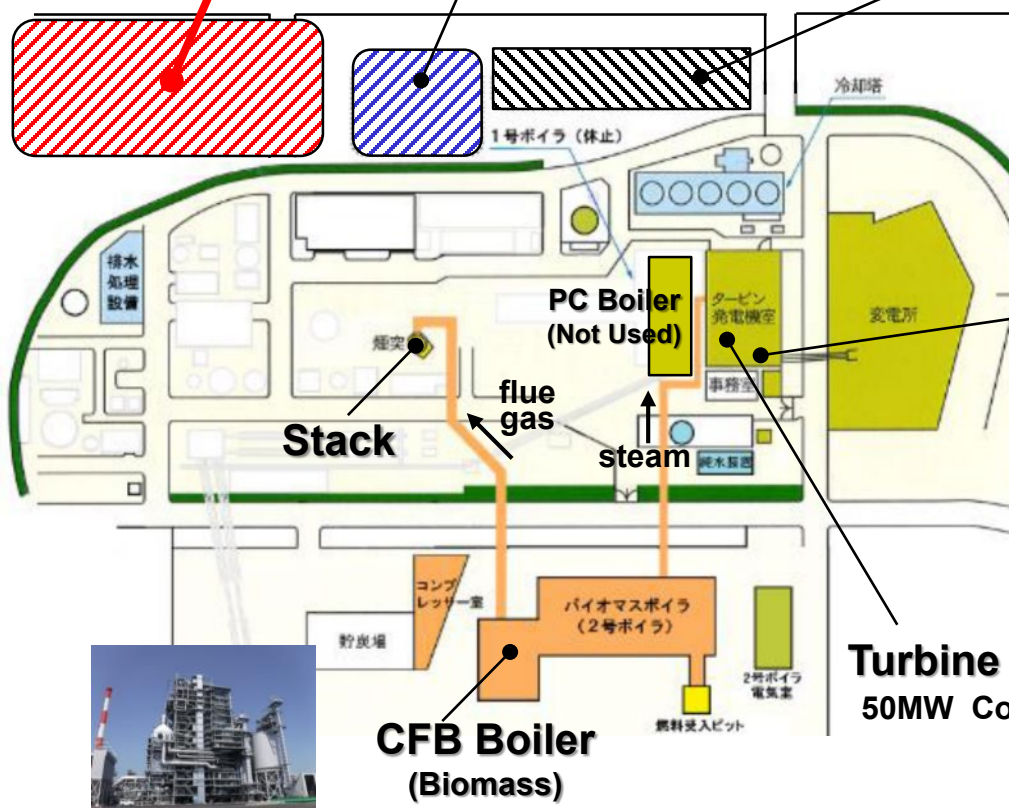
CO₂ Capture Demonstration Plant

Constructed under the Ministry of the Environment Project



PCC Pilot Plant

Toshiba owned



Turbine No.2

Full Size Steam Turbine Test Facility



IoT Server

Data Collection & Remote monitoring

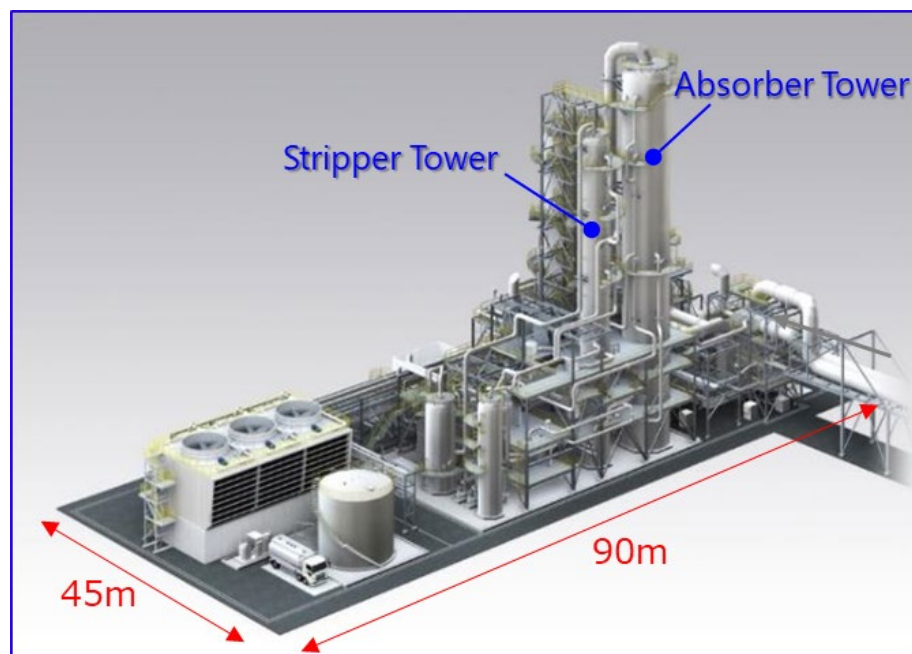
Turbine No.1

50MW Commercial

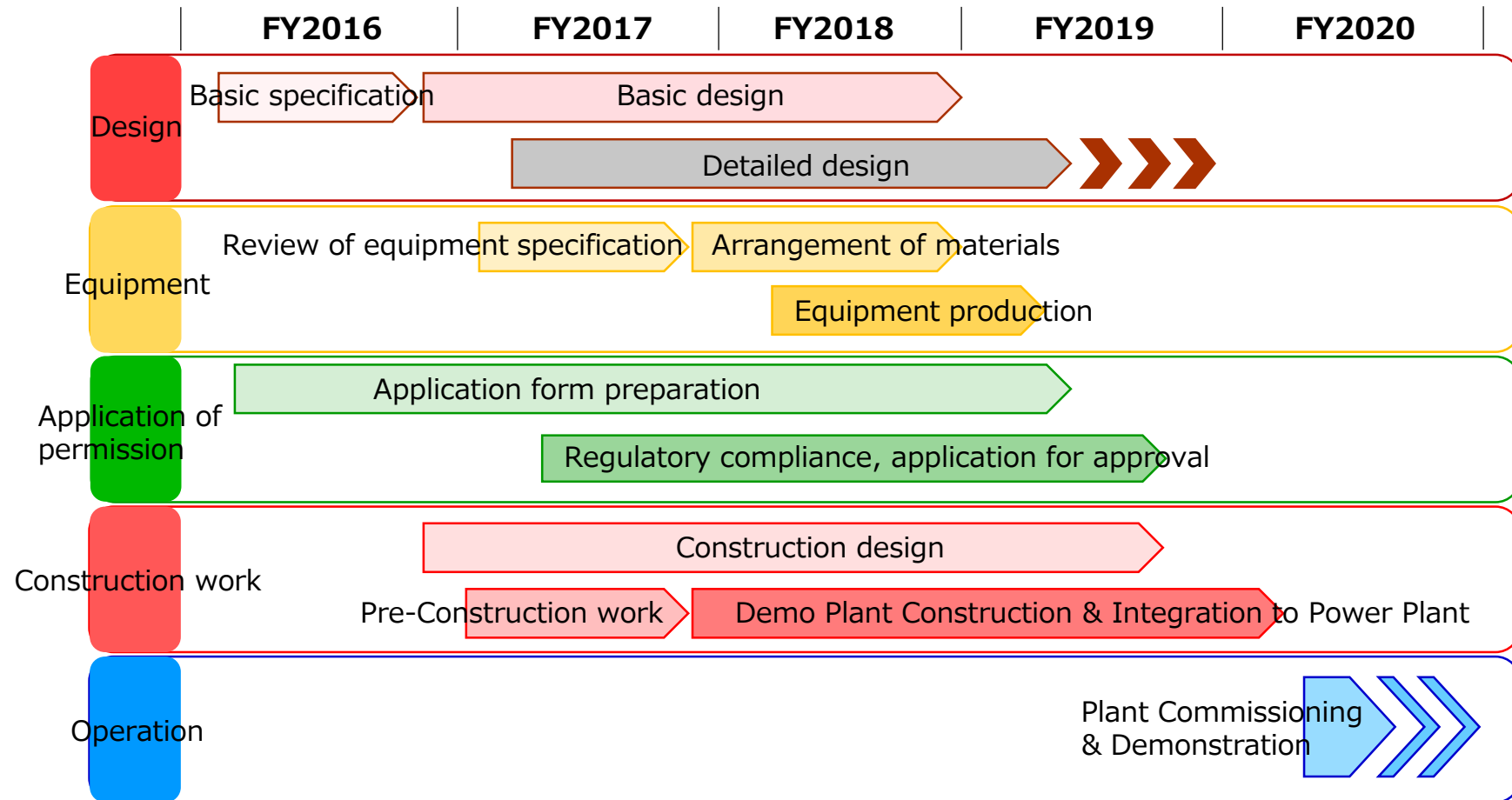
CO₂ Capture Demonstration Plant – Features

- ◆ Captures more than 500 tons-CO₂/day from Mikawa Power Plant.
(more than 50% of its total emissions)
- ◆ Fully integrated with the Power Plant, with turbine extraction steam feeding the energy for desorbing CO₂ at the stripper tower.
- ◆ The Mikawa Power Plant has a boiler burning 100% biomass.
This project has the potential to be one of the first BECCS project in the world.

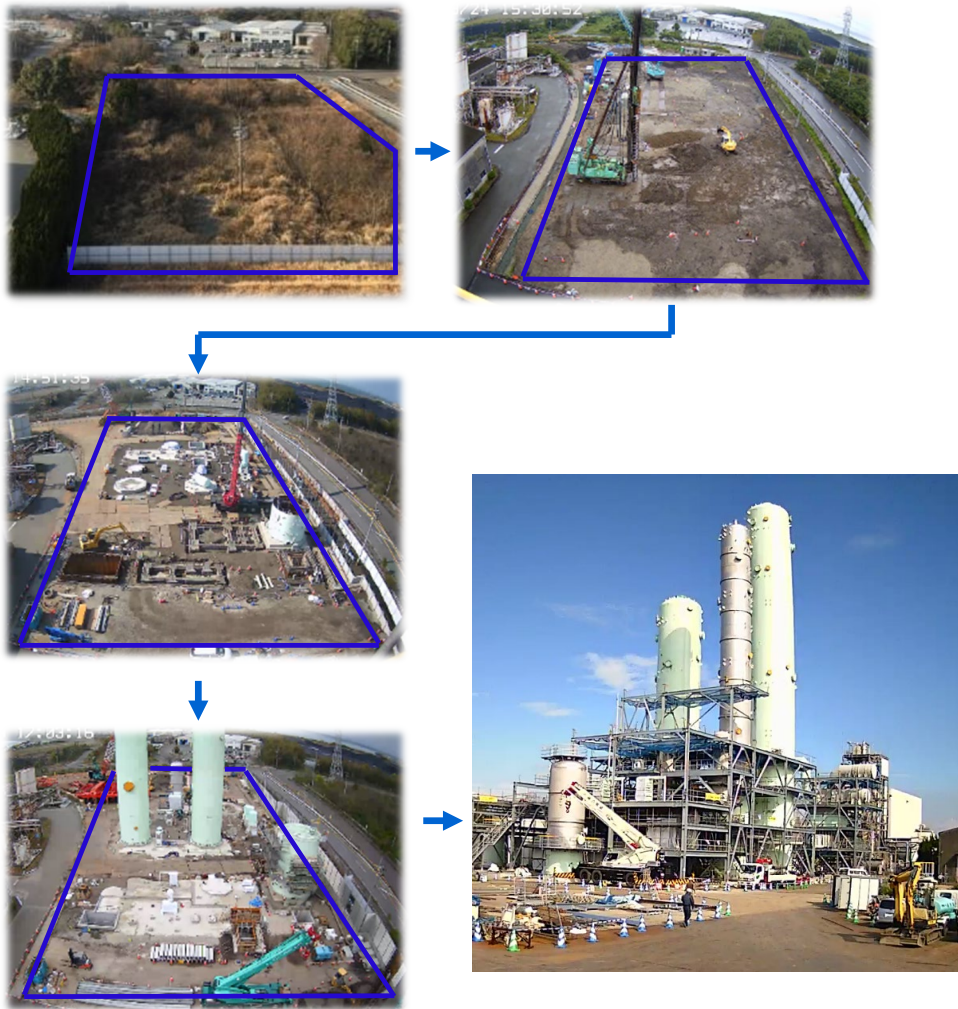
※BECCS: Bio-Energy with CCS



CO₂ Capture Demonstration Plant – Schedule



CO₂ Capture Demonstration Plant – Construction

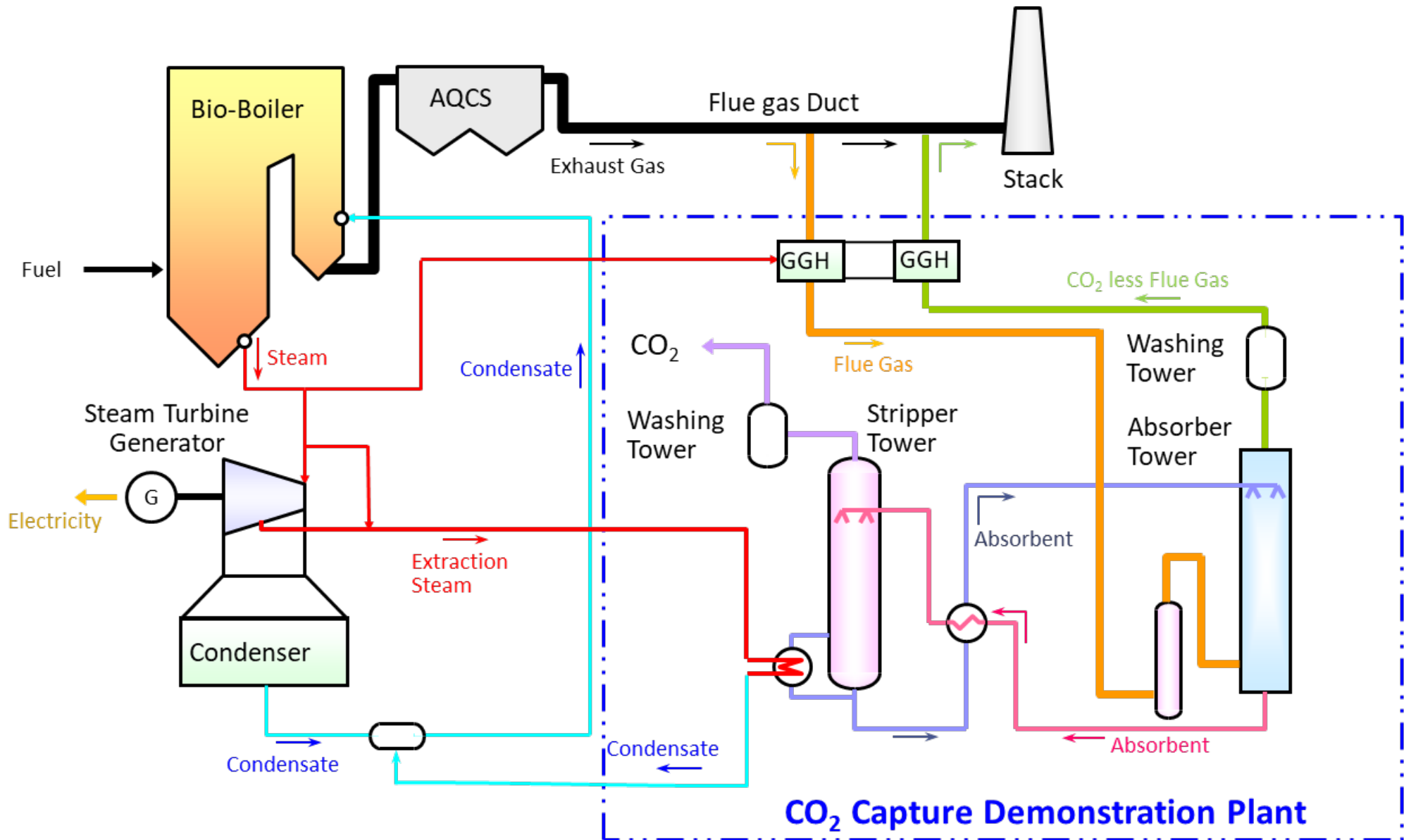


Present Status

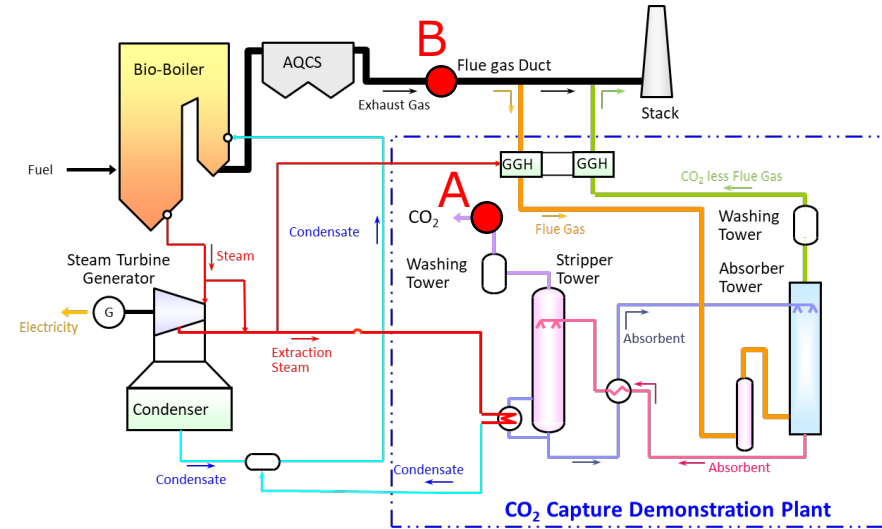
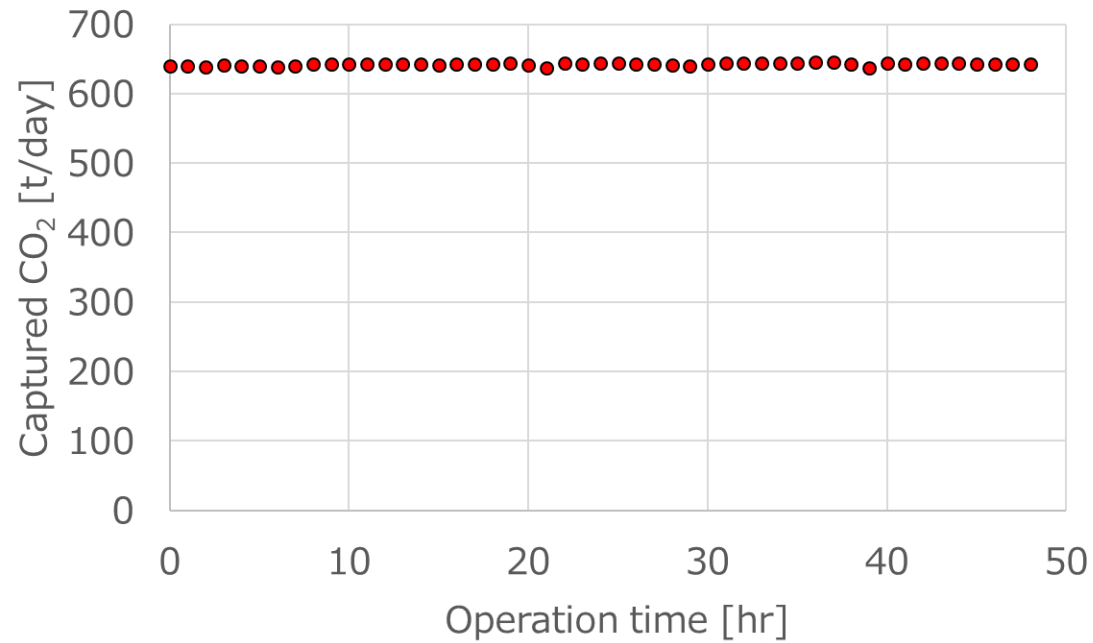


Video

CO₂ Capture Demonstration Plant – Stable Operation (1)



CO₂ Capture Demonstration Plant – Stable Operation (2)



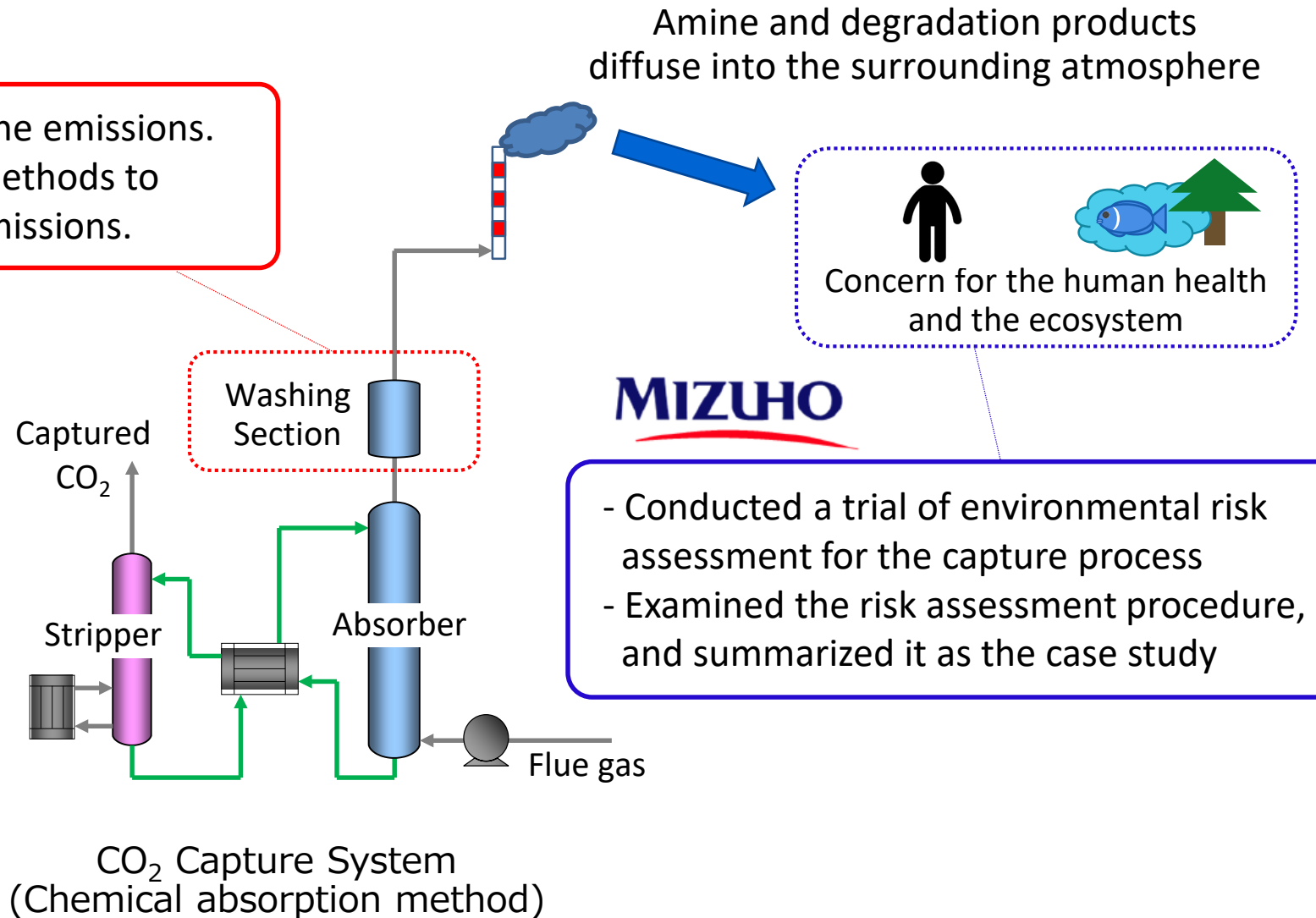
Average value in 48hrs operation

- Captured CO₂ : 640ton/day (··· A)
- Capture ratio : 54% (··· A/B*100)

CO₂ Capture Demonstration Plant – Amine Emission (1)

TOSHIBA

- Evaluation of amine emissions.
- Investigation of methods to mitigate amine emissions.



MIZUHO

- Conducted a trial of environmental risk assessment for the capture process
- Examined the risk assessment procedure, and summarized it as the case study

CO₂ Capture Demonstration Plant – Amine Emission (2) … Emission Mitigation_1

2015～2017 : 「Understanding emission phenomenon」

Characterization of amine emissions

Location : Mikawa Pilot Plant

Treated gas : Flue gas from Mikawa Power Plant



2017～2018 : 「Technology development」

Evaluation of new mitigation method of amine emissions

Location : Bench Scale Test Plant

Treated gas : Simulated gas at the absorber outlet in Mikawa Pilot Plant



2018～2020 : 「Demonstration」

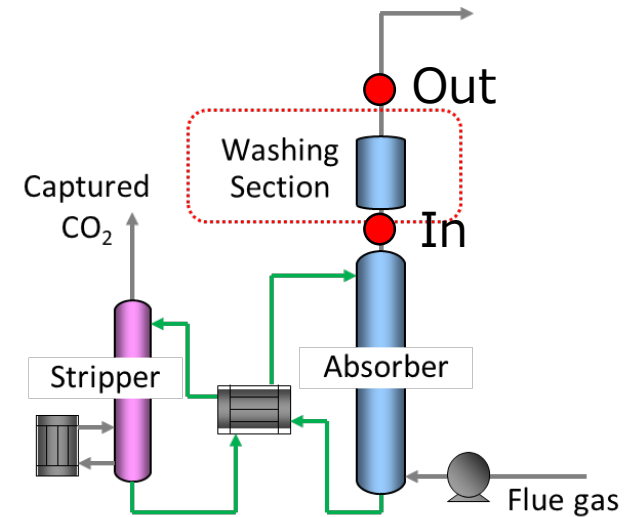
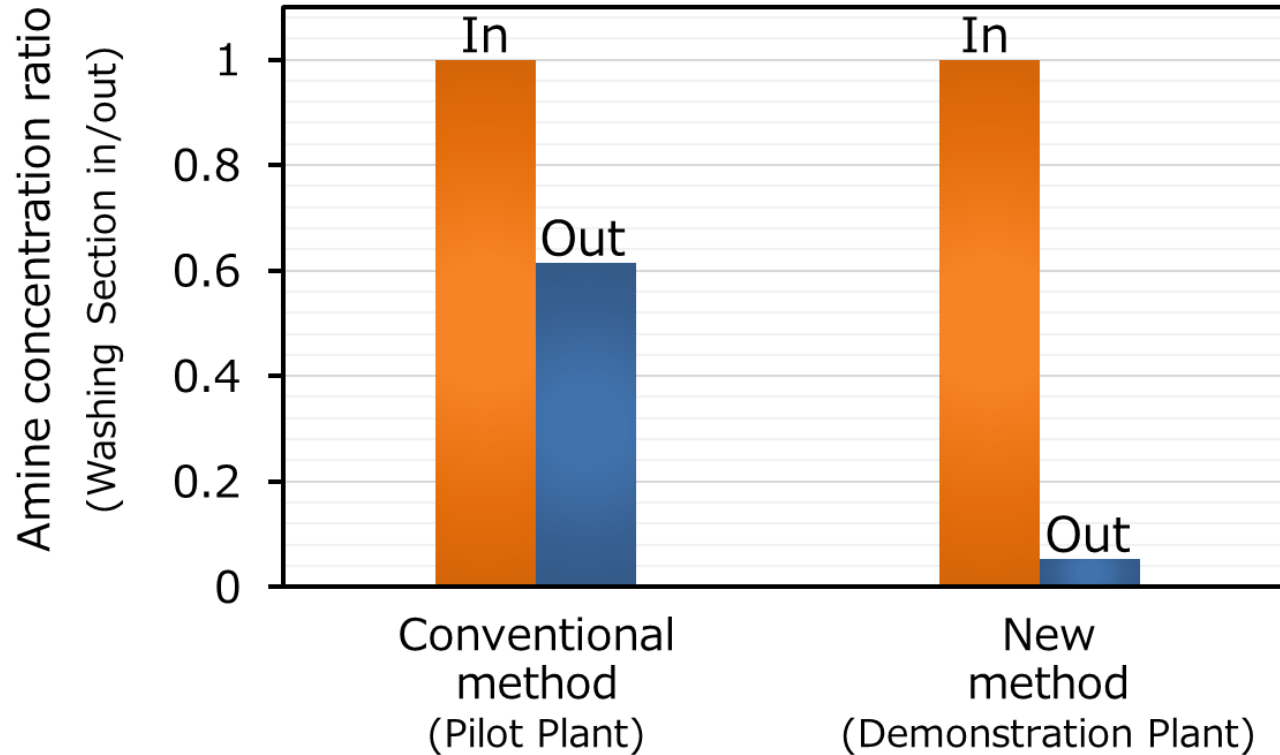
Installation of new mitigation method of amine emissions
/ Measuring amine emissions

Location : Demonstration Plant

Treated gas : Flue gas from Mikawa Power Plant

CO₂ Capture Demonstration Plant

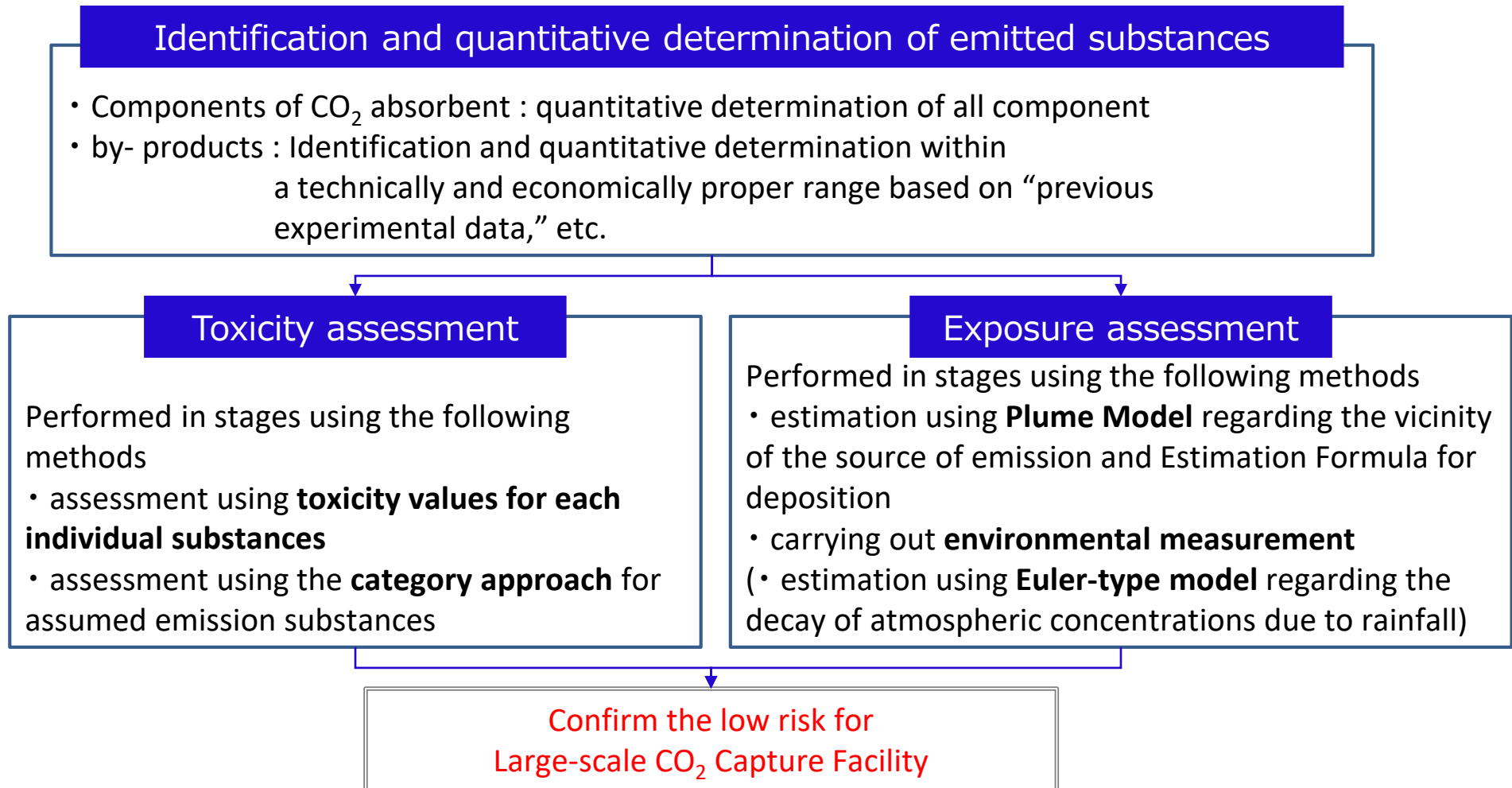
- Amine Emission (2) ... Emission Mitigation_2



CO₂ Capture Demonstration Plant

– Amine Emission (3) ··· Risk assessment

Risk assessment procedure



03

Transport, Storage, Policies and measures

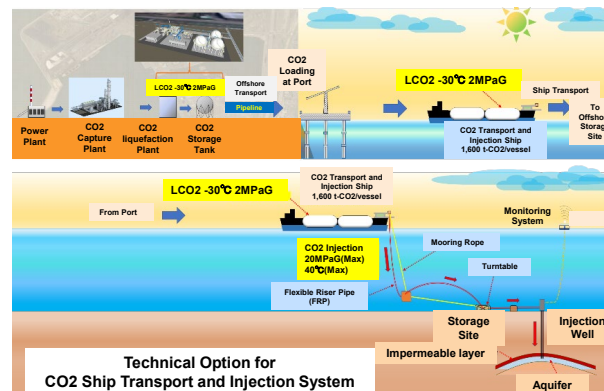
Transport : Study of the transportation of captured CO2 and Injection System

Project Partner :     

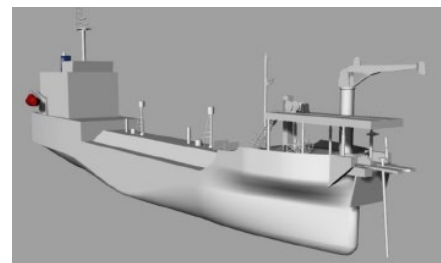
Theme	2016	2017	2018	2019	2020
Evaluation of transportation costs in integrated Systems	<ul style="list-style-type: none"> Study for technical issues related to CO2 transport and countermeasures 		<ul style="list-style-type: none"> Study of transport scenarios 	<ul style="list-style-type: none"> Screening of scenarios 	<ul style="list-style-type: none"> Basic concept for demonstration of CCS integrated system
Evaluation of future transportation costs	<ul style="list-style-type: none"> Study for the combination of sources & sinks and select the transport models 		<ul style="list-style-type: none"> Transport model rationalization and countermeasure proposal 		<ul style="list-style-type: none"> Transport model concept for future commercial phase
Study of CO2 transportation overseas					<ul style="list-style-type: none"> Study of CO2 transportation overseas

Results

- Multiple transportation scenarios were considered and cost evaluation were performed based on feasible scenarios in demonstration phase.
- Scheduled to obtain Approval in Principle (AIP) for demonstration Ship.
- A transportation system for large-scale commercialization was examined and a cost evaluation was carried out.
- Research on CO2 transport overseas was conducted.



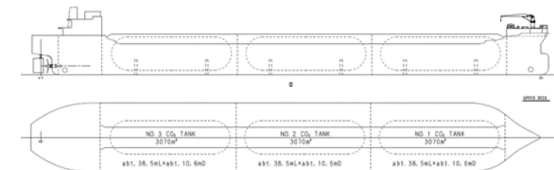
CO2 Ship Transport and Injection System



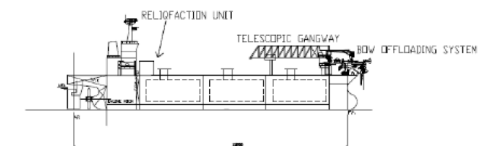
CO2 transport / injection vessel image for Approval in Principal (AIP)



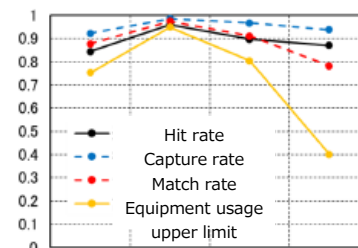
Aquarium test of offshore facility for injection



Large transport / injection vessel with SAL system



10,000t CO2 transport vessel



Examination of capacity factor based on weather forecast

Storage :

Study of leakage prevention and remediation technology for CO2 stored under the seabed

Project Partner :

MITSUBISHI MATERIALS



電力中央研究所
Central Research Institute
of Electric Power Industry

Mitsubishi Corporation Exploration



DIA CONSULTANTS

JANUS
JAPAN NUS CO., LTD.

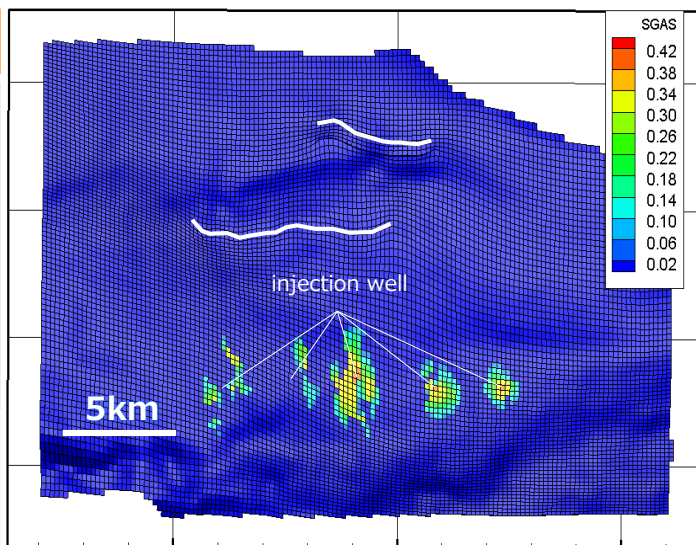


THE UNIVERSITY OF TOKYO

Theme	2016	2017	2018	2019	2020
Draft CO2 Leakage Control and Repair Methods, and Consider Subsurface Facility	<ul style="list-style-type: none"> Storage performance assessment method referencing overseas data, etc. Consider CO2 leakage control and repair measures 		<ul style="list-style-type: none"> Establish a risk assessment method Optimization of well positioning referencing data including "CO2 storage site research project" Consider CO2 leakage control and repair measures 		
Verifying carbon dioxide hydrate formation	<ul style="list-style-type: none"> Develop technologies to assess CO2 permeability, refine permeability reduction models 		<ul style="list-style-type: none"> Assess hydrate layer formation and CO2 permeability in conditions identical to those under the sea floor 		
Research on carbon dioxide monitoring methods	<ul style="list-style-type: none"> Tests including comparison of monitoring methods Comparative and other monitoring method tests 		<ul style="list-style-type: none"> Demonstration and assessment of monitoring methods Monitoring method verification/assessment 		<ul style="list-style-type: none"> Consider practical application Practical application tests

Results

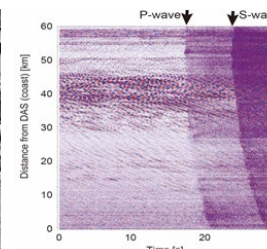
- The engineering technology and system required for subseafloor storage was shown, and a system was established to start development as soon as a candidate storage site was decided.
- Practical monitoring plans and system construction were carried out by verifying monitoring methods and technologies.



CO2 saturation distribution in large-scale cases
(40 years after the start of injection)
(ENVCCS 2019)



Continuous monitoring source device



Examples of natural earthquakes recorded by distributed acoustic sensing (DAS)



Sensor installed on the seabed



Underwater drone equipment set and pH sensor

Policies and measures : Development of Strategies for Enabling CCS in Japan

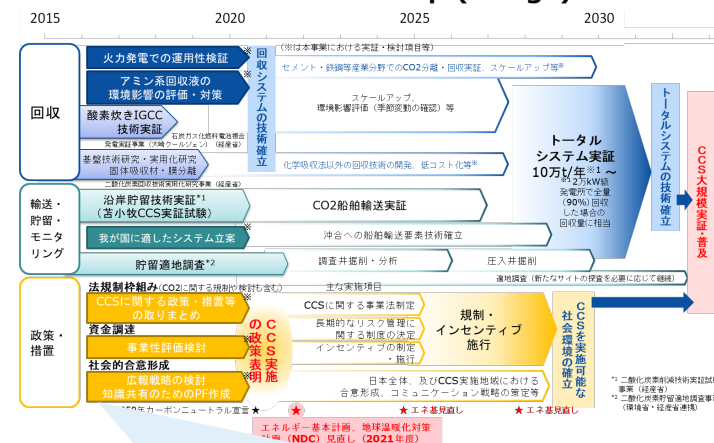


Theme	2016	2017	2018	2019	2020
Policies and measures	<ul style="list-style-type: none">• Study on technical issues of Capture Ready concept• Study on CCS branding and communication strategy• Design of Knowledge Management System (KMS) and CCS portal site• Study on CCUS accounting guideline	<ul style="list-style-type: none">• Economic analysis of power plants under various capture ready scenarios• Scenario analysis on CCS introduction into power sector• Study on policy and measures to enable and facilitate CCS deployment in the society• Development of communication plan for consensus building on CCS• Development and proposal of possible schemes for the early implementation of CCS and identification of necessary policy and measures.• Development of contents for the KMS and communication tools• Development of CCU accounting guideline through case studies	<ul style="list-style-type: none">• Development of a CCUS accounting guideline and case study on BECCS.• Preparation of a communication strategy and tools for consensus building.		
Roadmap for CCS deployment in Japan	<ul style="list-style-type: none">• Examination of items of the roadmap• Drafting the first version of the roadmap	<ul style="list-style-type: none">• Elaboration of a pathway that takes into account technological and social constraints, as well as policy developments related to climate change.	<ul style="list-style-type: none">• Proposal of the roadmap• Economic analysis on the demonstration and a commercial CCS system.		

Results

- The value of CCS was appraised based on energy and electricity supply and demand scenario analysis, research on stakeholder opinions, and branding workshops, etc.
- An overarching communication strategy to accommodate diversified view of stakeholders was developed.
- CCS Knowledge Management System and a portal platform were developed for consensus building.
- Possible schemes for the early introduction of CCS in Japan was proposed.
- CCUS accounting guidelines with case studies on various CCU technologies and BECCS were developed.
- The roadmap plan which consisted of the flow of the CCS implementation for 2050 and the flow of technology development and demonstration by 2030 was proposed.
- The costs of the demonstration project and future large-scale CCS projects were estimated.

<Draft of roadmap (Image)>



The flow of technology development and demonstration for capture, transport, storage, and policies and measures up to 2030 was materialized.

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Thank you for your attention !

